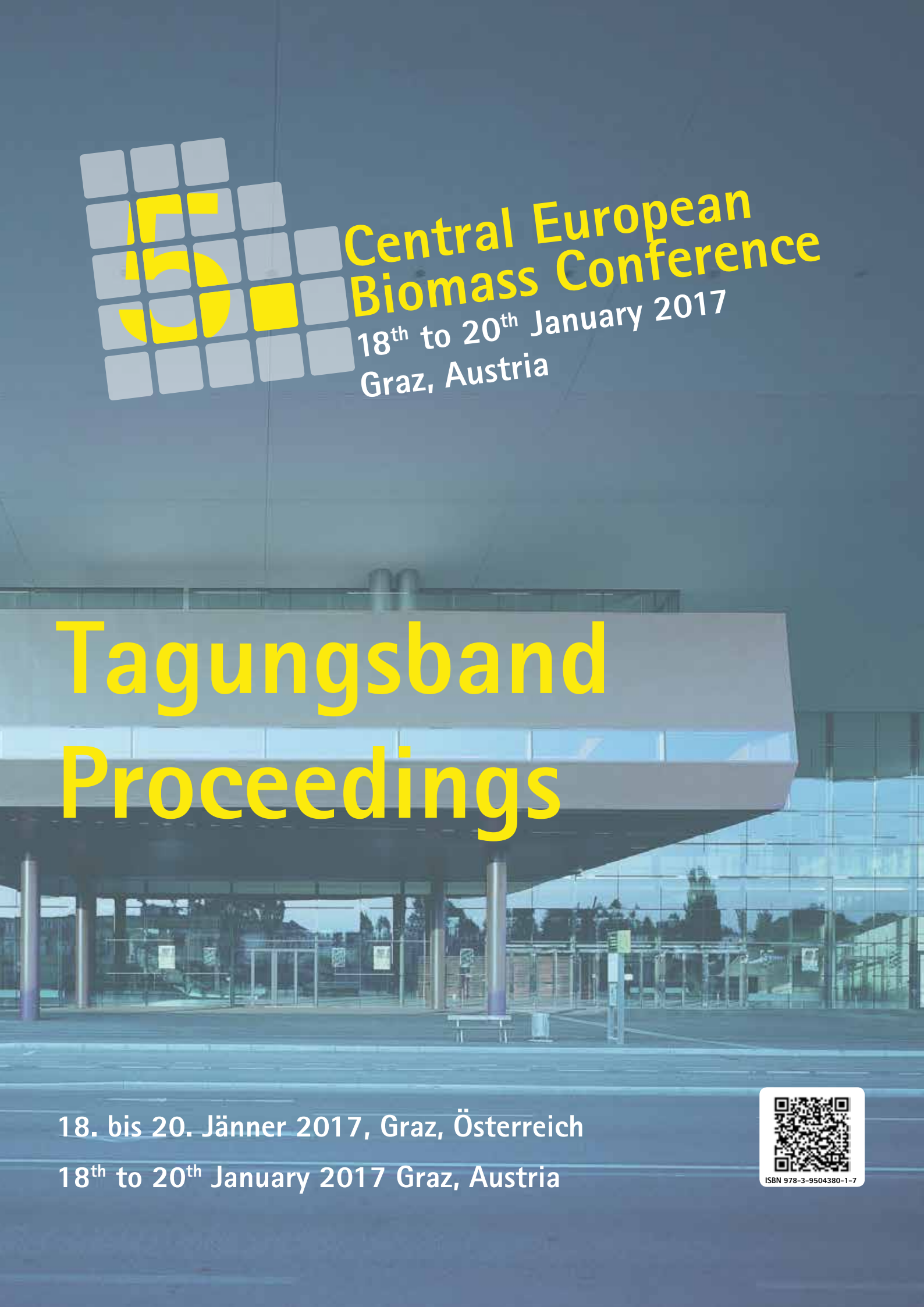

Central European Biomass Conference

18th to 20th January 2017

Graz, Austria

Tagungsband Proceedings

18. bis 20. Jänner 2017, Graz, Österreich

18th to 20th January 2017 Graz, Austria

ISBN 978-3-9504380-1-7

5. Mitteleuropäische Biomassekonferenz

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Bioenergie ist die Basis für einen erfolgreichen Weltklimavertrag

Bioenergie in Mitteleuropa ist ein Erfolgsrezept, das forciert und weltweit ausgerollt werden kann. Die regionale Nutzung von Biomasse reduziert CO_2-Emissionen, Kaufkraftabfluss sowie die Abhängigkeit von fossilen Brennstoffen und schafft zusätzliche Arbeitsplätze. Die Mitteleuropäische Biomassekonferenz hat den Anspruch, Protagonisten aus allen Bereichen der regionalen Bioenergienutzung zusammenzuführen und basierend auf den bisherigen Erfahrungen und aktuellen technologischen Entwicklungen neue Impulse für die Energiewende zu setzen.

Vielzahl an Gewinnern

17 % der in Österreich eingesetzten Energie und 57 % der erneuerbaren Energien basieren mittlerweile auf Biomasse. Haushalte und Gewerbe konnten ihre Energierechnung in den vergangenen Jahren durch den Einsatz von Brennholz, Hackgut und Pellets nahezu halbieren, die Holzindustrie ihren CO_2-Fußabdruck und ihre Energiekosten mit dem Einsatz von Rinde und Lauge stark reduzieren und ihr Produktportfolio durch Pellets, Briketts und erneuerbaren Strom erweitern. Die Forstwirtschaft intensiviert dank der Einnahmen aus bisher schwächer nachgefragten Holzsortimenten Waldpflege- und Forstschutzmaßnahmen. KWK-Anlagen leisten einen zentralen Beitrag für die Strom- und Fernwärmeerzeugung. Mit der Produktion von Biotreibstoffen ist es gelungen, eine sinnvolle Verwertungsmöglichkeit für Agrarüberschüsse zu schaffen und die Importabhängigkeit von Eiweißfuttermitteln zu reduzieren.

Leitveranstaltung des Bioenergiesektors

Mit mehr als 1100 Teilnehmern aus allen Kontinenten ist die im Dreijahresrhythmus ausgerichtete Mitteleuropäische Biomassekonferenz eine der führenden Branchenveranstaltungen weltweit und die Leitveranstaltung der mitteleuropäischen Bioenergiebranche. Die zeitgleich stattfindende „Häuslbauer"-Messe mit rund 40.000 Besuchern und einem traditionellen Schwerpunkt auf der Energiebereitstellung im Gebäudesektor bietet dazu eine hervorragende Ergänzung.

Als Highlights der **5. Mitteleuropäischen Biomassekonferenz** sind Veranstaltungen der Internationalen Energieagentur und des Weltbiomasseverbandes geplant, besondere Schwerpunkte werden auf die folgenden Bereiche gelegt:

- Nachhaltigkeit auf regionaler und nationaler Ebene sowie bei verschiedenen Wertschöpfungsketten
- Netze und Hybridsysteme auf Basis moderner Biomassefeuerung und Feuerungssysteme mit niedrigsten Emissionen
- Neue Technologien für die Bioökonomie
- Politik, Märkte und Konsumentenverhalten
- Wärme und Strom aus Biomasse
- Brennstoffcharakterisierung und Qualitätssicherung

Ein umfangreiches Exkursionsprogramm und ein Industrieforum spannen den Bogen von der Theorie zur Praxis. Den Bereichen Biogas und Pellets werden eigene Branchentage gewidmet. Ein umfangreiches Rahmenprogramm mit Social Events sowie einer Matchmaking-Veranstaltung bietet ausreichend Raum für Vernetzung.

Wir freuen uns darauf, Sie bei der **5. Mitteleuropäischen Biomassekonferenz** begrüßen zu dürfen.

Josef Plank
Vorsitzender des Organisationskomitees, Präsident ÖBMV

Andrä Rupprechter
Bundesminister für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft

Hermann Hofbauer
TU Wien, Vorsitzender des Wissensch. Komitees

Ingmar Höbarth
Geschäftsführer Klima- und Energiefonds

Bioenergy as a basis for a successful World Climate Treaty

The World Climate Treaty – a tremendous opportunity for the biomass industry. Bioenergy in central Europe is a recipe for success for households, businesses, the environment, the timber industry, agriculture and forestry and municipalities – a recipe that may be stepped up and rolled out around the world. The regional use of biomass helps to cut CO_2 emissions, the reduction of purchasing power and dependence on fossil fuels; it also creates additional jobs. The Central European Biomass Conference intends to bring all protagonists together from all the sectors where bioenergy is employed regionally and to generate new impetus for the energy transition on the basis of previous experiences and current technological developments.

Many winners

17 % of the energy used in Austria and 57 % of renewable energies are created with biomass. Households and businesses have in recent years been able to almost halve their energy bills through the use of firewood, woodchips and pellets while the timber industry has been able to significantly reduce its carbon footprint and energy costs by utilizing bark and lye and extend its product range through the introduction of pellets, briquettes and renewable electricity. The forestry sector has – thanks to revenues generated from types of wood with previously weaker demand – been able to intensify its forest-management and -protection measures.

The bioenergy sector's leading event

With more than 1,100 participants from all over the world, the three-yearly Central European Biomass Conference is one of the world's leading industrial meetings and the top event for the bioenergy sector in central Europe.

The 'Home Building' trade fair, which will be taking place at the same time and which is expecting around 40,000 visitors to attend, traditionally focuses on energy provision in the building sector and is a great event to complement the conference.

Planned highlights of the **5th Central European Biomass Conference** include events organized by the International Energy Agency and the World Bioenergy Association. The 5th Central European Biomass Conference is staying abreast of these developments by focusing its efforts for 2017 particularly on the following aspects:

- Sustainability at regional and national scale and sustainability considerations for different value chains
- Biomass-combustion-based grids and hybrid systems and lowest-emission biomass combustion systems
- Advanced technologies for the realization of a biobased economy
- Policies, markets and consumer attitudes
- Heat and electricity from biomass
- Fuel characterization and quality assurance

The gap between theory and practice is to be bridged by an extensive programme of excursions and an industrial forum. Separate industry days will be dedicated to the fields of biogas and pellets. Sufficient scope for networking will be created by an extensive accompanying programme with social meetings and a matchmaking event.

We are looking forward to welcoming you to the **5th Central European Biomass Conference.**

Josef Plank
Chairman of the Organising Committee, President ABA

Andrä Rupprechter
Federal Minister for Agriculture, Forestry, Environment and Water Management

Hermann Hofbauer
TU Wien, Chairman of the Scientific Committee

Ingmar Höbarth
Managing Director of the Climate and Energy Fund

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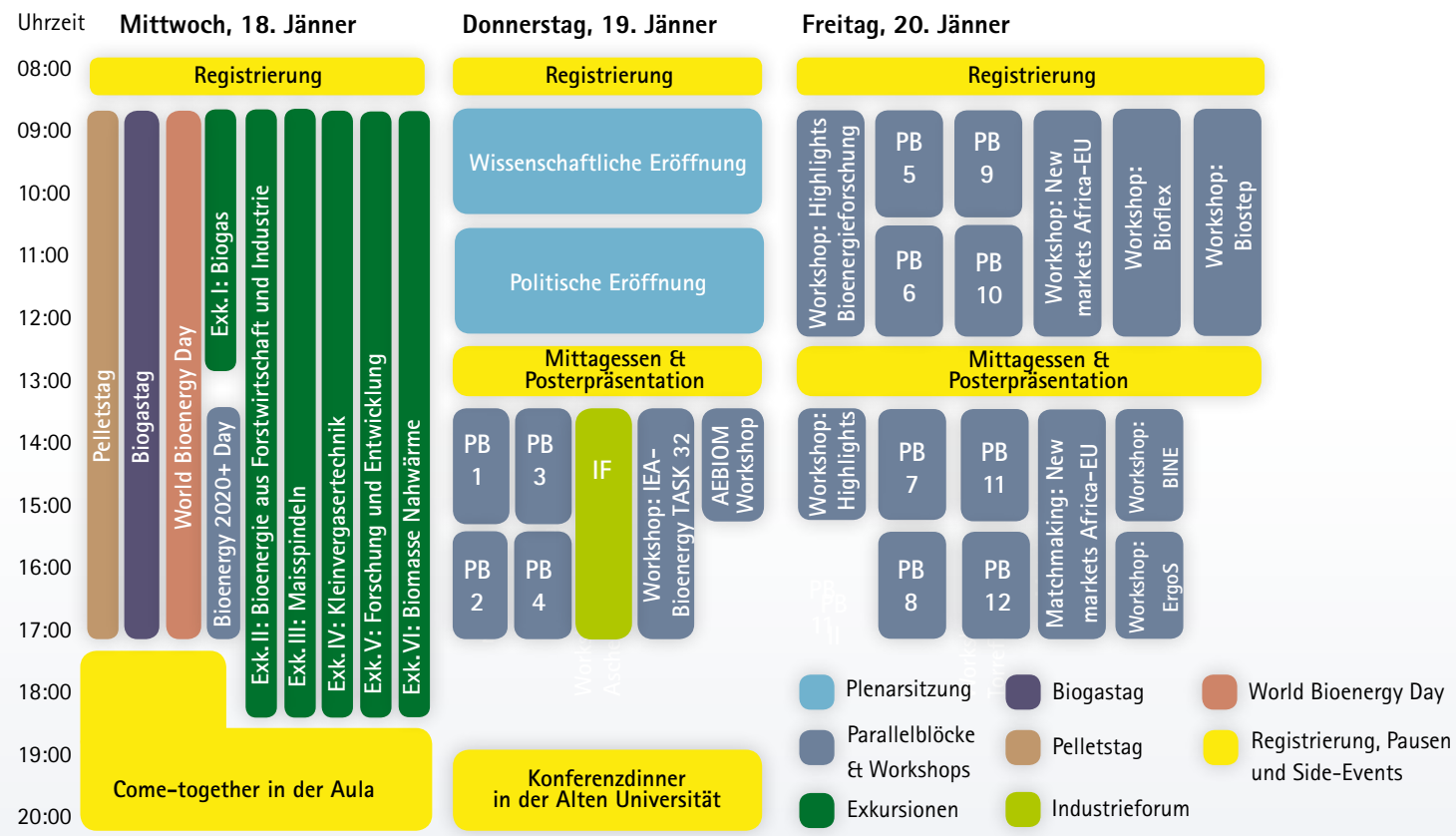
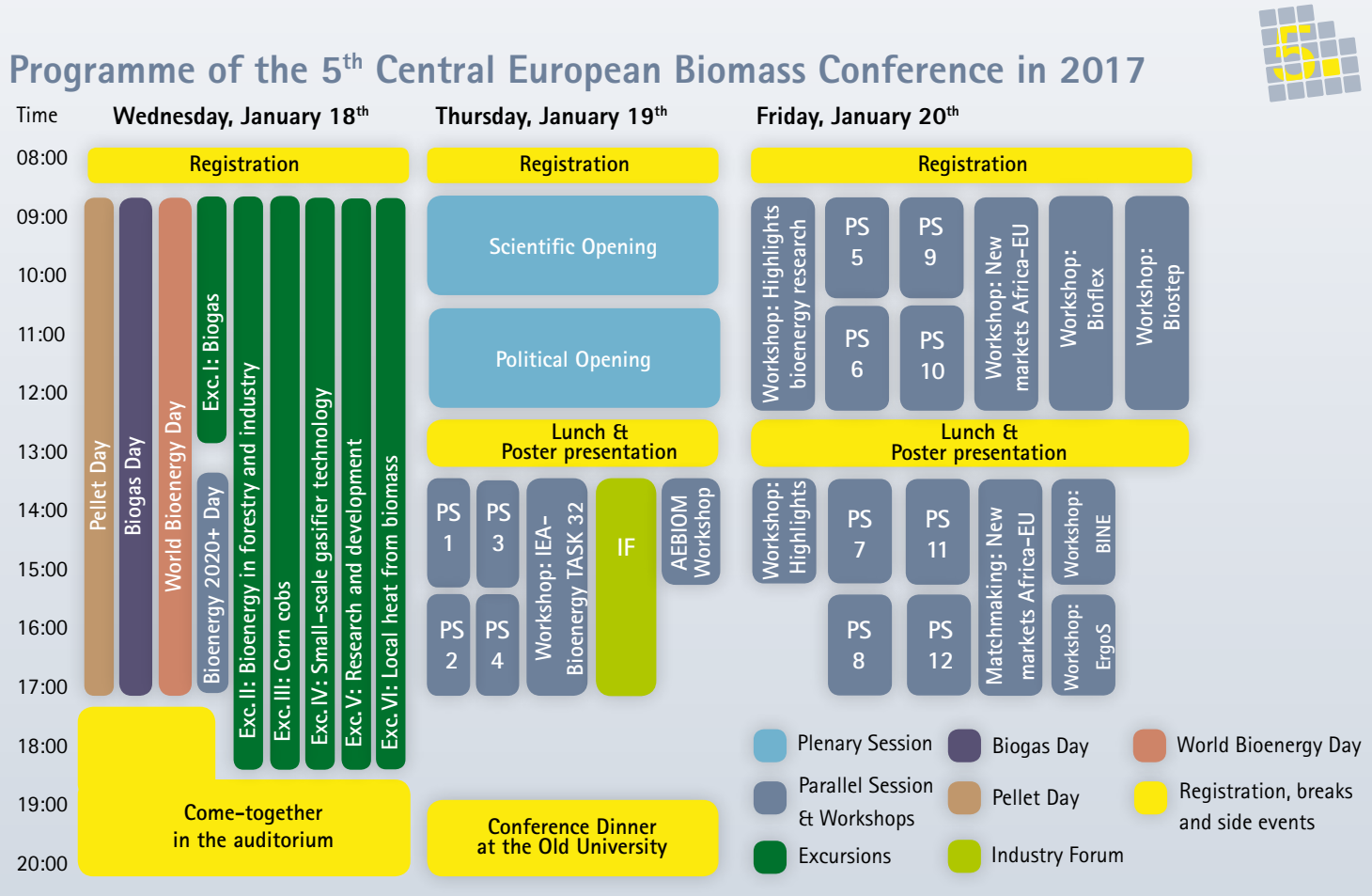
Programm der 5. Mitteleuropäischen Biomassekonferenz 2017



Programme of the 5th Central European Biomass Conference in 2017



Programmübersicht

Mittwoch 18 Jänner

08:00–09:00 **Registrierung**

08:00–12:30 **Exkursion I**

08:00–18:30 **Exkursionen II–V**

09:00–17:00 **2. Mitteleuropäischer Pelletstag, Saal 1**

09:00–17:00 **Biogastag, Saal 11**

09:00–17:00 **World Bioenergy Day, Galerie**

13:30–17:00 **Bioenergy 2020+ Day, Saal 12**

ab 17:00 **Come-together**

Donnerstag 19 Jänner

08:00–09:00 **Registrierung**

09:00–12:30 **Plenarsitzung, Saal 1**

12:30–13:30 **Mittagspause** und **Posterpräsentation**

13:30–15:00 **PB 1, Saal 11**
Biogas

13:30–15:00 **PB 3, Saal 1**
Brennstoffaufbereitung und -upgrading

15:30–17:00 **PB 2, Saal 11**
Bioökonomie-Systembetrachtungen

15:30–17:00 **PB 4, Saal 1**
Neue Ressourcen, Potenziale & Risikomanagement für Versorgungsketten

13:30–17:00 **Industrieforum, Galerie**

13:30 - 17:00 **AEBIOM Workshop,** Saal 10

13:30 - 17:00 **Workshop:** IEA Bioenergy Task 32 – Praxisnahe Testmethoden für Kleinfeuerungen, **Saal 12**

20:00 **Konferenzdinner**

Freitag 20 Jänner

08:00–09:00 **Registrierung**

09:00–10:30 **PB 5, Saal 1**
Biomassefeuerungssysteme mit niedrigsten Emissionen

09:00–10:30 **PB 9, Galerie**
Brennstoffcharakterisierung und Qualitätssicherung

11:00–12:30 **PB 6, Saal 1**
Netze und Hybridsysteme auf Basis moderner Biomassefeuerung

11:00–12:30 **PB 10, Galerie**
Nachhaltigkeit auf regionaler und nationaler Ebene

12:30–13:30 **Mittagspause** und **Posterpräsentation**

13:30–15:00 **PB 7, Saal 1**
Strom und Wärme aus Biomasse

13:30–15:00 **PB 11, Galerie**
Nachhaltigkeitsbetrachtungen verschiedener Wertschöpfungsketten

15:30–17:15 **PB 8, Saal 1**
Technologien für die biobasierte Ökonomie

15:30–17:00 **PB 12, Galerie**
Politik, Märkte und Konsumentenverhalten

09:00–15:00 Highlights der Bioenergieforschung 2017, **Saal 12**

09:00–12:30 **Workshop:** New Markets: Africa meets EU, **Saal 10**

13:30–17:00 **B2B-Matchmaking:** New Markets: Africa meets EU, **Saal 1a**

09:00–12:30 **Workshop:** Bioflex, **Saal 11a**

13:30–15:00 **Workshop:** BINE, **Saal 11a**

09:00–12:30 **Workshop:** Biostep, **Saal 11b**

15:30–17:00 **Workshop:** ErgoS, **Saal 11a**

Programme overview

Wednesday 18 January

08:00–09:00 am **Registration**

08:00 am–12:30 pm **Excursion I**

08:00 am–06:30 pm **Excursions II–V**

09:00 am–05:00 pm **2nd Central European Pellet Day, Room 1**

09:00 am–05:00 pm **Biogas Day, Room 11**

09:00 am–05:00 pm **World Bioenergy Day, Galerie**

01:30–05:00 pm **Bioenergy 2020+ Day, Room 12**

from 05:00 pm **Come-together**

Thursday 19 January

08:00–09:00 am **Registration**

09:00 am–12:30 pm **Plenary session, Room 1**

12:30–01:30 pm **Lunch** and **Poster presentation**

01:30–03:00 pm **PB 1, Room 11**
Biogas

01:30–03:00 pm **PB 3, Room 1**
Fuel pretreatment and upgrading

03:30–05:00 pm **PB 2, Room 11**
Bioeconomy – system considerations

03:30–05:00 pm **PB 4, Room 1**
New resources, potentials and supply chain risk management

01:30–05:00 pm **Industry Forum, Galerie**

01:30 - 05:00 pm **AEBIOM Workshop,** Room 10

01:30 - 05:00 pm **Workshop:** IEA Bioenergy Task 32 – practical test methods for small-scale furnaces, **Room 12**

08:00 pm **Conference dinner**

Friday 20 January

08:00–09:00 am **Registration**

09:00–10:30 am **PB 5, Room 1**
Lowest emission biomass combustion systems

09:00–10:30 am **PB 9, Galerie**
Fuel characterization and quality assurance

11:00 am–12:30 pm **PB 6, Room 1**
Biomass combustion based grids and hybrid systems

11:00 am–12:30 pm **PB 10, Galerie**
Sustainability at regional and national scale

12:30–01:30 pm **Lunch** and **Poster presentation**

01:30–03:00 pm **PB 7, Room 1**
Heat and electricity from biomass

01:30–03:00 pm **PB 11, Galerie**
Sustainability considerations for different value chains

03:30–05:00 pm **PB 8, Room 1**
Technologies for a biobased economy

03:30–05:00 pm **PB 12, Galerie,** Policies, markets and consumer attitudes

09:00 am–03:00 pm Highlights of bioenergy research 2017, **Room 12**

09:00 am–12:30 pm **Workshop:** New Markets – Africa meets EU, **Room 10**

01:30–05:00 pm **B2B-Matchmaking:** New Markets Africa meets EU, **Room 1a**

09:00 am–12:30 pm **Workshop:** Bioflex, **Room 11a**

01:30–03:00 pm **Workshop:** BINE, **Room 11a**

09:00 am–12:30 pm **Workshop:** Biostep, **Room 11b**

03:30–05:00 pm **Workshop:** ErgoS, **Saal 11a**

POLYTECHNIK Luft- und Feuerungstechnik GmbH

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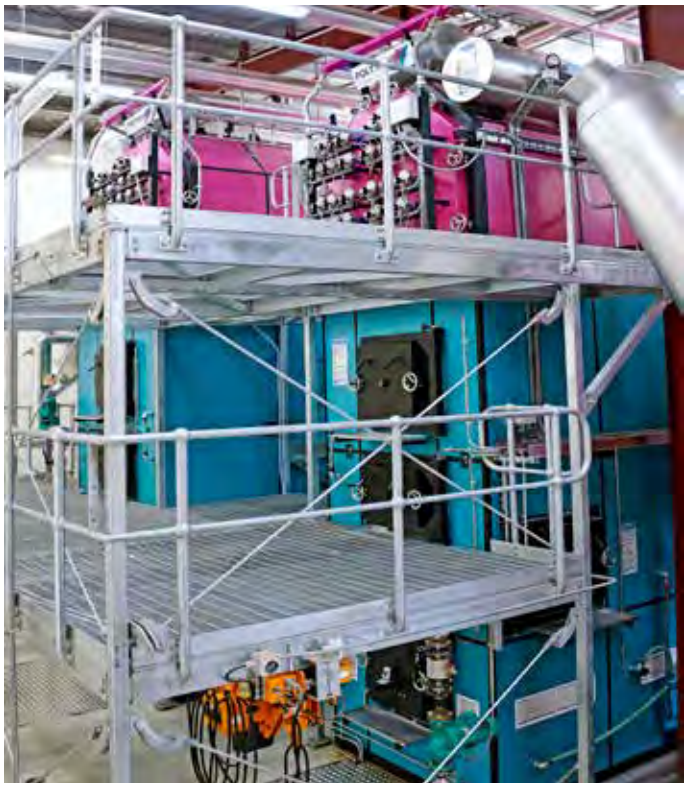

The Austrian company, Polytechnik Luft-und Feuerungstechnik GmbH, is one of the most distinguished providers of firing systems for biological fuels and is well-known for designing and supplying turn-key systems. Its current export rate is more than 98 %.

The company provides these firing systems with a power range of 300 kW – 30,000 kW (single boiler output). Different firing systems, such as underfeed systems, underfeed combustion stokers and reciprocating stokers, are used, depending on the type and water content of the fuel. The medium carriers are warm water, hot water, steam and thermal oil.

The systems may be used for heating and process heating as well as for generating electricity (steam and ORC processes). Capacity ranges from 200 kW to 20,000 kW electrical power (current).

There are already more than 3,000 Polytechnik systems in operation globally.

In other industries and in the municipal sector, local and district heating plants are offered alongside the firing systems and combined heat and power plants. The company's broad service network facilitates top quality and highly efficient customer care.

Die österreichische Firma „Polytechnik Luft-und Feuerungstechnik GmbH" ist einer der bedeutensten Anbieter von Feuerungsanlagen für biogene Brennstoffe und ist bekannt für die Planung und Lieferung von schlüsselfertigen Anlagen. Die Exportrate beträgt derzeit über 98 %.

Das Unternehmen bietet diese Feuerungsanlagen in einem Leistungsbereich von 300 kW – 30.000 kW (Einzelkesselleistung) an. Je nach Art und Wassergehalt des Brennstoffes werden verschiedene Feuerungssysteme (System Unterschub, Unterschub-Ausbrandrost und Vorschubrost) eingesetzt. Medienträger sind Warmwasser, Heißwasser, Dampf oder Thermoöl.

Die Anlagen können für Heizungs- und Prozess-wärme sowie für die Stromerzeugung (Dampf- und ORC- Prozess) eingesetzt werden. Der Leistungsbereich reicht hierbei von 200 kW – 20.000 kW elektrische Leistung (Strom).

Weltweit sind bereits über 3.000 Polytechnik- Anlagen im Einsatz.

In der allgemeinen Industrie sowie im kommunalen Bereich werden neben den Feuerungs- und Kraft-Wärme-Kopplungsanlagen auch Nah- und Fernwärmeanlagen angeboten. Das weit verzweigte Servicenetz des Unternehmens ermöglicht eine optimale und rasche Kundenbetreuung.

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Messe Congress Graz: Floor plan

The rooms for the **5th Central European Biomass Conference** are located in the 1st floor of the Messe Congress Graz. After the registration at the main entrance you will reach the conference rooms through the escalator right next to the registration.

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Programm Teil 1

Programme Part 1

2. Mitteleuropäischer Pelletstag, Saal 1, 9:00 – 17:00

Vortragssprache Englisch

Mittwoch 18 Jänner

Pelletsproduktion & -verbrauch in Mittel- und Osteuropa – Zwischenstand und künftige Entwicklung

„In den vergangenen Jahren ist es in Mittel- und Osteuropa zu einer sehr dynamischen Entwicklung bei der Produktion und Nutzung von Pellets gekommen. Der 2. Mitteleuropäische Pelletstag gibt die Möglichkeit, sich einen umfassenden Überblick über die Entwicklungen in dieser Region und auf den internationalen Pelletsmärkten zu verschaffen und mit Experten wie Geschäftspartnern in Kontakt zu kommen."

Chairman: Christian Rakos, Geschäftsführer proPellets Austria

09:00 **Eröffnung**
- Eric Vial, *Präsident European Pellet Council, Belgien*
- Hermann Schultes*, *Präsident der Landwirtschaftskammer Österreich*

09:20 **Der Europäische Pelletsmarkt – Daten und Fakten**
Gilles Gauthier, *Europäischer Biomasseverband (AEBIOM), Belgien*

09:40 **EN Plus Certification – Experiences in Eastern Europe**
Martin Englisch, *BEA Institut für Bioenergie GmbH, Österreich*

10:00 **Europas modernstes Forschungslabor im Bereich Pelletierung**
Martin Weigl, *Holzforschung Austria, Österreich*

10:30 **Kaffeepause**

11:00 **Aktuelle Marktentwicklungen von Pelletsöfen**
Marco Pallazzetti*, *Pallazzetti Lelio S.p.A, Italien*

11:20 **Zukunftsperspektiven für den Pellets-Heizkesselmarkt**
Christian Rakos, *proPellets Austria, Österreich*

11:40 **Pelletsverbrauch in großen Kraftwerken und KWK-Anlagen in Europa**
Arnold Dale, *Ekman & Co, Schweden*

12:00 **Pelletsbrenner – für erneuerbaren industriellen Prozesswärmebedarf**
Björn Forsberg, *World Thermal Service AB, Schweden*

12:30 **Mittagspause**

13:30 **Entwicklung Pelletsproduktion und Pelletskonsum**
- **Serbien und Bosnien**
  Branko Glavonjic, *Universität Belgrad, Serbien*
- **Kroatien**
  Ante Pašalic, *BEA Institut für Bioenergie GmbH, Österreich*
- **Ukraine**
  Georgiy Geletukha*, *SEC Biomass, Ukraine*
- **Baltikum**
  Didzis Palejs, *Latvian Biomass Association, Lettland*
- **Kanada**
  Gordon Murray, *Wood Pellet Association of Canada, Kanada*

15:10 **Kaffeepause**

15:30 **Entwicklung Pelletsproduktion und Pelletskonsum**
- **Italien**
  Annalisa Paniz, *Associazione italiana energie agroforestali, Italien*
- **Deutschland**
  Martin Bentele, *Deutscher Energieholz- und Pellet-Verband e.V., Deutschland*
- **Slowenien**
  Gernot Stadlober, *Stadlober GmbH Brennstoffhandel, Österreich*
- **USA**
  Ben Moxham, *Enviva, Vereinigte Staaten von Amerika*

17:00 **Come-together**

**angefragt*

2nd Central European Pellet Day, Room 1, 09:00 am – 05:00 pm

Language English

Wednesday 18 January

Pellet production & consumption in Central and Eastern Europe – preliminary result and future developments

„The production and use of pellets show a very positive development especially in Central and Eastern Europe. The 2nd Central European Pellet day offers a comprehensive overview of the developments in this area and on international pellet markets and provides an opportunity to get in touch with experts such as business partners."

Chairman: Christian Rakos, CEO of proPellets Austria

09:00 am **Opening**
- Eric Vial, *President European Pellets Council, Belgium*
- Hermann Schultes*, *President of the Austrian Chamber of Agriculture*

09:20 am **The European Pellet Market – Facts and Figures**
Gilles Gauthier, *European Biomass Association (AEBIOM), Belgium*

09:40 am **EN Plus Certification – Experiences in Eastern Europe**
Martin Englisch, *BEA Institut für Bioenergie GmbH, Austria*

10:00 am **BioUp: Europes largest pelletizing lab**
Martin Weigl, *Holzforschung Austria, Austria*

10:30 am **Coffee Break**

11:00 am **Current market developments for pellet stoves**
Marco Pallazzetti*, *Pallazzetti Lelio S.p.A, Italy*

11:20 am **Future prospects for pellet and boiler markets**
Christian Rakos, *proPellets Austria, Austria*

11:40 am **The development of pellet use in large scale power and CHP plants in Europe**
Arnold Dale, *Ekman & Co, Sweden*

12:00 pm **Pellet burners – for industrial process**
Björn Forsberg, *World Thermal Service AB, Sweden*

12:30 pm **Lunch break**

01:30 pm **Development of pellet production and consumption**
- **Serbia and Bosnia**
  Branko Glavonjic, *University Belgrade, Serbia*
- **Croatia**
  Ante Pašalić, *BEA Institut für Bioenergie GmbH, Austria*
- **Ukraine**
  Georgiy Geletukha*, *SEC Biomass, Ukraine*
- **Baltics**
  Didzis Palejs, *Latvian Biomass Association, Latvia*
- **Canada**
  Gordon Murray, *Wood Pellet Association of Canada, Canada*

03:10 pm **Coffee break**

03:30 pm **Development of pellet production and consumption**
- **Italy**
  Annalisa Paniz, *Associazione italiana energie agroforestali, Italy*
- **Germany**
  Martin Bentele, *Deutscher Energieholz- und Pellet-Verband e.V., Germany*
- **Slovenia**
  Gernot Stadlober, *Stadlober GmbH Brennstoffhandel, Austria*
- **USA**
  Ben Moxham, *Enviva, United States of America*

05:00 pm **Come-together**

**requested*

Biogastag, Saal 11, 9:00 – 17:00

Die Rolle von Biogas im Zeithorizont eines Jahrzehnts

„Die Biogastechnik besticht durch ihre unschlagbare Vielseitigkeit sowohl im Bereich der Energieanwendung (Strom- und Gasnetz) als auch im Bereich der Treibhausgasminderung."

Norbert Hummel, Stellvertretender Obmann der ARGE Kompost & Biogas Österreich

Chairmen: Franz Kirchmeyr, *ARGE Kompost & Biogas, Österreich*

09:00 **Eröffnung**
- Johann Seitinger, *Landesrat Steiermark, Österreich*
- Norbert Hummel, *Stellvertretender Obmann, ARGE Kompost & Biogas, Österreich*
- Jan Stambasky, *Präsident European Biogas Association, Belgien*

09:30 **Zu erwartende Entwicklungen in der Biogastechnologie**
Frank Scholwin, *Biogas & Energie, Deutschland*

09:50 **Treibhausgasminderungspotenzial durch Vergärung landwirtschaftlicher Nebenprodukte und organischer Abfälle**
Franz Kirchmeyr, *ARGE Kompost & Biogas, Österreich*
Stefanie Scheidl, *European Biogas Association, Belgien*

10:10 **Diskussion**

10:20 **Kaffeepause**

10:50 **Biogas done right**
Lorenzo Maggioni, *Consorzio Italiano Biogas e Gassificazione, Italien*

11:10 **Vergärung von Maisstroh und Zwischenfrüchten – Was kann erwartet werden?**
Josef Höckner, *BioG GmbH, Österreich*

Vortragssprache **Deutsch**

Mittwoch 18 Jänner

11:30 **Maßnahmen zur Erzielung hoher Erträge bei Zweitfrüchten**
Manfred Szerencsits, *Öko Cluster, Österreich*

11:50 **Düngungs- und weitere Effekte von Gärprodukten: Bodeneigenschaften, Unkrautsamen, Krankheitserreger**
Markus Gansberger, *AGES, Österreich*

12:10 **Diskussion**

12:30 **Mittagessen**

14:10 **Konzept für einen europäischen Biomethanhandel**
Attila Kovacs, *European Biogas Association, Belgien*

14:30 **Aufbau eines internationalen Biomethanregisters**
Andreas Wolf, *AGCS , Österreich*

14:50 **Biomethanhandel – von der Produktion bis zur Vermarktung**
Stefan Malaschofsky, *Biogas Margarethen am Moos, Österreich*

15:10 **Die Rolle von Biomethan im Salzburger Masterplan Klima + Energie 2020**
Gerhard Löffler, *Land Salzburg, Österreich*

15:30 **Bioabfallmanagement in Laibach, Umwandlung in Biomethan und dessen Einsatz im Transportsektor**
Snaga Javno podjetje d. o. o., Slowenien

15:50 **Diskussion**

16:10 **Schlussbemerkungen und Come-together**

Biogas Day, Room 11, 09:00 am – 05:00 pm

The role of biogas within a decade

„The combination of theory and practise is a great opportunity to watch modern techniques in the field and to follow the latest developments in the sector of biogas."

Norbert Hummel, Vice-Chairman of ARGE Compost & Biogas Austria

Chairmen: Franz Kirchmeyr, *ARGE Kompost & Biogas, Österreich*

09:00 am **Opening**
- Johann Seitinger, *Member of the Provincial Government Styria, Austria*
- Norbert Hummel, Vice-Chairman *of ARGE Kompost & Biogas, Austria*
- Jan Stambasky, *President European Biogas Association, Belgium*

09:30 am **Expected technical development of biogas technique**
Frank Scholwin, *Biogas & Energie, Deutschland*

09:50 am **GHG mitigation digesting agricultural by-products and biowaste**
Franz Kirchmeyr, *ARGE Kompost & Biogas, Austria*
Stefanie Scheidl, *European Biogas Association, Belgium*

10:10 am **Discussion**

10:20 am **Coffee break**

10:50 am **Biogas done right**
Lorenzo Maggioni, *Consorzio Italiano Biogas e Gassificazione, Italy*

11:10 am **Digesting corn stover and catch crops – what can we expect?**
Josef Höckner, *BioG GmbH, Austria*

Language **German**

Wednesday 18 January

11:30 am **Measures achieving high yields seconds crops**
Manfred Szerencsits, *Öko Cluster, Österreich*

11:50 am **Fertilization and other effects of digestate: soil properties, weed seeds, pathogens**
Markus Gansberger, *AGES, Österreich*

12:10 pm **Discussion**

12:30 pm **Lunch break**

02:10 pm **BIOSURF: A concept for enabling European biomethane trade**
Attila Kovacs, *European Biogas Association, Belgium*

02:30 pm **Development of an international biomethane registry**
Andreas Wolf, *AGCS, Austria*

02:50 pm **Biomethane trade – from production and trading perspective**
Stefan Malaschofsky, *Biogas Margarethen am Moos, Austria*

03:10 pm **Biomethane's role within Energy master plan of the state of Salzburg**
Gerhard Löffler, *Land Salzburg, Austria*

03:30 pm **Biowaste management in Ljubljana, transformation to biomethane and its use for transport**
Snaga Javno podjetje d. o. o., Slowenien

03:50 pm **Discussion**

04:10 pm **Closing remarks & Come-together**

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www.wvtbreiding.de

World Bioenergy Day, Galerie, 9:00 – 17:00

Vortragssprache **Englisch**

Mittwoch 18 Jänner

Biomasse- und Bioenergiemärkte

„Mit einem Potenzial von mindestens 150 EJ Energie könnte sich die Bioenergieproduktion in den nächsten Jahrzehnten verdreifachen. Mit dieser Veranstaltung wollen wir einen weltweiten Überblick über attraktive Biomasse- und Bioenergiemärkte bieten."

Remigijus Lapinskas, *Präsident Weltbiomasseverband*

Chairman: Douglas Bradley, *Weltbiomasseverband, Schweden*

09:00 **Eröffnung**
- Josef Plank, *Präsident Österreichischer Biomasse-Verband*
- Mark Bailey, *Kanadischer Botschafter in Österreich*
- Vertreter der *Außenwirtschaft Österreich*

Der Klimavertrag von Paris und Bioenergie – passt das zusammen?
Remigijus Lapinskas, *Präsident Weltbiomasseverband, Schweden*

CO_2-Besteuerung und Ausstiegsstrategien für fossile Brennstoffe
Heinz Kopetz, *Ehrenpräsident Österreichischer Biomasse-Verband*

10:30 **Kaffeepause**

11:00 **Biomasse-Export**
- **Kanada**

Gordon Murray, *Wood Pellet Association of Canada, Kanada*
- **Baltikum**

Didzis Palejs, *Latvian biomass association, Lettland*
- **USA**

Ben Moxham, *Enviva, Vereinigte Staaten von Amerika*
- **Südostasien**

Saku Rantanen, *Tasma Bioenergy, Singapur*
- **Südamerika**

Geraldine Kutas, *Brazilian Sugarcane Ind. Assoc., Brasilien*
- **Russland**

Sergei Sorokin

12:30 **Mittagessen**

13:30 **Unternehmen, Forschung und Auswirkungen**

Advantage Austria – Sprungbrett für Bioenergie-Technologie, Länderberichte:
- Dänemark: Wolfgang Stelte, Danish Technological Institute
- Griechenland: Gerd Dückelmann-Dublany, der österr. Wirtschaftsdelegierte in Athen
- Japan: Luigi Finocchiaro, Branchenexperte des Außenwirtschafts Centers Tokio

Bioenergie-Forschung als Schlüssel zum Erfolg
Manfred Wörgetter, *National Representative in IEA Bioenergy, Österreich*

Bioenergie in Österreich – eine regionale Erfolgsgeschichte
Christoph Pfemeter, *Österreichischer Biomasse-Verband, Österreich*

15:00 **Kaffeepause**

15:30 **Biomasse-Investitionen**
- **Australien**

Andrew Lang, *Vize-Präsident Weltbiomasseverband, Schweden*
- **Türkei**

Tanay Sidki Uyar, *Bioenergy Association of Turkey, Türkei*
- **China**

Kelvin Hong, *Great Resources, China*
- **Ukraine**

Georgiy Geletukha, *Bioenergy Association of Ukraine, Ukraine*
- **Schweden**

Gustav Melin, *Swedish Bioenergy Association, Schweden*
- **Japan**

Aikawa Takanobu, *Renewable Energy Institute, Japan*

17:15 **Come-together**

**angefragt*

WKO AUSSENWIRTSCHAFT AUSTRIA Canada

World Bioenergy Day, Galerie, 09:00 am – 05:00 pm

Language **English**

Wednesday 18 January

Biomass and bioenergy markets

„In this session, speakers from all continents will emphasize the importance of bioenergy in the global energy and climate scenario. "

Remigijus Lapinskas, *President World Bioenergy Association*

Chairman: Douglas Bradley*, *World Bioenergy Association, Sweden*

08:00 am **Opening**
- Josef Plank, *President Austrian Biomass Association*
- Mark Bailey, *Ambassador Canadian Embassy*
- Representative *of the foreign trade office Austria*

Fossil fuel exit strategy and CO_2 taxation
Heinz Kopetz, *Honorary President Austrian Biomass Association*

Paris and Bioenergy – does it fit?
Remigijus Lapinskas, *President World Bioenergy Association, Sweden*

10:30 am **Coffee break**

11:00 am **Biomass as Export fuel**
- **Canada**

Gordon Murray, *Wood Pellet Association of Canada, Canada*
- **Baltics**

Didzis Palejs, *Latvian biomass association, Latvia*
- **USA**

Ben Moxham, *Enviva, United States of America*
- **Southeast Asia**

Saku Rantanen, *Tasma Bioenergy, Singapore*
- **South America**

Geraldine Kutas, *Brazilian Sugarcane Ind. Assoc., Brasilia*
- **Russia**

Sergei Sorokin

12:30 pm **Lunch**

01:30 pm **Business, Research and Effects**

Advantage Austria – springboard for bioenergy technology, country reports:
- Denmark: Wolfgang Stelte, Danish Technological Institute
- Greece: Gerd Dückelmann-Dublany, Austrian Trade Commissioner
- Japan: Luigi Finocchiaro, Expert Advantage Austria Tokio

Bioenergy as a key for success
Manfred Wörgetter, *National Representative in IEA Bioenergy, Austria*

Bioenergy in Austria – a good story to tell
Christoph Pfemeter, *CEO Austrian Biomass Association, Austria*

03:00 pm **Coffee break**

03:30 pm **Biomass investments**
- **Australia**

Andrew Lang, *World Bioenergy Association, Sweden*
- **Turkey**

Tanay Sidki Uyar, *Bioenergy Association of Turkey, Turkey*
- **China**

Kelvin Hong, *Great Resources, China*
- **Ukraine**

Georgiy Geletukha, *Bioenergy Association of Ukraine, Ukraine*
- **Sweden**

Gustav Melin, *Swedish Bioenergy Association, Sweden*
- **Japan**

Aikawa Takanobu, *Renewable Energy Institute, Japan*

05:15 pm **Come-together**

**requested*

ADVANTAGE AUSTRIA WKO Canada

BIOENERGY 2020+ Day
Saal 12, 13:30 – 17:00

Vortragssprache **Englisch**

Mittwoch **18** Jänner

„Das österreichische Biomassekompetenzzentrum BIOENERGY 2020+ stellt Ergebnisse aus aktuellen Forschungsprojekten vor. Im Fokus stehen die Aktivitäten aus dem laufenden COMET-Forschungsprogramm."

Chairman: Walter Haslinger, *Bioenergy 2020+ GmbH, Österreich*

13:30 **Beginn**

Ausgasungsverhalten von Pellets – Evaluierung, Sicherheitsfragen und vorsorgliche Maßnahmen
Waltraud Emhofer, *Senior Researcherin Biomasseverbrennungssysteme*

Hoch- und Niedertemperaturkorrosion in Biomasseanlagen
Stefan Retschitzegger, *Unit Head Biomasseverbrennungssysteme*

Synthetische Biotreibstoffe aus der Biomassedampfvergasung – Stand der Entwicklung
Reinhard Rauch, *Area Manager Biomassevergasungssysteme*

Evaluierung von Zweibett-Wirbelschicht-Dampfvergasungssystemen mithilfe von Kaltmodellen und CPFD-Simulation
Stephan Kraft, *Junior Researcher Biomassevergasungssysteme*

Herstellung von Biochemikalien aus CO2 durch Gasfermentation mit Hilfe von Clostridia spp.
Lydia Rachbauer, *Researcherin Biokonversion und Biogassysteme*

Algenbioraffinerie – Status & Forschungsanwendungen
Bernhard Drosg, *Area Manager Biokonversion & Biogassysteme*

15:00 **Kaffeepause**

Vorbehandlung von Altholz für die stoffliche und energetische Verwertung
Christa Dißauer, *Researcherin Nachhaltige Versorgungs- und Wertschöpfungsketten*

Pyrolyse der Feinfraktion von Restmüll und von Klärschlamm
Martina Meirhofer, *Researcherin Nachhaltige Versorgungs- und Wertschöpfungsketten*

Modellbasierte Regelung von Biomasseverbrennungssystemen
Christopher Zemann, *Researcher Automatisierungs- und Regelungstechnik*

Modellprädiktive Regelung von Wärmenetzen
Daniel Muschick, *Senior Researcher Automatisierungs- und Regelungstechnik*

Modellierung der Bildung anorganischer Aerosole in Biomassefeuerungen
Thomas Gruber, *Senior Researcher Modellierung und Simulation*

Modellierung der Bildung von Ruß in Biomassefeuerungen
Ali Shiehnejad-Hesar, *Senior Researcher Modellierung und Simulation*

17:00 **Ende** und **Come-together**

bioenergy2020+

BIOENERGY 2020+ Day
Room 12, 01:30 – 05:00 pm

Language **English**

Wednesday **18** January

„The Austrian biomass competence centre BIOENERGY 2020+ presents results of recent research projects. The focus is on the activities of the ongoing COMET research programme."

Chairman: Walter Haslinger, *Bioenergy 2020+ GmbH, Austria*

01:30 pm **Opening**

Pellets off-gassing – evaluation, safety issues and prevention
Waltraud Emhofer, *Senior Researcher, Biomass combustion systems*

High and low temperature corrosion in biomass fired heating plants
Stefan Retschitzegger, *Unit head, Biomass combustion systems*

Synthetic biofuels by biomass steam gasification – status of development
Reinhard Rauch, *Area Manager, Biomass gasification systems*

Evaluation of dual fluidized bed gasification systems by means of cold flow modelling and CPFD simulation
Stephan Kraft, *Junior Researcher, Biomass gasification systems*

Production of biochemicals from CO_2 by Clostridia spp. via gas fermentation
Lydia Rachbauer, *Researcher, Bioconversion and biogas systems*

The algae biorefinery – status and research applications
Bernhard Drosg, *Area Manager, Bioconversion and biogas systems*

03:00 - 03:30 pm **Coffee break**

Pre-treatment of post-consumer and demolition wood for recycling and energetic utilisation
Christa Dißauer, *Researcher, Sustainable supply and value chains*

Pyrolysis of the fine fraction of municipal solid waste (MSW) and of sewage sludge
Martina Meirhofer, *Researcher, Sustainable supply and value chains*

Model based control of biomass combustion systems
Christopher Zemann, *Researcher, Automation and control*

Model predictive control of heat grids
Daniel Muschick, *Senior Researcher, Automation and control*

Modelling of inorganic aerosol formation in biomass combustion systems
Thomas Gruber, *Senior Researcher, Modelling and simulation*

Soot formation modelling in biomass combustion systems
Ali Shiehnejad-Hesar, *Senior Researcher, Modelling and simulation*

05:00 pm **End and Come-together**

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PLENARSITZUNG
Bioenergie nach Paris
Saal 1, 9:00 – 12:30

Chairman: Ingmar Höbarth, *Klima- & Energiefonds, Österreich*

„Durch den Weltklimavertrag ist der Ausstieg aus fossilen Energieträgern besiegelt. Die energetische Biomassenutzung wird dadurch weltweit an Bedeutung gewinnen - mit ungeahnten Möglichkeiten für die heimische Wirtschaft."

Josef Plank, *Präsident ÖBMV*

Donnerstag 19 Jänner

09:00 Wissenschaftliche Eröffnung

- **Siegfried Nagl,** *Bürgermeister von Graz, Österreich*
- **Franz Titschenbacher,** *Präsident LK Steiermark, Österreich*
- **Vertreter** der *Außenwirtschaft Österreich*

Bioenergie für künftige Energiemärkte – weltweite Highlights
Hermann Hofbauer, *Technische Universität Wien, Österreich*

Biowärme für Gebäude und Industrie – Perspektiven bis 2030
Lukas Kranzl, *Energy Economics Group, Österreich*

Die Rolle der nachhaltigen Waldbewirtschaftung für Wald- und Klimaschutz
Tomas Lundmark, *Swedish University of Agricultural Sciences, Schweden*

10:30 **Kaffeepause**

11:00 Politische Eröffnung

- **Josef Plank,** *Präsident Österreichischer Biomasseverband, Österreich*
- **Remigijus Lapinskas,** *Präsident Weltbiomasseverband, Schweden*

Österreich auf dem Weg zu 100 % erneuerbarer Energie
Andrä Rupprechter, *Bundesminister für Land- und Forstwirtschaft, Umwelth und Wasserwirtschaft, Österreich*

EU Bioenergie 2030: Herausforderungen und Möglichkeiten
Didzis Palejs, *Präsident Europäischer Biomasse Verband (AEBIOM), Belgien*

Mythen und Fakten zur Energiewende
Georg Günsberg, *Politik- und Strategieberater, Wien, Österreich*

12:30 - 14:00 **Mittagspause und Postersession**

Simultanübersetzung

PLENARY SESSION
Bioenergy after Paris
Room 1, 09:00 am – 12:30 pm

Chairman: Ingmar Höbarth, *Klima- und Energiefonds, Austria*

„Due to the world climate treaty the withdrawal from nuclear energy is sealed. The energetic biomass use will gain in importance worldwide - with unimagined possibilites for our domestic economy."

Josef Plank, *President Austrian Biomass Association*

Thursday 19 January

09:00 am Scientific Opening

- **Siegfried Nagl,** *Mayor of Graz, Austria*
- **Franz Titschenbacher,** *President Styrian Chamber of Agric., Austria*
- **Representative** *of the foreign trade office Austria**

Bioenergy technology for future markets – worldwide highlights
Hermann Hofbauer, *Technical University Vienna, Austria*

Biomass for heat in buildings and industry – perspectives up to 2030
Lukas Kranzl, *Energy Economics Group, Austria*

Active forest management and its role for climate change mitigation
Tomas Lundmark, *Swedish University of Agricultural Sciences, Sweden*

10:30 am **Coffee break**

11:00 am Political Opening

- **Josef Plank,** *President Austrian Biomass Association*
- **Remigijus Lapinskas,** *President World Bioenergy Association, Sweden*

Austria on the way to 100 % renewable energy
Andrä Rupprechter, *Federal Minister for Agriculture, Forestry, Environment and Water Management, Austria*

EU Bioenergy 2030: Challenges and possibilites
Didzis Palejs, *President European Biomass Assoc. (AEBIOM), Belgium*

Myths vs. facts in the public debate on energy transition
Georg Günsberg, *Political consultant, Vienna, Austria*

12:30 - 02:00 pm **Lunch and Poster presentation**

Simultaneous translation

9:00–12:30 Uhr

Plenarsitzung

Bioenergie nach Paris

Wissenschaftliche Eröffnung

9:00 am–12:30 pm

Plenary Session

Bioenergy after Paris

Scientific Opening

Biomass for heat in buildings and industry in EU28: policy questions and perspectives up to 2030

Lukas Kranzl
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Michael Hartner, Albert Hiesl, Andreas Müller, Gustav Resch, Technische Universität Wien, Institute of Energy Systems and Electrical Drives

Around 50% of the final energy consumption in EU-28 is used for heating and cooling. Thus, this sector plays a key role for achieving global and European energy and climate targets. Different policy frameworks on the national and European level currently are in place for decarbonising the sector (Renewable Energy Directive, Energy Performance of Buildings Directive, Ecodesign Directive, Emission Trading Scheme, including the European Commission's proposed package of measures published late 2016). In 2012, about 11% of this sector was covered by biomass. Thus, biomass currently covers by far the largest share of renewable heating and cooling. However, the dynamics of different renewable heat systems differ substantially among sectors and technologies.

This presentation will address the following questions: (1) What is the role of biomass for heat in buildings and industry in EU-28 in scenarios up to 2030? (2) How could policies and framework conditions affect the uptake of biomass in different sectors?

In order to answer these questions, we use a modelling framework of various sectoral and energy system models: The sector models Invert/EE-Lab, Forecast-Tertiary and Forecast-Industry are bottom-up models which in this study are applied for the sectors residential and tertiary buildings as well as industry respectively. The models cover the EU building stock and industrial processes in strongly disaggregated way. They model the future uptake of various energy efficiency measures as well as heating and cooling supply technologies, depending on the economic and political framework. They deliver the development of energy demand by sectors, end-uses and energy carriers in scenarios until 2030. The model Green-X in this study is applied for developing scenarios of district heating supply mix as well as for providing a consistent framework of allocating bioenergy potentials in all sectors (heating and cooling, electricity, transport). We use this model framework for developing a current policy scenario until 2030 and to discuss the impact of more ambitious policy measures and framework conditions.

The results show that due to current policy framework, overall biomass demand for heating increases also in the current policy scenario, even though currently low prices for fossil fuels provide a difficult framework in particular in some countries and some sectors. However, the current policy scenario shows that under these assumptions additional measures will be required to achieve the EU RES targets for 2030. The presentation discusses how this gap can be filled and what could be the role for biomass in the different sectors in more ambitious scenarios.

The presentation builds on the project "Mapping and analyses of the current and future (2020 - 2030) heating/cooling fuel deployment" carried out for the European Commission.

Active forest management and its role for climate change mitigation

Tomas Lundmark
Swedish University of Agricultural Sciences
Umeå, Sweden
Tomas.Lundmark@slu.se
www.slu.se

Annika Nordin, Bishnu Chandra Poudel, Nils Fahlvik

Forests and other wooded land cover more than 40 % of the total land surface in the EU- region (28 member countries and six cooperating countries) and more than 95 % of the forests in this region are under management. Since most of the forests in the EU are already managed, the forests' ability to contribute further to the necessary climate change mitigation as well as to the merging bioeconomy, depends to large extent on the potential to harvest a larger share of the growth and also on the potential to increase growth with more active management. The role of forests and forestry in terms of climate change mitigation is increasingly discussed both in science and policy. Forests can deliver carbon benefits in two principally different ways. The CO_2 concentration in the atmosphere can be altered by changes in carbon stocks in living biomass and in carbon stored in soils and litter. A net removal of CO_2 occurs as long as CO_2-fixation via photosynthesis surpluses CO_2-emissions via autotrophic and heterotrophic respiration.

The CO_2 concentration can also be altered if forests are managed for biomass production and a part of the annual net growth is harvested and used for substitution that result in reduced emissions of fossil carbon and/or a built up of carbon stock in wood products. An important difference is that the displacement of fossil fuels results in a permanent benefit while the carbon storage option is temporary. To understand the full complexity of forest management and carbon balance both the effects on carbon stocks and substitution has to be considered simultaneously. The concept of forest management also takes on different meanings around the world and together with different assumptions of the temporal and spatial system boundaries adopted in the different analyses opposing views on the climate change mitigation effects of forestry and the use of forest-based products have been the result. In forest countries like Austria and Sweden a long-term sustainable flow of timber from the forest is obtained by adapting annual harvest to annual forest growth so that growing stock is not reduced on the landscape level. In this way no carbon depth occur after harvest. This concept of sustainable forest management is well in line with the strategy identified by IPCC generating the largest sustained climate change mitigation benefit in the long term.

The most important factors defining the long term mitigation benefit is the growth rate of the forests (harvest and/or storage potential) and the use of forest based products (substitution potential). Recently the discussion on biofuels carbon neutrality has heated up as well as whether it is better to manage or conserve forests for the climate. Given the Paris Climate Agreement (2015), which explicitly refers to forests and forestry in climate change mitigation, it is now urgent to reconcile these disputes, and to communicate and discuss the state-of-the-art of science with stakeholders. We use a comprehensive modeling approach to describe forest growth and yield at the landscape level for different management regimes. The analyses include carbon stock changes in forest biomass, soil carbon and forest based products as well as the effects on substitution carbon benefits.

13:30–17:00 Uhr

Workshop:

IEA Bioenergy TASK 32

01:30 pm–05:00 pm

Workshop:

IEA Bioenergy TASK 32

Austrian contributions to Task 32

Christoph Schmidl
Bioenergy2020+
Gewerbepark Haag 3
3250 Wieselburg-Land
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www.bioenergy2020.eu

In the last **working period 2013 –2015** the following priority topics were defined in IEA Bioenergy Task 32: fuel characterisation, pre-treatment and supply, "next generation" small- and medium-scale biomass combustion, industrial and utility-scale biomass combustion and power generation as well as biomass cofiring. Task 32 organised international workshops covering specific issues derived from the priority topics defined. In the working period 2013 –2015 five workshops and a conference have been organised. Within the scope of the priority topics, in total 6 reports, studies and position papers have been compiled.
Austria actively contributed to Task projects which were of relevance for Austria as well as observed and gathered information regarding Task topics on which no active work has been ongoing in Austria. Following Task results were coordinated by Austria:

- **Advanced Characterisation Methods for Solid Biomass Fuels.** IEA Bioenergy Task 32 report (Link:http://www.ieabcc.nl/publications/IEA_Bioenergy_T32_Advanced_characterisation_methods_for_solid_biomass_fuels.pdf)
- **Techno-economic evaluation of selected decentralised CHP applications based on biomass combustion with steam turbine and ORC processes**. IEA Bioenergy Task 32 report (Link: http://www.ieabcc.nl/publications/TEA_CHP_2015.pdf)

In the current **triennium (2016-2018)** the following topics will be worked on: (1) domestic heat production, (2) progress in biomass fired CHP applications, (3) reduction of emissions, (4) cofiring and full conversion, (5) low grade fuels and fuel pretreatment (6) greenhouse gas effects of biomass combustion including carbon capture & storage and (7) dissemination of information.
Austria will contribute to topics of relevance for Austria and coordinate the preparation of reports for Task topics (2) and (3):

Progress in biomass fired CHP applications
In recent years, a whole range of technologies have been developed and demonstrated for the power generation of small-scale biomass. The current state of these developments as well as selected best practice examples of industrial cogeneration plants of small and medium capacity are assessed on the basis of real performance figures and the results are summarized in a report. The report is coordinated by the Austrian member and is to be concluded by end of 2017.

Reduction of emissions
In work package 3 the focus will be placed on pre-normative research on measurement and test methods. Together with partners from Germany, the standardized measuring and testing methods used in space heating appliances and central heating boilers for biomass are collected and compared. In addition, selected current method developments in this area are described and their differences compared to the existing standards are analysed. The publication of the final report on this project is planned for the end of 2017.
Furthermore an international **Workshop on new emission measurement methods** is organised by the Austrian Task member in the frame of the Central European Biomass Conference on 19 January 2017 in Graz.

13:30–17:00 Uhr

Industrieforum:
Bioenergie

01:30 pm–05:00 pm

Industry forum:
Bioenergy

HERZ Energietechnik GmbH

DI Dr. Morteza Fesharaki
HERZ Energietechnik GmbH
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In September 2016 HERZ celebrated the 120th anniversary of the company and can look back on a successful, steadily growing market presence. HERZ has 8 production sites in Austria as well as 14 others in Europe. With more than 20 sales offices and sales partners in around 100 countries, the company generated sales of around 250 million euros with 2,500 employees.

HERZ Energietechnik GmbH - Successful with biomass plants & heat pumps
HERZ Energietechnik employs over 230 people in production and sales. At its company locations in Pinkafeld/Burgenland and Sebersdorf/Styria, a state-of-the-art production facility and a research institute are available for new innovative products. As a result, established collaborations with research- and education institutions can be intensified.
The Austrian biomass specialist presents itself as a complete supplier for renewable energy systems. HERZ stands for modern and environment friendly heating systems with the best user-friendliness. The plants for alternative energies are high-tech products with highest comfort.

The product range of HERZ Energietechnik: The full-service provider!
With the latest technology of pellet and wood-chip heating systems from 4 kW to 1,500 kW, the wood gasification boilers up to 40 kW as well as heat pumps up to 80 kW, HERZ offers a complete range of modern, cost-effective and environment friendly heating systems with highest comfort and best user friendliness. HERZ also supplies hot water tanks and domestic hot water heat pumps, buffer tanks and fresh water modules.

Comfortable and environment friendly heating with the power of the nature
The biomass boilers automatically clean the fuel grate and the heat exchanger surfaces, thus ensuring economical fuel consumption, consistently high efficiency and maximum comfort.

The combustion grate as well as the heat exchanger surfaces is full automatically cleaned at all automatic biomass boilers. This ensures economical fuel consumption, consistently high efficiency and maximum comfort. The heat pumps impress with a high coefficient of performance, lowest operating costs and are available for a wide range of heat sources such as soil flat plate collectors, geothermal probes, ground water or air.

As one of the most experienced producers of log wood, wood chips, pellets plants and heat pumps, the consideration of the environmental situation, ecology and environmental protection has top priority for HERZ. Whether you decide on heating with log wood, pellet or wood chips: When heating with biomass, not only the money bag benefits, but also the environment due to CO2-neutral combustion. The commotherm heat pumps represent efficient use of renewable energy sources such as soil, water or air.

From the region – for the region
In addition to supporting the domestic economy, which is ensured by the production directly in the region, HERZ also makes an important contribution to the preservation of numerous jobs in Austria. Therefore, the decision to purchase a HERZ product not only benefits the company, but also the entire region.

BINDER - Biomass boilers up to 20 MW
With its takeover of the renowned company BINDER GmbH, located in Bärnbach in the Austrian province of Styria, HERZ has expanded its range of biomass boilers to 20,000 kW. With warm water, hot water and saturated steam boilers, boilers for special fuels, hot air (drying) systems, thermal oil systems & CHP-systems HERZ - in combination with BINDER - is the special contact for private as well as for commercial and industry customers.

Komptech GmbH

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The Komptech company
Komptech is a leading international manufacturer of machines and systems for the mechanical and mechanical-biological treatment of solid waste and biomass, and the processing of woody biomass for use as a renewable fuel. The product range comprises over 30 different types of machines, which cover the key steps in waste handling and biomass processing. Modular construction with different power classes simplifies combining machines into complete systems. The focus is always on innovative technology and solutions that bring maximum user benefit.

Biomass processing
Energy generation from renewable sources is the order of the day, to counteract negative environmental effects like the greenhouse effect and resulting climate change. Komptech supplies machines for processing wood in all of its many forms, from logs to forestry residue and municipal cuttings to old wood, all of which can be processed to provide energy or raw materials. The company's products range from machines for shredding and chipping to screening and separation to clean out contraries.
For example, high-speed chippers or low-speed shredders can turn woody green cuttings into a coarsely structured fuel. Subsequent separation by a stone separator or drum screener brings a considerable quality improvement - fines go to composting and contraries are removed by stone separation, magnetic separation or wind sifting. The customers for the fuels are biomass heating and cogeneration plants, who need a low-cost fuel with a specific calorific value and grain size.

In keeping with our slogan "Technology for a better environment" we see it as our function to develop the right concepts and the most economical machines to meet these challenges. Because in processing woody biomass into fuel, the goal is always to get maximum fuel output for minimum energy input.

Company facts and figures
2016 group revenue: approx. € 105 million
60% revenue in Europe (of which 10% in Eastern Europe), the rest in the US, Japan and Australia.
4 companies at 3 locations in 3 countries - Austria, Germany, Slovenia
Employees: approx. 560

Reliable and Economic Bioenergy Technology

In order to safeguard global energy supplies, the generation of energy from renewable resources is essential. Wood, in particular, is a vital source of energy. Based on years of work in research and development, S*YN*CRAFT® has succeeded in transforming this renewable raw material efficiently and effectively into heat, and most notably electricity, using breakthrough technology. The patented energy conversion technology impresses not only with maximum fuel efficiency of 92%, but also with its economic viability. *SYN*CRAFT®, THE wood gasification plant, guarantees reliable and economical bioenergy, as well as independence from conventional energy supplies.

The highly innovative and floating fixed bed technology from *SYN*CRAFT® revolutionises the energy production process from wood. *SYN*CRAFT® plants are able to convert low-cost woodland fractions into premium gas quality and achieve high electrical efficiency rates of 30%. In addition to system availability, innovative high and low temperature flows, no additional costs for ongoing and reliable operations, *SYN*CRAFT®, THE wood gasification plant, generates revenue in the form of premium quality charcoal. This closes the ecological circle and CO_2-neutral energy generation delivers positive returns, for which *SYN*CRAFT® received the prestigious “Energy Globe“ award in 2016.

*SYN*CRAFT® plans and installs turnkey systems with an electrical output of between 200 and 500 KW. The adaptation or renovation of existing systems to ensure efficient base load supply are also one of the core competencies of this privately owned company, based in Tyrol. Successful reference facilities can be visited at any time in Austria and Italy.

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Feuer und Flamme!
Hargassner ihr Biomasse Spezialist

Hargassner – Ein Familienunternehmen mit Tradition und Herz! Seit über 30 Jahren am Markt und mit mehr als 86.000 zufriedenen Kunden, hat sich die Firma am nationalen und internationalen Biomasse-Markt etabliert.

Firmengeschichte

Vor 30 Jahren überzeugte Anton Hargassner seine Frau, bei dem neu gebauten Familienhaus auf eine selbstgebaute Heizung zu setzen. Als Sohn eines landwirtschaftlichen Betriebs kam kein anderer Brennstoff als Holz in Frage. Da damals die Holzheiztechnik praktisch nicht existierte, entwickelte Hargassner die Hackschnitzelheizung für das eigene Haus damals selbst. Seine Frau überzeugte er damit, dass die selbstgebaute Heizung automatisch mit Brenngut beschickt wurde. Für diese und ähnliche Entwicklungen erwarb Hargassner in den folgenden Jahren Patente und gründete 1984 die Firma Hargassner GesmbH im oberösterreichischen Weng.
Seit 30 Jahren produziert die Firma Hargassner nun schon Hackgutanlagen und seit über zehn Jahren auch Pelletsanlagen. Im Angebot sind Anlagen im Leistungsbereich von 9 bis 200 kW mittels Kaskadenlösung bis 800 kW. Seit 2010 werden auch Stückholzkessel von 20 - 60 kW hergestellt. Neu im Sortiment befinden sich die Stückholz/Pellets Kombikessel. Die Firma verfügt über eine Produktionskapazität von 10.000 Kessel/Jahr. Das Unternehmen beschäftigt mittlerweile über 220 Mitarbeiter. Seit 2013 beträgt die Gesamtfläche der Firma 30.000 m2. In der Produktion sind modernste CNC-gesteuerte Blechbearbeitungsmaschinen, Schweißroboter und eine vollautomatische Pulverbeschichtungsanlage im Einsatz.

Innovation

Ein Hauptaugenmerk im Unternehmenskonzept wird auf die eigene Forschungs- und Entwicklungsabteilung gelegt. Die Produktentwicklung findet innerhalb der Firma Hargassner statt gemäß dem Motto „Vorsprung durch Qualität und Technologie“. Seit 2012 ist das neue Forschungs- und Entwicklungszentrum eröffnet – Größe: weitere 3.600 m2. Das neue Forschungs- und Entwicklungszentrum stellt quasi eine Firma in der Firma dar. Ohne die eigentliche Serienproduktion zu stören, können hier Prototypen gebaut werden. Mit 20 neuen Versuchsständen ist nun auch eine kontinuierliche Forschung möglich. Auf dem Prüfstand stehen nicht nur Heizungen, sondern vielmehr auch neue Brennstoffe und Bedienelemente.

Neuheiten 2017

Hargassner bietet neu Hackgutheizungen im Leistungsbereich bis 330 kW an. Diese sind mittels Kaskadenlösung bis zu 2 MW kombinierbar und vereinen die gewohnte Eco-HK Qualität und Leistungsfähigkeit.

Auch brandneu ist die Erzeugung von Wärme und Strom aus Holz. Mit der neuen KWK Heizung können 60 kW Wärme und 20 kW Strom erzeugt werden. Speziell geeignet ist diese umweltfreundliche Energieversorgung für Gewerbebetriebe, öffentliche Bauten und Nahwärmenetzbetreiber. Zum Einen überzeugt sie durch eine kompakte Bauweise mit sehr wenig Platzbedarf, zum Anderen durch den vollautomatischen Betrieb durch das durchdachte Regelungskonzept – die ideale Lösung für alle, die einen konstanten Energiebedarf haben, wie z.B.: Gastronomie & Hotellerie oder Industriebetriebe, Micronetze etc.

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URBAS Maschinenfabrik GmbH

Founded:	1929
No. of employees:	450
Manufacturing Facility:	35 000 m²
Turn over:	appr. 80 Mio.
Market:	worldwide
Export:	appr. 70%
Market areas:	Steel Construction, Hydroelectric, Energy technology as Biomass Boiler for warm water, process steam, steam power plant and woodgas-CHP All areas as general contractor possible
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POLYTECHNIK group is one of the world's leading suppliers for Biomass Heat and Power Plants, providing equipment, systems and services that are individually designed for customers in the lumber industry, the public sector, major energy suppliers, and industrial users of energy. In each business segment, the group is among the top companies in the market and, with its broad range of products, is able to offer turnkey solutions to its customers based on innovative technologies. The POLYTECHNIK portfolio also includes a comprehensive range of services worldwide. The POLYTECHNIK group, with head offices in Weissenbach, Austria, employs around 230 people and has 4 manufacturing sites and more than 15 engineering, sales and service subsidiaries throughout Europe, as well as 4 additional offices overseas. The company's export rate is currently almost 99%. POLYTECHNIK is a global technology leader and supplier of biomass combustion plants and known for the planning and delivery of turnkey plants. The company offers these fired boilers with a thermal output ranging from 300 kW to 30,000 kW (single unit output). Depending on the type and water content of the fuel, various combustion systems (reciprocating grate, horizontal grate, and horizontal combustion grate) are used. Warm water, hot water, steam and thermal oil are used to transfer the energy. The plants can be used to produce heating and process heat, as well as electricity. The electrical output ranges from 200 kW_{el} to 20,000 kW_{el} (per turbine generator). On the basis of its decades of experience, Polytechnik has completed numerous reference installations for well-known customers in the core markets of A, D, NL, I, CH, F, E, FIN, S, the Baltic States, and Eastern Europe (Poland, Russia, Czech Republic, Romania, Slovakia, Slovenia, etc.), and Japan and Korea. All told, more than 3,000 combustion systems have been installed to the complete satisfaction of the company's customers. Continuous further development of the existing products is ensured by ongoing major research projects, as well as collaborations, such as those being conducted with the Technical Universities of Munich, Vienna and Graz, as well as with the Austrian Research Institute / Institute for Eco-Technology in Vienna.
The result is a technology that achieves levels far below the emission thresholds permitted by law, that increases effectiveness and that thus enables almost unlimited use in the combustion of biomass.
Value creation steps that require intense know-how (acquisition, engineering, production control, quality control, commissioning) and overall project management are carried out at the Weissenbach head office. From there, too, all of the plants that have been installed worldwide are monitored and serviced electronically by means of telemaintenance. The vital technical knowledge relating to production is maintained and further developed in Weissenbach. Production of the plants is carried out in four different production sites in the European Union. These companies are certified to ISO 9001 and operate a thorough quality management system. By virtue of ongoing research and development, the Weissenbach location also has one of the most modern of testing facilities for biomass fuels. At this site, it is possible to load and combust a very great variety of fuels and then to measure and test their emission levels. At the end of 2014 Polytechnik was awarded a special honour. The Austrian Ministry of Economy has bestowed the National Coat of Arms Award of the Republic of Austria on the company for its outstanding achievements and services rendered to the country's economy. Now it holds its place among those few companies that have this award as a special sign of recognition and respect for their leadership and successful work in their respective industries. Polytechnik is not only aligned to current trends for producing ecologically compatible products, but also actively enables sustainability by promoting cutting-edge technology in growth markets, thus making a considerable contribution to the carbon-neutral generation of energy. In so doing, the company bases its effort on its customers' requirements. Its ultimate goal is customer satisfaction. The fact that it has been successful in meeting this objective in the past is demonstrated by an impressive list of reference projects and the high demand for Polytechnik products.

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An innovative pellet cooler for cost reducing energy efficiency and higher operational reliability

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Flexible, modular and energy-efficient equipment for the processing of biomass – the mission of CEBCON Technologies! We offer innovative modular solutions for the processing of biomass. Whether for decentralised energy generation from biomass, or the production of biomass fuels such as wood pellets, our systems are part of these production processes and offer intelligent solutions that are particularly energy-efficient, flexible, and even improve fire safety.

Outstanding energy efficiency, flexible design and increased fire safety: CEBCON has developed an innovative, internationally patent-pending pellet cooler featuring an energy-efficient heat recovery system for use in the pellet production process. Depending on the selected design, the cooler can process granules from a variety of biomass. This includes pellets made from: - By-products from the forestry and timber industry, sawdust, logs; - Agricultural waste such as straw, shells, husks; - Solid fermentation residues from biogas production; - Whole plants such as bamboo, miscanthus, wood from short-rotation plantations. In addition to its heat recovery, the cooler is characterised by considerable electricity savings of 45-70% as well as by fewer wearing parts than conventional pellet coolers. The cooler can be implemented either as an integrated component for new pellet production facilities or as a stand-alone module to replace existing facilities.

The innovative CEBCON pellet cooler improves energy efficiency in pellet production, increases operational safety and achieves significant cost reduction. In addition, thanks to its special design as a containerised cooler, it increases flexibility: This facilitates transport and assembly, while reducing the amount of space required. The newly developed pellet cooler is a shaft cooler, the walls of which consist of heat exchanger plates. Due to the special arrangement of these cooling elements, the wood pellets or other solid, bulk biofuels are cooled particularly effectively and gently, in particular avoiding dust formation and large quantities of exhaust air. COOLING CAPACITY: Depending on the chosen design, the plant has a cooling capacity of 2-5 to pellets/h.

