

Österreichische Mitarbeit in IEA Bioenergy Task 42 „Biorefining“

Highlights 2012 - 2015

Gerfried Jungmeier

bmvit Bioenergie Fachgespräch
Wien 18. März 2016

*The Austrian participation in Tasks 42 of IEA Bioenergy is financed
by the Federal Ministry for Transport, Innovation and Technology /
Department for Energy and Environmental Technologies*



Most Sustainable Use of Biomass?

Example maize

This plastic bag is made from maize, a renewable resource, and decomposes naturally



Do we need both for the BioEconomy?

This biofuel is made from maize, a renewable resource to reduce GHG emissions





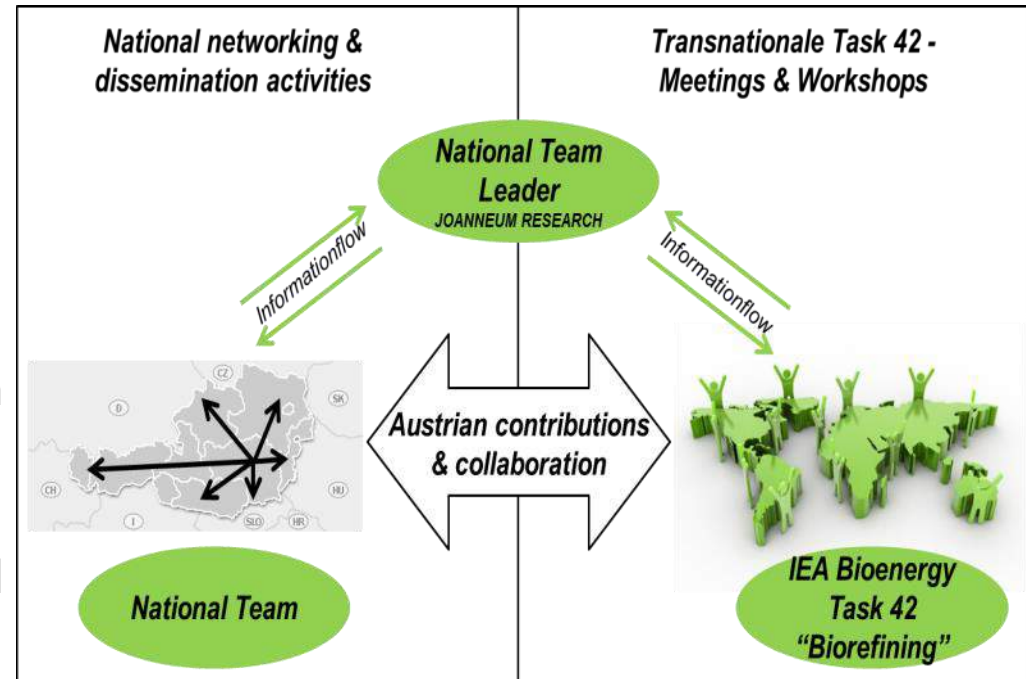
“There is no scientific evidence that the material use of biomass provides greater sustainability benefits than the energetic use, or vice versa.

BUT there is evidence that the combined energetic and material use (“biorefining”) of biomass has the potential for large sustainability benefits.”

■ 7 Task Meetings

■ 5 Stakeholder – Workshops

- 10/2013, Graz/Austria
- 09/2014, Antwerpen/Belgien
- 12/2014, Guelph/Canada
- 05/2015, Sassari/Italien
- 11/2015, Berlin/Deutschland



■ 24 Publikationen von Österreich

■ 31 Präsentationen, davon 7 in Österreich

■ 1 Bioraffinerie-Trainingskurs: „Value Chain Assessment of Biofuel-driven Biorefineries“, Budapest, 07/2014

Stakeholder Workshop Global Bioeconomy Summit

“present & discuss the potential role of biorefining and its stakeholders in the transition to a future BioEconomy using biomass for co-production of food, feed, biobased products and bioenergy”



IEA Bioenergy

The Role of Biorefining in the Bioeconomy

Parallel Workshop
organised by
IEA Bioenergy Task42 Biorefining
Thursday 26 November, 11:30 – 13:00

GLOBAL BIOECONOMY SUMMIT 2015

25 to 26 November
Berlin, Germany

Gerfried Jungmeier, Martin Beermann
Coordinator Task42 Biorefining
November 2015

IEA Bioenergy, also known as the Implementing Agreement for a Programme of Research, Development and Demonstration in Bioenergy, functions within a framework created by the International Energy Agency (IEA). Views, findings and publications of IEA Bioenergy do not necessarily represent the views or policies of the IEA Secretariat or of its individual Member countries.

- Leading stakeholders on the transition towards a BioEconomy
- **Role of Biorefining** within this transition process
- Main **drivers** that support this transition process
- Main technical **barriers** that hinder this transition process
- **Role** of national and international governments
- **Supporting** policies & instruments

Brochure with 4 Austrian Biorefineries

IEA Bioenergy is an international collaboration set-up in 1978 by the International Energy Agency (IEA) to improve international co-operation and information exchange between national bioenergy R&D programmes. Its Vision is that bioenergy is, and will continue to be a substantial part of the sustainable use of biomass in the BioEconomy. By accelerating the sustainable production and use of biomass, particularly in a Biorefining approach, the economic and environmental impacts will be optimised, resulting in more cost-competitive bioenergy and reduced greenhouse gas emissions. Its Mission is facilitating the commercialisation and market deployment of environmentally sound, socially acceptable, and cost-competitive bioenergy systems and technologies, and to advise policy and industrial decision makers accordingly. Its Strategy is to provide platforms for international collaboration and information exchange, including the development of networks, dissemination of information, and provision of science-based technology analysis, as well as support and advice to policy makers. Involvement of industry, and encouragement of membership by countries with a strong bioenergy infrastructure and appropriate policies. Gaps and barriers to deployment will be addressed to successfully promote sustainable bioenergy systems. The purpose of this brochure is to provide an unbiased, authoritative statement on biorefining in general, and of the specific activities dealt with within IEA Bioenergy Task42 on Biorefining, aimed at stakeholders from the agro-sector, industry, SMEs, policy makers, and NGOs.

