Deutsches Biomasseforschungszentrum
gemeinnützige GmbH

DBFZ

IEA Bioenergy Task 37: Country report Germany 2021

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Content

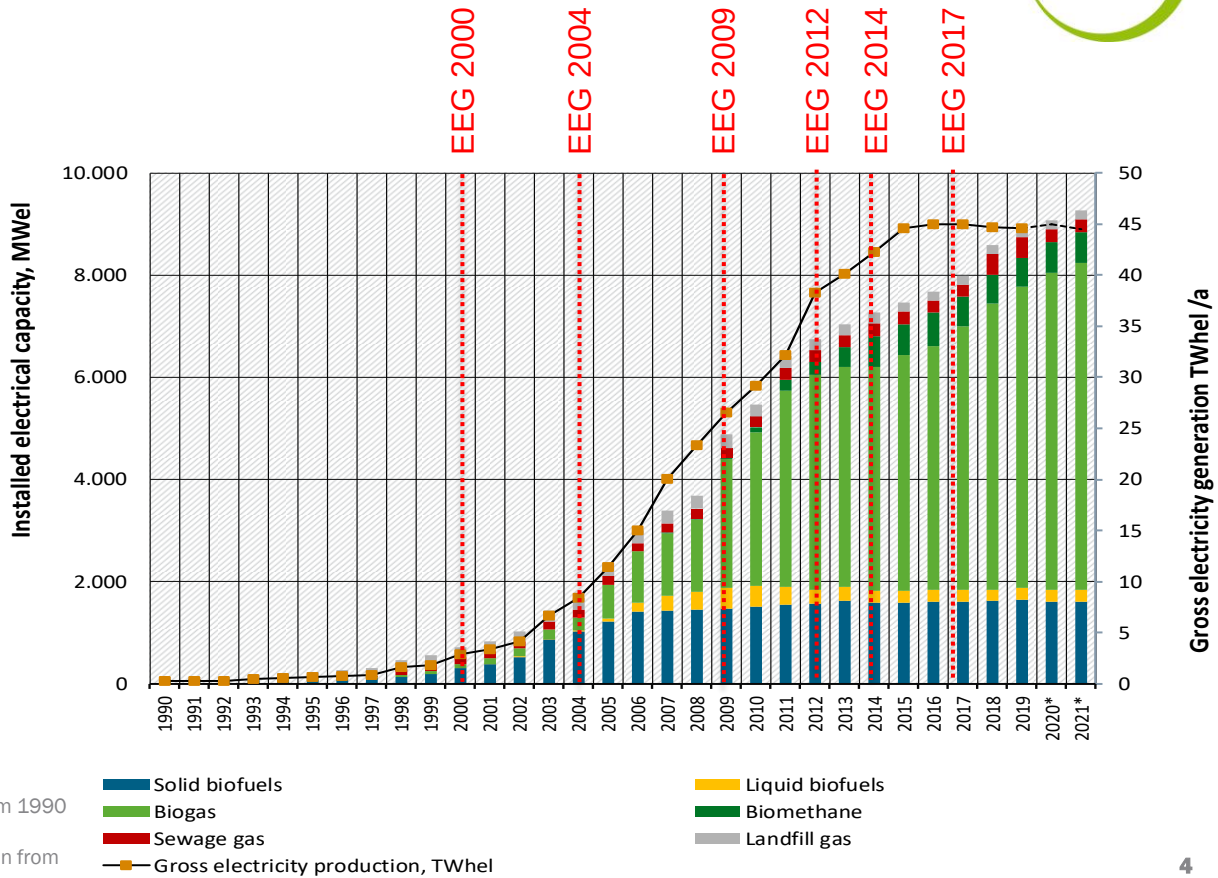
(1) Biogas plant inventory
(2) Biogas production and utilization
(3) Financial support system

