Deutsches Biomasseforschungszentrum
gemeinnützige GmbH

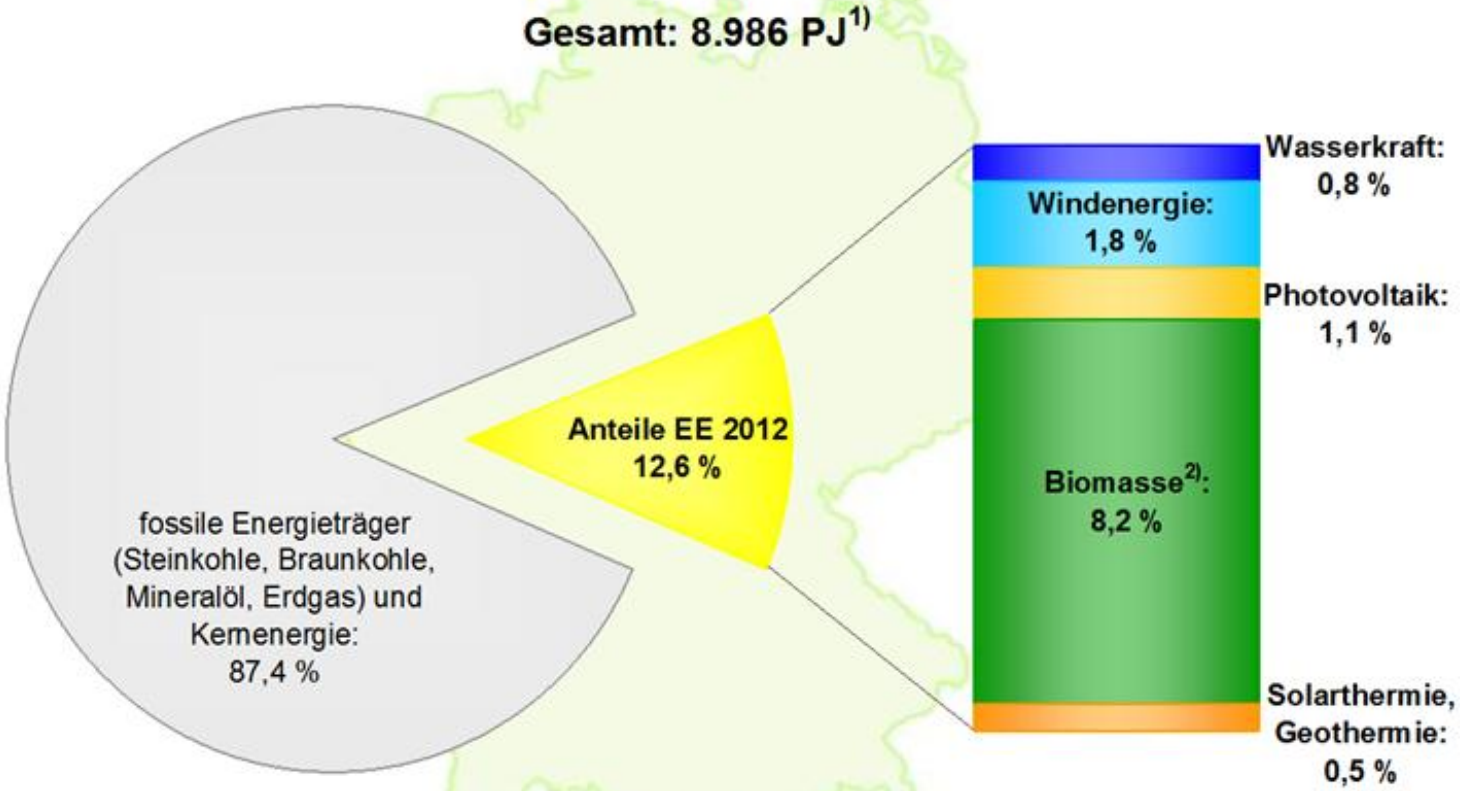
DBFZ

Stock development of different technologies under the German Renewable Energy Source Act (EEG)

German-Japanese Biomass Day, Tokyo and Morioka, 2013

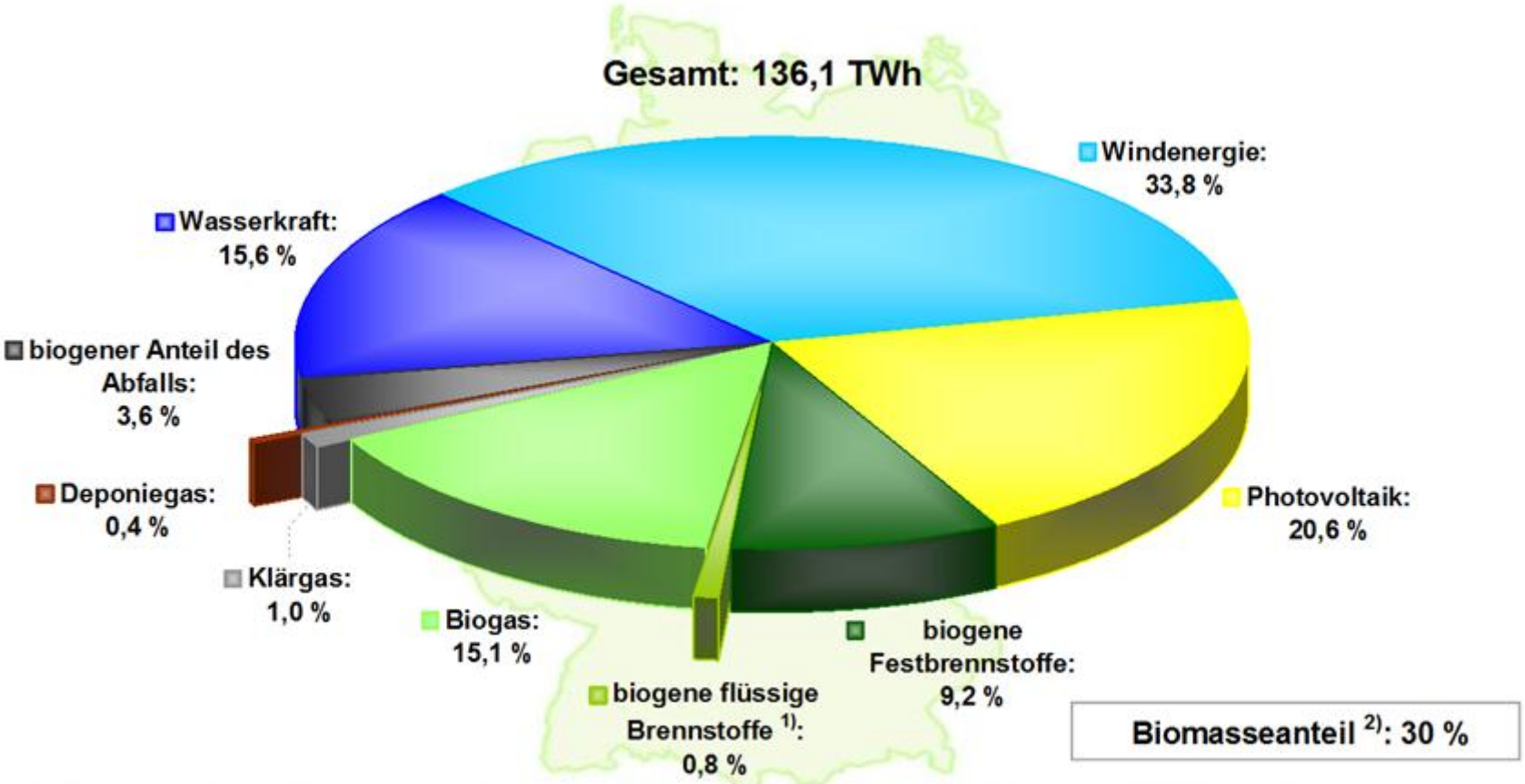
Alexander Krautz

Share of bioenergy at the energy supply in Germany
ドイツのエネルギー供給における バイオマスエネルギーの割合



1) Quelle: Arbeitsgemeinschaft Energiebilanzen e.V. (AGEB); 2) Feste und flüssige Biomasse, Biogas, Klär- Deponiegas, biogener Anteil des Abfalls, Biokraftstoffe;
Quelle: BMU - E I 1 nach Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat) und ZSW, unter Verwendung von Angaben der AGEB;
EE: Erneuerbare Energien; 1 PJ = 10^{15} Joule; Abweichungen in den Summen durch Rundungen; Stand: Februar 2013; Angaben vorläufig