IEA Bioenergy

IEA Bioenergy – Task42 Biorefining

IEA BIOENERGY Task42 BIOREFINING



Sustainable and synergetic processing of biomass into marketable food & feed ingredients, chemicals, materials and energy (fuels, power, heat)

BBI bioCRACK Pilot Plant (Austria)

State of the art: Pilot Plant
Type of biorefinery: A pilot plant (applies all refinery for the production of diesel fuel, jet-petrol and bio-ethanol based bioenergy)

Location: BBI refinery (Schwechat/Vienna, Austria)
Owner: BBI - BioEnergy International AG
Funders: Linz (GrowthPartner biomass based crops, steel)
Support: The first fuel jet-petrol, diesel

Description: BBI - BioEnergy International AG is creating and technology leader in the conversion of commercial food-grade plants using the Multi-Feedstock Technology. In 2009 BBI started its research activities in the Fermentation-based area. The development is called bioCRACK technology produces mineral diesel with renewable origin that can be used as regular diesel. It is now ready with existing refinery units. This concept fills an important niche producing diesel fuel with the greatest amount while simultaneously converting the biogenic share.

Contact: BBI - BioEnergy International AG, Email: info@bbienergy.com, Web: <http://www.bbienergy.com>, <http://www.bbienergy.com>

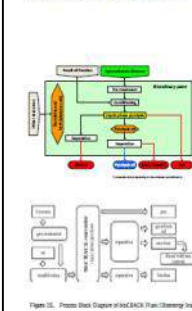


Figure 13: Process flow diagram of bioCRACK Plant (BioEnergy International AG)

Ecodoma Algae Biorefinery (Austria)

State of the art: Demonstration Plant
Type of biorefinery: a full-scale biorefinery producing bioethanol, glycerol & hex, omega-3s fatty acids and biofuel from microalgae

Location: Ecodoma on the Linz, Austria
Owner: Ecodoma production GmbH
Funders: GrowthPartner
Support: BioEnergy, BioEnergy & Hex, omega-3s fatty acids and biofuel

Description: Ecodoma is the worldwide technological leader in the conversion of microalgae species for algae. The unique and patented technology enables the production of biomass on an industrial scale under economic costs in less than 100 hours per year. Furthermore the system is highly sustainable and consumes natural resources. The technology of "Tandem partners" is based on an unique combination of repeatedly regeneration of surface to allow photosynthesis with carbon, photo active volume, continuous support of microalgae with nutrients light.

Contact: Julia Grotz, ecodoma production GmbH, T. +43 73 248 90 10, E. ecodoma@ecodoma.com, www.ecodoma.com

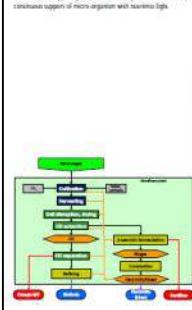


Figure 14: Ecodoma Algae Biorefinery (Ecodoma production GmbH)

AGRANA Biorefinery Pischelsdorf (Austria)

State of the art: Commercial Scale
Type of biorefinery: Two platform (sugar, Co2), sugar/ glycerol for the production of bioethanol, wheat starch and glycerol, and CO2 from agriculture raw materials by integration wheat starch processing the existing bioethanol facility

Location: Pischelsdorf, Austria
Owner: AGRANA BioEnergy GmbH
Funders: Agricultural Bank Austria
Support: Agricultural Bank Austria

Description: The biorefinery project of the AGRANA BioEnergy GmbH in Pischelsdorf (Lower Austria) represents the hybrid concept of a complete and sustainable utilization of the used agricultural raw materials. The plant uses existing bioethanol production plant is replaced with a new wheat starch and glycerol production facility that is a separate unit since 2013. In addition, the large and new water tower CO2 separation plant currently in operation in Austria successfully started operating in early 2014.

Contact: AGRANA BioEnergy GmbH, Email: info@agrana.com, Web: <http://www.agrana.com>

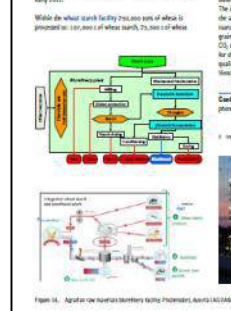


Figure 14: Agrana bioenergy biorefinery (Agrana BioEnergy GmbH)

Pils-Biorefinery (Austria)

State of the art: Commercial Scale
Type of biorefinery: a full-scale biorefinery producing pulp, paper, oil, xerogel, wax and electricity & heat from wheat

Location: Pils, Austria
Owner: B&E Holz AG, National Holz Group, EMERG
Funders: GrowthPartner
Support: Pulp paper mill oil, xerogel, wax and electricity & heat

Description: The major products from the Pils-pulping process in Pils is made pulp. A part of the pulp is directly converted to packaging paper grades. The Black liquor from the pulping process consists the dissolved organic biomass from which a large variety of chemicals can be produced. Oil and xerogel products are used for example in cosmetics, perfumes, advanced paper etc. The quality of the chemicals from oil and xerogel oil cannot be reached with synthetic generated products made from petro oil.

Contact: Klaus Eberhart, B&E Holz AG, Dr. Ludwig Stadler, B&E Holz AG, EMERG, Email: info@bte.com, www.bte.com

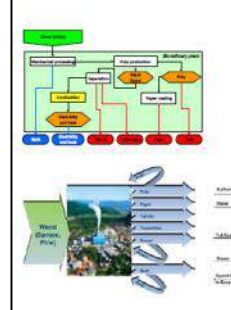


Figure 14: Pils-Biorefinery (B&E Holz AG)



INDUSTRIAL BIOREFINERIES & WHITE BIOTECHNOLOGY

Edited by Ashok Pandey, Rainer Höfer, Mohammad Taherzadeh,
K. Madhavan Nampoothiri, and Christian Larroche



Based on the classification system of biorefineries and the “Nelson’s complexity index” for oil refineries a **Biorefinery Complexity Index (BCI)** is developed by assessing the **Technology Readiness Level (TRL)** of each features of a biorefinery.

