Deutsches Biomasseforschungszentrum
gemeinnützige GmbH

DBFZ

Overview of decentral sector coupling with biomass

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Biomass to Power and Heat 2018

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Definitions I: decentral

Decentralized or distributed (bioenergy provision): "...is (...) generation and storage performed of small, grid-connected devices referred to as distributed energy resources" (English Wikipedia: Distributed generation 05.06.2019)

- moderate size of conversion plants (e.g. < 10 MW_{el}, more typical in Germany < 1 MW_{el})
- location of conversion plant near to utilisation of bioenergy (short to middle range heat transfer)
- regional biofuel provision / regional value chain

Smart bioenergy: decentralized +

- sustainable biomass resources
- capacities adapted to regional demand
- intelligent integration into a renewable energy system
- integration into bioeconomy

Definitions II: (energy) sector

Remember: *„sector“ can have very different meanings!*

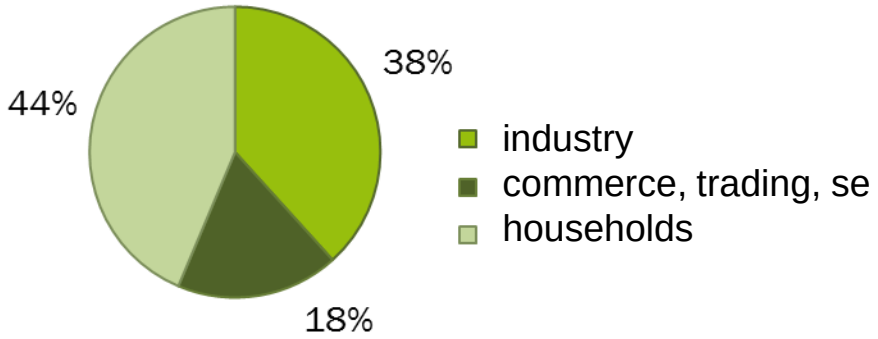
Sectors of energy system

- households
- commerce, trading and services
- industry (incl. big scale energy provision)

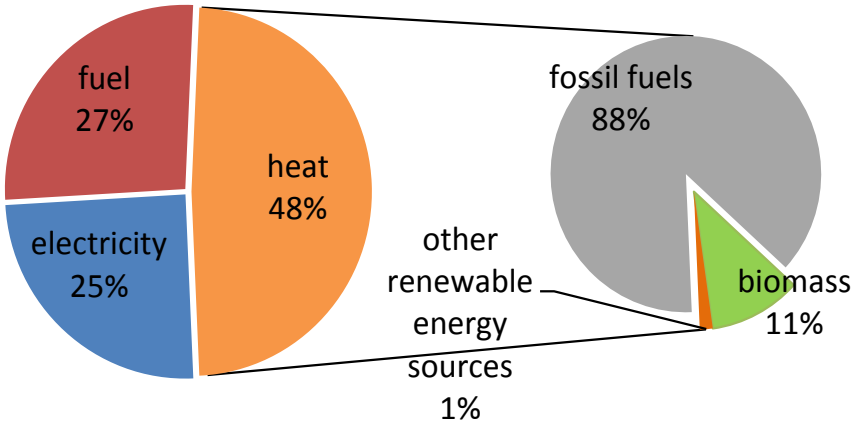
Sectors of energy purposes

- electrical power
- heating and cooling
- mobility
- (biofuels for different purposes including material use)

Final energy consuption for heating and cooling (Germany 2013-2016)



Final energy consumption in Germany 2014 – total: 2.400 TWh



Sources:
AG Energiebilanzen e.V. (AGEB): Anwendungsbilanzen für die Endenergiesektoren in Deutschland in den Jahren 2013 bis 2016, Stand: November 2017

Definitions II: (energy) sector coupling

sector coupling: „… parallel regard and connection of the three sectors “ („power generation, heat supply and mobility“) „of the energy system …, which shall be coupled, as well as should be optimized together at the same time“

(German Wikipedia, 22.03.2017, translated)

For sectors of energy system

- combined energy provision of buildings and purposes of different sectors; e.g. connection of industrial waste heat to private houses or publlic buildings

Sectors of energy purposes

- parallel provision of energy to two or more sectors (e.g. CHP)
- conversion of energy from one sector to another (e.g. power from combustion plant)
- impact of energy provision and utilisation from one sector to the others (e.g. avoidance of power utilisation for heat pump by a stove)

Systematic overview of coupling of energy provision purposes

Conversion from one sector to another

- fuel to heat (e.g. oil boiler)
- fuel to power (e.g. coal power plant)
- heat to power (e.g. ORC)
- power to heat (e.g. electric heater)
- power to fuel (e.g. hydrogen-generation)
- power to mobility (e.g. eMobility)

Parallel supply of different purposes

- power and heat (e.g. CHP)
- mobility and heating/cooling (e.g. cars)
- fuel production plus fodder (e.g. biodiesel)
- power and mobility (e.g. PV system with connection to accumulator of car)