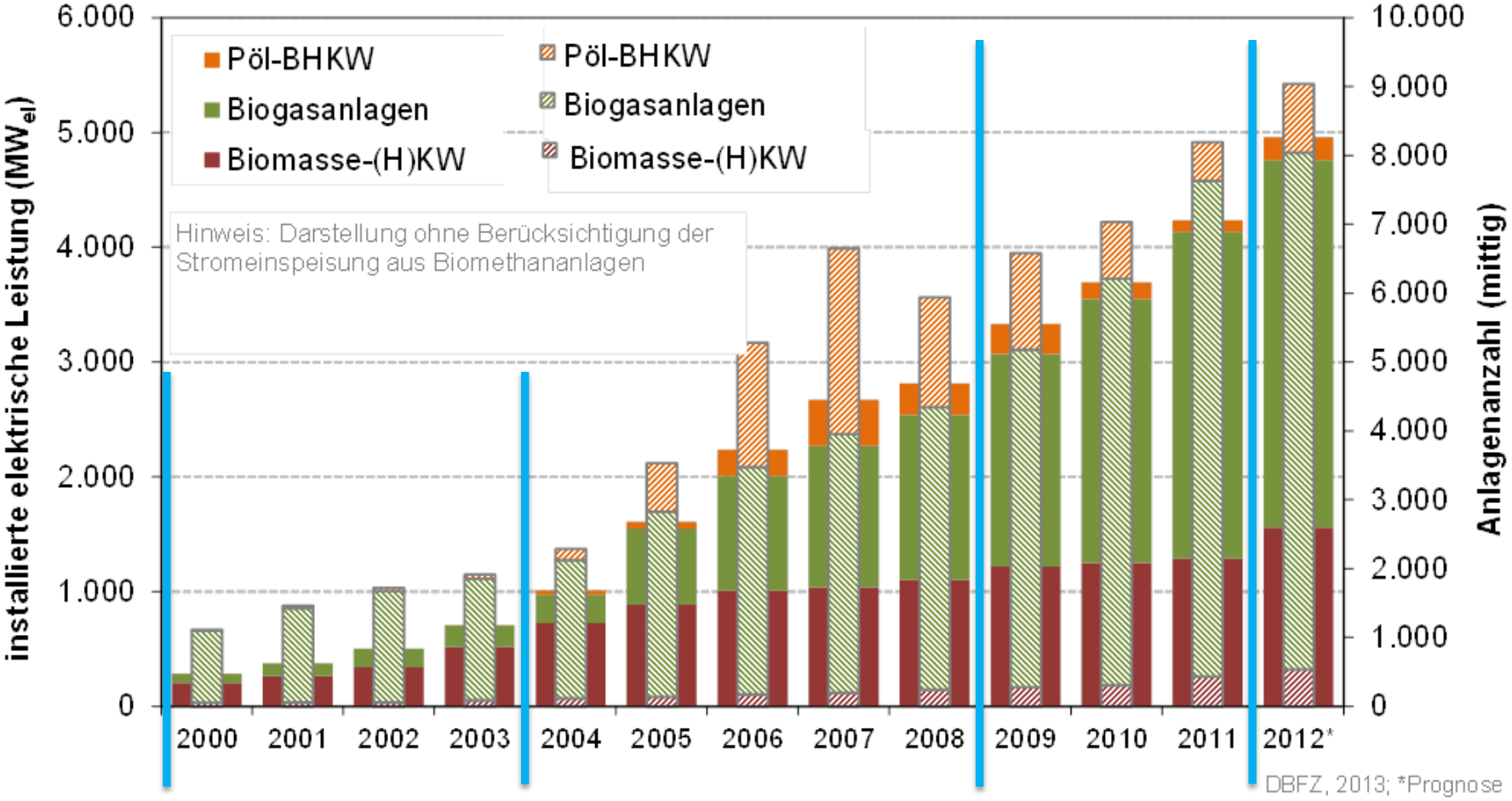
Share of bioenergy at the electricity generation of renewable energies in Germany
ドイツの再生可能エネルギー発電に占める バイオマスエネルギーの割合



1) Inklusive Pflanzenöl; 2) Feste und flüssige Biomasse, Biogas, Klär- und Deponiegas, biogener Anteil des Abfalls; aufgrund geringer Strommengen ist die Tiefengeothermie nicht dargestellt;
1 TWh = 1 Mrd. kWh; Abweichungen in den Summen durch Rundungen;
Quelle: BMU - E I 1 nach Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Stand: Februar 2013; Angaben vorläufig

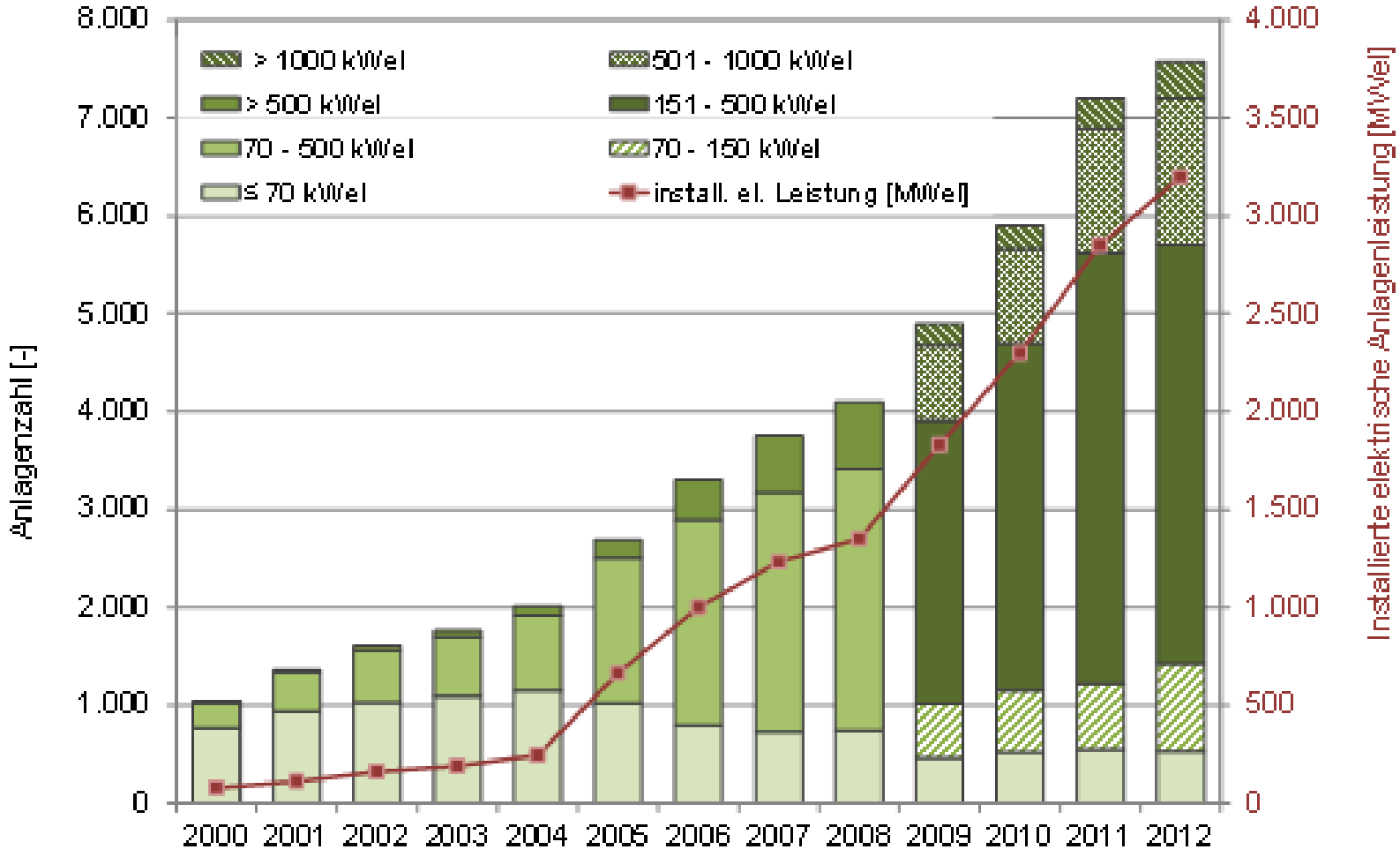
Development of installed capacity and number of plant for electricity generation from biomass in the context of the EEG