8. Oleochemical Biorefinery
 9. Lignocellulosic Biorefinery
 10. Synthetic Biorefinery (Thermochemical Biorefinery)
 11. Next Generation Hydrocarbon Biorefinery
 12. Green Biorefinery
 13. Microbial Biorefinery
 14. Case Studies
 15. Biorefinery Concepts in Comparison to Petrochemical Refineries
 16. Biorefinery Complexity Index
 17. Discussion and Conclusions
- References

This report, that was prepared on behalf of IEA Bioenergy – Task42 Biorefining, addresses a selection of the most promising biorefinery concepts to produce large volumes of road transportation biofuels by 2025. Biorefining, i.e. the sustainable processing of biomass into a spectrum of marketable bio-based products (food/feed ingredients, chemicals, materials) and bioenergy (fuels, power, heat), is the optimal approach to use biomass resources as efficient as possible, thereby optimising the specific financial added-value obtained from the biomass at acceptable social and ecological impact. In energy or biofuel-driven biorefineries the main focus is to produce transportation fuels from biomass, where chain composing agro-, forestry and process residues are used to co-produce added-value bio-based products to make the overall product portfolio more market competitive.

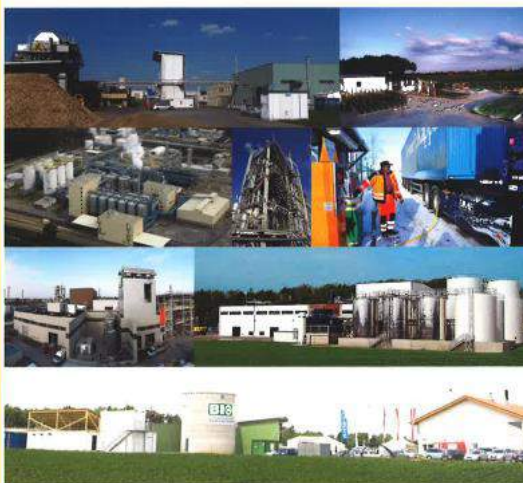
The road transportation biofuels produced in both commercial scale, demonstration scale and conceptual biofuel-driven biorefineries dealt with in this report are: 1) biodiesel from oilseed crops and residues, 2) bioethanol from sugar and starch crops, 3) bioethanol from straw – biochemical pathway, 4) bioethanol from wood – combined bio-/thermochemical pathway, 5) bio-methane from grass and manure, 6) bio-methane from wood, 7) FT-biofuels from straw, 8) FT-biofuels from wood, 9) bioethanol from wood and liquor, 10) bioethanol from starch crops and straw, 11) biofuels from microalgae. Concepts 3, 4, and 5 are environmentally assessed in more detail in section 5.

The purpose of the report is to provide an unbiased, authoritative statement aimed at stakeholders from the agro-sector, forestry sector, industry, SMEs, policy makers, and NGOs.

IEA Bioenergy

IEA Bioenergy – Task42 Biorefining

Biofuel-driven Biorefineries



A Selection of the Most Promising Biorefinery Concepts to Produce Large Volumes of Road Transportation Biofuels by 2025

Coordinated by Austrian participation

.....Based on this **first selection of most promising biorefinery concepts to produce large volumes of road transportation biofuels by 2025** the Task 42 is assessing the sustainability of these biorefinery concepts by analyzing economic, environmental and social aspects in comparison to conventional processes and products. **In a next step a “biorefinery fact sheet”** for each of these selected “energy driven” biorefineries is developed, key characteristics for a specific production capacity of road transportation biofuel

Poster Award 2015

BioEconomy Strategies in the Member Countries of the IEA Bioenergy Implementing Agreement

– current status, approaches and opportunities

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This contribution presents results of a survey on bioeconomy strategies in the 22 member countries of the IEA Bioenergy Implementing Agreement II, aiming at getting a broad overview of the progress and the priorities of such strategies inside and outside Europe. Strategy documents were analyzed in a framework of questions to compare patterns as:

- Scope (governmental, regional, industry sectors)
- Position of bioenergy (including bioliquids) in a future BioEconomy
- Main economic sectors in a future BioEconomy
- Current focus of implementation (R&D, transition to markets, policy development)
- Vision and (measurable) targets

Objectives

Status of BioEconomy strategies (2014)



- **Germany (Task 42-member)**
National policy strategy bioeconomy 2030 (2014)
- **The Netherlands (Task 42-member)**
Framework memorandum on the Bio-based Economy (2012)
De Overheidsvisie op de bio-based economy in de energietransitie (2007)
- **Finland (The Finnish Bioeconomy Strategy (2014))**
- **South Africa (The Bio-Economy Strategy (2013))**
- **Sweden (Swedish Research and Innovation Strategy for a Bio-based Economy (2012))**
- **Austria (Task 42-member)**
Research, technology and innovation Strategy for Bio-based Industries (2014)
- **Denmark (Task 42-member)**
Growth plan for water, bio and environmental solutions (2014)
- **Japan (Task 42-member)**
Biomass Industrialization Strategy (2012)
- **United States (Task 42-member)**
National Bioeconomy (2012)
- **Norway**
Research Programme on Sustainable Innovation in Food and Bio-based Industries 2012-2022 (2012)
- **France**
Les usages non alimentaires de la biomasse (2012)
- **Switzerland**
Green Economy: Region and Action Plan (2013)
- **United Kingdom**
Waste of resource? Stimulating a bioeconomy (2014)

Results

Country	National strategies	Scope of Strategies	Position of Bioenergy in a BioEconomy		Economic sectors in the focus of strategies	Main strategies	Current focus of implementation
			Governmental	Industry			
Australia							
Belgium							
Canada							
China							
Denmark							
France							
Germany							
India							
Japan							
South Africa							
Sweden							
Switzerland							
United Kingdom							
United States							
Other							

