Energy and Biomass Sustainability

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acatech – National Academy of Science and Engineering

- The **institution**
  - acatech: independent and self-determined representative of science and technology in Germany and abroad
  - Supported by the federal government and the 16 federal states as a national academy since January 1, 2008
- The **network** (as of September 2018)
  - 513 members in Germany and abroad / 101 senators
- The **objectives**
  - Scientific recommendations
  - Knowledge transfer
  - Promotion of young scientists and engineers
  - Innovative capacity

Patron: Federal President Frank-Walter Steinmeier

The Presidents of acatech: Dieter Spath (left) and Karl-Heinz Streibich

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acatech Topical Network
Biotechnology and Bioeconomy

- Members: 40 scientists and 6 enterprises
- Lead: Thomas Bley, TU Dresden
- Since 2011, meets twice a year
- Topics:
  - **Innovation Potential of Biotechnology (2016)**
  - Wood – resource for a new bioeconomy?
  - Artificial Photosynthesis
  - New Projects:
    - Potential of Biotechnological Energy Transformation (*to be concepted*)
    - Increasing the Industrial Application of Biotechnologies

How to cope with challenges of the 21th century?

- **Sustainable living** – behavior changes, societal agreements
- **Sustainable production** – technology, regulatory frameworks, incentives

➔ **Sustainable bioeconomy**

  – in harmony with nature and the environment
  – knowledge-based, innovative
  – with circular use of (renewable) resources

Comprehensive definition of bioeconomy

Plants, microbes, animals, biodiversity, biotechnology, „C“ in CO_2, biological knowledge

Sustainable production and use of **biological resources, processes and principles** to provide products and services in **all economic sectors**.

Agriculture/forestry/fisheries, food, paper, textiles, chemicals, pharma, building & construction, ICT, …

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Bioeconomy - Developments

- Key area of activity: Sustainable agricultural systems and food
- two new proposed areas of activity:
  - urban development
  - resource protection and biobased circular economy.
- key research topics for promoting the bioeconomy on the demand side:
  - energy sector
  - artificial photosynthesis and direct storage of sunlight.

Innovation Potential of Biotechnology

Economic Relevance and Market Potential in Germany (I)

- **Cross-sectional technology** in the high-tech sector,
  constantly new application possibilities,
  creation of new markets

- **Opportunities** and **market potential** (worldwide):
  - **Industry**: Opportunities through emerging bio-economy,
    partial substitution of chemical processes;
    sales potential up to **EUR 800 billion (2025)**

  - **Medicine**: Opportunities through biopharmaceuticals,
    biosimilars, diagnostics;
    sales potential approx. **280 billion USD (2020)**
  - **Agriculture**: Opportunities from new crops;
    seed sales potential approx. **USD 28 billion (2019)**

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Innovation Potential of Biotechnology

Economic Relevance and Market Potential in Germany (II)

Key figures for Germany 2015: almost **600** dedicated companies, **18,000 employees, € 3.4 billion** turnover, € **1 billion R&D** spending small, predominantly SME-oriented sector

SWOT analysis of the German biotechnology-related industry:

- **Strengths:** high performance of the research system, qualification, mix of SMEs and global players, engineering skills
- **Weaknesses:** low supply of venture capital, no continuous financing chain (“Valley of death” - general problem for German start-up sector), weak transfer culture
- **Opportunities:** Cross-sectional technology with many applications, high value-creation potential, development of bio based industries
- **Risks:** lack of acceptance, migration or dissolution of the red BT due to lack of financing

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Euro-CASE Bio-economy Platform

Euro-CASE

- Launched in November 2015
- Lead: Bruno Jarry, Vice President National Academy of Technologies of France (NATF)
- 13 member academies
- Close collaboration with EU Initiatives
- works on an overview of the **status of the bio-economy in Eastern Europe**

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SAPEA: Science Advice for Policy by European Academies

- **Horizon 2020 project** (2016-2020) receiving € 6 million EU funding
- **100+ Academies in over 40 countries** across Europe
- disciplines of engineering, humanities, medicine, natural sciences and social sciences
- Part of the European **Scientific Advice Mechanism** (SAM),
  - independent, interdisciplinary and evidence-based scientific advice on policy issues
  - Advice to the European Commission
  - SAPEA works closely with the SAM High Level Group of Scientific Advisors
- **Topics** are e.g. Food from the Oceans, authorisation processes of plant protection products in Europe, novel carbon capture and utilisation technologies …