EEG施行以降のバイオマス発電設備容量とプラント数推移



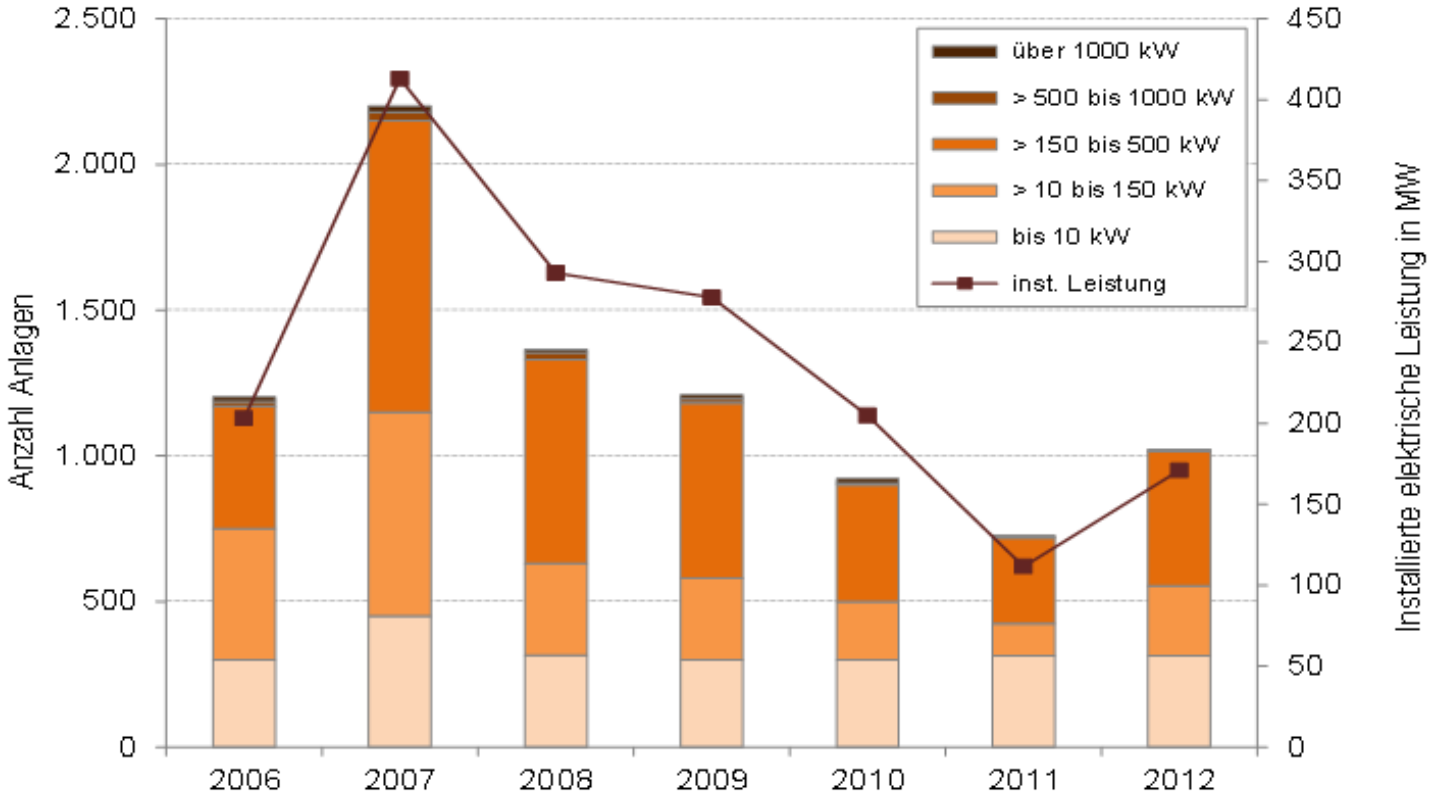
EEG 2000 EEG 2004 EEG 2009 EEG 2012

Development of electricity generation from biogas
バイオガス発電量の推移



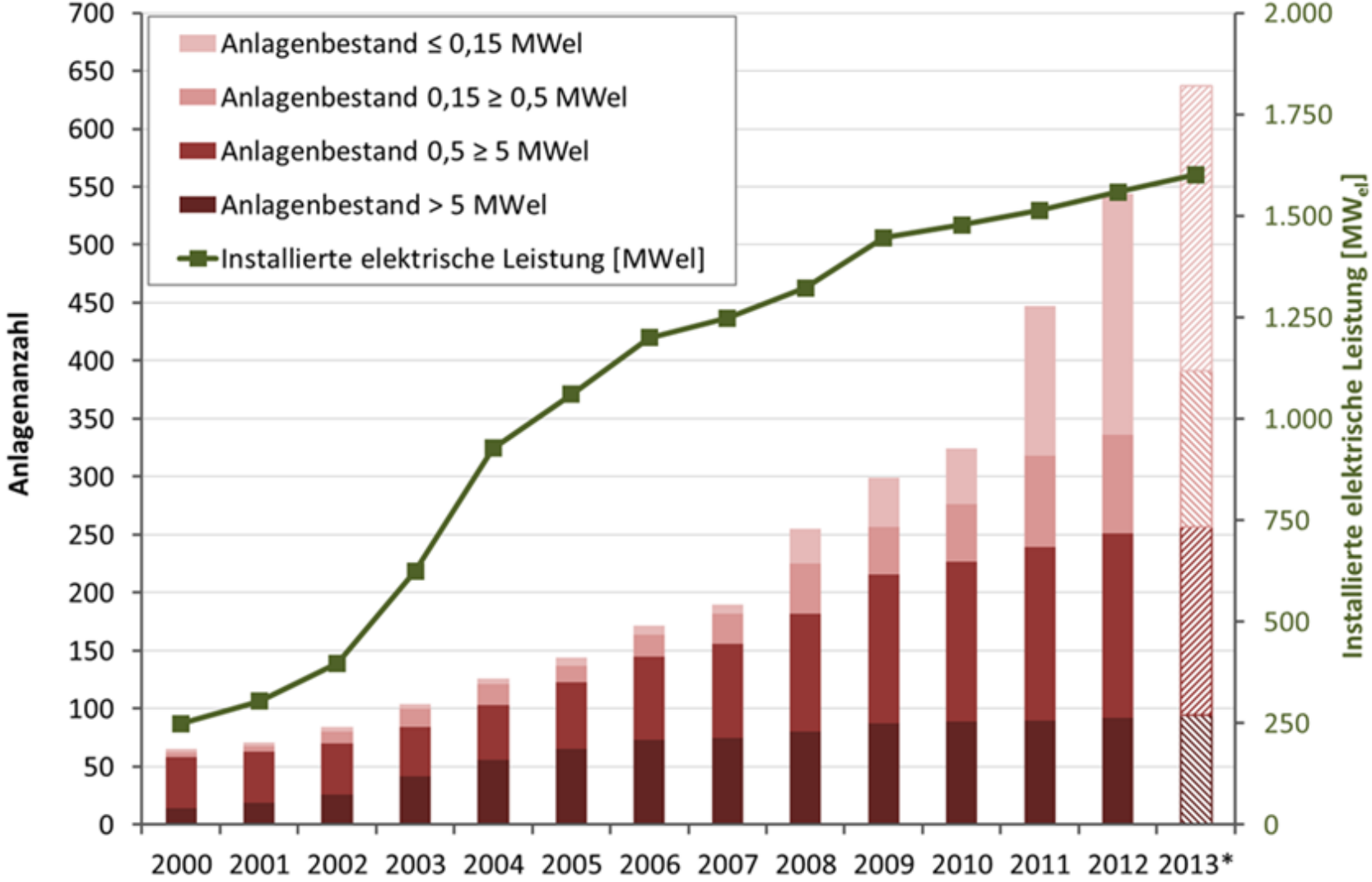
- **Strong increase after the introduction of the bonus for regrowable resources from 2004**