ADVANTAGES OVER CONVENTIONAL COOLERS: - Special design features of the cooler enable very energy-efficient operation compared to conventional coolers, while nevertheless achieving the same cooling capacity and throughput. - The recovered heat of 91 kWh or approx. 600 MWh/a (assuming 6,500 production hours per year and a press capacity of 4 to/hour) can be used for drying and conditioning the raw material before pressing. - The electricity consumption of the cooler is around 45-70% lower than that of the comparable systems. For a conservatively calculated number of production hours of 6,500 h/a and a press capacity of 4 to/h, the electricity savings amount to approximately 11.6 kWh or 75 MWh/a. - This enables a significant reduction of energy costs during production, resulting in savings of around EUR 24,000 per year (depending on the electricity and heat prices at the location in question). Unlike conventional systems, the cooler pays for itself quickly due to the above-mentioned energy savings. - Maintenance costs are also reduced due to the design features. It was possible to dispense with bag filters and large blowers, while using simpler components. Because of the few moving parts, the wear and the risk of failure, as well as the operating expenses (lubrication, etc.) are low. - In addition, the cooler is safer to operate as a result of the avoidance or minimisation of explosion and fire risks during cooling. The risk of fire is negligible compared to counter-stream coolers. - And finally, the pellet cooler is flexible and easy to use: It is equipped with necessary temperature and level sensors as well as control technology and can be integrated into the upstream plant control system for automated operation. In addition, the cooler is designed in standard container format, which reduces the transport and installation costs. Pre-assembly and testing are carried out at the factory before delivery to the customer: These result in a shorter assembly time (by up to 80%) and accelerated commissioning.

AGRANA Stärke GmbH

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AGRANA veredelt als international ausgerichtetes österreichisches Industrieunternehmen landwirtschaftliche Rohstoffe zu hochwertigen Lebensmitteln und einer Vielzahl von industriellen Vorprodukten. Rund 8.600 Mitarbeiter erwirtschaften an weltweit über 50 Produktionsstandorten einen Konzernumsatz von rund 2,5 Mrd. €. Das Unternehmen wurde 1988 gegründet und ist heute führender Anbieter von Zucker und Isoglukose in Zentral- und Osteuropa, im Segment Stärke ein bedeutender Produzent von kundenspezifischen Stärkeprodukten in Europa und Weltmarktführer einer breiten Palette von Bio-Stärkespezialitäten. AGRANA ist außerdem Weltmarktführer bei Fruchtzubereitungen und der größte europäische Produzent von Fruchtsaftkonzentraten. Und:

AGRANA ist größter Hersteller von Bioethanol in Österreich.
Die AGRANA Bioraffinerie in Pischelsdorf (NÖ) ist durch die Integration einer Weizenstärkefabrik mit der Bioethanolanlage mittlerweile ein Musterbeispiel für Ressourceneffizienz und gilt international als Benchmark. Dabei gehen die bei der Herstellung von Weizenstärke und –gluten bzw. Kleie ungenutzt bleibenden Rohstoffbestandteile als *sidestream* in die Bioethanolerzeugung. Gemeinsam mit dem Eiweißfuttermittel Actiprot und mit hochreinem CO_2, welches u.a. in der Getränkeindustrie eingesetzt wird, werden am Standort Pischelsdorf aus dem Rohstoffen Mais und Futterweizen somit hochwertige Produkte hergestellt und der Rohstoffinput zu 100 Prozent verwertet.

Die Fakten der perfekten Bioraffinerie
Die Produktion von Ethanol am Standort Pischelsdorf
spart 70% Treibhausgasemissionen gegenüber Benzin (300.000 t CO_2 Einsparung)
bewirkt eine 30% geringere Partikel-Emission und damit eine niedrigere Feinstaubbelastung durch Benzin-Motoren
ersetzt durch die Gewinnung von gentechnikfreiem Eiweißfuttermittel als Nebenprodukt den EU-Import von rund 200.000 t gentechnisch verändertem Sojaschrot aus Südamerika
stellt für die Getränkeindustrie 100.000 t Gärungs-Kohlensäure aus nachwachsendem Rohstoff statt aus fossilen Quellen her
sorgt für eine wichtige Marktentlastung bei Getreide
AGRANA produziert in Österreich und Ungarn rund 400.000 m^3 Bioethanol, wofür rund 1 Mio. t Überschussgetreide benötigt werden. Damit führt AGRANA in Mitteleuropa – mit einem Überangebot von ca. 8-12 Mio. t Getreide pro Jahr – immerhin rund 10% dieser Menge einer lokalen Wertschöpfung statt eines unbearbeiteten Exports zu.
stellt Bioethanol ausschließlich aus dem Stärkeanteil von Futtergetreide-Überschüssen her und lässt den wertvollen Proteinanteil im Futterkreislauf

AGRANAs Bioethanolerzeugung leistet somit einen essentiellen Beitrag zur Treibhausgas-Reduktion, Feinstaubverringerung, Eiweißfuttermitteleigenversorgung und gewünschten Stabilisierung des Getreidemarkts.
Genau das ist nachhaltige Veredelung agrarischer Rohstoffe!

Valmet GesmbH

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Valmet is the leading global developer and supplier of technologies, automation and services for the pulp, paper and energy industries. Valmet's vision is to become the global champion in serving its customers. Our 12,000 professionals around the world work close to our customers and are committed to moving our customers' performance forward – every day.

Valmet's services cover everything from maintenance outsourcing to mill and plant improvements and spare parts. The strong technology offering includes pulp mills, tissue, board and paper production lines, as well as power plants for bio-energy production. Valmet's advanced automation solutions range from single measurements to mill wide turnkey automation projects.

The company has over 200 years of industrial history and was reborn through the demerger of the pulp, paper and power businesses from Metso Group in December 2013.

Valmet's net sales in 2015 were approximately EUR 2.9 billion. Valmet's head office is in Espoo, Finland and its shares are listed on the Nasdaq Helsinki.

Our Energy offerings include:

Bubbling fluidized bed (BFB) combustion technology with wide fuel flexibility, high combustion efficiency, high reliability, excellent controllability and low emissions. BFB boilers are available in the size range of 10 to 400 MWth. Their proven technology and design ensure excellent combustion results, as well as minimal unplanned shutdowns and maintenance.

The **Advanced circulating fluidized bed (CFB) boiler** combines high-efficiency combustion of various solid fuels with low emissions, even when burning fuels with completely different calorific values at the same time. The wide size range of CYMIC covers boilers from 50 to 1200 MWth with high fuel flexibility. The main advantage of the CFB boiler is its superb fuel flexibility. Most of the over 70 references around the world are multifuel boilers that combust biomasses and fossil fuels in continuously varying proportions.

Valmet develops and supplies **Power Plants** that produce power and heat in an efficient, yet sustainable way. Our focus is on the flexible utilization of local renewable biomass and recycled fuels as well as innovative technologies and service capabilities. You can choose a power plant solution that best fulfills your requirements from several alternatives. They are all modular, featuring standardized, pre-designed and factory-tested modules with pre-engineered options. Their modular design ensures fast and low-cost project development, fast delivery, as well as low implementation and minimized delay risks. The capacity of Valmet's modularized power plants ranges from 1 to 10 MWe.

Gasification is rapidly developing combination of technologies and services for effectively converting biomass, recycled materials and waste into a usable form of energy. The CFB (circulating fluidized bed) gasification process works by partially combusting the biomass or waste at high temperatures using a controlled amount of air. The resulting product gas is a versatile energy carrier, which offers a range of benefits.As a global leader in CFB gasification technologies and services, Valmet offers gasification solutions to meet the needs of various power and process industry sectors. Each of these solutions generates energy from biomass and waste with high overall efficiency.

Boiler conversions: Converting old boilers into bubbling fluidized bed (BFB) technology is an environmentally sustainable solution and can be carried out at a highly competitive cost. A BFB conversion helps reduce emissions and also solves other environmental issues, such as sludge disposal. Many types of old boilers – pulverized-fired, grate and recovery boilers – can be converted into fluidized bed combustion. After a conversion, a boiler can burn various biomass fuels and industrial by-products. Gas and oil can be used as supplementary fuels. A boiler modernized in this way can match the performance of a brand-new BFB boiler.

BIOENERGY 2020+ GmbH

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BIOENERGY 2020+ GmbH offers research, development, demonstration and other services in the field of biomass to energy to its customers. The centre's research activities cover all relevant technologies such as biomass combustion, gasification, and bioconversion, for the efficient and environmentally friendly provision of fuels, heat and power from biomass. In addition, the centre also researches options for the industrial, non-energy use of biomass, e.g. the production of primary products for the chemicals industry.

As a centre of excellence, BIOENERGY 2020+ combines the benefits of fundamental research and application-oriented, technological knowledge, acquired during more than 15 years of project work. Our core task is to carry out industry-driven research at an internationally competitive level. We have successfully supported boiler and stove manufacturers in improving their products, developed a technology for biomass gasification and various downstream syngas processes, and identified the methane potential of a variety of feedstock mixes for biogas producers. To achieve this, we have developed our own tools such as model-predictive automation and control and models of single particle combustion and combustion on grates. Techno-economic and greenhouse gas emission assessments, market analysis for biomass feedstock and bioenergy carriers, and monitoring the status of technology implementation round off our bioenergy related expertise.

In carrying out our research work, we also train young researchers and prepare them for careers in both academic and industrial research. Every year we allow a considerable number of students to complete their academic theses based on BIOENERGY 2020+ projects.

With 90 employees and more than 100 industrial and scientific cooperation partners, we have been able to create critical masses and to establish ourselves as one of the world's leading research institutions in our fields of expertise. We always endeavour to work with our numerous partners in order to drive knowledge transfer between science and industry on one side and the cooperation between the relevant actors in a variety of technology fields on the other. The COMET funding, which we can access until 2023 assuming a successful interim evaluation, is an important asset for achieving this, and we utilise it in particular for performing mid- to longterm and strategic research in the following fields of expertise:

- Alternative biogenic fuels and substrates
- Pretreatment and upgrading of biomass residues
- Fuel, substrate and ash characterisation
- Low-emission and efficient biomass combustion systems
- Small and microscale combined heat and power generation systems
- Micro grids
- Thermal gasification of biomass
- Polygeneration of energy, fuels and chemicals
- Synthetic chemicals and biofuels from biomass
- Biogas and bioconversion
- Algal biorefineries
- Automation and control of thermal processes
- Modelling and simulation of thermochemical processes
- CFD-aided technology development
- Custom software development
- Special process engineering fields
- Sustainable supply and value chains

Froling: The big name for heat and electricity made from wood and pellets
Innovative solutions with a capacity range from 7 to 3,000 kW

Froling is the big name in automated biomass boilers fuelled by pellets, wood chips or log wood. The family-owned manufacturer offers high-efficiency heating systems (ranging from 7 to 3,000 kW) as well as solutions for fuel storage, tanks, heat exchangers and control systems. It exports to more than 35 countries worldwide and has large-scale manufacturing plants in Austria and Germany. With the experience of over 50 years in heating technology Froling developed the new wood power plant Type CHP, which produces heat and electricity from wood. The CHP50 has received the "Energy Genie" in 2015, which is an Innovation Award of the Ministry of Environment for new products according to the criteria of innovation, energy saving und novelty.

The Froling fixed-bed gasifier CHP 50 is available with an electrical output of 46/50/56 kW and a thermal output of 110 – 115 kW and achieves a total efficiency of more than 85%. The CHP can be installed ready for operation in a container (wood gasification system including safety technology, exhaust gas line and automatic gas flare) and is already put into operation and tested at the production plant of Froling. The other possibility is the indoor-variant where eg. up to 20 units can be installed as a cascade at one location. The first systems are successfully in operation since 2013. The customers are very enthusiastic about the fully automatic betrieb and the high efficiency. The worldwide acting Froling service team can ensure a appropriate on-site support of the CHP system.

Customer care from planning to servicing

The broad range of services provided by Froling is greatly valued by heating engineers, builders, planners, architects and other engineers. No matter what your need, Froling offers a full advice, planning, implementation and after-care service. Experts from around the world take part in training sessions at our training offices. Froling also offers a highly extensive customer service network.

Facts and figures:
Factories: Grieskirchen (AUT), Stritzing (AUT), Marzahna (GER)
Sales/training/competence centres: Grieskirchen (AUT), Munich (GER), Strasbourg (FRA), Bolzano (ITA)
Staff: around 600
Export ratio: over 80 percent
Markets: Europe (our main market); USA; other distributors around the world

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FUMIS AirMaster – electromechanical platform for optimisation of wood-log stove combustion process

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FUMIS by ATech electronics proved itself in last 5 years as the trendsetter in the field of biomass combustion controllers. After successfully launching FUMIS Alpha controller for pellet stoves that had an innovative solution for airflow measurement via delta P sensor, FUMIS keeps on innovating. In 2014 and 2016 FUMIS presented solutions that bring pellet stoves into IoT area with great emphasis on user experience and especially user comfort – the true reason why people use heating devices in the first place.

Now FUMIS is presenting a new solution, this time for wood-log stoves and fireplaces – FUMIS Airmaster, which consists of mechanical and electronical part with embedded, fully customizable, logic.

Mechanical part is designed to distribute the inlet air through three different airways (primary air, secondary air, and tertiary air). Three stepper motors control the three flaps of the three airways, which in turn regulate the amount of distributed air. The manipulation of these airways has proved itself to be a very efficient way to control the power output, efficiency and emissions throughout the different phases, together with improving user comfort.

The system is working with a wide range of different sensors that help the systems to optimize the combustion process. Although the system could include as much as four different sensors: K-type sensors for measuring the temperature in the combustion chamber, Lambda sensor for measuring the oxygen content in the flue gases, dP sensor for measuring the pressure, ambient temperature sensor; it could also work with only i.e. K-type sensor. The system is, thus, completely modular and customizable to producer's needs.

FUMIS AirMaster is, thus, a system that automatizes and optimizes combustion process in the wood-log stoves and fireplaces. It allows the manufacturer of wood stoves and fireplaces to develop highly efficient stoves that are controlled either with smartphone application, remote control, display or by buttons on the stove.

New Markets: Africa Meets EU Workshop & B2B Matchmaking

One to one meetings with potential business partners

Glen Wilson

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www.aebiom.org *in collaboration with* www.africa-eu-renewables.org

The Africa-EU Renewable Energy Cooperation Programme (RECP) is a multi-donor programme that supports the development of markets for renewable energy in Africa. It works through industry associations, such as the European Biomass Association (AEBIOM), to bring together European and African partners and acts as a platform to support projects in Africa to achieve maturity. In light of this aim AEBIOM, in collaboration with the RECP, has organised a B2B Matchmaking session on the 20th of January, as part of the Central European Biomass Conference. All who attend the conference are welcome to register for New Markets: Africa Meets EU Workshop and B2B Matchmaking.

Kurzfassung LEC – Large Engines Competence Center

Das Large Engines Competence Center (LEC) ist Österreichs führende Forschungseinrichtung im Bereich der Verbrennungstechnologien für Großmotoren. Die Entwicklung umweltfreundlicher, effizienter und robuster Großmotoren steht im Fokus. Die wesentliche Zielsetzung des COMET-K1-Zentrums LEC EvoLET – als Teil der LEC GmbH – besteht in der Schaffung der Grundlagen für den Technologiesprung zur nächsten Generation von Gas- und Dual Fuel Motoren. Dadurch soll der bestmögliche Einsatz dieser Motoren in unterschiedlichsten Anwendungsfeldern ermöglicht werden.

Die Zusammenarbeit mit Technologie- und Weltmarktführern sowie innovativen KMUs erlaubt uns eine permanente Weiterentwicklung der Methodik und die Verbesserung der Konzepte im Bereich der Verbrennungstechnologien für Großmotoren. Unser internationales Partnernetzwerk, das COMET-Forschungsprogramm und die Infrastruktur an der TU Graz bieten die idealen Rahmenbedingungen um maßgeschneiderte Lösungen für unsere Partner zu entwickeln und Innovation zu fördern. So steht am LEC etwa eine umfassende Prüfstandsinfrastruktur für die Großmotorenentwicklung mit Einzylinder-Forschungsmotoren zur Verfügung.

Das Zentrum gliedert sich in verschiedene Bereiche, wovon die drei Areas (Area A – NG & NNG Combustion, B – Dual Fuel Combustion und C – Robust Engine Solutions) direkt mit der Umsetzung der technologieorientierten Themen im Forschungsprogramm LEC EvoLET befasst sind. Die Area X (Simulation & Validation) fungiert domänenübergreifend und unterstützt die Forschung der anderen Areas.

Neben den Aktivitäten im Rahmen des COMET-K1-Programms ist das LEC in folgenden Bereichen tätig:

- Engine Applications
  Auftragsforschung im Bereich von Verbrennungskonzepten für Gas-, Diesel- und Dual-Fuel-Motoren sowie Komponententests (z.B. Reibung, Verschleiß. Ölverbrauch, thermodynamische Bewertung)
- Services
  div. Dienstleistungen (z.B. Studien, Gutachten, Beratungen im Bereich Energieerzeugung, Nachhaltigkeit, Emissionsgesetzgebung, etc.)
- Software
  Entwicklung und Vertrieb von innovativer Software für Messfehlerdiagnosen sowie hochflexibler Software zur Analyse und Simulation des Arbeitsprozesses von Verbrennungsmotoren

Ausgewählte Referenzprojekte:

- *Combustion Concept J920* - Ein hocheffizientes Verbrennungskonzept für den neuen 9,5 MW Jenbacher Gasmotor von GE
- *Blast Furnace Gas to Power* - CO_2-Reduktion durch den effizienten Einsatz von Hochofengas (Gichtgas) in Großgasmotoren für die Strom- und Wärmeerzeugung
- *HyWood* - Nachhaltige Strom- und Wärmeerzeugung mit wasserstoffreichem Synthesegas aus Biomasse
-

Ao. Univ.-Prof. Dr. Andreas Wimmer (Geschäftsführer und wissenschaftl. Leiter)

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13:30–15:00 Uhr

Parallelblock 1

Biogas

1:30–3:00 pm

Parallel Session 1

Biogas

Cover-Crops for biogas-production: Increasing acceptance and environmental effects

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Cover or catch crops (CC) reduce environmental risks of farming and improve soil and water quality. If harvested, they also provide feedstock for biogas plants. In combination with manure and other farm residues (e. g. maize straw) they enable biogas production without further tightening of land use competition, limitation of food production or increase of maize cultivation. Therefore, we investigated the energy yields achievable with CC in 5 field experiments (2 of them over 6 growing seasons) and on farm scale (approx. 1000 ha). With the data collected and the modelling tools STAND (humus content balance), BoBB (erosion), STOTRASIM (nitrate leaching) and SPI® (ecological footprint) we also analyzed ecological effects and economic efficiency.

Energy yields: In most cases CC dry matter (DM) yields varied between 2.5 and 6 tonnes (t) ha^{-1}. Under favourable conditions 7 - 8 t ha^{-1} were achieved. Biogas digester lab scale experiments resulted in an average energy content of 280 Nl methane (CH_4) kg^{-1} DM or 307 Nl CH^4 kg^{-1} organic DM. Therefore, an average gross energy yield of approx. 1300 m^3 CH_4 ha^{-1} can be expected from 4.5 t DM ha^{-1}. Extrapolated on 50 % of arable land in Austria this would result in approx. 860 Mio. Nm^3 CH_4. Considering the total energy invested from cultivation to compression for biofuel use a net energy yield of about 1000 m^3 CH_4 remains per ha. Regarding energy efficiency it is also viable to use CC with low yields: The generation of compressed CH_4 from 2 t DM ha^{-1} still requires only 19 – 23 % of the gross energy content. With the straw of grain maize or Corn Cob Mix (CCM) comparable energy yields per ha can be achieved as with CC.

Humus content and soil fertility: In comparison to complete fallow in a crop rotation with silage maize and cereals the humus balance can be improved from – 50 to 280 kg humus carbon (C) ha^{-1} $year^{-1}$ with the production of biogas from 4.5 t DM ha^{-1} CC and the return of an equivalent amount of digestate. With a CC-yield of 2.5 t DM ha^{-1} the humus balance results in 220 kg C ha^{-1} $year^{-1}$. It is still slightly higher than the balance of the same CC remaining on the field as green manure (170 kg C ha^{-1} $year^{-1}$). Additionally it is important to consider that 20 – 50 % of the assimilated carbon can be found in the plant roots and that roots and root exudates as well as CC harvest residues provide fresh organic matter for soil life. Furthermore, biomass production was considerably higher, if cover crops were used for biogas production because of earlier cultivation and later harvest than mulching. On the other hand, if summer cover crops remain on the field without incorporation in soil during winter considerable amounts of the biomass can also get lost into atmosphere. Nevertheless it is important to avoid soil compaction during CC harvest and digestate application.

Erosion control: The risk of erosion can be reduced by approx. 50 % in comparison to complete fallow if CC with 2.5 t DM ha^{-1} remain on the field as green manure. A comparable reduction can be achieved, if CC with 4.5 t DM ha^{-1} are harvested for biogas production. Because of better weed suppression, tilth and soil structure of CC with higher biomass, it is more likely to apply conservation tillage and avoid ploughing as well as the application of glyphosate. With a CC (4.5 t DM ha^{-1}) used for biogas in a crop rotation without ploughing the risk of erosion can even be reduced by approx. 75 % in comparison to complete fallow with ploughing.

Water balance and water protection: On the plots of our field experiments approx. 30 % of the precipitation contributed to groundwater recharge in crop rotations without CC. With 2.5 t CC DM ha^{-1} remaining on the field as green manure groundwater recharge was reduced to approx. 27 % whereas 4.5 t DM CC ha^{-1} caused a reduction to approx. 25 %. Despite lower dilution nitrate concentration was reduced by green manure CC from 55 to 54 mg NO_3 l^{-1} and in case of biogas production to 43 NO_3 l^{-1}. CC remaining as green manure reduced the total nitrate leaching by 6 %. CC used for biogas with a return of an equivalent amount of digestate reduced total leaching in comparison to complete fallow by 26 %.

Nitrous oxide (N_2O) emissions: The risk of nitrous oxide emissions was estimated with statistical models and results are bound up with corresponding uncertainties. CC serving as green manure increase N_2O-emissions in comparison to complete fallow approx. by 60 % from 1.4 to 2.3 kg N_2O-N ha^{-1} a^{-1}. Harvesting CC for biogas increases emissions in comparison to complete fallow approx. only by 15 % to 1.7 kg N_2O-N ha^{-1} a^{-1}. Compared to green manure CC N_2O-emissions are reduced approx. by 25 %.

Ecological footprint SPI®: In comparison with complete fallow and considering the substitution of natural gas with biogas the footprint of arable farming can be reduced by approx. 50 %. Biogas produced of maize on 20 % of arable land reduces the ecological footprint approx. by 20 % and from maize straw by 25 %.

Public acceptance: The societal and economic benefit of biogas production as well as of arable farming are enhanced in many ways. CC including flowering plants (e. g. sunflowers) additionally increase public perception in the immediate surroundings. In conjunction with the avoidance of land use competition public acceptance may therefore be increased significantly. Thus, incentives for biogas production from CC should also be included in agri-environmental programmes.

Wood ash from district heating plants for the upgrading of biogas from anaerobic digestion

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Many technologies have been developed in the last decade for the upgrading of biogas produced during the anaerobic digestion (AD) of agricultural biomass as well as biowaste. The main aim is the gas cleaning from CO_2 with subsequent concentration of CH_4 up to minimum 95% to obtain biomethane for grid injection or/and transport use. In this way it is possible to diversify the final use of biogas and to contribute to the EU objectives of 10% of biofuel for transport within year 2020.
Most part of the upgrading solutions on the market are economic sustainable only for big plants (>300-500 Nm^3/hour of biogas), thus the development of low cost systems dedicated to small biogas plants or used for the exploitation of the surplus biogas which cannot be converted to power seems to be a topic to explore.
A previous project carried out by the Florence University (UniFI) in the years 2011-2013 showed the capacity of bottom ash from a waste burning plant to capture the CO_2 present in the landfill biogas. As an alternative to waste bottom ash, in alpine regions the availability of ash deriving from the combustion of wood biomass, carried out in district heating plants, represents an opportunity to better use this kind of waste before final disposal.
In the present work the bottom ash (BA) residuing from the combustion of wood in a central heating plant was used to convert the AD biogas in a high-grade gas rich in methane with the aim to evaluate its application for biomethane production.
Preliminary tests were carried out by the UniFI laboratory in a static single-stage reactor, made of a fixed bed of bottom ash (BA) crossed by a gas flow rate of 3.7 $Nm^3/(h \cdot MgBA)$. On the basis of previous results (Mostabuer P., Lombardi L. et al., 2014[1]) the gas used was a mixture of 45-48% CO_2 (in volume) and N_2 as remaining amount, to simulate the composition of biogas from AD. The gas flow rate and quality before and after the treatment and temperature above and under the BA layer (and room temperature) were measured in continuous. The results showed a good removal of CO_2, which was about 100% in the first 14-16 hours, in a first test, and up to 26 hours in a second test of the process accompanied by increase of temperature inside the reactor. With respect to other typologies of ash used in the cited previous projects the capacity of wood ash to capture the CO_2 seems to be higher, reaching in the reported test values up to 120 g of captured CO_2 per kg of wood ash. However, when the test was stopped, the volumetric concentration of CO_2 in the exiting stream was still below 0.5%, meaning that the ash capacity of capturing CO_2 to upgrade biogas was still available. On the basis of these preliminary encouraging lab results the project is continuing with a 2nd phase in a pilot plant. The AD process of source selected food waste is carried out in a dry-batch reactor (overall exploitable = 16 m^3) under mesophilic conditions. The biogas produced is monitored by means of a gas analyzer (EC 322, Eco-Control Milan, Italy) in order to continuously detect the amount of methane, carbon dioxide, oxygen and hydrogen sulfide produced. The biogas is sent to the single-stage static reactor containing moisturized wood ash. The main aims of this 2nd phase are the following: 1) to confirm the positive results obtained at lab scale; 2) to optimize the process parameters and the capture behaviour of ash; 3) to detect the environmental quality of ash after the treatment to identify

[1] Mostbauer, P., Lombardi, L., Olivieri, T., Lenz, S., 2014. Pilot scale evaluation of the BABIU process - Upgrading of landfill gas or biogas with the use of MSWI bottom ash. Waste Management. Waste Management, 34 (1), pp. 125-133

Scenario based balancing of nutrients from digestates and farm fertilizers

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A majority of surface waters and more than one third of groundwater bodies in Germany are unable to meet the objectives and limits of the EU Water Framework Directive (WFD 2000/6/EG). Meanwhile especially too high nitrogen inputs from agricultural sector are responsible for this. [Wasser und Abfall 6/2015 and BMU, UBA (2013): Wasserwirtschaft in Deutschland – Teil 2: Gewässergüte].

The nitrogen as well as the often linked phosphorus excess has negative effects on the ecosystems. Therefore, the limit values for nitrogen output in the German Fertilizer Application Regulation are considered to be extended to digestate of plant origin in order to reduce the nutrient load. In regions with anaerobic digestion (AD) plants and simultaneous livestock farming there is already a competition for distribution of digestate and farm fertilizers/manure on agricultural land for fertilizer usage. Especially when the livestock farmers have to import animal feed and therefore nitrogen and phosphorous, too. The competition will increase in future by structural change in agriculture sector.

In case of excessive fertilization in individual communities or regions, the soils and water bodies can be loaded too much with nutrients. However, an agricultural use of digestate and farm fertilizers serves the purpose of recycling nutrients, which is the primary goal. Transport in neighboring communities or regions for nutrient balancing is the easiest solution. The economic radius, however, is extremely limited, mainly due to the high water content but also the nutrient balances often are not known among the neighboring farmers. This can result in local over fertilization, whereas for the neighboring fields conventional fertilizer has to be purchased.

At Fraunhofer Institute UMSICHT in Sulzbach-Rosenberg a model for nutrient balancing from digestate and farm fertilizers was developed for Bavaria, the largest federal state in Germany with approximately 2.330 AD plants on VBA (Visual Basic for Applications) based Excel programming. This model can be used to identify regional hotspots or to calculate various scenarios like future intensification of livestock farming or reduction of agricultural land. As a result, at an early stage countermeasures against over-fertilization can be developed, planned and introduced. And the excess digestate and farm fertilizers are available for alternative utilization.

With given statistical data (e.g. AD plants and livestock quantities, the AD plant sizes as well as the agricultural land per community) and user inputs (e.g. substrate composition and substrate degradation data in the AD plants, nutrient contents in farm manure and their generation per animal and nutrient application limits per hectare agricultural land) the resulting nutrient amounts and excesses can be calculated down to community level and the results can be made visible in an interactive, colored map for hotspot identification.

GHG mitigation effects from anaerobic digestion of manure and consideration of these effects within the certification of biomethane as transportation fuel

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As a result of an intensive debate about the sustainability of bioenergy production in general and the production of biofuels for transport in particular, the EU Commission has introduced a number of sustainability criteria as part of the Renewable Energy Directive (EU RED).
These sustainability criteria include amongst others, requirements regarding the greenhouse gas (GHG) emission saving potential of biofuels. Since the fulfillment for these criteria has become a precondition of any promotion mechanism related to the national biofuel quota system, the calculation of the GHG emissions has gained significant importance for biofuel producers as well as for certification schemes and auditors.
In the case of the GHG emissions calculation of biomethane, based on anaerobic digestion of manure, the consideration of credits for avoided methane emissions from conventional manure management is a relevant factor for the overall GHG saving potential.
Conventional storage of manure inevitably leads to climate-relevant emissions and can be a remarkable contributor to the overall GHG emission inventory of the agricultural sector.
The German agricultural sector has been responsible for GHG emissions of around 66 Mil. tonnes of carbon dioxide (CO_2) equivalents in 2014. This represents 7.3% of total greenhouse gas emissions this year. With almost 9 million tonnes of CO_2 equivalents per year, more than 10% of the agricultural related GHG emissions are caused by the conventional storage of manure from livestock production.
The early introduction of manure from livestock production as a substrate in a biogas plant can help to avoid the conventional storage and thus the emissions associated with this kind of manure management.
The magnitude of emissions avoided differs according to the type of manure from livestock production and the used storage system.
In order to consider this mitigation effect in the GHG balance of biogas and biomethane production, emission credits can be used. There are two factors that are necessary for the calculation of the emissions from manure storage und thus for the calculation of the emission credits, (i) the maximum methane-producing capacity of the manure (B_o), this factor varies by species and diet; (ii) the methane conversion factors (MCF). The MCF describes the share of methane that is produced in various storage systems and by annual average temperatures.
In the literature there are varying information regarding the level of these parameters.
For the calculation of the emission credit factor factors in the present study, average methane yields and typical values for the storage specific methane conversion factor MCF were assumed.
Independent of the magnitude of the calculated emission credit, it is the question how these mitigation effects can be included in the calculation of the GHG mitigation potential of biomethane.
In principle, the EU RED methodology allows for the accounting of various options to save GHG emissions along the entire value chain of biofuel production, e.g. emission savings through carbon capture and replacement, through improved agricultural management. But options for including emission mitigation effects from manure fermentation are not clearly described or defined and are not included in corresponding default values for biogas and biomethane from manure.
Within H2020 project Biosurf, we have developed an approach to solve the above mentioned methodological challenges while remaining consistent and conform to the EU RED approach.

The valence of flexible green electricity generation units

DI Dr. Bernhard Stürmer, University College for agrarian and environmental pedagogy, Angermayergasse 1, 1130 Vienna, bernhard.stuermer@agrarumweltpaedagogik.ac.at

Introduction: With increasing share of fluctuating electricity generation capacities, keeping the power grid stable becomes to an increasing challenge. The uncertainty at the forecast of power consumption increases with increasing installed photovoltaic capacity, while the increasing uncertainty at the forecast of the electricity production increases with the installed wind capacity. Due to limited available distribution capacity of the electricity grid, the established compensating systems are reaching limits with increasing expansion. The importance of regional compensation is gaining in importance. In addition to the established hydropower in Austria, biogas or biomethane and biomass cogeneration have a good prerequisite for the supply of necessary capacities at the balancing markets as well. The question is, up to which electricity price, it is advantageous to use flexible capacities. For this purpose, in this article, the year 2015 is evaluated retrospectively by the use of linear planning in a land constrained energy economy.

The model approach: In order to be able to assess the excellence of flexible green electricity generation capacities (P_{flex}), the most cost-effective expansion scenario of wind power, photovoltaics, and P_{flex} within the 4-hour-time intervall is calculated by means of linear planning. The linear programming model can freely select the necessary capacities to meet the needs of every 15 min time period. Wind power and photovoltaics have to reach the highest 15 min load and the flexible green power capacities can use load fluctuations, from a medium load level, of +/- 25%. The load fluctuation is assessed with the average weekly prices of the secondary balancing power (Peak, Offpeak, Weekend). In the target function, the costs (c) of the current mix are minimized; hence the current requirement is achieved for every 15 min block (bj) at least. The model can freely choose between additional wind, photovoltaic, and P_{flex} capacities (i) in a coefficient matrix ($A_{i,j}$). The price (p_i) for these capacities is calculated as average full costs (wind 100 EUR/MWh$_{el}$, PV 120 EUR/MWh$_{el}$) or varied (P_{flex} 75-500 EUR/MWh$_{el}$). The capacities (x_i) are optimised so that the resulting current mix is cost-minimised. Hydropower (run-on-river) was assumed to be constant.

$$\min_x c = \sum_i (p_i x_i)$$

$$s.t. \quad \sum_i (A_{i,j} x_i) \geq b_j \quad for\ all\ j$$

Results: The results show, that there is a considerable expansion requirement of wind, PV, and flexible green electricity production capacities to meet the domestic demand. In the case of wind power, calendar week 23 to 33 fell below average. Electricity production from photovoltaic plants is highly restricted, especially between calendar week 47 and 7. Accordingly, the power of electricity generation from these technologies is less favourable during these periods. Over a curtain shadow price (see Figure 1) for the flexible green power generation capacities it is more favourable to increase the wind power or photovoltaic respectively (up to the factor of 20 in wind resp. up to a factor of 60 in photovoltaics compared to the status quo). Below this curtain shadow price it is more favourable to use the flexible green electricity capacities.

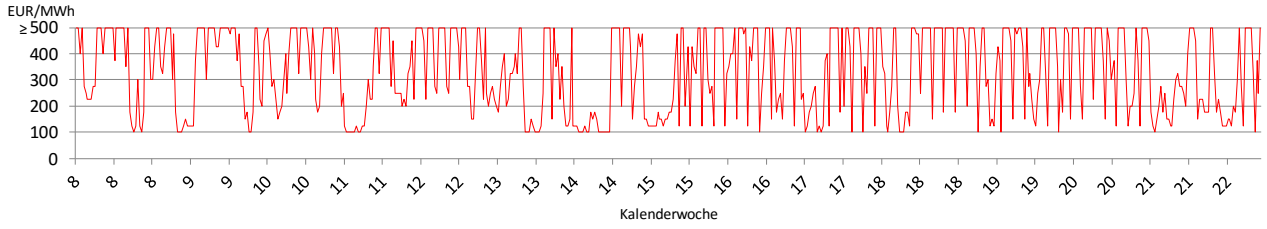

Figure 1: Trend of the shadow price of flexible green electricity generation capacities in calendar week 8 to 22

Conclusion: The extension of capacities of all renewable technologies is necessary in an electricity mix of the future.
Only the interaction of all technologies ensures a cost-effective and secure supply of green electricity.

15:30–17:00 Uhr

Parallelblock 2

Bioökonomie: Systembetrachtungen

3:30–5:00 pm

Parallel Session 2

Bioeconomy: system considerations

Fostering a Circular Forest Bioeconomy

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From Spain down in the south to Finland up in the north – research and development in the field of circular forest bioeconomy is carried out all over Europe. In the H2020 project ERIFORE, 13 leading research organizations in ten European countries jointly focus their usual research activities to build a collaboration network that can turn scientific discoveries into new business models, novel products and services enabling sustainable growth. The general objective of the project is to facilitate research development in the field of circular forest bioeconomy towards the following overall targets:

1) Coordinate, complement and update major European research infrastructure to enable and unlock the full potential of available forest biomass in balance with diverse use of forests.

2) Foster a new level of co-operation between the major RTD providers in the field.

3) Establish a globally competitive European research infrastructure delivering next generation technologies, especially in the following areas:
- From paper to novel biomaterials.
- Upgrade of current pulping process into an integrated wood-based biorefinery.
- Recycling and use of forest biomass waste streams as raw materials.
- Generate enabling technologies & knowledge to be applied in bioeconomy transformation.

The suggested future European research infrastructure will facilitate the development towards enhanced utilization of renewable raw materials and renewal of established European process industry. Besides introducing the overall project this presentation will focus on a studiy that will help at reaching the general objectives:

Mapping the Emerging Landscape of Bio-based Industry and Research Cooperation: Results of a Social Network Analysis

The results of this study will show the existing networks of forest biorefinery research and development within the European context. It aims at uncovering the active research clusters including university institutes, research centers, industry and associations. More interestingly it will address potential gaps especially considering integrated biorefinery development but also with a special glance at the Austrian perspective.

Strategic Actions for the Transition of the Pulp and Paper Industry into Biorefinery: Insights from a Delphi Study

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Being a mature industry, pulp and paper industry (PPI) possess strength points coming from its existing infrastructure, technology know-how, and abundant availability of biomass. However, the declining trend of the wood-based products sales sends a clear signal to the industry to transform its business model in order to increase its profitability. With the emerging global attention on bio-based economy and circular economy, coupled with the low price of fossil feedstock, the PPI starts to integrate biorefinery as a value creation business model to keep the industry's competitiveness. Nonetheless, biorefinery as an innovation exposes the PPI with some barriers, of which the uncertainty of the promising product becomes one of the major hurdle.

This study aims to assess factors that affect the diffusion and development of forest biorefinery in the PPI, including drivers, barriers, advantages, disadvantages, as well as the most promising bio-based products of forest biorefinery. The study examines the identified factors according to the layer of business environment, being the macro-environment, industry, and strategic group level. Besides, an overview of future state of the identified factors is elaborated as to map necessary improvements for implementing forest biorefinery.

A two-phase Delphi method is used to collect the empirical data for the study, comprising of an online-based survey and interviews. Delphi method is an effective communication tools to elicit ideas from a group of experts to further reach a consensus of forecasting future trends. Collaborating a total of 50 experts in the panel, the study reveals that influential factors are found in every layers of business of the PPI. The politic dimension is apparent to have a significant influence for tackling the economy barrier while reinforcing the environmental and social benefits in the macro-environment. In the industry level, the biomass availability appears to be a strength point of the PPI while the knowledge gap on technology and market seem to be barriers. Consequently, cooperation with academia and the chemical industry has to be improved. Human resources issue is indicated as one important premise behind the preceding barrier, along with the indication of the PPI's resistance towards biorefinery implementation as an innovation. Further, cellulose-based products are acknowledged for near-term product development whereas lignin-based products are emphasized to gain importance in the long-term future.

KEYWORDS
Pulp, paper, biorefinery, bio-based economy, lignocellulosic, biomass, Delphi method

BIOFoNIE – Überblick über die internationalen Forschungsaktivitäten zu Biobased Industries

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Dieser Beitrag präsentiert einen Überblick über die aktuellen F&E-Programme und deren thematische Schwerpunkte hinsichtlich stofflicher Nutzung von Biomasse in einer Biobased Industry in den EU-28 und OECD-Ländern.

Die Biobased Industry nutzt erneuerbare und biogene Rohstoffe zur Bereitstellung eines vielfältigen Portfolios an Produkten und Dienstleistungen. Sie bietet damit die Chance, unter Berücksichtigung von Ressourceneffizienz und Kreislaufwirtschaft, die Umstellung verschiedener Wirtschafts- und Industriesparten auf nachwachsende Rohstoffe und erneuerbare Energie zu beschleunigen. Die Entwicklung entsprechender Technologien und Gesamtkonzepte sowie neuer Wertschöpfungsketten zur Nutzung biogener Rohstoffe und Energieträger in einer „Biobased Industry“ steht daher derzeit im Fokus vieler nationaler und internationaler Forschungs- und Entwicklungs-Strategien und Förderprogramme.

Ausgehend von der „FTI-Strategie für die biobasierte Industrie in Österreich“ des Bundesministeriums für Verkehr, Innovation und Technologie mit den darin identifizierten Entwicklungspfaden und wesentlichen Themenbereichen werden in diesem Beitrag in insgesamt mehr als 40 Ländern die aktuellen F&E-Programme und deren thematische Schwerpunkte hinsichtlich stofflicher bzw. energetischer Nutzung von Biomasse analysiert, bewertet und zusammenfassend aufbereitet, um die österreichischen Aktivitäten im Vergleich zu den anderen Ländern vergleichend darzustellen. Die Ergebnisse zeigen u.a., in welchen Ländern der derzeitige F&E-Fokus auf Biotreibstoffe verstärkt wird, oder in Richtung verstärkter stofflicher Biomassenutzung dreht. Zudem werden die größten und wichtigsten nationalen und internationalen industriellen Partner und Forschungseinrichtungen sowie große Leuchtturm – und Demoprojekte präsentiert.

Diese Untersuchung erfolgte im Auftrag des Bundesministeriums für Verkehr, Innovation und Technologie und in Zusammenarbeit mit dem Task 42 „Biorefining“ der Internationalen Energieagentur IEA Bioenergy.

LCB production based on corn stover – Preliminary feasibility study for Serbia

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According to the Serbian National Renewable Energy Action Plan, biomass presents over 60 % of total RES potential, whereby corn stover presents significant and until now unused feedstock. In the same time, fulfilling of the Renewable Energy Directive (RED) stated targets till 2020 is less optimistic in the case of biofuels for transport.
As subcontracting of FP7 project S2BIOM, the study of technical and economic feasibility of facility for production of lignocellulosic bioethanol (LCB) in Serbia, based on corn stover as feedstock, has been conducted. Objective was also to consider environmental issues, like potential for reduction of GHG emissions and preservation of soil fertility by applying sustainable corn stover off-take.
Technology for production of LCB is currently in early commercial phase of maturity, and for this study input data of sole European plant were used. According to this, 5 tons of bone dry corn stover is needed for the production of 1 ton LCB.
Terminology of corn stover potentials was introduced: 1. theoretical (all aboveground residues of corn, i.e. aboveground biomass except corn), 2. technical (harvestable, depending on harvest procedure), 3. sustainable (without negative impact on environment) and 4. energy (remaining after subtraction of previous potential for other uses and foreseen response of farmers). For the last stated potential the mapping was provided, whereby only density of plots of larger than 5 ha were considered. Possible imports from neighbouring countries were considered as well. Issue of supply security was also elaborated. Example, impact of draught on corn, i.e. corn stover yield reduction.
The prerequisites for satisfactory corn stover harvest procedures have been stated: 1. reduction of grain harvest productivity may not exceed 10 %, 2. corn stover contamination, soiling, may be up to 5 %, 3. corn stover harvest may not increase grain losses over 1 %. Corn stover harvest procedures practiced in other countries were considered. It was found out that the best solution will be to perform two-pass corn stover harvest procedure, but machinery for it, at this moment, are not available in Europe. The storage issues were tackled as well, and it seems that it presents not so big problem as it was presumed. The open air storage on elevated basement and by tarpaulin covered stacks seems to be reasonable solution. Costs of harvested, finished by storing at primary storage till delivery were estimated in range between 42 and 45 €/t for corn stover dry matter, including values of removed nutrients and some revenue for farmers.
Supply logistic was evaluated by application of location-allocation-problem, and the best potential locations for LCB refinery identified, whereby only these having Danube harbour were selected. These resulted with estimation of average supply costs for corn stover on a plant location of 57 and 60 €/t for water and road transport, respectively.
It is currently unrealistic to determine precise values for total GHG emissions of an entire LCB chain, due to lack of data for its production process. In this study calculated are only GHG emissions for feedstock procurement and its pre-processing. They are, for supply region radius of 60 km in the range 13 to 15 gCO_{2eq}/MJ, what makes about 40 % of defined limit, which is 33.5 gCO_{2eq}/MJ. It is also not easy to comprehend all issues related to preservation of soil fertility. Generally, this can be solved by removal of 35 to 40 % of above ground residues, in combination with adequate crop rotation and other measures. This removed amount enables, in combination with non-turning soil tillage, protection of wind erosion.
Financial analyses were performed for two plant capacities, 40 and 50 thousands of tonnes of LCB per annum, and expressed by liquidity, project IRR, equity IRR and payback period. The costs of feedstock, investments and inputs were varied to perform sensitivity analysis. In the best case the production costs per ton, without profit, were under 650 €/t. This was compared with price for bioethanol on stock exchange, plus incentives for LCB included. For example, if the stock exchange price is 500 €/t, incentives should be 150 €/t. The problem of adequate collection of corn stover has been identified as crucial, and future efforts should be oriented toward its solving.

The Biorefinery Innovation System: Lessons to be learned & Questions to be asked

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The Bio-economy and associated terms have been increasingly used and discussed (Staffas et al., 2013). According to OECD (2006) the concept of bio-economy can be defined as "transforming life science knowledge into new, sustainable, eco-efficient and competitive products". Therefore innovation plays a crucial role when realizing the vision of a bio-economy. The concept of the innovation system stresses that the flow of technology and information among people, enterprises and institutions is key to an innovative process. It contains the interaction between the actors who are needed in order to turn an idea into a process, product or service on the market (Hekkert et al., 2011). The concept of bio-refining, equivalent to petrochemical refining is a basic concept bio-economic innovation (Langeveld et al., 2010). Boehlje and Bröring (2011) described three dilemmas for innovation and adoption in context of the increasing multi-functionality of renewable raw materials: the competing goals dilemma, the incumbent versus new entrant competition dilemma and the industry boundaries dilemma.

The vision of a bio-economy as well as its implementation by biorefinery concepts are ideas that aim at integrated value chains. The focus on comprehensive sustainability in economic, social and environmental terms requires value chain and life-cycle thinking. Hence, the vision of a bio-economy opens a range of research issues (Langeveld et al., 2010), which can be grouped into four principal emphases, such as consumer preferences, process engineering, socio-economics, and production (Dixon et al., 2007).

In terms of industrial innovation management most of the bio-economic technology development must be considered as multi-stakeholder (e.g. public private partnerships; triple-helix; Etzkowitz and Ledesdorff, 2000) and inter firm (e.g. bio-economy clusters) processes based on technology or innovation chains. Although being considered a multi-stakeholder process not all competent and relevant actors in the technological system can be directly involved in the entire process, but it is possible to use socio-economic methods (e.g. surveys) to increase overall involvement.

De Jong and colleagues (2010) see the transportation sector as the main driver for development and implementation of biorefinery processes. They state that significant amounts of renewable fuels are necessary in the short and midterm to meet policy regulations. Hence, policy regulations could be considered as being the main driver but if we expect biorefineries to make substantial contributions towards (transportation) fuel demands in the future, the process of diffusion of innovation will most likely see a number of other higher value products targeted on the way towards this goal (De Jong et al., 2010). As in case of petrochemical refineries (FitzPatrick et al., 2010) a biorefinery requires low value high volume as well as high value low volume products to be economically feasible. The so called "valley of death" between research results and successful commercialization is often explained by a lack of market orientation and focus in research (Cooper, 2006).

For this presentation the scientific literature regarding biorefinery development was analyzed from an innovation system perspective. As a result several principal issues for future innovation management in biorefinery development are identified.

13:30–15:00 Uhr

Parallelblock 3

Brennstoffaufbereitung und -upgrading

1:30–3:00 pm

Parallel Session 3

Fuel pretreatment and upgrading

Monitoring of fuel wood drying efficiency through meteorological data based models

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A common way to determine biomass fuel quality is its calorific value, which is strongly influenced by its moisture content. Calorific value of fresh substance decreases substantially with increasing moisture content. Drying is a measure to reduce the moisture content and reversely increase the calorific value. Knowledge on the state of moisture content is therefore vital for gaining the most profit in terms of energy from the material.

Since 2009, a series of studies have been carried out by the Institute of Forest Engineering, University of Natural Resources and Life Sciences, Vienna on the topic of fuel wood drying. The goal of these studies was to develop an experimental design for modelling natural drying performance of fuel wood log piles based on meteorological data. Application of models under different climatic conditions, impact of rainfall events and treatment types, as well as environmental and economic implications of fuel wood drying were studied.

Metal frames, similar to timber truck structures, based on load cells were loaded with logs. Similar to a giant scale, these devices allow to permanently monitor the drying performance of the pile through weight alteration, while a meteorological station captures the respective drying conditions. From 2009 to 2016, five drying cycles, two of beech and one of pine, oak and poplar logwood each were conducted. The studied logs covered a diameter range of 10 cm to 30 cm and were between 3.5 m and 5.0 m long. Per frame between 10 m³ and 17 m³ of logs were stored and the initial load was 10 and 18 tonnes. The logs were stored for eight to fourteen months, usually starting between September and March.

Regression analysis is employed to develop the meteorological data based drying models. Model validation is either achieved by vice-versa application of models to different countries datasets or repetition of experiments. Cost benefit analysis is used to determine economic effects, while environmental effects are determined by assessing the impact of drying on transport.

In general, logwood moisture contents decreased about 20 % to 30 % from storage start in winter to the end of summer. Dry matter losses between 0.7 % (beech) and 3.4 % (pine) were observed during storage during this period. Sufficiently accurate models (within ± 2 % from the observed drying curve) could be established for logwood on different time interval (hourly, daily and monthly) basis. As long as validation data was within the range of the models, application proved to be successful. Rainfall events of > 30 mm delayed drying of pine several days. Revenues created through drying increased by up to 52 % due to drying. Drying proved to be beneficial in environmental terms, as truck transport trips decreased by 22 %, while transported calorific value rose by 48 % for beech logwood within one drying period.

In March 2016 two variates of poplar logs were stored to investigate the effect of splitting on the drying performance of logwood was started, employing the same approach. While the logs remained untreated in the first, they were split into halves in the second. At the end of September, split logs had lost about three to four times more moisture than logs without treatment. Starting from a moisture content of about 50 %, split logs reached about 31 % at the end of September, while intact log moisture content was about 44 %.

Drying fuel wood in the form of logwood is a possible storage technique before chipping and transporting. It is beneficial in terms of drying efficiency, low dry matter loss rates and in terms of economy. Therefore, if possible, this should be the method of choice.

Container trials to examine the effects of fuel screening on the storage behavior of wood chips

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The limited availability of forest products requires a sustainable and resource efficient use of the raw material. Optimization potentials are present throughout production and conversion of wood chips. Thereby, storage of fresh wood chips plays an important role, as it is used for drying of bulk material but also to compensate for temporal and spatial differences in fuel supply and demand. However, biological degradation processes during storage may cause high dry matter losses and a decline in fuel quality. These degradation processes might be increased by a large amount of fines, such as needles and leaves, due to their large specific surface area and high amount of easily available nutrients for microbial growth. Furthermore, a large quantity of small particles might decrease pore volume within storage piles and, thus, decrease air exchange rates, leading to longer drying periods. Hence, resource efficiency and profitability might decrease due to a large amount of fines. Therefore, the aim was to monitor and compare dry matter losses and fuel quality changes of screened (particle diameter > 8 mm) and unscreened (as received) wood chips under small scale conditions.

Fresh wood chips were stored in containers (0.6 m³) for 23 weeks using five different assortments, i.e. wood chips from forest residues of deciduous and coniferous trees, wood chips from energy round wood of Norway spruce and European beech and wood chips from short rotation coppice of European poplar. Each assortment was stored in two variants: screened (particle diameter > 8 mm) and unscreened (as received). The storage took place in a rain and wind protected outdoor shelter. Each container was equipped with a temperature sensor to constantly monitor wood chip temperature. Furthermore, air temperature and relative humidity were recorded during the storage period.

The five months storage period was dominated by a warm and dry climate. Average air temperatures were 19.0 °C and relative humidity 65.2 %. After 23 weeks, weight losses of wood chips ranged from 21 to 53 w-%. Average decreases in moisture content and dry matter losses were 21.5 w-% (± 4.2 w-% SD) and 8.6 w-% (± 6.1 w-% SD), respectively. A high moisture content at the beginning of the storage period strongly correlated with high dry matter losses. This might be due to the fact that these wood chips were exposed to optimal moisture contents for fungal growth, i. e. 30 - 50 w-%, for a longer period of time. Screening of wood chips had a positive drying effect and also dry matter losses were smaller compared to the respective unscreened variant. Accordingly, temperature differences between wood chips and ambient air (Twood chips - Tambient air) and dry matter losses increased with the amount of fines (i.e. particle diameter < 3.15 mm).

During warm and dry summers, the drying effect can be large. It can even be enhanced by screening off fines. The results on drying and dry matter losses of forest residues and energy round wood chips during the trials with container storage reached similar levels compared to field trials under practical conditions. Therefore, small scale container trials can be a simple method to assess storage behavior of wood chips on larger scales.

Field Trials to Examine the Storage Behavior of Wood Chips from Forests under Practical Conditions

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The storage of wood chips is important for the biomass supply chain, as it compensates for temporal differences in production and consumption. Typical storage-related problems are a decline in fuel quality and dry matter losses due to microbial activity.
In field trials, the storage of spruce chips from forest residues (crown material) and from energy roundwood (thin delimbed stem sections of low quality) with and without rain protection (fleece) was examined. Trials lasted for five months each and were conducted both during winter and summer.
Sampling was done with balance bags, which were arranged grid-like within the wood chip piles when building up the experiment and pulled out during the storage period. This allowed for both temporal and spatial resolution as well as repeated measures. Overall, more than 1 000 bags were analyzed. In each pile, temperature measurements were executed at 3 positions to examine the influence on dry matter losses and quality changes. In addition to wood chip piles, both assortments were stored unchipped in piles without rain protection.
The results show that changes in moisture content and dry matter losses were significantly (factorial ANOVA, $p < 0.05$) dependent on storage duration, season, assortment and rain protection (fleece). With increasing storage duration, moisture contents decreased and dry matter losses increased. During summer there was stronger drying and higher dry matter loss than during winter. Forest residue chips (FRC) dried and decomposed more than energy roundwood chips (ERC). With fleece stronger drying and higher dry matter losses occurred than without. In total, the highest decrease in moisture content was 22.6 weight percentage points and the highest dry matter loss was 11.1 w-% (both during summer after 5 months of storage in FRC covered with fleece).
The change in usable energy content was primarily influenced by dry matter losses and changes in moisture content. In winter, loss of usable energy was low, except for the uncovered FRC pile (-11.3 %). This pile had high dry matter losses but showed no drying. In the other piles the energy loss was relatively low, because either there was only little dry matter loss (ERC) or the dry matter losses were widely compensated by the drying of the chips (FRC with fleece). In summer, even a slight increase in usable energy content occurred. This was a result of strong drying that compensated dry matter losses, which were higher than in winter. Ash content and net calorific value (on dry basis) only changed marginally during storage of wood chips.
Unchipped storage led to lower dry matter degradation in both assortments. Moisture content of unchipped piles changed only during summer. Unchipped roundwood dried very strongly to a moisture content of about 24 w-%. Additional to dry matter losses caused by biological degradation, the amount of biomass which fell to the ground (mainly needles and fine twigs) had a large effect on total dry matter losses in unchipped forest residue piles. Overall, the dry matter losses in these piles were comparable with the losses measured in forest residue chip piles, but mean decrease in energy content was somewhat higher. However, the ash content of the unchipped piles decreased distinctly because of the reduction in needles and bark.
In conclusion, forest residue wood chips should be stored with rain protection or as short as possible during winter. During a dry and warm summer, wood chips can be stored without restrictions. Unchipped storage can be mainly recommended for energy roundwood concerning energy content. For unchipped forest residues, however, ash content can be reduced by defoliation and thus the quality can be improved in this way compared to chip storage.

Improvement of wood chip quality by screening and drying

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Purpose. Small wood chip boilers < 100 kW require homogeneous and high quality biofuels for failure-free and low emission combustion. These requirements are not always met as wood chips are produced from a high variety of different raw materials using numerous production chains. To ensure high fuel qualities for small furnaces, low quality fuels such as wood chips from forest residues may be processed by secondary measures, e. g. by screening and drying. However, studies on the effectiveness of these techniques are rare and general information on secondary fuel improvement is limited.

Approach. Six field studies on screening and drying of forest residue chips were conducted as best practice examples during the research project “qualiS – Development of a Quality Management System for Wood Chip Production”. Studies were done at production sites of larger fuel producers. Process chains included screening with two drum screens, two star screens and two horizontal screening machines. Drying was done technically using forced aeration in a continuous rolling-bed dryer, a continuous belt dryer, a walking floor dryer or in drying containers. In most cases, excess heat from biogas plants was applied. Additionally, drying was also performed naturally in large storage piles during two case studies. Fuel samples were collected before, during and after processing. Wood chips were analyzed for moisture content, ash content, net calorific value, bulk density, particle size distribution and chemical fuel quality according to international standards. Wood chip quality was related to specifications A1 to B2 of ISO 17225-4 for graded wood chips.

Results. Most samples of forest residue chips could not be classified according to ISO 17225-4 before processing due to exceeding moisture content, ash content and the amount of fines. In some cases, classification was further limited by the share of overlong particles. Screening ensured the reduction of fines which then allowed for classification of the fuels as particle size class P31S or P45S. In addition, screening reduced the amount of green biomass such as needles and impurities by mineral soil and, thus, reduced the ash content and concentrations of combustion critical chemical elements such as nitrogen (N), chloride (Cl) or potassium (K). Artificial drying provided wood chips with moisture content < 15 w-% while natural drying in storage piles for one year sometimes still showed values > 30 w-%. Overall, screening proved to be more efficient with dry instead of fresh wood chips. The net calorific value (on dry basis) was only marginally affected by processing. Overall, secondary fuel processing improved fuel quality of forest residue wood chips and ensured conformity with fuel property classes A2 and B1 of ISO 17225-4.

Conclusions. Results indicate clear improvements in wood chip quality. In many cases, secondary measures such as screening and drying ensured conformity with fuel specifications according to ISO 17225-4. Thus, even low quality raw materials such as forest residue chips may become suitable for residential combustion systems.

Update on the Status of Torrefaction as Biomass Upgrading Technology

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Starting with a short introduction to the principles of torrefaction and the original visions of the companies promoting the technology and resulting fuels the presentation will advance quickly into discussion of the technological achievements in the past 7 years. Newest results on some of the characteristics of torrefied fuel, such as water uptake, explosivity, density, grindability and durability will be presented. Reference to published results by T40, T32 and the SECTOR project will be taken as well as to results of individual companies in torrefaction.

The topic of trading torrefied products will be addressed from a logistics point of view. Achievable cost advantages of torrefied biomass in respect to other solid biomasses on long distance supply chains will be presented. The health and safety topic will be addressed by providing the status with MSDS and other regulation and permissions around torrefied biomass.

Within this also issues under discussion in developing the fuel tradability further overcoming eventual critical issues as well as status with regulatory requirements such as REACH will be addressed.
To complete the presentation selected projects and companies as organised in the IBTC will be shortly presented by showing status of the project, capacity of plants, type of product and experience gained in consumption of the products.

15:30–17:00 Uhr

Parallelblock 4

Neue Ressourcen, Potenziale & Risiko-management für Versorgungsketten

3:30–5:00 pm

Parallel Session 4

New resources, potentials and supply chain risk management

Weed competition and control in willow crops

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Energy crops such as Willow (*Salix spp*.) provide a fast growing supply of biomass which can be harvested at regular intervals. Issues surrounding the increased use of willow as an alternative source of fuel include; high establishment costs, extended return on investment and agronomy issues such as weed control. Weed control can have a direct effect on the establishment and yield of the crop and broadleaf weed control presents a particular problem as there is a very limited range of herbicides which can be safely used on the crop. Improved knowledge regarding broad leaf weed control methods has the potential to make the crop more attractive to land owners and result in potentially higher yields and a shorter return on initial investment. Minimal work has been conducted on weed control in willow. The efficacy of eight weed control treatments was investigated in experiments conducted in the Republic of Ireland.

Treatments included interrow applications of herbicide and cultivation which was applied either once or twice during the growing season. Additionally, a treatment in which plastic mulch was applied after sowing was included. One treatment was kept completely free of weeds by hand weeding and one treatment had no weed control. The trials were harvested after one year growth (one year old roots) and then after a further two years of growth (three year old roots). Complete weed control, through hand weeding, had the most positive effect on willow yield with a substantial increase in yield over no weed control after one year growth. Interrow applications of an herbicide and cultivation also had a positive effect, increasing yield over the treatment which received no weed control.

The positive effects of weed control in the establishment year were also observed in the first commercial harvest, two years after the crop had been cut back. Complete weed control resulted in a yield increase of 67% over no weed control at this harvest (three year old roots). The trials that received one application of interrow treatments had a 25% increase over no weed control while two applications of interrow treatments resulted in a 60% increase in yield. Efficient weed control during the first growing season can substantially improve growth of willow crops during their first growing season as well as resulting in substantially greater yields during the first commercial harvest.

Mobilisierung und Bereitstellung agrarischer Reststoffe am Beispiel der Steiermark

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Südoststeirische Bauerngruppen betreiben beispielgebend für viele Regionen weltweit erstes Logistikzentrum für agrarische Reststoffe

Das südsteirische Murtal gehört zu den waldärmsten Regionen Österreichs. Die Nutzung von Holz zu Wärme- und Stromproduktion stößt dort in einigen Gebieten an ihre Nachhaltigkeitsgrenzen. Auf der Suche nach Lösungen ist es im Zuge dieses Projektes weltweit erstmalig gelungen, ein Logistikzentrum für agrarische Reststoffe aufzubauen, welches unter anderem einen weiteren Ausbau der Nutzung von Biomasse auch in waldarmen Regionen vorantreiben wird und somit fossile Energieträger ersetzt.

Ungenutzte Reststoffe: Mehrere Jahre haben innovative südoststeirische Bauerngruppen gemeinsam mit der Landwirtschaftskammer Steiermark experimentiert, jetzt haben sie eine sinnvolle Lösung für ein Logistikzentrum gefunden. Die Basis für alle Überlegungen war: ungenutzte biogene Reststoffe, wie Landschaftspflegematerial, Maisspindel, Getreidespelzen, Stroh etc., sollen einer sinnvollen stofflichen und energetischen Verwertung und Nutzung zugeführt werden. Neben der Nutzung forstwirtschaftlicher Biomasse zur Wärmeerzeugung zeigen Studien, dass die landwirtschaftliche Biomasseproduktion weitere signifikante Beiträge zur Energiebereitstellung in Österreich liefern kann. Das technische Potential agrarischer Reststoffe liegt in der Steiermark bei 0,7 Mio. t TM, in Österreich bei 2,4 Mio. t TM, in Europa bei 131 Mio. t TM, sowie weltweit bei 1.380 Mio. t TM pro Jahr. Das weltweite Potential für holzartige Biomasse liegt bei 2.120 Mio. t TM (Quelle: Nova–Institut.eu – 2015). Zum Vergleich dazu, liegt die derzeitige, weltweite Nutzung von Steinkohle bei rund 5.500 Mio. t pro Jahr.

Bestehende Infrastruktur: Einige Betriebszweige in der Agrarindustrie verfügen über technische Kapazitäten, die in Zeiten schwächerer Auslastung zur Bearbeitung von agrarischen Reststoffen genutzt werden können. Gutes Beispiel dafür sind Maistrocknungsanlagen. Die gigantische Infrastruktur einer Trocknungsanlage ist nur 2 Monate im Betrieb, wird also zehn Monate lang nicht oder nur teilweise genutzt. Das bietet eine gute Grundlage dafür, dieses freie Zeitfenster für eine effektive und effiziente Be- und Verarbeitung sowie zum Betreiben einer Logistikkette für diese ungenutzten Reststoffe zu nutzen. Damit ist es möglich, eine regionale Versorgung der Bevölkerung aufzubauen.

Agroindustrie nutzt agrarische Reststoffe. Idealerweise sollte auch die bestehende Agroindustrie von fossiler Energie auf Biomasse umsteigen. Im südoststeirischen Musterbeispiel ist dies natürlich der Fall. Die Trocknungsanlage der Firma Tschiggerl Agrar bezieht die Wärme für die Trocknung des Erntegutes aus Maisspindeln. Dabei ist weltweit erstmalig gelungen, Maisspindel nahezu betriebskostenfrei zu ernten und somit einen äußerst interessanten Brennstoff (Maisspindeln von einem Hektar Mais ersetzen ofenfertig vom Feld 600 bis 800 l Heizöl) zur Verfügung zu stellen. Tschiggerl Agrar konnte durch dieses Verfahren in 4 Jahren rund 1.000.000 Liter Heizöl substituieren. Europaweit werden über 90 % der Trocknungsanlagen noch fossil befeuert.

Die sinnvolle Nutzung regionaler Reststoffe ist aus der Sicht der Landwirtschaftskammer Steiermark ein Gebot der Stunde und wird von der Europäischen Union im Rahmen der Initiative „Intelligent Energy“ unterstützt. Die Hauptmotivation für diese Initiative liegt in den steigenden Pelletsimporten der Europäischen Union (2014 – 38 % Importquote – Quelle Eurostat.). Nähere Informationen zum Thema gibt es unter www.sucellog.eu sowie im Energiereferat der Steirischen Landwirtschaftskammer.

Perspectives for establishing SRCs in Northern Greece

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The objectives of this work was the analysis of potential for SRC development in the Region of Kentriki Makedonia, Northern Greece, and the identification of potential areas for the establishment of SRC plantations, taking into consideration different evaluation features, like soil, water resources, plant species for cultivation, biodiversity and environmental parameters. This work was based on the analysis of several parameters affecting the decision making for the establishment of SRC plantations and evaluation of several areas for the establishment and cultivation appropriate woody species under short rotation, taking into account sustainability considerations (determined in the framework of the project, e.g. impact on landscape, soil, water, erosion, biodiversity, etc.) as well as current legal issues.

The evaluation of potential areas for the establishment and cultivation of plantations was based on land use and recommendations and criteria for sustainable production. Existing geo-spatial data and other information and data from the national agricultural statistics, as well as, ancillary information regarding legal issues were used for editing, spatial analysis and development of filters for the selection, taking into account sustainability factors and criteria. According to criteria for sustainable production, the establishment of SRC in protected areas should generally be avoided. However, national legislation for protected areas includes proposals on agricultural land located in these areas in order to address threats to particular species of plants, animals and birds. In this context, the contribution of agri-environmental measures is expected to play an important role. The establishment of woody species and their sustainable cultivation can positively contribute in this direction, because of the significant effects of the agri-environment and the maintenance or improvement of biodiversity. Short rotation crops next to water bodies could be used as "riparian buffer zones' to protect the water from a high concentration of nutrients, prevent erosion and protect soil from flooding. The width of the riparian zone could range from 30 meters (protection from nutrients leaching) to 150 meters (protection from floods and soil erosion). Groundwater is an important natural resource for every type of crop, especially in Mediterranean countries and regions like Central Macedonia, where agricultural practices require sufficient use of irrigation water. The significant potential of groundwater guarantees the successful creation and efficient production of woody biomass in the region. According to the European Soil Data Centre estimates (ESDAC), the pH of the soil in the region ranges from 5.56 to 7.32. Given the information about the appropriate characteristics for particular fast-growing species, almost all the arable land in the Region could be used for the cultivation of fast-growing species. The lowlands near to surface waters are very vulnerable to flooding, especially during periods of high rainfall. Surface water bodies such as rivers and lakes of the region create conditions of high risk of flooding during winter, so the establishment of plantations with fast-growing forest species on agricultural lands is expected to mitigate negative effects. The result of this approach is the identification of agricultural lands, permanent and non-permanent irrigation in the region of Kentriki Macedonia. Regarding selection of species, permanently irrigated lands are more suitable for the species, varieties and clones of poplar (*Populus sp.)* due to the higher demand for water. Previous experimental plantations of Forest Research Institute showed that clones I-81/74 and He-X3 had higher yields and are highlighted as most promising for biomass production (K. Spanos, 2002). Black locust (*Robinia pseudacacia*) has significantly lower water requirements and is most promising in non-permanently irrigated lands. In these areas species of Eucalyptus (*Eucalyptus sp*.) could also be cultivated but frost occurring in the region creates unfavorable conditions SRC production. Alternatively, the species Eucalyptus could be established in areas with milder weather.

The establishment and cultivation of short rotation coppice in the region of Kentriki Makedonia, is expected to have positive impact to the environment, soil conditions, surface and ground water, quality of water and the landscape. Very important for the efficient SRC for the production of solid biofuels (woodchips) is the experience of stakeholders (farmers and their unions) in the growing and harvesting of wood species. Taking into consideration areas already cultivated with forest species and intermediate results of spatial selection process, the following figures are proposed:

- Irrigated areas are suitable for establishment of poplar SRC
- Non-irrigated areas are suitable for establishment of robinia SRC
- In areas close to the sea eucalypt species could be used as alternative to robinia SRC

Under that process, two main areas were identified for SRC cultivation of poplar species. Non-irrigated lands are more suitable for Robinia species and irrigated lands are more suitable for poplar species. Poplars are also suitable for protected areas where agro-environmental measures for increment of biodiversity are required. Additionally, establishment of poplar plantations is a good solution for the development of Riparian buffer zone, in order to avoid leaching of nutrients from agricultural areas to surface and groundwater.

Developing and evaluating strategies to overcome biomass supply risks

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The aim of this paper is to develop and evaluate innovative strategies in order to overcome biomass supply problems and to increase the competitiveness of wood based energy production. Potential impacts of the socio-economic, political and ecological environment on future demand and the supply situation are scanned by means of portfolio and risk analyses. Based on a SWOT- strategy development process preventative and coping strategies are formulated.

A holistic evaluation of the developed strategies by stakeholders of the whole biomass supply chain, including competing industries (i.e. bioenergy, pulp and panel industry) is performed by applying a standardised group decision process (Analytic Hierarchy Process) and reveals the most promising, robust strategies. The applied strategy development and evaluation process was well accepted by the stakeholders, with them cooperating in a constructive manner and engaged discussions.

The proposed strategy development process and the portfolio of the top ranked strategies is a research contribution which facilitates both; the wood based bioenergy production in increasing supply security, and further research focusing on strategic issues of the forest fuel supply chain. Furthermore, the portfolio of the top ranked strategies assists relevant bioenergy stakeholders (e.g. investors, feedstock procurement managers and government agencies) in making strategic decisions with regard to investment, biomass supply and policy.

Modeling the bioenergy potentials of municipal sewage plants

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Bernhard Schmid, Thomas Kienberger

Wastewater treatment is an energy-intensive process and leaves energy-rich residues! The purification residues like digester gas and sewage sludge, represent significant energy potentials. Digester gas is already a widely-used energy source to cover parts of the internal power and heat requirement of a sewage plant. Furthermore sewage sludge is classified as a non-fossil energy carrier in reference to thermal recycling. On the basis of this information two essential research questions need to be answered. On the one hand: Which energy demand do different types of sewage plants have? And on the other hand: How is it possible to integrate the bioenergy potentials on side in order to design optimal wastewater treatment systems in terms of energy efficiency?

The power and heat requirement of a sewage plant depends on numerous factors, like the plant size, the applied treatment technology or the sewage sludge composition. Hence, it is necessary to generate energy balances in order to determine the energy demand of the various plant types. The analyses of single process stages without integration in an overall system provides only a limited insight into energy requirements and is not a sufficient base for further energy analysis. Thus, the goal is to develop a model, able to illustrate the energy system including all process steps. The modular model enables users to generate the energy balance of aerobic and anaerobic sewage plants in various sizes, as well as the energy potentials of the occurring residues.

Furthermore, it is essential to integrate the bioenergy potentials of digester gas and sewage sludge into the overall plant system. On the basis of the energy balance of the sewage plant it is possible to generate and estimate energy networks. Therefore, it is necessary to expand the system boundaries in order to integrate heat exchangers or energy production elements, like combined heat and power units or aggregates for thermal sewage sludge utilisation. The goal is to generate energy-self-sufficient and economical efficient systems.

In order to determine an optimum concerning power- and heat-self-sufficiency, various types of networks are analysed. The best approach to design an energy-optimised sewage plant network, is a three-step method. The first step, is the selection of the type of sewage plant. Due to a better energy performance, mainly caused by the utilisation of digester gas by combined heat and power units, all subsequently designed energy networks base on anaerobic treatment. In the second step, it is necessary to analyse the possibilities of sewage sludge utilisation. Hence, the technologies for sewage sludge dewatering, drying and thermal recycling are selected. In order to reach a dry substance content of about 30 % through dewatering, compactor-technology is used. Based on the good system compatibility, concerning the dry substance content (about 80-90 %) and the heat recovery, a low-temperature-belt-dryer gets integrated into the network. For the thermal recycling two different approaches were preliminarily analysed - fluidised-bed-combustion and autothermal gasification. The third and last step, is to take account of the waste heat flows. In order to optimise the heat balance and to reduce the energy consumption, it is essential to use waste heat for internal, or even external purposes. Taking only energetic aspects into consideration, following combination constitutes the optimum: anaerobic sewage plant with digester gas utilisation, compactor, low-temperature-belt-dryer, gasifier and internal heat recovery. Depending on local requirements this network allows to focus either on power or on heat-self-sufficiency.

To summarise, the modular model enables the user to determine the bioenergy potentials of municipal sewage plants, as well as to identify optimal utilisation and storage possibilities. Furthermore the results lead to a new research question: Can wastewater treatment plants provide energy system services and storage capacities in the future energy market?

09:00–10:30 Uhr

Parallelblock 5

Biomassefeuerungssysteme mit niedrigsten Emissionen

9:00–10:30 am

Parallel Session 5

Lowest emission biomass combustion systems

Innovative technological solutions for a biomass boiler with near-zero particulate emissions

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The use of renewable bioresources as energy sources or as alternatives to fossil-based feedstock for the production of thermal or electric energy, or both simultaneously, has recently received much attention. Biomasses in general seem to be realistic alternative fuels leading to environmental, technical and economic benefits. However, in order to further increase the share of energy produced from biomass plants, it is necessary to improve the critical issues which to date have limited their spreading. In particular, environmental impact (particulate emissions) is identified as the most determining limit.

The paper describes an innovative technological solution developed and tested at the University of Bologna to further increase biomass plant marketability and shows a preliminary design on how it can be integrated in a commercial biomass boiler for residential application.

The innovation consists of a high efficiency and low cost filter for particulate emissions: the first prototype of bubble-column scrubber was tested in University of Bologna laboratory on a 25 kW_{th} and reaches PM2.5 removal efficiency up to 95%. A second prototype is under development and testing and it is showing promising results in terms of both removal efficiency and cost reduction.

The paper will show the last preliminary experimental results and evaluate how the new technology can be integrated in a residential size biomass boiler from a technological and economic point of view.

Low Emissions, Retrofit, Wood Gas Burner for Wood Pellets

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At the CEBC 2011 Prof. Jorka Jokiniemi from the University of Eastern Finland und VTT reported on the very low fine particle and gas pollutant emissions of a 15 kW fixed-bed counterdraft gasifying pellet burner (Pyro-Man), based on staged gasification-combustion. In 2013, when the Pyro-Man prototype became accessible, FHNW initiated a project funded by different stakeholders to verify these promising results, and to determine the sensitivity of emissions to varying load as well as a set of other parameters. Additionally, the tests led to improved knowledge on the entire gasification process.

To achieve the project targets, different test stands were constructed and employed.

- The Pyro-Man test stand to observe the flame and gasification zones as well as measure temperatures and gas compositions in the gasifier
- The start-up test rig for detailed investigation of all relevant parameters that influence the start procedure and performance
- A single wood pellet gasifier to study the dynamic behaviour of all phases from drying and pyrolysis to oxidation under controlled conditions with accurate measurement of the product gas with FTIR, FID and infra-red gas analysers.

In the measurements of the Pyro-Man test stand the low emissions performance (3 - 5 mg CO/m^3, 1 - 2 mg dust/m^3 and NO_X < 100 mg/m^3, all at 13% O_2) could be verified over a wide power range of 7 to 20 kW and Lambda (excess air) between 1.2 and 2.0.

Nevertheless, elevated pollutant emissions were observed at certain operating conditions, e.g. during ignition and shutdown phases. With our start-up test rig, the amount of start emissions could be reduced by a factor of 5 to 10. But to achieve our goals (emission limits over the whole burning cycle) further improvements are necessary in future developments. With this in mind, design improvements were made and implemented in a new 10 – 50 kW burner, which also will demonstrate the scalability of the design principle, based on an understanding of process.