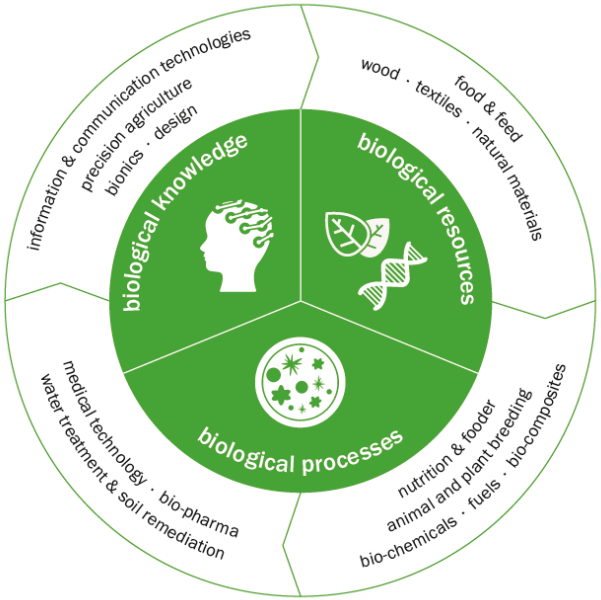
The German Bioeconomy Council – objectives and tasks

1. Encouraging R&D of new technologies
2. Setting up positive framework conditions for a biobased economy
3. Improving interdisciplinary training & professional development
4. Dialogue with stakeholders

It is the German Bioeconomy Council‘s aim to establish a cross-sectoral knowledge-based bioeconomy generating sustainably created products and services, thus combining economic growth with the objective of environmental compatibility.

Bioökonomierat
17 Council Members

Comprehensive understanding of bioeconomy



Source: German Bioeconomy Council, 2016

- Knowledge-based production & utilization of biological resources,
- innovative biological processes & principles (knowledge)
- to sustainably provide goods and services across **all** economic sectors.

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Biologization of the economy

German Bioeconomy Council definition:

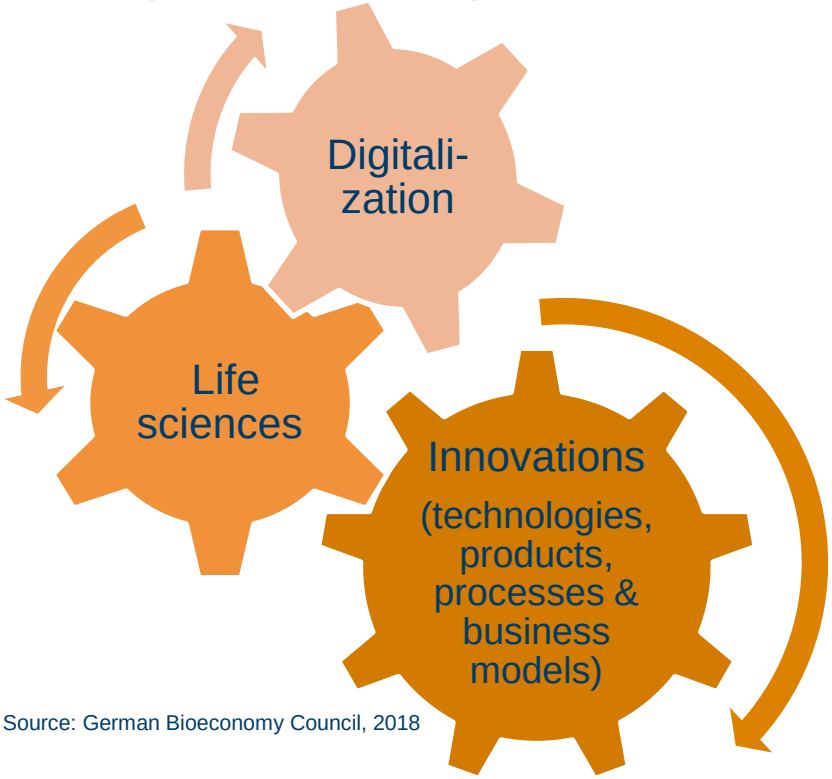
>> Collective term for the increasing ***integration of the principles of nature*** in a modern economy, or the development of products and solutions with the help of the ***life sciences****.

** life sciences:*

Medicine, Biomedicine, Pharmacy, Biochemistry, Molecular Biology, Biophysics, Bioinformatics, Biotechnology, Human Biology, Agricultural Technology, Nutrition Science and Food Research, Biodiversity Research, scientific processing of biogenic natural resources, etc.

Source: von Braun, J. *Bioeconomy - Science and Technology Policy to Harmonize Biologization of Economies with Food Security.* In: D. Sahn (Hrsg.): *The Fight Against Hunger and Malnutrition.* Oxford University Press, 2015, S. 240 - 262.

Biologization & Digitalization



Source: German Bioeconomy Council, 2018

- Big data & “omics“-technologies
- Genome editing of organisms & breeding
- Biorobotics
- Bio-sensors & chips
- Bioprospecting in pharma
- Agriculture & forestry 4.0
- Plastics moulding & 3D-printing
- Personalized nutrition
- Bioinspired algorithms & software
- Storage technologies (DNA)
- etc.