Development of electricity generation from liquid biomass
液状バイオマスからの発電量の推移

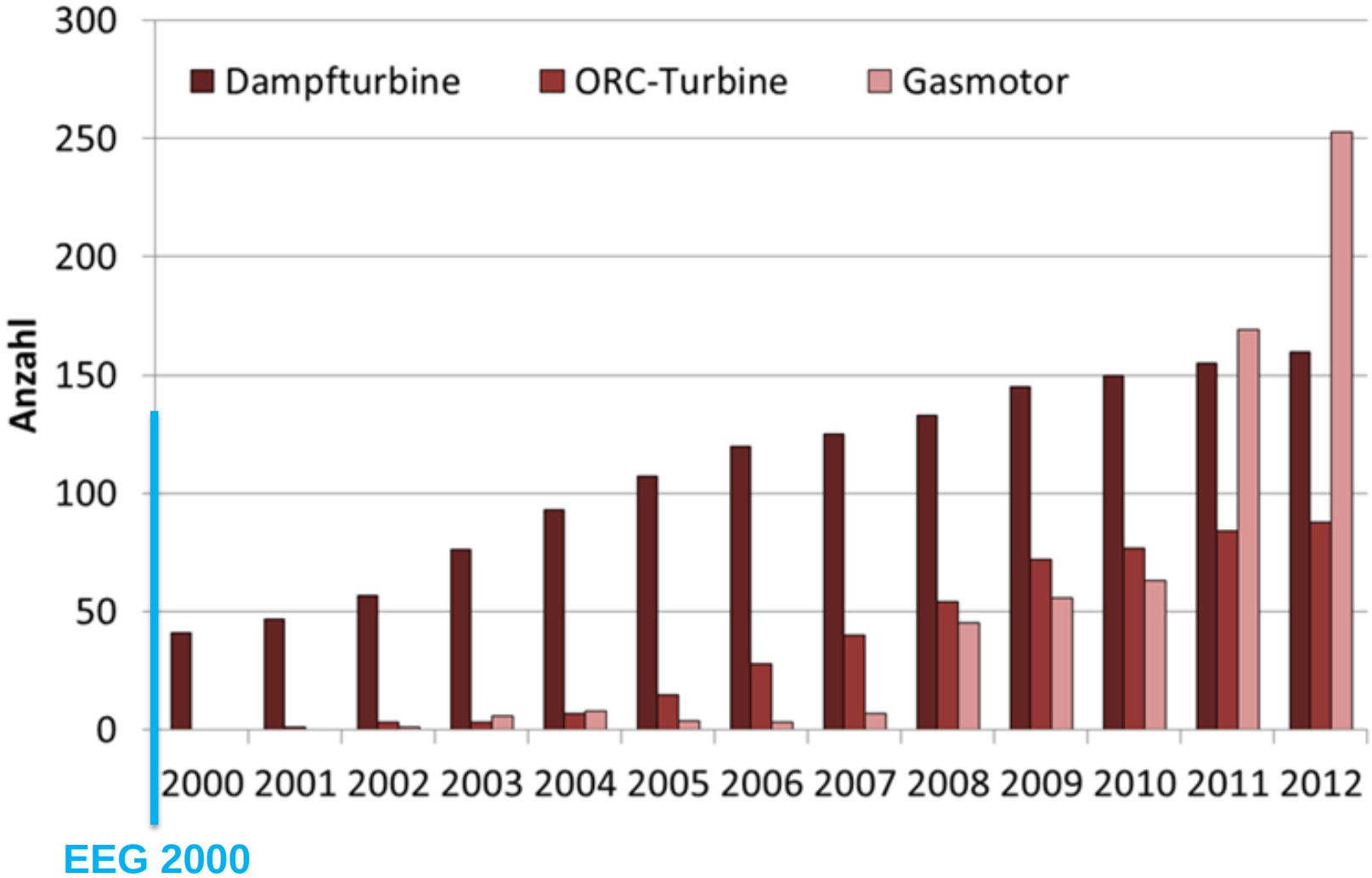


- **Strong annex to 2007**
- **stock decline after a sharp rise in fuel costs from 2008**
- **As of 2012, no promotion of new plants by the EEG**
- **low vegetable oil prices in 2012 ⇨ Reactivation of existing plants in 2012**

Development of electricity generation from solid biomass
固形バイオマスからの発電量の推移



Development of used technologies in the EEG
EEG施行以降の技術利用の推移



Main support elements for the use of different technologies
様々な技術に対する主な支援策

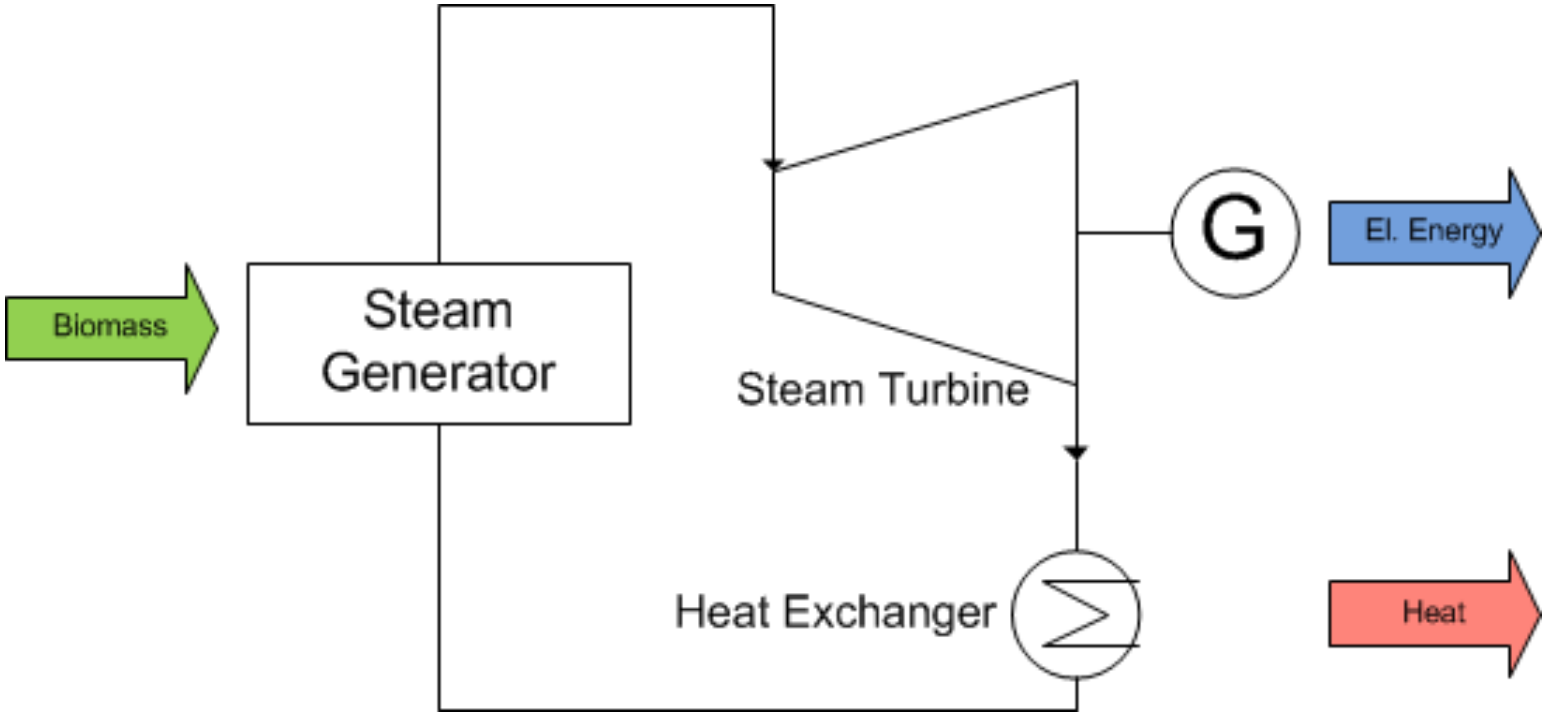
EEG 2000

- Introduction of Feed-in tariff depending on the size of the system
- Comparatively low funding
- Transition of existing systems to the new compensation system
- Main development of large steam turbines based on waste wood
- No incentive to use heat