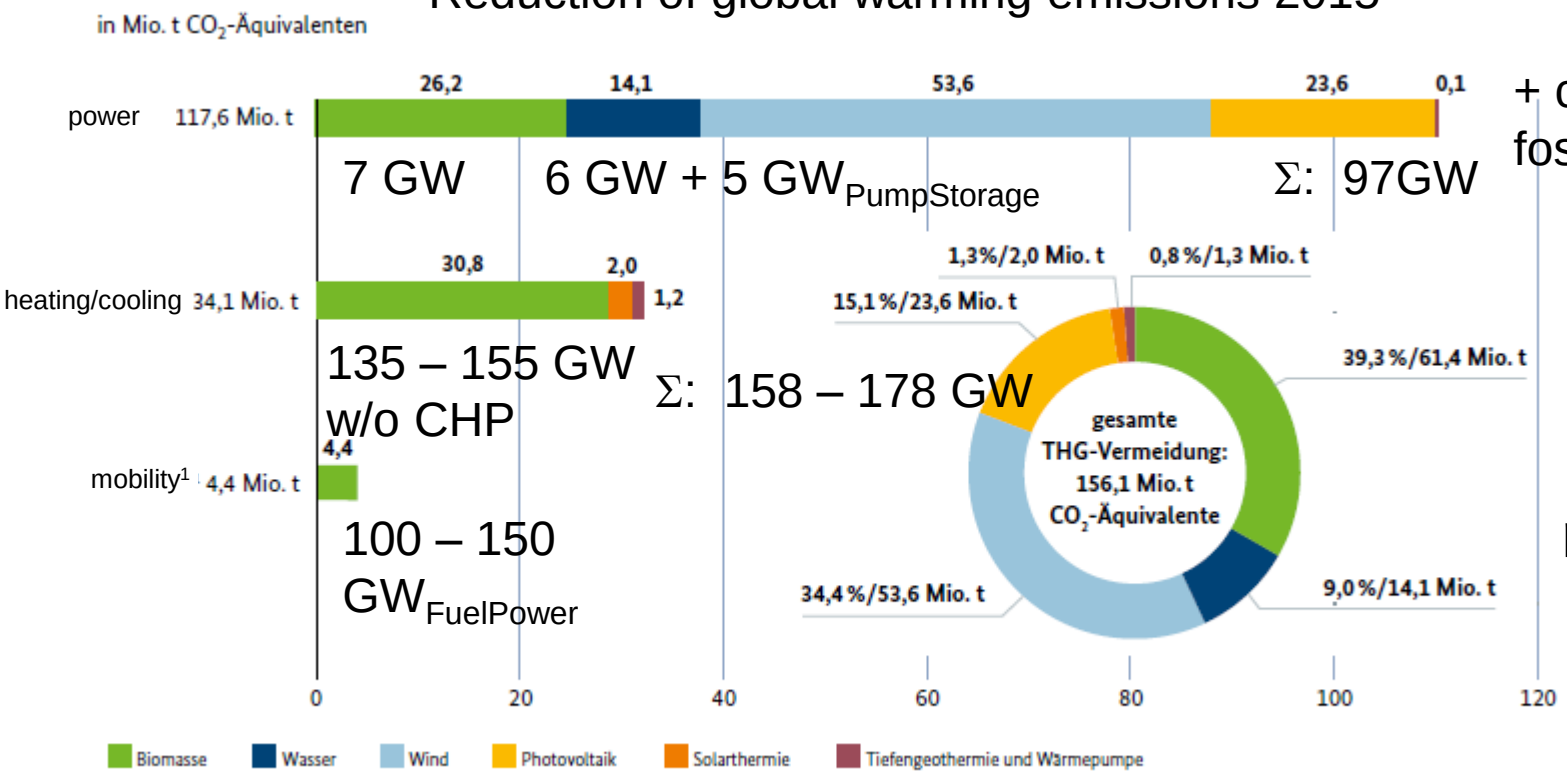
System integration

- demand oriented heat and power generation in combination with other renewable energies
- replacement of technologies in one sector with impact on other sectors (e.g. stove combined with heat-pumpe)
- production of high valuable materials in combination with energy supply from by-products
- generation of gases for chemistry and energy

Further on: focus on alternatives with biomass

Sector coupling – capacities in existing renewable energy supply

Reduction of global warming emissions 2015



1 biogene Kraftstoffe im Verkehrssektor

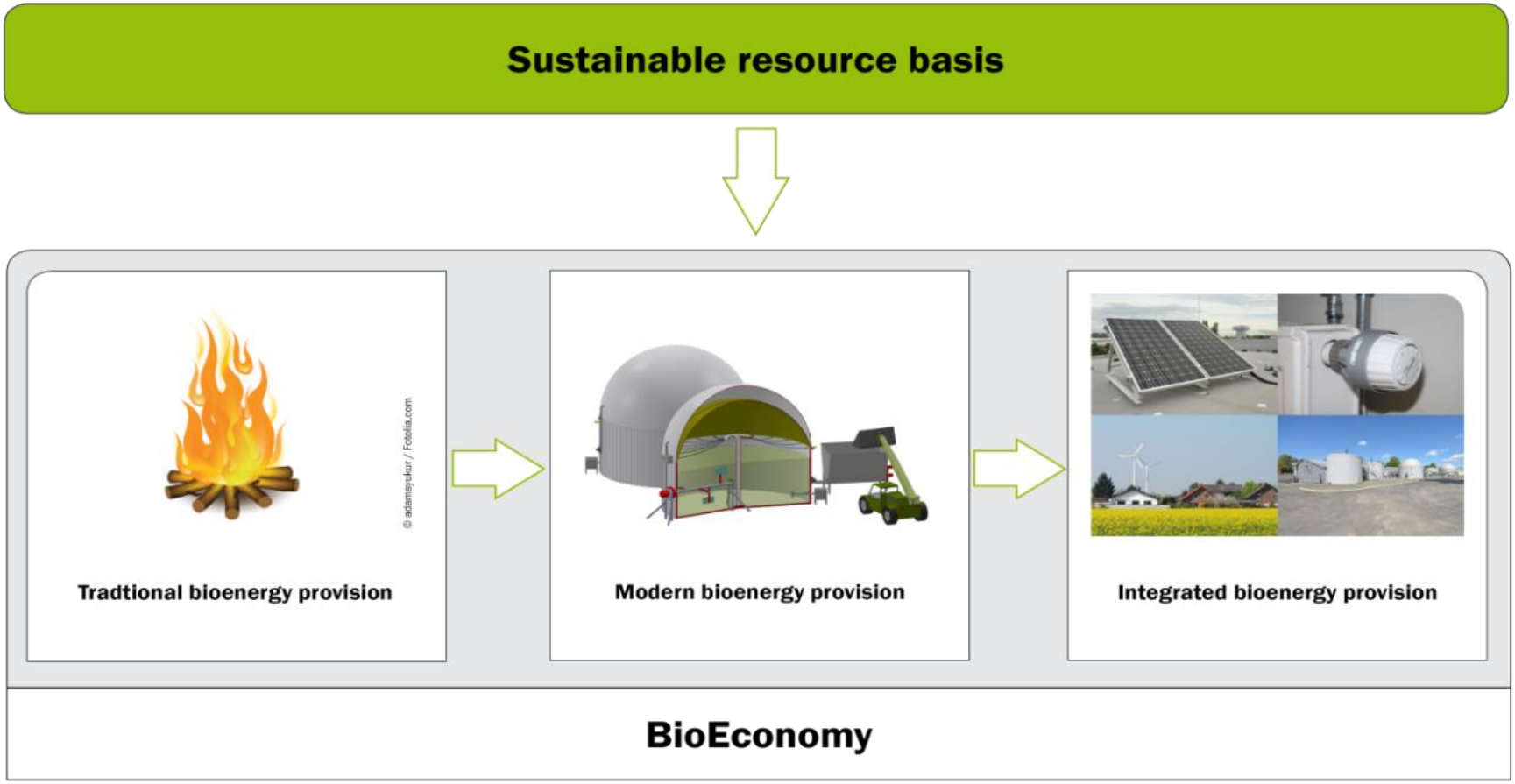
Quelle: Umweltbundesamt [22] – auf Basis dort zitierter Quellen

Bioenergy plays an important role in each sector!

Source BMWi, Erneuerbare Energien in Deutschland, Daten zur Entwicklung im Jahr 2015, 2016

Biomass utilisation has already a tremendous potential for secure energy supply by sector coupling.