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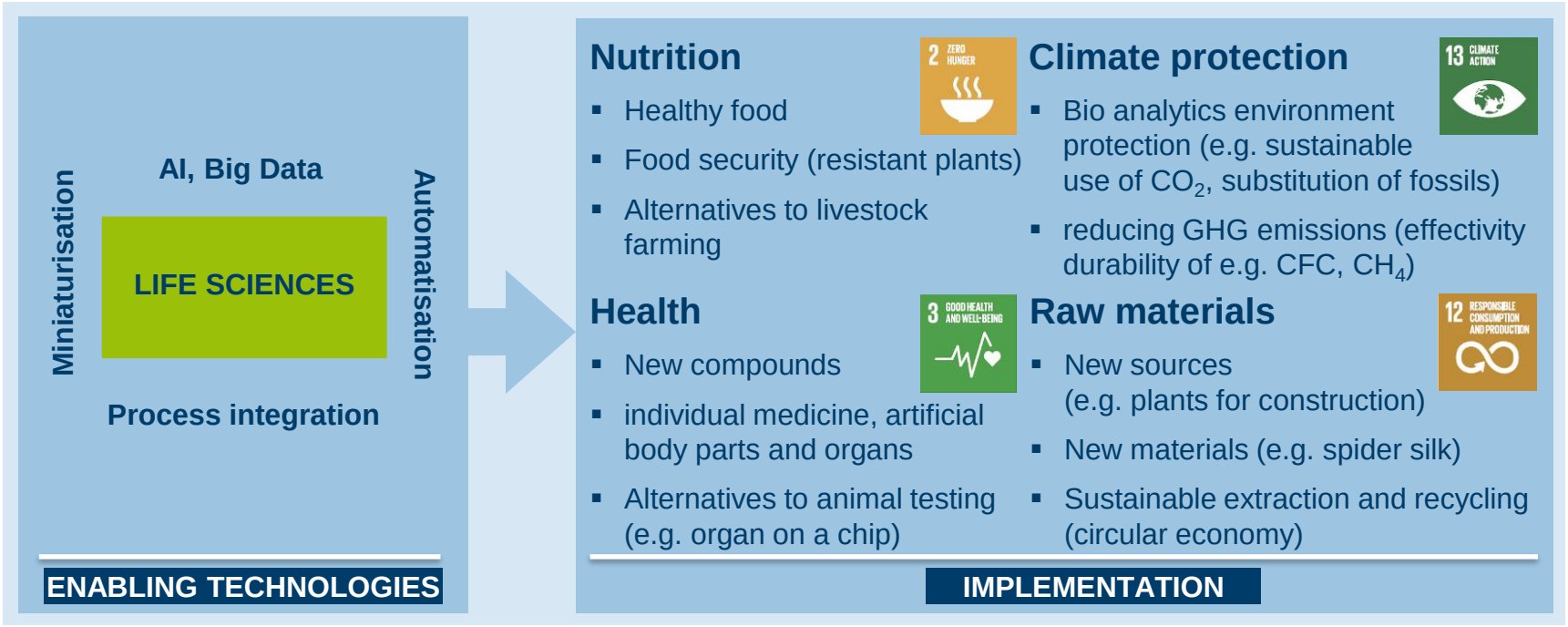
Biotechnology: Research and Implementation