Conclusions

- Bioeconomy is an important part of national transition strategies in 60% of the countries (AT, FI, FR, DE, JP, NL, NO, ZA, SE, CH, UK, US)
- the energy sector is almost always important in national transition strategies, and in most (65%) cases bioenergy has an equal position to other sectors in the BioEconomy, and is a priority in AU, BR, DK, IT, JP, US
- bio-based development is almost always a top-down (policy driven) approach
- most countries have a BioEconomy vision and general targets instead of measurable policy targets (measurable targets in CA, FI, NL, US)
- for market deployment all countries focus on R&D, 70% on transition aspects and 25% an additional policy development
- in all countries the agriculture, forestry and the energy sector are priority areas for the transition to a BioEconomy, and in 80% of the countries also the chemical sector is identified as a priority area
- in half of the countries biorefining is identified as key technology for successful BioEconomy deployment

Acknowledgement

This survey was commissioned and supported by the IEA Bioenergy Task 42 Biorefining and performed by JOANNEUM RESEARCH in cooperation with FITABA with the support of national representatives in the IEA Bioenergy Implementing Agreement.

IEA Bioenergy
Task 42 Biorefining



EUBCE 2015

1 - 4 JUNE | VIENNA - AUSTRIA
Messe Wien Congress and Exhibition Center

23rd European Biomass Conference & Exhibition



G. Jungmeier, V. Pignatelli, M. Monni, M. Beermann,
K. Kwant, K. Sipilä, R. Van Ree

have been nominated by the official jury for the
Poster Award
for the topic "Biomass Policies, markets and sustainability"

The Poster entitled
"BioEconomy Strategies in the Member Countries of the IEA Bioenergy Implementing
Agreement - Current Status, Approaches and Opportunities"

was deemed to be a particularly valuable contribution to the

23rd European Biomass Conference and Exhibition
Vienna, Austria, 1 - 4 June 2015

Ingwald Oberbörger
Conférencé General
Chairman

David Baxter
Technical Programme
Chairman

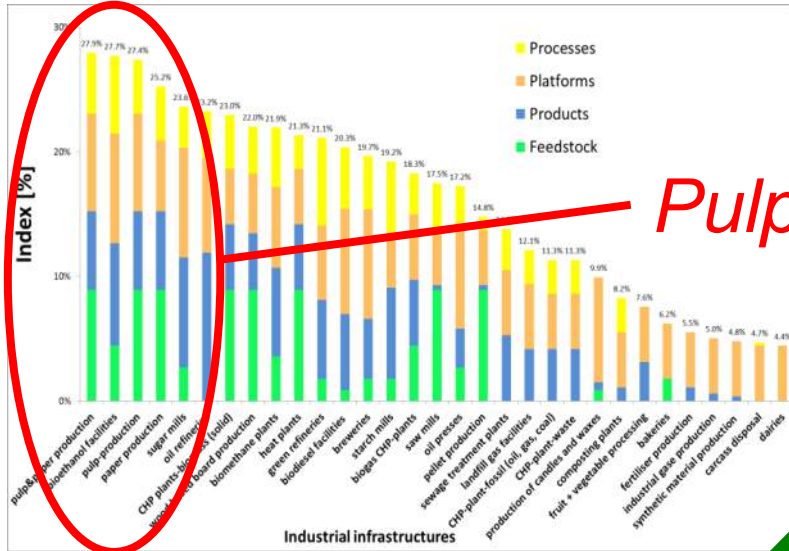
Dimitris Sidras
Poster Awards Coordinator

Peter Helm
Executive Committee

Angelo Grassi
Executive Committee

Upgrading industrial infrastructures to integrated Biorefineries in Biobased Industry