With this type of clean gasifier pellet burner with high modulation capability, there are number of new interesting opportunities and possibilities such as:

a) Replacing fossil fuel burners with renewable biomass in residential and industrial appliances,

b) Combusting non-woody biomass even below current emission limits or

c) Using condensing boiler technology.

Honeycomb Catalysts Integrated in Firewood Stoves – Potentials and Limitations

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Background
There is a need to implement suitable measures on the market that can effectively reduce gaseous and particulate emissions of batch-wise operated wood stoves, especially in real life operation. Several studies indicated that the use of catalytic converters can reduce gaseous and particulate emissions of such devices significantly. This study investigated the potentials and limitations of a commercial available noble metal catalyst regarding real life applicability.

Approach
Three different test series were performed:
1. Performance Analysis: The catalytic conversion rate was assessed under synthetic and real flue gas conditions regarding CO, CH_4, OGC and PM emissions in correlation with gas temperature and effective catalytic volume. The results were evaluated at different stoves with integrated ceramic and metallic honeycomb catalysts. Thereby, the primary effect of the honeycomb carrier as well as the effect of catalytic conversion on PM emission composition was quantified.
2. Safety Tests: The blocking risk of integrated ceramic and metallic catalysts was assessed at two different firewood stoves when only one batch per heating operation was performed. Therefore, 20 ignition batches were conducted with each type of integrated catalyst under natural draught conditions. The grade of blocking was assessed visually and by measurement of the pressure drop.
3. Long Term Tests: The effect of long term operation on the blocking risk and on the decrease of catalytic conversion rates of gaseous and particulate emissions was evaluated. Therefore, 110 batches were performed with each type of catalyst integrated in a firewood stove under constant draught level of 12 Pa. The effect of long term operation on emissions was quantified by the comparison of an initial and final assessment (test cycle of 5 batches before and after the performance of 100 batches).

Results and conclusions
A clear emission reduction potential of gaseous CO (75%-99%), OGC (40%-60%) and PM emissions (30%-40%) was obvious for integrated solutions. The most effective emission conversion was found during the start-up (CO, OGC) and burn-out phase (CO) of a firewood batch. Only a limited effect on CH_4 emission conversion was evident. First results about PM emission composition indicated no trend towards more EC or OC conversion. The primary effect of honeycomb carriers led to a considerable increase of emissions in most cases. Consequently, primary effects have to be considered during the development process of integrated solutions. Maloperation and long term operation can generally block the catalyst's surface with agglomerations. This results in an increase of the average pressure drop as well as in a decrease of catalytic conversion of CO and OGC emissions, but leads to an increase of PM emission conversion.
The results revealed that honeycomb catalysts should be used as integrated solution without bypass for optimal conversion performance. However, maloperation has to be avoided and a regular cleaning is necessary to remove agglomerations and to guarantee optimal conversion performance.
Further research should focus on the effect of catalysts on PAH emissions, especially Benzo(a)pyrene. The mechanisms leading to reduced PM emissions should be investigated more precisely.

Acknowledgements
One part of the study leading to these results has received funding from the European Union Seventh Framework Program (FP7/2007-2013) under Grant Agreement no. 286978. A further part of this study was done in the project "ClearSt" that was financially supported by the Austrian Research Promotion Agency (Grant Agreement no. 848940) in the frame of the program "Forschungspartnerschaften".

Design of domestic log wood and gasification boilers using CFD tools

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The paper describes the steady-state simulations of a wood log fired and that of a domestic gasification boiler, combusting biogenic fuels. Both are designed and manufactured by THERMODYNAMIKI S.A (KOMBI), a Greek company, with the design values for the gasification boiler being provided by Bioenergy+2020 GmbH (Austria). As explained, Computational Fluid Dynamics tools can be proven to be of valuable importance both for the designers and manufacturers of such type of boilers, since important fluid and fuel combustion characteristics can be identified in high detail, compared to simpler methods, thus allowing their further optimization before being introduced in the market. Due to the highly transient and complex nature of fuel combustion, ad-hoc models for logwood firebeds in the scheme of porous media and ad-hoc energy and mass sources/sinks have been developed and applied in the numerical models, so that they can reproduce the operation of both types of boilers for the case of a steady mode operation. As a first step, the numerical results are compared against corresponding experimental data and/or design values for the nominal load. As a second step the inclusion of a deflector has been numerically investigated in the case of a log wood boiler, revealing before its experimentation that it is capable of increasing the boiler efficiency. As concerns the case of the gasification boiler, almost 80% of the total pressure drop occurs in the area of turbulators, whilst its effect on the total heat transfer from the flue gas to the cooling medium is of very high contribution.
The proposed model can be further extended to being able to simulate the boilers' performance in a transient mode as well, including the start-up and shut down phases.

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A compact BaP emission measurement method for residential wood combustion and preliminary results from modern biomass boiler testing

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Polycyclic aromatic hydrocarbons (PAHs) are emitted during phases of incomplete combustion and are particularly harmful to the human health. Benzo(a)pyrene (BaP) as a representative of PAHs is restricted by the European Union to an annual average value of 1 ng m^{-3} in ambient air. This threshold is significantly exceeded during heating seasons in various regions. Residential wood combustion furnaces (RWCs) are considered to be one of the major sources for BaP pollution.
To obtain a detailed knowledge on BaP emissions from residential wood combustion furnaces (RWCs) a measurement method suitable for comprehensive BaP measurements is required. A compact sampling method was thus adapted and validated for different flue gas conditions. As one step for a better knowledge on BaP emission from RWCs, the emission behaviour of automatic biomass boilers has to be characterized.
For BaP measurements the dilution method according to ISO 11338-1 comprising a filter unit was adapted and validated. The validation criterion was defined by achieving more than 90 % of the BaP sampled with the suggested system omitting an additional adsorber unit. This criterion had to be reached at different BaP concentrations which could be also varying within test runs.
For the validation tests a possible carryover was assessed by an adsorber unit downstream the filter during the validation tests which were carried out in three steps. (1.) Flue gases from good to poor combustion conditions and thus with low to high BaP concentrations were sampled. (2.) Flue gas from combustion batches from a logwood stove with typically varying flue gas quality was tested. (3.) Flue gas from extremely poor combustion conditions was sampled and a consecutive flushing with purified, compressed air was carried out. CO was used as an indicator for the respective combustion performances. In the second part of the work six technologically different automatic biomass boilers were investigated. Flue gas measurements were carried out for full and part load operation, as well as for start and stop operation phase for each system, which allows differentiation of the emission performances in different operation phases.
In all validation tests the validation criterion that more than 90 % of BaP can be sampled after dilution in solid state on the filter unit was achieved. Even at different flue gas qualities (CO concentration of a minimum of 19 and a maximum of 13,763 $mg/m^3_{STP,dry,13\%O2}$) or varying flue gas qualities within test runs (maximum difference of CO concentration of 23,153 and 0 $mg/m^3_{STP,dry,13\%O2}$) the validation criterion of 90% was by far exceeded which is higher than according theoretical calculation expected. Highest BaP emissions from the investigated boilers occurred during start, with a mean concentration value of 6302 $ng/m^3_{STP,dry,13\%O2}$. Lowest concentrations occurred during full load operation (mean value 73 $ng/m^3_{STP,dry,13\%O2}$).
The present work shows, that BaP sampling can be realized with a quartz filter at different BaP concentrations in the flue gas of RWCs. Moreover this work demonstrates that automatic biomass boilers have by far lower emission concentrations in steady state operation than in start and stop operation. Under optimal application conditions with a minimum of start and stop operation automatic biomass boilers have potentially lowest BaP emission concentrations amongst RWCs.

11:00–12:30 Uhr

Parallelblock 6

Netze und Hybridsysteme auf Basis moderner Biomassefeuerung

11:00 am –12:30 pm

Parallel Session 6

Biomass combustion based grids and hybrid systems

Development of an optimized controller for pellet / solarthermal central heating systems

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In 2015 DBFZ and EIFER have started a common research project, which aims for the development and demonstration of an optimized controller for domestic pellet-based central heating systems equipped with solar thermal collectors. In former research projects of DBFZ and EIFER, it became obvious that such bivalent systems may suffer from restricted fuel efficiency and non-optimal solar use. Reasons for these effects are often found in the controlling strategy of the systems, leading to high system temperatures, short pellet boiler operating times and high numbers of starts and stops [1].
The basic idea of the project is to develop, implement and demonstrate innovative controlling strategies for flexible generation of the required heat. The aim is to reach higher system efficiencies and lower fuel consumptions, which enables also better solar coverage. The aim shall be reached by using model-based predictive controlling strategies in addition to the normal temperature-based controlling.
The controller is developed and tested in three different environments:

1. Fully simulated: During the project a complete simulation of a single family detached house, was developed using TRNSYS tools. The model integrates all heating system components and the building structure.
2. Partly simulated: A complete central heating system, including real pellet boiler, heating controller and heat storage as well as emulated solar thermal collectors and heat sinks was setup on the test stand. The test stand is able to emulate any thermal needs of a building, so the heating system can be operated in real time close to reality.
3. Real application: A demonstration site, equipped with a complete pellet boiler and solar thermal central heating system is part of the project. This detached single family house served the development of the TRNSYS simulation models and the dimensioning of the test stand setup. It will be finally used for testing the performance of the developed controller.

The approach of controller development is first to evaluate the benefits of different controlling strategies on simulation level, second to implement the controller on the test stand and finally to implement it in a robust software application, which will run on a computer at the demonstration site.
In the start phase of the project, the demonstration site was analyzed. Historical data was available since this site has already served for a pellet boiler monitoring in a former research project [2], [3]. As a next step measurement equipment was installed at the site and a complete monitoring of all energy fluxes, temperature levels and other required parameters was started.
Historical data, the building parameters, weather data provided by German Meteorological Services (DWD) and the data from the start phase of the project was then used for the fine-tuning of the simulation models.
The whole optimization is done with TRNSYS and GenOpt using new developed boiler type and controller algorithms. The optimal set of parameter will be applied to the stand setup to verify the theoretically determined results.
Based on test stand results and demonstration site results the improvement of performance will be assessed by comparing evaluation parameters, like pellet boiler fuel efficiency, heat storage efficiency, system efficiency, number of boiler starts, full load hours of the boiler, average boiler operation time per start, average boiler load and fuel consumption.
The data which was acquired at the demonstration site was analyzed and helped to identify the approaches for an improved controlling behavior. The controlling algorithm will be based on the following strategies:

1. Reduction of system temperature by adaption to forecasted outside temperatures and solar radiation.
2. Higher solar coverage by improved storage management.
3. Reduction of boiler starts by better use of modulation capabilities of the boiler.
4. Longer operation times per start, by definition of minimum run and stop times.

The project is at the moment in the phase of controller development. The controller will be further optimized at the test stand and installed at the demonstration site once it has proofed its stable operation.
Büchner et al.: Survey of modern pellet boilers in Austria and Germany – System design and customer satisfaction of residential installations, Appl Energy 2015;160:390-403
Schraube et al.: Small pellet boilers – Investigation of efficiencies from field measurements, CEBC 2011, Graz, Schraube et al.: Long-term monitoring of small pellet boiler based heating systems in domestic applications, 18th EBC 2010, Lyon

BIG Solar mit Biomasse: Solare und biogene Fernwärme für steirische Klein- und Großstädte – 90 % Biomasse-Anteil in der Kleinstadt, 18 % in der Großstadt

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Über nunmehr Jahrzehnte ist die Fernwärme in Graz gewachsen und stellt inzwischen 39% (rund 1000 GWh in 2013) des städtischen Wärmebedarfs zur Verfügung. Ein weiterer intensiver Ausbau des städtischen Fernwärmenetzes in den kommenden Jahren und Jahrzehnten ist überdies vorgesehen. Die Aufbringung der Energie für die Fernwärme wird derzeit zu einem großen Teil durch Abwärme aus fossil betriebener Kraft-Wärme-Kopplungen (KWK) bewerkstelligt. Die Betreiber dieser Kraftwerke haben im Mai 2014 deren Schließung verlautbart. Die modernen Gas- und Dampf (GuD) Kombikraftwerke können aufgrund der Situation am europäischen Elektrizitätsmarkt nicht mehr wirtschaftlich betrieben werden, während das noch in Betrieb befindliche Kohlekraftwerk bereits die technische Lebensdauer überschritten hat. Mit Ende des Liefervertrages soll der betreffende Kraftwerkspark 2020 außer Betrieb gehen. Nicht weniger als 80% der Energieaufbringung für die Grazer Fernwärme werden dadurch zu ersetzen sein. Die Stadt Graz hat aus diesem Grund 2014 gemeinsam mit den wichtigsten lokalen Energieversorgern ein Projektteam gegründet, welches sich dieser Herausforderung gestellt hat. In einer Reihe von Workshops mit Beiträgen von über 200 Experten entstand unter anderem ein Großsolaranlagenkonzept als vielversprechende Möglichkeit, welches Biomasse oder Erdgas als Nachheizung verwenden kann. Die Machbarkeit dieses Konzeptes wurde in einer Studie detailliert analysiert.

Das Ziel der Studie ist es, die (technisch und ökonomisch) optimale Größe eines Solarkonzeptes inklusive saisonale Wärmespeicher, Wärmepumpen und Biomasse-Nachheizung festzulegen, welches sich bestmöglich in die zukünftige Versorgungsstruktur von Fernwärmenetzen integrieren lässt. Zu diesem Zweck wurde bereits für Graz neben der Evaluation passender Flächen für Solarfelder, Biomasse-Ressourcen und Speicher und der technischen Optimierung mittels Simulationsrechnungen vor allem auch eine wirtschaftliche Detailanalyse durchgeführt. Als Baseline wird die Produktion der Wärme durch gewöhnliche Gaskessel verwendet.

Die Analysen ergeben ein wirtschaftlich konkurrenzfähiges Solarsystem im Bereich von rund 150.000 m² bis zu 650.000 m² Solarfläche, was einer solaren Deckung von 9 bis 26% der derzeitigen Grazer Fernwärme bedeuten würde. Diese Ergebnisse weisen auf ein sehr hohes Umsetzungspotential des Konzepts hin.
Die Biomasse würde dazu dienen, die Solarwärme via Absorptionswärmepumpe auf ein höheres Temperaturniveau zu heben und somit eine Einspeisung in das Hochtemperatur-Fernwärmenetz (bis 120°C) von Graz zu ermöglichen. Somit ergänzen sich zwei erneuerbare Energieträger optimal. Solarthermie mit hoher Flächeneffizienz (50 mal höher als Biomasse) und Biomasse mit hohem Temperaturpotential.
Die benötigte Wärme aus Biomasse läge bei 175 GWh. Eine Potentialstudie im Jahr 2014 hat ergeben, dass sich die entsprechende Holzmenge aus dem Zuwachs in den Bezirken Graz-Stadt und Graz-Umgebung von jährlich 7 fm/ha/a beschaffen ließe. Zu beachten ist allerdings die Feinstaubsituation in Graz und Umgebung.
Daher erscheint es sinnvoll, die Solarthermie-Biomasse-Kombination zunächst an Standorten einzusetzen, wo schon große Biomasse-Anlagen bestehen. Ein solcher Standort wäre z.B. Hartberg in der Oststeiermark. Hier werden ca. 60 GWh/a Prozessdampf für die Industrie benötigt und 40 GWh/a Heisswasser für die Stadtgemeinde. Der Prozessdampf ist aufgrund des hohen Temperaturniveaus rein von Biomasse bereitzustellen und die Heisswasser-Fernwärme könnte aus einer Kombination aus Biomasse und Solarthermie bereitgestellt werden. Alternativ ist hier auch die Nutzung der Kondensationswärme des Rauchgases mittels Absorptionswärme zu prüfen.

Effizienzsteigerung und Optimierung des Zusammenspiels von Scheitholzkessel, Pufferspeicher und Solaranlage durch die Verwendung mathematischer Modelle

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Kurzfassung
Scheitholzkessel sind noch immer eine weit verbreitete Form von Holz-basierten Zentralheizungssystemen und werden in der Regel mit einem Pufferspeicher und häufig auch einer Solaranlage kombiniert.
Moderne Scheitholzkessel verfügen zwar über eine automatische Zündvorrichtung, haben im Vergleich zu vollautomatisierten Hackgut- und Pellet-Feuerungen aber die wesentliche Einschränkung, dass sie selbst keinen Einfluss auf die zugeführte Brennstoffmenge sowie den Zeitpunkt des Nachlegens vom Brennstoff haben. Dadurch kommt es immer wieder zu Situationen in denen dem System mehr Energie durch das Nachlegen zugeführt wird als verbraucht bzw. in den Pufferspeicher übertragen werden kann. Die dadurch erforderliche extreme Drosselung des Abbrandes geht in der Regelung mit großen Effizienzeinbußen, stärkerer Kesselbeanspruchung und erhöhten Schadstoffemissionen einher. Außerdem führt das mangelhafte Zusammenspiel der einzelnen Komponenten auch häufig dazu, dass ein eventuell verfügbarer Solarertrag nicht vollständig genutzt werden kann, da der Pufferspeicher bereits zu einem ungünstigen Zeitpunkt vom Scheitholzkessel geladen wurde. Somit stellt die Regelung von Scheitholzkesseln mit Pufferspeichern und ggf. einer Solaranlage eine große Herausforderung dar. Trotz verstärkter Bemühungen im Laufe der letzten Jahre, sind dem Stand der Technik entsprechende Regelungen nicht in der Lage das volle Potential hinsichtlich Effizienzmaximierung, Emissionsminimierung und Benutzerkomfort zu gewährleisten, da sie die stark verkoppelten und zum Teil veränderlichen Zusammenhänge der einzelnen Prozessgrößen und Anlagenteile nur teilweise oder häufig gar nicht berücksichtigen können.

Aus diesem Grund setzen sich die diesem Artikel zugrundeliegende Arbeiten die Entwicklung eines modellbasierten Regelungskonzeptes zum Ziel, das ein effizientes Zusammenspiel von Scheitholzkessel, Pufferspeicher und Solaranlage ermöglicht, sowie das Betriebsverhalten der einzelnen Komponenten optimiert. Die Basis dieses Konzeptes sind einfache mathematische Modelle, die das dynamische Verhalten und die Zusammenhänge der einzelnen Prozessgrößen und Anlagenteile abbilden. Somit gilt es geeignete mathematische Modelle zur Beschreibung des dynamischen Verhaltens des Pufferspeichers, der Solaranlage und insbesondere des Scheitholzkessels zu entwickeln.

Im Vortrag wird einleitend das verfolgte modellbasierte Regelungskonzept prinzipiell vorgestellt werden. Im Anschluss daran wird ausführlich auf die mathematischen Modelle eingegangen.

Small, modular and renewable heating grids for South-Eastern Europe

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The heating and cooling demand in Europe accounts for around half of the EU's final energy consumption. Renewable energy policies often mainly focus on the electricity market, whereas policies for renewable heating and cooling are usually much weaker and less discussed in the overall energy debate. Therefore, it is important to put more emphasis on the support and promotion of renewable heating and cooling concepts.

Small modular district heating/cooling grids can be fed by different heat sources, including solar collectors, biomass systems and surplus heat sources (e.g. heat from industrial processes or biogas plants that is not yet used). Especially the combination of solar heating and biomass heating is a very promising strategy for smaller rural communities due to its contribution to security of supply, price stability, local economic development, local employment, etc. On the one hand, solar heating requires no fuel and on the other hand biomass heating can store energy and release it during winter when there is less solar heat available. Thereby, heat storage (buffer tanks for short-term storage and seasonal tanks/basins for long-term storage) needs to be integrated. With increasing shares of fluctuating renewable electricity production (PV, wind), the Power-to-Heat conversion through heat pumps can furthermore help to balance the power grid.

The objective of the CoolHeating project, funded by the EU's Horizon2020 programme, is to support the implementation of "small modular renewable heating and cooling grids" for communities in South-Eastern Europe. This is achieved through knowledge transfer and mutual activities of partners in countries where renewable district heating and cooling examples exist (Austria, Denmark, Germany) and in countries which have less development (Croatia, Slovenia, Macedonia, Serbia, Bosnia-Herzegovina). Core activities, besides techno-economical assessments, include measures to stimulate the interest of communities and citizens to set-up renewable district heating systems as well as the capacity building about financing and business models. The outcome is the initiation of new small renewable district heating and cooling grids in five target communities up to the investment stage. These lighthouse projects will have a long-term impact on the development of "small modular renewable heating and cooling grids" at the national levels in the target countries.

Improving the performance of heating grids – using Swedish know-how

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Sweden looks back on a long history as regards district heating. The first district heating systems were implemented in Swedish hospitals as far back as in 1878. In the early 20th century a number of business quarters in Stockholm and Malmö were connected up to a central heating network. The last decades in Swedish district heating have focused on energy efficiency.

A chief indicator of energy efficiency is the height of the return temperatures. According to a study carried out by Swedish planning office FVB the average return temperature in Sweden is 48°C. Despite this relatively low return temperature FVB assumes that the economic loss for district heating caused by return temperatures amounts to €75,000,000 per annum.

As part of a temperature analysis various district heating networks in Switzerland were studied applying Swedish methods. Return temperatures of 60°C and higher were recorded. With the support of FVB an assessment of various customers was made. To this end, the amount of heat consumed per month and the corresponding amount of water used by the individual consumers were read out. This enables customers to be classified in terms of the average temperature spreads and the influence on the height of the return temperature in the entire network return flow.

The first simple measures which can be taken to improve the return temperature are to close bypasses and set the control parameters properly. Another efficient step is to generate domestic hot water directly using a plate heat exchanger. Systems installed in Switzerland demonstrate that with the appropriate technical measures direct domestic hot water stations can also be used with hard water.

Lowering the return temperature gives operators of district heating networks long-term benefits. Low return temperatures permit condensation systems to be used in wood-fired heating plants, for example. Furthermore, thanks to the larger temperature spread a lower flow rate can be used in the heating network. This allows district heating pipes to have smaller dimensions and results in a corresponding drop in the cost of investment.

Taking concrete Swiss systems by way of example, modern and efficient systems for heat generation, heat distribution and heat customers shall be presented.

In Switzerland district heating network operators lose thousands of Swiss franks per day through inefficiency.

Freitag
20
Jänner

13:30–15:00 Uhr

Parallelblock 7

Strom und Wärme aus Biomasse

Friday
20
January

01:30–03:00 am

Parallel Session 7

Heat and electricity from biomass

Measuring the performance of biomass small-scale gasification plants by implementing mass and energy balances – Final results from the GAST project

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GAST is the abbreviation of 'Experiences in biomass GAsification in South-Tyrol: energy and environmental assessment'. The aim of the project, concluded in 2015, was the environmental and energy assessment of biomass small gasification installations that have been developed in the last years in the region of South Tyrol (Italy). The large number of plants based on various technologies and installed in a rather small area allowed carrying out a comparative study on a representative set of small-scale gasification-based commercial CHP unit. This provides a unique overview of the actual state-of-the-art of small-scale biomass gasification technology, in terms of efficiency of the plants, effectiveness of the adopted solutions and characteristics of the products and by-products.
The aim of this paper is to present the final results of the GAST project. The main characteristics of each plant in South Tyrol have been collected; plant localization, gasification technology, type of gasifier, biomass used as feedstock and its characteristics, feeding configuration (batch or continuous), gasifier agent, gas cleaning and conditioning system and type of engine for the electricity production.
According to the survey, a total of 70 projects concerning small scale biomass gasification have been presented since 2009. Among these, 36 plants have been authorized and are presently in operation (June 2015). The 36 authorized plants include 10 different technologies (plus one which is present but not authorized for issues related to the engine emissions), with electric power for the single modules ranging from 30 to 850 kW. The fixed bed reactor is the most used at these scales, but also fluidized bed reactors are applied on two different technologies.
Four representative plants have been selected and each of them has been monitored on-site for a time span of at least 5-6 hours, carrying out a comprehensive analysis of all the mass and energy fluxes. In particular, feedstock and char have been characterized in terms of composition, ash content and calorific value, while the producer gas composition has been measured after collecting the tar in accordance to the international sampling standard methodology UNI CEN/TS 15439. Moreover, environmental aspects have been taken into account, measuring the phytotoxicity levels in the char by means of germination tests.
The comparative analysis suggested that, even if some issues still remain – in particular as far as the required maintenance and operator supervision are concerned – the investigated gasification technologies reached in the last years a good level also at a scale that was not so efficient before. In fact, the analyzed plants showed similar overall efficiency, slightly lower than 70 %. However, one of them, utilizing a more refined input feedstock (i.e., pellets), reached a higher electrical efficiency (25.3 %) compared to the others (18.3 % and 16.8 %).

Subject area: Electricity from solid biomass
Keywords: Biomass gasification, cogeneration, efficiency, mass and energy balances

Holzvergasung im Schwebefestbett: Erfahrungen aus Praxisanlagen in Österreich

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Über die letzten Jahre wurden zahlreiche Biomassevergasungskonzepte bis auf den Status der kommerziellen Verfügbarkeit und verlässlichem Anlagenbetrieb weiterentwickelt. Eine von diesen Technologien ist die Biomassevergasung im Schwebefestbettreaktor. Vergleichbare Vergasertechnologien zeigen Nachteile im Bereich der Skalierbarkeit auf den dezentralen Leistungsbereich, sowie der Teerkonzentrationen im Produktgas oder auch bei Herausforderungen im Anlagenbetrieb durch Kompaktierung und Kanalbildung in der Brennstoffschüttung. Die Biomassevergasung im Schwebefestbett konnte in zahlreichen Testläufen, Pilotanlagen und auch kommerziellen Anlagen das Potential zum Umgehen von Problemen vergleichbarer Vergasertechnologien zeigen und die Vorteile des einzigartigen Reaktordesigns verifizieren.

Die Schwebefestbetttechnologie zeichnet sich vor allem durch vier Alleinstellungsmerkmale aus:

- Rohstoffflexibilität: hinsichtlich der Hackgutqualität (Waldhackgut, Sägenebenprodukte, …) inklusive Toleranz gegenüber Störstoffen wie Nägel, Steinen, ...
- keine Hilfsstoffe notwendig
- Biokohle als Nebenprodukt
- höchste Wirkungsgrade: mehr Strom bei maximaler Rohstoffflexibilität

In der nachfolgenden Tabelle werden die technischen Daten der verfügbaren Anlagengrößen angeführt, deren Kern die Schwebefestbetttechnologie dargestellt.

Tabelle 1: CraftWERK: Technische Daten der verfügbaren Anlagengrößen

	CW700	**CW1000**	**CW1200**
elektrische Leistung	**185 kW**	**261 kW**	**324 kW**
thermische Leistung (Basisausführung)	269 kW	393 kW	496 kW
thermische Leistung	409 kW	592 kW	746 kW
Brennstoffwärmeleistung	632 kW	892 kW	1168 kW
Brennstoffbedarf	149 kg/h	215 kg/h	281 kg/h
spezifischer Brennstoffbedarf	0,82 kg/kWh el	0,82 kg/kWh el	0,87 kg/kWh el
Nebenprodukt Biokohle	1,7 m^3/d	2,5 m^3/d	3,2 m^3/d

Die Präsentation wird neben der Beschreibung der Schwebefestbetttechnologie und ihrer Vorteile ergänzt durch Erfahrungen aus dem Praxisbetrieb und der Vorstellung von aktuellen Projekten.

Power & Biomass to Gas – Connecting Germany's Biomass Potentials with Power and Gas Transmission Systems

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Due to the German energy transition ("Energiewende") and an increasing share of intermittent renewable power production, e.g. wind and photovoltaics, more fluctuations in electricity generation will occur in future. This leads to changes in power generation and an increasing number of operational interventions such as redispatch of residual load power plants to prevent occurrences of bottlenecks in the power transmission grid. In future, different flexible generation units coupled with storage technologies could contribute to the stability of the power transmission grid.

The research project P&B2G (Power & Biomass to Gas) considers residual biomasses (agricultural, forestry, landscape management) as fuels for the Oxy-SER steam gasification [1]. This Sorption Enhanced Reforming (SER) process produces a high calorific and nitrogen-free syngas with low tar concentrations. It also enables the utilization of oxygen from the operation of an integrated water electrolysis system so that high proportions of the carbon contained in the biomass can be utilized in a P&B2G system. A high operational flexibility and a wide load range to compensate fluctuations in electricity generation can be provided by switching syngas utilization between a gas engine (generation of electricity) and a methane synthesis unit which is in combination with a water electrolysis (electricity consumption) to produce Substitute Natural Gas (SNG). Connecting the power and gas transmission system, the P&B2G technology represents a promising opportunity for energy transport and load compensation.

By a determination of intersections between the German power and gas transmission grids, and including the availability of residual biomass, eligible plant locations can be identified. Due to residual biomass potentials and its transportation costs, a realistic plant size of maximum 90 MW_{th} has been investigated in the project P&B2G. Based on a maximum distance of 10 km between power and gas transmission grids, 20 potential P&B2G plant locations were identified. At these locations, available fuel mixes vary from high straw contents at locations in Northern Germany to high forestry residual contents in Southern Germany. These different fuel mixes are considered in process simulations of the P&B2G plants to determine eligible operation points.
Including load flow calculations of the European power transmission grid, the contribution of each P&B2G plant location to the power grid stability can be examined. Investigations showed that P&B2G technology can prevent bottlenecks in the grid in times of high power feed-in rates from intermittent renewable energies.
A Life Cycle Assessment comprehensively determines the environmental benefits from the installation of P&B2G systems in comparison to conventional biomass firing systems and quantifies the potential to reduce environmental impacts of German electricity supply.

Further information can be found on the project website: http://www.pb2g.de

[1] Schweitzer, D.; Beirow, M.; Gredinger, A.; Armbrust, N.; Waizmann, G.; Dieter, H.; Scheffknecht, G.: Pilot-Scale Demonstration of Oxy-SER steam Gasification: Production of Syngas with Pre-Combustion CO2 capture, Energy Procedia, Volume 86 (2016) 56-68; DOI: 10.1016/j.egypro.2016.01.007

Decreasing water vapour condensation in producer gas: experimental investigation

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A demonstration CHP gasification plant based on proprietary technology, rated for 40 kW_e and 70 kW_{th}, has been installed and is currently being operated by Yanmar co. Ltd. in Italy. the system has collected more than 1600 operating hours in total, using local wood chips as feedstock. The gasifier comprises of a gas de-dusting and cleaning section that includes a cyclone, bag filters, gas coolers, and then a gas scrubber operated with re-circulated water.

Contaminated water in the scrubber loop is progressively polluted by the build-up of tars condensed during scrubbing; moreover, recirculating water constantly increases in volume because of water vapour removal from the producer gas, and therefore the water circuit overflows in a separated disposal tank that is part of the system.

The aim of the present work is to investigate the effect of varied water circulation flowrate on the residual concentration of tar and water in producer gas at the inlet of the cogeneration section, and preliminary assess its feasibility as a mitigation strategy for limiting the amount of contaminated water to be disposed.

The experimental campaign consisted in decreasing the heat removal in gas coolers by decreasing the flow rate of cooling water. This allowed a distinct steady operation condition with about 20°C increase in producer gas temperature after cleaning section. Gas coolers are water-gas heat exchangers and the decrease of water flow does not affect the performance of the following gas cleaning equipment, especially the water scrubber since cleaning water and cooling water are two distinct and separated circuits. Assuming constant 100% relative humidity of gas after scrubbing, a higher gas temperature reduces the amount of moisture condensation.

Two different operational configurations during measure test have been set up: A is the operation at rated parameters and B the operation at varied cooling water flowrate. Measurement of both water and tar content in producer gas for both configurations (A and B) had been carried out. All tests has been performed in consecutive runs, in order to keep boundary conditions as constant as possible. Producer gas sampling was carried out according to UNI CEN/TS 14539, with tar identification with GC-MS and GC-FID, while water content has been assessed via KF titration on the collected condensate.

Water vapour concentration in producer gas after cleaning section at operating condition B was increased, and accounted for +290%, when compared to operating condition A. This result let assume that, if operating B configuration is set as standard operating configuration, more than 4 litres/hour of contaminated water to be disposed of can be avoided.

With respect to gas quality, the shift from configuration A to B accounted for a 25% increase of GC detectable tar (overall relative accuracy of sampling process and analysis +/- 18%). Due to the very limited amount of gravimetric tar produced by the plant (<<500 mg/m3), a clear trend of gravimetric tar content at varied water flowrate could not be determined. As a conclusion, a very interesting decrease amount of wastewater to dispose has been proved experimentally through an increase of almost 20°C in gas temperature in gas cleaning section of the system. On the other hand, as expected, the gas quality in non-standard configuration has been slightly lowered. In order to understand if the moderate 25% GC detectable tar concentration increase can be acceptable for engine and other tar sensible components of the gasification system further test campaign is planned.

Torrefaction of woody residues at the small scale: first results of a fully automatic pilot plant operation

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Biomass torrefaction has the potential to bring significant additional biomass resources to the market and thus provides business opportunities in fuel production and utilization. Previous work has shown that torrefaction of wood and low cost trimmings and forest residues yields a solid fuel having improved storage and combustion properties.[1]
The paper presents an innovative pilot plant aiming at the torrefaction of woody residues. The project received financial support from the Swiss state of Vaud within the framework of their program “100 million for renewable energy and energy efficiency”
The so-called “TORPLANT” project aims at upgrading various local sources of biomass residues in order to produce pellets, heat and electricity, based on a concept developed by HEIG-VD.

Granit Technologies, HEIG-VD and Ökozentrum are partners in the construction and exploitation of the system:

- Granit Technologies SA is has been in charge of the development, engineering, construction, and implementation of the pilot-plant.
- Ökozentrum, has been responsible to supply the heating system using a FLOX burner coupled to a gas-turbine/compressor to recover the energy from the torrefaction gases.
- The University of Applied Sciences Western Switzerland has been leading the project and is in charge of pilot plant testing with the support of the other partners

The installation, of nominal output capacity of 100 kg/h, is designed to process biomass residues which are nowadays not integrated in recovery chains and which are locally produced, such as: wood waste from logging, green waste from the waste collection centres, and waste from anaerobic digestion units. The plant can run in automatic mode with remote supervision in order to reduce the final product energy cost.
The pellets produced from torrefied biomass have a volume reduction of one third in comparison to the classical pellets, which enables to reduce the production and delivery costs. In addition, the global energy necessary for the process is reduced due to the very effective recovery of energy from the gases produced during the process (Torgas).
Economic calculation have shown that a commercial plant of small capacity (500 kg/h output) can achieve good profitability and a ROI of 2-3 years with the current cost of biomass residues in Switzerland.
The commissioning of the pilot plant has taken place in May 2016. The paper presents the results of ten test runs expected to continue until December 2016; these runs are organised in 4 days 24h/24 operation (four shifts). The tests consist in recording all input, process, and output parameters enabling to calculate the energy efficiency of the various stages, in particular (not exhaustive):

- Raw Biomass supply with a conveyor belt
- Grinder to produce smaller size chips (40 – 60 mm)
- Tumbling dryer heated both by thermal oil and Torgas combustion gases
- Torrefactor
- Flox® burner and gas turbine/compressor system
- Thermal oil heat exchanger

In addition, several combustion tests to evaluate the torrefied products as a substitute fuel for biomass chips and pellets will be reported.

[1] Michel Jean-Bernard, McCormick Mark. Experimental investigation of continuous torrefaction conditions of biomass residues for the subsequent use of torrefied pellets in domestic and district heating systems. In: 10th European Conference Industrial Furnaces and Boilers”, 7-10/4/2015, Porto

15:30–17:15 Uhr

Parallelblock 8

Technologien für die biobasierte Ökonomie

03:30–05:15 pm

Parallel Session 8

Technologies for a biobased economy

bioCRACK: Ein weltweit einzigartiges Verfahren zur Generierung von Biotreibstoffen der 2. Generation

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Im BDI bioCRACK Verfahren wird feste Biomasse (z.B. Holz oder Stroh) durch sog. Flüssigphasen-Pyrolyse in einem heißen Trägeröl bei Temperaturen bis 400°C und bei Atmosphärendruck in kurzkettige Kohlenwasserstoffe umgesetzt. Durch die Interaktion von Biomasse und mineralischem Trägeröl wird auch das Trägeröl selbst zum Teil angegriffen und gespalten. Durch die Wechselwirkung zwischen Biomasse und Trägeröl entstehen Kohlenwasserstoffe mit hoher Wasserstoffsättigung, die sowohl aus dem Trägeröl selbst, als auch von der Biomasse stammen. Dieser innovative Ansatz gewinnt aber erst durch ein entscheidendes technisches Detail an wirtschaftlicher Bedeutung. Beim bioCrack-Prozess wird als Trägeröl ein kostengünstiges Zwischenprodukt aus der Erdölraffinerie (Vakuum Gas Oil – VGO) eingesetzt. Dieses Zwischenprodukt ist als Treibstoff nicht direkt verwendbar, da es bei Raumtemperatur eine Konsistenz ähnlich Margarine aufweist. VGO muss also in der Raffinerie unter hoher Temperatur und Druck mit Hilfe eines Wirbelschicht-Crackers (FCC) weiterverarbeitet und gespalten werden. Bei dieser Verarbeitung wird VGO jedoch nur zu geringen Teilen in Diesel und vermehrt in kurzkettiges Benzin umgesetzt, welches in Europa nicht in dieser Menge abgesetzt werden kann und exportiert werden muss.

Die weltweit einzigartige bioCRACK-Technologie wurde in den letzten Jahren durch kooperative Zusammenarbeit zwischen OMV (Standort Schwechat) und BDI vorangetrieben. OMV unterstützte das Projekt dabei durch Ressourcen und Nachbearbeitung, sowie Bewertung der flüssigen Rohprodukte. Die wissenschaftliche Begleitung erfolgte durch das Institut für chemische Verfahrenstechnik (IcVT) der Technischen Universität Graz. Es wurde ein experimenteller Ansatz mit Bau und Betrieb einer Pilotanlage umgesetzt.

Als direkte Kunden der bioCRACK Technologie werden Mineralölfirmen und Raffineriebetreiber gesehen, die vermehrt auf nachwachsende Ressourcen zurückgreifen und dabei ihre vorhandene Infrastruktur weiter nutzen wollen. Mineralölfirmen brauchen Biokraftstoffe der 2. Generation, um die Differenz zwischen der maximal möglichen Beimischung von Biokraftstoffen der 1. Generation und der entsprechend der ErneuerbareEnergienRichtlinie (EER) der EU erforderlichen Mindestbeimischung schließen zu könnenBeim „BDI bioCRACK Verfahren“ wird feste Biomasse und ein schwersiedendes Nebenprodukt der Mineralölraffination in einen Dieselkraftstoff mit mehr als 10% biogenem Anteil erzeugt. Dieser Dieseltreibstoff erfüllt die europäische Diesel-Qualitätsnorm und kann ohne jegliche Motoradaptierung in Dieselmotoren direkt eingesetzt werden. Die Vielzahl an möglichen Einsatzstoffen macht das bioCRACK Konzept sowohl für Anlagenbetreiber als auch für Rohstofflieferanten besonders interessant. Ein wichtiger Vorteil ist, neben der Nutzung von Holz, die Nutzbarmachung von Rückständen einjähriger Pflanzen (wie z.B. Stroh) mit hohem Anteil an Aschebildnern als Rohstoffquelle, die bei einer Verbrennung bzw. thermischen Vergasung durch störende Ablagerungen Probleme verursachen würden. Das bedeutet somit eine hohe Wertschöpfung bei gleichzeitiger höherer Rohstoffflexibilität. Die Vorteile sind unter anderem, dass bioCRACK im Vergleich zu anderen BtL-Verfahren mit geringem technischen Aufwand kostengünstig realisierbar ist. Weiters verfügt das Verfahren über eine hohe Rohstoffflexibilität und nutzt Synergieeffekte zwischen BtL- und Raffinerie-Technologie. Ein wichtiger Punkt ist hierbei, dass die Treibhausgasreduktion nachweislich deutlich über 80% liegt.
Im März 2016 wurde BDI mit dem Sonderpreis „VERENA“ – im Rahmen des Staatspreises Innovation – ausgezeichnet.

Simultaneous production of valuable fuels and platform chemicals from biogenic residues by hydrothermal carbonization

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In context of a growing world population, the issue of a secure food and energy supplies of humanity comes increasingly in the focus. In addition to the use as food, biomass can be used as energy or carbon source. Therefor biomass has an important influence in this field. The utilization competition of agricultural land between the cultivation of plants for energy supply and for food should be avoided. For this reason, the focus of biomass usage lies on biogenic residues such as landscape management material, food residues or agricultural waste. Due to the often high water content, these materials are less suitable for combustion or gasification processes. For such feedstocks, hydrothermal processes are a preferable opportunity, because the reaction medium is water and the wet organic feedstock does not need to be dried before conversion.

One important hydrothermal process is the hydrothermal carbonization (HTC). In the HTC process biomass is carbonized at temperatures of 180 – 250 °C and pressures of 1 – 5 MPa in the presence of water. The production of HTC-coal has been extensively discussed in recent years. First demonstrations plants was built and started with operation. One major challenge of the HTC technology is the process water disposal or utilization, because it contains many different organic compounds. These arising during the degradation of biomass by different reactions like hydrolysis, dehydration and decarboxylation. Some of these chemicals for example furfural or lactic acid are interesting raw materials for chemical industry.

Therefore, should be the aim of this investigation the development of an integrated approach for the simultaneous production of solid secondary fuels and high value chemicals by hydrothermal carbonization. For that purpose process water recirculation experiments have been conducted by means of a discontinuous stirred tank reactor with landscape management material at temperatures of 180 – 220 °C for 5 h. After cooling down to ambient temperature the HTC-coal was dried and analyzed in terms of elemental composition as well as its fuel properties (heating value and ash content). The process water composition, especially organic compounds like acetic acid, lactic acid and furfural was detected and quantified by GC-FID. To represent the recirculation results, the resulting process water was reused up to ten times.

Results showed that the recirculation leads to a concentration of short chain carboxylic acids like acetic acid, formic acid or lactic acid. The reaction temperature has a strong influence on the species distribution as well as on the equilibrium state. For coal quality no effects by process water recirculation is observed.

Based on the results of this investigation, process water recirculation is a suitable possibility to reduce the waste water volume and to generate high value chemicals.

Wasserstoff aus Biomasse – Stand der Technik und Perspektiven

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Wasserstoff wird nach wie vor zurecht als Energieträger der Zukunft angesehen. Eine Energieversorgung auf Basis Wasserstoff würde neue Dimensionen in Bezug auf Emissionen, Effizienz und die CO_2 Problematik eröffnen. Voraussetzung ist allerdings, dass der Wasserstoff aus erneuerbaren Energiequellen kommt. Die fluktuierenden erneuerbaren Energieformen insbesondere Wind aber auch Photovoltaik und die damit verbundenen Konzepte „Power to Gas“ haben dem Energieträger Wasserstoff wieder neuen Auftrieb verliehen. Weiters stehen nun bei allen wichtigen Autoherstellern marktaugliche Modelle mit Wasserstoff-Brennstoffzellen-Antrieb zur Verfügung, die in einigen Projekten derzeit international erfolgreich demonstriert werden[1] [2]. In Japan werden stationäre Brennstoffzellen am Markt angeboten und auch schon vielfach zufriedenstellend genutzt.

Bei den erwähnten Projekten wird Wasserstoff primär mittels Elektrolyse hergestellt. Dabei wird bevorzugt Überschussstrom aus erneuerbaren Quellen angedacht, der allerdings nur mit entsprechenden Speicherkapazitäten bedarfsgerecht zur Verfügung gestellt werden kann. Wasserstoff aus Biomasse steht hier eine verlässliche Alternative dar, wo der Wasserstoff entsprechend dem Bedarf erzeugt und dem Endkunden geliefert werden kann. Neue Entwicklungen ermöglichen die Erzeugung von Wasserstoff aus Biomasse über den Weg der thermischen Gaserzeugung und in einer Qualität, die dem aus der Elektrolyse kaum unterlegen ist.

Im Rahmen des vorliegenden Beitrages werden ausgehend von umfangreichen Untersuchungen zur Wasserstoffabtrennung aus dem Produktgas der Biomassevergasung der Energie Burgenland in Oberwart der Stand der Technik zur Wasserstoffgewinnung aus Biomasse über den Weg der thermischen Biomasse-Dampfvergasung vorgestellt. Dabei werden die erzielbaren Qualitäten und Ausbeuten unterschiedlicher Prozessketten diskutiert und verglichen. Darauf aufbauend werden schließlich das Potential und die technischen Möglichkeiten in Form einer Scale Up Analyse präsentiert. Wasserstoff aus Biomasse ermöglicht eine verbrauchsorientierte Erzeugung von erneuerbaren Wasserstoff und stellt daher einen unverzichtbaren Energieträger in einem zukünftigen Wasserstoffsystem dar. Ein ökonomischer Vergleich der Gestehungskosten für Wasserstoff aus Biomasse bzw. Wasserstoff aus Elektrolyse mit erneuerbarer Elektrizität zeigt, dass Wasserstoff aus Biomasse durchaus wettbewerbsfähig ist. Eine Betrachtung einer Energieversorgung bloß auf Basis zweier Verteilsysteme nämlich einem Wasserstoffnetz und Netz mit erneuerbarem Strom zeigt, dass alle Energiebedürfnisse der Bevölkerung ohne Probleme und Komforteinbußen bedarfsgerecht, emissionsarm und effizient erfüllt werden können.

[1] EU-Projekt CHIC, 5 Wasserstoffbusse mit Brennstoffzellenantrieb
[2] EU-Projekt HyFIVE, 10 Hyundai ix35 mit Brennstoffzellenantrieb

State of the art dual fluidized bed gasification of biomass in industrial scale

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Awareness of the consequences of climate change is leading to development of technologies using renewable sources to cover the global demand of energy. Biomass is the only renewable carbon source and as such CO_2-neutral. Utilization of biomass and biogenous residues in gasification plants is a promising technology to substitute fossil fuels for the production of electricity, heat, fuels for transportation and chemicals. Fluidized bed systems have proven to be suitable for gasification processes.

A dual fluidized bed gasification system was developed at the Vienna University of Technology. Separation of endothermic gasification from exothermic combustion is the main principle of this technology. This is realized by two separate reactors, connected with each other through a circulating bed material, which acts as heat carrier and catalyst in the process. Combustion provides the heat necessary for gasification. This innovative technology is not only capable of generating electricity and heat but also fuels for transportation and synthetic chemicals.

In Senden, near Ulm, Germany an industrial power plant using this technology is in operation for the generation of electricity and district heat. The power plant in Senden has a fuel power of 15 MW. It generates electricity of about 5.1 MW_{el} and provides about 6.4 MW_{th} of district heating. This power plant is the first of its kind to use logging residues, including cut-off root ends, branches, and tops as feedstock. This fuel comprises on average 15 % of needles and 15 % of bark.

In this work data from the power plant serves as basis for a case study on the successes and challenges of operating this innovative technology in industrial scale. Data from long-term operation has been evaluated and tar measurements have been performed on site. Tar measurements were conducted for different bed heights in the gasifier and for different temperatures. Furthermore, fuel sampling, ashing and analysis were carried out. In addition, samples from bed material, coarse ash, fine ash and fly coke have been collected and analyzed in detail to gain insight into the inorganic streams in the system. Consequences regarding deposit build-up from foreign mineral matter, which is transported into the fluidized bed together with the feedstock, will be explained. Moreover, optimization measures derived from lab scale investigations, which were then implemented in the industrial scale power plant, will be presented and discussed.

Through this comprehensive approach of the long-term operation and the influence of optimization measures a critical reflection on the role of such an emerging technology based on a renewable feedstock in both the present and the future is presented.

HCNG or hythane production from biomass steam gasification

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HCNG (**H**ydrogen **C**ompressed **N**atural **G**as) or hythane (**hy**drogen and me**thane**) is a mixture of H_2 and CH_4. The H_2 in the gas mixture should improve the flame speed of the CH_4 and, therefore, improve the combustion. At standard conditions, both gases can be mixed in every ratio. However, H_2 significantly reduces the higher heating value (HHV) of the gas mixture.

Due to the similarity of the Wobbe index (Wo) compared to natural gas, hythane could be used as fuel, for example, for cars, for gas boilers, or for industrial applications. In addition, a volumetric H_2 content of up to 40 % would be possible in the Austrian natural gas grid according to the Wobbe index. Consequently, hythane could replace or supplement the fossil CH_4 in the natural gas grid. However, one important factor, which has to be considered, is material compatibility.

The dual fluidized bed (DFB) biomass steam gasification process can generate a N_2 free product gas with a volumetric H_2 content of about 75 % and a volumetric CH_4 content of about 10 %, if $CaCO_3$ is used as bed material for the fluidized beds. In order to separate gas mixtures, pressure swing adsorption (PSA) is a state of the art technology. At industrial scale, it is used for H_2 separation after a CH_4 steam reformer and a water gas shift (WGS) reactor.

This work presents investigations for the separation of hythane from the product gas of DFB biomass steam gasification. Therefore, a parameter study with a lab scale PSA unit was conducted using a simulated product gas mixture containing about 75 % H_2, 11 % CH_4, 8 % CO, and 6 % CO_2. The varied parameters were the adsorption time and the adsorbent of the PSA.

First results show that it is possible to separate the H_2 and CH_4 from the product gas. The separated hythane shows a composition of about 20 % CH_4 and about 80 % H_2 and, therefore, a Wobbe index of about 46 MJ m^{-3} and a HHV of about 20 MJ m^{-3}. However, there is still a significant amount of CO contained in the hythane, which is too high for a possible injection into the natural gas grid. Therefore, future work should focus on investigations and processes in order to remove the CO within the hythane gas mixture.

Efficient use of biomass residues for combined production of transport fuels and heat

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The EU Low Carbon Roadmap requires decarbonization of all economic sectors, including transport. The targets for the transport sector are some 30 % reduction of greenhouse gases by 2030 and 60% by 2050. This means that both improvements in efficiency as well as introduction of low-carbon energy to transport are needed. These options include advanced liquid and gaseous biofuels, low-carbon electricity and hydrogen as well as so-called CCU-fuels from low-carbon electricity (power to gas - P2G and power to liquids - P2L). Some of these alternative energy carriers require new refueling infrastructure and vehicles, whereas liquid drop-in fuels can be used directly in current vehicles without modifications. As biomass is a limited resource in Europe, priority should be given to solutions that have the highest resource efficiencies, including well to wheel efficiency in transport and overall efficiency of biomass utilization for fuels, by-product energy and added value products. Gasification in combination with synthesis technologies represents a flexible production pathway, which not only can deliver fuels for road transport, but also renewable aviation kerosene and biomass based chemicals and plastics.

A significant penetration of advanced biofuels into the commercial fuel markets can only be achieved by developing concepts that are suitable to the smaller size range, can utilize wide variety of biogenic residues, and have clearly lower capital costs than previously proposed large-scale gasification-FT concepts having > 800 M€ investment costs. The R&D project BTL2030 presently carried out at VTT is focused on developing a process concept that will meet these targets. In this BTL concept, biomass residues are gasified in a dual fluidized-bed gasifier operated at a low temperature, raw gas is filtered at gasifier exit temperature, tars and hydrocarbon gases are catalytically reformed and the reformed gas is purified from sulfur compounds by sorbents. Clean syngas is used in synthesis processes, which are designed to the target scale of 30-50 ktoe/a. Synthesis off-gases and by-product heat are used to cover on-site needs and surplus is sold to co-located existing industrial co-generation or district heating power plants.

This paper outlines main findings of the pilot gasification tests carried out in 2016 with bark, forest residues and straw, and presents results from feasibility studies for the production of FT liquids in integration with district heating power plants or forest industry sites. Biomass conversion efficiency to drop-in synfuel is estimated to be in the range 50-55 % (LHV basis), while the overall biomass utilization efficiency to fuel and heat is comparable to that of combined heat and power production. Investment cost of a 50 ktoe/a plant will be 200-250 M€ and the production cost of FT-diesel is estimated to be below 80-100 €/MWh corresponding to 0,8-1 €/l. The gasification-based BTL concepts can also be boosted by additional hydrogen produced from low-carbon electricity as described in studies previously published by VTT. The proposed process concept also allows integration with an electrolyser to increase the conversion of CO and CO_2 to liquid fuels and makes use of byproduct oxygen in the autothermal reformer.

An analysis of the potential use of biomass residues in Finland and elsewhere in Europe is presented along with the achieved GHG reduction using the current updated (RED 2) EU sustainability criteria for liquid biofuels. For the GHG calculation of the hydrogen-enhanced biofuels, the emission profile of the electricity used for hydrogen production is a key factor. The principle of using wood primarily as the raw material of forest industries and using only mill residues and forest residues for the production of bioenergy has been the principle of wood utilization in Finland. These residues may represent up to 25 % of the present use of transport fuels in Finland by 2030, while in many European countries straw and other agro residues represent the best potential for the BTL concepts.

09:00–10:30 Uhr

Parallelblock 9

Brennstoffcharakteristik & Qualitätssicherung

9:00 am–10:30 pm

Parallel Session 9

Fuel characterization and quality assurance

Characterisation methods for solid biomass fuels regarding their thermal utilisation in fixed-bed reactors

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The increased utilisation of alternative biomass feedstocks (herbaceous biomass and agricultural residues) for combustion purposes can cause ash-related problems (ash melting on grates, deposit formation and corrosion) in furnaces and boilers. This can lead to increased particulate, NO_x, SO_x and HCl emissions. The application of fuel additives and fuel blends is one way to reduce problematic combustion behaviour. So far, the evaluation of fuels and the application of additives as well as fuel blends were based on experimental investigations and experiences. New characterisation methods (fuel indexes, thermodynamic equilibrium calculations (TEC), fixed-bed lab-scale reactor and single particle reactor experiments) have been developed. They can be used to characterise pure fuels, fuel additive mixtures and biomass fuel blends in a more comprehensive way.

An initial pre-evaluation of combustion-related problems that may arise can be performed by means of fuel indexes which are calculated on the basis of the results of chemical fuel analysis. Fuel indexes are checked and evaluated with regard to applicability by measurements performed at lab- and real-scale combustion plants for a large variety of fuels. They can directly be applied to pure fuels and biomass mixtures, whereby the application for biomass additive mixtures has to be checked. Since a meaningful prediction of the release of inorganic aerosol forming elements (especially for K) from the fuel to the gas phase is not possible with fuel indexes, a quantitative determination by TEC can be performed. TEC deliver quantitative information regarding ash transformation, the release behaviour of inorganic aerosol forming elements (S, Cl, K, Na, Zn, Pb) and ash melting behaviour. For a validation of the release of aerosol forming elements, fixed-bed lab-scale reactor experiments can be applied. The basic idea behind this reactor is to provide a tool which is capable to simulate the fuel decomposition behaviour in real-scale fixed-bed biomass combustion systems (grate furnaces). The experiments deliver information regarding thermal decomposition behaviour, the release of NO_x precursor species, the release of inorganic aerosol forming elements and provide a first indication regarding ash melting behaviour. By means of these experiments, release ratios of inorganic aerosol forming elements for the entire combustion experiment are determined. For a time resolved determination of the release behaviour, a single particle reactor connected to an inductively coupled plasma mass spectrometer (ICP-MS) was developed. With this reactor it is possible to simultaneously determine the surface and centre temperatures of a biomass particle, the weight loss of the particle and the composition of gases released during thermal conversion. Targeted experiments in a temperature range of 250°-1,050°C under inert, reducing and oxidising conditions can be performed. A series of validation tests, as well as tests with biomass fuels were performed. Especially the tests with softwood, straw and Miscanthus show that the simultaneous time resolved determination of the release of S, Cl, K, Na, Zn and Pb is possible, whereas the Cl signal can only be used with limitations. At the moment only very limited time resolved release trends are available and therefore, that data is urgently needed for a better understanding of the release of inorganic aerosol forming elements during thermal biomass conversion. Such data also represent a basis for the development of inorganic release models which can be used within computational fluid dynamics (CFD) simulations.

The application of the methods presented allows the identification of problematic combustion behaviour of biomass fuels. Furthermore, an appropriate additive ratio or a fuel blend can be determined to improve the combustion behaviour. A general guideline for the characterisation of pure fuel, fuel additive mixtures and biomass blends is available. These methods facilitate a newly developed fuel characterisation which reduces time-consuming and cost-intensive testing campaigns.

Quality control of wood chip production by validated simplified methods

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Operating small wood chip boilers in a way to get low emissions of dust and carbon monoxide requires a high quality fuel. That means quality control of wood chip production is very important. It is done with validated methods according to ISO 17225 Part 1 and 4 and the referred analytical standards. Using these methods reliable data are obtained but associated with significant effort in terms of cost and time. Operators of small wood chip boilers < 100 kw supporting their self with own fuel and smaller companies producing wood chips cannot effort the costs of the necessary number of these analyses to control the production process sufficiently. Simplified validated methods enable these people and companies to control their fuel quality by themselves.

The main parameters influencing the quality of wood chips are water and ash content and the particle size distribution.
The water content could be analysed on site by one of the commercially available instruments for quick determination. Due to costs of at least 1000 Euro for reliable instruments the determination with a normal oven based on the method of ISO 18134-2 could be a good alternative.
The particle size distribution affects combustion characteristics as well as the transportation of the fuel from the storage to the boiler by screw conveyer. The most important parameters are fines, oversized particle and the amount of the main fraction. For the determination of these parameters a simplified manual sieving method was developed based on the principles of DIN EN ISO 18827-1. Validation of these methods is part of the project qualiS founded by the German Federal Ministry of Food and Agriculture (FNR project 22005815).
For the determination of the ash content it is difficult to define a simplified method which could be used on site. Knowing the kind of wood and the approximate amount of bark the ash content of clean wood chips could be estimated from literature but contaminations can raise the ash content considerably. In case of visible contaminations on the wood chips it could be necessary to analyse the material according to DIN EN ISO 18122 in a laboratory.

The simplified method for the determination of the particle size distribution of wood chips is done by manually sieving of two portions of 2 l each for four minutes in one-minute-intervals. Two sieves with diameters of 300 mm are used, one sieve with an aperture size of 3,15 mm for the fines and a second one with an aperture size of the nominal top size of the main fraction, e. g. 31,5 mm for P31 wood chips according to ISO 17225-1. Oversized particles are collected by hand. All fractions are weighed and percentage is calculated based on the sum of fractions.
For validation of the method 45 samples of wood chips of different sizes (P16, P31, P45) were sieved manually and according to DIN EN ISO 17827-1. The mean differences between simplified and standard method (target value) for the fines were -8,7 % with a range from -2,5 % to -33,5 %. The higher deviations were obtained from samples with < 5 w-% fines. Samples with higher amounts of fines showed deviations less than 10 %. The mean difference for the main fraction was 0,0 % with a range from -3,5 % to 1,3 %. A robustness test about the influence of different users was done with 2 samples (P16 and P31) and 5 persons and gave good results with low deviations for fines and main fraction.
For the determination of the moisture content a typical household oven was used and drying was done with about 300 g sample for 24 h. Test with 14 samples of different moisture contents (5,8 % - 52,3 %) were done with this method and according to DIN EN ISO 18124-2 in double determinations each. Mean deviation between both methods was 0,1 w-% (range from -1,8 w-% to 2,8 w-%) with increasing deviations at higher moisture contents.

Stability of fast pyrolysis bio-oils: comparison of assessment methods

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Fast pyrolysis is a thermochemical conversion process in which biomass is thermally decomposed at temperatures ca. 500 °C in the absence of oxygen. The main product of this process is a liquid called bio-oil or pyrolysis oil. Bio-oil is intended to be used directly as a fuel or alternatively as an intermediate for the production of chemicals/transportation fuels by further upgrading (e.g. catalytic pyrolysis, hydrodeoxygenation). However, as a consequence of its chemical composition and high oxygen content (35 – 40 wt.%), it has some adverse properties such as acidity and instability imposing limitations for its commercial applications.

Crude bio-oil is an emulsion composed of reactive oxygenated compounds (e.g. aldehydes, ketones, furans, acids), sugars, lignin-derived monomers, oligomers, and water. During its storage (especially at elevated temperatures), oxygenated compounds in bio-oil react with each other through several polymerization mechanisms to form high-molecular weight compounds and water as a by-product. Besides, decomposition of unstable organic compounds in bio-oil could lead to gas-forming reactions (e.g. CO_2 by decarboxylation). This change in chemical composition is called “aging”. It is an exothermic process and it is often accompanied by an increase in viscosity, average molecular weight, and water-insoluble content of the bio-oil making it neither thermally nor chemically a stable product.

It is considered necessary to assess the stability of bio-oils as instability would complicate their commercial use either as an end or an intermediate product. There is still no standardized test method for assessing the stability of bio-oils, although it is generally assessed by observing viscosity change following an accelerated aging procedure at elevated temperatures (24h at 80–90 °C) which is then supposed to correlate with storage over a long-term (6-12 months) at room temperature. Further stability assessment methods include observing increase in average molecular weight of bio-oils and decrease in carbonyl content of bio-oils.

Micro-carbon residue test is a standardized test method for petroleum products and it is used to measure the coke forming tendency of a fuel. Highly polar, heavy oxygenated feedstocks give high micro-carbon residue (MCR) values. During aging, bio-oil components also polymerize to give water insoluble, high-molecular weight oxygenated components. It is proposed in this work that change in MCR values of fresh and aged bio-oils could be measured to assess the stability of the bio-oils as high-molecular weight compounds formed during aging would result in higher MCR values.

In the current study, crude bio-oils (from pine wood) produced in two different reactors (auger and rotating cone) were aged at 80 °C for 4, 8, 16 and 24 hours. Changes in water content, viscosity, and MCR values of both bio-oils were determined following the accelerated aging procedure. It was found for both bio-oils that as aging time increases, the MCR values of the bio-oils increase as well.
Further work regarding the evaluation of, and comparison with previously published stability assessment methods will be presented as well.

Evaluation of chemical wood chip quality using novel fuel indexes for solid biofuels

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Purpose. The concentration of chemical elements strongly determines the combustion behavior of solid biofuels. High shares of nitrogen (N), sulphur (S), chloride (Cl), potassium (K) or heavy metals might lead to high temperature corrosion, to emissions of NO_X, HCl, SO_X or fine dust and to low ash melting temperatures. Recently developed biomass fuel indexes (e. g. Sommersacher et al. 2012, Obernberger & Brunner 2015) may help to assess these combustion risks. However, for heterogeneous biofuels such as wood chips, general assumptions may be limited as element concentrations of these fuels are highly variable due to a high variation of raw materials and fuel production chains.

Approach. In total, 92 samples of wood chips (*n* = 75), of unchipped material (*n* = 11) and of twigs and needles (*n* = 6) were collected. Samples derived from natural wood, i. e. from forest residues and "energy round wood" of different tree species, but also from short rotation coppice (SRC), from roadside chipping and from urban forestry. All samples were analyzed for concentrations of 16 combustion critical chemical elements (As, Ca, Cd, Cl, Cr, Cu, Hg, K, Mg, N, Na, Ni, Pb, S, Si, Zn). Analysis was done according to European standards. Concentrations were compared to element thresholds of wood chip specifications according to ISO 17225-4 for graded wood chips. In addition, several existing biomass fuel indexes were calculated from the results. These indexed are commonly used to predict the risk of high emission for NO_X, SO_X, HCl and particulate matter, and to evaluate any combustion hazards such as high temperature corrosion, K-release and ash fusion related problems.

Results. Wood chips from natural wood (forest residues, energy round wood) showed conformity with the requirements set in ISO 17225-4 as the concentrations of critical elements were generally low. Elements for plant metabolism such as Cl, N or S increased with high shares of green biomass, e. g. in wood chips from forest residues compared to energy round wood. With increasing shares of mineral soil in samples, elements such as K, Ca, Mg and Si also increased. Rather high concentrations of Cd were found in SRC-willow and high amounts of Na and Cl were found in wood chips from roadside chipping. These values sometimes even exceed threshold limits of ISO 17225-4. Especially for wood chips from urban forestry, threshold values for critical elements can be exceeded depending on the amount of contamination with mineral soil and anthropogenic waste such as fertilizers, fungicides or garbage and also on the degree of mechanical processing of the biofuel. Biomass fuel indexes such as the sum of aerosol forming elements (K, Na, Pb, Zn), the 2S/Cl-ratio for high temperature corrosion or the molar Si/(Ca+Mg) ratio for ash-melting behavior indicated that biomass fuels without contamination with mineral soil, road salt or other anthropogenic waste can be considered uncritical for combustion.

Conclusions. In total, wood chips from natural wood can be considered uncritical for combustion in small boilers as fuel indexes do not indicate any elevated risk level. Contaminations with mineral soil or other impurities should be avoided if conformity with existing fuel standards shall be met. The results can further increase the awareness of differentiating fuel provision chains according to the desired fuel application and they can contribute to quality assurance by selecting suitable raw materials which shall be carefully processed along the process chain.

Experimental evaluation of the traceability of a pellet bulk flow using radio frequency identification technology

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Within the energy sector, Radio Frequency Identification (RFID) technology has prior been used as a logistical tool, though limited to the follow-up of entire biofuel batches in the transport to and from transshipment sites and energy plants. By applying RFID technology directly on a bulk biomass flow it should be possible to convey vital information on important fuel properties together with the fuel itself automatically to the boiler. Such innovative measure would give the opportunity to a better and faster control of the combustion, ultimately achieving greater efficiency, reduced emissions and lower maintenance needs.

In this work, RFID technology was evaluated for applicability to transport information directly in a fuel bulk fuel chain. Three separate trials with peat pellets were used: one dispersion trial for methodology testing and two additional trials for tracing the pellet quality. In all trials, the RFID tags were in different ways added to the bulk pellets flow at the manufacturing site. The bulk pellets were then transported, together with the embedded RFID tags, to a combustion plant. Upon delivery, the tags were scanned in the fuel conveying system, at the moment the pellets went into the boiler. Time of arrival and tags' serial number were recorded, which later were used to correlate time of passage to boiler operation data. In the dispersion test, several tags were dropped simultaneously into the pellet batch at the manufacturing site. At the boiler site, the difference in time of passage for the RFID tags could then be determined, resulting in a measure of how the tags had dispersed when being transported though the system. In the two additional tests for tracing of pellet quality, RFID tags were dropped, evenly distributed, into biomass pellet batches at the manufacturing site. Finally, to assess the full scale cost of an RFID system for application into a plausible fuel pellet chain, and related to the other costs accounted to the fuel, an economic evaluation of an RFID was performed. In the evaluation, a system for bulk traceability of 100 000 tons of pellet fuel (490 GWh) per year, including two RFID tags per tons of fuel, was used as model to illustrate the typical costs.

The overall results show that it is possible to convey and trace information of a bulk biofuel flow, from production site to boiler. The effect of the fuel change from wood pellets to peat pellet was evident from the boiler's operation data, and at the same time the fuel change could also be correlated to the passage of the RFID tags. This implies that RFID technology could be a promising method to automatically respond to changes in fuel qualities directly at the combustion site. However, the distribution test showed that the tags were unevenly dispersed over time. This implies that care has to be taken to the design and implementation of the RFID system to achieve adequate traceability of a bulk material. Finally, the economic evaluation of the RFID system shows that the investment cost for such a system is in the order of 75 000 EUR, corresponding to a marginal cost of approximately 1.2 EUR, or 7 - 8 ‰ of the pellet production cost, which should be seen as a reasonable cost level compared to the potential savings.

11:00–12:30 Uhr

Parallelblock 10

Nachhaltigkeit auf regionaler und nationaler Ebene

11:00 am - 12:30 pm

Parallel Session 10

Sustainability at regional and national scale

Evaluation of the effects of incentive programs for biomass district heating grids

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The Austrian program for rural development aims to increase the competitiveness of agriculture and forestry, improving the environment and landscape as well as the economic diversification in order to counteract the trend towards emigration from rural to urban agglomerations and to improve the quality of life in rural areas. Within this programme, the measures 321c "bioenergy production using biomass" as well as the related measure 311a "diversification of agricultural and forestry holdings by energy production from renewable resources and energy services", are used for investment incentives for bioenergy projects. This mainly means the construction and expansion of biomass district heating plants and district heating networks. The funding is financed by the EU, the Federal Government of Austria and its provinces.

The evaluation of effects is based on case studies of 20 representative heating plant sites that have been selected on the basis of their location, the size of the project, the project type and considering other factors. For the evaluation and assessment, an evaluation matrix was created which is specifically adjusted to the issues of biomass district heating plants and networks. It contains 30 indicators to describe the three impact spheres economy, regionality / social issues and environment. To determine the values of the individual indicators of each plant, funding and payment data provided by the Federal Ministry of Agriculture, Forestry, Environment and Water Management and funding agencies were used. Moreover, an on-site evaluation was conducted.

The evaluation shows, that the investment funding based on the measure 321c and 311a are an important incentive to build new and enlarge existing biomass district heating plants and networks in Austria leading to a significant increase of the renewable heat supply (897 GWh/a). Thus, the CO_2 emissions are reduced by a total of 298,000 tons per year. Besides, the construction and operation of biomass district heating plants show extremely positive and sustainable economic and social effects too. Particular important are the job creation and the added value created in the region due to almost exclusively utilisation of regional biomass resources and the preferred assignment of regional companies. The high degree of integration of farmers as plant operators and fuel suppliers lead to diversification into non-agricultural activities and incomes respectively. Biomass district heating plants are highly accepted and endorsed by municipalities and heat customers, contribute to a higher education and awareness concerning climate protection and sometimes initialise further renewable energy projects or climate protection activities within the region. However, there is potential for improving the information policy and public education in order to obtain additional heat customers. The efficiency of biomass district heating plants and networks has increased within recent years but has still potential for optimisation. This also applies to the use of heat recovery systems and alternative energy sources, such as solar thermal plants and flue gas condensation units, which should be implemented more often.

Due to the limited number of case studies (20 of 584 plants), a quantitative projection of evaluation indicators on the total number of projects is relatively unreliable. Despite their differences, all case studies have substantially good evaluation results. Thus, it is assumed, that all plants and projects funded by the measure 321c have a fundamentally positive effect in terms of the objectives of the Austrian Rural Development Programme.

In order to further enhance the effects of the incentive programme, it is recommended to improve the coordination of the involved institutions regarding the collection, storage and exchange of project and payment data and continue to simplify the funding process. Furthermore, the quality management system for biomass district heating plants and networks, which is obligatory within the funding process, should be pursued in order guarantee high plant efficiencies and a productive usage of public funding.

Controlling the declared geographic origin of wood/timber: Efforts to ensure forest sustainability and to support regulations and consumer interests

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Controlling the declared geographic origin of timber and wood is an important topic in view of illegal logging. Globally 20-40% of logging is estimated to be illegal. Often the focus is on the situation of logging in Africa, Southeast Asia and South America, but also in Europe illegal logging is a serious problem in several countries.

The EU and the USA have acted with respect to the situation and passed regulations to ensure control of wood/timber provenance – the FLEGT Action Plan (EU) and the Lacey Act (USA). In the FLEGT Action Plan the importer of non-EU (and EU) timber has to verify its declared origin. Conventionally in the control of geographic origin of food stuff stable isotope analysis is the method of choice and numerous articles have already been published on this topic. For wood/timber origin genetic analyses have rather been applied – however, also a few studies on stable isotope patterns have been carried out and evidenced the potential of this method also for the verification of timber origin.

Both methods have their advantages and disadvantages: stable isotope patterns are dominantly influenced by the environmental conditions of a tree locality. Genetic methods are working using the assumption that trees of the same species in geographically near distance are genetically closer related to each other than trees farther away from each other. Stable isotope patterns are not unique unlike genetic data, however, transfer of seeds or seedlings confuses the genetic methods, which are rather applicable to virgin forests, not plantations.

In this talk the isotope method is explained and examples of its successful application are presented. We show examples of its application: The control of declared geographic origin of African tropical timber, the discrimination between European and Siberian larch wood and differentiation by stable isotope method of Austrian central Alpine from Austrian southern Alpine and northern non-Alpine spruce.

Untersuchung der volkswirtschaftlichen Bedeutung der Biomasse-KWK Anlagen in Österreich

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Die energetische Nutzung von Holz ist aus Klimaschutzgründen sowie aus Sicht der Entwicklung des ländlichen Raumes eindeutig zu begrüßen. Zudem ist die Ausgangslage in Österreich angesichts der regionalen Verfügbarkeit des Rohstoffs ausgesprochen günstig.
Die Österreichische Energieagentur (Austrian Energy Agency – AEA) hat im Rahmen eines vom Klima- und Energiefonds finanzierten Forschungsprojektes in der KEM-Region Hartberg bereits gezeigt, dass die Nutzung von Energieholz große Vorteile für ländliche Regionen nach sich zieht. Dennoch gibt es Unsicherheiten über die Zukunft der Bioenergienutzung, beispielsweise in Folge des Auslaufens von Ökostromtarifen.

Ziel des von der IG Holzkraft beauftragten Vorhabens mit Laufzeit von März-August 2016 ist es daher, die Wertschöpfungsketten von Energieholz und dessen Verwertung in KWK-Anlagen zu Strom und Wärme eingehend zu analysieren und die volkswirtschaftliche Bedeutung von KWK-Anlagen für feste Biomasse in Österreich aufzuzeigen.

Methodisch wird auf den Vorarbeiten der AEA zur Untersuchung der Wertschöpfung in der KEM Region Hartberg aufgebaut, in dessen Rahmen die Bereitstellungsketten von (Energie)Holz bereits umgehend analysiert wurden. Zusätzlich erfolgt im gegenständlichen Projekt eine Befragung von Betreibern von KWK-Anlagen, um wichtige Daten zu Investitionszahlen, Beschäftigungsintensitäten, Kennzahlen der Anlage, Art des Brennstoffverbrauchs, Importanteile etc. zu erheben. Mittels dieser erhobenen Daten werden im Anschluss Bruttowertschöpfungs- und direkte Beschäftigungseffekte je Wertschöpfungsstufe berechnet. Methodisch wird darüber hinaus auch auf Input-Output-Analysen zurückgegriffen, um indirekte volkswirtschaftliche Effekte abbilden zu können. Zusätzlich werden die jeweils beteiligten Akteure beleuchtet. Darauf aufbauend wird exemplarisch gezeigt werden, welche volkswirtschaftlichen Auswirkungen für Österreich mit dem Außer-Betrieb Setzen von Anlagen – etwa in Folge des Auslaufens von Einspeisetarifen – einhergehen würden. Die Wertschöpfungseffekte sowie Beschäftigungseffekte werden dabei quantitativ bewertet. Anschließend erfolgt auch eine Beurteilung, wie sich der Beitrag zur Zielerreichung bei den Erneuerbaren Energien (inkl. der positiven Effekte der Substitution von fossilen Energieträgern durch feste Biomasse auf Treibhausgasemissionen) verändern könnte bzw. welche Auswirkungen es auf den Versorgungsgrad sowie die Importabhängigkeit bei Energieträgern gibt. Aus gegebenem Anlass wird auch auf den wichtigen Beitrag der KWK-Anlagen zur Waldhygiene und Aufarbeitung von Schadholzmengen – z.B. im Zuge der Borkenkäferproblematik – eingegangen. Zusammenfassend wird dargestellt werden, welchen Beitrag die KWK-Anlagen für feste Biomasse für die volkswirtschaftliche Wohlfahrt in Österreich leisten. Aufbauend auf den oben genannten Studienergebnissen werden konkrete Empfehlungen für Entscheidungsträger formuliert werden.

Sustainable Forest Management in Canada

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Canada is committed to the practices of sustainable forest management. In Canada, this is defined as management that maintains and enhances the long-term health of forest ecosystems for the benefit of all living things while providing environmental, economic, social, and cultural opportunities for present and future generations[1]. Canada's forest provides a range of benefits and holds many values, including: ecological, such as biodiversity, wildlife habitat and ecosystem services; economic, such as timber; other forest-related services, such as recreation, ecotourism and non-timber forest products; social, including employment that supports many rural communities; and cultural, of particular interest to Canada's Indigenous Peoples.