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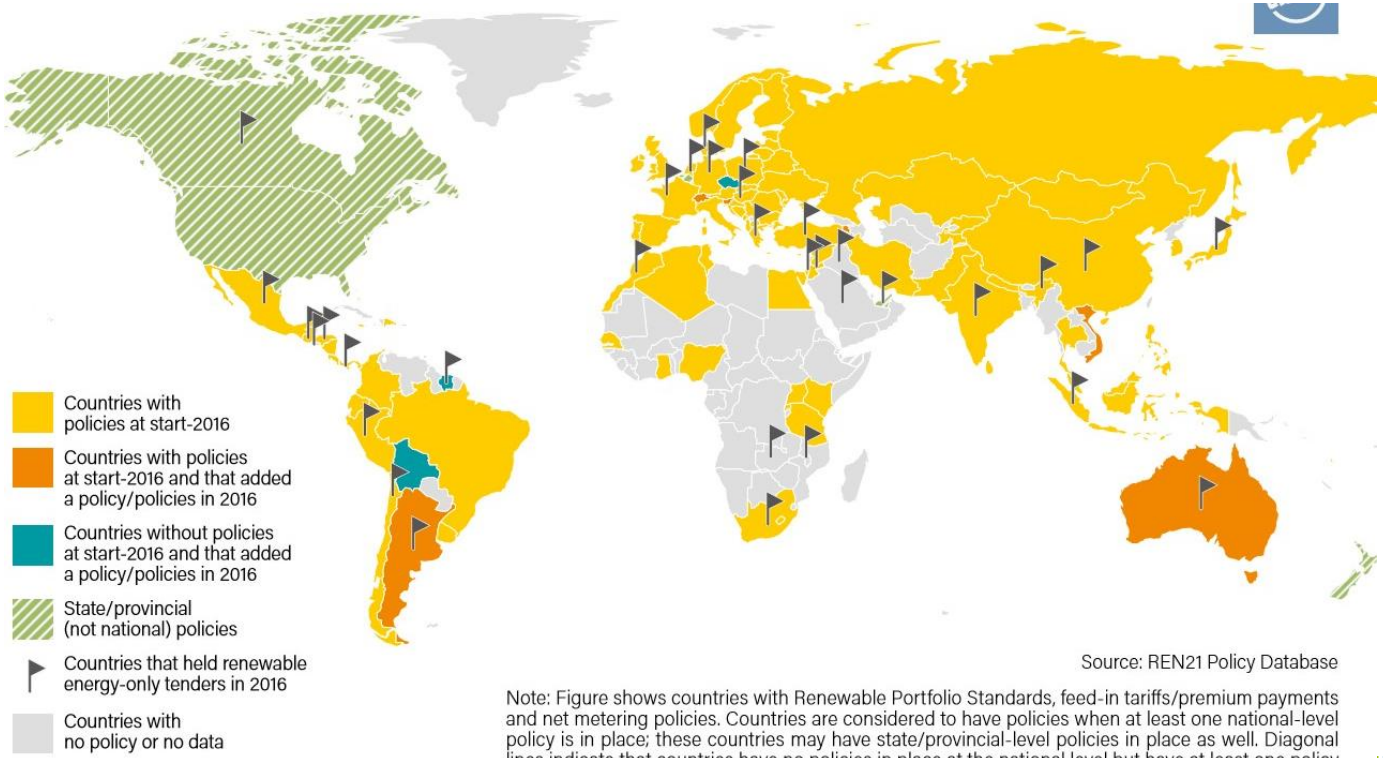
Countries with Renewable Energy Power Policies



Source: REN21 Policy Database

Note: Figure shows countries with Renewable Portfolio Standards, feed-in tariffs/premium payments and net metering policies. Countries are considered to have policies when at least one national-level policy is in place; these countries may have state/provincial-level policies in place as well. Diagonal lines indicate that countries have no policies in place at the national level but have at least one policy at the state/provincial level.

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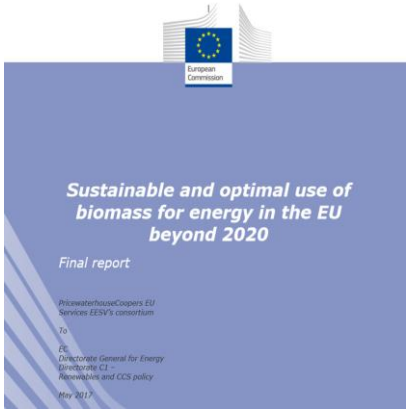
EU Report on Sustainable and optimal use of biomass for energy in the EU beyond 2020



EU Report from May 2017, https://ec.europa.eu/energy/sites/ener/files/documents/biosustain_report_final.pdf

- EU-wide target: at least 27 % renewable resources for final energy consumption for 2030
- Energy from biomass contributes almost two-thirds (123 Mtoe, 63.1 %) of the combined EU renewable energy production
- Assessment of the biomass supply potentials, analysis of potential gaps in the existing policy and regulatory framework, identification of possible policy options
- Analysis of the impacts of five policy options
- Environmental, economic and social impacts