SmartBioenergy concept



Source: Thrän, Smart Bioenergy, 2015

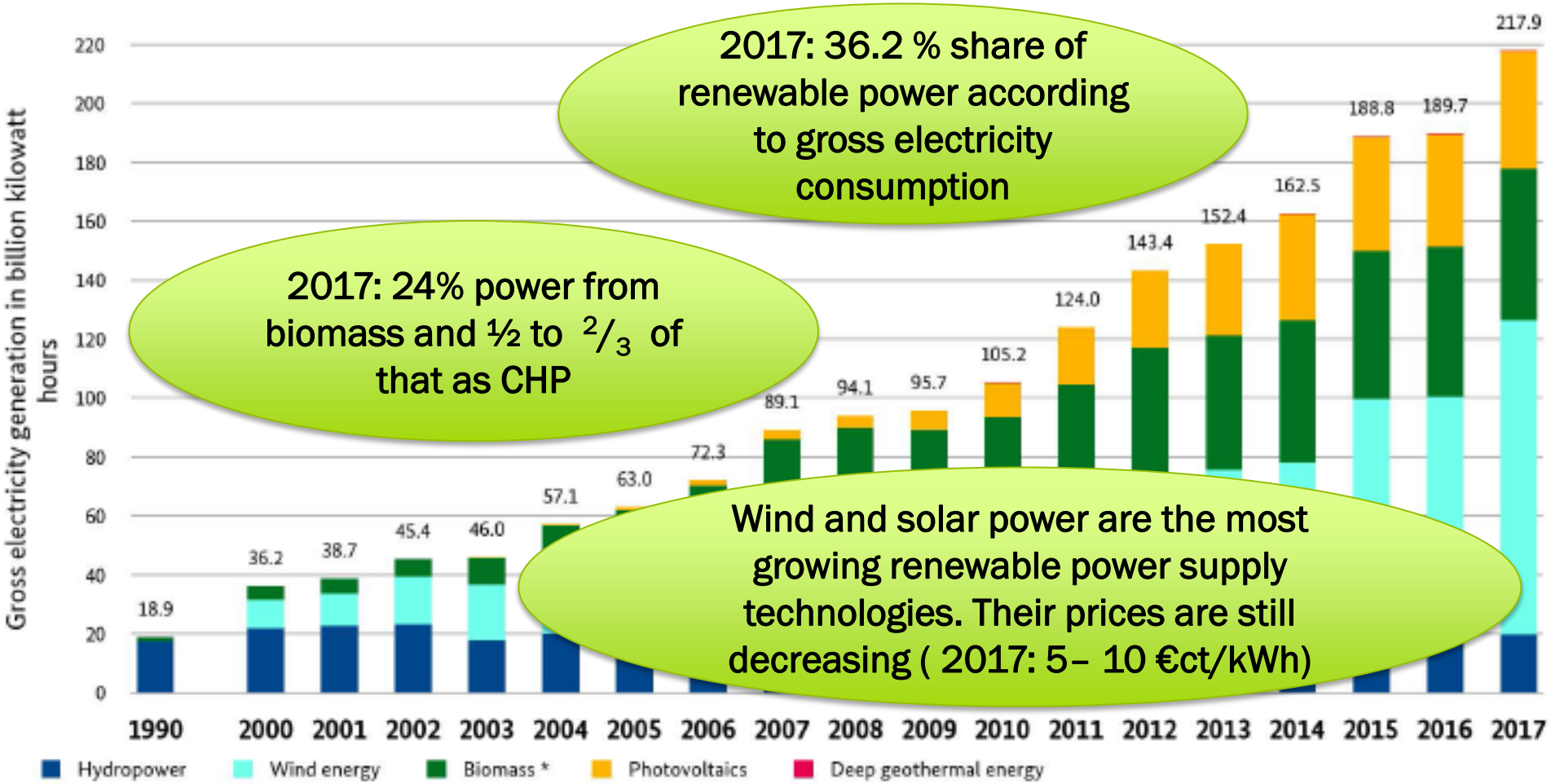
- Use of sustainable biomass resources
- Improvement of the technologies towards an intelligent integration of all renewable energies into a system dominated by renewables
- Integration into future bioeconomy strategies

What does Smart Bioenergy mean?

Size of biomass to bioenergy conversion plants and operation is adapted to regional resource basis and opportunities for high value utilisation (Efficiency and Effectivity) of the sustainable biomass (waste, residues and by-products):

- Future heat supply from solid biofuels – especially woody biomass - has to **close heat supply gaps** in a renewable heating system with all renewable sources and **shall stabilize the local power grid** as efficient and effective as possible (Back-up-stoves and CHP-technologies in all scales).
- **Optimized integration of biogas plants** in regional waste disposal, heat supply and flexible power generation to compensate fluctuations of wind and solar (also integration of wind- and PV-power-hydrogen into biogas plants for methane generation).
- **Integrated biorefineries** coupled with renewable wind- and PV-power (SynBioPtX) and storable intermediates.
- Integration of bioenergy into **hybrid- and multibrid-systems**.