Sustainable forest management criteria in Canada are measured using a set of scientifically-based indicators that represent the full range of forest values, biological, economic and social. Sustainability criteria and indicators form the basis of individual provincial regulations as well as third-party sustainable forest management certification programs. In fact, Canada's provincial, territorial and federal governments support sustainable forest management with an array of policies, laws and regulations. Canada has more third-party forest certification than any other jurisdiction in the world, which provides added assurance that Canada's forest products are from legal and sustainable sources[2].

The amount of timber harvest is one of the indicators of sustainable forest management. Provincial Crown land harvests are regulated by Allowable Annual Cuts (AAC). While there is no AAC calculated for Canada as a whole, the aggregate AAC across all provinces and territories has been relatively constant since 1990. In 2013, only two-thirds of this AAC was actually harvested[3]. Currently less than 0.3% of Canada's forest area is harvested each year, all of which is monitored closely by governments and must be promptly regenerated. In comparison, wildfires and insect outbreaks disturbed 7.2% of Canada's forest land in 2014[4].

Canada's pellet sector utilizes by-product or residual fibre from Canada's conventional forest product sector, fibre that would otherwise be disposed of without capturing any economic value. For example in British Columbia in 2014, 71% of the 67 million m^3 harvested went into lumber mills of which 44.5% was converted into lumber with the remaining volume of by-product chips and sawdust utilized by the pulp and pellet sectors. Four million m^3 of residual sawdust and shavings from these lumber mills supplied 94% of the fibre for BC's pellet sector, with the remaining 6% coming from harvest residuals left behind in the forest as unusable by the lumber sector[5]. Canada's sustainably managed forests provide 100% of the fibre for our wood pellet sector.

Canada is a key global supplier of high quality wood pellets using residual biomass from globally recognized sustainably managed forests. Wood pellets from Canada are well positioned to meet or exceed European sustainability criteria.

[1] A Vision for Canada's Forests - 2008 and Beyond. 2008. Canadian Council of Forest Ministers, Ottawa, Ont. 16p.
[2] SFM Canada, Canadian Council of Forest Ministers. http://www.sfmcanada.org/en/forest-products/legal-forest-products
[3] The State of Canada's Forests 2015. 2016. Natural Resources Canada, Canadian Forest Service, Ottawa, Ont. 75 p.
[4] National Forestry Database. Canadian Council of Forest Ministers. http://nfdp.ccfm.org/index_e.php
[5] Major Primary Timber Processing Facilities in British Columbia 2014. November 2015. Ministry of Forests, Lands and Natural Resource Operations, Victoria, B.C. 51p.

Options for Industry and Agriculture to Improve the Sustainability of Fatty Acid Methyl Esters

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The life cycle based greenhouse gas (GHG) balances of Fatty Acid Methyl Esters (FAME also called "Biodiesel") from various resources have been set in the Renewable Energy Directive (RED). Due to technology and scientific progress there are various options to improve the GHG balances of FAME. This Supporting Action for the European Commission assesses 10 such options:
1) "Biomethanol": Substitution of fossil methanol with biomethanol for the production of FAME; 2) "Bioethanol": Substitution of fossil methanol with bioethanol for the production of FAEE; 3) "CHP residues": Use of residues and co-products in a combined heat and power (CHP) facility; 4) "New plant species": for vegetable oils to increase biomass weight without detrimental effect; 5) "Bioplastics and biochemicals": Production of bioplastics and biochemicals from biomass (residues); 6) "Advanced agriculture": Advanced agricultural cultivation practices, e.g. soil carbon accumulation; 7) "Organic residues": Use of organic versus mineral fertilizer for feedstock cultivation; 8) "FAME as fuel": Use of FAME in machinery for cultivation, transportation and distribution; 9) "Retrofitting multi feedstock": Retrofitting of single feedstock plants for blending fatty residues, and 10) "Green electricity": Use of renewable electricity produced in a PV plant on site.
The assessment approach started with the GHG standard values of the RED and the corresponding background data documented in BioGrace. For the most relevant FAME production possibilities in Europe, characterized by

- feedstock (rapeseed, sunflower, palm oil, soybean, used cooking oil, animal fat) and
- FAME production capacity (50 - 200 kt/a), the technical and economic data of "Best Available Technology in 2015" (BAT 2015) were used as starting point to assess the improvement options. Based on the calculation of GHG emissions (g CO_2-eq/MJ) and production cost (€/t_{FAME}) an overall assessment of the options was made in a SWOT-Analyses and summarized in "Fact Sheets". The draft final results were reviewed in a stakeholder workshop. The following results of the assessment were obtained: A significant GHG reduction compared to the RED values in processing is possible, if best available technology (BAT) is applied. The GHG emissions of cultivation compared to RED are higher due to improved data on the correlation between fertilizer input and yields. The assessed GHG improvements options show that the potential to reduce emissions is relatively large in agriculture cultivation, but a relatively low in processing. The production cost analysis shows that revenues from co-produced animal feed and oil yield per hectare have a strong influence on total production costs, e.g. mainly animal feed from soybeans. The total FAME production cost of BAT are 280 – 1,000 €/t_{FAME}, including revenues from co-products. Cost ranges arise due to different feedstock and capacities. The greenhouse gas analysis of the improvement options results in a GHG reduction potential of 0 - 37 g CO_2-eq/MJ compared to BAT. The greenhouse gas mitigation costs of improvement options range between -260 and +1,000 €/t CO_2-eq. Options with negative greenhouse gas mitigation costs generate economic benefits compared to the base case. Feasible short term improvement options (2016) are
  - "CHP residues";
  - "FAME as fuel";
  - "Retrofittingmultifeedstock";and
  - "Biochemicals(Pharmaglycerol99.5+)". Feasible medium term improvement options (< 2020) are
  - "GreenelectricityfromPVplantonsite";
  - "Biomethanol";
  - "Advancedagriculture";and
  - "Organicfertilizer". Longer term improvement options (> 2020) are "Newplantspecies";and
  - "Bioethanol (instead of methanol for FAME production)".

Summing up the assessment one can conclude that the future FAME production has several options to further improve its GHG balance thus contributing substantially to a more sustainable transportation sector.
Acknowledgement: The work is financed by the European Commission, Tender No. ENER/C2/2013/628

13:30 - 15:00 Uhr

Parallelblock 11

Nachhaltigkeitsbetrachtungen verschiedener Wertschöpfungsketten

01:30 - 03:00 pm

Parallel Session 11

Sustainability considerations for different value chains

The role of grass digestion in the circular bio-economy

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The increase in the bioenergy use play significant role on the decrease of greenhouse gas emissions as well as on the improvement of economic and social aspects. It is expected that the efficient production and use of bioenergy could contribute to the reduction of climate change. In past few years high attention is given to the circular bio-economy. The profitability and environmental benefits of bioenergy use may be increased by the effective treatment of biomass and residues.

One of the processes for the biomass treatment is anaerobic digestion – biogas production. Biogas production is known for many years and in some countries is well developed. Different political, technological and other conditions influenced the differences between countries. Anaerobic digestion of biomass is usually used for treatment of manure or other residues, but harvested crops may also be used and increase the profitability of the system. One of the main crops for biogas production still is maize. The countries such as Germany try to initiate the reduction of the use of this crop for biogas production, but it is still not so easy to do that. Other potential raw material for biogas production may be perennial grasses. It is expected that perennial grasses are high yielding, do not require much management, their chemical composition is suitable for biogas production and they may increase the biodiversity as well as improve soil properties. The aim of the study was to analyze the profitability and GHG emissions and CO_2 savings in the process biomass – biogas – biomass.

Field and laboratory experiments were carried out at Lithuanian Research Centre for Agriculture and Forestry. Biogas productivity and LCA analysis were performed at Aleksandras Stulginskis University. Perennial grasses cocksfoot (*Dactylis glomerata*) was grown in the central Lithuania (55°23′50″ N, 23°51′40″ E) on the *Endocalcari-Epihypogleyic Cambisol* (*CMg-p-wcan*). Eight treatments were chosen for the experiment: control (not fertilized swards), fertilized with mineral nitrogen fertilizer (180 and 360 t ha^{-1}) and fertilized with digestate (the content of nitrogen in the digestate was 90, 180, 270, 360 and 450 t ha^{-1}). The swards were fertilized twice a year dividing the annual rate of fertilizers equally. The first fertilization was made in the spring at the beginning of the vegetation, the second – after the first cut. The swards were cut three times per vegetation season: at the heading stage and after regrowth (end of July and beginning of October). The energy input as well as energy potential was investigated using the scheme presented above. Biogas from perennials was produced at lab scale biogas reactor at mesophilic conditions. The LCA analysis was conducted using the SimaPro software.

The results of the experiment present that cocksfoot may be promising raw material for biogas production. The productivity of cocksfoot varies due to the year of sward use, climate conditions and rate of fertilizers applied. The increase in biomass yield has significant influence on the profitability of biogas production. The energy input is mainly influenced by the type of fertilization and transportation distance. Perennial grass processing into biogas has positive effect on the environment in terms of the GHG potential and creates sustainable closed cycle.

BioEconomy with Algae – Life Cycle Sustainability Assessment of an Algae-based Biorefinery

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Microalgae are currently considered to be highly attractive as a raw material for production of bioenergy and biomaterials in the future BioEconomy. The project FUEL4ME - Future European League 4 Microalgal Energy (www.fuel4me.eu) - is driven by the urgent need of transforming the current energy system into a sustainable one, which pursues the European and global energy goals reducing GHG emissions, finding alternatives to fossil fuels and fostering the renewable energies. Microalgae are one of the most attractive sources of liquid transportation biofuels (e.g. hydrotreated vegetable oils (HVO)), since they can produce energy-rich molecules. FUEL4ME develops and demonstrates an integrated and sustainable process for continuous biofuel production from microalgae, and thereby making the second generation of biofuels (HVO) competitive alternatives to fossil fuels. In order to make microalgae as a source for biofuels competitive with fossil fuels, it is important to reduce operational costs and to achieve high yields with low additional energy input in cultivation.

The viability of using microalgae for energy production depends on the overall sustainability (environmental, economic, social). Therefore a sustainability assessment is necessary. The life cycle sustainability assessment (LCSA) within FUEL4ME includes economic, environmental and social aspects and guides the development of the FUEL4ME process to realize the highest possible sustainability in comparison to a substituted reference system. The existing methodologies life cycle analysis (LCA), life cycle costing (LCC) and social life cycle analysis (S-LCA) are modified for the application to systems using microalgae for energy production. Within each dimension of the sustainability different elements of sustainability effects are assessed based on scientific indicators. Examples for elements of sustainability effects for the dimensions are:

- environmental dimension: global warming potential, water demand, land use
- economic dimension: costs of auxiliary energy, investment cost, trade effects
- social dimension: employment, human rights, regional cooperations

Based on the assessment of a possible future commercial biofuel production based on microalgae a set of specific parameters are identified to be most relevant for the overall sustainability: algae biomass yield 60 – 90 t_{DM}/(ha*a) algae oil yield 13 – 34 t_{oil}/(ha*a), electricity demand 80 – 700 kWh/t_{DM}, heat demand 100 – 1,300 kWh/t_{DM}, investment costs 140 – 3,700 €/(t_{DM}*a), number of employees 10 – 30 per ha, nutrient recycling 60 – 80 % of total demand of nutrients, CO_2 demand 330 – 350 t_{CO2}/t_{DM}, revenues from algae oil (640 – 860 €/t_{oil}) and PUFA 11,000 – 15,000 €/t_{PUFA}. The results of the assessment show that the PUFA production capacity has a strong influence on the economics and a reduction of GHG emissions more than > 60% in comparison to the substituted reference system is possible under favourable conditions. The results of the analyses of the economic, environmental and social elements are combined within the LCSA and considered within a multi-criteria analysis

FUEL4ME develops and demonstrates an integrated and sustainable process for continuous biofuel production from microalgae. The results of the life cycle sustainability assessment are used to identify obstacles for an efficient process in different dimensions and will help to guide the development towards the highest possible sustainability (environmental sustainability and economic feasible) in comparison to a substituted reference system.

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Environmental benefits from regional bioenergy value chains

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The EU has agreed ratification of the Paris Agreement to limit Global Warming to less than 2 °C. This commitment is a significant step in the direction to foster renewable energy. According to European Commission (2014), biomass used for electricity, heating and cooling is expected to make a key contribution to reach the EU renewable energy target. However, the provision, transport and conversion of biomass to energy also cause environmental effects. Moreover, biomass is not an infinite resource and the balance between forestation and deforestation needs to be stable to preserve forest health and biodiversity. For this reason, it is necessary to detect the most beneficial and efficient utilization of wood.

Sustainable supply chain management is promoted by the EU project SecureChain (http://www.securechain.eu/). The Institute of Waste Management of BOKU University Vienna is part of the consortium of 11 project partners from Germany, Austria, The Netherlands, Sweden, United Kingdom, Spain, Greece and Estonia and leads the sustainability workpackage. The project is funded by the research and innovation programme 'Horizon 2020' of the European Union under the Grant Agreement no. 646457 for the timeframe from 01.04.2015 to 31.03.2018. The expected impacts of the project are to mobilize more solid biomass, to maximize the share of sustainable bioenergy and to foster market uptake of most efficient systems. For this purpose, 21 pilot projects in six European model regions were identified which were submitted by local small and medium-sized enterprises (SME) via an open call. Next to knowledge transfer and advice in the field of fund raising and technical-logistical aspects, the SME's are informed about environmental aspects of their systems by means of Life Cycle Assessment (LCA). The detection of environmental hot spots - processes of their system which cause the most emissions relevant for e.g. Climate Change - shall help the SME's to operate in the most sustainable way.

Aspects of sustainable biomass production and use are framed in the Staff Working Document of the European Commission (2014) and also addressed in various EU projects (e.g. 'BioTrade2020plus', 'Basis Bioenergy') and other scientific publications in the bioenergy sector (e.g. Font de Mora et al., 2014). This talk considers those sustainability aspects in application to the pilot projects of SecureChain and shows exemplarily their possible environmental effects.

Ensuring sustainable feedstock is one of the primary aspects of sustainability. Sustainable Forest Management (SFM) needs to be secured in European Forests. Excessive removal of raw material can have negative affects to forest biodiversity and carbon stocks. In this context, a pilot project in Småland (SE) deals with wood ash recycling and redistribution at forests. Logistical aspects for the provision of wood from forest to gate are addressed in a pilot project in Catalonia (ES), where mobile wood chopping in comparison to a central stationary wood chopping unit is considered with different transport systems. Diesel consumption in wood chopping units and fuel consumption of tractors with trailers and/or lorries are key contributors to the environmental performance. Direct and indirect land use change is regarded in a pilot project in Western Macedonia (GR), where Paulownia tree is planted as feedstock for combined heat and power plants. The amount of fertilization and water usage to plant the trees are considered. The trees are planted at the moment on irrigated arable land, but it is planned to test and potentially grow plantations on depleted lignite mines. Finally, the performance of GHG emissions in the biomass supply chain remains key aspect of sustainability. Primary data is being collected from pilot projects to calculate their environmental performance. The talk shall provide insights into the topic of sustainable biomass with examples of SecureChain's pilot projects.

References:

EC (2014): Commission's Staff Working Document on the "State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU". SWD (2014) 259 final

Font de Mora, E. et al. (2015): Impact and achievements of bioenergy projects funded under Intelligent Energy-Europe. Proceedings of the IEE-II Bioenergy conference Brussels, 22 May 2014

Driving on biomass: biofuels vs hydrogen vs electricity

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Fuels based on biomass are considered as an important mean to cope with environmental problems in transport. The core objective of this paper is to investigate the perspectives of biomass-based fuels from economic and ecological points-of-view in a dynamic framework till 2050 for central European conditions.

The fuels investigated are:

- biofuels 1st generation (BF-1) as biodiesel from rapsmethylester (RME); bioethanol from wheat or corn; - biogas from organic waste, maize silage or grass;
- Biofuels 2nd generation as - biodiesel 2nd generation, Fischer-Tropsch (FT) diesel; - bioethanol 2nd generation from different types of lignocellulosic resources; - Synthetic natural gas (SNG);
- hydrogen from biomass as well as electricity from biomass;

The major results are: (i) Under current policy conditions – mainly exemption of excise taxes – the economic prospects of biofuels 1st generation (BF-1) in Europe are rather promising; the major problems of biofuels 1st generation are lack of available land for growing proper feedstocks and the modest ecological performance; (ii) Large expectations are put into advanced 2nd generation biofuels (BF-2) production from ligno-cellulosic materials like whole plants, wood and wood residues which are not in competition with food production; They could – in a favourable case – enter the market between 2020 and 2030. So the major advantage of BF-2 is that the potential will be significantly higher at levels of more than ten times of today's BF production; These advanced biofuels have significantly better ecological and energetic life-cycle performance in comparison to the 1st generation; (vi) Regarding the future costs of BF-2 it can be stated that in a favourable case by 2030 they will be close to the costs of BF-1; Consequently, by 2030 in Europe neither for BF1 nor for BF2 significantly lower costs than today can be expected. Yet, if prices of fossil fuels will start to increase again and given current tax policies BF-1 will become competitive already in the next years, BF-2 about a decade later. (vii) All analyzed fuels have lower CO2-emissions than gasoline. An additional problem for mobility with hydrogen and electricity are very high costs of the corresponding vehicles. By 2050 these costs could be reduced due to technological learning effects and efficient policy measures (e.g. CO2-based tax).

The major conclusions are:
• Since 2nd generation biofuels could enter the market between 2020 and 2030, 1st generation biofuels will remain in the market at least until 2030. However, if a CO2 based tax is introduced it is very likely that 1st generation biofuels could become irrelevant in the long term;
• With respect to hydrogen and electricity from RES: In 2010 and 2050 electricity is slightly favorable from ecological point-of-view given the same RES. Most favorable are wind and hydro followed by PV and biomass;
• Despite very good CO2 balances of hydrogen from renewable energy sources, use of hydrogen in a passenger cars will not become competitive before 2050 due to high capital costs;
The final conclusion is that biomass-based fuels will play a significant role only if the proper mix of CO2-taxes, intensified R&D, and corresponding riding down the Learning Curve are timely implemented.

Volks- und betriebswirtschaftliche Bewertung typischer bayerischer Nutzungspfade der Wärmebereitstellung aus Holz

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Die Energiewende von fossilen zu regenerativen Energieträgern ist eine der größten Herausforderungen des 21. Jahrhunderts. Dabei stellt Holz einen der wichtigsten Biobrennstoffe dar. Im Jahr 2010 entsprach die Menge energetisch genutzten Holzes in Bayern dem Energiegehalt von etwa 2,4 Millionen Tonnen Heizöl. Im Vergleich zu einem absoluten Heizölverbrauch von 4,3 Millionen Tonnen wird die Relevanz von Holz als regenerativer Energieträger deutlich.

Ziel der Forschungsarbeit war es, für Bayern typische, forstliche Produktsysteme der Wärmebereitstellung im Hinblick auf ihren möglichen Beitrag zur Reduzierung von Treibhausgasemissionen und ihre wirtschaftliche Wettbewerbsfähigkeit im Vergleich zu fossilen Energieträgern zu analysieren. Als volkswirtschaftliche Kennzahlen dienten die Treibhausgasvermeidungskosten, die Wertschöpfung (absolut und regional) sowie der Bruttobeschäftigungseffekt. Betriebswirtschaftlich wurden alle Produktsysteme außerdem anhand ihrer Rentabilität bewertet. Im Rahmen der Forschungsarbeit wurde die Rohholzbereitstellung der Baumarten Fichte, Kiefer, Buche und Eiche auf Grundlage von Modellbeständen analysiert. Darüber hinaus erfolgte die Bewertung der Rohstofftransformation in die Brennstoffe Scheitholz, Hackschnitzel und Pellets. Für die Nutzung dieser Brennstoffe zur Wärmeerzeugung wurden Feuerungsanlagen verschiedener Nennwertleistungen modellhaft dargestellt. Mittels Sensitivitätsanalysen konnten Hauptkostentreiber ermittelt, ihre Auswirkungen auf die Ergebnisse analysiert und entsprechende Optimierungspotentiale erkannt werden.

Die Ergebnisse der Forschungsarbeit verdeutlichen, dass jedes Produktsystem unterschiedliche Vor- und Nachteile hinsichtlich der jeweiligen Kennzahlen aufweist. Die Wärmebereitstellung aus Pellets generiert die höchste absolute Wertschöpfung, während die Nutzung von Hackschnitzeln die höchste regionale Wertschöpfung erzeugt und gleichzeitig geringe Wärmegestehungskosten beim Endkunden verursacht. Darüber hinaus ist die Wärmebereitstellung aus Hackschnitzeln aufgrund der geringsten Treibhausgas-Vermeidungskosten empfehlenswert.

Unter Berücksichtigung von Bruttobeschäftigungseffekten stellen Scheitholzfeuerungen eine interessante Alternative dar. Die Rohholz-Bereitstellungsverfahren üben einen deutlichen Einfluss auf die Vorteilhaftigkeit einzelner Produktsysteme aus. So sollten besonders laubholzbasierte Brennstoffe aus Naturverjüngung hervorgehen, um die Kosten für die Bestandesbegründung gering zu halten. Ein weiteres Erfolgskriterium ist eine angepasste Maschinenwahl bei der Aufbereitung der Energieholzsortimente. In der Holzernte führt ein steigender Mechanisierungsgrad bei der Baumart Fichte zu sinkenden Kosten und zu einer Maximierung der Rentabilität. Beim Laubholz konnte dieser Trend nicht nachgewiesen werden. Vor allem bei der Wärmebereitstellung aus Scheitholz ist darüber hinaus ein starker Einfluss der Lohnkosten auf Rentabilität und Vermeidungskosten nachzuweisen.

Aus dem Forschungsprojekt wurde deutlich, dass die Wärmebereitstellung aus Holz unter optimalen Bereitstellungsverfahren einen betriebs- und volkswirtschaftlich empfehlenswerten Beitrag zum Klimaschutz leisten kann.

15:30 - 17:00 Uhr

Parallelblock 12

Politik, Märkte & Konsumentenverhalten

03:30 - 05:00 pm

Parallel Session 12

Policies, markets and consumer attitudes

The Italian incentive system for the electricity production of biomass and biogas from agricultural products and byproducts: the first six years of implementation

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In the last two decades there has been a growing interest in renewable energy and energy conservation, mainly to secure supplying of energy and to limit the effect of climate change. Energy saving and energy from renewable sources are the fundamental pillars of the Kyoto Protocol and broader commitments at EU and international level for the reduction of gas emissions greenhouse effect.

In this context, the EU has taken a leading role over the years, issuing a set of measures aimed at strengthening the actions of the different Member States to achieve those objectives. The White Paper for Community strategy and action plan on renewable sources of energy (COM (97) 599) formed the basis for the Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources.

In Italy, following the financial laws 2007 and 2008, the Decree 18 December 2008, issued by Ministry of Economic development, defines the incentive mechanism for the production of electricity from renewable energy sources (RES) in the internal electricity market. The mechanism establishes that plants, that began operating or had been repowered as April 1999 until December 2007, are entitled to receive a certification, named green certificate, attesting electricity generation from renewable sources for the first twelve years of operation. Plants which began operating or had been repowered as January 2008 are entitled to receive green certificates for the first fifteen years of operation.

The green certificate system represents a support mechanism designed for encouraging electricity production from RES in particular from sources that ensure traceability and sustainability of the chain.
For biomass and biogases obtained from agriculture, animal husbandry and forestry on a short supply-line basis, the green certificate system recognized a multiplicative factor (K) equal to 1.8.

The Decree 2 March 2010, issued by the Ministry of Agriculture in concert with the Ministry of Economic development, defines the operating procedures to verify traceability of biomass in order to achieve K1.8.
The study describes the Italian incentive system and analyzes the impact of this policy through the data collected from audits carried out in the first six years of implementation of the measure, when producers passed from 41 in the year 2008 to 92 in 2013. In particular we analyze the geographical distribution of producers and the role played by agricultural farmers in terms of production of raw material and typology of biomass.

Why we heat, how we heat?

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Introduction
The incorrect operation of manually charged woodstoves causes harmful air pollutant emissions. Emissions can be reduced significantly when woodstoves are used properly in all phases of operation. With respect to the generation of emissions three critical phases during the operation can be distinguished: Heat-Up-Phase, Main-Heating-Phase, Add-Wood-Phase. All three phases include possible sources of operating errors. The objectives were first to identify operator errors in the three phases of operation and second to understand the user behavior, especially the reasons why operators make errors and how they learned the usage of their stoves. A deeper understanding of the causes of errors in the operation of manually charged wood stoves can help to develop effective training and education programs.

Methodology
In the period December 2015 to January 2016, three focus groups (moderated group discussion) were held in Lower Austria and Styria with a total of 21 participants. The participants operating wood fired stoves, cooking-stoves or tiled-stoves can be distinguished in two groups. Either they bought a new stove or they took over an existing stove from the family or by buying a house. For the research of the user´s behavior, the participants were asked to operate a model-stove made of cardboards. Different types of fuels and ignition aids were prepared so that participants could demonstrate how they prepare and ignite their stoves. Semi structured interviews and group discussions were used to get a deeper inside in the usage practice and the motives for action.

Results and Outlook
The research shows that the operating practice of wood stove users are mainly influenced by sales and after sales conversations with experts. Experts from the perspective of wood stove operators are tile stove masons, specialist suppliers and chimney sweepers. These experts and their arguments for a certain behavior give the user motives for taking action. In case of existing stoves, the heating behavior is often learned at a young age by the parents or grandparents through unconscious observation. If the learned approach works, this is usually not questioned. The underlying motive is the desire for an activity that comes about by watching. If problems occur during operation, the operating instructions and the chimney sweep are gaining importance. A central statement of the participants was: "When it burns everything is fine". Emissions are not questioned. Operating practices causing high emissions do not necessarily correlate with functional operation. Therefore, the sense as a motive of action, with regard to the willingness to change behavior, is of central importance. If a change of behavior is to be achieved during heating, explanatory approaches are recommended.

This research was part of the ongoing project “Clean Stoves”, which is funded by the European Commission.

Bioenergy Policies and Status of Bioenergy Implementation

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Countries across the globe show great variation in their specific drivers for bioenergy and their capability of producing biomass. To introduce bioenergy globally, we must understand the specific characteristic of each country. Successful market introduction of bioenergy is based on strong policies adapted to the local situation that turn low carbon energy provision into a business case.

Globally, most countries meet their energy requirements primarily from fossil sources such as oil, gas and coal. Yet, many countries strive to diversify their energy sources and cut the share of fossil fuels. Strong national policies have proven to be effective, and the share of renewables has risen constantly between 2000 and 2010, with bioenergy largely contributing to this development.

22 countries from around the globe and the European Commission have joined the IEA Bioenergy Technology Collaboration Programme (TCP) to coordinate the work of national programmes across the wide range of bioenergy technologies. The IEA Bioenergy Technology Collaboration Programme (TCP) is a strong international network with a vision to achieve a substantial bioenergy contribution to future global energy demands by accelerating the production and use of environmentally sound, socially accepted and cost-competitive bioenergy on a sustainable basis. Within IEA Bioenergy and its Tasks (networks that cover specific sub-topics), regular information exchange on bioenergy strategies and policies, the implementation of bioenergy in the national energy mix and on related R&D work is facilitated among these national experts.

In an effort to provide all this country-level information to a broader audience, it has recently been summarized in one comprehensive report, the “IEA Bioenergy Countries´ Report – Bioenergy policies and status of implementation”. The report was prepared from IEA statistical data, information from IRENA, and IEA Bioenergy Tasks country reports, combined with data as provided by delegates to the IEA Bioenergy Executive Committee. All individual country reports were reviewed by the national delegates to the Executive Committee, who take responsibility for the content. Further extensive review was done by the chair and the current and the former technical coordinator of IEA Bioenergy.

This report represents the only international collation of policies, statistics and R&D programmes on bioenergy that we are aware of. It provides information on bioenergy in a comparable manner across all featured countries. These countries show great variation regarding GDP, area, population, climate and total energy production and consumption. Contrasting and comparing these countries is herewith enabled for the interested reader, facilitating the evaluation of policy measures and informed decision making processes. References and links to further information sources expand the information accessible to the reader far beyond that given in the report alone.

Among the countries assessed, those with the largest total primary energy supply (TPES) are USA, Japan, Germany, Brazil, and Korea. Those with the largest total primary energy supply from bioenergy however are USA, Brazil, Germany, South Africa, and Canada. If ranked by share of bioenergy in the total primary energy supply, the ranking not only changes but also brings four new countries into the picture: Brazil, Finland, Sweden, Denmark, and Austria. The report also demonstrates that successful implementation of bioenergy can only be achieved through dedicated policy measures.

Bioenergy heat and power markets in the IEA's Medium Term Renewable Energy Market Report 2016

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Bioenergy is a key component of International Energy Agency (IEA) long term decarbonisation scenarios. In order to understand its potential to contribute to the achievement of the global climate agreement reached at the United Nations' 21st Conference of the Parties (COP21) in 2015, it is essential to understand the current status and growth trajectory of markets, and identify the challenges to overcome in order to maximise its contribution to a decarbonised energy system.

The IEA's Medium-Term Renewable Energy Market Report (*MTRMR*) 2016 assesses the latest market trends for renewables in the electricity, heat and transport sectors. The *MTRMR 2016* uses official IEA statistics, in combination with identified drivers and challenges to deployment, to outline the market status for renewables in 2015 and provide forecasts until 2021. Within the *MTRMR 2016*, bioenergy power and heat markets are assessed to provide key insights for the renewable energy industry, policy makers and other key stakeholders as to the role bioenergy is likely to play in the medium-term.

In 2015, renewable electricity capacity provided more than half of net additions to power capacity globally and expanded at its fastest pace to date with over 150 gigawatts of new grid-connected capacity coming online. This rapid growth was principally underpinned by solar photovoltaic (PV) and onshore wind technologies benefiting from reduced costs and an expansion into newer markets with excellent resources. In this context the current position of bioenergy both in the global power system, and its use and growth prospects in key markets until 2021 is clarified. In addition, insights are provided relating to bioenergy technology costs and associated considerations for policy support, as well as opportunities for bioenergy plants to operate flexibly according to the evolving needs of power systems moving towards higher shares of variable renewable energy.

The transformation of the heating sector is occurring at a relatively slower rate. However, bioenergy is the cornerstone of renewable heat production, providing around 90% of global renewable heat generation in 2014. Within the *MTRMR 2016* bioenergy for heat is outlined both from a regional deployment perspective and relative to other renewable heat technologies. The European context is then analysed to consider bioenergy for heat operational costs and the impacts of current low oil price environment on its cost competitiveness, considering the associated impacts on various markets for biomass heating systems. Furthermore, European renewable heat markets have been analysed and conclusions drawn from countries which have established significant shares of renewable heat in order to understand the underlying drivers and what lessons are available for other countries looking to stimulate growth.

Bioenergy power generation increased 9% y-o-y in 2015 and is forecast to reach over 650 TWh by 2021. The United States is currently the largest bioenergy generator, however some of the fastest average annual growth rates over 2015-21 are found in Asia, with China poised to lead generation by 2021. Opportunities for bioenergy to provide baseload power still exist in many countries, but the ability of bioenergy technologies to operate flexibly and economically contribute to meeting residual loads (e.g. those not covered by wind and solar PV technologies) will influence prospects in countries moving towards higher shares of variable renewables. Over 2014-21, consumption of modern bioenergy (excluding the traditional use of biomass) in the heating sector is anticipated to grow at an annual average growth rate of 2.5% to reach just under 15 EJ. Lower-cost fossil heating fuels appear to be linked to y-o-y reductions for biomass boiler, and to a lesser extent stove, installations in some countries in 2015. However, this is not universal and some markets have experienced growth. In addition, district heating and co-generation are shown as key means of delivering higher shares of bioenergy in the heating sector of several European countries.

Concepts and Instruments for a Rational Bioenergy Policy – A New Institutional Economics Approach

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Modern bioenergy uses can make an important contribution to transitioning to a low carbon energy system. However, in coordinating allocation decisions, markets fail due to the existence of greenhouse gas and other environmental externalities, knowledge and learning spillovers, security of supply externalities, market power and path dependencies in the energy system. In the European Union but also internationally, many governments have consequently adopted policies to support bioenergy expansion. By introducing a policy-driven demand for bioenergy, policy makers accept responsibility for a complex allocation problem, and risk replacing market failures by government failures. In this context, attaining efficient and sustainable outcomes is extremely challenging.

Focussing on the case of Germany and the EU, this talk presents economic theory-based recommendations for a bioenergy policy that strives for efficiency and sustainability while facing diverse uncertainties and other constraints, such as institutional path dependencies, transaction costs, the presence of multiple conflicting policy aims and interacting market failures. In particular, the presented study draws on New Institutional Economics and the theory of economic policy to identify solutions which deal with these constraints in a rational manner. As such, it aims to fill a gap between practical bioenergy policy making, and neoclassical theory-based concepts which strictly focus on a minimisation of greenhouse gas (GHG) mitigation costs.

Following a brief introduction to the methodological framework, theoretical insights are applied to the case study analysis of German and European bioenergy policy. In interaction with EU-level regulations, German bioenergy policy encompasses a mix of instruments directed at environmental and agricultural framework conditions in the primary biomass production sphere, R&D support for conversion technologies, indirect instruments in the utilisation sphere which increase the costs of fossil fuel substitutes, and direct utilisation-sided instruments which offer subsidies or command and control impulses for bioenergy use. The most important drivers for bioenergy use are sector-specific direct deployment support instruments (e.g. feed-in premiums for bioelectricity, biofuel quotas, minimum requirements for renewable heat use in new buildings), with little coordination between them. While this policy mix shows a large distance to neoclassical economics-based recommendations, it reflects the complexity of the allocative and regulative problems involved in bioenergy policy making.

The talk focusses on recommendations for the definition of a system of policy aims, and the choice of an allocative principle between markets and hierarchies to guide regulative interventions and instrument design. When deciding which aims to align bioenergy policy with, the institutional economics approach emphasises the importance of taking interactions between multiple efficiency-based and distributive policy aims into account. This leads to different policy recommendations than with a neoclassical approach, which would attempt to optimise policy choices with regard to one market failure and efficiency-based aim in isolation (e.g. GHG mitigation). Likewise, it is shown that market-based interventions which leave technology choices to market actors are not always the adequate choice as an allocative principle. Rather, there is an economic rationale for implementing a bioenergy policy mix which combines market-based GHG mitigation instruments (such as the European Emissions Trading Scheme) with more hierarchical interventions on behalf of RES technologies, and, under some conditions, technology-specific support for bioenergy use.

09:00–15:00 Uhr

Workshop

Highlights der Bioenergieforschung 2017

09:00 am–03:00 pm

Workshop

Highlights of Bioenergy Research 2017

Gasification of Biomass and Waste – Recent Activities and Results of IEA Bioenergy Task 33

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IEA Bioenergy is an organisation set up in 1978 by the International Energy Agency (IEA) with the aim of improving cooperation and information exchange between countries that have national programmes in bioenergy research, development and deployment. Activities within IEA Bioenergy are organized in ten tasks, one of which is Task 33: Gasification of Biomass and Waste.

Task 33 is one of the oldest IEA Bioenergy tasks. It currently has nine member countries and its focus is on promoting development and commercialization of biomass and waste gasification for production of heat, electric power and biofuels. This is achieved through meetings, workshops, projects, reports and presentations. Task 33 members meet twice per year. A workshop on a topic related to biomass or waste gasification is arranged in association with each meeting and is open to the public. Special projects, sometimes performed jointly with other IEA Bioenergy tasks, involve research or analysis of a gasification-related topic and usually result preparation of a report. All deliverables from the task are made publicly available on the task website, www.ieatask33.org.

IEA Bioenergy operates on three-year trienniums and for the current 2016-18 triennium Task 33 has planned a number of interesting workshops and initiatives. Already there have been workshops on production of aviation biofuels through biomass gasification and gas sampling, measurement and analysis in thermal gasification processes. Upcoming workshops will focus on gasification of waste as well as fluidized bed gasification of biomass. Special projects that will be performed during this triennium include a comprehensive report on gasification of waste highlighting opportunities, technologies and current activities in member countries. Another special project involves looking back on the history of biomass gasification development and finding commonalities among demonstration and commercial projects that were and were not successful to identify lessons that have been or should be learned. Yet another special project will focus on the many hundreds of small-scale biomass gasifiers in operation throughout the world to identify opportunities for valorisation of byproducts to improve the economics of the process. Task 33 maintains a interactive online database of pilot- and commercial-scale biomass gasification facilities in member countries. At the end of the triennium, a "state of biomass and waste gasification" report will be prepared to provide an overview of what has taken place in the areas of biomass and waste gasification in recent years, and notable success stories will be highlighted.

This presentation describes the scope, constitution, history and current activities of IEA Bioenergy Task 33. Details of specific Task 33 initiatives are presented, and upcoming events and projects are announced.

Status of Biomass Gasification – Database developed by Austria for IEA Bioenergy Task 33

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Austria is already participating in IEA Bioenergy since 1978 and in the gasification task for more than two decades. IEA Bioenergy is working in Triennia and one main work of Austria in the last Triennium from 2013 to 2015 was a web based database, where gasification installations are described. The database contains now more than 100 installations in different scales, with different TRL (technology readiness level), technology and actual status. There is also a filter include into the database, so that the interesting projects can be selected according to TRL, technology and status.

According to technology, it can be filtered to the categories:

- Heat production
- Combined heat and power (CHP)
- Fuel Synthesis
- Other gasification technology

Most installations are CHP, here especially in Europe much work is going on. Also in Fuel synthesis, there are more than 20 installations, but here most are at a lower TRL level, as this technology is still in pilot and demonstration level.

Bsed on the database a “status of biomass gasification report” is done. This report, which is delivered at the end of the triennium, provides an update on the status of biomass gasification development and commercialization in member countries. Input for the report is coming from individual member country reports and NTL’s, and the report is also done by Austria. The last report is available on the task website.

Not only the gasification task has a web based database, also several other task have such a database, the first task working with such a database was task 39 liquid biofuels. For this reason, all databases were combined and can be found now in the overall database http://www.ieabioenergy.com/installations/.

Energie aus Biogas - internationale und nationale Aktivitäten des IEA Bioenergy Task 37

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Das jüngste Arbeitsmeeting im Task wurde im direkten Anschluss an die IEA Bioenergy Conference in Brisbane/Australien abgehalten. Neben einer allgemeinen Task 37 Session gab es Beiträge zu verschiedenen Themen wie Biogas in der „Circular Economy“ oder der Einsatz von Kleinbiogasanlagen. Mit dem Vortrag „Monitoring in Biogasanlagen“ war auch ein österreichischer Beitrag zu hören. Schwerpunkte der weiteren Vorträge waren in den Bereichen der Anwendung der Biogastechnologie zur Vergärung von Gülle, Schlachtabwässer und Hühnertrockenkot zu finden. Ein großes Forschungsprojekt in Australien beschäftigt sich mit dem Thema der Nutzung der Bagasse aus der Bioethanolproduktion. Ein Rohstoff der zu mehreren Millionen t jährlich bei der Gewinnung von Zucker und in Folge oft zur Bioethanolgewinnung aus Zuckerrohr anfällt.

Das anschließende Taskmeeting wurde an der Universität Southern Queensland in Toowoomba abgehalten. Neben allgemeinen Austausch der teilnehmenden Länder wurden die Schwerpunkte in den verschiedenen Broschüren, Case Studies und Success Stories diskutiert. Derzeit stehen die Broschüren zu den folgenden Themen in Vorbereitung:

- Food Waste Digestion
- Grid injection and greening the gas grid
- International approaches to sustainable anaerobic digestion
- The role of anaerobic digestion and biogas in a circular economy
- Veracity and applicability of biomethane potential assay results

Die Broschüre zu den Batch- und kontinuierlichen Vergärungstests (Veracity and applicability of biomethane potential assay results) wird in Zusammenarbeit zwischen dem DBFZ (Deutschland) und dem IFA-Tulln (BOKU) durchgeführt. Hierbei sollen Standards bzw. etablierte Verfahren vorgestellt werden, um eine Vereinheitlichung dieser Verfahren zu erreichen. Dadurch sollen die Ergebnisse aus diesen weltweit durchgeführten Versuchen besser miteinander verglichen werden können.

Eine Case Study wird es in 2017 aus Österreich geben. Die Verwendung von Biertreber in der Biogasanlage bei der Brauerei Gösser hat nicht nur in Österreich durch die verschiedenen nationalen Auszeichnungen für Aufsehen geregt. In einer kurzen Beschreibung der Anlage, der Inputströme und der Energienutzung wird das Projekt dargestellt. Aktuell werden weitere Case Studies und Success Stories verfasst, beispielsweise über Kleinanlagen in den Niederlanden oder die Zuckerrübenvergärung in der Schweiz. Die Biogasbranche sieht sich in vielen Ländern mit Herausforderungen konfrontiert, gelöst werden diese mit neuen Ansätzen und häufig mit dem Kommittent zur Biomethannutzung.

IEA Bioenergy Task 39 Report on the State of Technology of Algae Bioenergy

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This IEA Bioenergy report provides an international update on the status and prospects for using microalgae and macroalgae as feedstocks for producing biofuels and bioenergy products. The report's scope covers algae-based options for producing liquid and gaseous biofuels, and also algae-based bioenergy in the more general context of integrated biorefineries. IEA Bioenergy Task 39 took the lead on this report, the IEA Bioenergy Executive Committee supported its compilation and it is co-authored by members of IEA Bioenergy Tasks 34, 37, 38, 39 and 42.

Key Messages

- Algae exhibit high photosynthetic efficiency and high yields (~55 t/ha annually), at least twice that of terrestrial plants, and remain an attractive target for future bio-based production.
- Significant progress has been made in algae cultivation and conversion systems with demonstrated deployment since the first report by IEA Bioenergy Task 39 published in 2010.
- The dramatic decline in the price of petroleum since August 2014, coupled with on-going low prices for natural gas, challenge cost-competitive production algal-based bioenergy products like gaseous and liquid fuels.
- The algae-based products industry has greatly expanded globally and includes the development of higher value food, feed, nutraceutical as well as oleochemical products with potential to mitigate the current challenge of the cost-competitive algae-based biofuel production.
- Nearer term opportunities exist to use algae in an integrated biorefinery context to make bioenergy coproducts, e.g., to make higher value specialty products to help support the coproduction of bioenergy.
- Resource (water, land, sunlight) and nutrient (N, P) availability remain key drivers of both economical and sustainability considerations of algae for biofuels and bioproducts.
- Synergies to exploit algae for combined wastewater treatment with coproduct bioenergy (or bioproducts) production are also a nearer term opportunity.
- Algae-based production to produce bioenergy products like liquid or gaseous fuels as a primary product is not foreseen to be economically viable in the near to intermediate term and the technical, cost and sustainability barriers are reviewed.
- Macroalgae have significant potential as a biogas crop in temperate oceanic climates in coastal areas to be co-digested for the production of biogas.

As to overcome the barriers to commercialization of algae bioenergy, there is a clear and urgent need for open data sharing and harmonization of analytical approaches along the processing pathway, from cultivation to product isolation, and for techno-economic analysis and LCA modeling.

The report will be made available at www.task39.org.

The European Wood Pellet Market for Small-scale heating

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The European market for wood pellets used in small scale heating systems (e.g. residential buildings, hotels, etc.) has been expanding significantly in the recent decade. Small scale heating based on wood pellets is arguably a mature technology, but whether the market for residential wood pellets is mature is another question. The market for industrial pellets – i.e. pellets used in large-scale facilities such as power stations or combined heat and power (CHP) plants – has been analysed in several previous studies (e.g. Xian et al., 2015 and Olsson and Hillring, 2014), but the same cannot be said for the small scale heating market.

In this work we describe and analyse (1) the current status with regard to internationally traded volumes of wood pellets and potentially underlying triggers as well as (2) the general state of the market for wood pellets for small scale heating regarding international market integration and other market characteristics. We aim to discern key market drivers, especially when it comes to interactions between national markets. Due to limitations in data availability, we focus our analysis on five national markets: Italy, Germany, Sweden, France and Austria.

Despite the incompleteness when it comes to data quality, there are interesting conclusions to be drawn. To begin with, even though Eurostat trade flow data has some limitations, it clearly shows a trend of increasing cross-border wood pellet trade in Europe. This seems to have translated into a detectable interaction between national markets. However, - measured in terms of interconnections between national prices – we could show this in only one case, namely the interaction between Germany and Austria. We furthermore find that modern trade theory and available data can give valuable insights into the development and status of the respective markets. In particular, relations between prices, exchange rate, seasonality and bilateral trade flows could be highlighted. However, the current state of market-related properties of the commodity does not allow the composition of a modelling framework based on competitive spatial equilibrium and related (theoretical) rules of functioning markets for the main wood pellet consuming countries for small scale heating in the EU.

Even though price volatilities for consumers are well below the volatility of other energy carriers and wood pellet prices are pressed down due to relatively mild winters and an oversupply, the development towards a competitive spatial equilibrium should be supported to increase access and affordability of wood pellets in the long run. Therefore, the development of benchmarks should be further supported and a harmonised approach for the collection of residential wood pellet prices in consumer regions as well as stronger efforts in the provision of other wood pellet related data would be necessary to reduce risks and to increase transparency, thus increase liquidity of this market. With respect to the wood pellets commoditisation process, liquidity and competitiveness of the international markets are the remaining major shortcomings. However, also non-market related properties with regard to commoditisation have to be considered: Internationally traded and regionally produced wood pellets are sometimes not perfectly fungible, no matter if certified or not, i.a. because consumers assign a certain intrinsic valuation to regionally produced wood pellets. This asks for analysis of consumer perceptions. Furthermore the value of wood pellets as an intermediary good could be improved by reducing physical and financial risks of solid biofuel storage. Based on the presented results and discussion, future research should further focus on better understanding the development of market-related properties of the commoditisation process. Modelling trials could be advanced by estimating the share of lower and higher quality wood pellets in the trade flow data by comparing specific costs based on monetary and physical trade flows to current residential wood pellet prices. Balancing monthly supply and demand as well as including information on stocks is expected to enhance the knowledge of trade flow patterns and price formation. Highlighting advantages of increased international trade with wood pellets for small scale heating through modelling overall cost reductions and increased resilience towards (supply chain) exogenous parameter changes (e.g. oil price, heating degree days, windfalls, etc.) could be promising future research objectives. Furthermore the convergency process of pellet markets for small scale and large scale combustion should be observed and analysed.

Global wood pellet industry and market – current developments and outlook

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Background and Objective
The wood pellet use in the heating and electricity sector has recorded a steady growth in the last years. Worldwide, the pellet production in 2010 is estimated about 15 million tons. During the last five years a steady increase is stated. However, there is a range of estimates from different publications. IEA bioenergy task 40 carried out an update of the situation on the national pellet markets in the most relevant pellet producing countries and the global development as well. The aim is to provide data for the market situation in 2015 and the expectation about further wood pellet production and consumption until 2025.

Approach
To describe the pellet market development, various country specific data is collected and compiled. The methodology is in line with earlier pellet studies from IEA Task 40 „Sustainable Bioenergy Trade so that the analysis provide coherent data for the time 2010 till 2015. As in the previous report, numerous experienced task members from academics and industry collaborated intensively and combined pellet market data of 30 countries. These contain updated information about regulatory framework, production, consumption, price trends, quality standards and trade aspects. Sources from national associations, scientific publications and also personal expertise ensure the reliability of the outcomes.

Results
At present, roughly three quarters of 30 country reports are nearly complete. The first evaluation confirmed the positive development in terms of production and consumption of wood pellets in almost all countries. The next processing steps are complete the specific country reports and merge the individual data to create a global overview of pellet market and trade in 2015. Till the end of the year the analysis is completed and the final figures will be validated. Based on these results and based on the scientific exchanges for the whole time of cooperation, statements can be made about the global production and consumption until 2025. The final results will be presented and shall be discussed in more detail at the conference.

Conclusions
The results of the initial evaluation indicate a global increasing demand for wood pellets. In addition, the market drivers in regions and countries with more or less growth are identified. Increased international pellet trade need to be supported by adequate frame condition not only for commerce, but also with regard to sustainability issues.

Biorefining- Activities and current results of IEA Bioenergy Task 42

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In a future BioEconomy, sustainable production, conversion and upgrading of biomass to both food and non-food will be key to successful carbon reduction and change from fossil based products. Sustainably produced biomass (crops, trees, algae, residues) need to be used as efficiently as possible - using biorefining approaches – to meet future demands of food, feed, biobased products (chemicals, materials) and bioenergy (fuels, power, heat). Biorefining is the optimal method for large-scale sustainable use of biomass in the BioEconomy. By accelerating the sustainable production and use of biomass, particularly in a biorefinery approach, the socio-economic and environmental impacts will be optimized. This will result in more cost-competitive and sustainable biomass valorisation strategies and reduced greenhouse gas emissions. It will also result in the efficient use of available resources (raw materials, minerals, water).

Biorefineries have already been applied for some considerable time in the food industry and the pulp & paper sector. However, manifold large-scale implementations of biorefineries for non-food (incl. bioenergy) applications are still lacking. The major reasons for this are: (i) some technologies which are part of integrated biorefinery concepts are currently not mature enough for commercial market implementation, (ii) there are limited pilot and demonstration plants to prove the feasibility for broad deployment, (iii) often stakeholders from different market sectors are not working together, and (iv) there is a lack of knowledge/expertise on the advantages of biorefinery processes for optimal sustainable biomass use at industrial, SME and (regional) governmental level.

The aim of IEA Bioenergy Task 42 is to facilitate the commercialization and market deployment of environmentally sound, socially acceptable, and cost-competitive biorefinery systems and technologies, and to advise policy and industrial decision makers accordingly. Task 42 provides an international platform for collaboration and information exchange between industry, SMEs, GOs, NGOs, RTOs and universities concerning biorefinery research, development, demonstration, and policy analysis.

A major objective of Task 42 is dissemination, for example by networking and communication of specific biorefinery information and results of science-based technology analysis. This also includes support and advice to policy makers and involvement with industry in the membership countries. Task 42 attempts to address gaps and barriers for biorefinery deployment to successfully promote market implementation of sustainable biorefinery systems. Within the 2016-2018 triennium Task 42 will focus on the role of Biorefining in a future BioEconomy. Task 42 work program contains four major Activity Areas:

1) Biorefinery Systems: analysis and assessment of biorefining in the whole value chain,
2) Product Quality: reporting on related biobased products/bioenergy standardisation, certification and policy activities at national, European and global levels,
3) Evolving BioEconomy: analysing and advising on perspectives of biorefining in a Circular BioEconomy, and
4) Communication, Dissemination & Training: knowledge exchange by stakeholder consultation, reporting and lecturing.

A variety of Biorefinery Fact Sheets which hold specific information concerning LCA, economic performance and supply chain of selected biorefineries has been published so far. The numbers of Fact Sheets are continuously extended and currently integrated into a data base. Recently a new Report on *Proteins for Food, Feed and Biobased Applications: Biorefining of protein containing biomass* has been published by Task 42. As with other dissemination material this protein report is available at the task webpage.

http://www.iea-bioenergy.task42-biorefineries.com/

Highlights from Bioenergy Task 32: Biomass Combustion and Cofiring

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Task 32 of IEA Bioenergy is a global collaboration network between 13 countries in 4 continents that collect, analyse, share and disseminate key information on biomass combustion and cofiring technologies. The main aim is to accelerate market introduction of more efficient, cost effective and clean combustion technologies in society. This varies from domestic combustion in woodstoves and pellet boilers to industrial biomass combustion, power generation and cofiring of biomass with coal.

This presentation highlights some of the key results of the last triennium of IEA Bioenergy Task 32, and looks ahead at upcoming deliverables. Some examples of related topics recently addressed are the commercialization stage of torrefaction technologies, a review of the status of biomass cofiring, the health impact of fine particle emissions from biomass combustion, economics of biomass CHP projects and optimal design guidelines of biomass fired district heating networks.

Austrian contributions to Task 32

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In the last **working period 2013 –2015** the following priority topics were defined in IEA Bioenergy Task 32: fuel characterisation, pre-treatment and supply, "next generation" small- and medium-scale biomass combustion, industrial and utility-scale biomass combustion and power generation as well as biomass cofiring. Task 32 organised international workshops covering specific issues derived from the priority topics defined. In the working period 2013 –2015 five workshops and a conference have been organised. Within the scope of the priority topics, in total 6 reports, studies and position papers have been compiled.
Austria actively contributed to Task projects which were of relevance for Austria as well as observed and gathered information regarding Task topics on which no active work has been ongoing in Austria. Following Task results were coordinated by Austria:

- **Advanced Characterisation Methods for Solid Biomass Fuels.** IEA Bioenergy Task 32 report (Link:http://www.ieabcc.nl/publications/IEA_Bioenergy_T32_Advanced_characterisation_methods_for_solid_biomass_fuels.pdf)
- **Techno-economic evaluation of selected decentralised CHP applications based on biomass combustion with steam turbine and ORC processes**. IEA Bioenergy Task 32 report (Link: http://www.ieabcc.nl/publications/TEA_CHP_2015.pdf)

In the current **triennium (2016-2018)** the following topics will be worked on: (1) domestic heat production, (2) progress in biomass fired CHP applications, (3) reduction of emissions, (4) cofiring and full conversion, (5) low grade fuels and fuel pretreatment (6) greenhouse gas effects of biomass combustion including carbon capture & storage and (7) dissemination of information.
Austria will contribute to topics of relevance for Austria and coordinate the preparation of reports for Task topics (2) and (3):

Progress in biomass fired CHP applications
In recent years, a whole range of technologies have been developed and demonstrated for the power generation of small-scale biomass. The current state of these developments as well as selected best practice examples of industrial cogeneration plants of small and medium capacity are assessed on the basis of real performance figures and the results are summarized in a report. The report is coordinated by the Austrian member and is to be concluded by end of 2017.

Reduction of emissions
In work package 3 the focus will be placed on pre-normative research on measurement and test methods. Together with partners from Germany, the standardized measuring and testing methods used in space heating appliances and central heating boilers for biomass are collected and compared. In addition, selected current method developments in this area are described and their differences compared to the existing standards are analysed. The publication of the final report on this project is planned for the end of 2017.
Furthermore an international **Workshop on new emission measurement methods** is organised by the Austrian Task member in the frame of the Central European Biomass Conference on 19 January 2017 in Graz.

Integrated bioenergy hybrids

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The global energy supply system is currently in transition from one that relies on polluting and depleting inputs to a system that relies on non-polluting and non-depleting inputs that are dominantly abundant and intermittent. In countries where wind and solar are expected to play a dominant role in the energy transition, integration of these intermittent energy sources with biomass can be used to reduce fluctuations in the energy supply. Therefore, bioenergy has potential to play a key role as a stabilising element in a renewable energy (RE) supply system. On the other hand, as biomass is often sustainably available only at limited quantities, sharing the energy supply contribution with other RE sources reduces the pressure from biomass availability. For example, implementation of hybrid systems in heating sector spares more bioenergy for transport sector, where there are less options for cutting emissions. In short, integrated renewable energy systems, or *integrated bioenergy hybrids*, have the potential to make renewable energy more abundant and stable in comparison to separate processes operating with single energy input.

Bioenergy technologies are already commercially available and widely applied at various size ranges, applications and locations. Integration of bioenergy with other renewable energy sources will open completely new application areas for bioenergy ranging from frequency regulation to reserve energy and other services needed to maintain a reliable and secure energy supply with low environmental impact. Fundamental technical barriers are not expected to arise as a result of such new applications. Rather, problems are expected to emerge in technology selection, optimisation, proper sizing, control and management of hybrid processes, and a successful resolution of these issues is needed to accelerate and support widespread implementation of these new applications.

The above mentioned topics have been the focus of a recent IEA Bioenergy special project: *Bioenergy RES hybrids*. The project surveyed the current status of bioenergy hybrid technologies in Finland, Germany and Austria and developed estimates on their future potential. In our presentation we summarise and disseminate the main findings of our project and suggest key actions for the next five years, needed to spur investment in bioenergy hybrids technologies.

Transnationale Forschungsförderung durch das ERA-NET Bioenergy / ERA-NET Bioenergy - support of transnational bioenergy R&D

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The European strategy for renewable energy sources identifies bioenergy as the most important renewable energy source for the future: a source of cleaner, more secure and sustainable power for Europe. Bioenergy is a highly diverse area: agricultural and forest residues and dedicated energy crops, municipal waste and landfill sites can all provide heat, power and transport fuels. As national programmes fund 90% of bioenergy research in Europe, coordinating them is key to improve the outcomes of R&D funding.

ERA-Nets (European Research Area Networks) aim to improve cooperation and coordination of national and regional R&D support programmes. ERA-NET Bioenergy is concerned with energy production from biomass and has set itself the goal to enhance European research cooperation and coordination in this field by way of networking of the relevant R&D programmes of national governments.

In ERA-NET Bioenergy, national ministries and agencies from currently eight countries (AT, CH, DE, IE, NL, PL, SE, UK) that own or manage bioenergy research programmes work together in order to improve cost-effectiveness and ensure the maximum research impacts for this vital energy sector. ERA-NET Bioenergy has been active since October 2004. Until December 2010, it was funded by the 6th Framework Programme of the European Commission. Since January 2011, ERA-NET Bioenergy is a self-sustained network organised on a membership basis.

So far the ERA-NET Bioenergy network has launched 11 joint calls for proposals with the following topics: “small-scale combustion”, “cleaning of product gas from biomass gasification”, “short rotation coppice”, “clean biomass combustion”, “sustainable forest management and optimised use of lignocellulosic resources”, “biogas and energy crops”, “small-scale heat and power production”, “integrated biorefinery concepts”, “innovative bioenergy concepts”, “biobased economy” and currently “Bioenergy as part of a smart and flexible energy system”. Almost 50 R&D projects were funded over the past 10 years.

European harmonization of methods to quantify methane emissions from biogas plants

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The preceding discussion has described biogas and the use of its energy content as a strategy to substantially mitigate anthropogenic greenhouse gases (GHG). During the last years, the numbers of biogas plants has considerably increased in Europe as well as worldwide, due to the growing demand for renewable energy as substitute for fossil energy carriers and the implementation of sustainable waste management practices. The European biogas sector accounts for thousands of biogas installations. However, the positive environmental benefit of the production of biogas depends on the level of unintended methane (CH_4) emissions at biogas plants. Robust and reliable monitoring of the overall CH_4 losses from practical biogas applications is thus crucial not only from an environmental perspective, but also from a safety and financial one. In addition, it is an important aspect in order to reflect and improve the plant-specific process efficiency. Since biogas plants are a composite of different, potential CH_4 sources (e.g. substrate storage, feeding system, digestate storage tanks, digester cover, gas utilization facilities, etc.), the quantification of fugitive emissions is an outstanding challenge. In the past years, attempts were undertaken to quantify single emission sources as well as overall emission from biogas plants using direct (on-site) and remote sensing methods. While measurements on site often focus on one type of CH_4 sources, remote sensing methods cover the overall emission plume. Among the current available emission measurement techniques, none is in a position to be recognized as the best international reference. Therefore, the establishment of a scientifically based standardization and harmonization of methods would greatly contribute to the assessment of the fugitive emissions from biogas plants.

The research project “MetHarmo” aims at evaluating the performance of five selected techniques (on-site methods including detection of gas leakages and flux chambers; remote sensing methods including inverse dispersion modelling and mobile tracer method with either open-path Tunable Diode Laser Absorption Spectrometry (OP-TDLS) or Cavity ring-down spectroscopy (CRDS), as well as Differential Absorption Light Detection and Ranging (DIAL) measurements) tested simultaneously on a German biogas and upgrading plant. In addition, the gained emission data will be supplemented by gas-formation tests of fermentation residues (digestate) from the biogas plant. The Institute of Waste Management will participate in the planned intercomparison campaigns using the inverse dispersion technique. OP-TDLS will be used to measure average CH_4 concentrations over a set distance in open air (open-path), while a 3D ultrasonic anemometer will provide the required wind and atmospheric stability information for the dispersion model.

The results of the project shall lead to a method harmonization expressed by a written guideline to perform standard measurements and a categorization of different methods. It should guide the user in analyzing and understanding reported emission values using different methods and approaches. This guideline may also serve as a basis for a common European standardization of measurement procedures and data evaluation to generate precise and comparable results within the EU. The inter-comparison campaign will start in autumn 2016. First result will be expected in spring 2017. A final workshop of the project will be hosted by Energieforsk in Malmö in spring 2018, where interested parties are welcome to register.

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Project partners: Deutsche Biomasseforschungszentrum gemeinnützige GmbH (DBFZ) (Project leader), SP Technical Research Institute of Sweden, University of Stuttgart, Central Institute for Meteorology and Geodynamics in Austria (ZAMG), Energieforsk – Swedish Energy Research Centre, Bioenergy2020+ GmbH, Avfall Sverige in Sweden, Technical University of Denmark (DTU), Boreal Laser Inc.

GrateAdvance - Advanced adjustable grate solutions for future fuel flexible biomass combustion technologies

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The energetic exploitation of other alternative fuels (short rotation coppice, Miscanthus), agricultural by-products (straw, corn cops) or biomass residues (nut shells, coffee grounds) becomes increasingly of interest. Due to variations in fuel properties – and the ash content in particular – biomass fuels considerably influence the conditions in the combustion zone and especially in the fuel bed. State-of-the-art combustion appliances usually are optimized for a particular fuel quality and typically approved only for utilization of standardized wood pellets (class A1 according to ISO). Fuels with a higher content of ash cause increased emission release during combustion. An unfavorable composition of ash forming elements in the fuel leads to slag formation on the grate and inside the combustion chamber. Low temperatures in the fuel bed and well-directed air supply in the combustion zone are known as crucial factors in order to avoid or reduce slag formation and minimize the release of PM emissions. Results of recent research projects have also shown a considerable influence of residence time and structure of the fuel bed.

Flexibly adjustable grate systems are therefore major prerequisites for combustion systems that can be operated with different types and qualities of biomass fuels, and to ensure low emissions and high operational security regarding slag handling at the same time. The GrateAdvance project deals with the development of next generation small scale biomass burner and boiler systems. Scientific object of this venture is to improve the understanding and modelling of the solid fuel conversion inside fuel bed with focus on ash-related compounds to describe slagging mechanisms and the impact of operational parameters (temperature, residence time, stoichiometry) on particle and emission release.

Results will be implemented in technology development and optimization of three particular combustion systems, ranging from domestic up to small commercial scale (100-300 kW). Furthermore, a novel control concept that is capable of adapting to varying fuel properties (low quality wood pellets, pellets from residues, pellets from upgraded biogenic waste streams) will be developed, and a concept for ESP integration for larger capacities is elaborated. Parts of the Austrian work share in this examination are:

- CFD modelling of the fuel-flexible grate section,
- further development of the patented screw burner technology (domestic scale) and
- development and implementation of the novel fuel-flexible control concept.

Based on these findings, conceptual design recommendations for combustion regimes avoiding ash slagging and ash release to the flue gas are being derived for burning ash-rich biomass fuels. Key-parameters that enable a self-adapting control dependent to varying fuel properties will be specified.

Technologies considered in this project will allow the adaption of conditions in the combustion zone, by systematic and targeted adjustment of grate parameters to minimize emissions and slagging problems, thus setting the basis for a new generation of biomass boilers. A novel control concept will ensure optimal combustion conditions for any biomass fuel, and specifically adjust to relevant fuel properties

Technologies developed and realized within this project are expected to meet emission requirements even for lower fuel qualities.

The GrateAdvance project is funded by the FFG within the 9th ERA-NET Bioenergy Joint Call: Bioenergy Concepts.

Resource-efficient fuel additives for reducing ash related operational problems in waste wood combustion

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The economic boost to use waste wood or other biomass waste products as a biomass fuel source are likely to increase as the cost for virgin wood fuel is in general significantly higher and the availability of virgin wood fuels for combustion purposes is limited. Wood waste arises via a variety of post-consumer waste and in different fractions, ranging from untreated, pre-consumer off-cuts to treated wood. Depending on the source, waste wood contains more or less elements that increase the risk to get ash-related problems in the boiler during combustion. Alkali chlorides formed from the critical elements released from biomass combustion may lead to severe ash deposition and corrosion problems in biomass-fired boilers. The majority of biomass and wood waste-fired power plant in Europe reports more or less extensive corrosion problems in the superheater as well as on furnace walls that cause unacceptably short life times. One of the measures to reduce the alkali chloride-related problems in biomass combustion is to use additives. Several different mineral- and sulphur containing additives have been proposed (Wang, 2012). Although there is a wealth of experience in the area of biomass combustion and additives, there is still a clear need for further development in several areas, including studies of new cheap and resource efficient fuel additives for reducing corrosion, fouling and slagging. Fuel additives can increase the reliability of biofuel plants and develop skills to extend the use of different types of biofuels, which ultimately may mean that the energy supply of conventional fuels with high environmental impact can be reduced. Furthermore, most of the studies reported in the literature are based on laboratory-scale tests, while more in-situ and industrial-scale tests are preferred with full-scale operations. In addition, new additives with multi-functions, high stability and reactivity and low cost should be identified and tested. It would be most attractive to find more additives from waste materials with low costs and high availability.

The overall objective of this project is to improve economic and environmental conditions and enlarge the market for the use of wood waste fuels in CHP plants by using resource efficient additives such as recycled gypsum or coal fly ash in combustion. Specific aims are to propose efficient and innovative fuel additive design concepts for reducing ash related operational problems (corrosion, fouling and slagging) during combustion of wood waste fuels. These design concepts should be validated by the performance of full-scale combustion tests. In addition, the integration of new additive design concepts to the CHP plants should be shown. This integration should be performed in ways that are economical, benefit the environment, conserve natural resources and provide the CHP plant a fuel mixture with right quality. Furthermore, it should be shown how fuel additive design concepts are related to reduced operation and maintenance costs. Concerning the ashes recycling processes from waste wood combustion with additives should be proposed to reduce the cost paid for landfilling. Finally, environmental and economic effects of using various additives in waste wood combustion in CHP plants should be determined.

At the moment, the development of efficient and innovative fuel additive design concept is ongoing. For the investigations a special designed lab-scale combustion reactor was used. With this reactor the combustion conditions on a grate furnace can be simulated. The big advantage of this reactor is the investigation under controlled and reproducible laboratory conditions. The experimental investigations are supported by theoretical considerations by means of high temperature equilibrium calculations. With this approach certain phases, responsible for problems during combustion e.g. corrosion, fouling and slagging, can be identified. Furthermore, the impact of the additive to minimise problems caused by corrosion, fouling and slagging can be evaluated. These calculations are also applied for the determination of an optimum additive ratio. The investigation on the laboratory-scale supported by theoretical considerations will later be validated by test runs in real-scale combustion plants.

09:00–12:30 Uhr

Workshop

BioFlex: Flexible Betriebsführungs-konzepte für Biomasse-KWK-Anlagen

09:00 am–12:30 pm

Workshop

BioFlex: flexible operations-management concepts for combined biomass heat and power plants

BioFlex – Betriebsführungskonzepte für Biomasse-KWK nach Auslaufen der Ökostromstromverordnung

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In Österreich werden zurzeit 129 Ökostrom-Anlagen für feste Biomasse mit einer elektrischen Gesamtleistung von 320 MWel betrieben. Viele dieser Anlagen arbeiten mit einem Dampf- oder ORC-Prozess, die an bestehende Fernwärmenetze gekoppelt sind. Betreiber von Ökostrom-Anlagen müssen sich aufgrund des baldigen Laufzeitendes ihrer Verträge nach neuen Möglichkeiten der Stromvermarktung umsehen. Das Wegfallen der konstanten Einspeisevergütungen stellt die betroffenen-Betreiber vor eine erhebliche wirtschaftliche Herausforderung. Gleichzeitig wird aufgrund der fallenden Strompreise die Fernwärmeerzeugung aus Strom (Power2Heat) mit Elektrodenkessel oder Wärmepumpe attraktiver.

Das im April 2016 gestartete Projekt BioFlex setzt sich mit der Flexibilisierung von Biomasse-KWK sowie den Möglichkeiten zur Teilnahme am Strommarkt auseinander. Die Kopplung zwischen Fernwärme und Stromnetz erfolgt einerseits durch bedarfsorientierte Stromerzeugung in KWK, und andererseits durch angebotsorientierte Stromabnahme mittels „Power-to-Heat“-Konzepten. Voraussetzung ist in beiden Fällen ein dynamischer Anlageneinsatz.

Es werden die verschiedenen Möglichkeiten am Strommarkt teilzunehmen (Fahrplanenergiemarkt, Regelenergiemarkt) vorgestellt. Darauf aufbauend werden die technischen Herausforderungen diskutiert und eine erste Abschätzung der Eignung von Biomasse-KWK zur Teilnahme gegeben. Abgerundet wird die Präsentation durch einen Projektausblick. In den kommenden zwei Jahren werden im Projekt einerseits verfahrenstechnische Untersuchungen an Biomasse-KWK zur Erhöhung der Lastwechseldynamik und Verbesserung der Teillastfähigkeit und andererseits Betriebsführungskonzepte mit unterschiedlichen Anlagenkonfigurationen und mathematischer Optimierung der Anlageneinsatzplanung untersucht.

13:30–15:00 Uhr

Workshop

BINE: Bidirektionale Einbindung von Gebäuden mit Wärmerzeugern in Wärmenetze

01:30 pm–03:00 pm

Workshop

BINE: bi-directional integration of buildings with heat generators into heating networks

Decentralized Bi-directional integration of Heat Grid customers: Implementation concepts in the heating network “Großschönau”

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In order to cover the heat demand of a settlement or a district in a sustainable and environmentally friendly manner, all renewable heat sources (solar thermal plants, biomass boilers or waste heat) should be used. Heat grids are an excellent way to integrate these heat sources into a comprehensive heat supply. Using them reduces emissions and can increase the overall energy efficiency. However, at the moment many of the locally available heat sources are mostly unused or at least just partially used. The reason for this is that the decentralized integration of heat sources in heat grids requires appropriate adaptations of hydraulics and control strategies in the grid, which are usually not trivial. It is also necessary to adapt the heat billing accordingly in a fair framework.

In the course of the FFG project "BiNe2+", the possibilities and prerequisites for this integration and the necessary modifications are investigated, in particular the requirements for the bi-directional transfer stations and their possibilities of integrating different heat sources into the district heating grid of “Großschönau”. Several prosumer (producer-consumers: the integration of buildings that provide heat at certain times while they take heat from the grid at other times) will be implemented in the test grid. To accomplish this, technical calculations, model development, controller design, simulation studies and tests with different heat sources are used in the test grid. For the further development and evaluation of the business models, game theoretic approaches are used, in particular in the context of multi-agent simulations.

The heat demand in the summer operation of the district heating network is to be covered by means of the integration of four decentralized prosumers. These can relieve the load on the network, and loss-making operating modes (for example, at the moment summer operation is almost always loss-making) can largely be avoided by intelligent decentralized solutions. At the same time, emissions can be reduced, since partial load operation as well as frequent switching on and off of the integrated biomass boilers can be avoided.

The search for potential decentralized heat sources (prosumers) in the test network, which can be practically implemented, and the development of the respective integration or feed-in concepts was a major challenge and is explained in more detail in the poster. Specifically, the process to select prosumers for the test grid will be discussed for the four prosumers which will ultimately be implemented. Precisely, the following four heat sources are currently in the pipeline to be integrated into the test network:

- Biomass using a 80kW woodchip boiler
- Solar thermal energy (36m²) using a 24kW heat pump
- Commercial waste heat from cooling plants using a 8kW heat pump
- Oil boiler (standby boiler) 320kW

09:00–12:30 Uhr

Workshop

BioStep: Eine Bioökonomiestrategie für Österreich

09:00 am– 12:30 pm

Workshop

BioStep: a bioeconomy strategy for Austria

BioSTEP Policy Workshop: “A bioeconomy strategy for Austria: The role of civil society”

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BioSTEP (www.bio-step.eu) is an EU-funded project that aims to promote a participative governance of the European bioeconomy through the engagement of stakeholders and citizens. The project utilizes a participatory approach to involve a variety of actors in dialogues on the future development of the bioeconomy. As part of its stakeholder engagement activities, BioSTEP will organise three policy workshops, to which stakeholders from relevant sectors will be invited in order to discuss existing (policy) challenges related to the future development of the bioeconomy and potential (policy) measures to address them.

The focus of BioSTEP’s third and final policy workshop will be on the national context in Austria. The Austrian government is currently in the process of developing a strategy for research, technology and innovation to support the emerging bioeconomy. Following this process, the development of a broader strategy is planned that comprises further policy domains and sectors. Against this background, the questions arise regarding what role civil society organisations should play in this process and how they can contribute to shaping the further development of the Austrian bioeconomy.

Besides businesses and research centres, civil society can be directly or indirectly affected by future developments in the bioeconomy field. Bio-based products and processes are associated with economic, social and environmental effects, which may have positive or negative impacts on society. This BioSTEP workshop aims to discuss the role of civil society organisations in the strategy development process in Austria, specifically reflecting on current approaches and what opportunities and challenges arise.

The outcomes of the Graz workshop and the previous workshops held in Utrecht (NL) and Glasgow (UK) will feed into a list of targeted policy recommendations for the (further) development of balanced and informed bioeconomy strategies at the regional, national and European levels. These recommendations will be presented and discussed at a stakeholder conference that will be organised by BioSTEP on 30 March 2017 in Brussels in order to inform the ongoing review of the EU Bioeconomy Strategy.

15:30–17:00 Uhr

Workshop

ErgoS: Energierückgewinnung durch offene Sorption

03:30 pm–05:00 pm

Workshop

ErgoS: Energy recovery through open sorption

Energy Recovery by Open Sorption - An innovative technology for flue gas condensation in biomass combustion systems

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Biomass, especially chipped wood, is commonly used as a fuel for district heating in Austria. Between 2005 and 2013 the energetic end use for district heating from solid biomass increased from 10 PJ to 34 PJ. The water content of the biomass fuel in district heating plants often reaches 50%. Thus, the recovery of condensing heat from water vapour in the flue gases is necessary to reach high energetic efficiencies. One possible technology is the open sorption process for the heat recovery from the flue gases, which is presented and discussed within this workshop.

The process is described by three main components, the open absorber, the generator and the condenser. A concentrated absorption fluid, a hygroscopic salt solution, is injected into the flue gases within the open absorber and the fluid absorbs the water vapour. Thus, the water vapour within the flue gases is directly used as refrigerant. Through this process the flue gases are dehumidified to a relative humidity of 30-40%. Afterwards the dried flue gases leave the system through the chimney. Meanwhile the salt solution is re-concentrated by boiling in the generator. Before the solution is re-injected into the absorber it enters a heat exchanger to recover the heat from the solution to the water of the heating circuit. The resulting pure water vapour is condensed at ambient pressure. The advantage of this process is that the majority of the recovered heat is available on a temperature level above the dew point. This fact increases the field of application compared to a conventional condensing heat exchanger. Moreover, particulate emissions can be reduced in the flue gases by the absorption too.

Within the Workshop the following presentations will be given and afterwards discussed:

- Presentation of the project ErgoS (**E**nergie**r**ück**g**ewinnung durch **o**ffene **S**orption)
- Open sorption technology – Basic principles and process layout
- Installation of a test facility for heat recovery from flue gases out of biomass combustion by an open soprtion process
- 3D CFD simulation of the test absorber for the open sorption process
- Experimental evaluation of open sorption technology for heat recovery in laboratory scale

Postersession

Poster Session

Experimental evaluation of a biomass pellet combustion concept developed for a 5 kW_{el} Stirling module

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Introductive Summary:
A Stirling engine directly integrated in a biomass pellet boiler promises to be an efficient and environment-friendly way to produce heat and electrical power for small scale applications. Electricity and heat produced from biomass is a valuable contribution to achieve the renewable energy targets of the European Union. Within the project StirBio a wood pellet fired combustion test facility with a nominal heat output of 30kW_{th} was developed to operate it with a fully integrated 5kW_{el} Stirling engine. The heat exchanger of the Stirling is optimized for hot flue gases from wood pellet and the combustion air is preheated by flue gas heat recovery. The results of the project StirBio show highest achieved electrical efficiency up to 15% and further optimizations of operation reliability, which is important for an intermediate-term successful market entrance of a biomass driven Stirling engine.