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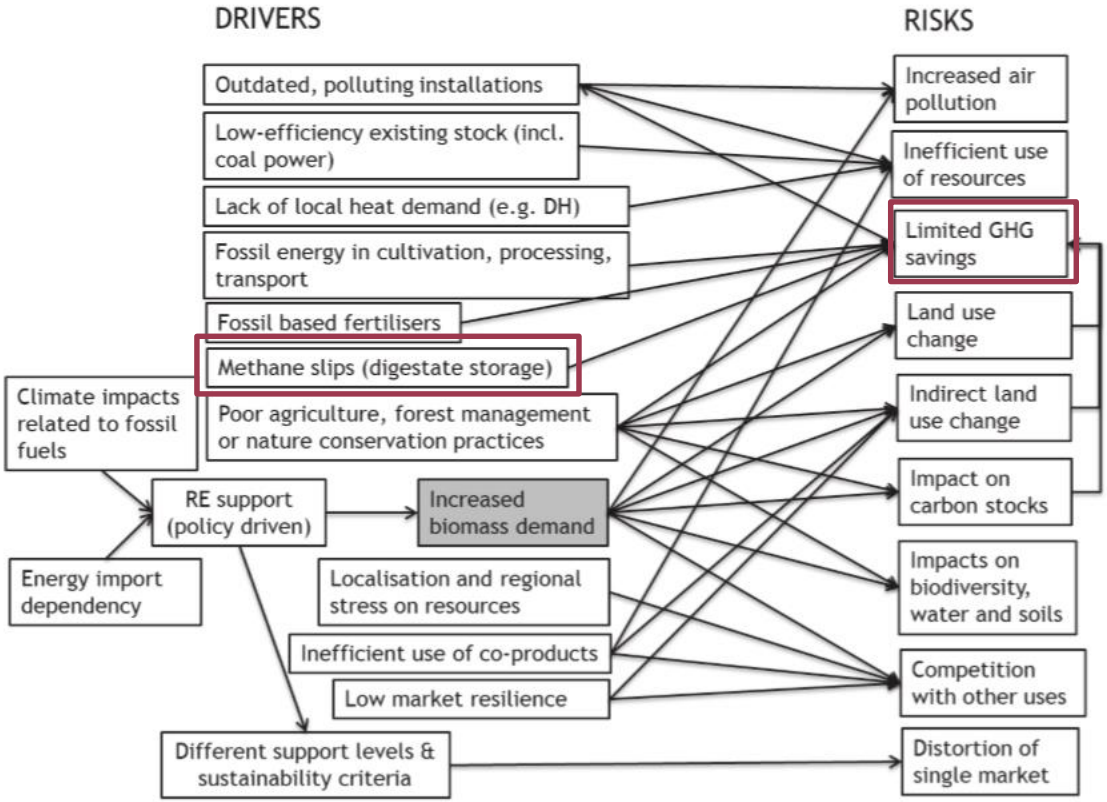
Problem tree for sustainability risks related to solid biomass and biogas for heat and power



Source: European Commission, Sustainable and optimal use of biomass for energy in the EU beyond 2020, Final Report, p 17

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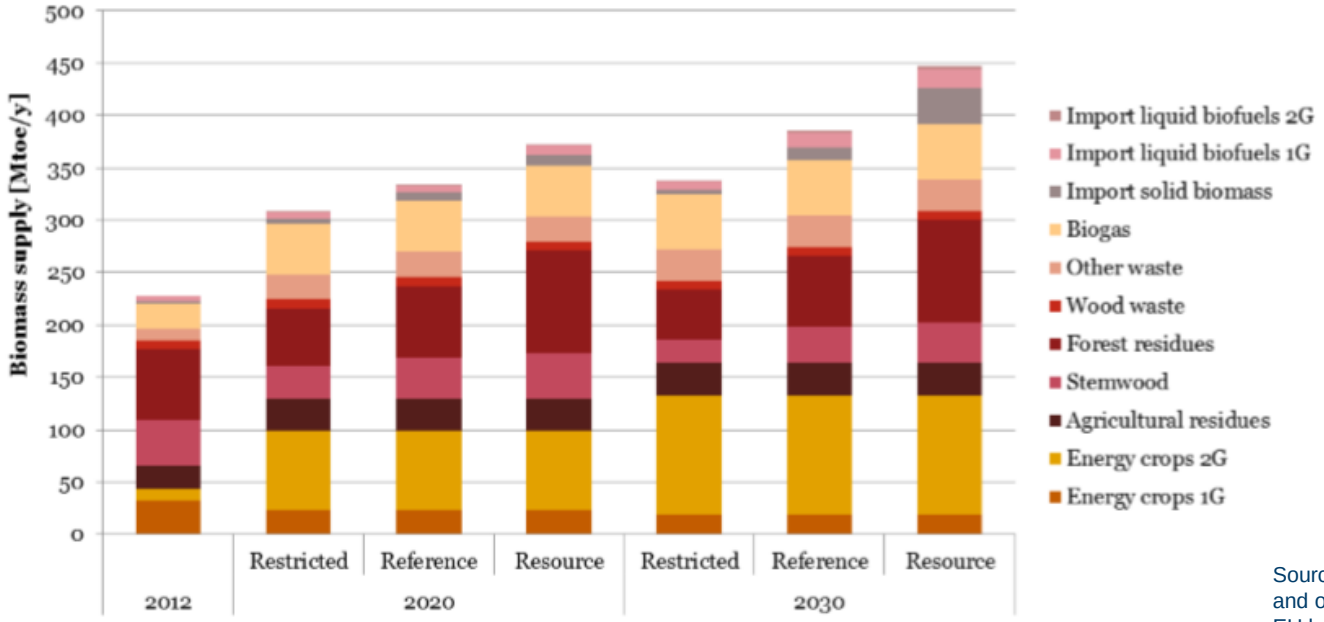
Overview of estimated biomass potential for bioenergy in the EU in 2010, 2020 and 2030 in terms of primary energy



Biogas and import of liquid biofuels are shown in final energy units.
1G: food- and feed-based energy crops, biofuels
2G: lignocellulosic energy crops, biofuels

- Energy Usage
- Impact/ efficiency?
- Pollutants?
- Ethical issues?