Methodology & Tool developed in Austria and now used in IEA Task 42

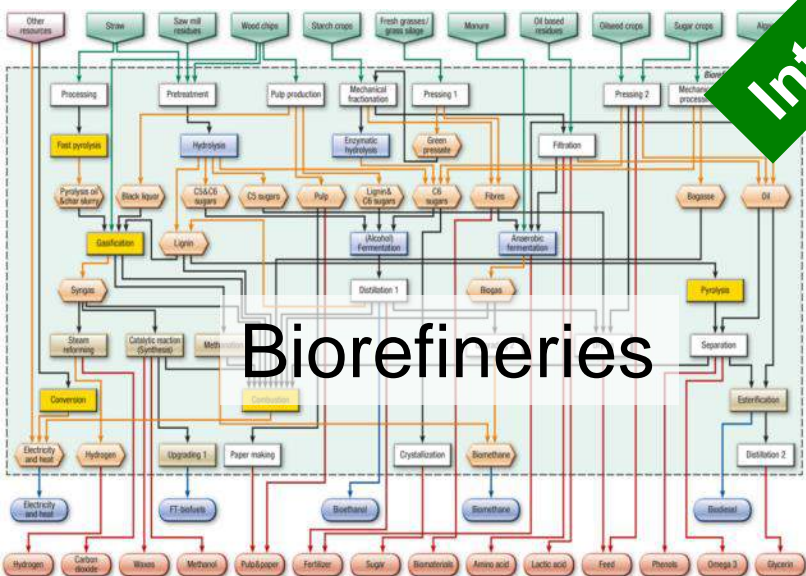


Pulp & paper industry

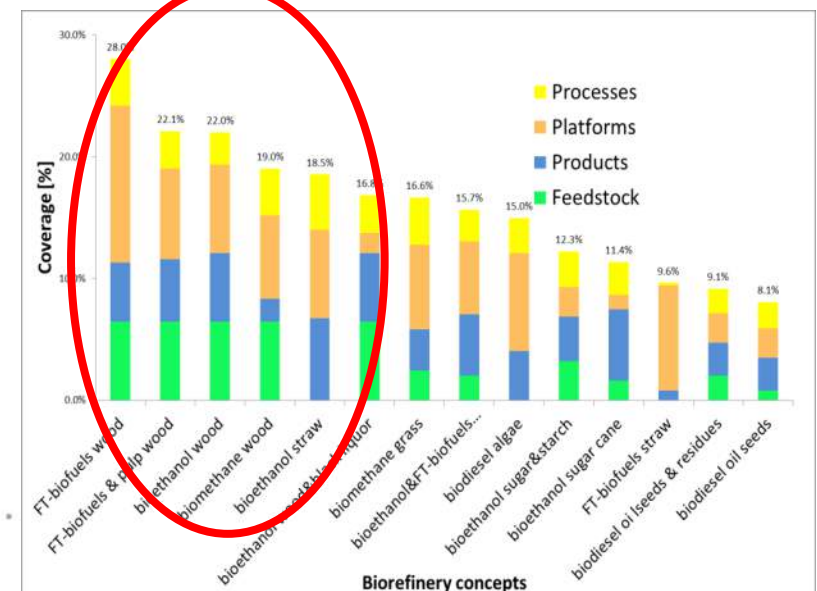


Infrastructure

Integration



Biorefineries



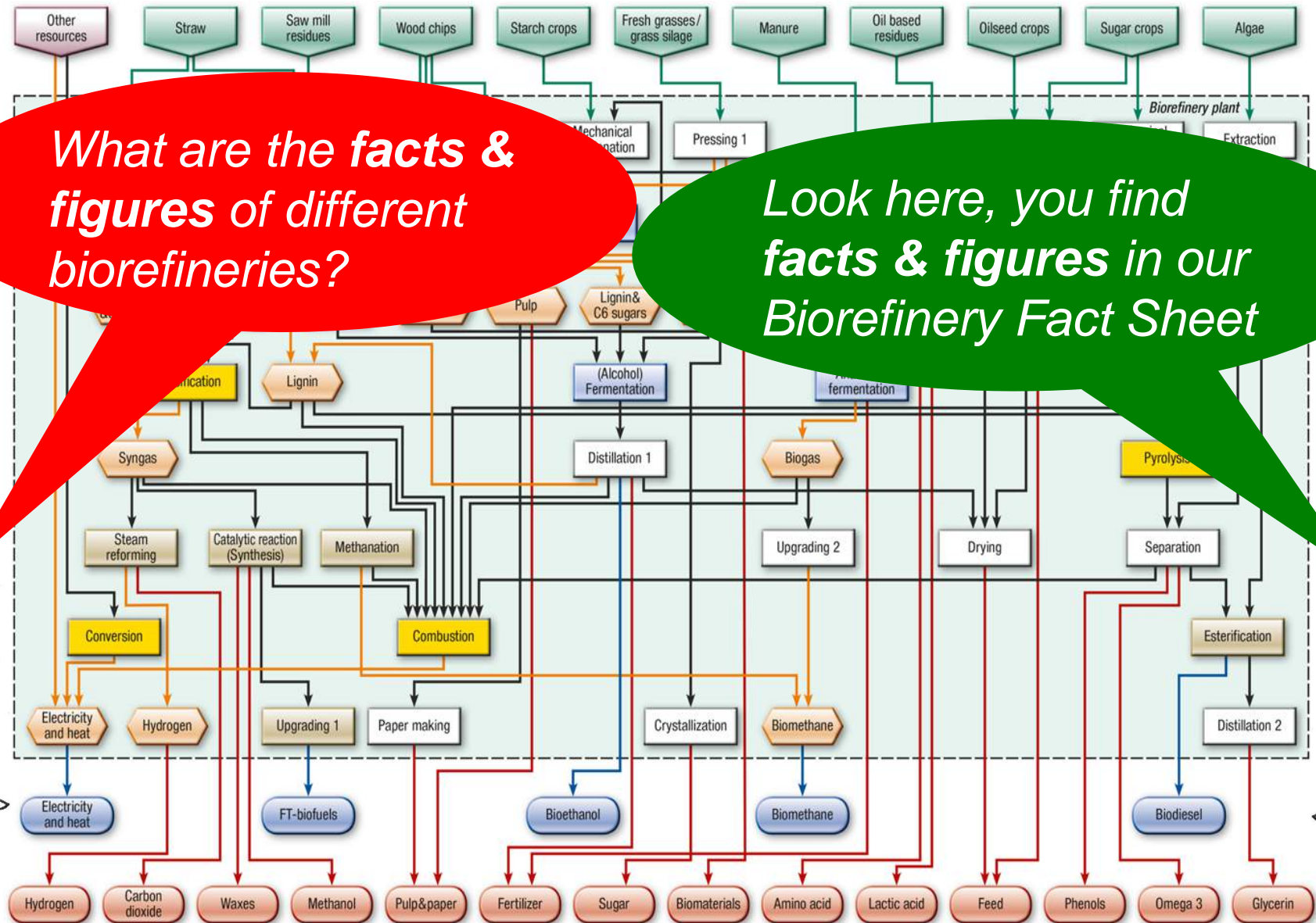
Biorefinery concepts



„Biorefining of ligno- cellulosic feedstocks integrated in an oil refinery - experiences from the Austrian demo plant“

Peter Pucher, BDI - Bioenergy International AG, und Gerfried Jungmeier, JOANNEUM RESEARCH, präsentierten in Berlin bei der Bioenergy Conference der Internationalen Energieagentur (IEA) **aktuelle Technologie-Entwicklungen** und Zukunftsperspektiven zur Erzeugung von **Biotreibstoffen aus Holz.**

Biorefineries for the Biobased Industry



Biorefinery Fact Sheet

Developed in Austria and now also used in IEA Bioenergy Task 42

Part A: Biorefinery Plant

Part B: Value Chain Assessment

Biorefinery FACT SHEET

"A 3-platform (black liquor, pulp, electricity&heat) biorefinery using wood chips for pulp, paper, turpentine, tall oil, bark, electricity and heat"

Part A: Biorefinery plant

The commercial scale biorefinery "A 3-platform (black liquor, pulp, electricity&heat) biorefinery using wood chips for pulp, paper, turpentine, tall oil, bark, electricity and heat" is shown in Figure 4. The wood or wood chips are transported to the biorefinery, where the wood is mechanically debarked and chipped. Then the pulp is produced from the fibres and the rest of the wood and auxiliary chemicals end up in the black liquor. A share of the pulp is further processed to paper. Via a separation process the tall oil and the turpentine are produced and the rest of the black liquor is combusted to produce heat and electricity for the biorefinery and the surplus energy is sold. In the liquor combustion the chemicals are recovered and used again for pulp production.