Approach:
Starting from state of the art technology the Stirling engine, the heat exchanger of the Stirling-module and the boiler concept were developed. The development and engineering of the heat exchanger and newly high temperature biomass pellet combustion were supported by computational fluid dynamics simulation (CFD). After finishing the design drawings, two testing facilities with an integrated Stirling module were constructed. The functional capability and the thermal and electrical efficiency were evaluated during extensive experimental tests. The project partners were Frauscher thermal motors GmbH, Vienna University of Technology (TU Wien) and Hargassner GmbH.

Results and conclusions:
The two developed prototypes showed that the requirements for highly efficient operation of a Stirling engine can be reached. The burner concept with the integrated air preheating leads to high temperatures (more than 1200°C) in the secondary zone and subsequently a high process gas temperature in the Stirling engine (> 600°C). The electrical efficiency reaches 13.9% on average and a top value of 15% and the overall efficiency reaches up to 90.3%. The Stirling engine from Frauscher Thermal Motor was operated stable for more than 200 hours and has been further developed close to the market at the end of the project. For ensuring permanent highly efficient and long low-maintenance operation further development steps are necessary. First, the development and integration of an automatic cleaning system for the Stirling heat exchanger is necessary. Second, a novel combustion control algorithm has to be created for running the pellet burner with low air excess to reach highest flue gas temperatures.
A continuous one-week test of more than 100 hours demonstrated the importance of the selection or development of suitable materials for the combustion chamber, because the high flue gas temperatures and the high change in temperature stress them immensely. After the test runs no effect of corrosion was detectable on the Stirling heat exchanger made from high-temperature resistant stainless steel. With further long-term measurements and field tests the corrosion tendency has to be investigated for developing countermeasures, if necessary. Through the gained expertise and results from the evaluation of the constructed testing facilities, measures for long-time low-maintenance operation are defined and subsequent development steps emerge.

Acknowledgment:
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CO_2 REDUCTION POTENTIALS AND COSTS OF BIOMASS-BASED FUELS FOR PASSENGER CARS IN AUSTRIA

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Biomass-based resources play a specific role for reducing Greenhouse gas emissions. The core objective of this paper is to analyse possible CO_2 saving potentials in Austria due to the increasing use of AEC in a policy forced scenario (Policy Lead Scenario) as well as to estimate CO_2 saving costs.
The biomass-based fuels considered in this study are: (i) 1st generation biofuels (bio-ethanol and biodiesel) and biogas; (ii) 2nd generation biofuels; (iii) hydrogen from biomass; (iv) electricity from renewable energy sources; We investigate in detail which quantities of biomass-based fuels can be possibly produced in Austria till 2050 in a Policy Lead Scenario (current and planed policy measures are considered in a dynamic context as well as technological learning effects). The energy production in this scenario is shown in Figure 1. It depicts the. As can be seen in this scenario by 2050 finally more than 130 PJ of AEC will be produced.

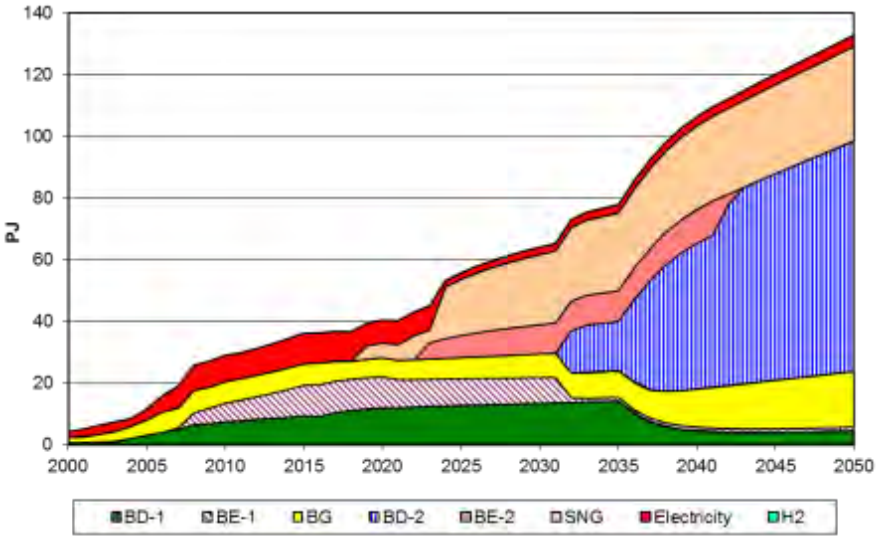

Figure 1: Energy production (final energy) in the Policy Lead Scenario (With max. 30% arable land in 2010, with CO2 tax, and with priority for biofuels)

The share of 2nd generation biodiesel is increasing starting from 2032. Finally, most BD-2 are produced from corn stover (whole plant used) from arable land. In this scenario with biofuels priority SNG provide significant contribution to energy production starting from 2017. Yet, this takes place only if it can be managed that these technologies – BTL, FT-Diesel, SNG – become mature and if significant learning effects are achieved. Due to the finally better energetic and economic performance of BD-2 it also substitutes BE-2 production after 2040. However, it must be noticed that energetic as well as economic developments of the different categories of BF-2 are of course not known in detail today. The major reasons why in Figure 3 BD-2 and SNG reach so high amounts are: (i) they have highest energy efficiency and hence lowest feedstock costs; (ii) they have lowest CO_2-emissions and hence lowest CO_2-taxes.
The final major conclusion is that only if the portfolio of actions described above – CO_2 tax, ecological monitoring system, and a focussed R&D programme for BF-2 and fuel cells – is implemented in a tuned mix it will be possible to exploit the potential of biomass-based fuels up to 2050 in Austria in an optimal way for society.

New possibilities for micro biogas plants in Slovenian agriculture

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The share of agriculture direct emissions is estimated at 10-12% of the global GHG emissions, excluding the emissions from fuel use, fertilizer production and agriculturally induced land use change. The total share of agriculture GHG emissions (direct and indirect) rises up to 30% of global GHG emissions, when it includes additional emissions from fuel use, fertilizer production and land use change (land use change alone accounts for 6–17%). The share of GHG emission from agriculture sector in Slovenia is about 10% of the total inventory greenhouse gas (GHG) emissions. The utilization of agricultural wastes for energy production presents one of the measures to decrease GHG emissions. The use of biogas as energy source has positive impact on the reduction of methane emissions as one of the greenhouse gases with high global warming potential.

Hence, the substantial development of technology for biogas production from biodegradable wastes, including agricultural wastes (manure, green wastes…), and consequently for heat and electricity production in CHP or as bio-methane after processing in cleaning plants, increases the possibility to extended the installation of micro biogas plants in agriculture sector.

Breeding farms with more than 50 livestock animal units (LSU) present a group with the greatest potential for the construction of micro biogas plants. The number of breeding farms in Slovenia, according to data from 2013, with more than 100 LSU is 165 farms with total of 35030 LSU, and 2142 breeding farms with 50 to 100 LSU, and total of 47232 LSU.

Calculation for biogas potential in breeding farms of 50 to 100 LSU and over 100 LSU presents a realistic possibility for using waste (manure) from livestock for biogas plants in the near future (potential 19.9 M m3 of methane per year). There are even more possibilities by installation of collective biogas plants, because more than 25% of all animals in Slovenia are raised in agricultural breeding farms with between 20 to 50 LSU.

For the purposes of monitoring the functioning of micro biogas plants under realistic conditions, we have developed and built a biogas plant on a dairy farm, which has started the testing operation in April 2015. The biogas plant has a modular structure, which means that it can be extended on other agriculture breeding farms. The paper will present the possible additional potential of micro biogas plants in Slovenia and will the analysis the results of the first year of the pilot micro biogas plant

Synthesis gas production by dry reforming of biogas

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In general, biogas is primarily used on-site for power generation using engine-driven-CHP units and thus used energetically. Methane and carbon dioxide are the main components of biogas in a ratio of about 1 - 1.5. This makes the process of dry reforming (eq. 1) interesting as alternative application.

$$CH_4 + CO_2 \leftrightarrow 2H_2 + 2CO \qquad \Delta_R H^0 = 247\ kJ/mol \qquad \text{eq.1}$$

The process of dry reforming coupled with thermochemical recuperation is one opportunity to increase the electrical efficiency of conventional engine driven CHP-units. This is achieved by a partial conversion of the feedstock biogas by using dry reforming, whereby the required reaction enthalpy is supplied by excess exhaust gas enthalpy for the endothermic process. In this way, excess exhaust gas enthalpy is transferred into chemical bonded energy of the produced reformat gas. Reformat gas and biogas are then burned in the engine.
Furthermore, the process of dry reforming is interesting for the production of reformat gas that is used for chemical synthesis processes, whereby an alternative value chain is created. Biogas then assumes the role of an educt for the production of H_2- and CO-rich gases that can be used for the production of methanol, DME or others.
The poster presentation deals with the usability of dry reforming and presents theoretical and experimental investigations. Based on thermodynamic investigations the process potential is shown under consideration of aspects like chemical conversion and yield but also with regard to possible carbonaceous deposits on solid catalysts. The shown experimental works include a catalyst screening for the selection of suitable catalysts as well as the identification of potential carbon types by using the method of Temperature-Programmed-Methanation (TPM). With this procedure, the selective inhibition of carbon formation by commercial catalysts can be shown, contrary to the thermodynamic potential. These results were confirmed in long term tests, whereby the principle feasibility could be shown.
Another content of the poster presentation are further measures for decreasing risk of carbonaceous deposits, inter alia, the saturation of biogas with steam or the addition of small amounts of air into the process of dry reforming.

Experimental analysis of the producer gas from an open top gasifier - Comparative study on different tar analysis approaches

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Gasification producer gas can be used in various prime movers, e.g. internal combustion engines and gas turbines, for the combined production of heat and power. The producer gas has a high potential to replace fossil fuels for decentralized energy generation, but it contains some undesired compounds (e.g., tar, particulate, fly ash, etc.) that need to be reduced to guarantee an acceptable operation. The presence of tar in the producer gas is one of the key technology barriers for the use of the gasification systems for engine applications. Tar is a bituminous oil present in the producer gas in vapor phase that is difficult to remove with a simple condensation or cleaning since it may cause the clogging of filter and valves and also the corrosion of the metallic components.
The present paper addresses a comprehensive screening procedure of the tar present in the raw producer gas generated by a small open top downdraft gasifier (1 kg h^{-1} biomass input) developed at the Indian Institute of Science (IISc), Bangalore. The main objectives of this research are the comparison of different approaches for the sampling and analysis of tar and the assessment of the capability of this gasifier to produce low-tar producer gas.
The tar analyses were carried out with two different approaches available in the scientific literature which include gas chromatography–mass spectrometry (GC–MS) analysis and the gravimetric approach. Additionally, tar has been collected using two different solvents; isopropyl alcohol (IPA) and hexane were addressed to compare their capability to dissolve tar compounds, which impacts their estimation. The study focuses comparing some of the methods used for characterizing tar and also compares the performance of the solvents used for the collection of tar.
The results of the GC–MS analysis of the collected samples showed that tar is mainly composed of light aromatic compounds, where benzene and toluene account for about 70% of the total detected tar. The gravimetric tar is roughly one order of magnitude lower than the total tar that was determined by GC–MS analysis on the collected samples. Light and heavy polycyclic aromatic hydrocarbons (PAH) compounds - with a molecular weight higher than 150 g mol^{-1} – have been detected in the gravimetric tars, however the main fraction is GC-undetectable. The two approaches for the analysis of tar have different capabilities and the choice of either the approaches would strongly depend on the selected gasification technology. The detailed experimental analysis evidenced that the IISc open-top reactor design results in a low tar content in the producer gas. The gravimetric tar in the raw gas were measured at 50–80 mg N m^{-3}, with minimum dependence on the choice of the feedstock used, i.e. Casuarina wood chip or coconut shell.

Subject area: Electricity from solid biomass
Keywords: Biomass gasification, open-top gasifier, tar analysis

Flexible biogas plants as regional balancing option in power distribution grids – results of the project “RegioBalance”

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Introduction:
In the research project “RegioBalance” the DBFZ examined if controllable and flexibly operat-ed biogas plants can contribute to avoid or reduce the demand for medium voltage grid expansion and if those flexibility options are economically beneficial compared to conventional grid expansion. For this pur-pose, five medium voltage substation districts (20 kV) were investigated. Regarding those five power distri-bution grids, different scenarios were calculated to show how bioenergy plants have to be evaluated grid-wise and to demonstrate how the resulting costs have to be interpreted economically as compared to grid expansion. Therefore, within the scope of a pro-active feeding management an evaluation approach was developed to compare the flexibility bioenergy option with the power grid expansion.

Results:
The economic evaluation approach is based on a calculation of opportunity cost in which costs and lost profits of bioenergy plants that are operated to the grid’s benefit are compared to future grid expansions. Based on selected substation districts it is shown if - and under which conditions - flexible biogas plants can be an addition to the necessary power grid expansion by reducing the demand for grid expansion or by giving the opportunity to postpone it further into the future. As a result, grid planning can be calculated with lesser feed-in capacity whereby the demand for grid expansion can be reduced. It is shown that in many cases opportunity costs for flexible biogas plants are below costs for grid expansion and, as a consequence, that savings concerning grid expansion can be generated. Thus, options for smart grid planning and management can be economically meaningful and should be further considered in the course of legal revisions, such as the Ordinance on Incentive Regulation (ARegV). For this purpose, developed recommendations for actions shall be presented that are necessary for the realization of alternative flexibility options accompanied by an increased cost efficiency of the energy transition in the power sector.

Exclusivity and topicality of the contribution:
Against the backdrop of current debates regarding the contribution of bioenergy/biogas to the energy system, a relevant issue is the cost analysis of various flexibility approaches of biogas plants. Altogether, there are diverse approaches that pursue a stronger integration of renewables and that are primarily focused upon limiting the required grid expansion by smart grid planning and management to a necessary degree.

Non-Ionic Surfactants as Additives to Prevent Stable Emulsion Formation in Biomass Steam Gasification Product Gas Scrubbers

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Dual fluidized bed steam gasifiers fed with biomass offer a promising renewable route to generate heat, electricity and valuable gases such as hydrogen. Undesired by-products of this process are condensate and tar. Whereas condensate mainly consists of water and little amounts of ammonia, tar is considered as organic matter with a molecular mass of benzene and higher. A cold biodiesel (rapeseed methyl ester, RME) scrubber can be used to remove condensate and tar from the product gas stream. An elegant way to reduce waste is to re-use the condensate for steam generation. For this task, a clean, oil-free condensate phase is necessary.
However, emulsion formation in the condensate phase of the scrubber's separation tank can take place and lead to failure of the steam generator. This work deals with the use of surfactants as additives to improve phase separation of biodiesel and condensate in order to use the condensate for steam generation.
Emulsions were prepared by bubbling air though Drechsel gas-washing bottles filled with an equal amount of RME, and water containing 1g/L ammonium carbonate. The addition of ammonium carbonate accounts for ammonia in the condensate, which promotes the formation of stable emulsions. Before mixing, 210ppm or 524ppm surfactant were added. The non-ionic surfactants SPAN 60 (sorbitan monostearate), SPAN 65 (sorbitan tristearate) and TWEEN 80 (polyoxyethylene sorbitan monooleate) were studied. Immediately after mixing, phase separation took place and was observed with a camera and scales attached to the gas-washing bottles. For comparison, the experiments were also conducted without any surfactant added as well as without ammonium carbonate added.
Both SPAN 60 and SPAN 65 significantly enhanced phase separation. The surfactant concentration did, however, not have a large effect on the phase separation. Even though ammonia was present, the time to completely separate RME and water was shorter than the separation time for pure water and RME.
The addition of TWEEN 80 did not improve phase separation. These experiments were indistinguishable from those without surfactant added. A reason for this behaviour may be found in the different hydrophilic-lipophilic balance of SPANs and TWEENs.
In summary, the addition of SPANs in the scrubber's condensate separation tank may help to increase process stability and thus reduce downtime and maintenance costs.

Evaluation of dynamic operation of a biomass fired Externally Fired Gas Turbine (EFGT) with a Hardware-in-the-Loop (HiL) concept

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The application of micro-scale externally-fired gas turbine (EFGT) plants occupies an increasing importance recently, especially when talking about reliable sustainable energy resources investigation like biomass. EFGT biomass fueled plants are presented as a promising energy solution in the literature, and discussed for the ranges of 100 kW_{th} like in [1][2][3]. While previous research focused on steady-state operation of EFGT, the main objective of this study is to test some biomass types and use the flexibility of the whole plant in order to add further knowledge in this technology, like the general behavior, parameters mapping for optimum output power, and the effect of biomass type variating.

For the purpose of the study, a 15 kW_{th} burner is installed along with a normal heating boiler for flexible combustion of different biomasses; the reference study is on normal wood pellets. The further parts of the system are modelled in a real-time, hardware-in-the-loop (HiL) simulation within a programmable logic controller (PLC). The main advantage of using HiL is overcoming the complex aspects accompanied with the modeled parts in addition to the flexibility of study. The HiL is implemented by Wago PLC which is connected with complete measurement sensors for temperatures, fuel weight, and gases mass flow, in addition to control the input heat from the burner by adjusting the suitable signal for feed in pellets motor.

Parameter optimization is conducted with flowsheet simulation (Aspen Plus) and included into the process control. The main results presented include dynamic behavior of the overall system, efficiency changes during part-load operation, and general suitability for grid-supporting, flexible power generation.

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Moderne, zertifizierte Brennstoffe als Voraussetzung für den Zubau von Holzfeuerungen

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Moderne Holzfeuerungen sind Hightech-Produkte, deren Hersteller vor allem im deutschsprachigen Raum zu finden sind. Ergänzend dazu liefert Holz als CO_2-neutraler sowie auf preiswerter heimischer Produktion basierender Brennstoff beste Voraussetzungen für die Energiewende am Wärmemarkt. Wenn die Holzenergie in Zukunft über den Einsatz im ländlichen Raum auch im städtischen Umfeld einen deutlichen Zubau erfahren sollen, wird jedoch nicht nur die Feuerungstechnik, sondern vor allem auch die Brennstoffseite deutlich höheren Anforderungen entsprechen müssen. Dies bedeutet vor allem strenge Qualitätsanforderungen, die einen effizienten, emissionsarmen sowie komfortab- len Betrieb gewährleisten. Mit dem Dauerthema Feinstaubbelastung ist vor allem die Luftreinhaltung ein Anspruch, den moderne Holzfeuerungen heute glaubwürdig nachweisen müssen.

Der Vortrag „Moderne, zertifizierte Brennstoffe als Voraussetzung für den Zubau von Holzfeuerun- gen“ präsentiert Stand und Resultate der vom Deutschen Pelletinstitut (DEPI) getätigten Initiati- ven. Deren Ziel ist die Systemerarbeitung für hochwertige Holzbrennstoffe der Sortimente Pellets, Hackschnitzel und Briketts unter dem Dach der ENplus-Zertifizierung.

Für Holzpellets hat das DEPI im Jahr 2010 die ENplus-Zertifizierung ins Leben gerufen. Sie basierte auf dem Prinzip, dass zur durchgängigen Brennstoffqualität neben dem Produktionsverfahren auch Logis- tik und Anlieferung beim Verbraucher mit hoher Sachkunde vorgenommen werden. Hierfür müssen Energie- und Pellethandel geschult sein. Die ENplus-Zertifizierung hat sich mittlerweile am Markt durchgesetzt und gilt auch international als Messlatte für eine Premiumpelletqualität, die den Be- trieb von Feuerungen auch mit hervorragendem Emissionsverhalten ermöglicht. Die Nutzung durch Produktion und Handel erfolgt mittlerweile in 33 Ländern, auch in Übersee. Deutschland und Öster- reich nehmen als ausgeprägte „Wärmemärkte“ für die Holzenergie dabei Vorreiterrollen ein.

Für Holzhackschnitzel und deren Feuerungen haben die Ansprüche an das Emissionsverhalten durch die in Deutschland - auch im internationalen Vergleich - sehr strengen Luftreinhaltevorschriften (Ver- ordnung über kleine und mittlere Feuerungsanlagen, 1. BImSchV) seit 2015 zu großen Problemen im Absatz geführt. Das Deutsche Pelletinstitut hat 2015 mit der Ausdehnung der ENplus-Zertifizierung auf diesen Energieträger begonnen und zwar im Rahmen eines öffentlich geförderten Projektes („Hackzert“). Die Markteinführung für nach ENplus zertifizierte Hackschnitzel in Deutschland soll im Oktober 2016 erfolgen. Wesentliche Inhalte des Zertifizierungssystems sind die Schaffung von auf Korngröße und Aschegehalt basierenden Qualitätsstufen. Damit die Abrechnung einheitlich über den Energiegehalt erfolgen kann, ist ein praktikables Messverfahren für den Wassergehalt der Lieferung Voraussetzung.
Die Perspektiven des Energieträgers Holzbriketts liegen vor allem in der Substitution von Scheitholz für Einzelraumfeuerungen (Öfen). Hierzu bietet das Deutsche Pelletinstitut seit März 2015 ein ent- sprechendes ENplus-Zertifizierungssytem an, das den Anforderungen der internationalen Brennstoff- norm ISO 17225-3 entspricht. Das Qualitätszeichen soll Kaufsicherheit bieten. Darüber hinaus beste- hen Vorgaben an die interne Qualitätssicherung des Produzenten.

Moderne Holzbrennstoffe sind die „Musterknaben“ der Bioenergie. Dieser Anspruch wird nur dann zu erfüllen und zu verkünden sein, wenn damit ein einheitliches, schlüssiges Marketingkonzept ver- bunden ist. Das ENplus-Siegel liefert hierzu gute Voraussetzungen und soll – auch international – für den Feuerungsbetreiber als Dachmarke für hochwertige Premiumholzbrennstoffe erkennbar werden.

Optimising Small Solid Biomass Fuelled Micro-Turbine Power Generation

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Technical Environmental Solutions Slovakia (TESS) has developed a small (50 kWe and 120 kWth), modular (standard series production), local (mobile unit for decentralised installation), green (fuelled by zero-carbon biomass), energy (combined heat and power generator) solution meeting significant world-wide demand.

Renewable energy sources based on biomass-fuelled technologies will be required to replace ***continuous*** legacy electricity sources. Studies indicate that available biomass can meet electricity production requirements with efficient conversion, where traditionally the best efficiency conversion to electricity has obtained in large centralised power stations.

However, biomass is a limited resource and any biomass-fuelled technology produces combined heat and power (CHP). While large centralised power stations may achieve 30% conversion of biomass to electricity, such stations are extremely wasteful of produced heat energy.

The CHP50120 is particularly adapted to decentralised energy production installed at the (heat energy) user, allowing optomised utilisation of both electricity and heat energy, where TESS biomass fuelled micro-turbine technology can exceed 80% conversion of biomass to energy.

The TESS development is derived from improvement of existing “BG50” biomass generator installations, followed by an extensive redesign to optimise efficiency and performance and the production of a first-of-series “CHP50120” unit.

Technical improvements will be discussed and trial results presented, including:

Modular designs for mobility, combustor, fuel bunker, ...
Optimising thermodynamics of working fluids (air and exhaust gases) …
On-going development for efficiency and reliability

Hence, the CHP50120 will revolutionise (continuous all-weather) power production through direct conversion of biomass to energy directly at the user location, optimising minimum-loss utilisation of both heat and power. And each installation creates jobs for both biomass production and for generator management.

Die Wagramer Bioraffinerie - Das 5 Stufen BF Biosystem

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1.) Die Biomasse - Wertstoffnutzung vor BIOGAS - NAWARO Anlagen mit Milchsäure- u. Stärkegewinn.
2.) Externe Hydrogenese vor Biogasanlagen mit Lignin- u. Feststoffabtrennung mit Gülleseparatoren
3.) Trocknung der Restbiomasse und „Pyrolyse“ zu Biotreibstoff (mit zusätzlich Biogas) der 2. + 3. Gen.
4.) Verwertung der aktivierten Biokohle (Terra Preta) mit Depotstreifenaufbau auf den Feldern
5.) CO_2 Verwertung durch Überstromnutzung (Wind u. Co) in Biogasanlagen. „Power - to - Gas“

1.) Stufe: Durch eine fahrbare Aufbereitungs- und Wertstofferntetechnik, wo von mehreren Biogasanlagen zu einer Bioraffinerie die Wertstoffe - Milchsäure - Aminosäuren und Stärke, bis 80 % des Inhaltes der Silage täglich gefahren werden. Dort werden alle Stoffe gereinigt, fermentiert, umgewandelt, als Reinstoffe geerntet. Der Abfall geht in die dortige Biogasanlage, das gereinigte Wasser geht wieder zur neuerlichen Wertstoffernte. Dafür bekommen die Biogasanlagenbetreiber von der Bioraffinerie ein Entgelt das die Wirtschaftlichkeit der Altanlagen sichert. Durch die stoffliche Aufbereitung der Silage wird eine Zerkleinerung und eine Auffaserung erzielt so dass mit diesem Rest eine bessere Gasausbeute erzielt wird. Die restliche Fehlmenge durch „Wertstoffabtransporte“ wird mit einer höheren Anbaufläche von 20 bis 25 % wettgemacht.
Mit der gewonnenen Milchsäure und Stärke kann Bioplastik hergestellt werden, das wieder verrottet.

2.) Stufe: Die neue Biogastechnik hat in unserem Fall eine „externe Hydrogenese“ wo die „Auslaugung- bzw. Umwandlung“ nach ca. 100 Std. die Biomasse (Lignin) mit einem Gülleseparator gepresst und separiert wird.
a.) Es kann auch Abfallbiomasse aus der Biomüll Tonne mitverarbeitet werden.
b.) Alle Feststoffe werden ausgeschieden, Vermenter haben keine aufwendige kraftraubende Rührwerkstechn .
c.) Bei einem Stromausfall gibt es keinen Auftriebseffekt der Biogasgülle mit Feststoffen.
d.) Die dadurch eingesparte Energie (Strom) ist beachtlich, den bei 5% Strom steigt die Gaseinspeisung um 12 %.
e.) Die Anlage hat eine höhere Leistung pro m³ Inhalt, die Abbaugeschwindigkeit der Gülle ohne Feststoffe steigt.
f.) Ohne Feststoffe in den Fermentern ist auch die neueste Technik der „Power - to - Gas“ durch H_2+CO_2 möglich.
g.) Die neue kleine Rührwerkstechnik erlaubt außerdem noch im Fermenterkopf riesige „Seelen“ (Speicher) aus Planen wo einerseits CH_4 sowie CO_2 und H_2 oder HHO aus der Elektrolyse zwischengelagert werden kann.

3.) Stufe: Hier werden die „Gärreste“ getrocknet und mit zusätzlicher Biomasse zu Biodiesel der 2. + 3. Gen. verarbeitet. Auch der aussortierte Abfall vor der Hydrogenese (Plastik und Holzteile etc.) wird mitverarbeitet.
Diese Anlage besteht im wesentlichen aus einer Pyrolyseanlage, einer Turmanlage wo mit Reinsauerstoff im Vergaserteil CO + Wassergas erzeugt wird. Sie hat eine hohe Verschwellleistung mit anschließender Katalyse.
Die zweite Schiene der Anlagenkomponenten ist eine Verölungs- eine mechanisch - katalytische Anlage die mit der Ersten zusammenspielt. Sie hat eine Öl - Biomassemahltechnik die bei 280 bis 400°C arbeitet. Sie ist für feine Biomassen konzipiert wie Stroh - Maisstroh - Heu - Schalen - Klärschlamm und eben den Gärresten. Der notwendige Wasserstoff wird vom Vergaser erzeugt, das CO wird über einen Wassergasshift - Reaktor in H_2 umgewandelt, auch Biogas wird eingespeist und über Katalysatoren an die „Biomassegase“ angehängt.
Bei der Kondensierung - nach der Reinigung - über eine gekühlte Rektifikation geleitet, entstehen Alkane und Alkene die auskondensieren. Es entsteht Diesel - Kerosin - und Benzin, wobei der größte Anteil Diesel ist.

4.) Stufe: Die „Abfälle“ sind in Wahrheit gar keine Abfälle, sondern ebenfalls Wertstoffe. Da bei diesem Konzept außer reiner Milchsäure - Aminosäuren - CH_4 Methangas - Strom und Biotreibstoff sowie noch „Biokohle“ und Biogasgülle anfallen, sind die letzten beiden Wertstoffe einer der besten Dünger in der LDW.
Gemeinsam mit dem aus der Nachbarschaft anfallenden Kompost und mit etwas Biogasgülle wird die „Biokohle“ mit EM (effektive Mikroorganismen) durch die Milchsäure ca. 3 Wochen bokashiert und mit Leben aktiviert - jetzt Terra Preta, wieder auf die Felder ausgebracht. Dieser Dünger wird immer auf dem selben Streifen, in den Boden eingebracht. Über die Jahre bilden der Biodünger mit der Biokohle ein Dünger - und Kohlenstoffdepot, das sich laufend auf natürliche Weise (bei über 8 % Humus im Depot) weiter aufbaut.
Humusaufbau bedeutet Hochwasserschutz - Bioverfügbarkeit der Nährstoffe - und hochwertige Lebensmittel.

5.) Stufe: = Power - to - Gas über Biogasanlagen - hier wird es erstmalig über die neue Technik möglich auch andere Gase wie z.B. - H_2 + CO_2 sowie HHO (Braunsgas) von unten zusätzlich einzuleiten, damit die speziellen Bakterien den Wasserstoff mit CO_2 zu CH_4 - Biogas umwandeln. Es werden dann statt 50 bis zu 90 % Biogas erzeugt. Der Strom für Elektrolyse u. Hochfrequenztaktung kommt bei Überschuss - das Gas geht in die Seelen.

Performance of a mixed alcohol synthesis lab-scale process chain operated with wood gas from dual fluidized bed biomass steam gasification

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Subject area: Bioeconomy

In this work the performance of a mixed alcohol synthesis (MAS) lab-scale process chain operated with real wood gas derived from dual fluidized bed (DFB) biomass steam gasification is studied. In order to condition the derived wood gas for the MAS catalyst, two different gas conditioning technologies were investigated.

The MAS is referred to as the synthesis of a mixture of alcohols, composed of methanol, ethanol, propanol, butanol, pentanol and, in some cases, higher alcohols. The synthesis of mixed alcohols using wood gas is a promising option in the field of biomass to liquids to produce high-value mixed alcohols for the transportation sector and the chemical industry.

The applied lab-scale process chain consists mainly of three process steps: gas conditioning to remove tar and to dry the gas, gas compression, and the mixed alcohol reactor, employing a molybdenum sulfide (MoS_2) based catalyst. This MAS lab-scale process chain processed H_2 rich wood gas derived from the commercial DFB biomass steam gasification plant Güssing, Austria.

Several experiments were conducted in order to investigate the CO conversion, liquid product distribution, and liquid product yield of the MAS. Therefore, two different gas conditioning units were successively applied. First, a steam reformer and, second, a rapeseed oil methyl ester (RME) gas scrubber, were investigated.

During the experimental investigations, extensive chemical analyses were carried out. The main gas components (H_2, CO, CO_2, CH_4, O_2, N_2, C_2H_6, and C_2H_4) and sulfur components (H_2S, COS, C_4H_4S, and C_xH_y-SH) were measured. In addition, liquid product analyses (methanol, ethanol, propanol, butanol, pentanol, and water) were performed.

Under these experimental conditions investigated mainly methanol, ethanol and propanol are produced. The mass fraction of propanol in the liquid MAS product could be increased from around 15 %, using the steam reformer, up to 50 % by employing the RME gas scrubber to the MAS lab-scale process chain.

Future work should focus on the long-term durability and performance of the MAS catalyst on wood gas derived from the DFB biomass steam gasification. Therefore, a long term testing of the entire process chain for at least 1000 hours of continuous operating time will be conducted.

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Quantifying hazardous off-gassing from thermally treated biomass: Safety implications along the logistic chain

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Today Europe consumes 75% of the wood pellets produced globally [1], and the trans-Atlantic import has grown exponentially in recent years. Tragically, several CO-poisoning incidents were reported during cargo discharge in 2002-2011. Biomass is prone to off-gassing during storage; forming potentially poisonous levels of carbon monoxide (CO), carbon dioxide (CO_2), and also releases numerous volatile organic components, VOCs. In the wake of the port causalities an extensive work was undertaken to create safety regulations, to measure notable CO and O_2-levels during cargo transport, by notable the University of British Colombia (UBC), Canada [2-4].

Biomass is the only carbon based renewable energy resource from which we sustainably can produce chemicals and transportation fuels, and is also increasingly used for heat and power production. Biomass fuel properties can be made to approach those of fossil coal by thermochemical pre-treatment e.g. torrefaction and steam explosion. Thermal pre-treatments partially degrade the biomass cell wall constituents; hemi- and cellulose, and lignin, releasing low-weight VOCs, giving rise to very different off-gassing behaviors compared to raw biomass.
Thermally treated biomass has been extensively studied for its' fuel quality and conversion efficiency, but its off-gassing behaviour has yet to be properly addressed. There are many known physicochemical parameters affecting off-gassing e.g. storage temperature and volume, moisture content, biomass species, and age etc. [2]. It is important to understand the effects of different treatments and storage parameters on off-gassing formation in order to reduce any hazardous exposure to humans along the logistic chain. Specifically, some VOCs are suspected to be similar to ones found in wood smoke and smoked food. Normally, exposure to harmful VOCs is not acute toxic but depending on exposure levels they can lead to adverse health effects over time. Also the health effects of CO-poisoning is not only acute toxic when exposed temporarily to high levels, but also has adverse effects from long-term low-level exposure [5]. In this first ever comparative study, off-gassing from torrefied and steam exploded biomass was monitored for changes in permanent gases (O_2, CO_2,CO, CH_4, and H_2) and VOCs, by alternating: pre-treatment severity (two process settings/treatment), storage temperature (20/40°C), and storage gas (Air, or inert gases (He, or N_2)). In order to measure the VOCs, TENAX-TA protocol was developed, with subsequent thermal desorption and GC/MS analysis. The material was stored in closed bottles, and measurements of the shifting VOCs gas composition of the head space in the bottles are done at 48h and 112h, while the permanent gases were monitored over 56 days of storage.

The results show that the developed TENAX-TA based VOCs analysis method is reproducible and able to detect vastly different emission profiles in treatment method, treatment severities and in storage conditions: temperature and storage gas composition. We could show that the two thermally treated materials exhibit vastly different VOCs profiles in comparison to the reference. The steam exploded materials emitted a number of furans, among them concerning high levels of furfural, and also that the material had higher or comparable levels of CO, CO_2, and CH_4 while undergoing O_2 depletion. The torrefied material emitted very little VOCs that were detectable with the TENAX-TA absorbent and had comparable or lower levels of CO, CO_2, and CH_4 off-gassing and O_2 depletion. In the reference samples, the head space gas composition was dominated by terpenes as α-pinene, β-pinene, and 3-carene and aldehydes: hexanal and octanal. The reference material formed the highest levels of CO and H_2. Moreover, the VOCs levels were greatly affected by the treatment severity, the storage temperature, and the storage sampling time. Samples were also purged with N_2, to elucidate the effect of available oxygen on VOCs formation, but the levels were similar to the samples stored in air.

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Combustion characteristics of barley straw stored with $CaCO_3$ during fluidized-bed combustion using quartz and olivine as bed materials

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Utilization of agricultural biomass residual streams can cause severe ash-related operational problems in combined heat and power plants through by fouling, slagging, and/or bed agglomeration due to the composition of their inorganic content. The resulting formed ash in fluidized-bed combustion mostly remains in the bed while a small part is vaporized as fly ash. The formed melt can in most cases be formed as a result of undesired chemical reactions between bed material and ash components. The alkaline ash constituents have ability to produce substantial quantities of oxides; with potassium as the element of major concern. SiO_2 is susceptible to attack from gaseous alkali compounds such as KOH (g), leading to formation of low melting alkali silicate compounds which slag and foul at normal combustion temperatures (700-900 °C).

Chlorine, often found in high quantities in straw, is a major factor in ash-related operational problems from the corrosion point of view. When Cl is present it reacts with alkali constituents, e.g., potassium, improving the mobility and therefore the vaporization of the alkali chlorides; leading to corrosion and higher rates of fouling and slagging of combustor surfaces; which reduces the lifetime of equipment. To reduce slag formation and bed agglomeration the element ratio K/Ca in the ash must be taken in consideration in relation to the amount of Lewis base forming elements. The K/Ca ratio can be addressed by blending in Ca- based additives which will decrease the risk for slagging or bed agglomeration by elevating temperatures of silicate melts. This may however also lead to elevated alkali components in particulate matter and gas phase.

There is on-going work studying the effect of adding Ca as CaO or $CaCO_3$ during storage of agricultural residues with the aim of creating an unfavourable alkaline microenvironment that prevents microbial growth during storage. The effect of this storage amendment is still being explored, but the effect in the combustion step of the process in terms of how well Ca will replace K in silicate melts have yet to be certainly quantified. The total ash composition resulting of such amendments may lead to a relative deficit of Lewis base forming elements (Si, P, S, Cl) to elements forming Lewis acids (Kn, Na, Ca, Mg, Fe, Al) in the fuel, and the total effect of such amendments is still not clear. The objective of the present study is therefore to determine the fouling and bed agglomeration characteristics during fluidized-bed combustion of barley straw stored with different dosages of Ca to biomass using two types of bed materials, quartz and olivine.

Verbesserung der Rostfeuerung durch die Optimierung von Roststäben – dargestellt anhand von Problemfällen und den dazu erarbeiteten Lösungen

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Die WVT Breiding GmbH ist ein Spezialist für Verschleißteile im Betrieb von Müllverbrennungsanlagen, Biomasseheizkraftwerken und Kohleverstromungsanlagen im In- und Ausland. Bereits seit 1985 steht der Name WVT Breiding für optimierte Verschleißteile aus Guss. Der Einsatz unserer Produkte findet dort statt, wo es sprichwörtlich brennt!

Als Familienbetrieb in zweiter Generation konzentrieren wir uns auf die Branche der Verbrennungsanlagen. Wir sind jedoch kein reiner Lieferant von standardisierten Gussprodukten. Die Analyse von Verschleißbildern bei jedem Kunden sind Ausgangspunkt von a) Problemfindung b) Ursachenanalyse c) Entwicklung optimierter und individualisierter Verschleißteile.
Aufgrund von Erfahrungen aus über 30 Jahren in der Optimierung von Ersatzteilen haben wir Patentlösungen entwickelt, die die Standzeit verlängern, die Anlagensicherheit erhöhen und die Effizienz der Anlagen verbessern. Häufig wählen wir Lösungen, die sich bei Kunden mit ähnlichen Verschleißproblemen bereits bewährt haben. Unsere Erfahrungen und unser Qualitätsmanagement führen dazu, dass ca. 60% der Erstausrüster zu unserem Kundenkreis gehören.
Sprechen Sie mit uns über häufig auftretende Probleme an Rosten. Die Diskussionen über - auf den ersten Blick individuelle - Verschleißbilder führen aus unserer Erfahrung häufig zu einem „das Problem haben wir auch“ Effekt bei den Anlagenbetreibern.
Beispiele zu unseren Roststab-Verbesserungen sind:

- Mehrteilige Multiflexstäbe
- Keramische Düsen zur Verhinderung des Ausbrennens von Düsen
- Verhakungssysteme zur Verhinderung von sich aufstellenden Roststäben
- Alternativen zu sich überlappenden Stäben
- Ein Rostkonzept zur Optimierung der Feuerung und des Ausbrands
- Verbesserte Geometrien und Kühlsysteme im Guss

Gerne stellen wir interessierten Teilnehmern unsere Ansätze zu Optimierungen von Biomassekraftwerken vor. Die Erfahrungsgewinne für die Betreiber können in den Betriebsalltag umgesetzt werden und sowohl die Effizienz der Anlage verbessern als auch Einkaufsbudget durch länger einsetzbare Ersatzteile schonen.

Ihr Team der WVT Breiding GmbH

Hocheffiziente Kraft-Wärme-Kopplung mit Holzpellets

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Als Gebäudetechnikunternehmen besteht die Burkhardt GmbH in Ihrer heutigen Form seit **1978**. Die Geschäftszweige Heizungs-, Klima- und Lüftungstechnik sowie Sanitär und Spenglerei zählen zu den Wurzeln des Betriebs.

2005 Erweiterung um den Geschäftsbereich Energietechnik. Hieraus resultierten Blockheizkraftwerke auf Pflanzenölbasis im mittleren Leistungsbereich. Parallel wurde nach alternativen Brennstoffen zur Verstromung geforscht.

2010 Erstes serienreifes Modell des Holzpelletvergasers V 3.90 am Markt. Zusammen mit dem BHKW ECO 180 HG (Zündstrahlbetrieb) haben die beiden Anlagen eine Leistung von 180 kWel und 270 kWth (70 kW vom Vergaser selbst) mit einem elektrischen Wirkungsgrad von >30% und einem Gesamtwirkungsgrad von 75%.

2015 Markteinführung des Holzvergasers mit neuem BHKW ECO 165 HG mit Ottomotor (Burkhardt Umbau des Zündstrahlmotors aus dem ECO 180 HG)

2016 Markteinführung des 50kW Holzvergasers V 4.50 und BHKW smartblock 50 T mit 50 kW elektrischer und 110 kW thermischer Leistung bei einem elektrischen Wirkungsgrad von 25% und einem Gesamtwirkungsgrad von 80 %.

Der Burkhardt Holzvergaser wird der autothermen Vergasung zugeordnet. Somit wird keine externe Wärmequelle
benötigt. Bei der thermischen Vergasung können holzartige und andere kohlenstoffhaltige Brennstoffe in ein brennbares Gas umgewandelt werden. Der Vorteil des Burkhardt Verfahrens liegt in der gleichmäßigen Gasbildung sowie in der Reinheit des Gases. Dies beruht auf dem Arbeitsverfahren „aufsteigende Gleichstromvergasung mit stationärer Wirbelschicht“. Stationäre Wirbelschicht bedeutet, dass die Vergasung in einem von unten nach oben geführten Luftstrom stattfindet, der so bemessen ist, dass die Pellets in bestimmten Zonen verwirbeln, dabei aber nicht heraus getragen werden.

Als Energieträger werden für den Burkhardt Holzvergaser Holzpellets verwendet, deren Vorteile äußerst vielfältig sind. Zum einen ist die Qualität genormt (ISO 17225-2, Güte A1 / EN Plus A1) hinsichtlich Wassergehalt, Aschegehalt und Ascheerweichungstemperatur. Zum anderen benötigen Pellets aufgrund der hohen Energiedichte ein geringeres Lagervolumen sowie geringeren Energieaufwand beim Transport. Außerdem begünstigt die Einheitlichkeit der Pellets einen homogenen Vergasungsvorgang und somit eine gleichbleibende Gasqualität. Zudem weisen Holzpellets eine CO2-neutrale Energiebilanz auf.

Eine große Wertschöpfung stellt die erzeugte Wärmeenergie des Holzvergasers und des Blockheizkraftwerkes bei einem Betrieb von mindestens 7500 h pro Jahr dar. So werden z.B. bei der 50 kW Anlage 825.000 kWh thermische Energie erzeugt. Diese entspricht der Wärmeäquivalenz von ca. 80.000 Liter Heizöl. Zusätzlich werden 375.000 kWh elektrischer Strom generiert, was in etwa dem Stromverbrauch von ca. 100 Haushalten entspricht. Der Burkhardt GmbH ist es somit gelungen hocheffiziente, in Serie produzierte Anlagen zur regenerativen Wärme- und Stromerzeugung zu entwickeln und erfolgreich im Markt zu etablieren. Mittlerweile sind über 150 Burkhardt Holzvergaser weltweit mit über 2.800.000 Gesamtbetriebsstunden in Betrieb.

AlgaeBioGas: algal-bacterial digestate treatment and biomass production

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In the era of searching for sustainable biofuels, biogas is one of the options. Number of biogas plants in Europe is rising and so is the quantity of side product, digestate, which is often separated on liquid and dry form. One 1 MWe mesophilic agricultural biogas plant produces 56 m^3 of liquid digestate per day, which could be used right away as fertilizer, stored for later use or disposed to waste water treatment plant, depending on certain biogas plant policy. All options are associated with considerable costs for biogas plants.

AlgaeBioGas project is focused on market introduction of algal-bacterial treatment of biogas digestate and feedstock production, an innovative technology which has significant economic and environmental benefits for biogas operators. Demonstration centre was built next to a biogas plant in Ljubljana, Slovenia and is in operation since September 2014.
Algae hold great potential for energy use because of their growth rate, easy production and better utilization of sunlight compared to conventional plants, shorter lifecycles and independence from fertile agricultural land. Biogas plants are rich sources of mineral nutrients, CO_2 and heat.

Demonstration centre for treatment of digestate consists of two algal ponds, main pond of 100m^2 and smaller inoculation pond of 10m^2, set up in a greenhouse. Liquid part of digestate from 0,53 MWe thermophilic biogas plant is fed in to the main pond, where algae and bacteria use nutrients (N, P) from digestate for their growth. Through algal photosynthetic activity, CO_2, in a form of fuel gases from the biogas plant, is used up together with nitrogen, phosphorus and other nutrients from digestate, resulting in algal biomass and oxygen production. Latter supports bacterial activity, resulting in use of organic matter, oxygen and nutrients for bacterial growth. The process enables recycling of nutrients from the digestate, reduction of unpleasant odor and at the same time production of biomass feedstock. Biomass is collected in the sedimenter and fed back to the biogas plant for biogas production. Heath from biogas plant cogeneration unit is used to heat up greenhouse in colder months.

Demonstration centre has been running since September 2014 and is currently able to process up to 400 L of digestate per day in optimal conditions. Testes have been made for biogas potential of algal biomass produced, as well as use of biomass as filling for bioplastics. Several other options for biomass use can be considered, depending on the type of digestate used. Additionally, tests on biogas potential and pre-treatment of biomass have been made.

The greenGain project - Supporting Sustainable Energy Production from Biomass from Landscape Conservation and Maintenance Work

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The project greenGain is looking for solutions to increase the energy production with regional and local biomass from landscape conservation and maintenance work, which is performed in the public interest. The main target groups are regional and local players who are responsible for maintenance and conservation work and for the biomass residue management in their regions. Moreover, the focus will be on service providers – including farmers and forest owners, their associations, NGOs, energy providers and consumers.

The threeyear project which started in January 2015 is supported by the European program Horizon 2020. Partners from Italy, Spain, Czech Republic and Germany are analysing the biomass feedstock potential coming from landscape maintenance and will assess various technological options to utilise this type of biomass. The aim is to identify possible obstacles and to provide customised recommendations to a wide range of stakeholders in the EU.

The project will show how to build-up reliable knowledge on local availability of this feedstock and it will provide know-how concerning planning, harvesting, pre-treatment, storage and sustainable conversion pathways. Furthermore, political, legal and environmental aspects as well as awareness raising and public acceptance actions regarding the energetic use of biomass from public areas will be assessed.

The project will facilitate the exchange between the model regions and other similar relevant players in the EU and share examples of good practice. The partners prepare a topic-specific website and knowledge platform, organise several workshops, conferences and educational site visits in various regions and carry out other standard public relations activities. General guidelines will be prepared to guarantee a wide dissemination to other regions in the EU.

Local companies, municipalities and public authorities are collaborating to identify those still underutilised non-food biomass resources and to discuss the way to integrate them into the local and regional biomass markets. The relevant resources in the greenGain model regions are e.g. biomass residues from rivers side cleaning, waterways and roadside cleaning, firewall infrastructure opening and maintenance, clearing of invasive vegetation in agricultural abandoned lands, vineyards and olive groves residues in landscape protected areas, biomass from the maintenance of protected moor areas, and material from urban parks maintenance.

Agricultural biomass utilization for energy purposes

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Biomass is one of key renewable energy sources in the Republic of Serbia. This is the reason for the development of cheap thermal devices burning biomass from agricultural production as quite available and cheap energy source. Researches in this area are very complex and in order to obtain reliable data it is necessary to carry out theoretical and experimental research of the process. Therefore, efforts have been made in the Laboratory for Thermal Engineering and Energy of the "Vinča" Institute to develop a technology for utilizing bales of various sizes and shapes for energy production. In this paper has been presented optimization of the existing furnace for biomass combustion in the way of improving energy efficiency and environmental protection. By proper dimensioning of furnace also could be avoided unnecessary investment costs. Two-dimensional turbulent flow model with homogeneous chemical reactions has been developed. Turbulent flow is considered using time averaging *Navier-Stokes* equations that are closed by k-ε turbulence model. Calculations based on the proposed models were conducted using commercial CFD package *FLUENT*. Comparative analysis of the results of modeling existing and proposed (optimized) furnace has shown lower CO emission at the proposed furnace outlet.

Parametric analyses of numerical simulations of specific processes or so called numerical experiments are very useful in engineering practice, because it is cheaper than experiments which may need costly changes to the plant. Also, it is the faster way to get the desired results and the data about the modified plant. In addition, it is possible to obtain a detailed picture of the relevant field sizes, all over the considered area, while experiment can be difficult, or almost impossible to realize.
Mathematical model of the process in the adiabatic combustion chamber for combustion of biomass was analyzed for the case of furnace volume change. Since the previous analyses confirmed the efficient operation of the furnace, the question arises whether the same effect could be achieved with some similar furnace of smaller volume. Also any reduction in combustion chamber volume will lead to reduction in investment cost and accordingly to cheaper energy obtained from this facility.

Fuel Flexibility and Low Emissions in Biomass-Fired Power Plants

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The Dall Energy biomass furnace combines updraft gasification and gas combustion. Combining updraft gasification and gas combustion into one unit offers several advantages to operation and maintenance, emissions reduction, and turndown ratio. These advantages have been evinced in a pilot plant, demonstration project, a 2MW plant and a 9MW plant. Next-generation heat and power production plants represent the next steps in this technology and several of these projects are now at the planning stage.

Efficient small-scale plants upgrading biogas – Potential analysis and economic assessment

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Biomethane has the potential to become an important and essential component of the future energy system in the sectors of fuel production and, especially by the use in CHPs, in power production on demand. Therefore, it is necessary to make biomethane available as cost-efficient as possible to ensure a social acceptance of this energy source. The specific costs for upgrading biogas to biomethane depend on the upgrading size and range between 1-2 ct kWh^{-1}. Due to the economy of scale they are higher for smaller upgrading capacities. According to the data base of the Federal Network Agency specific costs of grid feed-in were around 2.8 ct kWh^{-1} in 2011. The feed-in of upgraded biogas into natural gas grid is more cost-intensive for smaller upgrading capacities compared to the feed-in of larger ones with the same feed-in pressure. It is expected that the feed-in of biomethane into gas distribution grids with lower pressure level leads (significantly) to reduced costs for investments and operation. If so, small scale upgrading plants would justify higher costs for upgrading biogas to natural gas if the specific costs in total approximately remain the same. Within the context of the joint project “Efficient micro biogas upgrading plants” (eMikroBGAA) the cost reduction potentials of an optimized constellation of biogas upgrading and biomethane feed-in of smaller capacities are evaluated to show the potential of economically optimized biogas feed-in referred to the whole of Germany and to deduce recommendations for actions for an economic operation of those plants. Furthermore, optimized business models including legal framework are investigated. The joint project – headed by Fraunhofer IWES and the project partners DBFZ, DBI and dena – is funded by Fachagentur für Nachwachsende Rohstoffe (FNR e.V.) with a project duration from 11/2015 to 10/2017.

The presentation resp. the contribution for the conference will comprise the first results of the project whereby potential and economic analyses of those small-scale upgrading plants are focused. The intersection of feed-in potentials at gas distribution level (DBI) with feed-in information concerning biogas plant locations in Germany and biomass potentials allows an assessment of minimal and maximal potential for small-scale biogas upgrading. Besides the structure of grid operators the potential of existing on-site power generation plants as well as still available biomass from agriculture (energy crops and agricultural residues), and organic residues from local communities and industry will be considered by DBFZ resp. DBI. The gas grid information in combination with data of existing biogas plants collected by DBFZ and still available biomass potentials are adjusted by GIS (geoinformation systems). Hereby, also assessments for potential refittings of existing biogas plants with on-site generation for the production of biomethane and the construction of new built smaller biogas upgrading plants will be investigated.

At the end of 2016 in Germany about 200 plants for upgrading biogas to biomethane and approximately 8,500 biogas plants with on-site generation will be in operation. The current predominantly technologies used for upgrading biogas to biomethane are water scrubber, pressure swing adsorption and chemical scrubber. In addition to that, in comparison to preceding years membrane separation upgrading technologies have been utilized increasingly. At present, 17 manufacturers of biogas upgrading plants operate at the market using several upgrading technologies which are presented in a comparative cost analysis. Especially all upgrading technologies available at the market applied for smaller upgrading capacities (ca. 50 - 350 m^3_{STP} h^{-1}) are considered within the cost analysis.

An innovative pellet cooler for cost reducing energy efficiency and higher operational reliability

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Flexible, modular and energy-efficient equipment for the processing of biomass – the mission of CEBCON Technologies! We offer innovative modular solutions for the processing of biomass. Whether for decentralised energy generation from biomass, or the production of biomass fuels such as wood pellets, our systems are part of these production processes and offer intelligent solutions that are particularly energy-efficient, flexible, and even improve fire safety.

Outstanding energy efficiency, flexible design and increased fire safety: CEBCON has developed an innovative, internationally patent-pending pellet cooler featuring an energy-efficient heat recovery system for use in the pellet production process. Depending on the selected design, the cooler can process granules from a variety of biomass. This includes pellets made from: - By-products from the forestry and timber industry, sawdust, logs; - Agricultural waste such as straw, shells, husks; - Solid fermentation residues from biogas production; - Whole plants such as bamboo, miscanthus, wood from short-rotation plantations. In addition to its heat recovery, the cooler is characterised by considerable electricity savings of 45-70% as well as by fewer wearing parts than conventional pellet coolers. The cooler can be implemented either as an integrated component for new pellet production facilities or as a stand-alone module to replace existing facilities.

The innovative CEBCON pellet cooler improves energy efficiency in pellet production, increases operational safety and achieves significant cost reduction. In addition, thanks to its special design as a containerised cooler, it increases flexibility: This facilitates transport and assembly, while reducing the amount of space required. The newly developed pellet cooler is a shaft cooler, the walls of which consist of heat exchanger plates. Due to the special arrangement of these cooling elements, the wood pellets or other solid, bulk biofuels are cooled particularly effectively and gently, in particular avoiding dust formation and large quantities of exhaust air. COOLING CAPACITY: Depending on the chosen design, the plant has a cooling capacity of 2-5 to pellets/h.

ADVANTAGES OVER CONVENTIONAL COOLERS: - Special design features of the cooler enable very energy-efficient operation compared to conventional coolers, while nevertheless achieving the same cooling capacity and throughput. - The recovered heat of 91 kWh or approx. 600 MWh/a (assuming 6,500 production hours per year and a press capacity of 4 to/hour) can be used for drying and conditioning the raw material before pressing. - The electricity consumption of the cooler is around 45-70% lower than that of the comparable systems. For a conservatively calculated number of production hours of 6,500 h/a and a press capacity of 4 to/h, the electricity savings amount to approximately 11.6 kWh or 75 MWh/a. - This enables a significant reduction of energy costs during production, resulting in savings of around EUR 24,000 per year (depending on the electricity and heat prices at the location in question). Unlike conventional systems, the cooler pays for itself quickly due to the above-mentioned energy savings. - Maintenance costs are also reduced due to the design features. It was possible to dispense with bag filters and large blowers, while using simpler components. Because of the few moving parts, the wear and the risk of failure, as well as the operating expenses (lubrication, etc.) are low. - In addition, the cooler is safer to operate as a result of the avoidance or minimisation of explosion and fire risks during cooling. The risk of fire is negligible compared to counter-stream coolers. - And finally, the pellet cooler is flexible and easy to use: It is equipped with necessary temperature and level sensors as well as control technology and can be integrated into the upstream plant control system for automated operation. In addition, the cooler is designed in standard container format, which reduces the transport and installation costs. Pre-assembly and testing are carried out at the factory before delivery to the customer: These result in a shorter assembly time (by up to 80%) and accelerated commissioning.

New indexes to detect contamination of wood chips with mineral soil

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Purpose. Solid biofuels as wood chips might become contaminated by mineral soil during production processes. In this way fuels could be enriched by critical elements for combustion such as chloride (Cl), potassium (K), silicon (Si) or heavy metals. The source of high concentrations of these elements is not always clear. They may come from green biomass such as leaves and needles or result from contamination by other sources. To improve quality assurance during wood chip production, good indicators are required to determine the source of high concentrations of critical elements.

Approach. In total, 97 samples of wood chips (n = 80), of unchipped material (n = 11) and of twigs and needles (n = 6) were collected. Samples derived from forest residues and energy roundwood of different species, from short rotation coppice (SRC), from cuttings along roadsides and from urban forestry. All samples were analyzed for elemental composition (Al, As, Ca, Cd, Cl, Cr, Cu, Fe, Hg, K, Mg, Mn, N, Na, Ni, P, Pb, S, Si, Zn) according to European standards. Biomass fuel indexes for the contamination with mineral soil (Fe/Mn-ratio, Al/200-ratio) were developed using element concentrations in plants and soils from literature and own investigations. The developed indexes were tested with datasets (about 3000) from several research projects.

Results. Each index divided samples of wood chips into two classes, i. e. into samples that derived mostly from biomass and in samples with contamination of mineral soil. In total, 74 % of all samples could be classified as “biomass” or as “contaminated with mineral soil” by both indexes whereas 26 % of the classified samples were only consistent with one index. Samples that were classified as “biomass” never exceeded ash contents of 3.1 m.-% with Si contents ≤ 8.300 mg/kg. In contrast, samples classified as “contaminated” showed ash contents of up to 19.6 m.-% (Si ≤ 59.700 mg/kg). Co-occurring critical chemical elements were lower for samples classified as “biomass” compared to “contaminated”. First results for tree-biomass from the tests showed that less than 4 % cannot be classified by the indexes because the index is higher than required. Looking at tree species it occurs that mostly Scotch pine (*Pinus sylvestris*) was exceeding the index limit. Applying the indexes the group “contaminated with soil” showed higher amounts of ash and aerosol building elements than “biomass”. To remove the soil, pretreatment, like sieving, has to be proved. This way the quality of wood chips might be improved by removing soil material and thus decreasing potential aerosol building elements.

Conclusions. Fe/Mn- and Al/200-indexes were considered suitable for the evaluation of whether or not a biofuel sample is contaminated with mineral soil and to detect for example aerosol building elements. So far, indexes where tested for biofuels from wood. Applicability for non-woody biofuels has to be tested.

Optimisation of the post-consumer and demolition wood supply and value chain

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Introduction

One of the great advantages of wood is that it can be recycled several times (cascade use) before, eventually, being used for energy recovery. Wood recycling promotes an efficient use of resources and increases the total volume of CO_2 stored in wood based products. Wood waste arises via a variety of post-consumer wood and in different fractions, ranging from untreated, pre-consumer off-cuts to treated wood. Hence, post-consumer and demolition wood must undergo several process steps to be suitable for recycling. Based on innovative detection and sorting techniques the quality and the quantity of these wood resources with reduced contaminations can be largely extended. Together with leading industry partners (**BT-Wolfgang Binder GmbH, Fritz Egger GmbH & Co. OG, Komptech GmbH, LASCO Heutechnik GmbH, Mondi Uncoated Fine & Kraft Paper GmbH, Papierholz Austria GmbH, Umweltdienst Burgenland GmbH**), the **Bioenergy 2020+** team investigates the post-consumer and demolition wood supply chain in order to improve the economic and environmental conditions and enlarge the market for the use of post-consumer and demolition wood within the two projects **Up2ndUse (Comet)** and **REFAWOOD (ERA-NET Bioenergy, http://refawood.com/)**.

Objective & Approach

The overall objective is the upgrading of post-consumer and demolition wood into secondary raw materials and fuels for material and energetic utilization. The logistics and processing steps as well as technologies of post-consumer and demolition wood are investigated and optimized. In addition**,** efficient and innovative fuel additive design concepts for reducing ash related operational problems (corrosion/fouling/slagging) in combustion of post-consumer and demolition wood fuels are developed. The improved value chain will ensure a more sustainable and efficient supply of reprocessed post-consumer and demolition wood. Furthermore, recommendations to the respective industrial project partners regarding further steps towards industrial-scale process development and value chain transformation and even future R&D are given.
The Up2ndUse project focuses on the feedstock treatment and process chain development of post-consumer and demolition wood. Therefore, the processing steps mechanical preparation (e.g. crushing, sieving), drying and sensor-based sorting are evaluated and optimized during pilot scale tests. In the REFAWOOD project fuel additives which can enlarge the market for the use of wood fuels in CHP-plants by using resource efficient additives such as recycled gypsum during combustion. Full-scale combustion tests are performed in order to demonstrate effective fuel additive design concepts**.**

Results

- Recommendations for optimized value chains for enhanced material cascades based on post-consumer and demolition wood, including references regarding processing steps and technologies.
- Description of efficient and sustainable post-consumer and demolition wood value chains based on material cascades.
- New additive concepts for post-consumer and demolition wood fuels which can be integrated to the CHP plants in ways that are economical, benefit the environment, conserve natural resources and provide the CHP plant a fuel mixture with right quality.

LEAVES – Alternative Urban Bioenergy L.A.U.B.

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Autumnal leaf fall and its detritus in urban areas is widely considered to be at least a nuisance and even a hazard to local motorized traffic. It so follows, that the management and disposal of this particular waste, which comes in considerable quantities, usually poses quite a problem to cities´ administrations.

Some large cities with much green space compost their leaf detritus to be used for maintaining the cities´ gardens and parks. Often however the compost quantities produced exceed what is actually needed. Surplus urban leaf detritus could however be utilized sustainably and even profitably in another way. Amongst others, a striking new idea is to process the foliage to gain combustible biomass, which is consequently used to generate power in small and medium sized plants. The experience gained from an already operational plant in a small German town named Ibbenbüren might however be difficult to transfer to larger cities. Collection of raw material as well as methods of processing are to be analysed and evaluated, which requires particular knowledge of storage patterns, combustion behaviour, composition of fumes as well as ashes generated. This research will be guided scientifically and performed in such a way, that the results will, most certainly, generate new possibilities for the thermal usage of renewable energy resources. In the process, it would be highly desirable to prove if this particular kind of biomass fuel will be suitable for use in domestic stoves, which would add extra value to the project.

The use of dried leaf as a fuel in general has undisputable benefits. It is climate-neutral, sustainable and comes for free. The simple process of drying and pressing leaves could be carried out by mobile units, reducing transport distances, effort involved as well as emissions even further. It even offers to take advantage of the necessity of collecting and burning leaf detritus from infested trees to fight spreading vermin, which has become quite a problem in large cities, where trees are usually subject to all kinds of pests. Ultimately the resulting leaf ash suggests itself as a fertilizer.

Figures relating to the profitability of likely energy generation, the avoidance of surplus urban leaf detritus as well as substantial cost reductions indicate the feasibility of an idea already tried by test in situ in Germany:
It would be possible to collect 11-17 kt of biomass after taking into account the biomass used for compost production in a city like Vienna. This means an equivalent of 5-8 million litres of crude oil, saving 13-21 kt fossile CO_2. Annual proceeds of € 2 million seem to be possible.

For further investigation on the usage of urban biomass resources we hopefully suggest, that the once established cooperation between civil engineering and academic bodies will continue to work together, while the main stakeholders (e.g. administration or industry) in this matter are kindly invited to join such promising a task.

Investigation of the self-heating and self-ignition process of stored woodchips

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During the storage of biogenic resources such as woodchips and forest residues, destruction and conversion processes take place inevitably. Microorganisms metabolizing the main wood components cellulose, hemicellulose and lignin, cause an economical relevant material loss of 10 to 40 % during one storage period. As a consequence of the microbial activity and further exothermic processes such as oxidation and condensation processes, heat is produced inside the woodchip pile, leading to temperatures above 100 °C. Under certain circumstances (based on pile geometry, particle size or biomass quality), the pile temperature rises to >200 °C, causing partial pyrolysis and self-ignition. However, underlying mechanisms and influencing factors are still not well understood, making the prediction of a self-ignition almost impossible. Studies have shown that the initial temperature increase caused by the microbial activity is a key step in the self-heating and self-ignition process of woodchip piles. Inhibiting the microbial growth is therefore crucial to lower or even eliminate the risk of self-ignition.
During the research project “Biomassekonditionierung 2” the degradation of forest residues and industrial woodchips has been determined under varying conditions such as temperature, moisture content, oxygen availability and particle size distribution. Additionally investigations considering the self-heating and self-ignition process were conducted. In the course of a survey of 27 district heating plants in Vorarlberg, Tyrol, South Tyrol and Salzburg the current state of biomass storage as well as the occurrence of pyrolysis and self-ignition were evaluated. Temperature and gas measurements were conducted in order to clarify possible correlations between pile geometry, biomass quality and biological activity.
Out of these 27 district heating plants 14 had or still have problems with partial pyrolysis and self-ignition. The risk could be connected to the woodchip quality and the compaction of the woodchip pile. All incidents occurred with forest residues containing a high amount of needles and leaves. Additionally, the compaction of the pile lead to thermal degradation processes. The compaction is the result of the pile height, the particle size distribution and the built-up of the pile with a wheel loader. During gas measurements high amounts of carbon dioxide (CO_2), hydrogen (H_2) and methane (CH_4) were demonstrated. For forest residues containing leaves and needles also high amounts of hydrogen sulphide (H_2S) of 40 ppm were observed, bearing a high health risk. Temperatures of up to 85 °C were measured in 1.5 m depth. Self-ignition occurred close to columns of the storage building or in the border area of woodchips and trunk wood. Forest residues containing leaves and needles should be stored separately and processed immediately. Sawdust should be stored separately in order to avoid anaerobic areas. Drying the woodchips to a moisture content of less than 25 % reduces the self-heating processes and lowers the risk of self-ignition to a minimum.

Thermal imaging analysis of the kinetics combustion of waste biomass

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Currently, biomass-derived energy constitutes two-thirds of renewable energy and, as provided by the forecasts, will also play a key role in future environmental-friendly European energy system. Therefore, it would be necessary to introduce efficient utility chains – starting from raw material production stage, through the energy transformation and ending with the energy consumption by the end users.

Material consisted four mixtures of corn silage and apple pomace in a different percentage which was the mass of digestate from the laboratory installation for the production of biogas situated in Faculty of Production and Power Engineering (Kraków, POLAND).

The aim of the study was to determine the behavior of the biomass samples under an oxidizing atmosphere. As well as analyze the possibility of using digestates from biogas production as biomass for energy purposes, by determining their physical properties.

The study carried out an analysis of the biomass combustion process in the air atmosphere. Combustion process has been observed using FLIR Thermal Imaging System. Registered thermal images were subjected to digital image analysis. Analysis shows that biomass combustion process takes place in three stages: drying, devolatilization and char combustion.

Modification of a Biomass Heating Plant to a Small Cogeneration Plant – Experiences and Economics

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In April 2016 a screw expander from Heliex was commissioned at the district heating plant at Obertrum, Salzburg. The project started in 2014 by a first presentation of the screw expander technology to the management of nahwaerme.at. In biomass applications in particular, the Heliex Power Wet Steam Power Generator allows for a very simple CHP solution. The container sized, already assembled unit is a flexible system in terms of operation, allowing for generation based on changing steam flow supply to the unit; relevant to changing demands due to changing heating requirements (time of year) or even from use of different feedstock to the biomass boiler (different calorific values) the data show a perfect match of power produced and varying temperature demand of the district heating network. The patented Heliex Wet Expander technology offers low maintenance, easy to use, and cost efficient way of recovering and transforming energy in steam to electricity. An important key benefit of the Heliex system is that saturated steam is being used as main working fluid.

Main drivers for the investment decision have been: increased overall plant efficiency, especially during summer months, when the boiler may be operated at slightly higher loads, and low payback times below 2 years, due to an interesting tariff scheme for small CHP application in Austria. Currently the FIT granted is 220 €/MWh for solid biomass fired small power production below 500 kWe. Since the Wet Steam Power Generator is implemented into the steam cycle, fuel conversion rates into power, for this add on solution to an existing heating plant are above 80%. Meaning, for 80 kWe of electric power one requires additional fuel of around 100 kWth, only. At fuel cost of around 30 €/MWh own power production becomes economical in many cases with paybacks below 5 years, even if no FIT are granted.

The successful installation at Obertrum, where saturated steam is produced in a biomass boiler producing 6 MWth has another important advantage: When heat demand is at the maximum, power production from steam is too. This means at larger numbers and at times of the day when power consumption becomes important for the stabilisation of a local grid, these plant concepts have advantages in comparison to other renewable energy concepts including wind and photovoltaics. The nominal power of the Generator is 132 kWe, the operational data proof very high availability and very short outages for maintenance: 8.600 operational hours may be expected per year. Thus, since the heating plant may as well be operated in a non power producing mode, the HELIEX plant concept might as well participate to the control energy market – a discussion currently going on for subsidised bio energy plants. Especially since ramp up or down to or from full load does not take more than 30 sec.

The simple “plug & play” container sized Wet Steam Power Generator from Heliex, which as a fully assembled unit, may be manipulated by a fork lifter during installation, offers the advantage of several different financing models: from leasing to simple rent to own or BOT and contracting solutions. However, experiences show, that, due to the attractive economics and rather low total project investment of around 2.000 €/kWe, traditional sale of the component to the plant to be modernized is the owners preferred solution.

Recovery of ammonium from liquid digestates for industrial NOx-removal (ReNOx)

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Liquid digestate from biogas plants contains significant amounts of ammonia, which has to be removed in order to close in-plant water circulation without the risk of inhibiting the anaerobic digestion processes. Technologies like air- or steam-stripping turn out to be very cost-intensive due to the high amount of chemicals and energy needed and the large volumes of the involved apparatus (stripping columns). Therefore, stripping processes are of limited economic feasibility for digestate processing. Nevertheless, the selective removal of ammonium (NH_4^+) from the liquid phase would be an interesting option to allow in-plant recycling of process water together with a simultaneous production of an ammonium-rich solution, applicable as denitrification agent for industrial off-gas treatment (NOx-removal). Thereby, problems which arise from the output of unprocessed digestate on agricultural areas, for example legal restrictions concerning regional N-capacity, seasonal output limitations as well as N-losses or nitrate formation in groundwater can be avoided. These aspects are of special interest for areas with intense agriculture and stock farming. Besides biogas plants, other potential sources for NH_4^+ are existing sewage treatment plants. These plants often exhibit high amounts of ammonium in the sludge liquor especially during co-fermentation, which leads to increased N-reversal rates. Ammonium recovery from sludge liquor would reduce these reversal rate and lead to energy savings for aeration together with the possibility to obtain a marketable product from excessive nitrogen.

To produce an industrial NOx-removal agent suitable for catalytic and non-catalytic off-gas treatment by ammonium recovery from liquid digestates, a novel process called “ion-exchanger-loop-stripping” was developed. This process combines ammonium preconcentration via solid ion exchanger beds of natural zeolite followed by regeneration with simultaneous air stripping. Thereby, a purified, recyclable process water stream and a concentrated ammoniumsulfate-solution are generated, the latter being a valuable product for NOx-removal for example at cement works. Compared to conventional air stripping, the ion-exchanger-loop-stripping is operated with significantly smaller stripping columns and comprises lower chemical and energy demands. Revenues from the marketing of the NOx-removal agent together with savings regarding process water, costs of indirect discharge or aeration expenses should enable the construction of profitable retrofitting units to be installed at existing biogas and sewage treatment plants.

Technical feasibility of the process was proved with a small-scale laboratory plant capable of processing around 10 to 20 l h^{-1} of digestate. Ammonium removal rates of up to 80 % from digestate samples were reached within 60 min in laboratory experiments at ammonium input concentrations of 1000 mg l^{-1}. Special emphasis was put on the characterization and applicability of natural zeolites (mainly clinoptilolites) as ion-exchangers. Natural zeolites are available at reasonable prices and exhibit a high adsorption capacity and selectivity for ammonium. The cation exchange capacity (CEC) of the applied zeolites strongly influences the performance of the overall process. CEC of several different zeolite samples was determined in lab experiments (adsorption isotherms) to identify appropriate zeolites suited for ammonia adsorption from digestates.

To test the process under practical conditions, a mobile pilot plant capable of treating around 500 l h^{-1} of digestate was built, which is currently operated at the sewage treatment plant in Knittelfeld. Preliminary results of the operation show, that the process is running stable in a real environment. Removal rates for ammonium are lower than in lab scale experiments due to scale-up reasons. Nevertheless, there is potential for optimization, especially by varying the type and quality (e.g. particle size) of the utilized zeolite, adapting the flow conditions through the adsorption columns and the number and duration of the recovery cycles as well as optimizing the process temperatures and operating conditions of the stripping and washing units. Results from an economic evaluation of the process will be available after the completion of the pilot plant operation next year.

Production related Optimization of Wood Pellets Storage Properties

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In recent years wood pellets have been investigated along the entire supply chain sustaining the high quality of the product wood pellet. Beside fuel characteristics also storage behaviour of wood pellets has been examined. During storage of pellets, various compounds like carbon monoxide (CO), carbon dioxide (CO_2) and volatile organic compounds (VOCs) are formed, and the oxygen in the surrounding air decreases simultaneously. The reason for the release of emissions is the degradation of naturally wood components like resins or fatty acids. Current research on the so called “off-gassing phenomenon” focuses on two aspects, i) the search of the origin of the formation of the mentioned emissions and ii) the specific investigation of odoractive VOCs, which can be perceived as very unpleasant by costumers. However, both effects have in common that they cause insecurity at the enduser, which in turn leads to high efforts of the whole pellet industry to improve the storage properties by reducing the formation of emissions in general and odoractive emissions in particular.
Thus the project SmellProcess was initiated by proPellets Austria in cooperation with the three Austrian research institutions BIOENERGY 2020+ Gmbh, Graz University of Technology - Institute of Analytical Chemistry and Food Chemistry and Holzforschung Austria. Within a project duration of 2 years potential measures during the pellets production itself will be established for the first time. The research aims to identify and analyse influential parameters in pellets production on storage properties. For this purpose various (process-related) parameter variations are performed in industrial as well as in laboratory scale pelletizing experiments. Parameters like additives, raw material blendings, water regime and temperature conditions as well as post-production treatment parameters in the pelletizing process are examined in this regard. A number of industry partners were involved in the design of the experiments. Moreover, close cooperation among the three institutions enables a comprehensive characterization of the pellets with respect to their storage properties. Feedstock properties, release rates of CO and VOCs, identification of odoractive VOCs as well as particular physical and mechanical properties of the produced pellets are investigated.
For the ongoing identification of production-related influential parameters on storage characteristics of wood pellets, precise information of pelletizing process and analysis results are used. The ongoing project focused in its first year mainly on post-production treatment factors and water regime. The most recent results of the project indicate that post-production treatments of the produced pellets showed little to no impact on the off-gassing behaviour and did not result in a significant reduction of the released CO, CO_2 or VOC emissions. As post-production treatments are potentially cost intensive, technically difficult to set up and relatively ineffective cost/benefit considerations clearly do not favor this treatment. The results for the variation of water regime during pellet production showed that in the experiment a lower water content of the raw material during production was beneficial to the reduction of emission release from wood pellets. Nonetheless, further tests are necessary to confirm the preliminary results.
The project SmellProcess is funded within the framework of the FFG Basisprogramme. Furthermore, the financial support of the industrial partners is highly acknowledged.

Development of an International Standard for Ash Melting Behaviour

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Ash melting behaviour is an important parameter for solid biofuel evaluation. It should be stated according ISO 17225-series and there is a limit for the deformation temperature of wood pellets in ENplus quality assurance system. Ash melting is a complex process where also sintering, shrinkage and swelling may occur. The ash used for the test is a (homogeneous) material, prepared from the fuel. The determination is performed at a controlled rate of heating in a controlled atmosphere. The determined characteristic temperatures in the test can be used for comparison of the tendency of the ashes from different types and qualities of solid biofuels to form fused deposits or to cause bed agglomeration on heating.