Source: European Commission, Sustainable and optimal use of biomass for energy in the EU beyond 2020, Final Report, p 39

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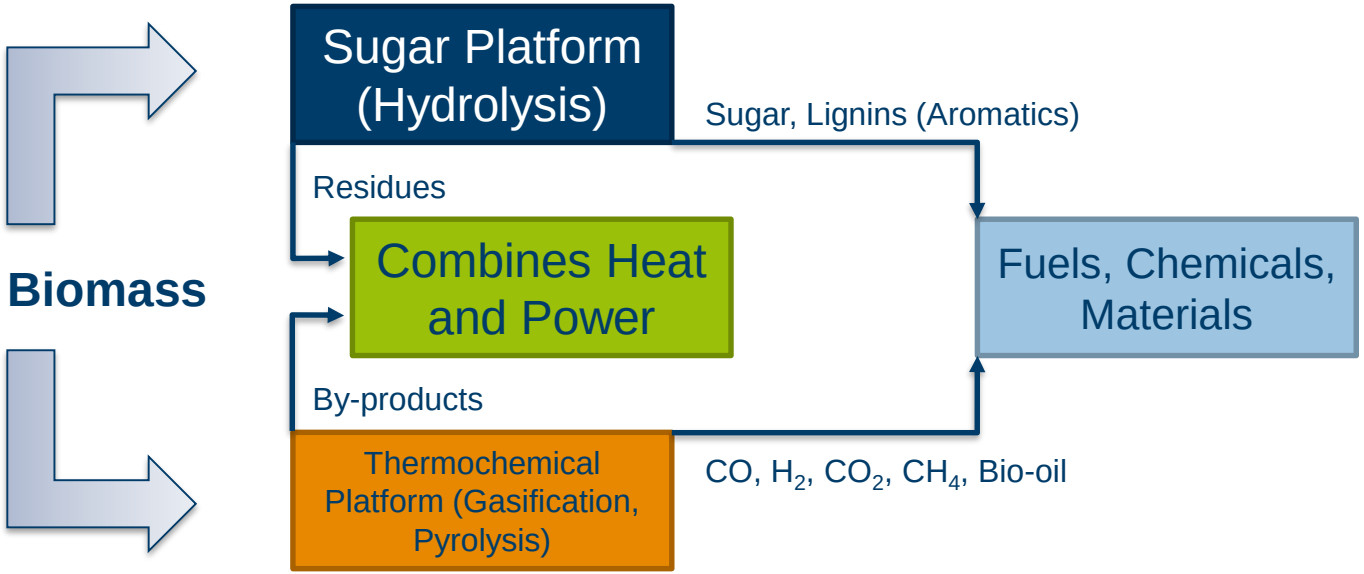
Biomass Conversion Technology „Platforms“



Source: based on James D. McMillan, National Bioenergy Center, National Renewable Energy Laboratory

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Biotechnological Energy Conversion

- Second-generation, acatech project in 2012
- Biomass-based energy sources as renewable energy replacement for coal and nuclear
- Open questions:
  - 10+ % Bioethanol in combustion engines?
  - Ethical issues on oils, starch, wood, sugar and others:
    „Food vs. Energy?“
    → Focus on waste materials
  - Commercial potential?

Example for new technology acceptance: Artificial Photosynthesis – Developing Technology Futures

- **Looking for acceptance ex post is not sufficient**; marketing campaigns did not prove useful for gaining acceptance
- In order to ensure the successful roll-out of technology-based innovations, it is seems appropriate **to engage in an early dialogue** with interested parts of the public, civil society
- new ways of upstream engagement / dialogue with citizens / ‘science with and for society’:
  - What are conditions for acceptance?
  - What kind of technology do citizens, users, NGOs wish?
  - How do different groups see opportunities and challenges?
- Method: anticipation, creation, assessment of technology futures
- Project chairs: Armin Grunwald, Alfred Pühler

Artificial Photosynthesis

An open field of research and innovation

- Background: Global Energy consumption increases, shortage of fossil fuels, problematic CO_2 emissions, energy storage as a challenge
- Approach

1. sunlight inexhaustable resource, available for free the world over
2. Artificial photosynthesis follows the example of plants: produce energy-rich hydrocarbons from H_2O, CO_2
3. Products: fuel for transportation, feedstock for chemical industry

"Develop a manufacturable **solar-fuels generator**, made of Earth-abundant elements, that will **use only sunlight, water, and carbon dioxide** as inputs and robustly **produce fuel from the sun** ten times more efficiently than current crops."