(1) Biogas plant inventory

Bioenergy plants in Germany

biomass including sewage gas and landfill gas (2020): installed **capacity ~ 9,3 GWel/a;** electricity production ~ 45 TWhel/a

- Biogas /Biomethane CHP
- Sewage and landfill gas plants (CHP)
- Vegetable oil CHP
- Solid biomass plants



Source: DBFZ, DBFZ 2020. Database: time series of the AGEE-Stat from 1990 -2019 cf. (BMWi 2020). *Forecast DBFZ

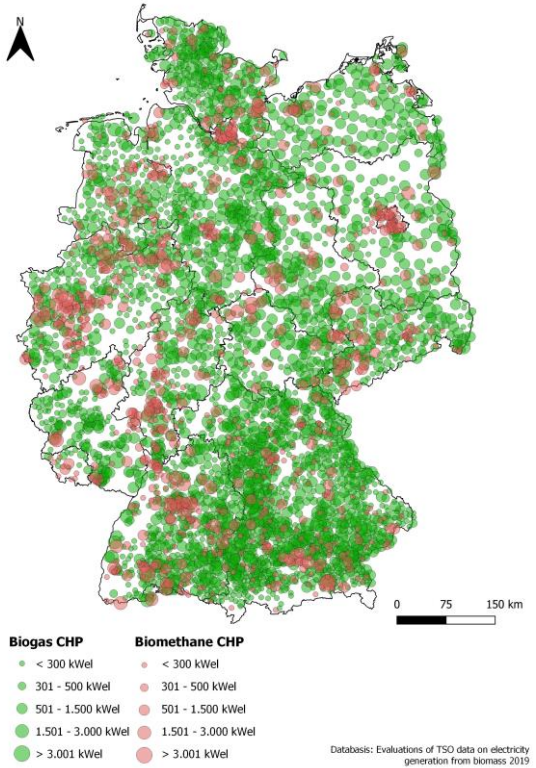
Figure: DBFZ, based on evaluation of TSO data on electricity generation from biomass 2020 (year 2019).

Biogas plant inventory (2020)

Plant type	Number of plants	Installed capacity [MW/a] 1)	Electricity production 1) [TWh/a]	Heat production 1) [TWh/a]
Biogas	8,700 2)	5, 848 2)	28.8	14.1
Agriculture 2)	~8,400	5.643	27.8	13.6
Biowaste 3)	~300	205	1.0	0.5
Biomethane 4)	232 (1,219)	621	2.9	3.9
Sewage sludge	1,271 5)	396	1.6	2.4
Landfill	280 6)	167	0.3	0.1
Total	10,483	7,032	33.6	20.5

1) Database: time series of the AGEE-Stat from 1990 -2019 cf. (BMWi 2020). 2) Estimation DBFZ
3) Substrate input of 142 plants ≥ 90% of biowaste of the whole input amount per year; biowaste is defined as separate collected municipal waste; about 150 co-fermentation plants with substrate input < 90% of biowaste including plants using agro-industrial residues.
4) dena 2021: 232 biogas plants with upgrading technologie to provide biomethane, 1,219 biomethane CHP in 2020.
5) Federal Statistical Office (destatis): https://www.destatis.de/DE/Presse/Pressemitteilungen/2020/08/PD20_310_433.htm
6) destatis 2021: energy statistics of electricity-feeding plants in 2020 according to table-code 43312-0001. (sewage sludge 453 plants, landfill: 280).