⇨ Development of the market at a low level

CHP – Steam Turbine
コジェネ – スチームタービン

- power range from some 100 kW_{el} up to more than 20 MW_{el}
- back-pressure turbine for constant heat demand; extraction condensation turbine for changes in CHP coefficient
- basic principle (can differ, e.g. for extracting turbines):



Source: Technologie Portrait Kraft-Wärme-Kopplung, Berichte aus Energie- und Umweltforschung 34/2010, Österreichisches Bundesministerium für Verkehr, Innovation und Technologie

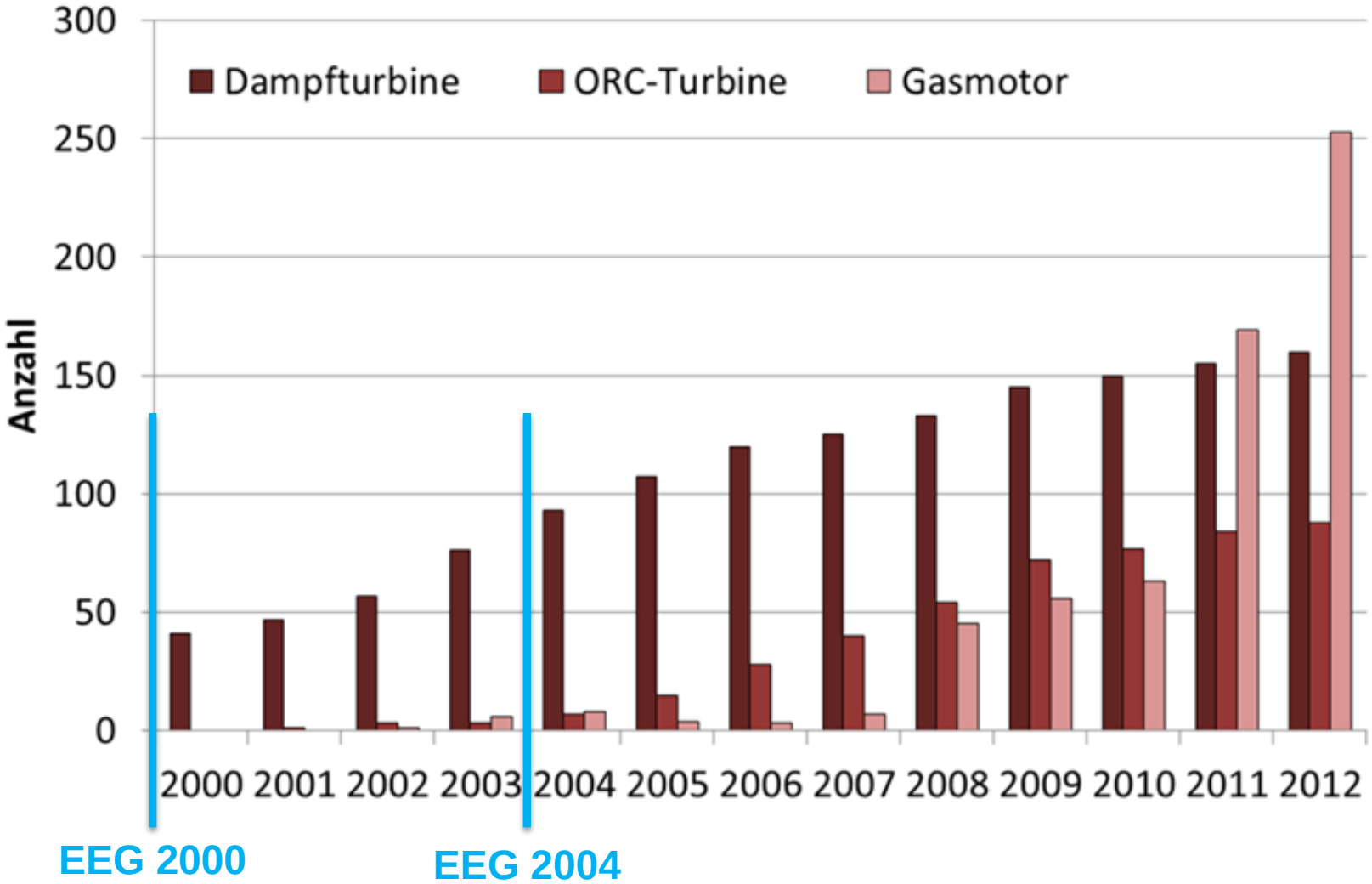
Example – Large Scale CHP

Large Scale Steam Cycle I
大規模スチームサイクル I

- 6 biomass CHP of Energiecontracting Heidelberg AG (ECH)
- 20.5 MW (fuel based thermal power)
- 21.7 t/h steam, 485 ° C, 64 bar_{abs}
- Output: 4.99 MW_{el}, up to 10 MW_{therm} (→90/←65 ° C)
- 55000 $t_{air\ dried}$/a , usually chipped wood, G 100
- conical, rotating grate
- general contractor: MW Biopower (Metso/Wärtsilä), Finland

Source: Energiecontracting Heidelberg AG, MW Biopower

Development of used technologies in the EEG
EEG施行以降の技術利用の推移



Main support elements for the use of different technologies
様々な技術に対する主な支援策

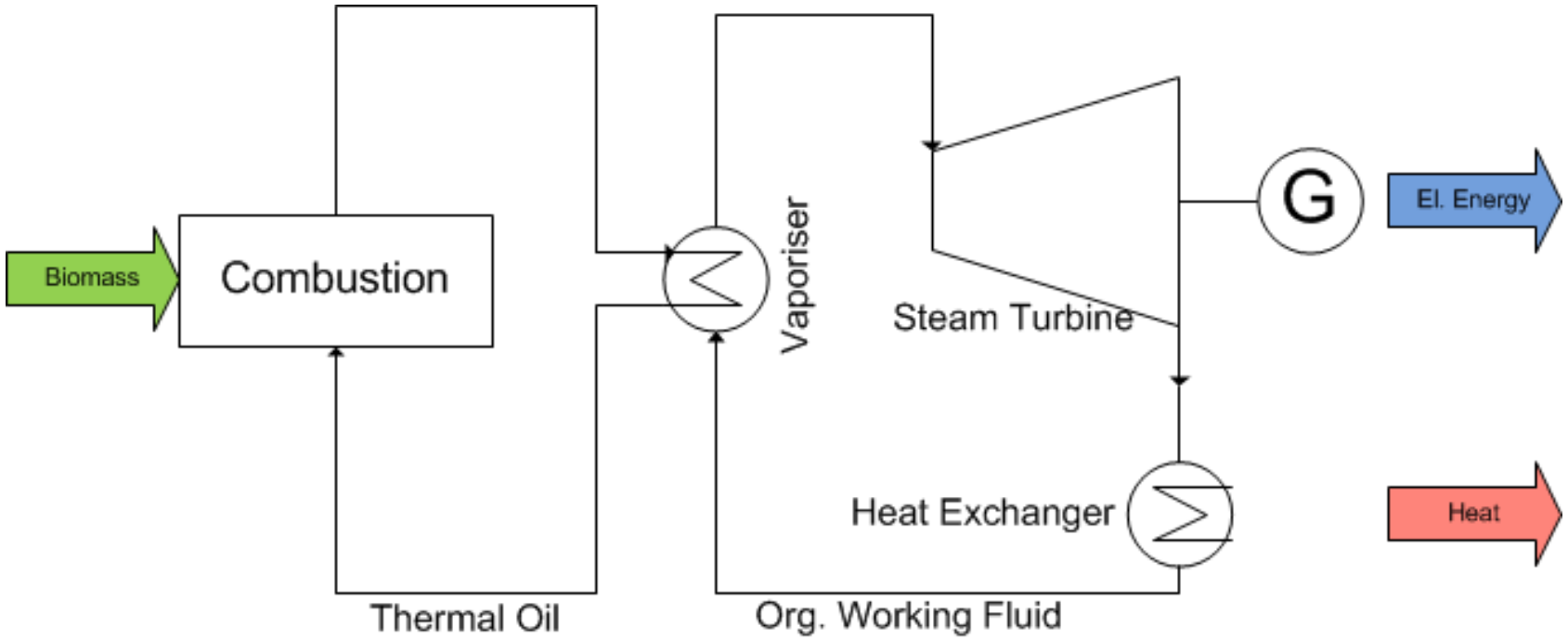
EEG 2004

- **Increase of the compensation rates**
- **Introduction of a bonus for regrowable resources (energy crops, for biogas, for example corn; for solid biomass, for example forest residues)**
- **Reason for introduction: food overproduction in Germany**
- **Introduction of a technology bonus as an incentive for the development of promising technologies (up to 5 MW)**
  - solid biomass - Organic-Rankine-Cycle (ORC)
  - biogas – Conditioning on quality of natural gas (biomethane) and feed-in to the natural gas grid
- **Introduction of CHP-Bonus (up to 20 MW)**