Joint Center for Artificial Photosynthesis (JCAP) Mission statement

Artificial Photosynthesis (schematic)

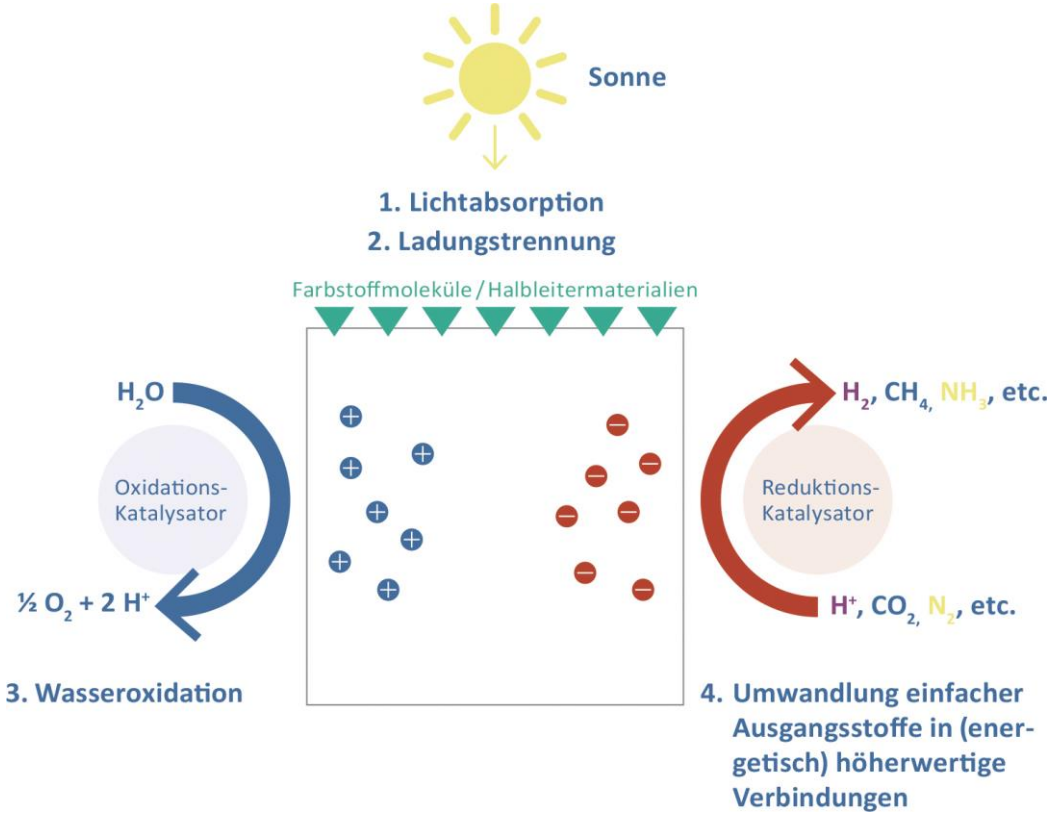
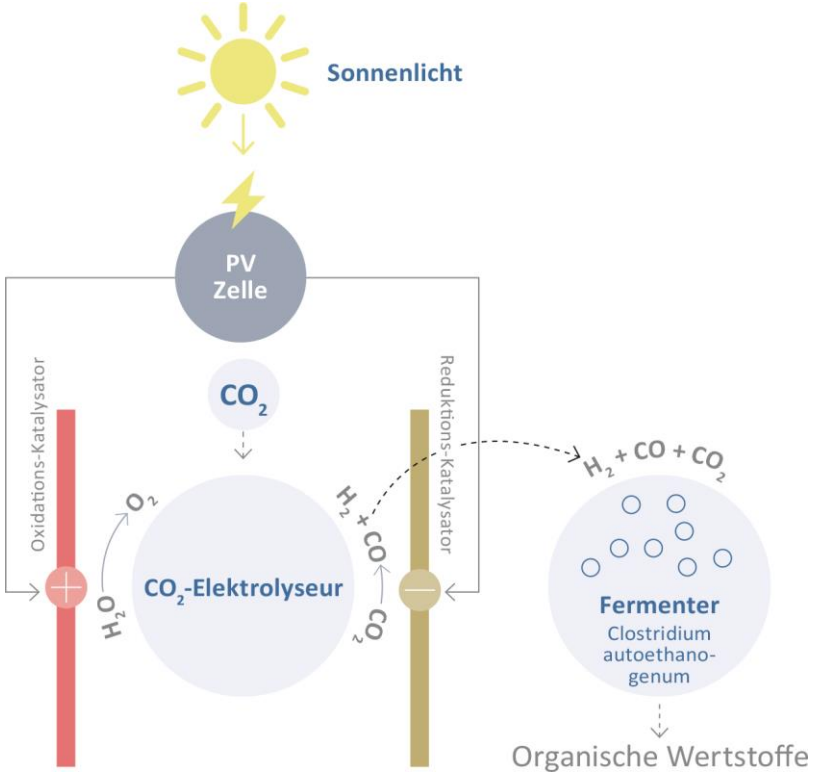
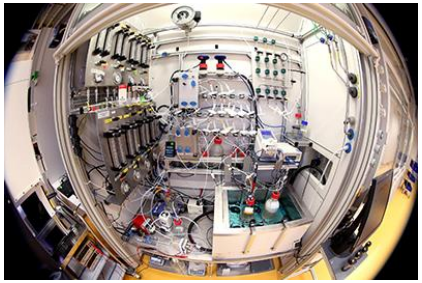