This biorefinery is state of the art and commercial production facilities have an annual pulp production capacity between 200,000 up to 1,000,000 t per year. The black liquor platform contains a lot of other chemicals that are not recovered today due to economic and technical limitations. In future the broad variety of different chemical in the black liquor offers a great potential for future developments and new commercial products.

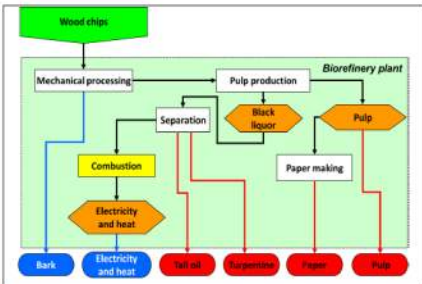


Figure 4: A 3-platform (black liquor, pulp, electricity&heat) biorefinery using wood chips for pulp, paper, turpentine, tall oil, bark, electricity and heat

Table 1: Key characteristics of biorefinery plant

Biorefinery plant: pulp, wood chips	
State of technology: commercial 2013	
Country: Austria	
Main data sources: Austria case study in cooperation with Austropapier, assumptions	
Products	Auxiliaries (external)
pulp: 400 [kt/a]	electricity: 0.00 [PJ/a]
paper: 13 [kt/a]	heat: 0.00 [PJ/a]
bark (50%): 122 [kt/a]	energy carriers: 1.29 [PJ/a]
tall oil: 6 [kt/a]	retrochlorinated V2SO4 (97%): 32.0 [kt/a]
electricity: 0.4 [PJ/a]	Q2: 8.0 [kt/a]
heat: 0.25 [PJ/a]	other: NaOH (30%), burnt lime, 32.0 [kt/a]
Feedstock	Costs
wood chips: 1495 [kt/a]	investment costs: 350 [Mio-€]
water: 29 [kt/a]	feedstock costs: 100 [€/t]
	number of employees: 400 [p]
Differences	mass energy
input to products (dry matter):	35% 53%

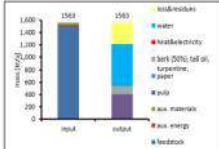


Figure 5: Mass balance of biorefinery plant

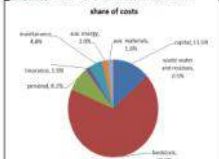


Figure 7: Share of costs

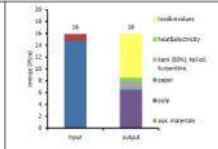


Figure 6: Energy balance of biorefinery plant

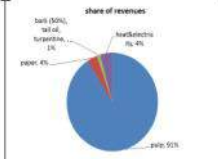


Figure 8: Share of revenues

Part B: Value Chain Sustainability Assessment

The method of the sustainability assessment - economic and environmental - is given in Annex 1. The main assumptions and modelling choices are documented in Annex 2.

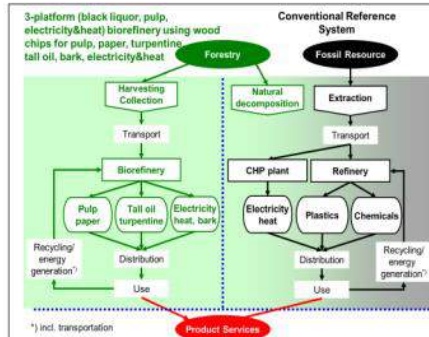


Figure 9: Comparison of biorefinery with conventional reference system on whole value chain (incl. 'end of life treatment')

Table 2: Key characteristics of biorefinery value chain

Whole value chain	
Greenhouse gas emissions	range
biorefinery	180 (170 to 210) [t CO ₂ -eq/t]
reference system	1297 (1250 to 1490) [t CO ₂ -eq/t]
relative	-86% (-80% to -92%) [%]
Cumulated energy demand	
biorefinery	2.3 (2.1 to 2.6) [PJ/t]
reference system	20.9 (15.8 to 26) [PJ/t]
relative	-89% (-85% to -100%) [%]
biorefinery	17.0 (15.8 to 20.6) [PJ/t]
reference system	22.5 (21 to 25.9) [PJ/t]
relative	-24% (-22% to -28%) [%]
Agricultural area demand	
biorefinery	0 [t a/t]
reference system	0 [t a/t]
Costs	
annual costs	239 (200 to 270) [Mio-€/a]
specific costs	402 (380 to 430) [€/t]
Revenues	
annual revenues	220 (210 to 230) [Mio-€/a]
specific revenues	360 (300 to 470) [€/t]

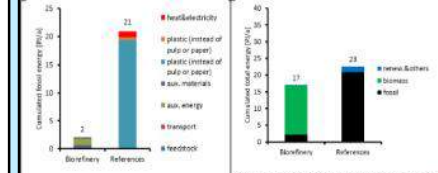


Figure 10: Estimated cumulated fossil energy demand of biorefinery and reference products

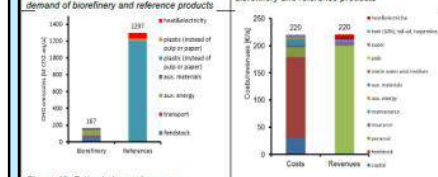


Figure 11: Estimated cumulated energy demand of biorefinery and reference products



Figure 12: Estimated greenhouse gas emissions of biorefinery and reference products



Figure 13: Estimated cost and revenues of biorefinery plant

Annex:

Methodology of sustainability assessment and data with references

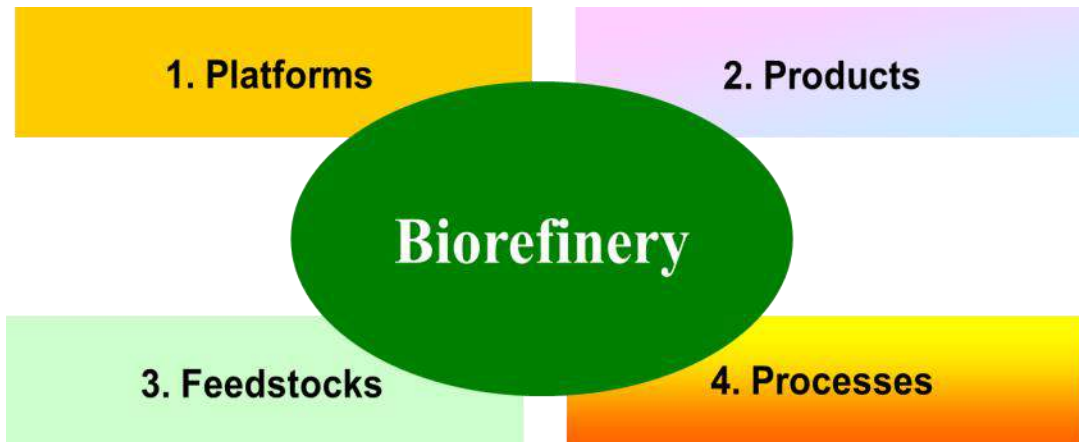
Biorefinery Fact Sheets are available

- 5 Glossy Fact Sheets
- 15 online on webpage
- incl. 2 Austrian Cases
 - Biorefinery Pöls AG (Steiermark)
 - Biorefinery BioCRACK (Schwechat)
- 5 non public
- 7 in progress (e.g. biogas, pyrolysis, protein, rubber dandelion, algae..)

All sheets are made with the „**Biorefinery Fact Sheet Calculator (V 2.1)**“ developed and owned by **JOANNEUM RESEARCH**

Developed in Austria and now used in IEA Bioenergy Task 42

The 4 Features to Characterise A Biorefinery Systems

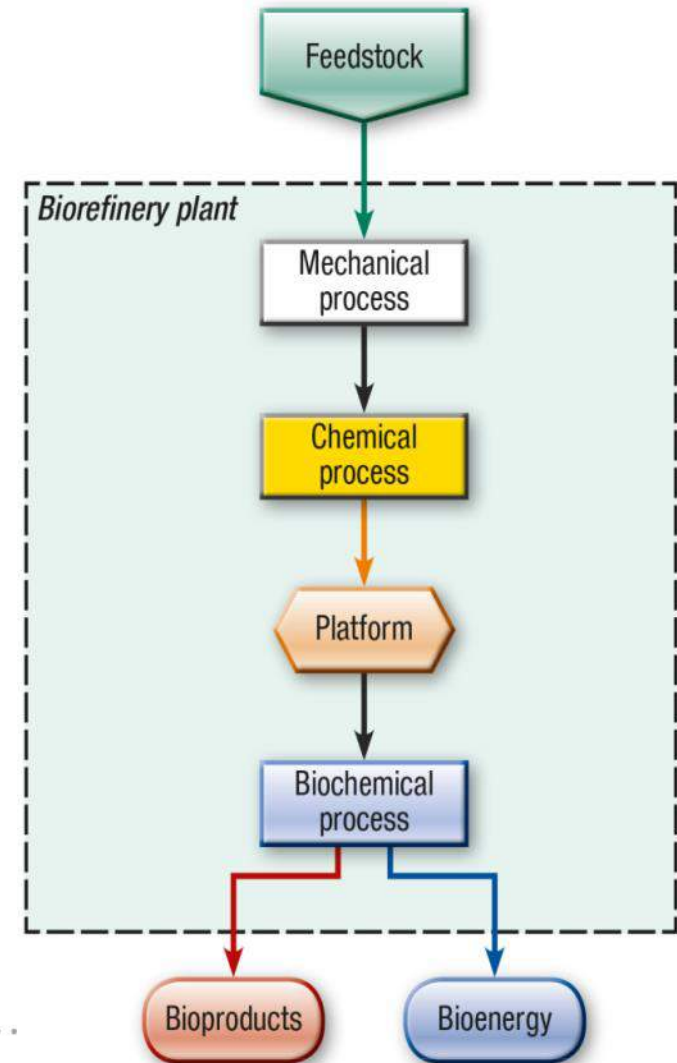


Naming:

➤ Principle: Number platforms (Name of platforms)/Feedstock/Products/Processes

➤ example: „2-platform (electricity&heat, syngas) biorefinery/wood chips/FT-biofuels, electricity, heat, waxes/steam gasification”

Generic system



Classification System is used...

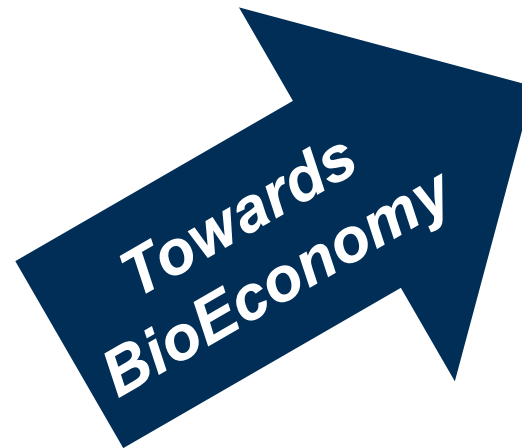
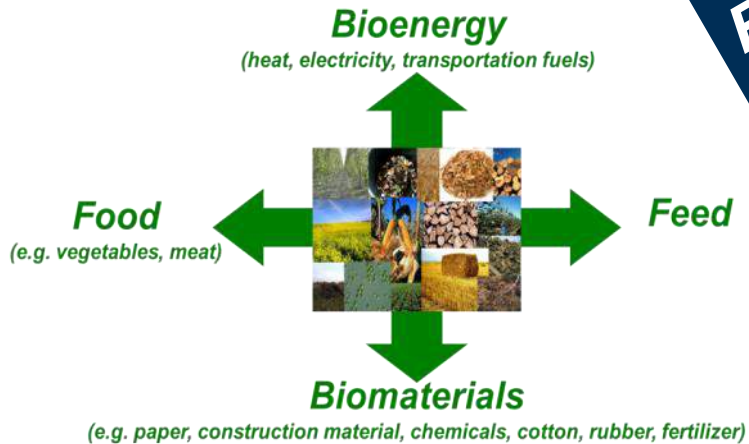