Currently characteristic ash melting temperatures are determined according CEN/TS 15370-1 “Solid biofuels – Method for the determination of ash melting behaviour Part 1 Characteristic temperature method”. This method is based on old coal standards (e.g. ISO 540) and was developed during BioNorm I project (2002-2004) to suit solid biofuels. It was not further developed or validated afterwards. Thus, publication as EN or ISO international standard was not possible.

Results of inter-laboratory comparison tests showed that CEN/TS test method is not described precisely enough to provide satisfactory and comparable results. Experience of labs working with this method frequently indicate that reproducible results are possible after moderate modification of the test procedure. In 2015 ISO decided to start a new work item (NWIP) and create an international standard with the author of this paper being project leader.

Since the test method was and will be empirical, development of the new standard started with a worldwide inquiry how tests are done in practise. More than 30 labs participated coming from 16 countries providing over 17.000 ash melting tests annually. Unexpected large differences in used methods and test details indicated the necessity of a more general revision of the method. A new draft is currently developed. This method will be tested and will be validated till end of 2016. Results of validation and a detailed discussion of parameters influncing ash melting behaviour will be presented in this contribution.

Influence of substrate and microbial biomass concentration and composition of the microbial community on the biogas production from different carbohydrates

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The project „MOST“ (“Model Based Process Control of Biogas Plants”), funded by the German Ministry for Education and Research aims at optimizing process control of biogas production plants by providing a mathematical model of the anaerobic digestion process calculated from identified key parameters. The consortium consists of ten partners from science and industry producing, analyzing, modelling, and interpreting the data. In one work package anaerobic biodegradation of model substrates - here cellulose, starch, and glucose - is investigated extensively as a base for mathematically modelling the biodegradation processes in biogas plants. These investigations include a literature review and experimental data.
This paper shows results of bench scale experiments dependent not only of the concentration of the substrates cellulose, glucose, or starch, but also of the concentration of the biomass and associated changes in composition of the microbial community. The fed-batch experiments were performed in 2-L bioreactors equipped with gas meters and sensors for methane and carbon dioxide. Digestate from a biogas plant treating fruit and vegetable wastes was used for inoculation. Total solids and total volatile solids, VOA-TAC (volatile organic acid -to- buffer capacity ratio), and pH were measured. VFAs (volatile fatty acids) were analyzed with ion exclusion chromatography equipped with a conductivity detector. The microbial community composition was identified using Illumina Amplicon sequencing.
An amount of 214-270 $ml_{methane}/g_{glucose}$, 279-292 $ml_{methane}/g_{starch}$ and 285-338 $ml_{methane}/g_{cellulose}$ at an initial substrate concentration of 3 $g_{substrate}$ was obtained. During fermentations, the biomass was gradually reduced by 3 to 10 %. The reduction during the experiments with glucose resulted in an increase of the propionic acid concentration (1.8 mmol/l; up to 9.7 mmol/l) and in increased abundance of *Actinobacteria* as measured by 16S reads. In the course of the fed-batch experiment with starch, higher concentrations of propionic acid (1.4 – 3.3 mmol/l) and butyric acid (0.8 – 4.4 mmol/l) were detected as well as some additional fatty acids in low concentrations. In the starch reactors the microbial community composition changed mainly in favor of the phylum *Bacteroidetes*. Representatives of the phylum *Proteobacteria* dominated the cellulose-fed reactors. These did not show any elevated concentrations of VFAs.
The biogas and methane yields and the stability of the anaerobic biodegradation process depended on the substrate and on the microbial biomass concentration. Reduction of microbial biomass was associated with a more or less impaired degradation process. This effect varied by substrate. The effect was mostly shown during the fed-batch experiment with glucose followed by the experiment with starch. Within repeated feedings, the biomass adapted to all of the substrates tested, but only the adaptation to cellulose occurred without showing an impairment effect.

The experiments are currently continued with glycerol, palmitic acid, oleic acid, and proteins as additional model substrates and will be continued with mixtures of these substrates and complex substrates.

Kalte, intelligente Wärmenetze und neuartige Flüssigeisnetze als Plattform für Biomasseanlagen im Regelenergiemarkt

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Die Herausforderung moderner Volkswirtschaften besteht in der ökonomisch vertretbaren Umstellung der Energieversorgung auf nichtversiegende Energiequellen und nachwachsende Rohstoffe so schnell es irgend geht, um die bekannten negativen Einflüsse bisheriger Energieversorgung zu begrenzen.

Bisher werden Kältenetze wegen Ihrer schwierigen Wirtschaftlichkeit nur selten eingesetzt, um dezentrale Kühlung mit teurem Strom für Kompressions-Kältemaschinen abzulösen.
Die Technologie Vakuum-Flüssigeisspeicher kann ohne Wärmeübertrager und mit dem Kältemittel Wasser 0°C-Flüssigeis erzeugen, womit gegenüber konventionellen Kältenetzen (VL 6°C / RL 12°C) die Speicherkapazität bis zu dem Faktor 7,5 erhöht wird und damit Kältenetze wesentlich energieeffizienter und wirtschaftlich effektiver betrieben werden können. Das vorrätige Erzeugen von Kälte lässt den dafür nötigen Strom aus Biomasse als Regelenergie viel wertvoller vermarkten als in den bisherigen Anlagen zur Bereitstellung von Grundlast. Durch die bis zu 50% weniger Strom verbrauchende Technik und dem Ablösen umweltfeindlicher Kältemittel ist die Kombination Biomasse-Vakuumflüssigeisspeicher in besonderem Maße zielführend und zukunftsfähig. Eine moderne Kälteversorgung in urbanem Umfeld mit regionaler Biomasse ohne Erdöl und Erdgas wird möglich.

Bisherige Fernwärmenetze sind für einige neue Technologien ungeeignet. Solarerträge sind bei Vorlauftemperaturen von 90°C einfach schlecht. Wärmepumpen können nicht effektiv betrieben werden und der Brennwerteffekt bei der Gasverbrennung ist praktisch nicht möglich. Zentrale Großkraftwerke sind schlecht regelbar und spiegeln die Notwendigkeiten moderner Energieversorgung nur begrenzt wieder.

Kalte, intelligente Wärmenetze arbeiten mit deutlich kälteren Temperaturen, alle Arten von Wärmequellen werden integrierbar und hocheffektiv. Ein modernes Wärmeversorgungs-system kann damit Sonnenenergie und Erdwärme nutzbar machen, was die Biomasse als Regelenergieanbieter zwingend erforderlich macht. So kann das Blockheizkraftwerk vor den Toren der Stadt mit Holzgas betrieben werden, der Strom zum Antrieb der Wärmepumpen verwendet werden und die bisher nicht nutzbaren Abgastemperaturen die Quelltemperatur der Wärmepumpe anheben. An der Referenz des ersten Deutschen kalten Netzes in Dollnstein (Oberbayern) wird der Vortrag diese ganz wesentlichen Synergieeffekte deutlich machen. Das Zusammenspiel der verschiedenen Techniken bewirkt, dass die Nachteile des Einen durch die Vorteile des Anderen ausgeglichen werden und sich die Vorteile gleichzeitig addieren. Besonders interessant ist, dass diese Konzeption (örtlich angepasst) weltweit zum Problemlöser und damit zu einen deutschen Exportschlager werden könnte.
Eine decarbonisierte Wirtschaft ist möglich.

Research Coordination for a Low-Cost Biomethane Production at Small to Medium Scale Applications The Biomethane Map

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The Biomethane Map is developed by the European Horizon 2020 project **"Research Coordination for a Low-Cost Biomethane Production at Small and Medium Scale Applications",** short **Record Biomap.** The project has started on 1st of April 2016 and has a duration of two years. The project is coordinated by DBFZ - Deutsches Biomasseforschungszentrum gGmbH from Germany. The University of Warmia and Mazury (Poland) and the Swedish Institute of Agricultural and Environmental Engineering (JTI) are partners in this project.

The Biomethane Map presents companies and institutions in Europe who develop different innovative process and technology solutions for a competitive production of biomethane at small to medium scale. So far the production of biomethane is cost efficient at large scale only. The presented companies and institutions cover different technologies along the biomethane supply chain, from substrate pre-treatment, digestion and in the last step the upgrading of the produced biogas to biomethane. The focus lies especially on technologies in the first phases of development, e.g. between the experimental proof of the concept and a validated prototype (TRL - Technical Readiness Level of 3-5 according to EC definition).

An example for a promising technology which is presented in the map and will be further monitored in Record Biomap is the biogas upgrading through the *in-situ methane enrichment* technology in combination with a *wood ash filter* which both have been developed by the partner Swedish Institute of Agricultural and Environmental Engineering. But also other technologies for substrate pre-treatment such as the *ultrasound and hydrodynamic cavitaion,* developed by the University of Warmia and Mazury, or technologies for improved digestion processes like the *high organic loading plug flow digestion* will be presented and assessed.

The Biomethane Map will present a variety of company profiles and technology descriptions (TD). Based on these TDs an impact assessment will be carried out in order to find out where which technology can be applied best. On the one side, industry stakeholders or end users, such as biogas plant operators or component suppliers have the chance to find contacts who offer the right solution for their needs, and on the other side technology developers can find cooperation partners for further research through the Biomethane Map. So the platform aims to bring key players together on a continental level for an intense knowledge transfer and furthermore to shorten the time to market of the developed technologies.

The Record Biomap project will also investigate in administrative and political framework conditions for market implementation and give recommendations for optimisation of those. Available funding possibilities will be communicated to all interested stakeholders. The network will also serve to connect these stakeholders in order to develop new project concepts while further research needs will be identified. Different workshops at which the most promising technologies will be presented are planned to take place in Germany, Sweden and Poland, however, the results will also be presented at various national and European conferences.

Further information about the project and information how to join the network can be found on the project website: www.biomethane-map.eu

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Direktsynthese von Dimethylether (DME) aus regenerativen Rohstoffen

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Ein wichtiger Baustein hin zur nachhaltigen Energieversorgung, betrifft das breite Forschungsgebiet der Erzeugung von synthetischen Kraftstoffen aus Biomasse. Als ein vielversprechender zukünftiger Brennstoff wird in diesem Zusammenhang Dimethylether (DME) gehandelt, das aus Erdgas, Kohle oder nachhaltig aus Biomasse synthetisiert werden kann. Auf Grund seiner sehr guten Verbrennungseigenschaften und hoher Energiedichte kann DME als Additiv oder Kraftstoffersatz für Diesel oder Flüssiggas LPG (Liquefied Petroleum Gas) verwendet werden. Im täglichen Gebrauch findet DME bereits heute schon eine breite Verwendung als Treibgas in hochpreisigen Massenprodukten wie Haar- oder Locksprays oder als Rohstoff in der chemischen Industrie. Momentan entwickelt das DBI Gastechnologisches Institut gGmbH Freiberg ein innovatives Verfahren zur hocheffizienten Erzeugung von DME aus Biogas und Beimischung von Wasserstoff, welcher aus Überschussstrom über Elektrolyse gewonnen werden kann. Die ablaufenden Reaktionen können wie folgt beschrieben werden:

DME-Synthese für H_2-armen Feed

$$3CO + 3H_2 \rightarrow C_2H_6O + CO_2 \qquad \text{Gl.1}$$

DME-Synthese für H_2-reichen Feed

$$2CO + 4H_2 \rightarrow C_2H_6O + H_2O \qquad \text{Gl.2}$$

Die angestrebte Flexibilität des katalytischen Prozesses ermöglicht die Einbindung von volatilem erneuerbaren Strom aus Windkraft oder Photovoltaik in Zeiten mit Stromüberschuss. Ist dieser nicht gegeben, ist eine Wasserstoffzugabe nicht erforderlich. Insgesamt besteht so die Möglichkeit die Verteilungsnetzte bedarfsgerecht zu entlasten, überschüssigen Strom in ein hochwertiges Produkt zu überführen.

Im Beitrag werden die experimentellen Arbeiten und die entwickelten Reaktormodelle vorgestellt. Es konnte bereits ein geeignetes Katalysatorsystem für die einstufige DME Synthese bei variablen Wasserstoffanteil im Feed eruiert werden. Hierzu wurde eine Vielzahl verschiedener Katalysatorsysteme bestehend aus einem Methanol-und DME Katalysator in einer Laboranlage bei bis zu 300°C und 100 bar getestet. Für das gewählte Katalysatorsystem konnte ein kinetisches Modell zur Beschreibung der Reaktionsgeschwindigkeiten bzw. der sich daraus ergebenden Produktgaszusammensetzung in Abhängigkeit der Prozessvariablen wie z.B. Druck und Temperatur erarbeitet werden. Mit Hilfe des kinetischen Modells wurde ein ortsaufgelöstes Reaktormodell generiert, wodurch es ermöglicht wird, den Reaktorgeometrie als weiteren Einflussparameter zu untersuchen. Ziel ist es durch ein innovatives Reaktorkonzept und Wärmemanagement, dass aus thermodynamischer Sicht hohe Potenzial bzw. theoretisch erreichbaren DME-Ausbeuten, im Gegensatz zu herkömmlichen Anlagen voll auszuschöpfen. Im Abschluss des Beitrages wird die modellgestützte Auslegung und Konzeptionierung eines DME-Reaktors dargestellt.

Using lignified Biomass as Raw Material for Production of new Materials

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Society faces a worldwide pressure to reduce the dependence on fossil resources for material production. Lignocellulose biomass, such as wood residues constitute a renewable resource which does not compete with food production. The utilization of biomass depends essentially on nearly full conversion to value added products and on flexibility of usable substrates and achievable products.
This concept has been already investigated in the initial project „Modular Biorefinery of Lignocellulose" (FFG Project Nr. 834297). The aim of this project was to establish several process options in the lab scale and to evaluate them. For the project we expected the definition and evaluation of the optimal material flux and the establishment of several process steps in lab scale.
Based on this work we established the other modules, including novel technology for product purification (FFG project Nr. 843687 and Nr. 848600). The entire process chain was then evaluated for its economic and ecological impact. The material streams are mapped out in process descriptions within a broader business model, with the aim of maximizing the processes identified economically. The final project goal is to attract investors for the idea and find a production site for actually producing these new materials.
We aimed at following material streams, to be achieved by suitable chemical/physical separation methods:

- Hemicellulose and cellulose are mainly hydrolysed for the biotechnological conversion to lactic or itaconic acid. We could show the technical feasibility in both cases, however considerable research effort is required to achieve economically relevant yields.

- Purification of the organic acids based on a new technology of Fermtech GmbH which is based on recycling of the required chemicals.

- The material stream towards high value cellulose fibres is established and can be implemented in future if required.

- Lignin will be developed as novel raw material for aerogels (high performance thermic insulators and absorption materials) and carbogels (electrodes and membranes for electrochemical applications).

- Lignin will be further developed to replace phenol and resorcinol for phenol-formaldehyde analogous adhesives.

- N-modified lignins were developed as high value soil improvement.

The aspired modularity allows a distinct variation of substrate and product fluxes, in accordance with the general project aim of an innovative complete utilization of the available biomass. The concept is therefore robust towards available biomass and the actual value of different products.
The developed process including the required microorganisms for biotechnological product formation will be based on process descriptions, the experimental proof-of concept and a business model. To solve this multidisciplinary challenge the project consortium includes five partners: the University of Natural Resources and Sciences Vienna (BOKU) with the two departments of Biotechnology and Chemistry, the Technologie- und Dienstleistungszentrum (TDZ) Ennstal, and the two SMEs denkstatt GmbH und Fermtech GmbH, as well as the Österreichische Bundesforste AG.

Process simulation and sustainability assessment during conceptual design of biorefinery concepts for the BioEconomy Cluster of Central Germany

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The strong global dependence on fossil fuels results from the intensive use and consumption of petroleum based derivatives. With regard to the risks of diminishing petroleum reserves and growing climate change, there is need for an ecological and political acting. A promising approach is the change-over from a fossil-based chemistry to a bio-based in order to ensure the sustainable supply with basic chemicals and energy. Implementing sustainable biorefinery concepts is thereby seen as a path with great prospects. Due to the multitude of possible raw materials, products, conversion pathways and combinations of technologies, the development and related optimization of sustainable biorefinery concepts turns out to be a major challenge. In the context of sustainability this is especially true for economic and environmental criteria. For this reason it is necessary to provide the process engineers with a robust assessment methodology already during the conceptual design of biorefineries.

Process simulation is a very powerful tool for the calculation of mass and energy balances of integrated flowsheets. Its application is especially well-suited during conceptual design. It allows the development and comparison of different flowsheets already at an early stage of process design. Details can be added to the flowsheets as soon as they become available in the course of the project development. On the other hand the different methodologies for sustainability assessment of a conceptual production site are based on inventory data of the needed material and energy input. For the assessment of running facilities, these can be taken from actual in and output balances. During conceptual design, the data can be effectively estimated by process simulation.

A methodology on how to integrate the process simulation with subsequent sustainability assessment was therefore developed. The economic assessment can be realized in an early stage of conceptual design by calculation of operational costs and in an advanced stage by dynamic investment calculation. The environmental assessment is conducted by life cycle assessment. Different impact assessment methods like ReCiPe 1.08, EC-RED and others can be used, depending on the aim of the study. Based on the results of these calculations key parameters of the biorefinery concepts can be identified and iterative optimization approaches can be developed.

Possibilities for the application of the methodology in different biorefinery concepts will be presented. The products evaluated by the methodology are first and second generation biofuels and biochemicals. The results show the specific benefits and drawbacks of the respective biorefinery concepts. Furthermore it was shown that the iterative development has led to significant improvements of economic and environmental performance of the concepts in the course of the project.

The methodology was developed, optimized and applied throughout the last 4 years within the activities of the BioEconomy Cluster, funded by the Federal Ministry of Education and Research. It has helped to identify and develop process configurations with improved sustainability regarding both economic and environmental criteria. The methodology can now be applied to further biorefinery concepts.

Biogas Production by codigestion of slaughterhouse wastewaters and microalgae grown on the slaughterhouse digestate

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Microalgae, phototrophic microorganisms, are the most promising and more sustainable sourcefor the synthesis of various products with high added value in a variety of fields including the energy.
The exploitation of microalgae for the production of bioenergy is mainly due to their rapid growth, the need for low-floor areas and their ability to grow on different liquid waste thus reducing the costs of their production.

The biochemical characterization of microalgae isolated from the slaughterhouse digestateshowed vast wealth of total sugars which exceed 80% relative to the dry mass of the biomass and very low protein content.This feature has led the studies to produce biogas through anaerobic co- digestion.
The microalgae cells were cultured on slaughterhouse digestate. This allowed obtaining a high cell biomass in addition to the purification of this secondary effluent.

The anaerobic co-digestion was carried out between the culture of microalgae obtained above and the slaughterhouse wastewater with different proportions.The best result was achieved by feeding the reactor at a rate of 1/3 microalgae and 2/3 slaughterhouse wastewater to obtain 220 ml CH_4/g VS with using a hydraulic retention time of 6 days only.

Thereafter, in order to improve this yield, a thermochemical pretreatment of cells was carried out. This pretreatment allowedachieving more than 750 ml CH_4 / g VS after 4 days of anaerobic digestion. This therefore represents an improvement of 290 % over the initial value.

The anaerobic co-digestion of microalgae is a promising alternative for the production of bioenergy. This co-digestion is very important insofar as it enabled an improvement in yield of biogas which can be mainly due to the increase in the C/N ratio. This process is made more interesting by its coupling with the culture of algal cells on the produced digestate. This process also has a positive impact on the environment where the digestate, after the algae culture, has been purified biologically with very low emission of liquid and / or gas pollution.

Assessment of Sustainability for local biomass heat supply systems - considering ecological, economic and social issues

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1. Introduction The aim of this project was to define indicators to evaluate local heat supply systems based on renewable energy compared to fossil energy reference scenarios. With these indicators an assessment matrix was developed as a planning instrument for the realization of sustainable and energy-efficient local heat supply systems. Further inferences from single projects on regions can be done.
2. Methodology In these project a method was developed to assess the sustainability of local heat supply systems with the focus on ecology under consideration of economically and social aspects. This method uses a set of indicators composed of Input-, Output-, Efficiency- and Balance indicators. To realize advancement in comparison to present situations, an environmental quality target to advance the environmental impacts of minimum 75% was defined. For the developing and application of the indicators different examples from projects and scenarios of combined heat production from Biomass, Biogas, Solar heat combined with near-surface geothermal storage; geothermal energy and fossil peak-load supply were calculated. These scenarios were related to a basis fossil energy scenario. Overall, two district heating projects at Speichersdorf and Mitterteich (Bavaria, Germany) were compared. In this case, the project Speichersdorf with different coverage areas and decrease heat densities was investigated. The lengths of electrical grid of two areas are 10,828 m and 6,027 m. Those were opposed to the biomass district-heating project Mitterteich with a grid length of 360 m and a higher heat density decrease. Furthermore, a scenario for heat supply was designed and calculated using a geothermal plant operating in duplicate to provide heat to the large coverage area. The calculation of the various processes and scenarios was performed with the program GEMIS 4.8 based on the total heat generated (final energy) by the respective supply type. The study examined the main system components; boilers, solar heat collectors, geothermal energy storage, geothermal heat system and the distribution network. For this purpose, a life cycle assessment / life cycle analysis based on using the above indicators of energy and the emissions were calculated. To determine what fraction of energy and emissions are caused of the district-heating network itself, the heat supply variants listed below were calculated with and without distribution network and geothermal storage.
3. Results The variant V1Oil/Natural Gas is the reference scenario of decentralized plants on district heating supply based on oil and natural gas in comparison to the following variants:

- V2: biomass and fuel oil peak load,
- V2a: biomass, biogas and fuel oil peak load,
- V3 Solark40: biomass, 40% solar fraction, oil peak load,
- V4Solar20: biomass, 20% solar fraction and oil peak load
- V4aBGSolar20: biomass, biogas, 20% solar fraction and oil peak load
- V6 Geoth: geothermal plant with fuel oil peak load
- Mitterteich: biomass, natural gas peak load

The results of the individual indicators were grouped under the collective term environmental impacts. For each indicator a weighted rating system was developed, normalized and scaled to kWh. Hence, the balance sheet indicator “avoided environmental impacts” was developed to demonstrate the overall results and for assessment the compliance with the environmental quality objective. The emissions therefore have positive values and both indicators efficiency and value creation have a negative value and therefore considered positive in the overall assessment. The results of the environmental impact of different heat supply scenarios based on the evaluation of the designed system will be presented.

Dezentrale Wasserstofferzeugung mit autothermer Reformierung von Biogas

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Schwerpunkt der Präsentation ist die Darstellung der praktischen Erfahrungen am Institut für Wärmetechnik und Thermodynamik der TU Bergakademie Freiberg. Hier wurde im Rahmen des europäischen Projektes BioRobur (biogas robust processing with combined catalytic reformer and trap) ein Biogasreformer in der Leistungsklasse 50 m3/h im Normzustand Wasserstoff für dezentrale Wasserstoffgenerierung konzipiert, gebaut und in Betrieb genommen. Wichtige Innovationen dieses Konzeptes sind der Einsatz neuartiger regelmäßiger Katalysatorstrukturen, die mit einem 3D-Drucker hergestellt wurden, sowie die autotherme Reformierung von Biogas.

Die Auslegung erfolgte auf Basis von Simulationen der Masse- und Energieströme und Parameterstudien mit der Prozess-Simulationssoftware ASPEN PLUS®. Die simulierte Reformeranlage kann grundlegend in drei Prozessschritte unterteilt werden. Der erste Schritt beinhaltet Kompression, Vorwärmung und Mischung von Biogas, Dampf und Luft. Im zweiten Prozessschritt wird das Gemisch einem Reformer zugeführt und katalytisch in synthetisches Gas (Gemisch mit den Hauptbestandteilen H_2 und CO) umgewandelt. Die Erzeugung von Wasserstoff in der Qualität 5.0 wird im dritten Prozessschritt durch Hochtemperatur- und Niedrigtemperatur-Wasser-Gas- Shiftreaktionen und einem nachgelagerten Druckwechselabsorber erzielt. Der Anlagenwirkungsgrad wird von der Reformierungsart (partielle katalytische Oxidation, Dampfreformierung oder autotherme Reformierung), dem Maß an Wärmeintegration, der Vorwärmtemperatur der Edukte, dem Verhältnis von Dampf zu Kohlenstoff (S/C) und Sauerstoff zu Kohlenstoff (O/C) sowie der Abgasnutzung der Druckwechselabsorptionsanlage beeinflusst. Durch die Variierung dieser Randbedingungen in der Parameterstudie kann ein Anlagenwirkungsgrad von bis zu 65% erreicht werden. Der Anlagenwirkungsgrad setzt den Energiegehalt des erzeugten Wasserstoffes ins Verhältnis zur eingebrachten chemischen Energie des Biogases sowie der thermischen und elektrischen Energie für die Prozesserhaltung.

Die realisierte Versuchsanlage für die autotherme Reformierung von Biogas, welche nicht die Gasreinigung enthält, wurde im März 2016 erfolgreich in Freiberg in Betrieb genommen. Seitdem werden zahlreiche Experimente unter realistischen Bedingungen durchgeführt, um praktische Erfahrungen mit der Wasserstoffproduktion im industriellen Maßstab zu gewinnen. Dabei wurden neben der Variation der eingesetzten Katalysatoren auch die Auswirkungen der typischen Prozessparameter einer autothermen Reformierung, S/C- und O/C-Verhältnis sowie die Raumgeschwindigkeit (GHSV), untersucht. Bei den bisher durchgeführten Versuchen wurden Kaltgaswirkungsgrade (Verhältnis des chemischen Energiegehaltes im Synthesegas zu der chemischen Energie des genutzten Biogases) von bis zu 91% erreicht.

New laboratory scale fixed bed gasifier operating at conditions up to 950 °C and 20 bar

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For the production of heat, electricity, fuels, and chemicals based on renewable energies biomass gasification is an important process. To reach the targets for the use of renewable energies the biomass gasification should be flexible for different fuels, operating conditions, and products. With this flexibility a demand-oriented supply of energy from renewable sources is possible. The knowledge that could be gained with the new DBFZ counter-current fixed-bed gasifier should allow this flexibility for biomass gasifiers.

The DBFZ-gasifier is an outstanding and innovative system because of a fixed-bed volume up to six liters combined with the operation parameters (950 °C, 20 bar), the different gasification agents (mixtures of N_2, O_2, air, steam, and CO_2), the gravimetric analysis system for the fixed-bed mass during the reaction, the 20 thermocouples inside the fixed-bed (showing the temperature distribution along the fixed-bed height and width), and the three 450 °C gas sampling points extending along the fixed-bed height and diameter. With the new detailed information gained by this gasification plant the reactions inside the fixed-bed can be characterized in more detail. The DBFZ-gasifier has been put into operation in 2016 and will be used for the analysis of different fuels and operating conditions (temperature, pressure, gasification agents). The investigation of the temperature distribution along the fixed-bed at different operating conditions during the gasification reaction is of crucial importance, as well as a deeper understanding of the coke and slag formation. The scientific innovations of this test bed are:

- huge number of the installed thermocouples which allows a detailed measurement of the temperature distribution inside the reactor along the fixed bed height and width
- gravimetric fixed-bed mass investigation during the gasification reaction
- gas sampling during the reaction at a temperature of 450 °C at three different heights in the fixed-bed for the extensive analyses of hydrocarbons.

By this comprehensive technical equipment a detailed examination of the different gasification reactions taking place at the conversion of a fuel into a fuel gas is possible at a wide range of operating conditions. These new information should be used to enhance the flexibility of the fuels (e.g. stalk-good-natured fuels, biogenic rest materials), operating conditions and the products (electricity, heat, chemicals, fuel, e.g. SNG) of gasification plants to be able to develop new application possibilities. Furthermore, the influence of the fuel pretreatment, for example torrefaction, can be examined with the DBFZ-gasifier.

The test bed with a reactor diameter of 10 cm can be used for pellets, wood chips and fine fuels. The gasification agent can be switched independently. Before the gasification agent is led through the reactor it has been heated up to 950 °C. In the gasification reactor there is a heatable grate which can be used for the simulation of a glow bed. In addition, the reactor wall can be heated up to 950 °C in accordance with the reactor grate. The mass decrease of the fuel is continuously determined by four load cells. After leaving the gasification reactor the exhaust gas is cooled from 1050 °C to 450 °C so that hydrocarbons which were formed during the biomass conversion remain in the gas phase. The sampling of these gases to the analysis is possible in the reactor bed at three different heights of the reactor and at the reactor exit. Due to the gas sampling temperature of 450 °C and an specific dilution with nitrogen these gases can transported without any damage through the analytic systems. The product gas is cooled after the gasification reactor and the sampling to approx. 20 °C. The temperature monitoring in the reactor is realized by 20 thermocouples to be able to determine the temperature distribution along the reactor width as well as the reactor height. Thereby, moving hot zones can be made visible.

Beside "pure" gasification parameters (e.g. gas composition and product gas volume stream) the coke and slag building are of essential importance for the undisturbed operation of gasification plants.

A New Value Chain for European Rubber and Inulin Production for the BioEconomy

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Natural rubber is a sustainable material that is used for more than 40,000 products, among others natural rubber is applied in construction (adhesives, sealants), medicine (gloves, tubing) and transportation (matting, tyres) industries. Because of the specific quality aspects of natural rubber in many products it cannot be replaced by synthetic rubber.
DRIVE4EU - 'Dandelion Rubber and Inulin Valorization and Exploitation for Europe', a European demonstration project coordinated by Wageningen UR, DLO, aims at the development of the production chain of natural rubber and inulin from Russian dandelions (www.drive4eu.eu). The objective of the project is to set up a new European chain for the production and processing of natural rubber and inulin. At the moment natural rubber is exclusively harvested from the rubber tree (*Hevea brasiliensis*) of which about 90% is grown in South East Asia.
DRIVE4EU demonstrates the technical and economic feasibility of the use of Russian dandelion (*Taraxacum koksaghyz*, TKS) as a production platform for both natural rubber and inulin. The inulin can be used as raw material for interesting green chemicals, such as furan-based polymers. The combination of natural rubber and inulin makes Russian dandelion very interesting as a production platform. The project offers the EU a unique competitive advantage, because DRIVE4EU relies heavily on the industrial expertise in the fields of TKS breeding and biorefinery of inulin containing root crops. Most importantly, DRIVE4EU bridges the gap between research and the market.
The main activities of DRIVE4EU are plant genotypes with high root biomass, high rubber and inulin yield, seed batches for agronomic tests and large scale demo field trials, optimized cultivation and harvest methods for TKS, ecological analysis of the gene flow between TKS and wild dandelions, scaled-up and optimized extraction and refinery protocol for TKS natural rubber and inulin, testing and application of TKS natural rubber and inulin in end product uses, demonstration of the economic viability of the TKS production chain for natural rubber and inulin.
To prove the economic viability an economic analysis is performed. Within a first general economic analysis of rubber and inulin production from Rubber dandelion (Taraxacum koksaghyz, TKS) putative bottlenecks for the future commercialization of rubber and inulin from TKS are identified. The general economic analysis was based on the consideration of two possible future business cases in "10 years" and "25 years" with rubber and inulin (for food, chemicals, biogas and bioethanol) as main products and co-products: feed and biogas from roots, leaves pulp. The whole value chain from TKS cultivation to rubber and inulin includes the following 7 main processes: 1) TKS cultivation and harvesting; 2) TKS transport; 3) TKS (drying &) storage; 4) Biorefinery (including processing of inulin for food and chemicals); 5) Feed production; 6) Biogas production and 7) Bioethanol production. The assessment shows: The total costs in the whole value chain are dominated by the cost of the TKS cultivation and harvesting and the cost for biorefining (including processing of inulin for food and chemicals). The other costs for transportation, storage, biogas and bioethanol production are relatively low. An environmental assessment (LCA) shows information about the impacts of several environmental impacts, e.g. GHG emissions, land use change.
DRIVE4EU demonstrates a new value chain for European natural rubber and inulin production and enables the EU to become less dependent on the import of natural rubber and at the same time to respond to the threat of a global rubber shortage.
The project DRIVE4EU (Grant Agreement No. 613697) is co-funded by the European Commission, Directorate-General for Research & Innovation, within the 7th Framework Programme.

Fermentation of maize straw and catch crops - What can be expected?

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The experience of using field residues

… Especially harvesting, ensilage, processing, feeding and fermentation of maize straw and catch crops in biogas plants.

The company BioG develops and produces machines for the use of organic material in the energy production and additionally has their own 500 kW biogas plant. For more than 10 years BioG has dealt with the following subjects: maize straw, rape straw, catch crops, etc. as well as manure because of necessity to shape the biogas production economically also with low Austrian refits.

The quality gas yields of these materials, especially with maize straw led us follow up this matter. Annually currently areas of 150-250 ha of maize straw and 80-100 ha of catch crops are processed. As it is quickly turned out in practice, it is necessary to fray the material to get an equal contact surface for the bacteria. Because of this reason several shredding systems had been installed from different producers to test their capability of this material, the power consumption, the delivery rate, the sensitivity of foreign bodies and the wear for a time period of each at least 6 months.
Different harvesting methods have also been tried out and further developed.
During storage of the field residues all kinds of silage have been tested as well the silage of wet or dry maize straw, but also the mix of other materials such as catch crops or sugar beet pulps, maize straw, rape straw and manure. These are very strongly tending to bridging, which has to be considered with this aforementioned technique.

The feeding technique must also communicate with the downstream techniques, which means the steering technique has to know which quantity of material the successive shredding technique and the solid- or liquid feeding can be strained. Therefore a particular focus is on the development of the control engineering, which allows low-wear and energy-saving mode.

Economic, field-hygienic as well as ethic reasons field residues are a very interesting alternative of raw material for biogas plants, whose energy potential shouldn’t be disclaimed in any case.

Bioenergy Villages (BioVill)
7 Villages one Target - Increasing the Market Uptake of Sustainable Bioenergy

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BioVill is a three years project supported by the European Union's Horizon 2020 programme with a budget of EUR 1.99 million. The project started in March 2016 and is implemented by a collaboration of nine partners from seven countries: Austria, Germany as well as Croatia, Macedonia, Romania, Serbia and Slovenia. Many South-East European countries have high biomass potentials, but they are often not or inefficiently used for local energy supply and regional economic development. The project aims at preparing regional bioenergy concepts for the establishment of bioenergy villages in South-East Europe and thus transfers existing experiences from Austria and Germany to partners and villages in the target countries. Activities in the target villages represent best practices in planning of local energy infrastructure and stakeholder participation and shall inspire other interested regions.

In its final stage, a bioenergy village will be a village, municipality, settlement or community or a part of it which produces most of its energy for electricity and heating from local biomass as well as from other renewable energy sources. Key principles of a bioenergy village are:

- **Sustainability:** The biomass feedstock is produced locally and in a sustainable way.
- **Energy Self-Sufficiency:** A large share of the electricity and heat demand is covered by locally produced biomass or other renewable energies.
- **Local Ownership:** The business model allows also consumers, farmers and forest owners to become shared owners of the installations.
- **Regional Development:** The added value remains in the village and supports the local and regional economic development.
- **Public Participation:** The creation and management of a bioenergy village is based on a high level of public participation.
- **Resource Efficiency:** The energy concept of a bioenergy village includes also energy efficiency and energy saving measures.

Core activities of the project include setting-up favorable framework conditions, preparing the basis for bioenergy projects and push implementation activities. In a first step, the project draws a complete picture of the national and local policy framework and evaluates already existing infrastructure as well as the energy supply potentials and demands within the target regions. Impacts and feasibility of bioenergy projects are verified by techno-economical assessments. Furthermore, local stakeholders and citizens have the opportunity to learn from best practice in Austria and Germany and get involved in all stages of planning the local energy facilities. Finally, the villages receive detailed planning for new bioenergy value chains and pledge ongoing implantation by a Memorandum of Understanding. The outcome is a transfer of capacities and technologies to potential new markets of bioenergy systems.

Innovative Technologie für eine saubere und effiziente Verbrennung von pelletierter Biomasse

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Verbrennung durch direkte Einäscherung der Biomasse:
RRR ⇔ EEE
(Widergewinnung, Recycling, Wiedernutzung) (effizient, wirtschaftlich, ökologisch)

ecoHORNET Technologie, Erfindungspatent Nr. 123389, Nr. 128229, A 00443/1 Eigentum Iulian Hornet, widmet sich ausschließlich den regenerierbaren Energiequellen und der Hochleistungsverwertung des im Überfluß befindlichen Reichtums des Planeten - der BIOMASSE (der biologisch zersetzbare Anteil der Produkte, des Abfalls und der Rückstände aus Landwirtschaft, Tierzucht, Forstwirtschaft und den verbundenen Industrien, sowie auch der biologisch zersetzbare Anteil des Abfalls aus Industrie und Haushalt).

Die Technologie basiert auf der Verbrennung durch Einäscherung bei Temperaturen von über 1250^0C der in Form von Pellets befindlichen Biomasse in einem Verbrenner, der gleichzeitig Prozesse integriert, so wie: Vergasung, direkte Verbrennung, Einäscherung, Nachbrennung. Die Verbrennung ist vollständig, ohne Rauch in den Verbrennungsgasen, ohne Teer oder Kreosot, wobei die ausgeschiedenen Verbrennungsgase trocken und sauber sind.

Die von ecoHORNET Brennern genutzten Anlagen verlierenlangfristig weder an Kraft, noch an Leistung, wenngleich die Wärmekraft der Pellets verschieden ist, da der Brenner mit einem Verbrennungsbeschleuniger, einer Selbstreinigungs- und Ascherückgewinnungsvorrichtung ausgestattet ist. Die außerordentlichen Ergebnisse die bei der Verbrennung bei hohen Temperaturen erhalten werden: CO-Ausstoß<100 mg/m^3, Partikelemissionen < 7,4 mg/Nmc, VOC-Emissionen < 10 mg/Nmc, NOx < 75 mg/Nmc,etc. erlauben vielfältige Anwendungen, sogar auch bei rauchempfindlichen Anlagen, Feuchtgasen oder Pulver. (z.B.. Strahlungsrohre)
Gemäß der Technologie von ecoHORNET erfolgt die Einäscherung durch direkte Verbrennung, Pellets mit einem Durchmesser von 6-12 mm, Längen von 10-35 mm, Feuchtigkeit <10%, Dichte 650-750 kg/m^3, hergestellt aus Müll, Rückständen, Abfällen, energiegeladenen Pflanzen (Biomasse), unabhängig vom Inhalt an Silizium und anderen Unreinheiten, jedoch auch Holzpellets
Die Verbrennung bei über 1250^0C beseitigt das Entstehen von Dioxin und anderer Bestandteile mit krebserregender Wirkung, wobei die Verbrennung sämtlicher Bestandteile der Biomasse stattfindet. Dabei resultiert eine kleine Menge von Biomassemineralien, die als Düngemittel verwendet werden können.

Die Technologie und Anlagen von ecoHORNET sichern eine effiziente, wirtschaftliche und ökolkogische Umwandlung der Biomasse in Wärme- und Elektroenergie; es werden Millionen Arbeitsplätze geschafft; es wird die Unabhängigkeit der Familien und der Verwaltungen mit Energieversorgung auf Landesebene sichergestellt; die Wälder werden vor Rodung geschützt; fossile Brennstoffe werden ersetzt; Schadstoffemissionen werden um 50-80% reduziert; eine sofortige Sanierung des Bodens, des Wassers und der Luft findet statt, dadurch dass die Biomasse prioritär verarbeitet und umgewandelt wird (sauberes, geruchloses, ungiftiges, unveränderbares Granulat); die Müllhalden können abgeschafft werden.
Durch die Anwendung der ecoHORNET Verbrennungstechnologie, werden die Biomasse-Pellets zu einer effizienten, wirtschaftlichen und ökologischen Energiequelle, die uns, aber insbesondere der nächsten Generation, viele Sorgen erspart, da es sehr wichtig werden wird, wieviel wir verschmutzen und es sehr teuer werden wird, überhaupt zu verschmutzen. Heute haben wir einen Knotenpunkt im Kampf gegen die Natur erreicht.. Wir müssen eine richtig neue Lebensart erreichen, die auf regenerierbaren und verschiedenartigen Energiequellen beruht. Wir wollen die Idee akzeptieren, „unsere heutigen Bedürfnisse zu stillen ohne den folgenden Generationen die Möglichkeit zu rauben, ihre eigenen Bedürfnisse zu stillen."

R2E - Neue Geschäftsmodelle: Rauchgasreinigung und Energierückgewinnung aus Rauchgasen

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Die hocheffizienten SaveEnergy- Abgaskondensatoren, welche oft mit den SaveEnergy-Nasselektroabscheidern kombiniert werden, bilden das Fundament eines europaweiten Erfolgs und der Technologieführerschaft in diesem Bereich. Dies führt zu jährlichen Brennstoffeinsparungen von 20-30% je Anlage. Von den Einsparungen profitieren die Betreiber, wie auch die Umwelt gleichermaßen. Auf dieser technologischen Basis wurden nunmehr neue Geschäftsmodelle entwickelt.

Die Ausgangssituation ist gekennzeichnet durch die Tatsache, dass die meisten Heizwerke bzw. KWK-Anlagen das Rauchgas praktisch gar nicht nutzen, somit wertvolle Energie beim Rauchfang in die Umwelt entweicht. Neben dieser betriebswirtschaftlichen Verschwendung fordern gesetzliche Bestimmungen wie die FAV und das Energieeffizienzgesetz generell immer mehr Effizienz ein.

Um den Einstieg in diese Technologie am Markt leichter zugänglich zu machen, wird ab Anfang des Jahres 2017 die R2E GmbH Contractingmodelle anbieten. Als Standardmodell bietet die R2E Anlagen der Rauchgasreinigung und Energierückgewinnung aus Rauchgasen für „jedes“ Heizwerk und KWK-Anlage an, womit sich folgende Vorteile ergeben: a. keine Anschaffungskosten; b. saubere Abgase; c. Amortisation durch Energieverkauf; d. Abschichtungsmodelle.

Der Ablauf ist denkbar einfach: mittels zweier Quickchecks werden die technischen Daten eines Heiz(kraft)werks ausgewertet und die technische Eignung für die Energierückgewinnung festgestellt. Sind diese Werte passend, kann sofort mit der Planung und der Realisierung begonnen werden.
Anhand eines Beispiels aus Österreich wird der Prozess und die einzelnen Schritte dargestellt und ergänzend ein Überblick über Referenzprojekte in EU gegeben.

Batch fired straw boilers – Introduction of modern control systems

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Straw is troublesome type of fuel. It fluffy as well as inhomogeneous structure provokes several problems, mainly connected with handling, storage and feeding to the boiler. Low bulk density combined with diminished LHV, in comparison to coal, makes this fuel impractical for power plants to use. What is also important straw is absorbing water, and should be stored in covered deposits.

As most of biomass fuels, more than 70% combustive components is in form volatile matter. Such property leads to more complex constructions of boilers, mainly in air distribution, which is crucial to obtain low emission of carbon monoxide and other compounds formed during incomplete combustion. On the other hand, straw contains alkali and chlorine compounds which affects softening and melting temperatures of ash, what could promote corrosion problems, in high temperature sections of the boiler. That may also cause slagging on grate or other low temperature surfaces. Straw delivered to plants must fit certain requirements to reduce operational risks, and be treated as stable energy source. Low moisture content, stable LHV for delivered material, are quite rigid parameters for normally obtained straw. This restrictions are not applied for small and medium scale farms, what causes surplus of straw which may be used for energetic purposes. That's why in such places such leftover could be utilized by using simple and low-cost boilers. In Poland we observe increase in utilization of straw in batch fired boilers. Heat produced in such installations is used in households, or in energy demanding processes such as grain drying. This method is either ecological or economically friendly for farmers. Nowadays we observe demands for clean combustion technologies of all types of fuels, especially for renewables like straw.

Combustion in batch fired boilers is quite simple process, but it is connected with several inconveniences. First of all is high emission of carbon monoxide, which in many cases is far more than limits presented in EN-303-5 :2012 norm. Also there is problem with PM emission but this problem can be solved by installing dedusting units. The last very crucial factor is boiler efficiency. In such devices efficiency is normally below 80%, which is not sufficient in comparison to nowadays standards.
Paper presents results of research made on 100kWth batch fired boiler fuelled with straw bales. Studies were taken on the test stand in Oława, Poland. First of all preliminary tests were made to determine main control process parameters, which can cause high emission and low efficiency. In the next step improvements were proposed, connected mainly with air distribution and control algorithms. At last part, validation tests were made according to EN-303-5 norm, to estimate performance and emission factors of boiler with improved control system. Presented results shows that it is possible to improve performance as well as decrease emission by means of air distribution and control algorithms in straw fired boilers.

Artemisia Dubia Wall. For availability of sustainable biomass

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The development of a sustainable bio-economy leads to significant increases in demand for biomass and enhances the importance of renewable resources. Resources efficient use is closely related to the exploited technologies and conditions. The properly selected biomass types, technologies of their management can be cost-effective, reliable and can contribute to the quality improvement in the areas they serve for. It is important to have as many non-food plants that could be suitable, efficient producers of biomass and therefore it is essential to explore new crops, one of which is *Artemisia dubia* Wall. It is important to find out the potential of biomass, the qualitative utility, energy efficiency and other important economic and environmental issues and propose a technology for their use. The objective of the study is to investigate biomass potential of the *A.dubia* and the feasibility of biomass quality traits for thermochemical conversion. The investigation encompass the factors of the processes involved in the biomass cultivation, harvesting, and preparation for conversion, seeking to reduce environmental impact and to generate the maximum energy value.

Field and laboratory experiments were carried out in Central Lithuania (55°23′50″ N, 23°51′40″ E) at the Institute of Agriculture, Lithuanian Research Centre for Agriculture. *A.dubia* was grown on an *Endocalcari-Epihypogleyic Cambisol* (*CMg-p-wcan*). The study was conducted in two successive years, 2014 and 2015.

One of the major indicators determining economic benefit of biomass used for energy purpose is the above-ground plant biomass yield. The biomass of *A.dubia* was found to have the high DM content, which depending on the fertilization and it increasing biomass yield. It is noteworthy that the biomass of *A.dubia* was characterised by a better chemical composition for combustion as some of others perennial harbaceous plants. It is important that the biomass of *A.dubia* exhibited a relatively small ash content, which is an advantage when burning the biomass, since one can expect a higher calorific value. The values of important elements for combustion properties as carbon and sulphur in the biomass with or without N-fertilizers varied little. The preliminary average calorific value of the above-ground biomass of *A.dubia* was determined to be 18.60±0.38 MJ from 1 kg dry mass. Depending on the morphological plant part and fertilization technology used, the average calorific value for stems and for leaves varied. The stems of *A. dubia* are characterised by a smaller ash content and by the least dependence on the nitrogen fertilization intensity. Further research is needed to get more valid and reliable conclusions concerning biomass potential, chemical composition and suitability for combustion.

Economic and social impacts of biofuel and Omega-3 fatty acid production from microalgae

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Introduction
Microalgae are currently considered to be highly attractive as a raw material for production of bioenergy and biomaterials in the future BioEconomy. Algae are very diverse organisms and can be used for various possibilities for biofuel production e.g. hydrotreated vegetable oil (HVO), biomethane, bioethanol and value added products e.g., nutrients, biochemicals, biomaterials. Within the European project "FUEL4ME" an integrated and sustainable process for the continuous biofuel production from microalgae is developed and demonstrated at four different sites in Italy, Spain, the Netherlands and Israel. FUEL4ME aims to develop a process to produce large volumes of hydrotreated vegetable oil (HVO) as transportation biofuel as a competitive alternative to fossil fuels while coproducing high value Omega-3 fatty acid.
The project FUEL4ME applies a life cycle sustainability assessment (LCSA) providing scientific indicators for economic, environmental and social aspects of this new value chain and guides the development of the FUEL4ME process to realize the highest possible sustainability in comparison to a substituted reference system (fossil fuel and Omega-3 fatty acid from other sources).

Approach
Macro-economic impacts on 100kt/a of HVO production plant have been modeled by an economic Input-Output (IO)-Analysis. The strength of this approach is to depict sectoral relations and dependencies in detail. The major database for the IO-analysis is a Social Accounting Matrix (SAM). It depicts beside economic interrelationships of 65 economic sectors also information about value added, output value, type of use of goods (final use, export, import) etc. in the reference case. The used SAM shows data for EU27. Economic impacts not displayed on markets (so-called "external economic impacts") have been considered qualitatively; also market and political aspects of HVO and Omega-3 fatty acid production have been included.
Social impacts of the new technology are determined by a number of factors, mainly personal behavior, general moral values, interactions of different groups with their environment, political circumstances. Social indicators have a strongly regional character and besides that, differ from case to case. The aspects assessed in a social-LCA are those that are (in)directly affecting stakeholders.

Results
The new algal-based value chain will have positive external economic impacts due to a reduction of GHG emissions (> 60%) and improved energy supply security due to additional European biomass production. Also, demand for high-grade Omega-3 fatty acids as well as their price is steadily increasing whereas HVO depends on the highly volatile global mineral oil market. The production process should therefore be Omega-3 fatty acid-intensive as far as technically possible.
The production of 100 kt/a HVO and a respective quantity of Omega-3 fatty acids by this new algal based value chain results in approx. € 100 mio./a of economic value added Europe-wide as well as in additional or secured 2000 jobs/a at assumed production costs of € 1000/t HVO. Considering also effects from financing potential excess costs of HVO over fossil diesel and substitution effects the need for cost parity of HVO with fossil diesel appears clearly in order to fully exploit positive macro-economic impacts. Before cost parity is achieved negative impacts especially in economic value added may appear. For stimulating technological progress and learning effects the legislative frame needs to be more stable and long-term for making investments in this technology attractive.
Social impacts have been analyzed according to a checklist for different stakeholder categories (e.g. workers, local communities, society), different subcategories (e.g. health and safety, working conditions, equal opportunities) and related indicators relevant for biofuel production from algae. Thus, it is possible to identify social "hot spots" and the options for reducing the potential negative impacts and risks through different measures. Some of the most crucial social factors concerning the installation of a large algae cultivation system are anchored in the categories local community and society, like the engagement with local citizens, local employment and transparency to foster the acceptance of the new technology.

Effizienzsteigerung bei neuen oder bestehenden Biomasseanlagen durch Nachrüstung mittels “Power Pack“ zur Wärme- und Stromerzeugung

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Ausgangssituation:

In der gesamten Energieerzeugung, egal ob Wärme oder Elektrizität, stehen höchste Wirkungsgrade im starken Gegensatz zu den Energiebedarfsschwankungen. Tatsache ist, dass bei der Wärmeproduktion mittels Biomasse bestimmte Werte der thermischen Masse/Trägheit erreicht werden müssen aber jedoch gleichzeitig immer eine Verzögerung zwischen einem Lastwechsel und der Ausbeute in der Wärmeproduktion besteht.

Diese Auswirkung wird normalerweise noch verstärkt, wenn man den Kessel bei sehr niedriger Teillast betreibt, die sehr weit unterhalb der Kessel-Nennlast ist. Für diesen Fall ist die Dimensionierung des Wärmetauschers nicht ausgelegt bzw. vorgesehen.Üblicherweise finden in Biomassegroßkesseln Verbrennungskammern mit darüberliegenden horizontalen Röhrenwärmetauschern Anwendung. Die Größe der Wärmetauscher ist in den meisten Fällen an den Abmessungen der Brennkammer gebunden und daher oft limitiert. In den meisten Fällen wird der Wärmetauscher als 2-Zug Wärmetauscher ausgeführt.Ein 2-Zug Wärmetauscher wird dementsprechend dimensioniert, um eine kontinuierliche Rauchgasgeschwindigkeit zu haben und in Folge sich nur geringe Staubablagerungen im Wärmetauscher bilden.

Als Schlussfolgerung der Wärmeübergangsberechnung ergibt sich im ersten Zug des Wärmetauschers ein Wärmeübergang von 70-80 %, wobei im zweiten Teil des Wärmetauschers lediglich 20-25% abgegeben wird.
Der Grund dafür ist die hohe logarithmische Temperaturdifferenz (DELTA T) zwischen Abgas und Kesselwasser.

Diese Art der Anwendung trägt daher Gefahr, Kondensat im letzten Bereich des zweiten Zuges im Wärmetauscher zu bilden. Zusammengefasst bedeutet dies, dass im Teillastbetrieb eine Einschränkung besteht, da die Vermeidung von Kondensat im Wärmetauscher zu berücksichtigen ist. Dies hat eine Effizienzminderung zur Folge.

Die Neuentwicklung - das “Power Pack“

Das “Power Pack“ ist eine Entwicklung von HERZ / BINDER zur Optimierung der thermischen Leistung im niedrigen Teillastbetrieb (vor allem bei Fernwärmenetzen) und gleichzeitiger Stromproduktion, jedoch ohne überhitztes Wasser oder einen Dampfkreislauf. Das “Power Pack“ kann für jedes bestehende sowie neue Biomassekesselsystem verwendet werden, sofern ein horizontaler 2-Zug Wärmetauscher vorhanden ist. Das “Power Pack“ ist eine vormontierte Einheit, welche zwischen dem ersten und dem zweiten Zug des Wärmetauschers montiert wird und somit den natürlichen Weg der Heißgase verlängert. Diese Einheit ist ähnlich wie ein Blechkanal ausgeführt und verbindet automatisch den Ersten mit dem Zweiten Zug. Gerade bei Anlagen im Fernwärmebereich arbeitet der Kessel überwiegend im Teillastbetrieb.
Durch die Nachrüstung bzw. Verwendung dieser Entwicklung wird die Gesamteffizienz der Anlage gesteigert, da auch im Teillastbetrieb Strom produziert wird. Durch das “Power Pack“ wird eine bestehende Anlage mit einer Wärmeleistung von mehr als 800 kW so umgebaut, dass man mit dieser etwa 100 kW Strom zusätzlich produzieren kann. Durch das “Power Pack“ wird das Teillastverhalten der Anlage optimiert. Voraussetzung für eine wirtschaftliche Lösung ist eine Mindestabnahme von etwa 400 kW für mehr als 5000 Stunden / Jahr.

Clean Air by Biomass

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In the past decades research and development for biomass combustion heating systems focused on different possibilities for emission reduction and efficiency improvement. The impact and effectiveness of several primary (i.e. air staging, appropriate combustion chamber design, optimization of control system and user behavior) and secondary (i.e. electrostatic precipitators, catalysts, filters) measures were investigated and demonstrated successfully under lab testing conditions.

The *CleanAir by biomass* program aims at the investigation and demonstration of effectiveness of implemented primary and secondary measures under real-life operating conditions. Therefore a region in Styria (Austria) was chosen where several measures for optimization of biomass combustion quality are implemented. The effects of optimization measures are monitored and evaluated by field measurements as well as by pollution measurements over a duration of three years.

The program aims to prove and to demonstrate that the use of state-of-the-art technology combined with best-practice application lead to a significant improvement of air quality as well as to comply with European air quality regulations even in critical areas.

Four different categories of measures for emission reduction are implemented. These are (1) the replacement of old combustion technologies with state of the art technologies (stoves and boilers), (2) installation of secondary emission abatement technologies (SEAT), (3) improvement of the end-user´s behaviour by external training arrangements and educational advertising and (4) optimization of the central heating systems by optimization of control systems as well as the overall hydronic systems. Before replacing stoves and boilers and the installing of SEATs, all technologies are tested under lab testing conditions according to test procedures reflecting real life operation. Based on these results the selection of technologies for field application is carried out.

As model region Vorau, a village in Styria in Austria, was selected. Vorau is located in a basin which guarantees that primarily regionally emitted pollutants are respected, especially in the winter time at inversion conditions.

The effect of the emission reduction measures are monitored and evaluated with two parallel concepts: (1) Measurements and assessment of the air quality in the model region by air pollution monitoring (2) emission measurements and monitoring of combustion devices respectively before and after measure implementation in the field.

Based on this integrated approach the effectiveness of state-of-the-art biomass combustion technologies is demonstrated not only theoretically but especially in real-life operation.
The results will represent an example of possibilities of environmental friendly and sustainable use of biomass for residential heat supply. Further a basis for policy-makers is provided in order to force technological development towards better real-life performance and to support effective measures that guarantee significant improvement of air quality.

Scenarios for Short Rotation Woody Crops (SRC) in Croatia

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In 2011, technical potential of SRC for Croatia has been estimated as much as 60 PJ with focusing 83% of SRC cultivation at 235,650 ha of agricultural areas with moderately suitable soils and limited soil suitability. By now, that potential remains idle and bounded to experimental and research activities (e.g. clones productivity, agricultural practices and breeding). With inclusion of Croatian agriculture sector under the umbrella of the Common Agriculture Policy, the issue of SRC gained the spotlight as an eligible land use option for direct subsidies in agriculture and IACS measures for rural development.

In 2015, SRC was attributed a code within the system for identification of land parcels (ARKOD) and working group for Law on SRC has been established. Simultaneously, IEE SRCplus project commenced and provided support in capacity building, raising awareness on ecosystem services from SRC and dialogue between stakeholders. The project has identified a list of non-technical barriers for implementing SRC in Croatia where the two most important are: confusion with traditional cultivation of poplars and willows in forestry which hampers the dialogue between foresters and agronomists followed by legal framework still pending.

The main issue is the type of land suitable for SRC plantations which has a direct impact on economic feasibility. On the other hand, the project has recorded an emerging market in the targeted areas by establishing a dialogue among different stakeholders. SRC is positively greeted as a potential contributor to local development, employment and provision of ecosystem services. Wood processing industry has clearly stressed out its demand for SRC which represents a nucleus of development locally tailored SRC supply chains. The uncertainty in profitability of SRC remains a major issue that hinders the stakeholder's engagement in this type of activity. It has been estimated that establishment of a SRC plantation in Croatia would range 2,500 – 2,700 €/ha, excluding costs for site preparation. In addition, SRC in agroforestry seems to be an economically attractive option for Croatian farmers.

This paper gives an overview of technical and non-technical barriers for SRC production identified within the IEE project SRCplus, including economic factors influencing SRC growing with suggestions how to overcome the barriers and improve economic feasibility of planting SRC in Croatia.
Key words: SRC, Croatia, biomass, plantation

Decentralized Operation of Bi-directional Heat Grids: Aspects of Control Strategies

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Within a region accessed by a heat grid, there often exist small to medium-sized private or commercial heat producers with considerable (over-)capacities. These producers could provide a considerable amount of renewable heat to the grid. Possible sources encompass solar thermal plants, biomass boilers, waste heat from industrial or commercial processes and even heat from wastewater.
Buildings with capacities to generate heat often also have a considerable heat demand. Actors which, depending on the current situation, either receive heat from the grid or can provide it, are referred to as *prosumers* (producer/consumers). In the future, decentralized prosumers may become an essential element of heat supply. In particular, they can replace peak-load boilers in winter and even enable the central heating plant to be switched off completely in the summer. This will allow largely avoiding the unfavorable partial load operation mode of the main boiler.
However, the actual implementation of this approach faces considerable challenges. Three main topics can be identified:

- **Plant technology**: Renewable heat is often available only at a low temperature level, which requires the use of heat pumps. For hydraulic integration different options exist, from which the most suitable one must be selected depending on the specific situation.
- **Control strategy**: On the one hand, the prosumers must be able to feed in heat at positions under given hydraulic conditions, while at the same time keeping these conditions stable. On the other hand, a superordinate control strategy must ensure that the required heat is available at all times and that it is also generated in the most reasonable way.
- **Business model and legal aspects**: In order to be able to feed in, some investments are necessary (especially in the pump, the control unit and additional hydraulic connections). Business models are necessary which allow amortization of these investments and which are attractive enough for the feed-in option to be used. In addition, legal framework conditions must be found which guarantee a secure supply based on many small feeders.

This poster, accompanied by a workshop talk, presents control aspects of this integration, both in terms of subordinate and superordinate control:

- **Subordinate Control**: Standard control strategies for heat feed-in into grids have a set value either for the differential pressure or for the heat flux. Both strategies work well for a single producer, but can become problematic in the case of several producers. The first strategy can lead to oscillations of the differential pressure, the second one to a global drift of the pressure level. Both effects are unwanted, possibly leading to unreliable operation, strain on material and increased consumption of electric energy. These effects result mainly from the naïve uncoordinated use of simple linear controllers (e.g. PID controllers).
  In addition, the most common technique for controlling heat grids, i.e. the identification of the “weakest point” in the grid and using measurements at that point as a main input for the control unit, cannot be applied to bidirectional heat grids in a straightforward way, since the position of the “weakest point” strongly depends on the current operation mode.
- **Superordinate Control**: A main requirement for the operation of heat grids is that the heat demand is met at all times. Heat storage devices (from small buffer tanks to seasonal storages) can be used as hydraulic gates, which allow to decouple, at least to some extent, heat production and heat consumption. Having several heat producers available makes it possible to adjust the production mode in such a way that the required heat is produced with lowest cost and/or minimal ecological impact. This is an optimization problem which can be treated in several ways (merit-order-style market model approaches, centrally communicated prices, global optimization). Here we focus on a model-predictive global optimization strategy, based on a cost function which can include both economic costs and environmental impact.

Solares Heizwerk-Upgrade Eigenstromversorgung mit Photovoltaik

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Immer mehr Heizwerksbetreiber setzen zur Verbesserung der Gesamtenergiebilanz ihrer Heizwerke auf die Kraft der Sonne. Klimaschonendes und effizientes Heizen bezieht die regionale und erneuerbare Stromversorgung des Heizwerksbetriebes mit ein. Einige Photovoltaik-Anlagen zieren bereits die Dächer und Fassaden von Biomasse-Heizwerken. Doch welchen Nutzen bringt die Photovoltaik-Anlage am Heizwerk?

Sonnenstrom für Heizwerke
Auf den ersten Blick scheint die Eigenstromversorgung aus Photovoltaik wenig sinnvoll. Immerhin produziert die Photovoltaik-Anlage gut 50 Prozent des Jahresstromertrages außerhalb der Heizperiode. Jedoch wird auch im Sommerbetrieb, für die Versorgung der Umwälzpumpen sowie der Heiztechnik, elektrischer Strom benötigt. Das Stromlastprofil des Biomasse-Heizwerks Fernitz zeigt, dass der Grundlastbedarf eines ein Megawatt Heizkessels auch außerhalb der Heizperiode zwischen drei und vier Kilowatt liegt. Dieser Strombedarf ist durch eine Photovoltaik-Anlage gut abdeckbar. Mit der Installation einer acht Kilowatt Peak Photovoltaik-Anlage werden, bei einem Eigenversorgungsgrad von 80 Prozent, rund 6.400 Kilowattstunden Strom direkt für die elektrische Versorgung des Heizwerkes genutzt. Ergibt, bei einem Jahresstrombedarf von 40.000 Kilowattstunden, einen Autarkiegrad von 16 Prozent und jährlichen Kosteneinsparungen von Euro 650.

Preise für Photovoltaik-Anlagen stark reduziert
Die Preise für Photovoltaik-Anlagen sind innerhalb weniger Jahr von Euro 5.000 auf Euro 1.500 pro Kilowatt Peak ins bodenlose gefallen. Das entspricht einer Preisreduktion von 70 Prozent. Die Stromerzeugungskosten (Vollkosten) einer Photovoltaik-Anlage liegen derzeit zwischen acht und zehn Cent je Kilowattstunde und damit deutlich unter den Strombezugskosten von 17 Cent je Kilowattstunde. Bei entsprechender Eigenstromnutzung amortisiert sich die Photovoltaik-Anlage auch ohne Förderung. Die Einspeisung in das öffentliche Netz rechnet sich momentan nicht. Der Strommarktpreis liegt bei 2,5 Cent je Kilowattstunde.
In naher Zukunft kann durch die Reduktion der Speicherkosten der solare Autarkiegrad weiter erhöht werden. Der Markt für Solarstromspeicher wächst rasant und die Technologien entwickeln sich weiter. Die Preiseentwicklung für Solarstromspeicher folgt einer ähnlichen Preisekurve wie der Photovoltaik. Die Verdoppelung der produzierten Kapazitäten führt bei Lithium-Ionen Speicher zu einer Preisreduktion von 18 Prozent.

Perspektiven für die solare Stromerzeugung am Heizwerk
Die solare Eigenstromversorgung stärkt das Image der Biomasse-Nahwärmeversorgung beim Wärmkunden, verbessert die Gesamtenergiebilanz des Heizwerkes und führt letzten Endes zu Kosteneinsparungen im Heizwerksbetrieb. Die dafür notwendigen Dach- und Fassadenflächen sind jedenfalls vorhanden. Die solare Eigenstromproduktion eignet sich jedoch nur für Heizwerke mit Sommerbetrieb und ist nicht als Ersatzmaßnahme zu Energieeffizienzmaßnahmen gedacht. Die Umsetzung möglicher Stromsparmaßnahmen hat jedenfalls vor der Montage der Photovoltaik-Anlage zu erfolgen.

An investigation on the behaviour of nitrogen based impurities over a water gas shift stage and a biodiesel scrubber

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Hydrogen plays a major role in chemical industries. Refineries have huge demand on hydrogen for their hydro processing stages, which is mainly based on fossil fuel. To fulfil EU aims, an alternative way of hydrogen production was investigated.

Between 2012 and 2015 a pilot plant for hydrogen production out of lignocellulosic feedstock was installed on the side of a commercial fluidised bed gasifier in Güssing, Austria (CHP). The function of the plant was proven and first experimental results could be obtained.

Now optimisation processes are ongoing focussing, on the optimization of the plant for lower feedstock quality, which results in lower operation costs. In this work, the behaviour of nitrogen based impurities over a water gas shift (WGS) stage and a biodiesel scrubber used together as a gas treatment stage for a hydrogen production plant based on biomass gasification were investigated. Raw gas is extracted from the CHP after a dust removal. At the gas outtake temperatures of 150 °C are common. A Fe/Cr based water gas shift catalyst was used. To investigate the behaviour of impurities, extensive chemical analyses were carried out. The activity of the Fe/Cr catalyst was determined, by measuring the CO concentration in the tail gas. Also the performance of the biodiesel scrubber was observed and samples of biodiesel were taken.

A stable CO conversion over several days could be detected. Also a hydration of HCN could be observed over the water gas shift stage. An ammonia reduction could be measured over the whole gas treatment stage. Results show, that the gas treatment stage is able to remove nitrogen based process poisons, which are problematically for a hydrogen production plant.

Beside hydrogen production the gas treatment setup seems also to be a promising application to adjust the CO to H_2 ratio and clean gas for synthesis gas applications like methanation, Fischer Tropsch synthesis, dimethyl ether synthesis and mixed alcohols production.

Keywords: hydrogen, gas cleaning, gas treatment, impurities, ammonia, hydrochloric acid

Field testing devices for flue gas emission measurement of wood boilers - a comparison of chimney sweeper devices

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Purpose. Solid biomass combustion systems may cause particle emission and lead to air pollution. Therefore within the German 1st Federal Immission Control Ordinance (BImSchV) the particle emissions were further restricted to values below 0,02 g/Nm^3 (13% O_2) in 2015. During the field inspections by the chimney sweepers this limiting value may not be achieved, but this may not only be related to the fuel quality or to the furnace operation. The selection and accuracy of the measurement device itself can have an impact, too. Depending on the properties of the particles the different chimney sweeper devices may detect different particle concentrations in the flue gas. Therefore, four different chimney sweeper devices were operated in parallel and validated to the reference method VDI 2066 using a wood chip boiler.

Approach. Four chimney sweeper devices (Wöhler SM 96, Wöhler SM 500, testo 380 and Afriso STM 225) were purchased and used in parallel on a wood chip boiler. The reference method was in accordance to VDI 2066 while determining the particle emission simultaneously at a position before and behind the chimney sweeper devices. A broad range of particle emission concentrations was generated by using different qualities of wood chips. The boiler was mainly operated at full load, but in order to achieve higher concentrations of OGC also partial load operation was applied. In total up to eight different wood chip qualities and several wood pellet types were selected to create the desired wide range of gaseous emissions and particle concentrations in the flue gas.

Results.
The data are currently evaluated and the results shall be presented at the conference.

Quality assessment of wood pellets for residential heating systems and combustion behavior in a pellet stove

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Purpose. Wood pellets are widely used in pellet stoves and pellet boilers all over Europe. A high proportion of the pellets sold on the market are already labelled with EN_{plus} but a pellet screening which was recently conducted in Slovenia has proven low quality pellets. Another interesting issue is the chemical composition of pellets since this also influences the emission behaviour of pellets during combustion. One of the main contributors to particulate matter emissions is the aerosol forming element potassium (K) which is not limited in any pellet standard or quality label. Therefore, a high quality pellet stove may not meet the national regulations on particulate matter emission if potassium content is too high. This was one of the reasons for performing the pellet screening considering 42 different pellet samples collected on the European market. Twelve of these pellet samples were finally selected for the combustion tests in a conventional pellet stove.

Approach. For the present study 42 pellet samples in bags were collected from the European market with the main focus on the German market (20 samples). All pellet samples were extensively investigated including combustion properties, physical properties as well as their chemical composition. All values were compared to DIN ISO EN 17225-2. After the characterisation of all pellet samples twelve pellet assortments (all marked with the ENplus label) were selected for combustion tests in a pellet stove with a nominal heat output of 8 kW. Finally the emission behaviour of twelve pellet samples are shown and discussed.

Results and Conclusion. All pellet samples had a low ash content of below 0.52 w-% except for one sample indicating that there were no impurities in the pellets. Most of the other parameters were in accordance to the given standards. The sum of the aerosol forming elements varied between 476 and 1,128 mg/kg (dry fuel) which may be an indicator for particle emission.
The combustion of the twelve selected pellet assortments in a pellet stove leads to highly variable particle and carbon monoxide emissions, e.g. the measured PM-concentration ranged from 45 to 202 mg/Nm³ But no correlation between selected parameters - such as potassium or ash content or pellet durability – could be found in a multiple regression analysis. Pellet stoves seem to be more sensitive towards fuel changes compared to pellet boilers. Furthermore, it appears that the list of parameters as used in existing pellet fuel standards for describing fuel quality does not provide sufficient information about combustion behaviour in such appliances.

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The overall economic impact of biogas in Austria

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About 300 biogas plants in Austria produce energy and services of 125 mio. EUR in the year 2013. The present study aims at a detailed analysis of the production and capital formation activities of the biogas sector and their impacts on the national economy, applying input-output models (IO). For the analysis of the effects of production of biogas we develop an extended version of the mixed IO model that allows the consistent integration of detailed information on the structure of value added and intermediate inputs of biogas production. The effects of the capital formation of the sector are calculated by the classical Leontief model. The analysis is based mainly on data provided by the ARGE Kompost und Biogas, an organisation that comprises about two thirds of all biogas plant operators in Austria. Further statistical information considered comes, among others, from the energy balances, the green electricity statistics, the electricity statistics and the IO-tables. Apart from an ex-post analysis of the years 2002-2014 we also analyse the probable impact according to a plausible scenario of a renewed expansion of the biogas sector in 2016-2027.

Productivity development of renewable energy plants: An empirical study of the Austrian biogas sector

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Triggered by the first nation-wide Green Electricity Act in 2002, the number of plants and the installed capacity increased between 2002 and 2007. In 2007, the prices of the main inputs rose massively and the maintenance costs turned out to be higher than expected. The electricity generation costs from biogas exceed the prescribed feed-in tariffs. In addition, the amendment of the Green Electricity Act led to a worsening in the conditions which led the entire green energy industry in Austria to a halt. These developments brought many Austrian biogas plants in a difficult economic situation. Against this background, this empirical study investigates productivity change in the Austria biogas sector from 2006 to 2014. A Malmquist productivity index based on technical efficiency estimated by Data Envelopment Analysis is applied on a representative sample of 57 biogas plants covering about one quarter of the installed capacity in Austria. Productivity change is decomposed into efficiency change and technical change. Efficiency change is, in turn, broken up into pure technical efficiency change (catching-up) and scale efficiency change. Technical change is split up into pure technical change and change in scale of technology. The main results are: i) productivity increased by around 8 % on average with remarkable differences between least and best performers, ii) productivity change is mainly driven by pure technical efficiency change of approximately 5% and scale change factor of about 3 % on average, iii) almost zero pure technical change can be found.

BIOEUPARKS - Developing an efficient and sustainable biomass supply chain in 5 European Nature Parks

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Zehn Partner aus sechs europäischen Ländern haben sich im Projekt BIOEUPARKS die Steigerung des Anteils regionaler Biomasse in Schutzgebieten der EU zum Ziel gesetzt. Praktisch umgesetzt wurde das Projekt in Parks von fünf Projektpartnern. Durch die Nutzung regionaler Biomasse konnten mit dem Projekt BIOEUPARKS 33.000 t CO2 eingespart werden.
Das Projekt BIOEUPARKS im Programm Intelligent Energy Europe (IEE) hat dazu beitragen, den Anteil lokaler Biomasse aus nachhaltig bewirtschafteten Wäldern sowie landwirtschaftlichen Reststoffen zu erhöhen. Durch das Projekt konnten effiziente und nachhaltige Versorgungsketten in fünf europäischen Natur- und Nationalparks (IUCN Kategorie V) etabliert werden.
Auf die Einbindung der Bevölkerung und wichtiger Stakeholdern wurde im Projekt BIOEUPARKS großer Wert gelegt. Dadurch wurde einerseits Bewusstsein für die Verwendung regionaler Biomasse geschaffen und andererseits konnten mögliche Konflikte weitgehend vermieden werden.
Die Projektergebnisse wurden erstmals im März 2016 im Ausschuss der Regionen in Brüssel bei einer internationalen Konferenz unter dem Titel „Biomasse in Europäischen Schutzgebieten“ präsentiert. Insgesamt wurden in den fünf teilnehmenden Natur- und Nationalparks in der Projektlaufzeit von April 2014 bis März 2016 40.000 t regionale Biomasse mobilisiert und 100.000 MW thermische Energie erzeugt.
Der Naturpark Sölktäler war der einzige Österreichische Partner im Projekt BIOEUPARKS. Der Naturpark mit 1.600 Einwohner und einer Fläche von 28.800ha liegt in der Obersteiermark. 2/3 der Naturparkfläche gehören zum Natura 2000 Gebiet Niedere Tauern, dem größten Natura 2000 Gebiet der Steiermark. Forstwirtschaft und die Nutzung der Biomasse haben in den Sölktälern eine lange Tradition.
Durch die Umsetzung des Projekts BIOEUPARKS ist es im Naturpark Sölktäler gelungen, den Anteil regionaler Biomasse um 36% zu steigern. Bewusstseinsbildende Maßnahmen und intensive Gespräche führten letztendlich zu einer vertraglichen Verpflichtung der Betreiber der Biomasseheizwerke, ausschließlich regionale Biomasse zu verwenden. Die vier Biomasseheizwerke in den Sölktälern werden nun zu 100% mit regionaler Biomasse versorgt.

Projektpartner
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Experimental study of fouling issues in a biomass pellet driven Stirling engine

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Introductive Summary: Micro-cogeneration units for domestic application receive a broad attention, not only in the scientific community, but also in the industrial sector and politics. The EU directive 2004/8/EC emphasizes the importance of CHP (combined heat and power) systems based on a useful heat demand in the internal energy market [1]. Thanks to its efficiency and fuel flexibility, the Stirling engine is one of the most promising technologies for applications below 50 kW_{el}. However, biomass fuelled Stirling engines require combustion gases with low dust loads and high temperatures. At present these requirements remain the major challenges which obstacle a highly efficient and economic long-term operation.
This study focuses on fouling issues of a 5 kW_{el} Stirling engine fully embedded in a biomass pellet burner. The burner has a nominal heat output of 30 kW_{th} and the aspired as well as achieved electrical system efficiency is 15%. Particle matters in the combustion gas have to be avoided as they deposit on the heat exchanger decreasing the heat transfer rate and subsequently the efficiency. The methodical approach to bring the dust load under control contains the following main pillars: staged combustion, additional primary and secondary measures for emission reduction, optimised heat exchanger design, novel combustion control and automatic cleaning concept.
Approach: Within the project “StirBio” two test facilities with different Stirling heat exchanger designs have been developed and investigated. Both heat exchangers have a cylindrical symmetry but differ in their gas path (radial and axial flow direction). In case of the radial guidance, the heat exchanger design is characterized by many short flow channels with small cross sections, similar to a mesh. The small flow openings are highly sensitive to deposits, in contrast to the second design, which forms an annular flow gap. For the axial design an automatic cleaning concept based on pressurized air or steam burst was developed and applied for a patent (german patent application 10 2015 120 801.6) by Frauscher Thermal Motors GmbH.
Both prototypes were based on a staged combustion, in order to maximize the temperature and minimize the dust load of the combustion gas. Further primary measures under investigation were optimizing turbulence and residence time by varying the swirl of secondary air injection as well as minimizing the primary air velocity to avoid emissions from the firebed. Potential secondary measures were discussed, especially the integration of an uniflow cyclone. The prototype design and the assessment of appropriate primary and secondary measures for emission reduction were supported by CFD-simulations carried out by the TU Wien.
Results and conclusions: Quantitative and qualitative analyses of the deposits collected from the Stirling heat exchanger show a deposition rate of 3-4 g within 4 h for the radial gas guidance and <1 g/4 h for the axial one. Therefore and by observing the increase in pressure drop across the heat exchanger with operation time, the “axial” design was proven to be long term stable. The deposits do not stick to the heat exchanger and can be removed with a brush or pressurized air easily.
According to the elementary analysis the portion of organic carbon is <0.1 wt% which confirms complete combustion. The grain size distribution shows that less than 35 % of the deposited particles are <100 µm. Nevertheless, an automatic cleaning facility has to be implemented to ensure a permanent high efficiency.
Acknowledgment: The project was funded by the Austrian Climate and Energy Fund in the framework of the research program “e!MISSION” managed by the Austrian Research Promotion Agency.