Chart:
Leopoldina, acatech,
Akademienunion May 2018

Hybrid system (PV, electrolysis & fermentation)





Copyright: Evonik Industries AG

Chart:
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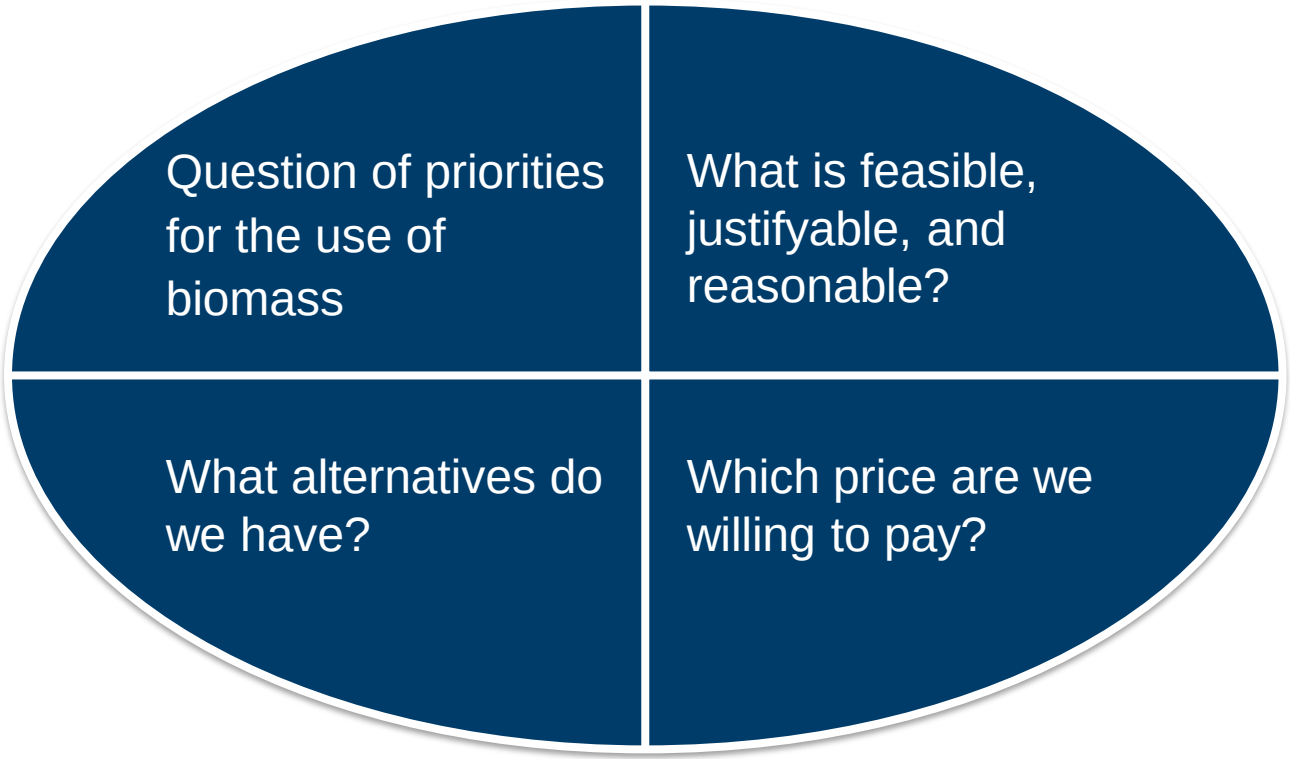
Summary: Energy vs. Food vs. Materials



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Thank you very much for your attention.

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