Biogas plants in Germany



Biogas plants (2020) ~ 9,000 plants (including shutdowns)

- ~ 8,700 on-site electricity conversion of biogas
- ~232 upgrading to biomethane

Installed electrical capacity

→ 6,5 GW_e

Gross electricity production

→ 31,7 TWh_e

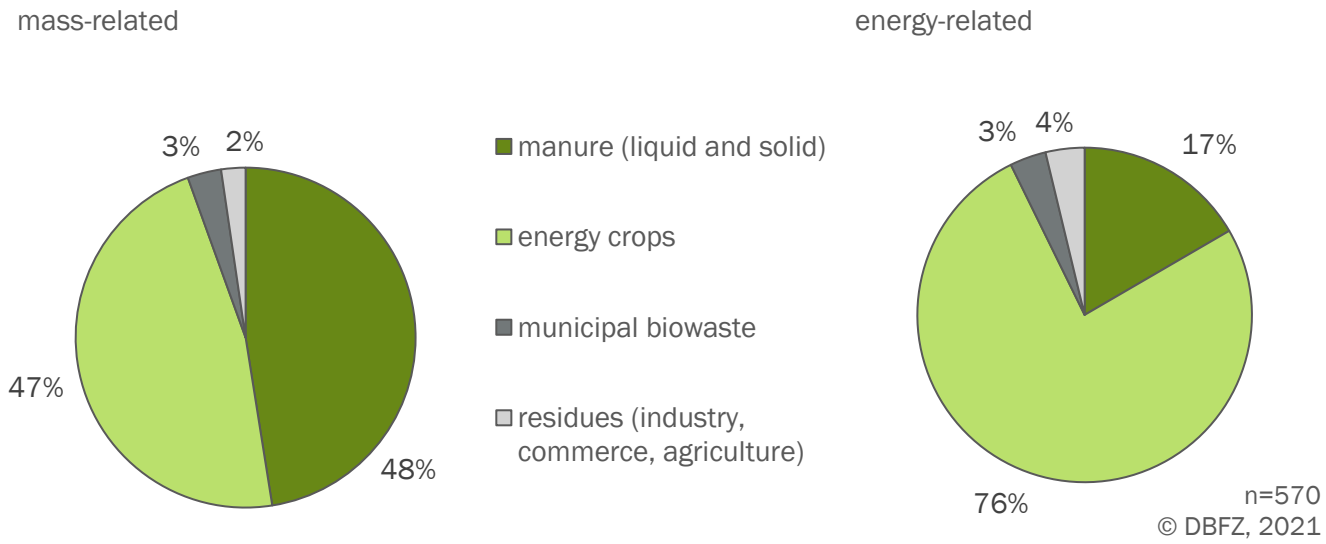
Heat supply

→ 18 TWh_{th}

References: Figure DBFZ state 10/2021, Database biogas and biomethane CHP according to analysis of TSO data 2020 (reference year 2019), Biogas plants: estimation DBFZ 2021 and dena 2021. Data regarding electricity/heat/installed capacity according to BMWI 2021.

Feedstock - biogas plants (in general)

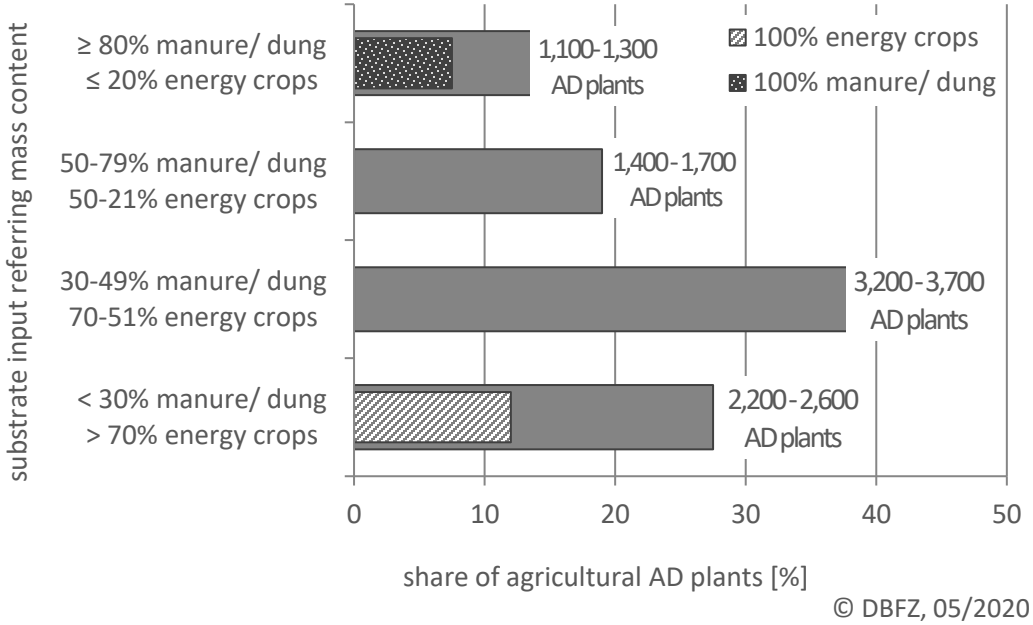
In total manure and renewable resources account for more than 90 % of the biogas in Germany