[1] Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and amending Directive 92/42/EEC; February 2004.

A Concept for Integrating Biomass Processing Technologies for the Reengineering of a District Heating Plant

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In most of the ex-socialist countries there were developed extensive networks of district heating systems. In the process of implementation of the market economy principles, there were many situations when the existing systems have not been able to be maintained in use.

There are many factors that have influenced such a process from the dramatic shift of the local economies to the ageing process with consequence on the change of the profile of the heat demand curves both in terms of daily demand profiles and seasonal demand profiles.

In the paper, there are analyzed in details the factors and the specific context and the impact on the profiles of the heat demand curves. A specific case study is provided.

The legal framework that facilitates the use of biomass as a fuel is analyzed and there are presented the specific advantages. Also, there are evaluated the implications on the local economies and the environmental impact. The method that is used is following the methodology of ecosystem services with an emphasis on sustainable supply of biomass.

The requirements in terms of quantities and qualities of heat that has to be supplied by the thermal district heating plant are leading to several technology alternatives. For the evaluation of the impact of requirements on the possible technologies that might be used, it has been used the Value Analysis approach based on FAST methodology.

The specific match of biomass technologies it has been used an in-house platform for ecoinnovation called INNOvolution. As an outcome of the heuristic process there were identified 3 base technologies as biomass gasification, Combine Heat & Power supply using the wood gas and a classical biomass boiler.
The biomass gasification technologies that were analyzed were both partial air combustion and steam gasification.

The CHP technologies that have been taken into consideration were based on internal combustion systems, Molten Carbonate Fuel Cells and gas turbine.

Following the detailed analyses of the alternative technologies there were prepared the alternative options for Multi-Criteria Decision and finally it has been selected a mix of biomass gasification based on partial combustion with air, CHP using internal combustion engines and a classical biomass boiler.
The concept for the district heating thermal plant based on hybrid technologies has been modeled and optimized using energy and exergy models. As a case study it has been used the case of a plant located in Romania.

There were identified the secondary energy resources and the solutions for internal recovery of heat using optimization techniques for heat exchanger networks.
The environmental impact analysis has been conducted based on Extended Exergy Accounting methodology and the compliance with the environmental impact regulations in Romania.
The analysis has been also extended to economic analysis in terms of investments, operation costs and different scenario for return on investment.

Comparison of selected firelighters for stoves from renewable and fossil fuels in terms of gaseous emissions

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Introductive summary
In Austria, waste paper, e.g. from newspapers, is often used to ignite the fuel in room heating appliances. However, paper has an increased ash content (up to 30%) and may contribute, depending on the type of print, to the formation of critical emissions as for example heavy metals. Furthermore, paper combusts very fast and consequently a significant amount of paper is used for ignition. In Austria there are approximately one million stoves installed. If the emissions during the start-up phase can be reduced, a significant impact on the environment is expected. This study aims at comparison of the performance of commercially available solid firelighters and the widely used newspaper. According to DIN EN 13240, a solid firelighter is a solid substance which is easily ignited by an open flame and is suitable to start the combustion of solid fuels. In this study, the gaseous emissions CO, SO_2, NO_X and organic hydrocarbons (orgC) of solid firelighters were evaluated.

Purpose of the work
The present study aimed at the following objectives: (A) Identify emissions during ignition (B) investigate the ignition phase (C) demonstrate the differences between commercially available firelighters and newspaper. (D) facilitate the decision for a firelighter,

Approach
Two series of tests were carried out, which demonstrate the emissions of firelighters. In the first set of tests, seven selected firelighters were ignited in the combustion chamber of the so-called “Candle Burner”, without fuel. In comparison, printed newspaper and printed glossy paper, which is typically used for leaflets, were tested. With each firelighter, three test runs were performed. For the second series, three of the previously tested firelighters were selected and tested with fuel: Two types of firelighters made from the renewable raw material wood combined with wax, and a firelighter made of paraffin based on mineral oil. Again, the Candle Burner was used to test the capability of fuel ignition. The innovative combustion concept of the Candle Burner utilizes wood briquettes as fuel that are positioned vertically in a feed shaft and continuously fed to the combustion chamber by a conveying mechanism. Consequently, this setup allows a standardized ignition procedure. For the fuel ignition tests, the considered type of firelighter was placed onto the front end surface of the briquette and then covered with a small briquette slice. This was done using one or two firelighters, respectively, in order to evaluate the difference in ignition behavior (emissions, time of heating up, etc.) with one or two pieces of firelighters.

Results
Since the emissions of SO_2 were below the detection limit, it can be concluded that no relevant fractions of sulfur are contained in the firelighters. Highest CO emissions were found, when applying in the newspaper and the glossy paper experiments. The highest levels of organic hydrocarbons were found for glossy paper. Increased NO_X emissions were measured using firelighters made of paraffin. Emissions from firelighters made of wood were very similar to each other. In the course of the measurements, also water content and ash content of firelighters were evaluated.

Conclusions
Commercially available firelighters are very different with respect to used raw materials as well as emissions. But they all have in common that they emit fewer emissions than conventional paper. Next steps include the evaluation of the behavior of emissions changes in operation. In the future, emissions during the ignition procedure shall be reduced.

Experimental study on the transport behavior of biogenic residues on a grate

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Motivation
For the thermal utilization of solid biomass in a grate firing the transport behavior of the grate has a significant influence on the residence time, the mixing of the fuel and on the combustion behavior. In the presentation the results of experiments on a cold grate model are described. The results are implemented into a software tool for the simulation of the combustion behavior of biogenic residues.

Methods
The experiments were performed on a specially designed test rig. In this test rig different parameters can be varied and the resulting impact on the residence time and mixing were analyzed. The grate consists of four non-movable and three movable grate bar rows, which are alternately arranged, starting with a fixed grate bar. The movable rows are each driven by a separate drive, variable in speed. This makes tests of different motion profiles possible. The side mounting of the grate bar rows is designed in a way that allows changing the angle of the grate bar rows. Furthermore different types of grate bar rows varying in height and length were implemented and tested. The grate angle can be varied very easily from 0°- 45° due to a portal system.
Colored tracer particles help to illustrate the movement of the particles as well as for the quantitative evaluation of the tests. In addition, the experiments were recorded by video cameras helping considerably in the interpretation of the experimental results.
The software tool is based on Excel-VBA, it's a static, 3-dimensional tool that is intended to simulate the combustion process of grate firing, in particular the use of biogenic residues.

Results
In various test series the grate angle, the angle and height of the grate bar, the motion profiles and the input materials were varied and evaluated. By the experiments residence time distributions were determined as a basis for the evaluation and interpretation.
Especially the video recordings help to identify dead zones or the slipping of upper fuel layers, which can be observed at steep grate bar angles combined with a high mass flow. Furthermore, it can be shown that with a reciprocating grate bar movement a strong mixing occurs, which may lead to uneven distribution or even fuel gaps on the grate.
Exemplary results are presented on the effect of the grate bar angle to the specific residence time. While the left figure shows that the grate bar angle under otherwise identical experimental conditions has no significant effect on the specific residence time, the right figure shows the interaction of the grate bar angle with different fuel mass flows.

Conclusion
On the one hand the results are used to design a flexible moving grate for the combustion of biogenic residues and on the other hand they are used for the optimization of the transport model of a simulation tool. A systematic design of experiments and a systematic test evaluation help to identify mathematical correlations between the geometric configuration of the grate and the transport behavior. The transport model, which is implemented in the simulation tool, could be significantly improved by using the results from the experiments.

Combustion tests with different biogenic residues in a 350-kW grate furnace

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Motivation
For the development of a flexible furnace for different biogenic residues, several feedstocks were analyzed in detail. It was aimed at gaining detailed information on the combustion behavior of the feedstocks. The emissions level of particulate matter, NO_X, SO_2, HCl, CO as well as process parameters were analyzed in combustion tests at practical conditions. The results from the tests are the base to define operating strategies and optimized technical settings to deal with the evaluated feedstocks. Moreover measures for a technical optimization are discussed and tested.

Methods
For the project the following feedstocks were chosen: Roadside green cuttings, miscanthus, digestate, olive stones, corncobs and by-products from milling like husks. In addition to the standard fuel analysis (chemical composition, proximate analysis, and lower heating value) more parameters like particle size distribution, bulk density, shrinkage behavior, thermogravimetric analysis, slagging behavior were investigated.
Practical combustion tests in a 350-kW grate furnace are conducted to determine the expected level of emissions. With respect of the legal framework it is evaluated whether secondary measures have to be considered. Moreover optimization measures for the furnace are derived based on the test results. The obtained values are used for a feasibility study including a legal and economic analysis.

Results
For the examined feedstocks only limited data especially from practical tests are available in literature. With the results from the combustion tests relevant data of high interest for the scientific community, users and manufacturers as well will be displayed in this presentation.
Data from the practical tests with different interesting feedstocks are presented including the continuous measurement of emissions and process parameters (e.g. left chart showing the flue gas composition during a combustion test).

Moreover the results from the described extended fuel analysis will be displayed, like the results from the experiments regarding the shrinkage behavior, which influences the transportation of the bulk good as well as the pressure drop above the grate (left picture). The right chart shows the results from TG-Analysis with different fuels. All generated data are the base for a feasibility and economical study for the focused materials.

Conclusions
The investigations of UMSICHT aim to apply the obtained results in terms of a targeted system optimization and thus to make the whole supply chain of the investigated feedstocks more efficient. The results show that the tested feedstocks are controllable and can be used with certain technical adjustments in combustion plants of less than 1 MW.

Comparison of Rapid Moisture Content Determination Methods for Wood Chips

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Moisture content is the most important fuel quality parameter of wood chips as it influences the net calorific value, fuel combustion behavior in boilers and the storability of the biofuel. Correct and on-time moisture content determination is crucial at many points during production and distribution of wood chips. However, the standardized method for moisture content determination, i. e. oven drying according to EN 14774-2, consumes both time and labor. Moreover, the heterogeneity of wood chips often requires a large amount of samples, often exceeding the capacity of drying cabinets.
Newly developed gravimetric or electric methods may be suitable alternatives to provide a rapid and accurate moisture content determination for wood chips.

In total, nine different measuring instruments were selected for rapid testing including two infrared dryers, four dielectric instruments, two conductivity and one TDR (time-domain-reflectometry) method. Oven drying according to EN 14774-2 was used as reference. Testing was carried out on five different assortments, i. e. on wood chips from forest residues of deciduous and coniferous trees, on wood chips from energy round wood of Norway spruce and European beech and on wood chips from short rotation coppice of European poplar. Based on fuel specifications for wood chips according to ISO 17225-4, testing was done at five levels of moisture content, i. e. at the moisture content of fresh material “as received”, at 35 w-%, at 25 w-%, at 15 w-% and at 10 w-%.

On average, the mean absolute measuring deviation ranged from -2.6 w-% (± 1.7 w-% SD) to 3.8 w-% (± 4.7 w-% SD). Thereby, best results were obtained with the infrared dryer MA35 for a large range of different moisture contents. However, for infrared driers only small sample sizes of 5 – 35 g are used, which can cause large deviations when testing heterogeneous material. But both infrared dryers allowed for moisture content determination between 0 – 100 w-%. In contrast, the electric methods were less accurate and their measuring ranges were smaller but they allowed for larger sample sizes. Furthermore, their accuracy strongly increased with decreasing moisture content. Most of the electric instruments reached best results on forest residues chips of conifer and were dependent on bulk densities of wood chips. Hence, customized calibration curves for individual assortments should improve measurements.

The high accuracy of the oven drying method could not be reached by the tested devices. However, by using a high amount of samples the average moisture content of all measurements approximated the reference value. Therefore, some instruments could be recommended for quality assurance during production. Nevertheless, the heterogeneity of wood chips should not be disregarded. Representative sampling and accurate sample preparation are thereby fundamental for obtaining high-quality results. Thus, sampling may be considered of higher importance compared to instrument precision.

Analysis of RDF fraction grinding in terms of production technology of agglomerated fuel.

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In Poland, the municipal waste management policy has undergone a profound reform in a last years. The previous model which was in force for many years, the majority of municipal waste (about 85%) was deposited in landfills Poland moved to the model where the wastes are pre-sorted and specified solution are introduced for recovery from the waste stream fraction of the potential energy sources and biodegradable matter. After such activities we receive raw materials with relatively high energy potential. For the purpose of developing waste management sector new, highly efficient technologies need to be introduced for proper processing of this material. One of the most important technological problems in waste management is processing of oversize fraction (RDF, SRF) form the sorting of municipal wastes. Market research showed that in Poland several problems arise like for example, insufficient number of units for waste processing and its capacity, specially concerning thermal incineration. Nowadays, major part of this fuel, is used by cement factory, where it is combusted with conventional fuels. The data presented by Polish Cement Association, shows that currently cement industry is processing yearly about 750 Gg of RDF. There is observed upward trend in consumption in this sector, but there is a market limit which is set on 1,4 Tg per year, with production potential of RDF is set to be even 3,5 Tg yearly. So it could be noticed, that there is significant surplus of the material with high potential for energy purposes.

That's why in the project "EkoRDF - an innovative manufacturing technology of alternative fuel from municipal waste for power and heating plants - a key component of the Polish waste management system" financed by Polish Centre for Research and Development (GEKON Programme), is introduced innovative technology for fuel production from RDF fraction. This product, called "EkoRDF" will be produced from the materials delivered form Mechanical Biological Treatment (MBT) facilities. The final product will be pellet with diameter higher than 15mm.

One of the major task, realized during this research is to prepare this material for agglomeration. In fact such materials has diverted geometry and for agglomeration purposes, milling process need to be conducted. In this study, it was assumed that the grinding process will be carried out in the two different systems : hammer mill and knife cutter. Both shredder were operating with sieves with hole diameter of 10, 15 and 20 mm. The main objective of this study, is to prepare technology with minimal energy expenditures. Therefore, all tests were conducted on stand which records energy inputs, which data can be related to final product. The raw material used in the test cycles was at different moisture content (30, 20, 15%), with described particle size distribution, morphology and bulk density. After tests obtained product was analyzed to describe its quality: moisture content, particle size distribution, bulk density, angle of repose and friction coefficient. Such collected data allows to describe the process of RDF fraction shredding for further processing i.e. agglomeration. The conclusion worked out in this investigation will be used in the design of the planned processing technology of municipal waste to the highly energetic fuel.

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Removal of impurities and inhibitors by adsorption and membrane filtration from beech wood hydrolysates

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The utilization and conversion of lignocellulosic biomass, such as straw or wood, into bio-energy, bio-fuels and bio-chemicals is of great importance due to the risk of diminishing petroleum reserves and growing climate change. The process chain or so called biorefinery starts with the pretreatment or separation of the lignocellulose in its three main constituent's cellulose, hemicellulose and lignin. Among a lot of pretreatment methods employed to treat cellulosic materials, organosolv pretreatment is seen as a process with great prospects, due to the mild and easy recoverable solvents. The solid cellulose fraction is separated and can be further processed into pulp or sugar. Lignin, which is dissolved during the organosolv process is precipitated and can be used as an additive in binding agents or depolymerized into single phenolic building blocks. Hence, the remaining aqueous solution or wood hydrolysate mainly contains hemicellulose-derived sugars at low concentrations and impurity and inhibitory compounds such as organic acids, furan derivatives and phenolic components. In order to convert the wood hydrolysate into marketable products, e. g. xylonic acid, furan dicarboxylic acid or tetrahydrofuran, via combined chemical and biotechnological processes, the impurity and inhibitory compounds have to be removed and the useful have to be concentrated. The selection of the appropriate separation processes and their thoroughly integration are of paramount importance for the realization of an economical biorefinery approach.

The aim of this study, which takes place in the scope of the demonstration project "KomBiChem^{PRO}" and is funded by the German Federal Ministry of Education and Research, is to develop an efficient separation strategy for the removal of impurities and inhibitors from beech wood hydrolysates out of organosolv pretreatment. Object of investigations are to determine the potential of the processes liquid phase adsorption and membrane filtration as well as combinations of them. At the beginning various adsorption materials and ultrafiltration, nanofiltration and reverse osmosis membranes are screened concerning their separation efficiency to the impurity and inhibitory compounds and the concentration of sugars. Adsorption materials were tested by kinetic and equilibrium experiments at different pH-values, temperatures and solution concentrations with model solutions and original hydrolysates. The membranes were also tested at different pressures, pH-values, temperatures and solution concentrations using the membrane module Alfa Laval LabUnit M20. The chemical analyses are conducted by high performance liquid chromatography (HPLC) to determine sugars, gas chromatography (GC) to detect furans, organic acids and phenols and phenolic component and UV/VIS spectroscopy for the quantification of ligneous material in the original hydrolysates.

The results from adsorption experiments, meaning reaction kinetics, adsorption capacities and equilibrium concentrations are fitted to pseudofirst- and pseudosecond-order kinetic models and to Freundlich-, Langmuir- and BET-Isotherms. Membrane filtration is evaluated by calculating flux, retention, concentrations and performance by separation factor as well as observing fouling mechanisms. First results of this study are presented and discussed regarding the potential of liquid phase adsorption and membrane filtration in prospective biorefineries.

Increase of efficiency for biogas plants in Austria - Methodology and results

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Biogas is regarded as an essential source of energy in the present and future energy system. On a macroeconomic scale the biogas industry is a vital player in the Austrian energy system as well as a useful complement for Austrian farmers on a microeconomic scale. This industry has experienced ups and downs in recent years, currently it is worked on a framework for the sustainable development of the technology.

In the project BiGa-NET, several organisations (Industriewissenschaftliches Institut, Güssing Energy Technologies, ARGE Kompost & Biogas, TU Wien, BOKU Wien, planergy) joined forces in order to provide biogas plants in Austria with the best support possible, easy administrative on the one hand and on the other hand efficient and innovative. Most recent insights from research and development and lessons learned from practical experiences are combined to increase the efficiency of Austrian biogas plants. Thus, BiGa-NET as One-Stop-Shop is aiming for applied research projects in order to increase the overall economic performance of Biogas plants.
In this sense, the most efficient and effective optimisation measures and areas of R&D were already identified and analysed along the process chain from the acquisition of substrate to the utilization of gas in various and innovative ways. At three biogas plants, actions for optimisation were already set, two other plants are currently investigated. The implemented optimisation measures covered the fields of electricity consumption, utilization of heat and process stability of the fermentation biology.
In addition, a particular and efficient methodology for the assessment of data and analysis of the respective facility was developed for this purpose. Usually, when examining a biogas plant on site, the person in charge have initially very little knowledge on the particular plant, the way the process is designed, the economic and technical boundary conditions, peculiarities of the plant, etc. It takes a lot of time for the operator of the plant as well as for the external researcher to recover this deficit of knowledge and to be able to actually work with the biogas plant, which makes external analyses of biogas plants expensive and unappealing for the plant operator.

For this purpose a detailed question paper was designed to collect data before the on-site inspections, which covers figures of the plant as well as data sheets of technical devices, existing analyses of digestate and schemes of the plant. In this case the BiGa-NET researchers are able to remotely investigate the boundary conditions and many technical and economic operating numbers at the beginning. Optimally prepared, the actual on-site investigation of the plant combined with required measurements can be performed in an efficient way, both from an economic and temporal point of view, which designs the overall analysis of the biogas plant cost-effective for the operator. At the second site visit concrete actions to implement a R&D project can already be proposed.

Implications of circular economy theory for the cascading use of wood

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With upcoming debates on food vs. fuel competition of agricultural biomass within the last few years wood became more popular as feedstock for the bioeconomy (cf. BMEL 2014). Nevertheless, it became apparent quickly that these resources as well are not available indefinitely. In particular, the competition between material- and energy-related uses is of major importance regarding the utilisation of wood, provided forest protection is adequate.
One strategy to meet this challenge is the cascading use concept. Cascading use of biomass describes a strategy where feedstocks and products from it are used as long as possible in the economic system whereby residues from production processes and usage can be passed back to the economic cycle by recycling. Single-stage cascading use takes place when the feedstock is used once for material purposes and afterwards for energy-related use. Multi-stage cascading use is when the feedstock is used for energy use after at least two material-related uses (cf. BMELV 2008, Arnold et al. 2009 and Essel et al. 2014).
From a technical point of view multi-stage cascading use has advantages over single-stage cascading use, such as increasing resource productivity (UBA 2014), advantages in value creation (Gärtner et al. 2013) and a higher contribution to climate protection as wood in material uses retains carbon for a certain period of time (Gärtner et al. 2012). Nevertheless, only single-stage cascading use of wood is common practice (cf. Thrän et al. 2011, Witt et al. 2012). Diverse barriers prevent the recycling of wood-based secondary raw materials because they are used for energy-related purposes before material recycling takes place (UBA 2014). The support of bioenergy within the last years may have caused an unlevel playing field for material and energy uses of wood (OECD 2014:29), as well as for wood-based secondary raw materials (Witt et al. 2012).
To figure out possible reasons for this observed bias, the market and non-market determinants of the allocation of secondary raw materials are analysed. For this purpose, economic circular economy theory approaches are applied. As valuable residual materials and therefore marketable goods wood-based secondary raw materials are subject to the interplay between supply and demand on markets. Markets for secondary raw materials emerge when 1) they are qualitatively equivalent to primary raw materials (technological substitution potential), when 2) costs for using secondary raw materials including transaction costs are less or at least equal to the primary raw materials (economic substitution potential) and 3) when the substitution of material is accepted by the consumer (socio-economic substitution potential). These markets operate according to fundamental price functions, such as the signalling effect of prices (scarcity signal) and the allocation function of prices.
Therefore, willingness to pay for secondary raw materials as well as price and regulatory structures to cover market costs and transaction costs of logistics for a circular economy (i.e. costs for search, information and hedging) play an important role for the outcome. Besides behavioural barriers (e.g. mental models, bounded rationality etc.) that may distort supply and demand decisions, so-called market failures can arise due to positive and negative externalities (environmental and climate externalities), knowledge externalities or asymmetric distribution of information among market actors. Additionally, technological and institutional path dependencies as well as market power raise potentials for market failures.
Finally, it is analysed which policy implications might arise from this analysis of circular economy theory for the sustainable allocation of wood-based secondary raw materials and the sustainable cascading use of wood. Governance structures affecting the relative prices due to the internalisation of external costs, among others, are one possibility for the correction of market failures. For practical purposes, theoretically based “first-best solutions” for governance have to be modified according to second-best theory.

Das BiomasseVergasungsProjekt *SÜDTIROL 2015ff*

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Diese innovative Biomasse-KWK-Anlage speist 100% der verfügbaren Abwärme in das örtliche Fernwärmesystem ein. Der anfallende Restkoks und die Zyklonasche aus der Vergasung werden nach einer spezifischen Aufbereitung zu 100% landwirtschaftlich bzw. stofflich verwertet. Diese Holzvergasungsanlage zur Bioenergieerzeugung mittels Holzhackschnitzeln als Brennstoff kann als sehr umweltschonend und wirtschaftlich äußerst attraktiv bezeichnet werden.

Eckdaten des Projektes (Stand 12/2015)

Investitionsvolumen (gesamt)	**ca. 3.500.000 €**
Brennstoffart	**Holzhackschnitzel** (60-120) mm x (60-120 mm) x max. 30 mm
Wassergehalt / Feinanteil	**kleiner 20% / max. 5%**
Output elektrisch brutto	**~500 kW**
Output thermisch brutto	**~1.050 kW**
Wirkungsgrade *Holzgas-BHKW*	**38%$_{el}$ / 50%$_{th}$**
Wirkungsgrad *Thermochemische Vergasung*	**~80%**
Brennstoffbedarf	**~400 kg/h (15%$_{RF}$)**
Jahresbetriebststunden – BHKW	**~8.150!**
Warmwasserspeicher	**20 m³**
Jahreswärmeverkauf an Dritte	**~ 6.500 MWh**
Jahresstromverkauf	**~ 3.715 MWh**
Eigenenergiebedarf	**< 5 kW$_{el}$ / ~ 260 kW$_{th}$**

Dieses Projekt soll in naher Zukunft noch um eine sog. *Thermische Nachverstromungseinheit* ergänzt werden. Durch die intelligente Nutzung der etwa 550 Grad heißen Abgase des Holzgas-BHKW ist mit einer zusätzlich verfügbaren elektrischen Dauerleistung von etwa 40 bis 50 kW zu rechnen.

Sida als Brennstoff –Anbau, Pelletierfähigkeit und Verbrennungseigenschaften

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Einleitung und Zielsetzung
Im Projekt „SIDecA" wird das Potential der Virginiamalve- *Sida hermaphrodita (L.)* Rusby hinsichtlich mechanischer Aufbereitung und thermischer Verwertung untersucht und bewertet. Die mehrjährige Pflanze stellt aufgrund ihrer vorteilhaften Eigenschaften bezüglich Kulturführung, Ökologie, Ertrag und energetische Verwertbarkeit eine vielversprechende neue Energiepflanze dar. Neben der Nutzung als Rohstoff für Biogas und Bioethanol-Gewinnung wird der Fokus auf die Praxistauglichkeit hinsichtlich mechanischer Verdichtung und thermischer Verwertung gelegt. Rohstoffe von insgesamt 3 Ernten verschiedener Standorte und Bestandesdichten wurden bis dato chemisch charakterisiert, 3 Ernten eines Standortes wurden pelletiert und auf ihre Verbrennungseigenschaften geprüft. Dabei wurden verschiedenste Aufbereitungsmethoden beziehungsweise Aufbereitungswege untersucht. Ein Kreuzvergleich der ausgewerteten Prozessdaten liefert Informationen über Potentiale und Möglichkeiten der Anwendbarkeit im industriellen Maßstab.
Material und Methoden
Das verwendete Material stammt aus drei Winter-Ernten der Jahre 2014, 2015 und 2016. Ungefähr 1,5 Tonnen des verholzten oberirdischen Halmgutes wurden verarbeitet, davon etwa 1 Tonne zu Versuchsbrennstoff. Um eine praxistaugliche Prozessabfolge für diese neue Energiepflanze zu generieren, wurden die verschiedenen Verfahrensschritte im Pelletiervorgang variabel gestaltet. Beispielsweise wurden unterschiedliche Trocknungsregime und Zerkleinerungstechniken angewandt, sowie zwei unterschiedliche Presstechnologien: Ringmatrizenpresse und Flachmatrizenpresse. Auch andere Prozessparameter, wie Zerkleinerungsgrad, Presskanallänge, Wassergehalt, und Durchsatzleistungen wurden variiert. Mit ca. 1000 kg Sida-Pellets wurden Verbrennungsversuche durchgeführt. Referenzversuche mit anderen Rohstoffen (z.B. Weide, Miscanthus) dienen einer qualitativen Einordnung im Vergleich zu bereits erforschten Alternativ-Brennstoffen. Die Ergebnisse dieser Versuche in Kombination mit der chemischen und brennstofftechnischen Charakterisierung des Brennstoffes dienen als Grundlage für die Bewertung der allgemeinen Einsetzbarkeit als Brennstoff für Kleinfeuerungsanlagen.
Ergebnisse Diskussion
Die Ergebnisse der Versuche zeigen, dass die Pelletierung von Sida bei ähnlichen Bedingungen wie bei Nadelholz möglich ist, wobei der Prozessverlauf einer stärkeren Variabilität unterliegt. Eine geringe Trocknung des Ausgangsmaterials ist meistens erforderlich, kann aber bei günstigen Erntebedingungen auch vollständig entfallen. Die Kollermühle hat sich als günstige Zerkleinerungstechnologie erwiesen, da hier zugleich eine Vorverdichtung des Materials stattfindet. Die fertigen Pellets haben bei richtiger Verarbeitung eine sehr gute mechanische Festigkeit, und einen Aschegehalt von rund 3 %, das Ascheschmelzverhalten sowie der Gehalt an Stickstoff und Chlor liegen in einem günstigen Bereich, die Abhängigkeit des Stickstoffgehaltes von der Dünge-Intensität ist noch nicht untersucht. Bei den Verbrennungsversuchen zeigte sich der Rohstoff als anlagenfreundlich, da keine nennenswerte Verschlackungsneigung festgestellt wurde. Aus den Ergebnissen lassen sich grundsätzliche technologische Anforderungen – vor allem im Bereich Asche-Management und Emissionen ableiten. Die gemessenen NOx-Emissionen beim Betrieb mit Sida sind mit den Emissionen beim Betrieb mit Fichtenholzpellets in etwa vergleichbar. Die Staubemissionen sind vergleichbar mit den Staubemissionen beim Betrieb mit Pellets aus Kurzumtrieb (Weide). Eine finale Bewertung von Sida als Brennstoff erfolgt im letzten Projektjahr unter Einbeziehung aller Analysenergebnisse. Die bisherigen Daten lassen Sida als durchaus vielversprechenden Rohstoff für die Brennstoffproduktion erscheinen.
Ausblick: Sida weist als mehrjährige Pflanze eine Reihe vielversprechender Vorteile auf: Sie ist nicht invasiv, gedeiht auch auf ärmeren Standorten, kann Trockenperioden unbeschadet überdauern und zeigt vorteilhafte Eigenschaften als Brennstoff auf. Das im Antragsstatus befindliche Folgeprojekt PerEnergy.Net:Eurpe untersucht die Pflanze vertiefend um unter anderem auch stoffliche Verwertungsmöglichkeiten zu untersuchen.

Simulation und Bewertung der Herstellung von sauerstoffhaltigen Dieselersatzkraftstoffen aus Zellulose und Hemizellulose nach Aufschluss durch ein Organosolv-Verfahren

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Um nach dem Klimavertrag von Paris die geforderten CO_2-Einsparungen erreichen zu können, ist der Einsatz von flüssigen Biokraftstoffen im Transportsektor ein wichtiger Schritt. In dieser Arbeit wurde die Herstellung von Biokraftstoffen der zweiten Generation aus lignozelluloser Biomasse simuliert und bewertet. Die dabei betrachteten Kraftstoffe sind Aceton, Butanol, Ethanol, Dibutylether, 2,5-Dimethylfuran, γ-Valerolacton, 2-Methyltetrahydrofuran, sowie 2-Methylfuran.
Das Konzept der Kraftstoffherstellung ist in Abbildung 1 gezeigt. Auf Basis von Literaturdaten und Prozesssimulationen konnte die Massenbilanz für den Aufschluss von Miscanthus sinensis als lignozellulose Biomasse durch einen Organosolvprozess berechnet werden. Die nach der Trennung von Zellulose und Hemizellulose erhaltenen Produktströme waren die Grundlage für die Auslegung der Herstellungsprozesse der genannten Kraftstoffe. Prozessführungen zur Abtrennung der Zielkomponenten von Nebenprodukten wurden simuliert.

Aufbauend auf die Massenbilanzen konnte eine Bewertung hinsichtlich energetischer Kraftstoffeffizienz, Prozessaufwand, möglicher Treibhausgaseinsparung und Anlagenkosten durchgeführt werden. Dabei wurden verschiedene Konstellationen der Prozesse betrachtet. Für die Prozesskosten konnten die Rohstoff- und Transportkosten, Energiekosten, Personalkosten und Wartungskosten der Anlagen abgeschätzt werden. Die Treibhausgaseinsparung wurde nach EU-Richtlinie berechnet, wobei die Emissionen von Transport und Kultivierung der Biomasse sowie prozessbedingte Emissionen ermittelt und als Summe auf ein Megajoule an produzierten Treibstoffen bezogen wurden. Dadurch konnte ein Vergleich mit dem Einsatz von Kraftstoffen fossilen Ursprungs (Diesel) gemacht werden. Es hat sich gezeigt, dass nur Gesamtprozesse mit interner thermischer Nutzung der Hemizellulosefraktion - und selbst da nur teilweise - eine Treibhausgaseinsparung aufweisen.

Situation and development trends of agricultural biogas plants in Slovenia

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In 2016 Slovenia has 26 biogas plants with a total installed capacity of 28,2 MW_{el} electric power. The heat energy is used to heat the biogas plant itself and the nearby buildings. Only a few of the biogas plants emit (sell) the heat to other users (greenhouses etc.). The production of biogas and electrical energy from biogas plants has stagnated in recent years due to severe droughts in agriculture, especially in the cultivation of maize, which is the main input substrate for biogas plants.

Biogas plant owners can choose between two types of feed-in support scheme: "guaranteed purchase" and "operating premium". Guaranteed purchase for electricity, produced from biogas from agricultural input substrate, is between 140,37 to 159,74 EUR/MW_{el} and for electricity, produced from biogas from biodegradable waste, is between 129,15 to 139,23 EUR/MW_{el} depending on the size of the biogas plant. We also have a bonus – extra pays (supplement) for the biogas produced from larger amount of manure or for selling heat energy. Since 2012, there is no interest in the construction of new biogas plants due to the prohibition of the use of maize silage. In the last two years it is not possible to come in feed-in support scheme as a new producer of biogas.

Agricultural potential for biogas is calculated from livestock manure and from plant biomass. With regard on calculation with the least interference with the primary agricultural production we have 86 MW_{el} agricultural potential of biogas in Slovenia. The largest share is in the Pomurje, Podravje and Central Slovenian Region. We have 3 different Associations for biogas in Slovenia.

In Slovenia, investors have many problems in placing their biogas plants in the human environment. Neighbors, NGOs, civil initiatives often speak about public – social unacceptability of old and future biogas plants, sometimes justified, but sometimes also not. The general public is mostly against biogas plants.

Further development of agricultural biogas plants is dependent on the support system and agricultural potential. Depending on the structure of farms in Slovenia we will have to build micro and small-scale biogas plants, which will use livestock manure - slurry as the main substrate (due to the reduction of greenhouse gas emissions).

Keywords: biogas, state, support schema, potential, development, Slovenia

Strom aus Holz - eine sinnvolle Ergänzung zu bestehenden Nahwärmeanlagen

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Mit Holzvergasung zu klima- und umweltfreundlichem Strom aus der Region

STROM AUS HOLZ – EIN ALTBEWÄHRTES VERFAHREN WIEDER MODERN
Strom aus Holz ist – wie bei vielen regenerativen Energieformen – keine neue Idee.
Die Holzvergasungs-Technologie wurde in Zeiten von Treibstoffmangel in Fahrzeugen verwendet. So hatte man während und nach dem zweiten Weltkrieg PKWs, LKWs und sogar Lokomotiven mit Holz- und Holzkohlevergasern ausgestattet. Aus drei Kilogramm Buchenholz konnte in etwa die Treibstoffleistung eines Liters Benzin hergestellt werden.
Der Klimawandel und die damit verbundene Notwendigkeit, den CO2-Ausstoß zu verringern, rücken die effiziente Energiegewinnung aus erneuerbaren Ressourcen in den Mittelpunkt des energiepolitischen Interesses. Im Gegensatz zu Wind- und Photovoltaikstrom steht, der aus Holz gewonnene, Strom jederzeit zur Verfügung.
Das zur Verbrennung im Motor erforderliche Holzgas entsteht bei der Erhitzung von Holz.

HOLZGASGEWINNUNG
Wenn Holz im Ofen verbrennt, entweicht Holzgas und wird von der Flamme entzündet. Deshalb hat die Flamme einen Abstand zum Holz. Das ist der Bereich, in dem sich das Holzgas mit Sauerstoff vermischt, der durch das rasche Aufsteigen der erhitzten Luft von unten nachströmt. Dieses Prinzip macht man sich bei der Gewinnung von Holzgas zu Nutze, unterbindet jedoch im Vergaser das Entstehen einer Flamme durch Entzug des Sauerstoffs. Dadurch kann das Holzgas abgesaugt und zur Verbrennung in einem Motor verwendet werden.

VERFAHRENSABLAUF
Das, für den Vergasungsprozess benötigte (aus der Region stammende), Hackgut wird gesiebt, vorgetrocknet und durch thermochemische Prozesse im Holzvergaser in brennbares (Holz-)Gas umgewandelt. Nach der Reinigung des Holzgases durch Filteranlagen erfolgt dessen Verbrennung und Verwertung mittels Kraft-Wärme-Kopplung über Gasmotor und Generator zu elektrischem Strom und Wärme. Im Gegensatz zu anderen KWK-Verfahren wird kein Arbeitsmedium wie Wasser oder Thermoöl benötigt. Teure und energieaufwändige Zwischenspeicherung ist nicht erforderlich.

IDEALE ERGÄNZUNG ZU BESTEHENDEN BIOMASSE-NAHWÄRMEANLAGEN
Der erzeugte Strom wird in das öffentliche Ökostromnetz eingespeist. Die im Holzgas-Verwertungsprozess anfallende Wärme ist hervorragend zur Grundlastabdeckung eines vorhandenen Nahwärmenetzes geeignet, denn die *sinnvolle Verwendung der Abwärme* ist das entscheidende Kriterium einer wirtschaftlichen Holzverstromung.
Die Doppelnutzung von Bewegungsenergie und Abwärme ermöglicht bei Holzvergasungsanlagen einen erstaunlichen Wirkungsgrad von rund 80%. Im Vergleich dazu erreicht ein Atomkraftwerk lediglich einen Wirkungsgrad von max. 35 %. Der nachwachsende Energieträger Holz kommt aus einheimischen Wäldern und gewährleistet kurze Transportwege, die wiederum für Energieeinsparung im Treibstoffbereich sorgen. Kompakt und wartungsfreundlich gebaut, ermöglichen die Holzvergasungsanlagen einen in höchstem Maße störungsfreien Betrieb.
Aufgrund massiver Ressourceneinsparung und Effizienzsteigerung lässt sich eine wesentlich höhere Wirtschaftlichkeit des Gesamtsystems erzielen. Die Holzvergasungstechnologie stellt somit eine ideale Ergänzung zu bestehenden Biomasse-Nahwärmeanlagen dar.

The use of open sorption technology for heat recovery in biomass combustion applications - measurement results from laboratory tests

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In Austria solid biomass is commonly used as a fuel for district heating. Between 2005 and 2013 the energetic end use for district heating from solid biomass increased from 10 PJ to 34 PJ. In such facilities the biomass fuel often has a high water content up to 50%. Thus, the recovery of condensing heat from water vapour in the flue gases is necessary for reaching high energetic efficiencies. In this publication an open sorption process for the heat recovery from the flue gases is analysed.
The main components of this process are the open absorber, the generator and the condenser. In the open absorber a concentrated absorption fluid, a hygroscopic salt solution, is injected into the flue gases, which absorbs the water vapour. Thus, the water vapour contained in the flue gases is directly used as refrigerant. Through this process the flue gases are dehumidified to a relative humidity of 30-40%. The dried flue gases leave the system through the chimney. Meanwhile the salt solution is re-concentrated by boiling in the generator. Before the solution is re-injected into the absorber it enters a heat exchanger to recover the heat from the solution to the water of the heating circuit. The resulting pure water vapour is condensed at ambient pressure. The advantage of this process is that the majority of the recovered heat is available on a temperature level above the dew point. This fact increases the field of application compared to a conventional condensing heat exchanger. Moreover, particulate emissions can be reduced in the flue gases by the absorption too.
Within the project ErgoS the use of the open sorption process for heat recovery and emission reduction is evaluated technically and economically. Therefore a test plant is designed, constructed and experimentally assessed. Details for the design were fixed based on results of CFD-Simulations performed by the Institute of Thermal Engineering (IWT) at the University of Technology in Graz. The constructional design was developed by BIOENERGY 2020+ GmbH together with the Güssing Energy Technologies GmbH. First calculations for the plant design show a potential efficiency increase of more than 20%. These calculations are based on a biomass furnace with a nominal heat output of 30 kW fired by wood chips with a water content of 50%. In this publication the test setup and measurement results are presented and compared to the calculations.

Biomass potentials of aquatic macrophytes as biogas substrate in Germany

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The project "AquaMak" (Aquatic Macrophytes – economic and ecological ways of use) deals with the emergence of aquatic weeds in rivers and lakes in Germany. The Subject of research was based on the idea of reducing costs for de-weeding affected water bodies in Germany. It is assumed that the biomass gained by de-weeding can be integrated into existing material supply chains, for example in biogas production. This would help to reduce costs and therefore facilitate water body maintenance for public authorities and private owners that are obliged to maintain these water bodies according to legal stipulations (e.g.EU-Wasserrrahmenrichtlinie). It would also provide biogas production plants with "waste" biomass that is not seen as conflictive as maize which is often seen critically in fuel-versus-food discourses.
Our research approach was based on a nation-wide survey on existing water de-weeding operations and the biomass harvested, followed by extensive testing of water weeds regarding their suitability as biomass supply for biogas plants. This research was accompanied by studies investigating ecological and social impacts of water weed growth and weeding as well as an economic investigation of the value chain. Initial Data was gathered by a questionnaire which contained closed and open questions on the location of the water bodies being de-weeded, reasons for de-weeding, time patterns, costs and quantities of biomass by de-weeding, technical information on the equipment being used, biomass disposal and if the contestants were aware of other stakeholders and their interests.
Biomass gas generation and ensiling tests were conducted to compare the substrate to other substrates. To evaluate the ecological impact of aquatic de-weeding we collected data on appearance as well as quantity and species of aquatic macrophytes in Germany. The aim of the query was to estimate biomass production of aquatic systems on a landscape level. Additionally we investigated conflicts in nature conservation resulting from aquatic de-weeding such as disturbance of breeding animals, habitat loss for fishes, dragonflies etc. To assess stakeholder interests and possible conflicts, four case studies were carried out at affected rivers and lakes. Stakeholders were interviewed using guideline interviews which were recorded, transcribed and analyzed using computer aided text analysis. Further data was gained by desk research on literature on the topic in scientific journals as well as press articles.An economic assessment was carried out using the data from the survey as well as applying known costs of processing biomass for use in biogas plants, which include costs for ensiling the raw material with addition of straw due to its high water content.The questionnaire was sent out to 1.123 organizations of which 408 responded, resulting in a 36% response rate. Of these, 169 carried out aquatic plant de-weeding or contracted others for the task. Results showed that aquatic de-weeding takes place in streaming waters as well as in Lakes. Most aquatic de-weeding takes place in landscapes with low downward gradients located in the northern part of Germany and the Rhine and Danube river valleys. These areas reportedly contain a high percentage of protected areas (Habitate Directive Sites, Bird Directive Sites). Concerning economical aspects, a very wide range of costs per unit were reported. The deviance resulted of differences between rivers and lakes as well as of the technical equipment being used. Another huge difference was made up by disposal costs. Moreover, it turned out that most entities did not apply a consequent full-cost approach. Unfortunately, only singular respondents could provide exact financial data on each of the processing steps of de-weeding and disposal of water plants so that a final conclusion on material costs is not possible at the given time. It can be assumed though, that aquatic biomass today is economically not in a competitive position in comparison to existing input material. The data also showed that actually there is practically no use of aquatic biomass as biogas input material at the moment due to technical, legal and logistic problems. The stakeholder analysis showed that there are conflicting interests being affected by de-weeding of water bodies. Nature conservation groups called for leaving the plants in the water, a view that was partially supported by fishers and legal authorities. These were opposed by farmers and water sports associations who liked "their" rivers and lakes free of plants. There was a strong debate about responsibilities for de-weeding, as local authorities only claimed responsibility for matters of flood protection and water level management, whereas the other stakeholders held them responsible for their interests as well.
Technical results from the ensiling and gas production tests were promising. It could be shown that pure ensiling is possible under lab conditions, leading to high methane yields:
Elodea silage (6,7% DS) 257,5 ml_{STP} CH_4/g oDS and 12,6m^3_{STP} CH_4/t FM
Elodea/straw silage (30% DS) 231,0 ml_{STP} CH_4/g oDS and 55,2m^3_{STP} CH_4/t FM
DS dry substance
oDS organic dry substance
FM fresh matter
STP standard temperature and pressure
The methane yield of two tons of elodea straw silage is comparable to the methane yield of one ton maize silage.
Also the mixture with straw, to enhance dry matter contents to >30%, which enables ensiling in clamp silo, showed successful results.

Microalgae biorefinery: potentials and scopes

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Microalgae are promising organisms that have remarkable potential to grow and thrive under different growth conditions. They represent a large diversity and are able to grow in marine or fresh water, they multiply rapidly and accumulate large amounts of added value components compared to traditional crops, and do not compete for arable lands.

Indeed, microalgal lipids for biofuels production took much attention during the past decade without reaching the desired ending due to the high production costs that made this production uncompetitive in the energy market. Moreover, the total focus on biofuels indirectly neglected the true potential of microalgae that embed valuable components such as proteins, fatty acids, pigments and carbohydrates. These components have a great potential to be valorised in the market of food, feed, bioplastics, cosmetics, fertilizers and pharmaceuticals, and to significantly multiply the overall profit.

Total valorisation of microalgae components in the framework of a biorefinery is a worthwhile endeavour that could generate new line of products in the market. The process will therefore require a sequence of unit operations such as cell disruption, extraction, fractionation and purification. Although the approach of microalgae biorefinery is a promising idea, many challenges need to be overcome in order to reach the desired outcomes in terms of efficiency, yields and quality. Among these challenges is to implement the appropriate scalable unit operations that respects the integrity of each component of interest in the downstream process and that require low energy input.

One of the main objectives of the MIRACLES project is to lay the foundation for a scalable biorefinery that valorises the primary components of microalgae. The focus is on the development and integration of mild cell disruption and environmentally friendly extraction and fractionation processes. This includes functionality testing and product formulation based on established industrial algal strains. An overview of an integrated multiple-product microalgae biorefinery will be presented.

This research was carried out within the EU MIRACLES project (www.miraclesproject.eu) and has received funding from the European Union's Seventh Framework Program for research; technological development and demonstration under grant agreement No 613588.

Subject area: Biomass potentials and markets

Optimisation of biomass-to-end-use chains through densification

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The European Union plans to shift parts of its economy towards a biobased system commonly referred to as a Bioeconomy in order to reduce carbon emissions and dependencies on fossil fuel imports. Therefore biomass supply will have to scale up, probably also by means of developing and implementing novel densification processes. The objective of this paper is to describe and evaluate generic biomass-to-end-use chains based on densified biomass through pelletisation, torrefaction and pelletisation as well as higher temperature pyrolysis for liquid bioenergy carrier production. Impacts with regard to economic- and environmental criteria in contrast to comparative fossil based fuels and un-densified biomass feedstock are in the spot-light of this work. Therefore, we analyse the processing of wood chips and wheat straw as exemplary cellulosic biomass feedstocks to different bioenergy carrier types namely pellets, torrefied pellets and pyrolysis oil under various framework conditions. A set of transportation modes and distances is simulated to display the delivery of the bioenergy carriers to different types of end users for which the cumulated costs of the respective biomass-to-end-use chain is compared with reference fuels and raw biomass. Next to costs also required energy for bioenergy delivered is calculated for every step throughout the entire biomass-to-end-use chains. We find that optimal plant sizes for simple pelletisation are at 40 kt $year^{-1}$ for wood chips while theoretical production of torrefied pellets and pyrolysis oil exhibit more favourable economies of scale. For these, more expensive densification technologies about 150 kt $year^{-1}$ and 390 kt $year^{-1}$ with wood chips as feedstock are calculated with the same frame conditions respectively. Production costs for torrefied pellets (8.8 GJ t^{-1}) are comparable to production costs of traditional pellets (8.1 GJ t^{-1}) when based on wood chips while pyrolysis of wood chips and torrefaction and pyrolysis of straw are considerable higher. Higher bioenergy carrier production costs at the densification plant gates have to be outweighed by gains through transporting and storing higher energy contents under unchanged expenses. Delivered bioenergy carrier costs at the end user, the consumers' conversion efficiencies and priced in conversion advantages for altered bioenergy carrier specifications through densification determine in the end the most cost effective bioenergy carrier type. Results are expected to vary for different end users of which FT-Diesel via gasification, residential heating and industrial process heat as well as electricity production in co-fired coal plants are considered.

Economic Analysis of Secondary Fuel Quality Treatments for Wood Chips from Forest Residues

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Purpose. In Germany, fuel for wood chip boilers < 100 kW is traded mostly on a regional and small scale market. A large share of wood chips on this market is produced from forest residues. To comply with high fuel quality standards for small furnaces, additional fuel processing such as screening or drying is recommended. However, these quality improvement techniques increase production costs of the final product. To assess the efficiency secondary fuel quality treatment steps, an online survey and field studies on typical production chains were conducted.

Approach. During the research project "qualiS – Development of a Quality Management System for Wood Chip Production" the most commonly used fuel processing techniques were identified through a nationwide online survey amongst wood chip producers. According to the gathered information, screening and technical drying are the most relevant techniques in Germany.
Based on the results of the survey, six enterprises were selected as best practice examples for case studies on secondary fuel treatments. The studies included a rolling bed dryer with star- and horizontal screen, two star screen machines, a drum screen, a continuous belt dryer, drying containers and variations of natural drying in storage piles. In each case study, time studies were conducted to evaluate the efficiency of the various treatment steps. For each production chain, different parameters were measured directly in the field. These parameters included energy consumption, throughput rates and shares of each produced assortment. Additional information such as investment, labour and maintenance cost were provided by the companies. With the compiled data the costs of each production step were calculated.

Results. The cost for technical drying varied from 1.85 €/m³ for the continuous belt dryer to 16.66 €/m³ for the rolling bed dryer and were -as expected - strongly affected by the throughput rates. Natural drying in piles was the cheapest method with 0.29 €/m³, albeit the drying effect was of course much lower than in technical drying. The screening costs varied less. With the three different types of star screen machines, screening costs amounted to 0.27 €/m³, 0.65 €/m³ and 0.68 €/m³. In one case, screening was conducted after a longer storage period, resulting in higher screening costs of 1.13 €/m³. Additional costs for buildings and maintenance also varied greatly and lay between 1.31 €/m³ to 5.38 €/m³, depending on operational concept and infrastructure. The yield of the main product, i.e. high quality wood chips, ranged from 57.34 – 74.68 % of the raw material.

Conclusions. The results show that the highest costs in secondary fuel treatments for wood chips arise from technical drying. Screening costs with different machines were always lower. The costs of the process steps vary depending on the setup of the operation and of the enterprises. Economic performance of the whole processes is also highly influenced by marketing opportunities for the significant amounts of by-products.

Innovative technique to monitor the removal of siloxane with sorbent materials: biochar and activated carbons

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For the future energy prospective, renewable fuels exploitation coupled to highly reliable and efficient local generator systems appear as a promising solution. SOFC energy generator couples the highly efficiency with the renewable fuel exploitation with residential power sizes, well distributed in a local territory. These generators are based on nickel anode structure with solid oxide materials. Nickel suffers the trace compounds poisoning derived especially from the sulphur, silica and chorine compounds. These trace compounds are detectable in renewable fuels such as biogas produced from the anaerobic digestion of organic waste or from waste water sludge. Siloxanes due to their strong and irreversible behavior on SOFC performance, already at ppbv level, requires to be deeply removed. Siloxanes at ppbv level and in the anode environment can produce silica oxides that strongly limit the energy performance blocking the three phase boundary. In this work the sorbent removal performance of commercial activated carbons and wastes of gasification and pyrogasification processes are investigated. PTR-ToF-MS was adopted as innovative and reliable technique to monitor the removal performance of sorbent materials. D4 was adopted as model compound for siloxanes. To best simulate the removal performance in an industrial SOFC energy site, two different GHSV levels were considered in order to investigate the effect of the gas velocity on the sorbent removal performance. Two different materials were selected: a commercial activated carbon and a biochar. Interesting results were achieved to feed a SOFC generator continuously.

Novel concepts for CO_2 utilisation to produce value added products

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The worldwide emissions of CO_2-containing gases are increasing continuously, while at the same time the need for additional carbon-based resources grows. CO_2 represents an alternative and valuable source of carbon, which could be a suitable raw material for a variety of different products. The utilisation of CO_2 rich gases as a feedstock for the European process industry to produce materials, chemicals and fuels could be a key solution to reduce greenhouse gases and the dependence on imports of fossil resources.

In the Austrian project *UseCO2 – Utilisation of CO_2 from industry* experts from research institutes, universities, iron and steel industry and energy sector developed novel concepts for CO_2 utilisation. For the conversion of CO_2 to value added products a large number of different thermochemical and biotechnological pathways exist. The project identified interesting value chains for the utilisation of CO2 from industry and evaluated pathways with regard to scalability, possible products, technology readiness, economics and potential international markets.

After consideration of variable advantages and disadvantages of several possible conversion routes, three promising biotechnological production pathways for the utilisation of industrial CO_2 were identified:

- In System 1 CO_2 is used for the cultivation of specific cyanobacteria. After biomass growth nutrient limitation is applied to accumulate polyhydroxybutyrate (PHB) within the cells. This PHB rich biomass is further processed via hydrothermal liquefaction into the products biocrude and propylene. The remaining aqueous phase contains mineralized nutrients which can be recycled in the cultivation step.

- System 2 consists of an acetate fermentation with *Acetobacterium woodii* using H_2 and CO_2 for the production of acetate. Acetate is an important basis chemical with a wide variety of application options. The current microbial organic acid production is sugar-derived, with the developed novel system no additional carbon source is necessary apart from CO_2.

- System 3 follows a biorefinery approach. CO_2, light and nutrients are used for microalgae cultivation. The produced biomass is further processed via acidification to organic acids like acidic acid or propionic acid. In a heterotrophic fermentation step those acids are converted into polydydroxybutyrate (PHB) which is used for the production of biodegradable plastics. Fermentation residues are used for biogas and biomethane production.

A strategy for research, technology and innovation for the most promising value chains for utilisation of industrial CO_2 was developed and could lead to new ways for recirculation and reuse of emitted CO_2 in European industry.

Emissionen bei Pellets-Kleinfeuerungsanlagen

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Der technische Stand von Biomasse-Kleinfeuerungsanlagen wurde in den letzten Jahren laufend verbessert. So stehen heute ausgereifte Systeme zur Verfügung, die durch hohe Bedienungsfreundlichkeit, hohe Wirkungsgrade sowie niedrige Emissionen gekennzeichnet sind. Parallel dazu wurden auch die gesetzlichen Anforderungen hinsichtlich Emissionen stetig verschärft. Vor allem die zwingende Reduktion der Partikel- und NO_x-Emissionen ist bei Biomassefeuerungen im Vergleich zu nahezu aschefreien fossilen Brennstoffen eine Herausforderung.

Die in den aktuellen Anforderungsnormen für biogene Festbrennstoffe definierten Grenzwerte lassen eine beträchtliche Schwankungsbreite bei A1-Qualitäten zu. So ist beispielsweise der zulässige Aschegehalt der Brennstoffe in der ISO 17225-2 für Holzpellets der Klasse A1 mit maximal 0,7 % definiert. Prüfbrennstoffe weisen in der Regel jedoch Aschegehalte von 0,3 % auf.

In der Praxis – bei wiederkehrenden Überprüfungen - kommt es zu teilweise erheblichen Abweichungen von den Messergebnissen des Prüfstandes. Während bei der Typenprüfung Brennstoffe von höchster Qualität verwendet werden, weisen die in der Praxis verwendeten Brennstoffe mitunter erhebliche Schwankungen in der elementaren Zusammensetzung auf. Die Abweichungen sind neben den eingesetzten Brennstoffqualitäten auch auf variierende Einflussgrößen wie Betriebs- und Wartungszustände der Heizkessel zurück zu führen.
Mit Hilfe von Prüfstandmessungen und praxisnahen Dauerversuchen werden die Unterschiede der Ergebnisse aus Typenprüfungen und wiederkehrenden Untersuchungen sowie der Einfluss der Brennstoffqualität erhoben. Darüber hinaus zeigen die Ergebnisse der Dauerversuche mit einem definierten Lastzyklus, dass die Emissionen, insbesondere von Staub, über eine durchschnittliche Heizperiode aufgrund von Ablagerungen und Verunreinigung deutlich zunehmen. Mit Hilfe einer Reinigung der Anlage können die Emissionen nahezu wieder auf die Ausgangswerte der Anlagen im Neuzustand gebracht werden.

Brennstoffe mit höherem Kaliumgehalt zeigen den Einfluss dieses Elements auf das Verbrennungsverhalten deutlich. Neben hohen Partikelemissionswerten ist ein signifikanter Einfluss auf die Ascheerweichung und eine damit verbundene Verschlechterung der Betriebszustände der untersuchten Anlagen feststellbar.
Basierend auf den Untersuchungsergebnissen wird versucht, den Einfluss der Brennstoffqualität und des Wartungszustandes der Anlage auf die Emissionen zu quantifizieren.

Biomass and peat co-combustion in medium scale grate boilers – a primary measure for reduction of fine particle emissions

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The demand for increased overall efficiency, improved fuel flexibility and more stringent environmental legislations promote development of new fuel- and technology related concepts for the bioenergy sector. Fine particulate matter (PM_1) in the ambient air are associated with both health- and climate related concerns, and an increased focus is today seen in Europe on this topic, e.g. illustrated by the newly defined European MCP- and Eco Design directives. Previous research has shown that peat has the potential to reduce the formation of inorganic ash-particles when co-combusted with biomass fuels. The objectives of the present work was therefore to; *i)* demonstrate the possibilities to reduce the emission of PM_1 during co-combustion of softwood with peat in grate fired boilers, and *ii)* investigate the influence of peat ad-mixing approaches, i.e. co-pelletizing or separate fuel feeds.

The work includes results from three experimental campaigns, performed in separate grate fired medium scale boilers (200 kW, 2 MW and 4 MW, respectively). In two of the campaigns, pelletized stemwood-based softwood where co-combusted with different mix-in levels of peat (5, 10, 15 and 20 wt-%). In the third campaign, Salix chips were co-combusted with 15 wt-% peat. Chemical equilibrium model calculations were used to determine the mix-in levels. The peat assortments were selected based on results from previous research as well as their availability. The used peats had relatively high Al/Si and Ca/Si ratios, although with somewhat varying ash content between 2.6 and 6.2 wt-%. Particle mass concentrations and size distributions were determined using a 13-stage (0.03-10 µm) low-pressure cascade impactor from Dekati Ltd (DLPI). The sampled particulate matter and bottom ashes were characterized by SEM-EDS for morphology and elemental composition as well as by P-XRD for crystalline phase composition.

The results showed that co-combustion with peat provided a PM_1 reduction for all fuel blends, between 30-50% lower emissions. In addition, the overall chemical composition of PM_1, analysed by SEM/EDS, displayed a decrease in chlorine concentration and an increase in sulfur. XRD analysis confirmed higher crystalline content of K_2SO_4 and K_3NaSO_4 instead of KCl suggesting that PM_1 emissions are not only reduced but also shifted in composition. Overall, the study illustrates that; *i)* the fine particulate emissions from medium scale grate combustion of typical softwood fuels can be significantly reduced, up to 50%, by co-combustion with peat, and *ii)* these positive effects were observed in all studied cases, regardless of the peat ad-mixing approach.

Characterising electricity markets for a flexible power production out of biogas – current situation, key factors and trend analysis

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The running out of fixed feed-in tariffs, granted from the Austrian Green Electricity Act, leads to the situation that biogas plant operators have to search for new business models, in order to keep their plant in operation. At the same time, increasing wind and PV power installations lead to an increasing need of control reserve and balancing energy. As for those products higher revenues can be achieved as on other electricity markets (e.g. spot markets), this could be an option for biogas plant operators to find an alternative electricity marketing strategy.

Biogas CHP engines are technically capable of providing positive and negative secondary control power. An economic assessment for marketing of control reserve for biogas plants in Austria has not been done yet. The first step to address this task, is to characterise the intended market and identify key factors, which have to be considered for a participation.

The objective of this study is to evaluate historic data concerning prices of control reserve products as well as actual call frequencies for the provided power. Those two factors determine the possible revenues from participating on the market for control reserve. Additionally, legal framework as well as actual developments concerning market mechanisms are addressed.

Preliminary results show, that demand (calls) as well as prices for control reserve increased the last three years. In order to keep the costs for control reserve low, the Austrian transmission system operator (Austrian Power Grid AG) tries to acquire more control reserve distributors. This is, on the one hand, a chance for biogas plants operators to enter the market. At the other hand, this could lead to a decrease of the prices of control reserve as well as the chance to get the acceptance of a bid.
First results show that, past average prices and call frequencies on control reserve markets allow considerably higher revenues compared to spot markets like the EXAA or EPEX. Nevertheless, the level of the actual fixed feed-in tariffs could not be reached. Further investigations will consider different market strategies in order to increase revenues.

The database is used to create suggestions for the operation of CHP engines, in order to participate on the control reserve market. In the course of the “Bio(FLEX)Net” project, the concept of flexible electricity production for the distribution of secondary control reserve should be demonstrated on real-scale level.

Integrated bioeconomical complexes with the biggest significance in Europe's bioenergy, fulfilling the criterions of Global Climate Agreement at the UN- Paris 2015

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The Hungarian SME offers an integrated technological system of bioengineering, biotechnology and climate protection processes in different sizes and diversity of technical content. The system materialized in industrial complexes is adaptable to various local conditions. Main advantages are the worldwide applicability, negative or zero carbon emission, high climate, environmental, health protection effect and bioeconomic efficiency.

This sustainable bioindustrial complex(BIC) is a special - harmonised and feasible - interconnection of modular bioenergetic, biotechnological production, climate-, environment and health protection subunits with multiple possibilities of connection to in- and output facilities and networks.

The combination of renewable energetic, biotechnological, climate, environment and health protection processes are adaptable to greenhouse gas conversion necessity, territorial conditions (natural resources); able to transform the pollutants, natural resources and organic waste to energy, simultaneous with production of valuable biotechnological products.

The CO_2 emitted from internal subsystems (such as fermentation,pyrolysis,torrefaction,trigen energy production) and arriving from external sources (power plants, other emitters) is integrally valorised by bioconversion.
These process improve the enhanced efficiency of BIC by mitigation of carbon footprint and generation of important treadable CO_{2eq}.
All energy requirement of the BIC is ensured by own bioenergy production. The excedent of energy or biofuels (biomethane,bioethanol, biodiesel, LBM,CBM, biorefinery products in conformity of specific needs) is provided to external networks (electrical, NG grid, district heating&cooling) or valorified by biofuels commercialisation chaines.

The BIC is connectable to a lot of emitting sources, is capable to conversion of biodegradable and burning waste(biomass,municipal) to energy and valuable products(biochar,biooils,biofertilizers) by use of modern thermochemical processes(pyrolysis,gasification, torrefaction) and bioconversion of CO_2 and GHGs in dynamical photobiocatalytical reactors(DPBR).

The paper present the key parameters of BIC , their possible in- and outputs and as wellas the processes used

The BIC provide a sustainable and efficient, compact bio- and circular economical solution to Europe's and the world's bioenergy and climate-environmental problems with the biggest significance in fulfilling the criterions of the Global Climate Agreement at the UN-Paris 2015.

Liquid Phase Pyrolysis Based Biomass Liquefaction

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Liquid phase pyrolysis

Non-renewable energy resources such as oil and coal will not suffice the increasing demand of energy in the future. To fill the upcoming gap a biomass liquefaction concept has been developed. This concept consists of two main process steps. In the first step lignocellulosic biomass is converted into pyrolysis oil and pyrolysis char through the bioCRACK process [1]. In the second step the intermediate products are upgraded. Two upgrading technologies were investigated: hydrodeoxygenation (HDO) of pyrolysis oil [2] and hydrogenation of pyrolysis char. The bioCRACK process was successfully operated in pilot scale (100 kg/h lignocellulosic feed) over two years.

Continuous HDO of liquid phase pyrolysis oil

Liquid phase pyrolysis oil was upgraded by continuous hydrodeoxygenation in lab scale. Hydrotreatment was performed catalytically in a plugflow reactor. Operation parameters were 400°C and 121 bar hydrogen pressure. Lab scale results showed a carbon yield of 38% in the fuel phase with a carbon content of about 86% and a hydrogen content of about 13%. The elemental composition as well as the water content of the product phase for different liquid hourly space velocities is shown in table 1. The boiling range of the fuel phase is between diesel and gasoline.

Table 1: Elemental composition and water content of the organic phase

50h HDO treatment	LHSV [h^{-1}]	Water content	C [%]	H [%]	Rest = O [%]	N [%]
Organic phase	0.5	0.02%	86.6%	12.9%	0.0%	0.4%
Organic phase	1	0.01%	85.9%	13.6%	0.0%	0.5%
Organic phase	2	0.13%	85.4%	12.9%	1.3%	0.4%

At a space velocity of 3 [h^{-1}] unsteady operating conditions, like irregular pressure changes, were observed.

Liquefaction of pyrolysis char

Direct liquefaction of pyrolysis char was carried out in lab scale catalytically and non-catalytically. Non-catalytic biochar liquefaction showed a conversion of 84% and an oil yield of 72% [3], catalytic biochar liquefaction resulted in 100% conversion and 95% oil yield.
The design parameters for pilot scale of the hydrodeoxygenation technology as well as the hydrogenation technology (upgrade of pyrolysis oil as well as biochar) are under evaluation.

[1] Schwaiger, N.; Elliott, D. C.; Ritzberger, J.; Wang, H.; Pucher, P.; Siebenhofer, M. Green Chem. 2015, 17, 2487–2494.
[2] Pucher, H.; Schwaiger, N.; Feiner, R.; Ellmaier, L.; Pucher, P.; Chernev, B.; Siebenhofer, M. Green Chem. 2015, 17, 1291–1298.
[3] Feiner, R.; Schwaiger, N.; Pucher, H. RSC Adv. 2013, 3, 17898–17903.

Warren-Spring based model for the shear yield locus of biomass powders

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Energy from biomass should replace in the future a part of the energy we consume. Indeed, it can be converted into heat, electricity or fuels. Biomass upgrading into energy can be achieved with technologies similar to those existing for coal gasification, like entrained flow reactors. In such gasifiers, biomass has to be injected as a fine powder, with particle size below 1 mm. These powders have poor flowing properties, due to their cohesion, which comes from their low bulk density (around 200 kg/m3), high polydispersity, needle-like shape and small size (30 microns-1mm). Low flowability can lead to major issues in the process (fouling, arching…). It is therefore crucial to accurately characterize the cohesion of these powders in the conditions of the processes, to be able to propose technical solutions to this issue.

Our objective is to characterize the flowability of fine wood powders under low consolidation stresses. Indeed, in the gasification process, powders are submitted to low consolidation stresses (<5kPa), due to their low bulk density and Janssen's stress saturation in silos. In this work we propose a characterisation of shear resistance of slightly cohesive powders under low compaction stresses by measuring yield loci, and a study of the dynamic avalanche angle for the normal stresses close to zero. The yield loci of the powders have been measured with a powder rheometer (FT4 from Freeman Technology), for consolidation stresses below 5kPa with an adapted method enabling to measure the shear stress for normal stresses down to 0.01kPa. The dynamic avalanche angle has been measured with a rotating drum (10 cm diameter and 3.5 cm thickness), for 24 different powders: coarse and fine wood powders as well as other materials (wheat flour, talcum, sugar, wheat semolina, olivine…).

The results show that, contrary to non-cohesive powders, wood powders exhibit a curved yield locus that cannot be described with a straight line (the Mohr-Coulomb failure criterion), because the results at small and negative normal stresses would be overestimated. Moreover, the rheometer cannot measure the shear stress at zero normal stress. Yet, important parameters such as cohesion (Y-intercept) and traction (X-intercept) have to be derived from the yield locus. Therefore, the objective is to describe accurately the lowest stresses of the curved loci. An original model based on Warren-Spring equation is used to describe the loci. This method is found to fit correctly the data.

The angle of avalanche represents the ability of the powder to flow under its own weight. Therefore we try to link the evolution of this angle with the ratio of cohesive forces over the weight called cohesion length. The results show a linear relation between these parameters.

In these studies, relationships between powder physical parameters and flowing parameters have been highlighted. With simple measures on a biomass powder (aerated density and avalanche angle), these relationships allow to model its yield locus with a satisfactory accuracy. The proposed methods describe accurately the yield loci of cohesive biomass powders, and in particular the small stress range and the cohesion.

Small-scale biomass heating: Assessing strategies for a challenging market

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Background

Austria has been the leading country for small-scale biomass heating technology, but currently the domestic market is shrinking. During the last three years sales figures for small-scale biomass heating, i.e. boilers for residential heating, decreased significantly in Austria.

The objective of the study on hand was to find out the reasons for this development and to outline strategies to reverse this trend, in particular strategies for improving professional training of craftsman.

Method

A survey among installers and bioenergy experts was carried out in order to investigate the driving factors in biomass market developments. Installers are the most important opinion leaders for changing the heating sector towards renewable energies. Thus, leading representatives of the guild, all of them working as installers and entrepreneurs, were consulted. The applied methodology was an adapted SWOT analysis. First of all Strengths, Weaknesses, Opportunities and Threats (SWOT) were collected by the means of open-ended questions. Secondly, the participants got this collection and were requested to rank the items in each category.

Thirdly, the most important strengths, weaknesses, opportunities and threats were used to develop strategies in a participative decision process within a workshop setting. Finally, the strategies were ranked.

Results and discussion

The poster shows a summary matrix for the SWOT-Analysis and strategy development. As most important strengths have been identified: (1) sufficient wood quantity in Austria and (2) regional value creation. The most relevant weaknesses are: (1) high acquisition costs and (2) space requirement for biomass heating systems. The top-ranked opportunities are: (1) resource potential is still increasing and (2) Paris agreement. Important threats are (1) low prices for fossil fuels and (2) negative perception of biomass.

The project team suggested a broad range of strategies. However, only selected strategies that are believed to be the most relevant were included in the final matrix. A promising strategy, combining strengths and opportunities, is to “develop the profession installer further towards an overall energy manager for buildings”. Evidently, this strategy addresses the guild and professional representatives. Qualified installers should have profound knowledge in small-scale biomass heating and enthusiasm for biomass heating and energy efficiency; thus, the cooperation between installers and the bioenergy sector, namely the Austrian Biomass Association, is substantial.

The in-detail results are currently used to develop the training programme “Biowärme-Installateur®”, carried out by the Austrian Biomass Association.

Practical relevance of ash melting tests for solid biomass fuels – a close look in view of an upcoming new ash melting standard

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Introduction
Ash melting and slag formation respectively is still a critical factor in the utilisation of solid biomass fuels. So far, the characteristic temperatures method (CEN/TS 15370) is most frequently used, and currently activities for the development of a new ISO standard based on this method are in progress.
The characteristic temperatures method is currently the only standardised method that is available for the description of the ash melting properties of solid biomass fuels, and no alternative methods could be established for this purpose so far. However, the significance with regard to practical performance and the applicability of this method for a wide range of biomass fuels is frequently doubted, and consequently the specification of critical parameters and related threshold values is a sensitive issue.

Approach
In the present work fundamental considerations concerning requirements for an accepted and practicable method are discussed systematically, and particular aspects and conclusions are underpinned with data and analysis results. In this regard, special focus is set on experiences from practical combustion tests with a broad variety of fuel qualities, but also results from various laboratory test methods are presented.

Results
Test conditions in the laboratory in some respects differ from combustion conditions in real combustion appliances, and some of these parameters can considerably influence the ash melting behaviour and slag formation performance respectively. The transformation of lab test results into practically relevant threshold values or recommendations is therefore the trickiest problem to solve.
Apart from practical relevance, aspects like e.g. nature and precision of the parameter determined, availability of equipment, staff requirements, duration of analysis or objectiveness of evaluation are identified to be the most important requirements for a well-accepted method.
Results of an extensive data set of woody and non-woody biomass fuels show that the characteristic temperatures method is well suited to discriminate high quality from low quality fuels. However, the major challenge is a differentiation and related quality assurance among better qualities of (mostly wooden) fuels. In this regard, the reproducible determination of the characteristic deformation temperature (DT) – which is a frequently used quality feature –, and even the significance of this parameter is questionable.

Conclusions
Many parameters influence the degree of ash melting or slag formation of biomass fuel ashes, and it is hardly feasible to consider all factors in one single method. In this regard, individual methods for particular applications could be a practicable approach and consequently more than one method for ash melting characterisation is conceivable.
The principle of the characteristic temperatures method is still considered as useful. However, optimisation of the method in terms of sample preparation as well as evaluation and interpretation of the received data are required, in order to receive reliable and significant results.
The significance of any method with regard to the respective field of application is of main importance, and indicative parameters and respective threshold values need to answer specific questions in this regard.

Investigation on benefits of smaller scale utilization of torrefied wood pellets on local communities in Japan and Germany

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Pelletisation needs extra energy within the process compared to wood chip production. Also additional costs occur. Torrefaction of the raw material or of the pellets is another energy consuming and cost intensive process step. Therefore it is not for sure that the final costs of the torrefied pellets are accepted on the fuel market. FFPRI (Japan) and DBFZ (Germany) have worked on a method to calculate final costs of the torrefied wood pellets and to identify the money value of the possible advantages of the product.
FFPRI is an institute of the National Research and Development Agency in Japan, and the mission is to contribute to sustainable development of the world blessed with rich and diverse forest, through researches on forest, forestry and forest products. One of the main research projects is efficient utilization woody biomass for energy and materials.
DBFZ Deutsches Biomasseforschungszentrum gemeinnützige GmbH in Germany is a research company owned by the Federal States of Germany under the supervision of the Federal Ministry of Food and Agriculture (BMEL). Its core mission is "application-oriented research and development in the use of regrowable resources as an energy source and integrated base material within the bioeconomy, giving particular consideration to innovative technologies, economic impact and environmental concerns“*.
In cooperation of the FFPRI and the DBFZ intensive research takes place in the field of production and consumption of torrefied wood pellets. One aspect of the work is the search for economical feasible utilisation cases. In Japan heating of greenhouses for agriculture is an important source of heat demand. According to the political strategy of Japan to increase the use of biomass for energy generation the FFPRI is researching the production of torrefied wood chips in a continuous process by a rotary kiln from Actree together with Sanyo trading, which have the necessary pelletisation technology and knowledge. First combustion tests of the product have taken place in wood pellet stoves as well as in pellet boilers. Results of the economic feasibility and the combustion behaviour are given in the poster.
At the same time, DBFZ is researching an improved quality control of the torrefaction process on a small batch process in a rotary drum. Reproducibility of the torrefaction process depends on homogeneity of the biomass and of the temperature control in the process. External heating creates some offset between contact temperature of the material and measured temperatures within the reactor. Additionally DBFZ has developed a micro scale gasifier of charcoal on a laboratory scale together with a motor engine with a nominal electricity output of 0.55 kW_{el}. Latest results according to technical aspects of changing fuels towards torrefied wood pellets and to feasible market strategies are shown in the poster.
FFPRI and DBFZ have a common method for economic research. On that basis the different economical background in Japan and Germany are also described in the poster. The different utilisation purposes will be shown and the results about the economical options will be presented.
Japan with its quite huge potential of wood biomass has good opportunities for increasing heat production from improved wood fuels. Germany at the same time needs new ideas to use the storable biomass for stabilising the electricity supply while wind and solar bring high fluctuations to the grid. At the same time heat generation especially during the winter time will keep important. Micro-CHP-technology could have good economical chances in the future.