ICS 13.020.20, 65.040.20, 71.020		VDI-RICHTLINIEN		Januar 2016 January 2016	
VEREIN DEUTSCHER INGENIEURE		Klassifikation und Gütekriterien von Bioraffinerien Classification and quality criteria of biorefineries		VDI 6310 Blatt 1 / Part 1 Ausg. deutsch/englisch Issue German/English	
Die deutsche Version dieser Richtlinie ist verbindlich.		The German version of this standard shall be taken as authoritative. No guarantee can be given with respect to the English translation.			
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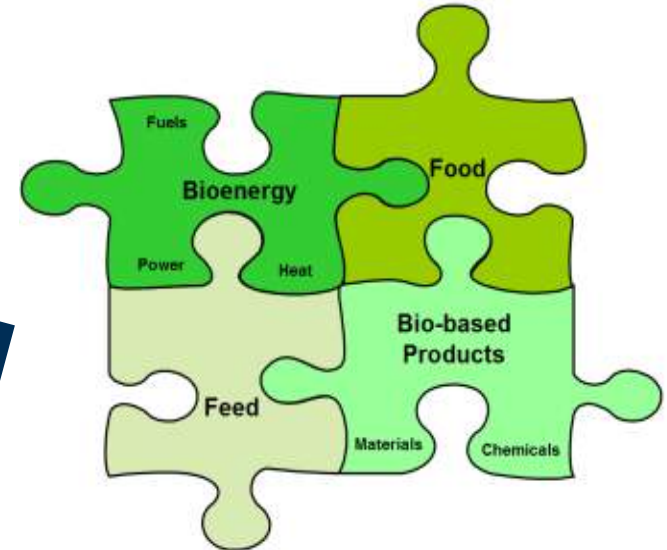
VDI 6310 Jänner 2016: „Klassifikation und Gütekriterien von Bioraffinerien“

The New Way in BioEconomy: From Competition to Integration

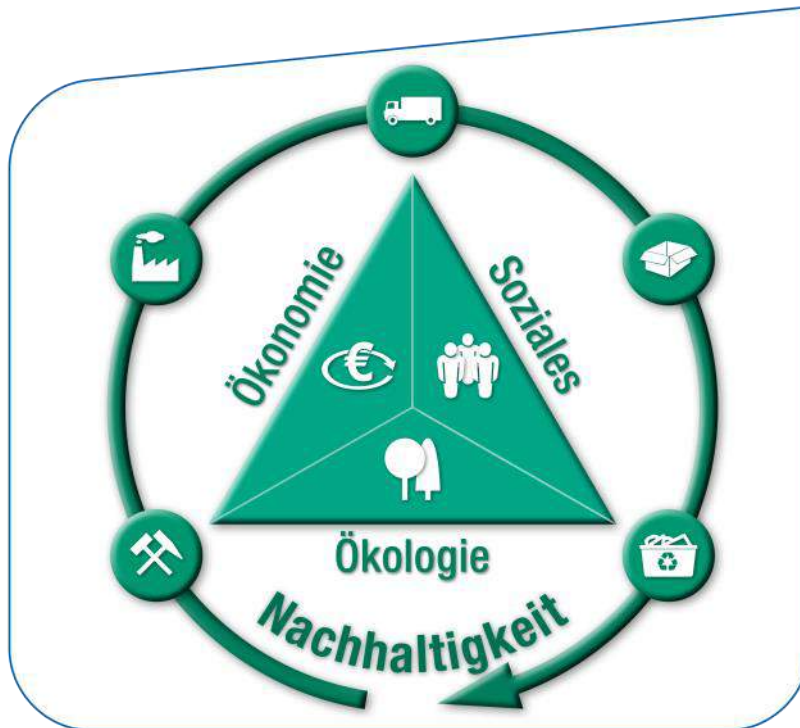
Competition



Integration



Your Contact



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20

- Entwicklung wirtschaftlicher **Chancen** aus dem Klimawandel
 - **Low Carbon Society** – Entwicklung und Übergang zu einer kohlenstoffarmen Wirtschaft / Gesellschaft bis 2050
 - Stärkung der **Resilienz** gegenüber Klima- und Wetterrisiken
 - **Erneuerbare Energieversorgung**
 - **Zukunftsfähige Lebensstile**
- Etablierung eines **europäischen interdisziplinären Forschungszentrum**
- Wissenschaftliche Exzellenz in **drei Forschungsgruppen**
 - Wetter- und Klimarisiko-Management
 - **Zukunftsfähige Energiesystem und Lebensstile**
 - Internationale Klimapolitik und -ökonomie



Die VIER Einflüsse der Treibhausgas-Emissionen

Zukunftsfähiges
Energiesystem

Lebensstile

$$tCO_{2\ddot{A}q} = \frac{t_{CO_2\ddot{A}q}}{GJ_{Energie}} * \frac{GJ_{Energie}}{DL} * \frac{DL}{P} * P$$

- 1) Emissionsfaktor
(z.B. erneuerbare Energie)
- 2) Energieeffizienz
- 3) Dienstleistungen (DL) pro Person
- 4) Anzahl der Personen

Zukunftsfähige Energiesysteme und Lebensstile

Zukunftsfähigkeit



Umwelt



Wirtschaft



Gesellschaft