⇨ **Development of the ORC technology**

CHP with Organic-Rankine-Cycle (ORC)
オーガニックランキンサイクル（ORC）を伴うコジェネ

- **power typically 200 kW_{el} - 1500 kW_{el}**
- **el. efficiency 10 – 20 %**
- **basic principle:**



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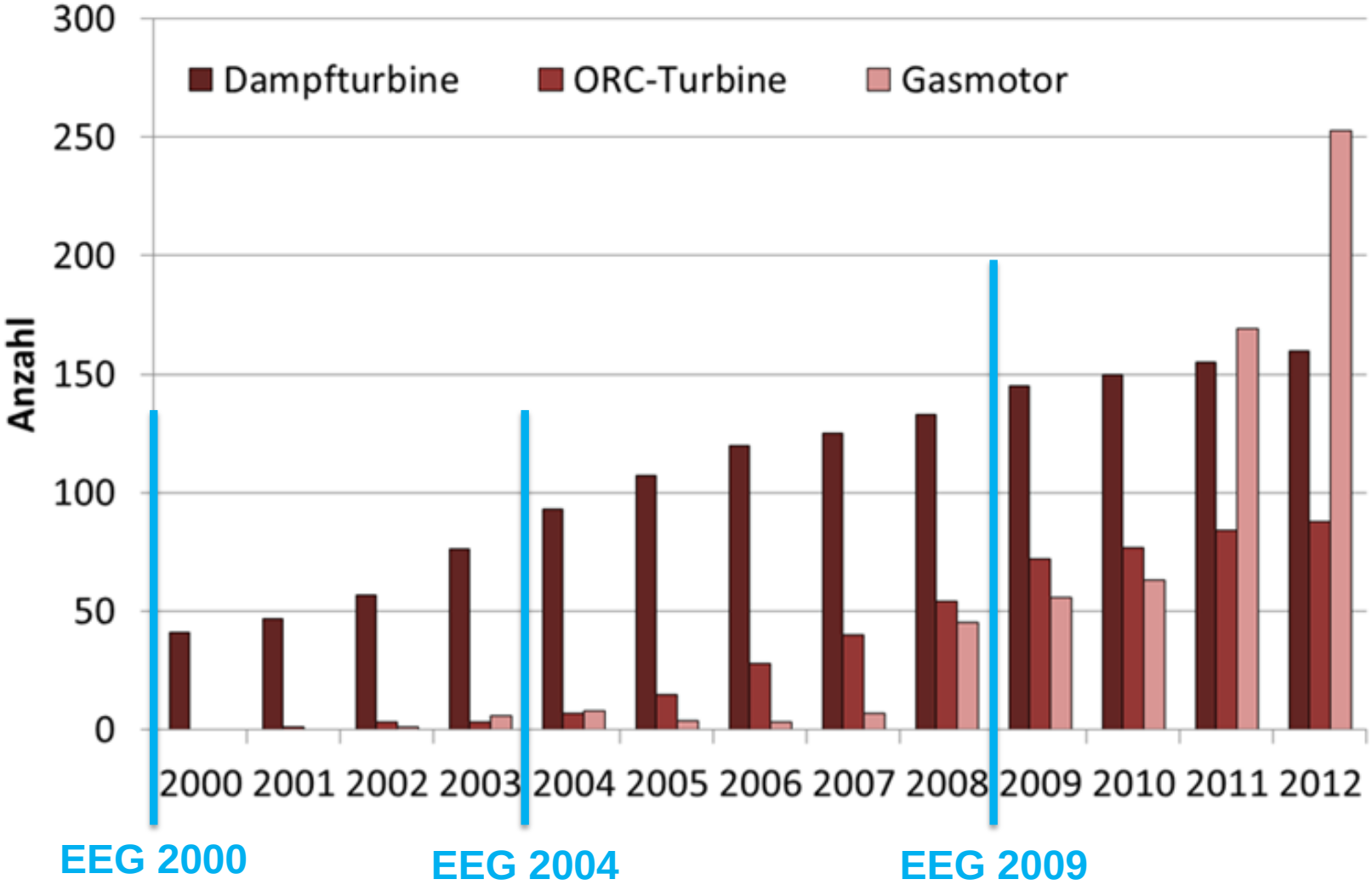
Development of used technologies in the EEG
EEG施行以降の技術利用の推移

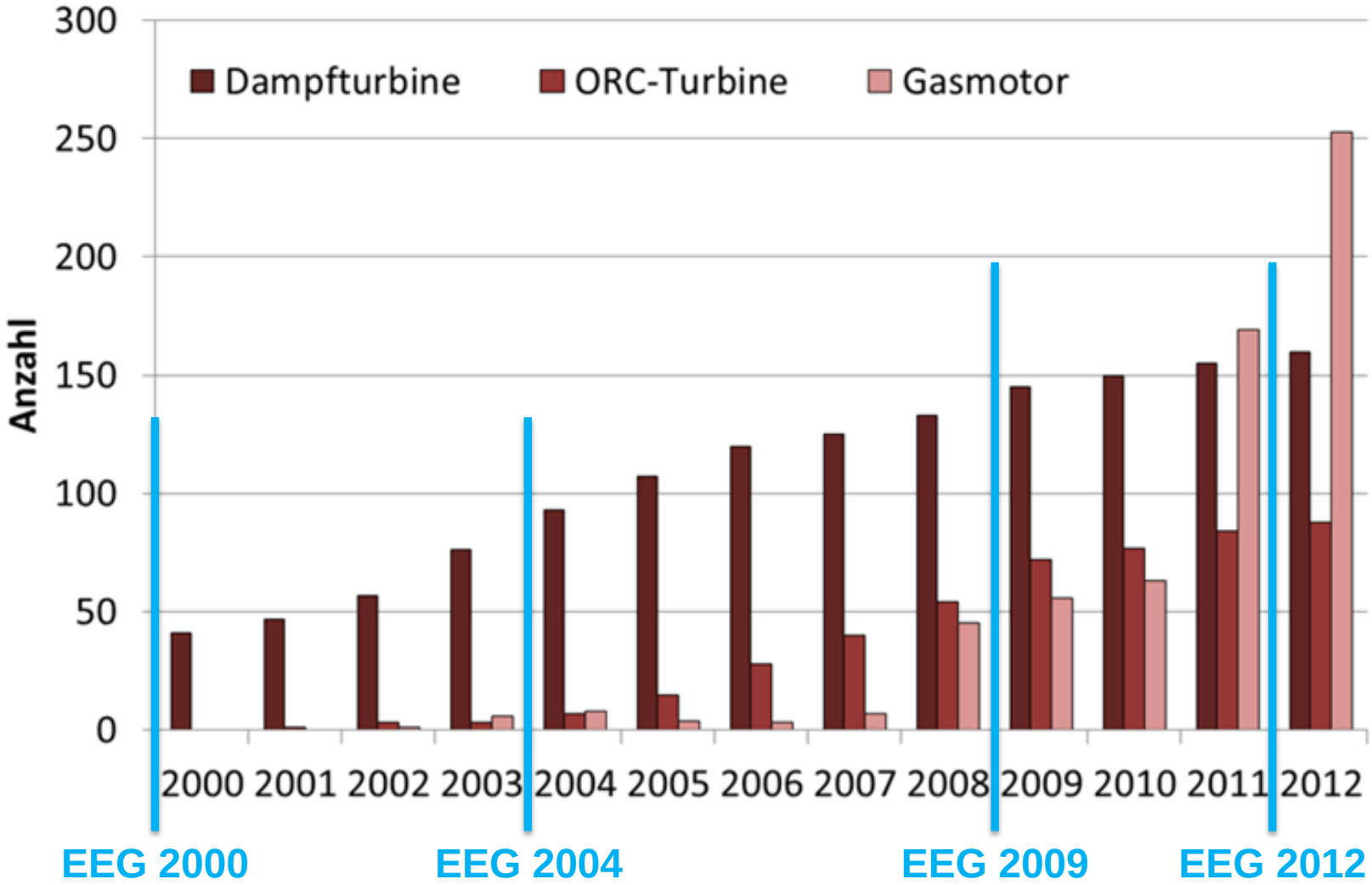


Main support elements for the use of different technologies
様々な技術に対する主な支援策

EEG 2009

- **Greater promotion of biogas technology**
- **Increase the CHP-Bonus connected with introduction of limits for eligibility**
- **Low annex in all areas**