* Article 2 of DBFZ Articles of Association

Emissions reduction from small wood chip boilers by optimization of combustion control and fuel selection

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Increasing interest in reduction of air pollution led to stronger regulations of emissions control for wood combustion units. Different legal regulations in Europe are in process or established. In Germany the First Federal Emission Control Act for small and medium sized boiler states the value of 20 mg/m^3 as limit for dust emissions since 01.01.2015. For small boilers without additional filters it is challenging to keep this limit and it requires proper maintenance of the boilers as well as fuels of high quality.
For the operation of small boilers the additional installation of a dust filter could be a significant financial burden. In this context combustion tests were conducted to improve the combustion control and to find fuels enabling to run small wood chip boilers without dust filter and keeping the limit of 20 mg/m^3 reliably. Also the influences of different parameters of fuel quality on the emissions were investigated.

Combustion tests were conducted with two wood chip boilers, one 75 kW boiler with a step grate and another 50 kW boiler equipped with a dumping grate, both with a side feed of the fuel in two test phases. First the best combustion control was determined with two different fuels varying the ratio of primary and secondary air and content of residual oxygen in the exhaust gas, respectively. Emissions of CO and dust were analyzed as well as NOx and hydrocarbons. In a second test phase run with the optimized combustion parameters eleven different fuels were used.

The wood chips used in the tests covered a range of particle size classes from P16S to P45S with moisture contents from 6 % to 29 %. The moisture content of 29 % of one of the samples was in the range of the recommended maximum for the boilers with 25 % for the smaller boiler and 35 % for the larger one. All fuels had a very low ash content (≤ 0,7 %) except for the wood chips from logging residue (approx. 4 %). Particular attention was paid to the influence of fines. To recognize exclusively the effect of increasing amounts of fines without the contribution of higher ash contents fines were prepared from the original woodchips and mixed in to the samples they were taken from. With exception of the wood chips from logging residue all original samples had amounts of fines < 5 % and the samples with added fines had amounts of 10 % and 15 %, respectively.

Optimization of combustion control showed in mean the best results with recommended settings for the 75 kW boiler and with only slight changes from recommended settings for the 50 kW application.
Comparing the influence of different fuels on the dust emissions the best results were obtained with smaller wood chips (P16S, P31S) with low or moderate moisture content (7 – 23 %) with results within the range from 10 – 27 mg/m^3 depending to the boiler and instrument used for analysis (reference method and on site instruments were applied). Larger wood chips (P45S) with low moisture content also achieved similar results but with increasing moisture values for dust emission rose to about 60 mg/m^3. The behavior of the two tested boilers was very similar with slight advantages for the larger one. Higher amounts of fines seem to increase the dust emissions slightly. Best results for the CO emissions were determined for wood chips with moisture contents up to 23 % with CO-values in a range between 40 and 110 mg/m^3. Tests with partial load (30 %) showed significant higher dust (90 – 230 mg/m^3) and CO emissions (400 – 1100 mg/m^3).

The results demonstrate that operation of the boiler with dust emissions below 20 mg/m^3 is possible not only on the test bed but with commercially available fuel and real live conditions but requires the selection of suitable fuel of high quality and optimization of combustion control. It was shown that increasing the moisture content or the fines content lead to higher dust emissions. But the biggest influence came from partial load operation resulting in significant higher emissions of dust and CO.

Pyrolysis of sewage sludge to produce fuels and chemical feedstock

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Introduction
The use of biomass as an energy source and resource is being promoted in order to prevent global warming by reducing greenhouse gases. But the amount of biomass is limited. The use of wood for energy purposes for example is heavily criticized by the wood processing industry. In case of agricultural commodities the food processing industry presents itself as an important competitor. Additionally in many cases large amounts of biogenic residues are treated insufficiently. Biogenic residues and waste are alternative raw material to produce fuels and chemical feedstock. Sewage sludge is one of this alternatives raw materials. The aim of this work is to investigate pyrolysis of sewage sludge in order to produce chemical feedstock.

Objective
Pyrolysis is a process in which organic substances are thermally decomposed in oxygen-free atmosphere. The process temperatures are ranging between 300°C and 900°C. As a result of thermal conversion the carbonaceous content of sewage sludge is converted into gaseous, liquid and solid products. The overall objective of this work is to investigate the influence of heating rate, pyrolysis temperature and residence time to the composition of products.
Approach

The sewage sludge pyrolysis experiments are carried out in a laboratory scale plant equipped with a screw feeder reactor operating at ambient pressure. The reactor is heated by an electrical furnace with three heating zones, which could be controlled independently. The Temperature can be varied between 200°C to 600°C and the residence time of solid material can be varied between 5 to 12 min. The composition of the products is analyzed with GC/MS and ultimate analysis.

Expected Results
- product distribution (gaseous, liquid, solid) as a function of temperature, heating rate and residence time
- composition of products according to temperature, heating rate and residence time

Highly efficient MBMBR treatment of biomass heat recovery condensate – example BHW Flachau

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While heat recovery systems have been the best available technology with regard to gas and oil combustion since the end of the 20th century, and standards for treatment of the resulting condensate are well established (i.e. DWA A-251), the use of technically mature (active) heat recovery systems at biomass combustion systems is a phenomenon of the last years. Biomass heat recovery condensate is predominantly outsourced to local wastewater treatment plants due to a lack of technical standard solutions.

The quantity of condensate incurring mainly depends on the moisture and hydrogen content of the biomass combustible material, the air ratio of combustion and the heat distribution return temperature and can be assumed at a level of 0.05 to 0.2 l/kWh boiler-heat. The composition of the condensate depends on the elemental composition of the different types of biomass combustible materials and the process parameters of combustion and consists of ash particles passing the flue gas cleaning system, containing metals and heavy metals (primarily Pb, Cd, Zn, Cu, Cr), remains of unburnt organic carbon and hydrocarbon compounds, PAH, incomplete oxidised Nitrogen compounds – primarily NH_4-N and NO_2-N – and Sulfur and Chlorine compounds, either in solution or as a particulate substance.

The design introduced in this paper and applied at Flachau/Salzburg biomass heating plant for treating biomass heat recovery condensate is based on a moving bed membrane bio reactor (MBMBR) process and enables exceeding direct discharge quality: At a maximum boiler capacity of 7 MW_{th}, 3.5 m³/h, respectively 70 m³/h condensate is cooled down, neutralised and introduced into the 9 m³ moving bed bioreactor under the tower condenser, where sessile microorganisms on growth bodies eliminate biodegradable carbon remains and nitrification takes place. Through the C-MEM ultrafiltration membrane system consisting of porous hollow fibre cartridges with pore sizes of 0.02 – 0,2 µm all suspended solids up to a level of < 0,3 NTU are retained in the bioreactor and the permeate is discharged into the near Gries river.

A detailed overview will be given of

- Formation and quality of biomass heat recovery condensate
- MBMBR process applied for treatment
- Data on and evaluation of performance regarding treatment and energy efficiency
- Advantages compared to indirect discharge

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Programm Teil 2

Programme Part 2

Workshop: IEA Bioenergy TASK 32

Saal 12, 13:30 – 17:00

Praxisnahe Testmethoden für Kleinfeuerungen

Vortragssprache **Englisch**

Donnerstag 19 Jänner

„Technologischer Fortschritt benötigt geeignete Testmethoden, um sichtbar zu werden. Gleichzeitig sind Testmethoden wichtige Werkzeuge, um technologischen Fortschritt anzuregen und zu steuern. Der Workshop gibt einen Überblick über neue Beurteilungsmethoden für häusliche Biomassefeuerungen. Ein Schwerpunkt der Veranstaltung liegt auf den praxisnahen „beReal"-Testmethoden für Scheitholz und Pelletsöfen."

Chairman: Christoph Schmidl, *Bioenergy 2020+ GmbH*

13:30 Begrüßung & Einführung

- Jaap Koppejan, *Procede Biomass BV, Niederlande*
- Hans Hartmann, *TFZ Straubing, Deutschland*
- Christoph Schmidl, *Bioenergy 2020+ GmbH, Österreich*

Session 1: Das „beReal"-Projekt

13:40 **Die Brennholzmethode**
Marius Wöhler, *Hochschule für Forstwirtschaft Rottenburg, Deutschland*

14:00 **Die Pelletsmethode**
Hans Hartmann, *TFZ Straubing, Deutschland*

14:20 **Wissenschaftliche Highlights**
Gabriel Reichert, *Bioenergy 2020+ GmbH, Österreich*

14:40 **Kennzeichnungssystem**
Christoph Schmidl, *Bioenergy 2020+ GmbH, Österreich*

15:00 **Kaffeepause**

Session 2: Aktuelle Methodenentwicklungen

15:40 **Aktuelle Entwicklungen von Testverfahren in den USA**
Lisa Rector, *NESCAUM, Vereinigte Staaten von Amerika*

16:00 **Die EN-PME-Methode**
Michael Sattler, *Ökozentrum Langenbruck, Schweiz*

16:20 **Lastzyklustest für Biomassekessel**
Elisa Carlon, *Bioenergy 2020+ GmbH, Österreich*
Markus Schwarz, *Bioenergy 2020+ GmbH, Österreich*

16:40 **Emissionen von Pelletskesseln kleiner Leistung**
Lukas Sulzbacher, *Josephinum Research, Österreich*

17:00 **Ende**

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Workshop: IEA Bioenergy TASK 32

Room 12, 01:30 – 05:00 pm

Practical test methods for small-scale furnaces

Language **English**

Thursday 19 January

„Technological progress requires suitable test methods to become visible. At the same time test methods are important tools to stimulate and guide technological progress. The workshop provides an overview of new evaluation methods for domestic biomass combustion systems. One focus of the event will be on the real-life oriented „beReal" test methods for firewood and pellet stoves."

Chairman: Christoph Schmidl, *Bioenergy 2020+ GmbH*

01:30 pm Welcome & Introduction

- Jaap Koppejan, *Procede Biomass BV, Netherlands*
- Hans Hartmann, *TFZ Straubing, Germany*
- Christoph Schmidl, *Bioenergy 2020+ GmbH, Austria*

Session 1: The „beReal" project

01:40 pm **The firewood method**
Marius Wöhler, *University of Applied Forest Sciences Rottenburg, Germany*

02:00 pm **The pellet method**
Hans Hartmann, *TFZ Straubing, Germany*

02:20 pm **Scientific highlights**
Gabriel Reichert, *Bioenergy 2020+ GmbH, Austria*

02:40 pm **Labelling concept**
Christoph Schmidl, *Bioenergy 2020+ GmbH, Austria*

3:00 pm **Coffee break**

Session 2: Current method developments

03:40 pm **Current developments of US testing protocols**
Lisa Rector, *NESCAUM, United States of America*

04:00 pm **The EN-PME method**
Michael Sattler, *Ökozentrum Langenbruck, Switzerland*

04:20 pm **Load cycle test for biomass boilers**
Elisa Carlon, *Bioenergy 2020+ GmbH, Austria*
Markus Schwarz, *Bioenergy 2020+ GmbH, Austria*

04:40 pm **Emissions from small-scale pellet boilers**
Lukas Sulzbacher, *Josephinum Research, Austria*

05:00 pm **End**

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Industrieforum

Simultanübersetzung

Donnerstag 19 Jänner

Bioenergie, Galerie, 13:30 – 17:00

Chairman: Walter Haslinger, *Bioenergy 2020+ GmbH , Österreich*

Im Industrieforum werden österreichische und internationale Unternehmen aus dem Bereich Bioenergie ihre Aktivitäten, Kernkompetenzen und Referenzen mittels einer kurzen Präsentation vorstellen. Im anschließenden Get-together-Diskussionsforum haben Teilnehmer die Möglichkeit, Vertreter der präsentierten Unternehmen zu treffen und mögliche zukünftige Kooperationen und Projekte auf einer individuellen Basis zu diskutieren. Das Industrieforum ist für alle Konferenzteilnehmer offen.

Es gibt noch **freie Plätze!** Wollen Sie Ihr Unternehmen präsentieren? Anfragen an **bauderer@biomasseverband.at**

13:30 **Einleitung Moderator**

Herz Energietechnik GmbH, Wolfgang Karlovits

Komptech GmbH, Andreas Kunter

SynCraft Engineering GmbH, Marcel Huber

Hargassner GmbH, Anton Hofer

Urbas Maschinenfabrik GmbH, Peter Urbas

AEBIOM, Glen Wilson

Polytechnik Luft- und Feuerungstechnik GmbH, Thomas Hofmann

CEBCON Technologies GmbH, Valery Detzel

Valmet GmbH, Markus Bolhar

Bioenergy 2020+ GmbH, Dina Bacovsky

AGRANA Stärke GmbH, Horst Hartl

LEC GmbH, Johann Reichmann

Fröling Heizkessel- und Behälterbau GmbH, Wolfgang Aichinger

ATech electronics d.o.o., Davor Jakulin

Im Anschluss:
Diskussionsforum Get-together (inkl. Kaffee und Kuchen)

Für die Konferenzteilnehmer wird hier die Möglichkeit geschaffen, mit Unternehmen direkt in Kontakt zu treten. Dazu stehen den Unternehmen unmittelbar neben dem Vortragssaal Stände zur Verfügung, an denen sie sich entsprechend präsentieren können. In entspannter Atmosphäre bei Kaffee und Kuchen können dort persönliche Kontakte geknüpft und Projekte besprochen werden. Die Stände sind mit Tisch und Stühlen ausgestattet und stehen den Unternehmen am 19. Jänner ganztägig zur Verfügung.

17:00 **Ende der Veranstaltung**

Industry Forum

Simultaneous translation

Thursday 19 January

Bioenergy, Galerie, 01:30 – 05:00 pm

Chairman: Walter Haslinger, *Bioenergy 2020+ GmbH , Austria*

In the Industry Forum national and international companies active in the fields of bioenergy will present their core competencies, activities and relevances in a short presentation. In the subsequent discussion forum the participants have the chance to meet members of the presented companies and can initiate possible future projects and cooperations on an individual basis. The Industry Forum is open to all conference participants.

There are still some **free places availabe**! Send your request to **bauderer@biomasseverband.at.**

01:30 pm **Introduction Chairman**

Herz Energietechnik GmbH, Wolfgang Karlovits

Komptech GmbH, Andreas Kunter

SynCraft Engineering GmbH, Marcel Huber

Hargassner GmbH, Anton Hofer

Urbas Maschinenfabrik GmbH, Peter Urbas

AEBIOM, Glen Wilson

Polytechnik Luft- und Feuerungstechnik GmbH, Thomas Hofmann

CEBCON Technologies GmbH, Valery Detzel

Valmet GmbH, Markus Bolhar

Bioenergy 2020+ GmbH, Dina Bacovsky

AGRANA Stärke GmbH, Horst Hartl

LEC GmbH, Johann Reichmann

Fröling Heizkessel- und Behälterbau GmbH, Wolfgang Aichinger

ATech electronics d.o.o., Davor Jakulin

Following:
Discussion forum: Get-together (incl. Coffee & Cake)

This discussion forum will offer the opportunity for participants to contact representatives of the presented companies and to discuss possible future projects and cooperations. For individual discussions in relaxed atmosphere each company will have its own stand next to the hall where the company presentations take place, equipped with chairs and tables, where coffee and refreshments will be served. These information stands will be available on 19th January.

05:00 pm **End**

The biggest renewable energy source in the world: Mother Nature

Nature never runs out of energy. Flora and fauna renew themselves every day, creating bio mass as they do, which is wonderful for us to use to generate fuel, electricity and heat. Renewable raw materials, our sun, wind, water and energy efficiency, are the backbone of a sustainable and conscientious use of our resources. Talk to us about renewable energy – the most natural thing in the world.

RENEWABLE ENERGY

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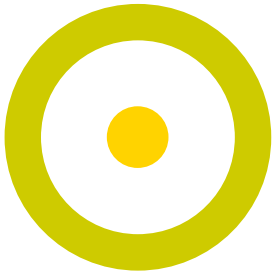

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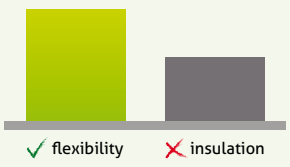

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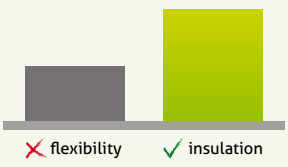

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www.tuev.at/biomasse

AEBIOM Workshop: EU Winterpackage

Saal 10, 13:30 – 17:00

Vortragssprache Englisch

Donnerstag 19 Jänner

„Anlässlich der Veröffentlichung des EU-Winterpakets, dass eine Fülle an neuen Ansätzen und Regeln für die Bioenergiepolitik der Europäischen Union beinhaltet, wird der Europäische Biomasse Verband (AEBIOM) einen eigenen Workshop ausrichten. Neben der Information über die aktuellen Richtlinienvorlagen wird im Workshop besonderer Augenmerk auf den Austausch von Standpunkten und Diskussion gelegt."

Jean-Marc Jossart, *AEBIOM*

AEBIOM
EUROPEAN BIOMASS ASSOCIATION

Auswirkungen des EU-Winterpakets auf die Bioenergiebranche

Jean-Marc Jossart, *AEBIOM Generalsekretär*

Die neuen Nachhaltigkeitspolitik der EU: neue Regeln für feste Biomasse:

- Zusammenfassung der Komissions-Vorschläge
- NGO-Angriffe: Handlungsbedarf für die gemeinsame Kommunikation?

Fanny-Pomme Langue, *AEBIOM Policy Director*

Raumwärme auf dem Weg zur Elektrifizierung?

Nathalie Hemeleers, *AEBIOM Policy Advisor*

Das „clean energy for all package" behandelt folgende Themen:

- Erneuerbare Energien & Bioenergie
- Energieeffizienz
- Strommärkte
- Nachhaltigkeit
- Förderungen
- Governance

Kommissionsvorschläge: www.ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

AEBIOM Workshop: EU winter package

Room 10, 01:30 – 5:00 pm

Language English

Thursday 19 January

„The European Biomass Association (AEBIOM) will organize a workshop on the occasion of the publication of the EU package "Clean Energy for all Europeans", which contains a wealth of new approaches to bioenergy policy in the European Union. In addition to the information on the current draft legislative proposals, special attention will be devoted to the exchange of standpoints and discussion. "

Jean-Marc Jossart, *AEBIOM*

AEBIOM
EUROPEAN BIOMASS ASSOCIATION

Impact of the EU winter package on the bioenergy sector

Jean-Marc Jossart, *AEBIOM Secretary General*

The EU's new sustainability policy: new rules for solid biomass

- Summary of the European Commission legislative proposal
- NGO attacks: Need for action for corporate communications?

Fanny-Pomme Langue, *AEBIOM Policy Director*

The Heating sector: Towards electrification?

Nathalie Hemeleers, *AEBIOM Policy Advisor*

The "clean energy for all package" covers the topics:

- Renewables & Bioenergy
- Energy efficiency
- Electricity markets
- Sustainability
- Funding
- Governance

Commission papers: www.ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

Parallelblock 1

Biogas

Saal 11, 13:30 – 15:00

Chairman: Arthur Wellinger, *Triple E&M, Schweiz*

13:30 **Beginn**

Zwischenfrüchte für Biogas: Akzeptanzverbesserung und effektiver Umweltschutz
Manfred Szerencsits, *Ökocluster, Österreich*

Holzasche aus Fernwärmeanlagen zum Upgrading von Biogas
Silvia Silvestri, *Fondazione Edmund Mach, Italien*

Szenariobasierte Nährstoffbilanzierung von Gärresten und Wirtschaftsdüngern
Markus Heberlein, *Fraunhofer Umsicht, Deutschland*

THG-Minderungseffekte durch Wirtschaftsdünger in Biogasanlagen unter Berücksichtigung von Biomethan als Kraftstoff
Katja Oehmichen, *Deutsches Biomasseforschungszentrum GmbH, Deutschland*

Die Wertigkeit von flexiblen Ökostromerzeugungseinheiten
Bernhard Stürmer, *Hochschule für Agrar- & Umweltpädagogik Österreich*

15:00 **Kaffeepause**

Vortragssprache **Englisch**

Parallelblock 2

Bioökonomie: Systembetrachtungen

Saal 11, 15:30 – 17:00

Donnerstag 19 Jänner

Chairman: Hubert Röder, *Hochschule Weihenstephan Triesdorf, Deutschland*

15:30 **Beginn**

Stärkung einer kreislauforientierten forstlichen Bioökonomie
Barbara Hedeler, *Wood K plus GmbH, Österreich*

Strategische Rahmenbedingungen zur Transformation der Papier- und Plattenindustrie zu Bioraffinerien: Einblicke aus einer Delphi Studie
Natasha Gabriella, *Universität Graz Institute of Systems Sciences, Innovation and Sustainability Research, Österreich*

Überblick über die internationalen Forschungsaktivitäten zu Biobased Industries
Martin Beermann, *Joanneum Research Forschungsgesellschaft mbH, Österreich*

Herstellung von Lignocellulose Ethanol (LCB) aus Maisstroh – eine Machbarkeitsstudie für Serbien
Milan Martinov, *University of Novi Sad, Faculty of technical sciences, Serbien*

Das Bioraffinerie-Innovationssystem: Was wir lernen und welche Fragen wir stellen sollten
Tobias Stern, *Karl-Franzens-Universität Graz, Österreich*

17:00 **Ende**

Vortragssprache **Englisch**

Parallel Session 1

Biogas

Room 11, 01:30 – 03:00 pm

Chairman: Arthur Wellinger, *Triple E&M, Switzerland*

01:30 pm **Opening**

Intertillages for biogas plants: Increasing acceptance and effective protection of the environment
Manfred Szerencsits, *Ökocluster, Austria*

Wood ash from district heating plants for the upgrading of biogas from anaerobic digestion
Silvia Silvestri, *Fondazione Edmund Mach, Italy*

Scenario based balancing of nutrients from digestates and farm fertilizers
Markus Heberlein, *Fraunhofer Umsicht, Germany*

GHG mitigation effects due to the utilization of manure in biogas plants
Katja Oehmichen, *Deutsches Biomasseforschungszentrum GmbH, Germany*

The valence of flexible eco-electricity-production-units
Bernhard Stürmer, *University College for Agrarian and Environmental Pedagogy, Austria*

03:00 pm **Coffee break**

Language **English**

Parallel Session 2

Bioeconomy – system considerations

Room 11, 03:30 – 5:00 pm

Thursday 19 January

Chairman: Hubert Röder, *Hochschule Weihenstephan Triesdorf, Germany*

03:30 pm **Opening**

Fostering a Circular Forest Bioeconomy
Barbara Hedeler, *Wood K plus GmbH, Austria*

Strategic Actions for the transition of the pulp and paper industry into Biorefinery: Insights from a Delphi Study
Natasha Gabriella, *University of Graz, Institute of Systems Sciences, Austria*

Survey of international RTD activities on biobased industries
Martin Beermann, *Joanneum Research Forschungsgesellschaft mbH, Austria*

LCB production based on corn stover – Preliminary feasibility study for Serbia
Milan Martinov, *University of Novi Sad, Faculty of technical sciences, Serbia*

The Biorefinery Innovation System: Lessons to be learned & questions to be asked
Tobias Stern, *Karl-Franzens-Universität Graz, Austria*

05:00 pm **End**

Language **English**

Parallelblock 3

Brennstoffaufbereitung und -upgrading
Saal 1, 13:30 – 15:00

Chairman: Stefano Grigolato, *University of Padova, Italien*

13:30 **Beginn**

Monitoring der Energieholztrocknung mittels wetterdatenbasierter Modelle
Gernot Erber, *Universität für Bodenkultur Wien, Dep. Wald- u. Bodenwissenschaften, Österreich*

Untersuchung der Effekte einer Hackschnitzelsiebung auf das Lagerverhalten von Hackschnitzeln in Behälterversuchen
Theresa Mendel, *Technologie- und Förderzentrum, Deutschland*

Feldversuche zur Untersuchung des Lagerverhaltens von Waldhackschnitzeln unter praxisnahen Bedingungen
Nicolas Hofmann, *Bayerische Landesanstalt für Wald und Forstwirtschaft, Deutschland*

Verbesserung der Hackgutqualität durch Siebung und Trocknung
Daniel Kuptz, *Technologie- und Förderzentrum, Deutschland*

Update zum Status der Torrefizierung als Biomasseaufbereitungstechnologie
Michael Wild, *Wild&Partner KG, Österreich*

15:00 **Kaffeepause**

Simultanübersetzung

Parallelblock 4

Donnerstag 19 Jänner

Neue Ressourcen, Potenziale & Risikomanagement für Versorgungsketten
Saal 1, 15:30 – 17:00

Chairman: Johannes Schmidt, *Universität für Bodenkultur, Institut für nachhaltige wirtschaftliche Entwicklung, Österreich*

15:30 **Beginn**

Unkrautbekämpfung in Energieweidebeständen
Isabella Donelly, *Teagasc CELUP, Irland*

Mobilisierung und Bereitstellung agrarischer Reststoffe am Beispiel der Steiermark
Alfred Kindler, *Landwirtschaftskammer Steiermark, Österreich*

Möglichkeiten zur Etablierung von Kurzumtriebshölzern in Nord-Griechenland
Ioannis Eleftheriadis, *Center for Renewable Energy Sources, Griechenland*

Entwicklung und Evaluierung von Strategien zur Bewältigung von Risiken in der Biomasseversorgung
Peter Rauch, *Universität für Bodenkultur Wien, Institut für Produktionswirtschaft und Logistik, Österreich*

Modellierung von Bioenergiepotenzialen kommunaler Kläranlagen
Kerstin Schopf, *Montanuniversität Leoben, Österreich*

17:00 **Ende**

Simultanübersetzung

Parallel Session 3

Fuel pretreatment and upgrading
Room 1, 01:30 – 03:00 pm

Chairman: Stefano Grigolato, *University of Padova, Italy*

01:30 pm **Opening**

Monitoring of fuel wood drying efficiency through meteorological data based models
Gernot Erber, *University of Natural Resources and Applied Sciences, Austria*

Container trials to examine the effects of fuel screening on the storage behavior of wood chips
Theresa Mendel, *Technologie- und Förderzentrum, Germany*

Field trials to examine the storage behavior of wood chips from forests under practical conditions
Nicolas Hofmann, *Bavarian State Institute of Forestry, Germany*

Improvement of wood chip quality by screening and drying
Daniel Kuptz, *Technologie- und Förderzentrum, Germany*

Update on the status of torrefaction as biomass upgrading technology
Michael Wild, *Wild&Partner KG, Austria*

03:00 pm **Coffee break**

Simultaneous translation

Parallel Session 4

Thursday 19 January

New resources, potentials and supply chain risk management
Room 1, 03:30 – 05:00 pm

Chairman: Johannes Schmidt, *University of Natural Resources and Applied Sciences, Austria*

03:30 pm **Opening**

Weed competition and control in willow crops
Isabella Donelly, *Teagasc CELUP, Ireland*

Mobilization and supply of agricultural residues in Styria
Alfred Kindler, *Styrian Chamber of Agriculture, Austria*

Perspectives for establishing SRCs in Northern Greece
Ioannis Eleftheriadis, *Center for Renewable Energy Sources, Greece*

Developing and evaluating strategies to overcome biomass supply risks
Peter Rauch, *University of Natural Resources and Applied Sciences, Institute of Production and Logistics, Austria*

Modelling of the bioenergy potentials of urban sewage plants
Kerstin Schopf, *Montanuniversität Leoben, Austria*

05:00 pm **End**

Simultaneous translation

Parallelblock 5

Biomassefeuerungssysteme mit niedrigsten Emissionen
Saal 1, 9:00 – 10:30

Chairman: Christoph Schmidl, *Bioenergy 2020+ GmbH, Österreich*

09:00 **Beginn**

Innovative technologische Lösungen zur Umsetzung eines Biomassekessels mit minimalsten Staubemissionen
Augusto Bianchini, *University of Bologna, Department of Industrial Engineering, Italien*

Schadstoffarmer Retrofit-Holzgasbrenner für Holzpellets
Josef Wüest, *Fachhochschule Nordwestschweiz, Schweiz*

Wabenkatalysatoren in Scheitholzöfen – Potenziale und Grenzen
Gabriel Reichert, *Bioenergy 2020+ GmbH, Österreich*

Entwicklung von Scheitholzvergaserkesseln mithilfe von computergestützten Simulationsmethoden
Nikolaos Nikolopoulos, *Chemical Process and Energy Resources Institute, Griechenland*

Benzo(a)pyrene Emissionen im Abgas moderner Biomassekessel
Franziska Klauser, *Bioenergy 2020+ GmbH, Österreich*

10:30 **Kaffeepause**

Simultanübersetzung

Parallelblock 6

Freitag 20 Jänner

Netze und Hybridsysteme auf Basis moderner Biomassefeuerung
Saal 1, 11:00 – 12:30

Chairman: Panagiotis Grammelis, *Centre for Research and Technology, Griechenland*

11:00 **Beginn**

Entwicklung eines optimierten Reglers für kombinierte pelletsgefeuerte und solarthermische Zentralheizungsanlagen
Daniel Büchner, *Deutsches Biomasseforschungszentrum gemeinnützige GmbH, Deutschland*

BIG Solar mit Biomasse: Solare und biogene Fernwärme für steirische Klein- und Großstädte
Moritz Schubert, *S.O.L.I.D. Gesellschaft für Solarinstallation und Design mbH, Österreich*

Optimierung des Zusammenspiels von Scheitholzkessel, Pufferspeicher und Solaranlage durch Verwendung mathematischer Modelle
Jonas Schulz, *Bioenergy 2020+ GmbH, Österreich*

Kleine, modulare und erneuerbare Wärmenetze für Südosteuropa
Dominik Rutz, *WIP Renewable Energies, Deutschland*

Netzanalyse und Optimierung von Wärmenetzen – ein schwedischer Ansatz
Roger Stahel, *IS SaveEnergy AG, Schweiz*

12:30–13:30 **Mittagspause und Postersession**

Simultanübersetzung

Parallel Session 5

Lowest emission biomass combustion systems
Room 1, 09:00 – 10:30 am

Chairman: Christoph Schmidl, *Bioenergy 2020+ GmbH, Austria*

09:00 am **Opening**

Innovative technological solutions for a biomass boiler with near-zero particulate emissions
Augusto Bianchini, *University of Bologna, Department of Industrial Engineering, Italy*

Low emission retrofit producer gas burner for wood pellets
Josef Wüest, *Fachhochschule Nordwestschweiz, Switzerland*

Honeycomb catalysts integrated in firewood stoves – potentials and limitations
Gabriel Reichert, *Bioenergy 2020+ GmbH, Austria*

Design of domestic log wood and gasification boilers using CFD tools
Nikolaos Nikolopoulos, *Chemical Process and Energy Resources Institute, Greece*

Benzo(a)pyrene emission in the flue gas from modern biomass boilers
Franziska Klauser, *Bioenergy 2020+ GmbH, Austria*

10:30 am **Coffee break**

Simultaneous translation

Parallel Session 6

Friday 20 January

Biomass combustion based grids and hybrid systems
Room 1, 11:00 am – 12:30 pm

Chairman: Panagiotis Grammelis, *Centre for Research and Technology, Greece*

11:00 am **Opening**

Development of an optimized controller for pellets/solarthermal central heating systems
Daniel Büchner, *Deutsches Biomasseforschungszentrum gemeinnützige GmbH, Germany*

BIG Solar with biomass: solarthermal and biomass based district heating systems for Styrian cities
Moritz Schubert, *S.O.L.I.D. Gesellschaft für Solarinstallation und Design mbH, Austria*

Optimizing the interaction of firewood boiler, heat storage and solarthermal facility using mathematical models
Jonas Schulz, *Bioenergy 2020+ GmbH, Austria*

Small, modular and renewable based heating grids for SE Europe
Dominik Rutz, *WIP Renewable Energies, Germany*

Improving the performance of heating grids – using Swedish know-how
Roger Stahel, *IS SaveEnergy AG, Switzerland*

12:30–01:30 pm **Lunch and Poster presentation**

Simultaneous translation

Parallelblock 7

Strom und Wärme aus Biomasse
Saal 1, 13:30 – 15:00

Chairman: Matthias Gaderer, *Technische Universität München, Deutschland*

13:30 **Beginn**

Ermittlung der Leistung kleiner Biomassevergasungsanlagen durch die Implementierung von Massen- und Energiebilanzen
Marco Baratieri, *Freie Universität Bozen, Italien*

Holzvergasung im Schwebefestbett: Erfahrungen aus Praxisanlagen in Österreich
Markus Huemer, *MCI - Internationale Hochschule GmbH, Österreich*

Strom & Biomasse zu Gas – die Verknüpfung von Biomassepotenzialen mit Strom- und Gasübertragungsnetzen am Beispiel Deutschland
Marcel Beirow, *Universität Stuttgart, Institut für Feuerungs- und Kraftwerkstechnik Deutschland*

Reduktion der Wasserdampfkondensation im Produktgas: Experimentelle Untersuchungen
Roberto Mussi, *Yanmar Research Europe, Italien*

Torrefizierung von Holzreststoffen im kleinen Maßstab: Erste Ergebnisse einer vollautomatischen Pilotanlage
Jean-Bernard Michel, *University of Applied Sciences Western Switzerland, Schweiz*

15:00 **Kaffeepause**

Simultanübersetzung

Parallelblock 8

Technologien für die biobasierte Ökonomie, Saal 1, 15:30 – 17:15

Freitag 20 Jänner

Chairman: Hermann Hofbauer, *Technische Universität Wien, Österreich*

15:30 **Beginn**

bioCRACK: Ein einzigartiges Verfahren zur Generierung von Biotreibstoffen der 2. Generation
Edgar Ahn, *BDI – BioEnergy International AG, Österreich*

Produktion hochwertiger Brennstoffe und Grundchemikalien aus biogenen Reststoffen mittels hydrothermaler Carbonisierung
Jakob Köchermann, *Deutsches Biomasseforschungszentrum GmbH, Deutschland*

Wasserstoff aus Biomasse – Stand der Technik und Perspektiven
Hermann Hofbauer, *Technische Universität Wien, Österreich*

State-of-the-art Zwei-Bett-Wirbelschichtvergasung aus Biomasse im industriellen Maßstab
Matthias Kuba, *Bioenergy 2020+ GmbH, Österreich*

HCNG oder Hythan-Herstellung mittels Biomasse-Dampf-Vergasung
Michael Kraussler, *Bioenergy 2020+ GmbH, Österreich*

Effiziente Nutzung von Biomassereststoffen zur gekoppelten Herstellung von Treibstoffen und Wärme
Esa Kurkela, *VTT Technical Research Centre of Finland, Finnland*

17:15 **Ende**

Simultanübersetzung

Parallel Session 7

Heat and electricity from biomass
Room 1, 01:30 – 03:00 pm

Chairman: Matthias Gaderer, *Technical University Munich, Germany*

01:30pm **Opening**

Measuring the performance of biomass small-scale gasification plants by implementing mass and energy balances
Marco Baratieri, Free University of Bolzano, *Italy*

Biomass gasification in the stepped co-current fixed bed: experiences from field installations in Austria
Markus Huemer, *Management Center Innsbruck, Austria*

Power & biomass to gas – connecting Germany's biomass potentials with power and gas transmission systems
Marcel Beirow, *University of Stuttgart, Germany*

Decreasing water vapour condensation in producer gas: experimental investigation
Roberto Mussi, *Yanmar Research Europe, Italy*

Torrefaction of woody residues at the small scale: first results of a fully automatic pilot plant operation
Jean-Bernard Michel, *University of Applied Sciences of Western Switzerland, Switzerland*

03:00 pm **Coffee break**

Simultaneous translation

Parallel Session 8

Technologies for a biobased economy, Room 1, 03:30 – 05:15 pm

Friday 20 January

Chairman: Hermann Hofbauer, *Technical University Vienna, Austria*

03:30 pm **Opening**

bioCRACK: an unique process to produce 2nd generation biofuels
Edgar Ahn, *BDI – BioEnergy International AG, Austria*

Simultaneous production of valuable fuels and platform chemicals from biogenic residues by hydrothermal carbonization
Jakob Köchermann, *Deutsches Biomasseforschungszentrum GmbH, Germany*

Hydrogen from biomass - state-of-the-art and outlook
Hermann Hofbauer, *Technical University Vienna, Austria*

State-of-the-art dual fluidized bed gasification of biomass in industrial scale
Matthias Kuba, *Bioenergy 2020+ GmbH, Austria*

HCNG or hythane production from biomass steam gasification
Michael Kraussler, *Bioenergy 2020+ GmbH, Austria*

Efficient use of biomass residues for combined production of transport fuels and heat
Esa Kurkela, *VTT Technical Research Centre of Finland, Finland*

05:15 pm **End**

Simultaneous translation

Parallelblock 9

Brennstoffcharakterisierung & Qualitätssicherung
Galerie, 9:00 – 10:30

Chairman: Josef Rathbauer, *Biomasse-Lehr- und Forschungszentrum Francisco Josephinum, Österreich*

09:00 **Beginn**

Charakterisierungsmethoden für feste Biomasse in Hinblick auf die thermische Nutzung in Festbettreaktoren
Peter Sommersacher, *Bioenergy 2020+ GmbH, Österreich*

Qualitätskontrolle der Hackschnitzelproduktion durch validierte vereinfachte Methoden
Volker Zelinski, *Hochschule für Angewandte Wissenschaft und Kunst, Deutschland*

Stabilität von Pyrolyseölen: Vergleich von Bewertungsmethoden
Mehmet Pala, *Ghent University, Faculty of Bioscience Engineering, Department of Biosystems Engineering, Belgien*

Bewertung der chemischen Brennstoffqualität von Holzhackschnitzeln mittels moderner Brennstoffindizes
Daniel Kuptz, *Technologie- und Förderzentrum, Deutschland*

Experimentelle Evaluierung der Verfolgbarkeit eines Pelletsschüttgutmassenstroms mit RFID-Technik
Peter Sundberg, *SP Technical Research Institute of Sweden, Schweden*

10:30 **Kaffeepause**

Simultanübersetzung

Parallelblock 10

Freitag 20 Jänner

Nachhaltigkeit auf regionaler und nationaler Ebene
Galerie, 11:00 – 12:30

Chairman: Gerfried Jungmeier, *Joanneum Research Forschungsgesellschaft mbH, Österreich*

11:00 **Beginn**

Evaluierung der Wirkung der Förderung von Biomasseheizwerken und Nahwärmenetzen
Harald Schrammel, *AEE INTEC, Österreich*

Kontrolle der geographischen Herkunftsangaben von Holz
Micha Horacek, *Biomasse-Lehr- und Forschungszentrum Francisco Josephinum (BLT), Österreich*

Untersuchung der volkswirtschaftlichen Bedeutung der Biomasse-KWK-Anlagen in Österreich
Lorenz Strimitzer, *Österreichische Energieagentur, Österreich*
Hans-Christian Kirchmeier, *IG-Holzkraft, Österreich*

Nachhaltiges Forstmanagement in Kanada
Dave Patterson, *Forestry Innovation Investment Ltd., Kanada*

Möglichkeiten in Industrie und Landwirtschaft zur Verbesserung der Nachhaltigkeit von Biodiesel
Gerfried Jungmeier, *Joanneum Research Forschungsgesellschaft mbH, Österreich*

12:30 - 13:30 **Mittagessen und Postersession**

Simultanübersetzung

Parallel Session 9

Fuel characterization and quality assurance
Galerie, 09:00 – 10:30 am

Chairman: Josef Rathbauer, *Biomasse-Lehr- und Forschungszentrum Francisco Josephinum, Austria*

09:00 am **Opening**

Characterisation methods for solid biomass fuels regarding their thermal utilisation in fixed-bed reactors
Peter Sommersacher, *Bioenergy 2020+ GmbH, Austria*

Quality control of wood chip production by validated simplified methods
Volker Zelinski, *University of Applied Sciences and Arts, Germany*

Stability of fast pyrolysis bio-oils: comparison of assessment methods
Mehmet Pala, *Ghent University, Faculty of Bioscience Engineering, Department of Biosystems Engineering, Belgium*

Evaluation of chemical wood chip quality using novel fuel indexes for solid biofuels
Daniel Kuptz, *Technologie- und Förderzentrum, Germany*

Experimental evaluation of the traceability of a pellet bulk flow using radio frequency identification technology
Peter Sundberg, *SP Technical Research Institute of Sweden, Sweden*

10:30 am **Coffee break**

Simultaneous translation

Parallel Session 10

Friday 20 January

Sustainability at regional and national scale
Galerie, 11:00 am – 12:30 pm

Chairman: Gerfried Jungmeier, *Joanneum Research Forschungsgesellschaft mbH, Österreich*

11:00 am **Opening**

Evaluation of the effects of incentive programmes for biomass district heading grids
Harald Schrammel, *AEE INTEC, Austria*

Controlling the declared geographic origin of wood/timber
Micha Horacek, *Biomasse-Lehr- und Forschungszentrum Francisco Josephinum (BLT), Österreich*

The national economic relevance of biomass CHP plants in Austria
Lorenz Strimitzer, *Österreichische Energieagentur, Österreich*
Hans-Christian Kirchmeier, *IG-Holzkraft, Österreich*

Sustainable forest management in Canada
Dave Patterson, *Forestry Innovation Investment Ltd., Canada*

Options for Industry and Agriculture to Improve the Sustainability of Fatty Acid Methyl Esters
Gerfried Jungmeier, *Joanneum Research Forschungsgesellschaft mbH, Austria*

12:30 - 01:30 pm **Lunch and Poster presentation**

Simultaneous translation

Parallelblock 11

Nachhaltigkeitsbetrachtungen verschiedener Wertschöpfungsketten
Galerie, 13:30 – 15:00

Chairman: Manfred Wörgetter, *Bioenergy 2020+ GmbH, Österreich*

13:30 **Beginn**

Die Rolle der Grasvergärung einer kreislauforientierten Bioökonomie
Vita Tilvikiene, *Lithuanian Research Centre for Agriculture and Forestry, Litauen*

BioÖkonomie mit Mikroalgen – Life Cycle Sustainability Assessment einer algen-basierten Bioraffinerie
Maria Hingsamer, *Joanneum Research Forschungsgesellschaft mbH, Österreich*

Nutzen regionaler Bioenergie-Ketten aus ökologischer Sicht
Silvia Scherhaufer, *Universität für Bodenkultur, Österreich*

Fahren mit Biomasse: Biotreibstoffe vs. Wasserstoff vs. Strom
Reinhard Haas, *Technische Universität Wien, Institut für Energiewirtschaft, Österreich*

Volks- und betriebswirtschaftliche Bewertung typischer bayerischer Nutzungspfade der Wärmebereitstellung aus Holz
Andrè Tiemann, *Hochschule Weihenstephan Triesdorf, Deutschland*

15:00 **Kaffeepause**

Simultanübersetzung

Parallelblock 12

Politik, Märkte & Konsumenten-verhalten
Galerie, 15:30 – 17:00

Freitag 20 Jänner

Chairman: Lukas Kranzl, *Technische Universität Wien, Österreich*

15:30 **Beginn**

Das italienische Fördersystem für Ökostrom aus Biomasse – Erfahrungen der ersten sechs Jahre
Annalisa Angeloni, *Council for agricultural research and economic analysis, Italien*

Warum wir heizen, wie wir heizen
Josef Walch, *FH Wiener Neustadt für Wirtschaft und Technik GmbH, Österreich*

Bioenergie-Politik und Status der Implementierung
Dina Bacovsky, *Bioenergy 2020+ GmbH, Österreich*

IEA-Bericht zum erneuerbaren Energiemarkt
Pharoah Le Feuvre, *International Energy Agency (IEA), Frankreich*

Konzepte und Instrumente einer rationalen Bioenergiepolitik – ein institutionenökonomischer Ansatz
Alexandra Purkus, *Helmholtz-Zentrum für Umweltforschung GmbH, Deutschland*

17:00 **Ende**

Simultanübersetzung

Parallel Session 11

Sustainability considerations for different value chains
Galerie, 01:30 – 03:00 pm

Chairman: Manfred Wörgetter, *Bioenergy 2020+ GmbH, Austria*

01:30 pm **Opening**

The role of grass digestion in the circular bio-economy
Vita Tilvikiene, *Lithuanian Research Centre for Agriculture and Forestry, Kedainiai, Lithuania*

BioEconomy with algae – life cycle sustainability assessment of an algae-based biorefinery
Maria Hingsamer, *Joanneum Research Forschungsgesellschaft mbH, Austria*

The benefits of regional bioenergy value chains from an ecological perspective
Silvia Scherhaufer, *University of Natural Resources and Applied Sciences, Austria*

Driving on biomass: biofuels vs. hydrogen vs. electricity
Reinhard Haas, *Technical University Vienna, Austria*

National and business economic assessment of typical value chains for providing heat from wood in Bavaria
Andrè Tiemann, *Hochschule Weihenstephan Triesdorf, Germany*

03:00 pm **Coffee break**

Simultaneous translation

Parallel Session 12

Policies, markets and consumer attitudes
Galerie, 03:30 – 05:00 pm

Friday 20 January

Chairman: Lukas Kranzl, *Technical University Vienna, Austria*

03:30 pm **Opening**

The Italian incentive system for the electricity production of biomass – the first six years of implementation
Annalisa Angeloni, *Council for agricultural research and economic analysis, Rome, Italy*

Why do we heat the way we heat?
Josef Walch, *University of Applied Sciences Wiener Neustadt, Austria*

Bioenergy policies and status of bioenergy implementation
Dina Bacovsky, *BIOENERGY 2020+ GmbH, Austria*

Bioenergy heat and power markets in the IEA's Medium Term Renewable Energy Market Report 2016
Pharoah Le Feuvre, *International Energy Agency (IEA), Paris, France*

Concepts and instruments for a rational bioenergy policy – a new institutional economics approach
Alexandra Purkus, *Helmholtz-Zentrum für Umweltforschung GmbH, Leipzig, Germany*

05:00 pm **End**

Simultaneous translation

An event organised by AEBIOM
EUROPEAN BIOMASS ASSOCIATION

Bioenergy Opportunities in Africa
Workshop & B2B Matchmaking

- Unique opportunity to get informed on how to launch bioenergy business ventures in Africa.
- Participate in the B2B matchmaking session to network and discuss business opportunities.

Date: **20th Jan. 2017**
Time: **9am–5pm (CET)**
Where: **CEBC, Graz (AT)**

Access to Finance

A range of financing options will be showcased, and opportunities for support towards accessing finance presented.

B2B Matchmaking

This is an opportunity for African and European entrepreneurs to come together for networking and joint business development.

Market Information

This workshop will provide participants with invaluable insights into Africa's fast-evolving bioenergy markets.

REGISTER:
www.cebc.at/en

or scan the QR code:

In collaboration with

RECP
Africa-EU Renewable Energy Cooperation Programme

A project funded by the European Union

New Markets: Africa meets EU
Workshop & B2B-Matchmaking

Vortragssprache **Englisch**

Freitag 20 Jänner

9:00 - 17:00
Workshop: Saal 10
B2B-Matchmaking: Saal 1a

9:00 **Austrian Expertise, African Opportunities**
Christoph Pfemeter, *Österreichischer Biomasse-Verband*

European Private-Sector Interest
Jean-Marc Jossart, *European Biomass Association (AEBIOM)*

Africa-EU Renewable Energy Cooperation Programme (RECP) Services
Alexander Huppertz, RECP

Focus on Nigeria
Godwin Eni Aigbokhan, *National Competitiveness Council of Nigeria*

Focus on Senegal
Aziz Fall, *National Renewable Energy Agency (ANER), Senegal*

10:30 **Kaffeepause**

11:00 **Focus on Rwanda**
Dr. Ivan Twagirashema, *Energy Private Developers (EPD), Rwanda*

Focus on Uganda
Nolbert Muhumuza, *Awamu Biomass Energy, Uganda*

11:45 **Focus on Africa - Diskussion**

Moderator: Remigijus Lapinskas, *President World Bioenergy Association*
Aziz Fall, *ANER, Senegal*
Godwin Eni Aigbokhan, *NCCN, Nigeria*
Dr. Ivan Twagirashema, *EPD, Rwanda*
Nolbert Muhumuza, *Awamu Biomass Energy, Uganda*
Alexander Huppertz, *RECP*

12:30 **Mittagspause & Last minute check-in**

14:00 **B2B Matchmaking Einfürhung**

14:20 **Slots 1 - 3 B2B Meetings**

15:30 **Kaffeepause**

15:45 **Slots 4 - 6 B2B Meetings**

Registration for B2B talks: *www.cebc2017.talkb2b.net*

Nützen Sie die Chance und ...

- entdecken Sie Möglichkeiten in Afrika
- finden Sie Technologien, F/E-Projekte und Know-how!
- treffen Sie an einem Tag mehrere potenzielle Kooperationspartner am selben Ort!
- bewerben Sie Ihre Profile weltweit!

RECP Africa-EU Renewable Energy Cooperation Programme

AEBIOM European Biomass Association

WKO Aussenwirtschaft Austria

New Markets: Africa meets EU
Workshop & B2B matchmaking

Language **English**

Friday 20 January

09:00 am - 05:00 pm
Workshop: Room 10
B2B matchmaking: Room 1a

9:00 am **Austrian Expertise, African Opportunities**
Christoph Pfemeter, *Austrian Biomass Associatio, Austria*

European Private-Sector Interest
Jean-Marc Jossart, *European Biomass Association (AEBIOM)*

Africa-EU Renewable Energy Cooperation Programme (RECP) Services
Alexander Huppertz, RECP

Focus on Nigeria
Godwin Eni Aigbokhan, *National Competitiveness Council of Nigeria*

Focus on Senegal
Aziz Fall, *National Renewable Energy Agency (ANER), Senegal*

10:30 am **Coffee Break**

11:00 am **Focus on Rwanda**
Dr. Ivan Twagirashema, *Energy Private Developers (EPD), Rwanda*

Focus on Uganda
Nolbert Muhumuza, *Awamu Biomass Energy, Uganda*

11:45 am **Focus on Africa Panel Discussion**

Moderator: Remigijus Lapinskas, *President World Bioenergy Association*
Aziz Fall, *ANER, Senegal*
Godwin Eni Aigbokhan, *NCCN, Nigeria*
Dr. Ivan Twagirashema, *EPD, Rwanda*
Nolbert Muhumuza, *Awamu Biomass Energy, Uganda*
Alexander Huppertz, *RECP*

12:30 pm **Lunch Break & Last minute check-in**

02:00 pm **B2B Matchmaking Introduction**

02:20 pm **Slots 1 - 3 B2B Meetings**

03:30 pm **Coffee Break**

03:45 pm **Slots 4 - 6 B2B Meetings**

Registration for B2B talks: *www.cebc2017.talkb2b.net*

Take this unique opportunity to ...

- present your innovative ideas and projects
- search for brand new technologies, R&D projects and expertise
- meet numerous prospective cooperation partners at one location in one day
- promote your organisation and expertise world-wide

RECP Africa-EU Renewable Energy Cooperation Programme

AEBIOM European Biomass Association

ADVANTAGE AUSTRIA WKO

Highlights der Bioenergieforschung 2017: Nationale & internationale Ergebnisse aus den IEA Bioenergy Tasks sowie dem ERA-NET Bioenergy
Saal 12, 9:00 - 15:00

09:00 **Begrüßung und Einführung IEA Bioenergy TCP**
Theodor Zillner, *Bundesministerium für Verkehr, Innovation und Technologie (bmvit), Österreich*
Luc Pelkmans, *Technical Coordinator IEA Bioenergy, Belgien*

Session 1: Highlights aus den IEA Bioenergie Technologieprogramm

09:30 **Vergasung von Biomasse und Abfall - aktuelle Aktivitäten und Ergebnisse aus dem IEA Bioenergy Task 33**
Kevin J. Whitty, *University of Utah, Vereinigte Staaten von Amerika*

09:45 **Stand der Biomassevergasung - Von Österreich entwickelte Datenbank für den IEA Bioenergy Task 33**
Reinhard Rauch, *Technische Universität Wien, Österreich*

10:00 **Energie aus Biogas - internationale und nationale Aktivitäten des Bioenergie Task 37**
Bernhard Drosg, *Universität für Bodenkultur Wien, IFA Tulln, Österreich*

10:30 **Kaffeepause**

11:00 **Markteinführung konventioneller und fortgeschrittener flüssiger Biotreibstoffe aus Biomasse – Bioenergie Task 39**
Dina Bacovsky, *Bioenergy 2020+ GmbH, Österreich*

11:15 **Holzpelletmarktbericht - eine globale Perspektive - Ergebnisse des Bioenergie Task 40**
Fabian Schipfer, *TU Wien, Energy Economics Group (EEG), Österreich*

11:35 **Holzpellethandel für Kleinfeuerungsanlagen - Markttreiber und Hindernisse - Ergebnisse des Bioenergie Task 40**
Kay Schaubach, *DBFZ, Deutschland*

11:50 **Bioraffinerien: Aktuelle Aktivitäten & Ergebnisse des IEA Bioenergy Task 42**
Michael Mandl, *Tbw research GmbH, Österreich*

12:05 **Highlights aus dem Bioenergie Task 32: Biomasseverbrennung und -mitverbrennung**
Jaap Koppejan, *Procede Biomass BV, Niederlande*

12:30 Mittagspause

13:30 **Österreichische Beiträge im Bioenergie Task 32: Biomasseverbrennung und -mitverbrennung**
Christoph Schmidl, *Bioenergy 2020+ GmbH, Österreich*

13:45 **Bioenergie Task 41 - Sonderprojekt: Die Rolle von Bioenergie RES Hybriden in einem emissionsarmen Energiesystem**
Ilkka Hannula, *VTT - Technical Research Centre of Finland Ltd, Finnland*

Session 2: ERA-NET Bioenergy – Überblick und aktuelle Projekte

14:00 **Vorstellung des ERA-NET Bioenergy**
Carina Lemke, *Fachagentur Nachwachsende Rohstoffe (FNR), ERA-NET Bioenergy Sekretariat, Deutschland*

14:15 **MetHarmo - Europaweite Harmonisierung von Messmethoden zur Quantifizierung von Methanemissionen aus Biogasanlagen**
Marlies Hrad, *Universität für Bodenkultur Wien, Österreich*

14:30 **GrateAdvance - Neue Brennstoff-flexible Biomasse-Rostfeuerungen**
Sabine Feldmeier, *Bioenergy 2020+ GmbH, Österreich*

14:45 **REFAWOOD - Ressourceneffiziente Brennstoffadditive zur Verringerung der verbrennungstechnischen Probleme bei der Rest- und Gebrauchtholzverbrennung**
Peter Sommersacher, *Bioenergy 2020+ GmbH, Österreich*

15:00 **Ende**

Freitag 20 Jänner

bmvit

Vortragssprache Englisch

Highlights of Bioenergy Research 2017: National and international results achieved by IEA Bioenergy Tasks and ERA-NET Bioenery, Room 12, 09:00 am – 03:00 pm

09:00 am **Welcome and Introduction IEA Bioenergy TCP**
Theodor Zillner, *Austrian Federal Ministry for Transport, Innovation and Technologies, Austria*
Luc Pelkmans, *Technical Coordinator IEA Bioenergy, Belgium*

Session 1: Highlights from the IEA Bioenergy TCP

09:30 am **Gasification of Biomass and Waste – recent activities and results from IEA Bioenergy Task 33**
Kevin J. Whitty, *University of Utah, United States of America*

09:45 **Status of Biomass Gasification – Database developed by Austria for IEA Bioenergy Task 33**
Reinhard Rauch, *TU Vienna, Austria*

10:00 am **Energy from Biogas - international and national activities „Bioenergy Task 37"**
Bernhard Drosg, *University of Natural Resources and Life Sciences, Austria*

10:30 am **Coffee break**

11:00 am **Commercializing Conventional & Advanced Liquid Biofuels „IEA Bioenergy Task 39"**
Dina Bacovsky, *Bioenergy 2020+ GmbH, Austria*

11:15 am **Global wood pellet industry - market and trade study – IEA Bioenergy Task 40 results**
Fabian Schipfer, *TU Wien, Energy Economics Group (EEG), Austria*

11:35 am **The European Wood Pellet Market for small-scale heating - data availability, price developments and drivers for trade - IEA Bioenergy Task 40 results**
Kay Schaubach, *DBFZ, Germany*

11:50 am **Biorefining - recent activities and results from IEA Bioenergy Task 42"**
Michael Mandl, *Tbw research GmbH, Austria*

12:05 pm **Highlights from Bioenergy Task 32: Combustion and Cofiring"**
Jaap Koppejan, *Procede Biomass BV, Netherlands*

12:30 pm Lunch

01:30 **Austrian contributions to Task 32: Combustion and Cofiring"**
Christoph Schmidl, *Bioenergy 2020+ GmbH, Austria*

01:45 pm **Task 41 - special project: The role of Bioenergy RES hybrids in a low-emission energy system**
Ilkka Hannula, *VTT - Technical Research Centre of Finland Ltd, Finland*

Session 2: ERA-NET Bioenergy - overview and current projects

02:00 pm **Presentation of the ERA-NET Bioenergy**
Carina Lemke, *Agency for Renewable Resources (FNR), ERA-NET Bioenergy Secretariat, Germany*

02:15 pm **MetHarmo - European harmonisation of methods to quantify methane emissions from biogas plants**
Marlies Hrad, *University of Natural Resources and Life Sciences, Austria*

02:30 pm **GrateAdvance - Advanced adjustable grate solutions for future fuel flexible biomass combustion technologies**
Sabine Feldmeier, *Bioenergy 2020+ GmbH, Austria*

02:45 pm **REFAWOOD - Resource-efficient fuel additives for reducing ash related operational problems in waste wood combustion**
Peter Sommersacher, *Bioenergy 2020+ GmbH, Austria*

03:00 pm **End**

Friday 20 January

bmvit

Language English

Workshop: BioFlex

Flexible Betriebsführungskonzepte für Biomasse-KWK-Anlagen

Saal 11a, 9:00 - 12:30

Chairman: Christoph Rosenberger, *Österreichischer Biomasse-Verband*

09:00 **Eröffnung**
- Christoph Rosenberger, *Österreichischer Biomasse-Verband*
- Ralf Ohnmacht, *VOIGT+WIPP Industrial Research, Österreich*

09:15 **Möglichkeiten der zukünftigen Vermarktung von Strom aus Biomasse-KWK**
Babette Hebenstreit, *FH Vorarlberg, Österreich*

09:30 **Technische Herausforderungen einer Flexibilisierung**
Alfred Hammerschmid, *BIOS Bioenergiesysteme, Österreich*

09:45 **Erfahrungen aus der Praxis**
Hermann Unsinn, *TIWAG, Österreich*

10:00 **Rechtliche Möglichkeiten für Biomasse-KWK-Anlagen**
Martin Seidl, *ÖMAG, Österreich*

10:15 **Optimierungspotenziale für Biomasse-KWK-Anlagen**
Bernhard Kronberger, *VOIGT+WIPP Industrial Research, Österreich*

10:30 **Diskussion**

11:00 **Kaffee & Get-Together**

Vortragssprache **Deutsch**

Workshop: BINE: Bidirektionale Einbindung von Gebäuden mit Wärmeerzeugern in Wärmenetze

Freitag 20 Jänner

Saal 11a, 13:30 - 15:00

Chairman: Christoph Rosenberger, *Österreichischer Biomasse-Verband*

13:30 **Eröffnung**
- Christoph Rosenberger, *Österreichischer Biomasse-Verband*
- Daniel Reiterer, *AEE NÖ-Wien, Österreich*

13:45 **Potenziale und Einsatzgrenzen für die bidirektionale Einbindung von dezentralen Wärmeerzeugern in regionalen Wärmenetzen, am Umsetzungsbeispiel der Fernwärme von Großschönau**
Andreas Leitner, *Universität für Bodenkultur Wien, Österreich*

14:15 **Regelungstechnische Konzepte für den Aufbau von bidirektionalen Wärmenetzen – vom übergeordneten Wärmemanagement bis hin zur Hydraulikregelung von dezentralen Wärmeerzeugern**
Klaus Lichtenegger, *Bioenergy 2020+ GmbH, Österreich*
Daniel Muschick, *Bioenergy 2020+ GmbH, Österreich*

14:45 **Erarbeitung und Diskussion von möglichen künftigen Szenarien**

15:00 **Kaffee & Get-Together**

Vortragssprache **Englisch**

Workshop: BioFlex

flexible operations-management concepts for combined biomass heat and power plants

Room 11a, 09:00 am – 12:30 pm

Chairman: Christoph Rosenberger, *Austrian Biomass Association*

09:00 am **Opening**
- Christoph Rosenberger, *Austrian Biomass Association*
- Ralf Ohnmacht, *VOIGT+WIPP Industrial Research, Austria*

09:05 am **Possible future methods for the marketing of electricity generated by combined biomass heat and power plants**
Babette Hebenstreit, *FH Vorarlberg (University of Applied Sciences), Austria*

09:30 am **Technical challenges to greater flexibility**
Alfred Hammerschmid, *BIOS Bioenergiesysteme, Austria*

09:45 am **Practical experiences**
Hermann Unsinn, *TIWAG, Austria*

10:00 am **Legal opportunities for combined biomass heat and power plants**
Martin Seidl, *ÖMAG, Austria*

10:15 am **Optimization potentials for combined biomass heat and power plants**
Bernhard Kronberger, *VOIGT+WIPP Industrial Research, Austria*

10:30 am **Discussion**

11:00 am **Coffee & Get-together**

Language **German**

Workshop: BINE: Bi-directional integration of buildings with heat generators into heating networks

Friday 20 January

Room 11a, 01:30 pm – 03:00 pm

Chairman: Christoph Rosenberger, *Austrian Biomass Association*

01:30 pm **Opening**
- Christoph Rosenberger, *Austrian Biomass Association*
- Daniel Reiterer, *AEE NÖ-Wien, Austria*

01:45 pm **Potentials and limitations of use for the bi-directional integration of decentralized heat generators within regional heating networks, using the example of the implementation of district heating in Großschönau**
Andreas Leitner, *University of Natural Resources and Life Sciences Vienna, Austria*

02:15 pm **Technical control concepts for the development of bi-directional heating networks – from overall thermal management to the hydraulic control of decentralized heat generators**
Klaus Lichtenegger, *Bioenergy2020+ GmbH, Austria*
Daniel Muschick, *Bioenergy2020+ GmbH, Austria*

02:45 pm **Development and discussion of possible future scenarios**

03:00 pm **Coffee & Get-together**

Language **English**

Workshop: BioStep: Eine Bioökonomiestrategie für Österreich: Welche Rolle spielt die Zivilgesellschaft?

Saal 11b, 9:00 – 12:30

09:00 **Einführung und Vorstellungsrunde**
Holger Gerdes, *Ecologic Institut, Deutschland*
Zoritza Kiresiewa, *Ecologic Institut, Deutschland*

09:10 **Vorstellung des BioSTEP-Projekts und Ziele des Workshops**
Holger Gerdes, *Ecologic Institut, Deutschland*
Zoritza Kiresiewa, *Ecologic Institut, Deutschland*

09:30 **Bioökonomiestrategien in Österreich: Status Quo**
Elfriede Fuhrmann, *Bundesministerium für Land und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW), Österreich*

09:45 **Einblick ‚Dialogforen 2016' zur Bioökonomie-FTI-Strategie**
Erika Ganglberger, *Österreichische Gesellschaft für Umwelt und Technik (ÖGUT), Österreich*

10:00 **Die Rolle zivilgesellschaftlicher Organisationen in der Bioökonomie: Stellungnahmen unterschiedlicher Akteure**
Alexander Bachler, *Österreichischer Forstverein, Österreich*
Barbara Hammerl, *StadtLABOR Graz, Österreich*
Berthold Schleich, *ARGE Abfallvermeidung Ressourcenschonung und nachhaltige Entwicklung, Österreich*
Rosemarie Stangl, *Institut für Ingenieurbiologie und Landschaftsbau, Universität für Bodenkultur Wien, Österreich*
Bernhard Zlanabitnig, *Umweltdachverband, Österreich*

10:30 Kaffeepause

Vortragssprache **Deutsch**

10:50 **Diskussion**

12:20 **Zusammenfassung der Workshop-Ergebnisse**
Holger Gerdes, *Ecologic Institut, Deutschland*
Zoritza Kiresiewa, *Ecologic Institut, Deutschland*

Workshop: ErgoS: Energierückgewinnung durch offene Sorption: Eine innovative Technologie zur Abgaskondensation bei Biomasseverbrennungssystemen

Freitag 20 Jänner

Saal 11a, 15:30 – 17:00

Chairman: Ernst Höftberger, *Bioenergy 2020+ GmbH, Österreich*

15:30 **ErgoS – das Projekt**
Ernst Höftberger, *Bioenergy 2020+ GmbH, Österreich*

15:45 **Offene Sorption – Grundlagen und Prozessauslegung**
Babette Hebenstreit, *Bioenergy 2020+ GmbH, Österreich*

16:00 **Aufbau einer Versuchsanlage zur Wärmerückgewinnung aus Biomasseverbrennungsgasen mit einem offenen Sorptionsprozess**
Klaus Paar, *Güssing Energy Technologies, Österreich*

16:15 **3D-CFD-Simulation des Versuchabsorbers für die offene Sorption**
Stefan Kleindel, *TU Graz, Institut für Wärmetechnik, Österreich*
Christoph Hochenauer, *TU Graz, Institut für Wärmetechnik, Österreich*

16:30 **Experimentelle Evaluierung der offenen Sorption zur Wärmerückgewinnung im Versuchsmaßstab**
Rosemarie Schnetziger, *Bioenergie 2020+ GmbH, Österreich*

16:45 **Diskussion**

Vortragssprache **Deutsch**

Workshop: BioStep: A bioeconomy strategy for Austria: The role of civil society

Room 11b, 09:00 am – 12:30 pm

09:00 am **Introduction and Welcome**
Holger Gerdes, *Ecologic Institut, Germany*
Zoritza Kiresiewa, *Ecologic Institut, Germany*

09:10 am **Presentation of the BioSTEP project & workshop goals**
Holger Gerdes, *Ecologic Institut, Germany*
Zoritza Kiresiewa, *Ecologic Institut, Germany*

09:30 am **Bioeconomy strategies in Austria: Status Quo**
Elfriede Fuhrmann, *Bundesministerium für Land und Forstwirtschaft, Umwelt und Wasserwirtschaft (BMLFUW), Österreich*

09:45 am **Insights: 'Dialogue fora 2016' for the bioeconomy RTI-strategy**
Erika Ganglberger, *Österreichische Gesellschaft für Umwelt und Technik (ÖGUT)*

10:00 am **The role of civil society organizations in the bioeconomy: Stakeholder statements**
Alexander Bachler, *Österreichischer Forstverein, Austria*
Barbara Hammerl, *StadtLABOR Graz, Austria*
Berthold Schleich, *ARGE Abfallvermeidung Ressourcenschonung und nachhaltige Entwicklung, Austria*
Rosemarie Stangl, *Institut für Ingenieurbiologie und Landschaftsbau, Universität für Bodenkultur Wien, Austria*
Bernhard Zlanabitnig, *Umweltdachverband, Austria*

10:30 am Coffee break

Language **German**

10:50 am **Discussion**

12:20 pm **Zusammenfassung der Workshop-Ergebnisse**
Holger Gerdes, *Ecologic Institut, Deutschland*
Zoritza Kiresiewa, *Ecologic Institut, Deutschland*

Workshop: ErgoS: Energy recovery through open sorption: An innovative technology for gas condensation in biomass combustion systems

Friday 20 January

Room 11a, 03:30 pm – 05:00 pm

Chairman: Ernst Höftberger, *Bioenergy 2020+ GmbH, Austria*

03:30 pm **ErgoS – the project**
Ernst Höftberger, *Bioenergy 2020+ GmbH, Austria*

03:45 pm **Open sorption – principles and process design**
Babette Hebenstreit, *Bioenergy 2020+ GmbH, Austria*

04:00 pm **Building a pilot plant for heat recovery from biomass-combustion flue gases with an open sorption process**
Klaus Paar, *Güssing Energy Technologies, Austria*

04:15 pm **3D-CFD-simulation of the experimental absorber for open sorption**
Stefan Kleindel, *Institute of Thermal Engineering at the Graz University of Technology, Austria*
Christoph Hochenauer, *Institute of Thermal Engineering at the Graz University of Technology, Austria*

04:30 pm **Experimental evaluation of open sorption for heat recovery at an experimental scale**
Rosemarie Schnetziger, *Bioenergy 2020+ GmbH, Austria*

04:45 pm **Discussion**

Language **German**

Exkursionen

Mittwoch 18 Jänner

Exkursion I
Biogas

08:00 Abfahrt Graz

09:15 **Biogasanlage Hauptmann 500** kW_{el}
- Strom und Wärmeerzeugung
- Trocknung von Kürbiskernen und Mais
- Gülleverwertung

12:30 Ankunft Graz

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Exkursion II
Bioenergie aus Forstwirtschaft und Industrie

08:00 Abfahrt Graz

09:00 **Forstbetrieb Mayr Melnhof**
- KWK, Pellets, Säge, Erntetechnik und Schlagraumrückbringung

13:00 **Mittagessen**

13:30 **Biowärme Leoben, Hinterberg**
- Holzenergiecontracting Brücklwirt 300 kW

Biomassehof Leoben, Niklasdorf
- Biomasse - Logistik und Aufarbeitung

16:30 **Norske Skog**
- Papiermaschine und Abwärmenutzung

18:30 Ankunft Graz

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Exkursion III
Maisspindeln

08:00 Abfahrt Graz

09:30 **Tschiggerl Agrar GmbH, Halbenrain**
- Erntetechnik
- thermische und stoffliche Maisspindelnutzung
- rechtliche Grundlagen

11:00 **Südoststeirische Pelletierungsgenossenschaft eGen**
- Pelletierung von agrarischer Biomasse

12:15 **Mittagessen**

14:00 **Maisspindel-Verfeuerung mit Schneckenbrenner**
- thermische Nutzung von Maisspindelgrits

15:15 **Maisspindel-Verfeuerung mit Treppenrost**
- thermische Nutzung von Maisspindelpellets

16:30 **Maisspindel-Verfeuerung mit Raupenbrenner**
- thermische Nutzung von feldfallenden Maisspindeln

18:30 Ankunft Graz

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Excursions

Wednesday 18 January

Excursion I
Biogas

08:00 am Departure Graz

09:15 **Biogas plant Hauptmann 500** kW_{el}
- Electricity and heat production
- Drying of pumpkin seeds and corn
- Slurry utilization

12:30 pm Arrival Graz

© ARGE Kompost & Biogas Österreich

Excursion II
Bioenergy in forestry and industry

08:00 am Departure Graz

09:00 am **Forestry Mayr Melnhof**
- CHP, pellets, saw, harvesting technology & recirculation of forest residues

01:00 pm **Lunch**

01:30 pm **Biomass courtyard Leoben, Hinterberg**
- Wood energy contracting Brücklwirt 300 kW

Biomass courtyard Leoben, Niklasdorf
- Biomass - logistics and processing

04:30 pm **Norske Skog**
- Paper machine and heat recovery

06:30 pm Arrival Messe Graz

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Excursion III
Corn cobs

08:00 am Departure Graz

09:30 am **Franz Tschiggerl, Halbenrain**
- Harvesting technology
- Thermal and material use of corn cobs
- Legal basics

11:00 am **South-east Styrian Pellet cooperative eGen**
- Pelletisation of agricultural biomass

12:15 pm **Lunch**

02:00 pm **Corn cobs combustion with a scroll burner**
- Thermal use of corn cob grit

03:15 pm **Corn cobs combustion with a grate burner**
- Thermal use of corn cob pellets

04:30 pm **Corn cobs combustion with a caterpillar burner**
- Thermal use of field falling corn cob

06:30 pm Arrival Graz

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Exkursionen

Mittwoch 18 Jänner

Exkursion IV
Kleinvergasertechnik, Holzgas-KWK-Anlagen

08:00 Abfahrt Graz

09:30 **Bioenergie Grabner KG**
- Festbettvergaser CHP50 mit 4x50 kW_{el} und 400 kW_{th}

12:00 **Mittagessen**

13:30 **Green Power GmbH**
- Holzgas-KWK-Anlage 180 kW_{el} und 320 kW_{th} von URBAS GmbH

16:00 **HERZ Energietechnik GmbH**
- Fertigung von Heizkesseln

18:30 Ankunft Graz


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Exkursion V
Forschung und Entwicklung

08:00 Abfahrt Graz

09:00 **Kondensationsanlage im Biomasseheizwerk Leibnitz**
- 3,6-MW-Heizwerk (SCHMID energy solutions GmbH) mit Rauchgasreinigung und Wärmerückgewinnung (SAVE energy AG)

11:15 **POSCH GmbH**
- Innovationen bei Holzspaltern & Kreissägen

13:15 **Mittagessen**

15:15 **Bioenergy 2020+ GmbH**
- Institut für Wärmetechnik, TU Graz & LEC GmbH

18:00 Ankunft Graz

Organisatorisches: Der Treffpunkt ist um 07:45 bei der Konferenzregistrierung. Die Abfahrt für die Exkursionen erfolgt vom Parkplatz, Messe Graz
Vortragssprache: deutschsprachige Führung mit englischsprachiger Begleitung

Excursions

Wednesday 18 January

Excursion IV
Small gasifier, woodgas-CHP-plant

08:00 am Departure Graz

09:30 am **Bioenergie Grabner KG**
- Fröling fixed bed gasifier CHP50 with 4x50 kW_{el} und 400 kW_{th}

12:00 pm **Lunch**

01:30 pm **Green Power GmbH**
- Woodgas-CHP-plant 180 kW_{el} and 320 kW_{th} from URBAS GmbH

04:00 pm **HERZ Energietechnik GmbH**
- Production of heating boilers

06:30 pm Arrival Graz


© URBAS GmbH


© HERZ

Excursion V
Research and development

08:00 am Departure Graz

09:00 am **Condensation plant in biomass heating plant Leibnitz**
- 3,6 MW heating plant with flue gas purification (SCHMID energy solutions GmbH) and heat recovery (SAVE energy AG)

11:15 am **POSCH GmbH**
- Innovations in the field of wood splitters & disk saws

01:15 pm **Lunch**

03:15 pm **Bioenergy 2020+ GmbH**
- Institute for heat technology, TU Graz & LEC GmbH

06:00 pm Arrival Graz

Organizational issues: The meeting point is at 07:45 am at the conference registration. Departure for the excursions starts from the parking lot Messe Graz.
Language: German speaking guide with English speaking support

Exkursionen

Mittwoch 18 Jänner

Exkursion VI
Biomasse Nahwärme kombiniert mit Holzkraftwerken

08:00 Abfahrt Graz

10:00 **Nahwärmeheizwerkes Murau, Stolzalpe**
- 6MW Kesselleistung und Versorgung Brauerei Murau u.a. mit Heißwasser 120°
- Nachrüstung Heizwerk mit 500kWel Holzkraftwerk, Projektvorstellung

12:00 **Mittagessen Brauhaus Murau**

13:00 **Heißwasserübergabestation Brauerei Murau**

14:30 **Bio-Nahwärme Stadl an der Mur**
- 1,2 MW Biomassekessel Polytechnik
- 324kWel KWK-Holzkraftwerk von SynCraft zur Sommerlastwärmeversorgung

18:30 Ankunft Graz

Excursions

Wednesday 18 January

Excursion VI
Local heat from biomass combined with wood-fired power plants

08:00 am Departure Graz

10:00 am **Local heating plant in Murau, Stolzalpe**
- 6MW boiler output and supply of brewery Murau inter alia with hot water 120°
- Upgrade heating plant with 500kWel wood-fired power plant, project presentation

12:00 pm **Lunch Brauhaus Murau**

01:00 pm **Hot water transmission station brewery Murau**

02:30 pm **Bio-district heating plant Stadl an der Mur**
- 1,2 MW Biomass boiler Polytechnik
- 324kWel CHP-wood-fired power plant from SynCraft for summer heat supply

06:30 pm Arrival Graz

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Wir wissen, dass wir nicht allein dafür verantwortlich sind, dass die Welt immer grüner wird. Aber auf unsere Lösungen für die Behandlung von Abfällen und Biomasse sind wir trotzdem ziemlich stolz.

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