Development of renewable power in Germany

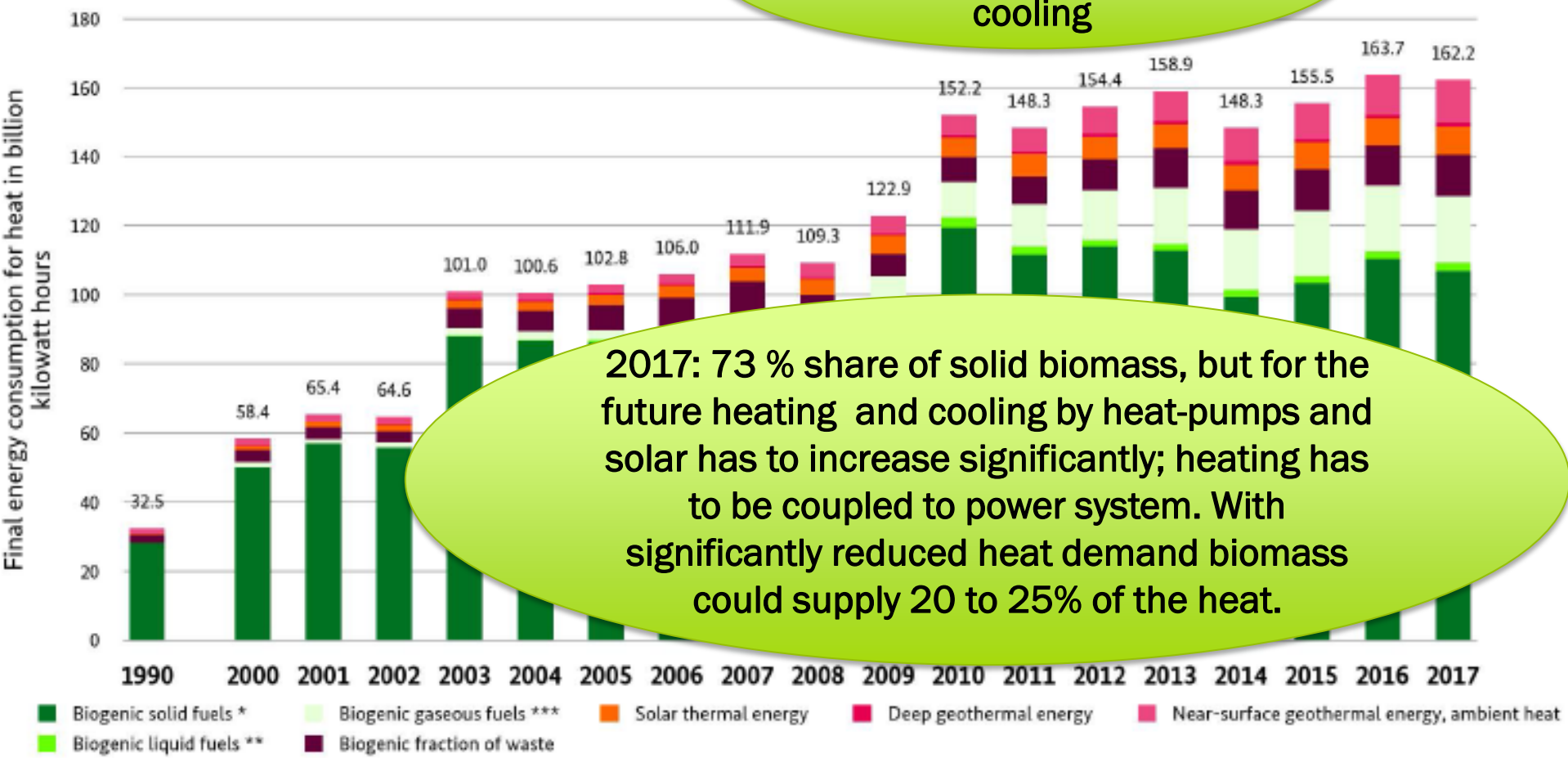


* incl. solid and liquid biomass, biogas incl. biomethane, sewage gas and landfill gas as well as the biogenic fraction of waste, from 2010 incl. sewage sludge; BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2018; all figures provisional

Source: Federal Ministry for Economic Affairs and Energy, Development of renewable energy sources in Germany 2017, February 2018

Development of renewable heat in Germany

2017: 12.9 % share of renewable heating and cooling

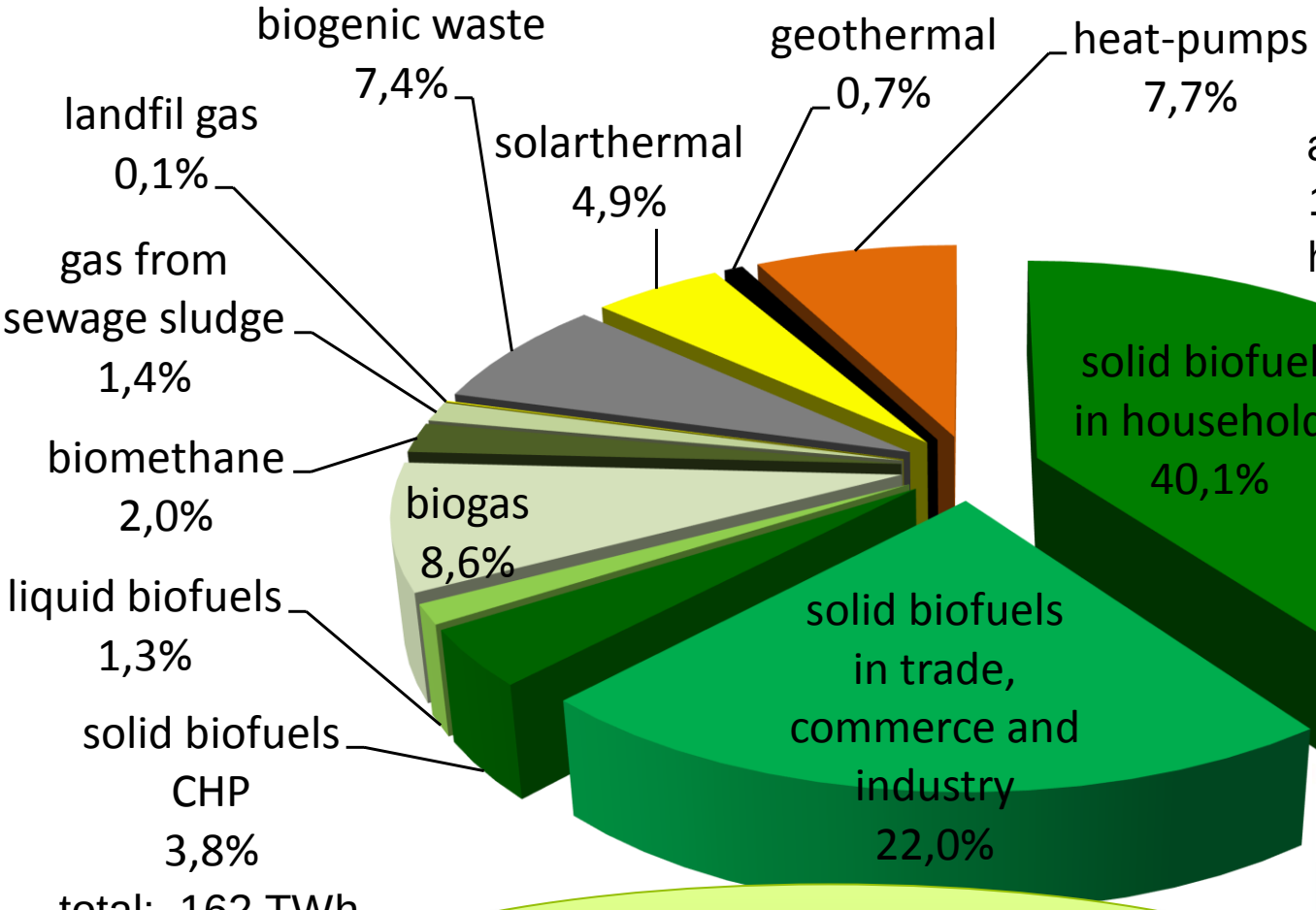


2017: 73 % share of solid biomass, but for the future heating and cooling by heat-pumps and solar has to increase significantly; heating has to be coupled to power system. With significantly reduced heat demand biomass could supply 20 to 25% of the heat.

* incl. biogenic share of waste and from 2010 incl. sewage sludge, ** incl. biodiesel used in farming, *** Biogas, biomethane and landfill gas; BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as at February 2018; all figures provisional

Source: Federal Ministry for Economic Affairs and Energy, Development of renewable energy sources in Germany 2017, February 2018

Technologies for renewable heat



about 1 mio. boiler and 10-11 mio. single room heaters

Source: Wodtke

Source: Guntamatic

Source: BWk 2018
Lenz et. al.

Still most renewable heat from biomass comes from only heating systems (full supply or base load); only about 12% is from CHP.