Development of used technologies in the EEG
EEG施行以降の技術利用の推移



Main support elements for the use of different technologies
様々な技術に対する主な支援策

EEG 2012

- **Restructuring of the EEG**
- **Introduction of a minimum heat utilization of 60% as a criterion of efficiency for a limited resource**
- **Introduction of market integration mechanisms (market premium)**

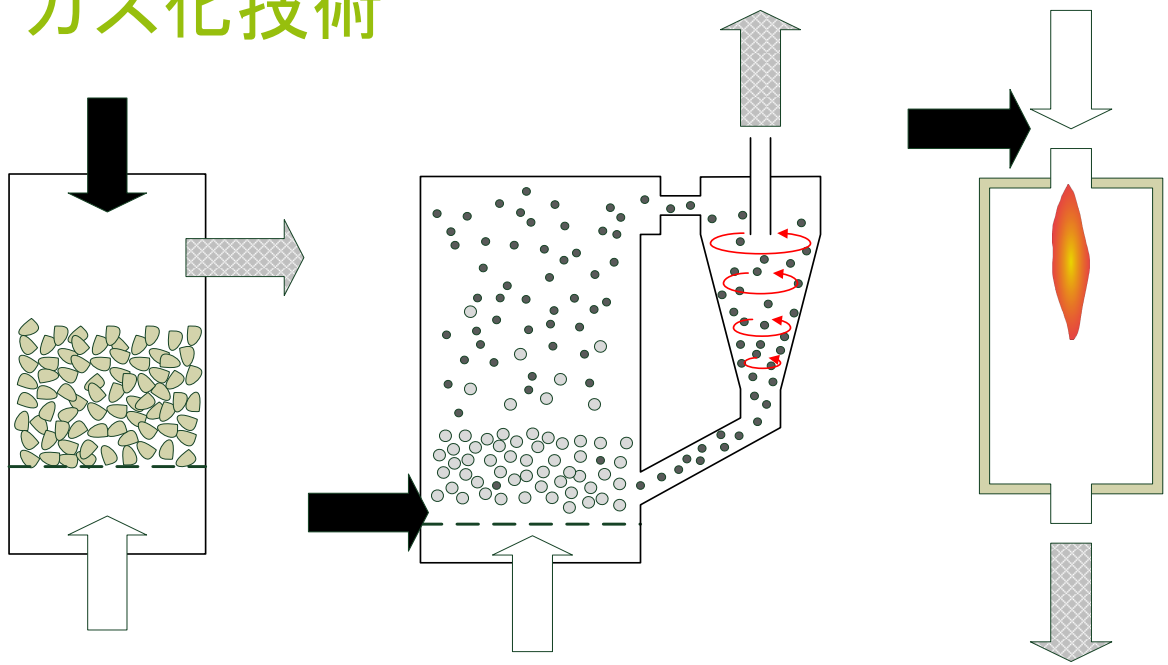
⇨ **Current annex ~ 40 MW/a**

⇨ **Main development by small scale gasification systems**

⇨ **rarely annex of new large plants because high competition for raw materials and a few locations with adequate heat utilization**

Excursion

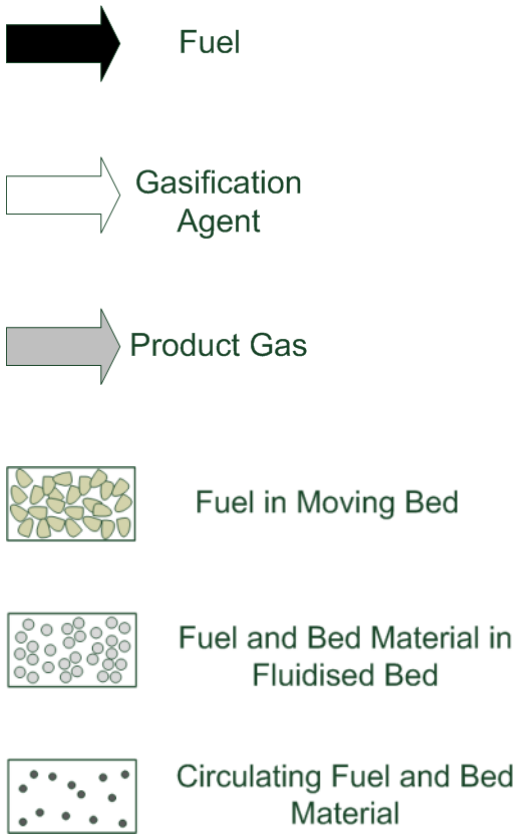
Gasification
ガス化技術



Moving Bed Gasifier (e.g. counterflow gasifier)

Fluidised Bed Gasifier(e.g. circulating fluidised bed)