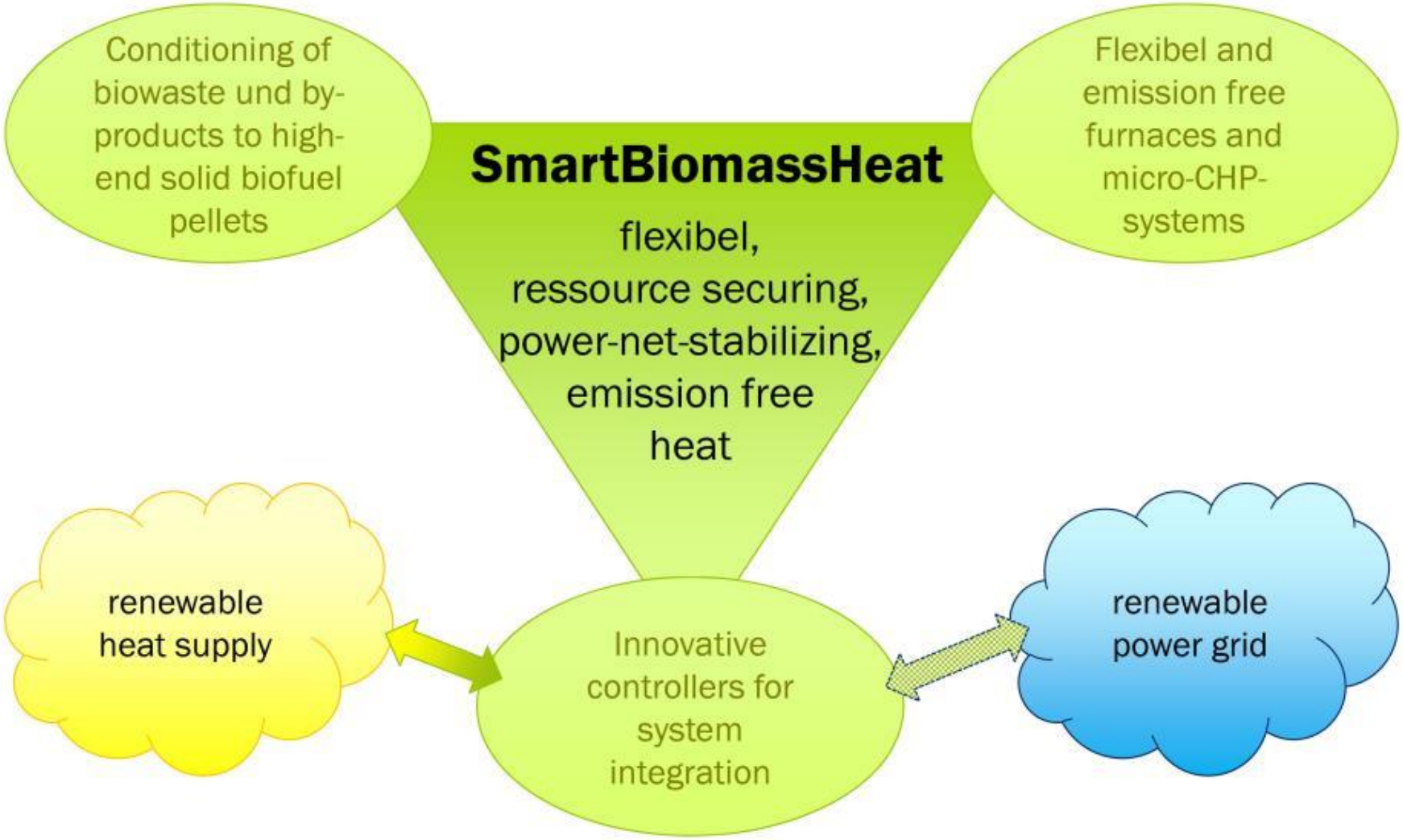
Expectations for future bioenergy markets

Electricity from solid biomass

- **In the very near future an optimization of full-load-hours will be targeted.**
- **New wood(heat-and-)power plants in the MW-scale will get very rare. Additional wood-gasifier-CHP plants depend on reliability and a reduction of investment costs.**
- **In the long run power from biomass will become one of the most expensive options in a renewable energy system. Therefore only highly flexible power production, reserve electricity and black-starting-ability will be needed.**
- **Economical feasibility relies on full use of the produced heat and power production at times of peak prices.**

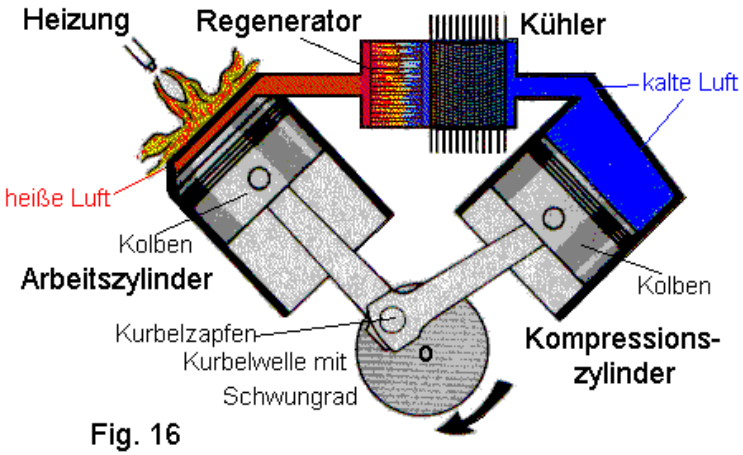
SmartBiomassHeat

„Future heat supply from biogenic solid fuels must become much more efficient, flexible and tailored to system requirements – it needs to get smarter!" "
(Dr. Volker Lenz, DBFZ)



Modern and standard CHP-technologies for solid biomass

Stirling-engine

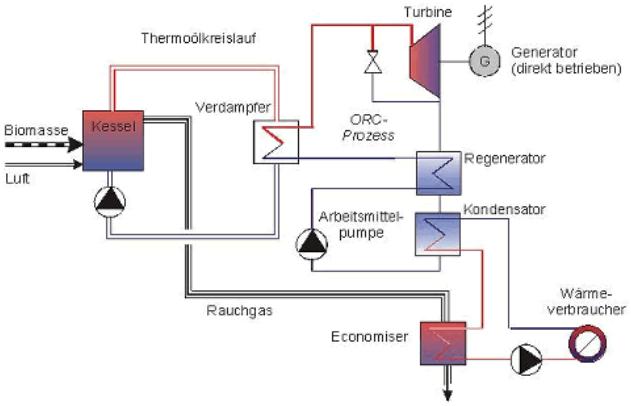


Source: DBFZ

Small-gasifier-CHP

Source: Thermochemical Testing Ground University Zittau

Biomass ORC



Source: DBFZ

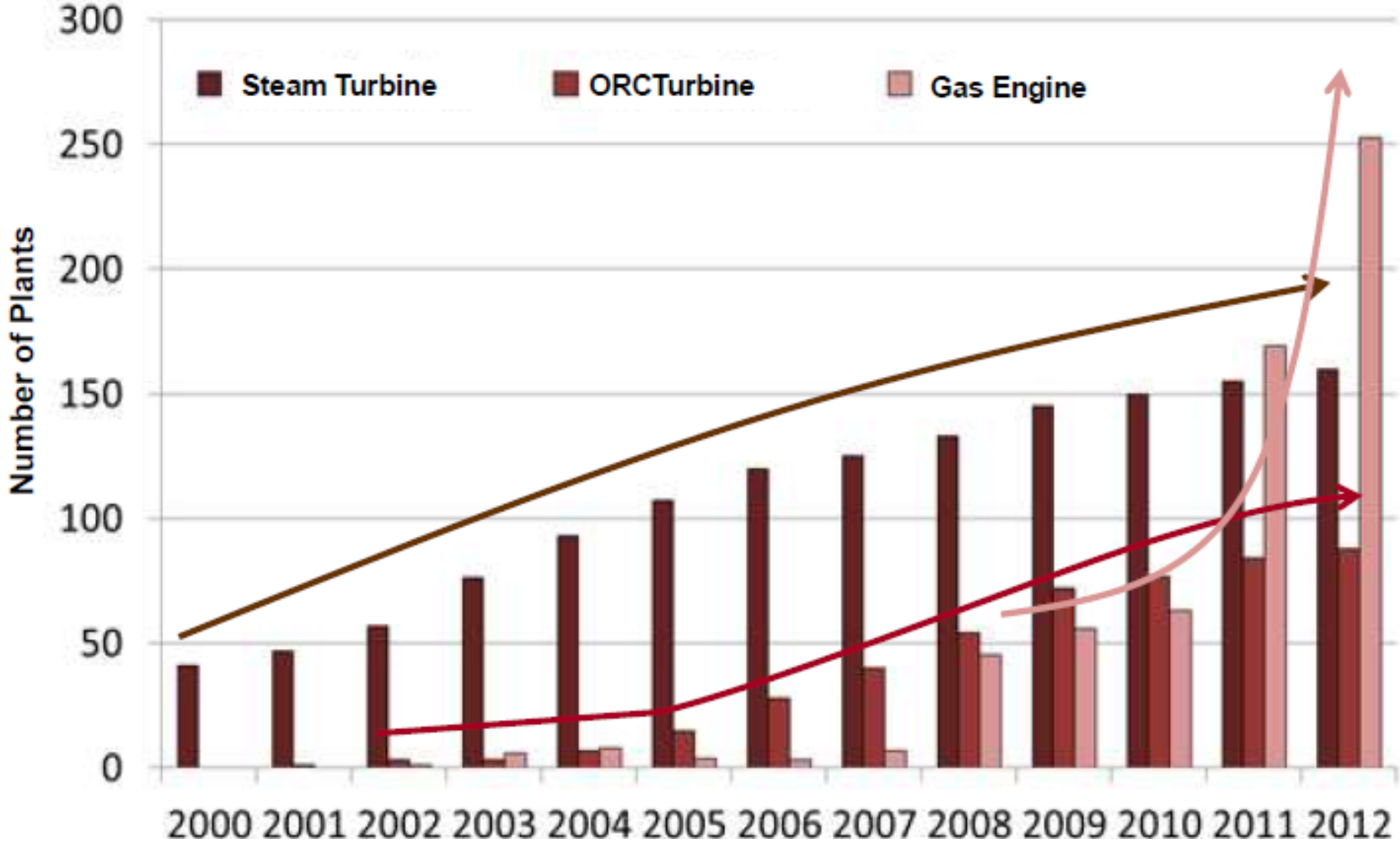
Waste wood power plant

Source: hessenENERGIE

Industrial gasifier Güssing

Source: DBFZ

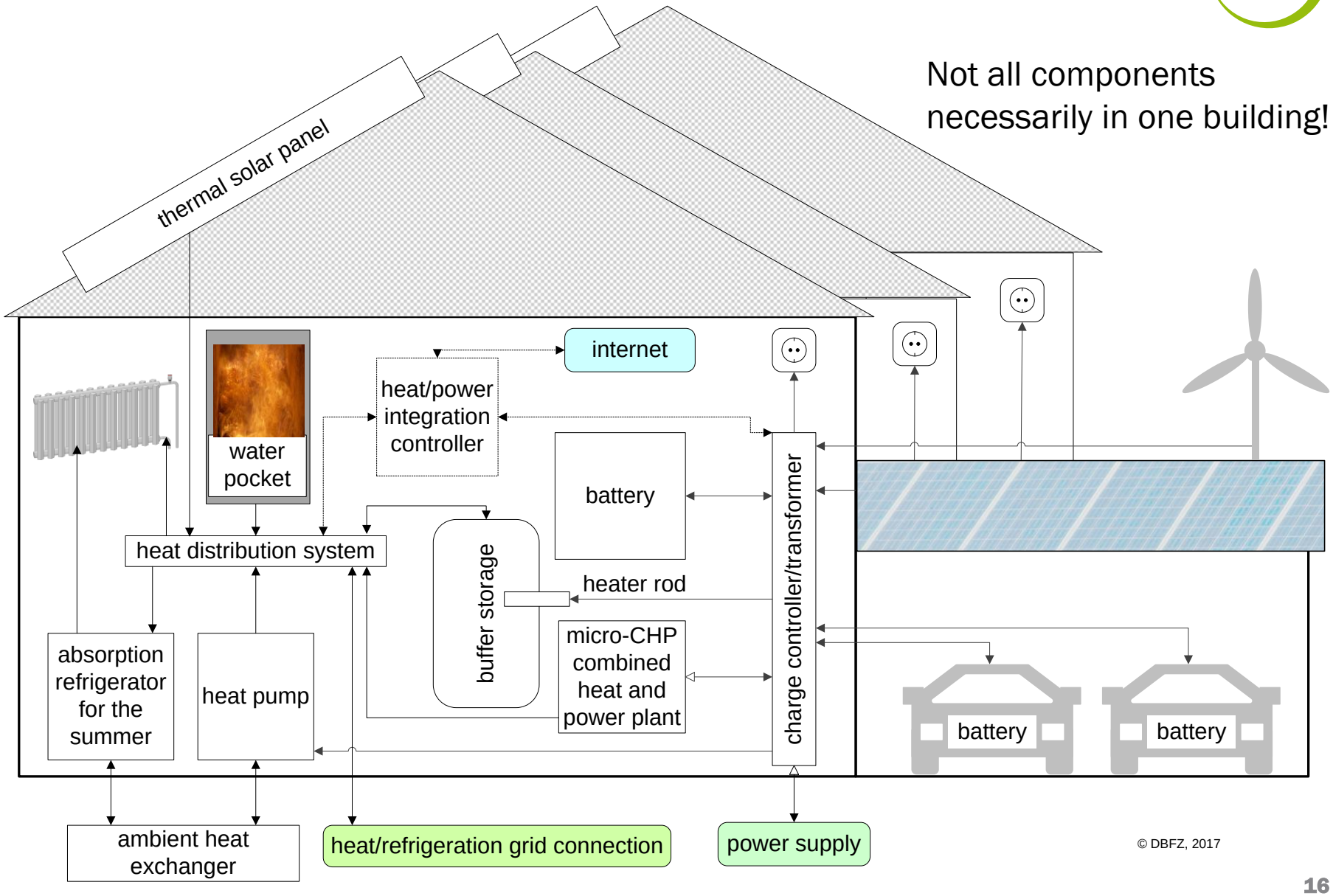
Change in used technologies for electricity production towards decentral CHP