Entrained Flow Gasifier



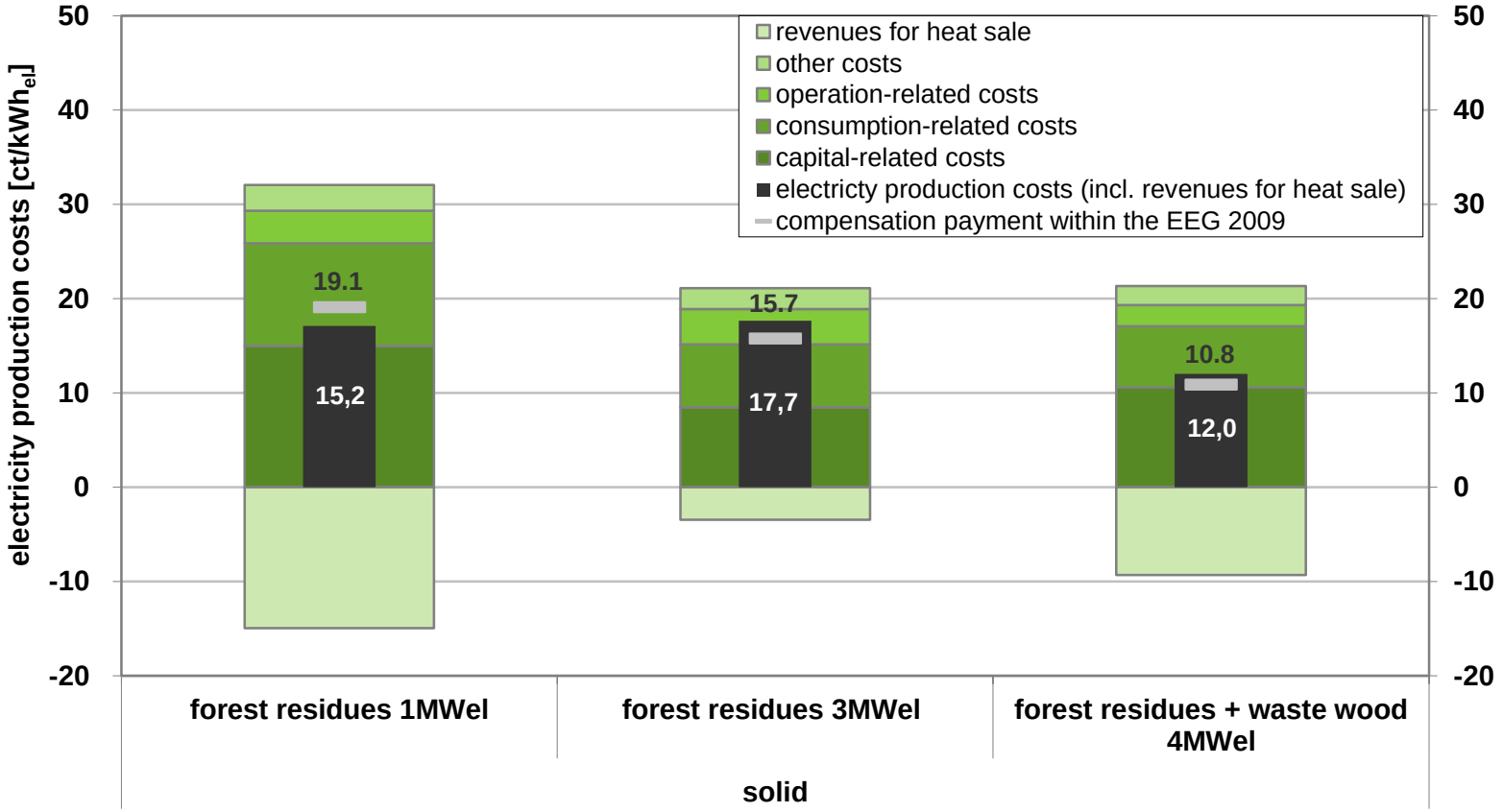
increasing gas velocity

decreasing particle size

decreasing residence time

Results of economic analysis

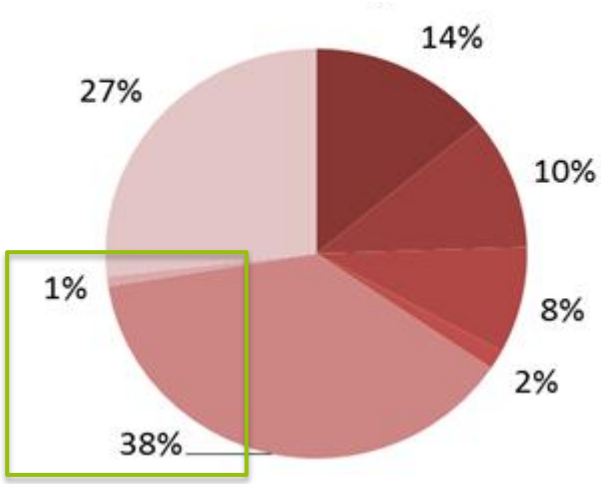
electricity production costs of solid biomass
固形バイオマスによる発電コスト



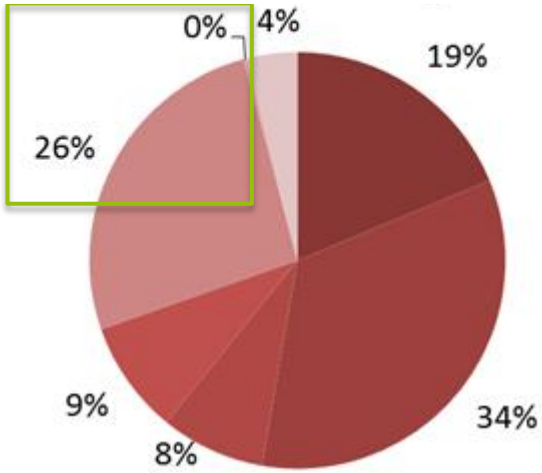
- **Main impact on the total electricity production costs have the investment of the bioenergy plant and the consumption of raw materials**
- **The revenues for heat sale is often the determining factor for economic efficiency**

Biomass use in solid biomass plants
固形バイオマスの利用「

share of plant number

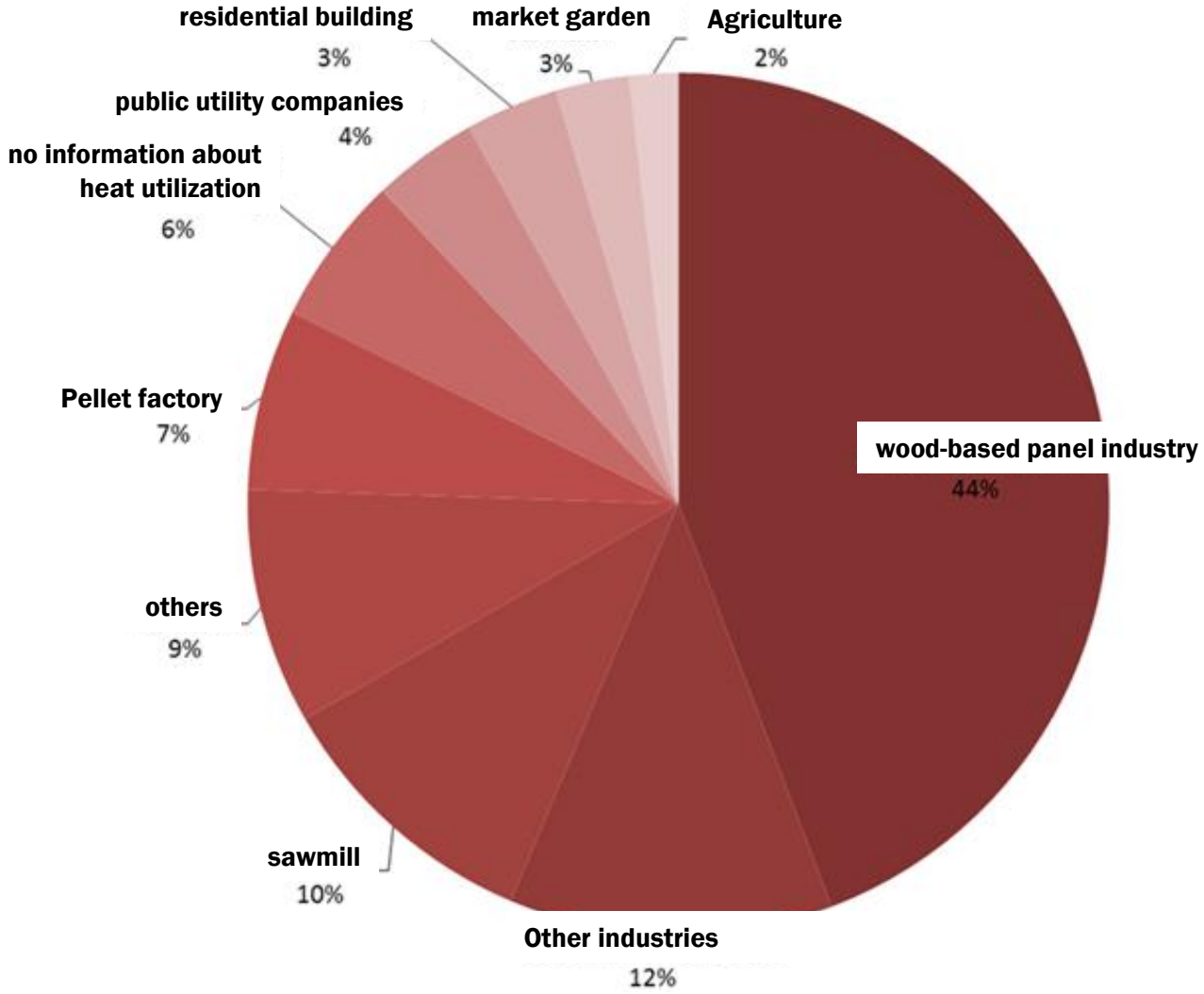


share of installed capacity



- Waste Wood cat. AI and AII
- Waste Wood cat. AIII and AIV
- Residues from the wood industry (bark, industrial wood residues)
- Residues from the paper- and pulp industry (bark, industrial waste wood, waste liquor)
- Landscape and natural wood residues
- Straw
- Unkown

Heat utilization from solid biomass plants
固形バイオマスによる熱供給



Conclusion

- The bioenergy sector is very heterogeneous with many different sources, technologies and stakeholders
- An excessive or insufficient support of individuel plants is often close together
- Clear conditions of invest are necessary
- The cost reductions will not be as high as wind or PV because of the prices for biomass, but a great value chain for the agricultural or forest sector could be created
- High heat utilization is important for the economic viability
- The Future of bioenergy is a system integrated provison
- Coinceration is in germany no solution, because it would destroy the established market for solid biomass and would prevent the move to alternative energies (high emissions of coal)

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