Source: DBFZ 2013

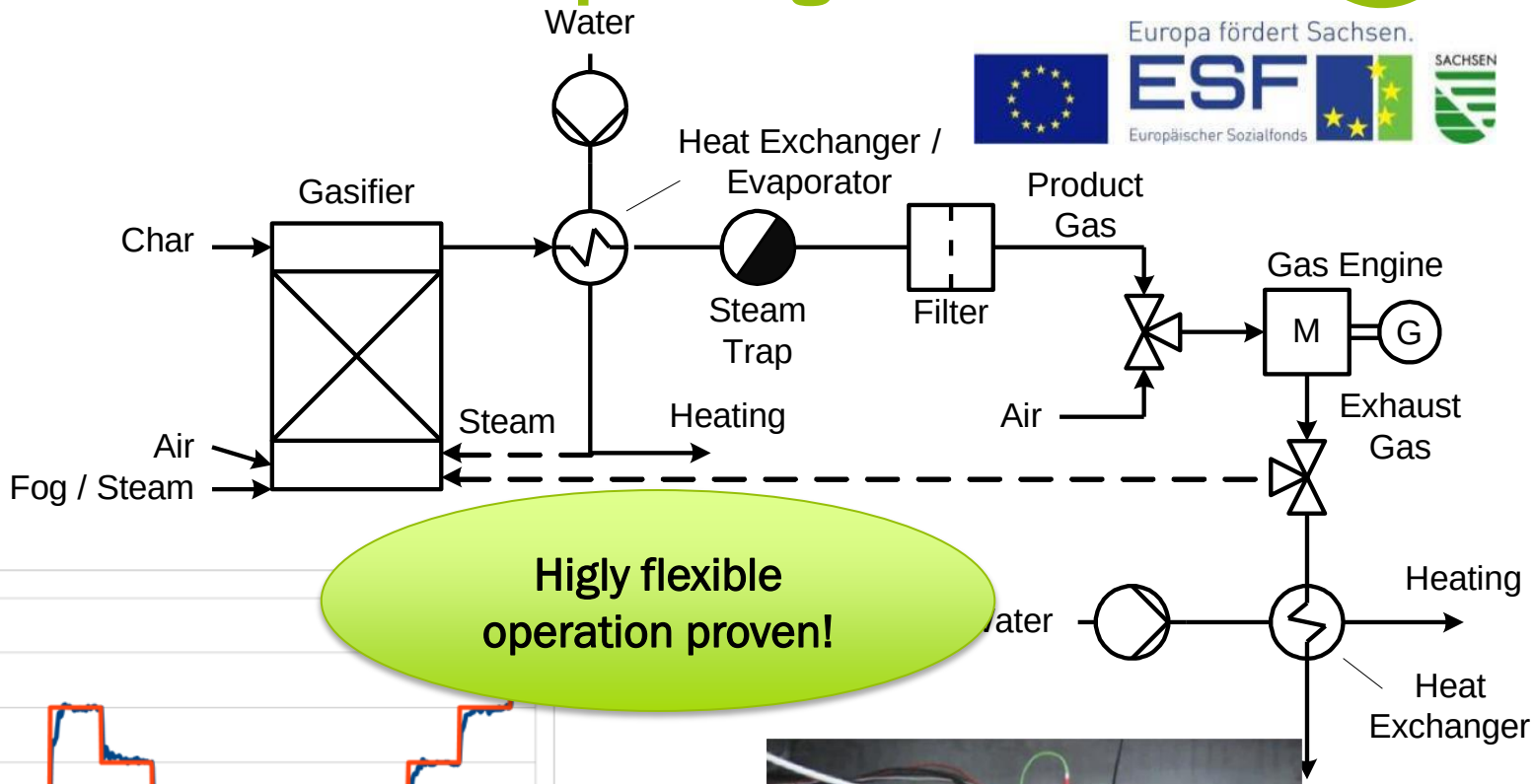
SmartBiomassHeat – Overview on components

Not all components necessarily in one building!

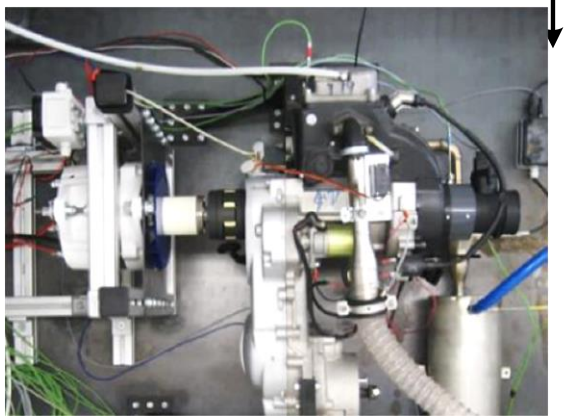


© DBFZ, 2017

DBFZ demonstrator: Counter-current charcoal gasifier with 0.55 kW_{el} moped engine



Higly flexible operation proven!



Source: DBFZ 2014, Dennis Krüger

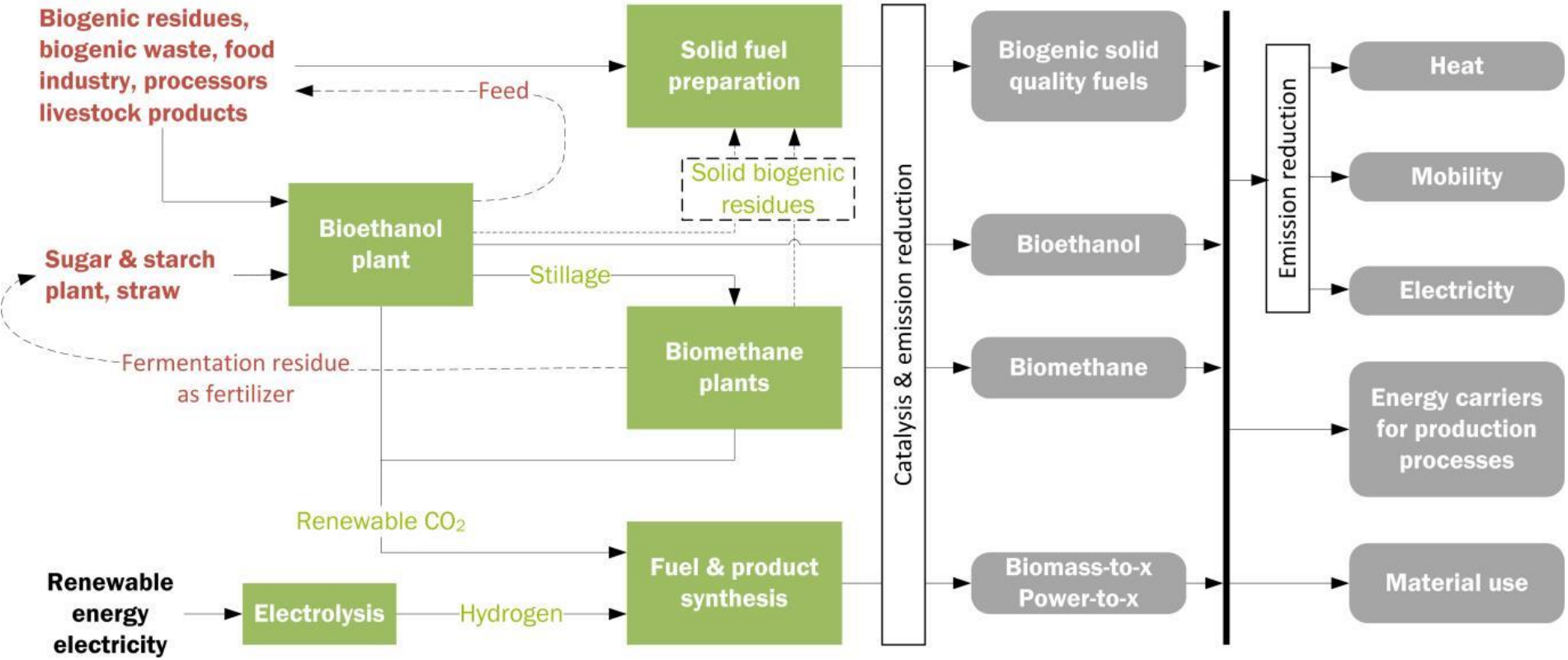
Examples of decentral sector coupling projects: WindNODE (within SINTEG)

Main target is to solve the challenges of fluctuating wind and solar power:

- Identification of typical consumers which can adopt there demand
- Identification of all kind of flexibilities (also additional flexible consumption)
- Identification of necessary market structures to activate flexibilities
- Integration of sector coupling (PtH – small scale as well as big scale 100 MW Berlin, PtC, supply oriented charging of eCars)
- more regional responsibility for net stabilizing

Source: https://www.windnode.de/konzept/flexibilitaeten/ (05.06.2018)

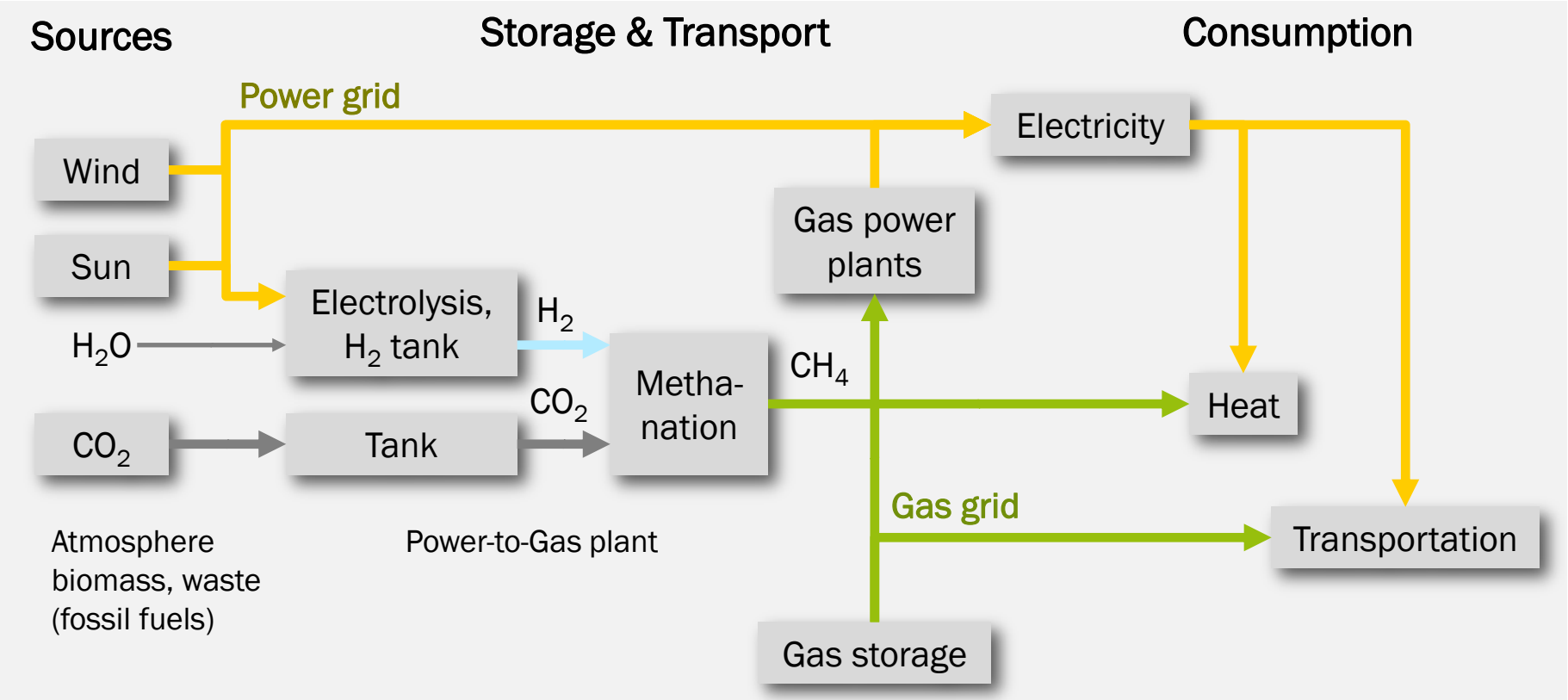
Example: SynBioPtX



Source: © DBFZ 11/2016 (w/o verification of compliteness)

Example: HybridSystems

- Combination of wood pellet boilers with solarthermal.
- Combination of biogas plants or wood chip combustion CHP with big solarthermal or geothermal systems.
- Combination of heat-pumps with back-up stove or biomass-CHP.
- Integration of wind- and solar-power into biogas plants via hydrogen generation and additional methane generation.



Source: based on IWES, ZSW/Schmid, J. & Günther M.: Methanisierung: CO_2 nutzen statt endlagern. In: energie|wasser-praxis, issue 3/2013, p. 15.

Conclusions

- The **role of bioenergy is changing** towards an **integrated and supply securing** utilisation of **sustainable** biomass potentials, especially **residues, by-products and biowaste** – smart bioenergy.
- Innovative methods, coupling and cascade use, precise and flexible controllable systems and integrated provision concepts are important components. Their development need a **reliable framework**.
- Regional adapted plant size, fuel preparation (analysing, drying, mixing, pelletisation, torrefication, HTC) and demand-oriented plant operation will improve **efficiency and effectivity** of biomass utilisation integrated in a renewable energy system with **significant price differences** according to availability of wind and solar. At the same time generating income in rural areas and providing high qualified jobs for operation and maintenance.
- **Sector-coupling** is one of the major strength of bioenergy but also one of the main drivers for future biomass to energy strategies.
- **Development of new products and new value-chains** need time for research and development (5 to 10 years) – so start with new and sometimes extraordinary ideas **now**.

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Smart Bioenergy – Innovation for sustainable future.
Need-based decentral bioenergy from by-products and residues!

Ansprechpartner

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