References: Database biogas DBFZ; operator survey 2021 (reference year 2020)

Feedstock – agricultural biogas plants

- Biogas plants with share of 51 – 70 % energy crops at substrate input dominate agricultural biogas plants
- about 1/3 of the biogas plants feedstock of ≥ 50 % liquid and solid manure (mass-related)
- In recent years, the construction of new biogas plants has been almost exclusively based on small liquid manure plants (according to § 27b EEG 2012, § 46 EEG 2014, § 44 EEG 2017) with substrate input ≥ 80 % manure/ dung (mass-related)



DBFZ 2020, Database Biogas, as of 6/2020, plant operator surveys

(2) Biogas production and utilization

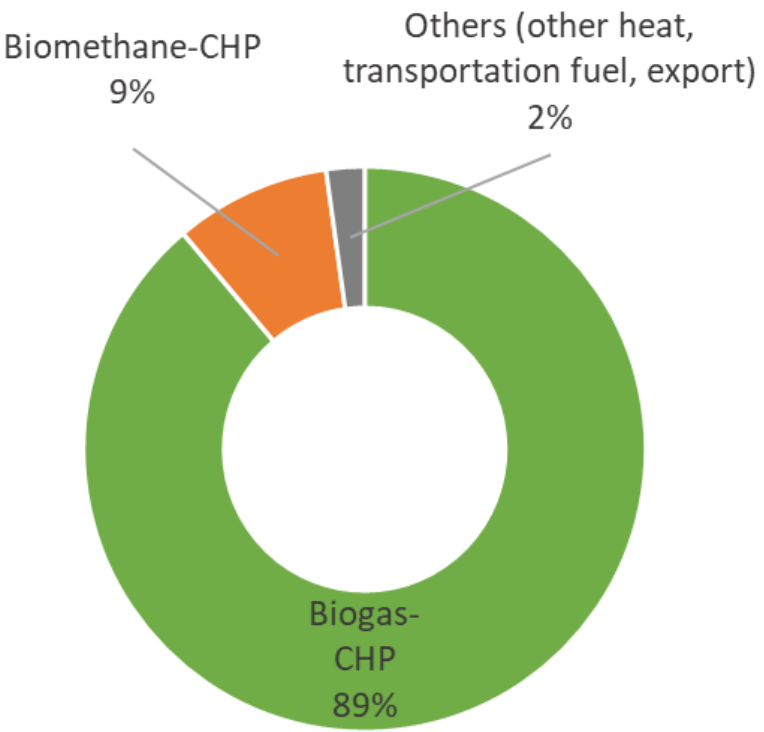
Biogas and Biomethane utilization

Utilization type	Amount, [GWh/year]
Electricity [1)]	31,706
Heat	18,000
Vehicle fuel	884

[1)] according to the DBFZ analysis as of 10/2021 based on TSO data for electricity production of biomass 2021 (reference year 2020) for biogas as well as biomethane data (dena 8/2021)

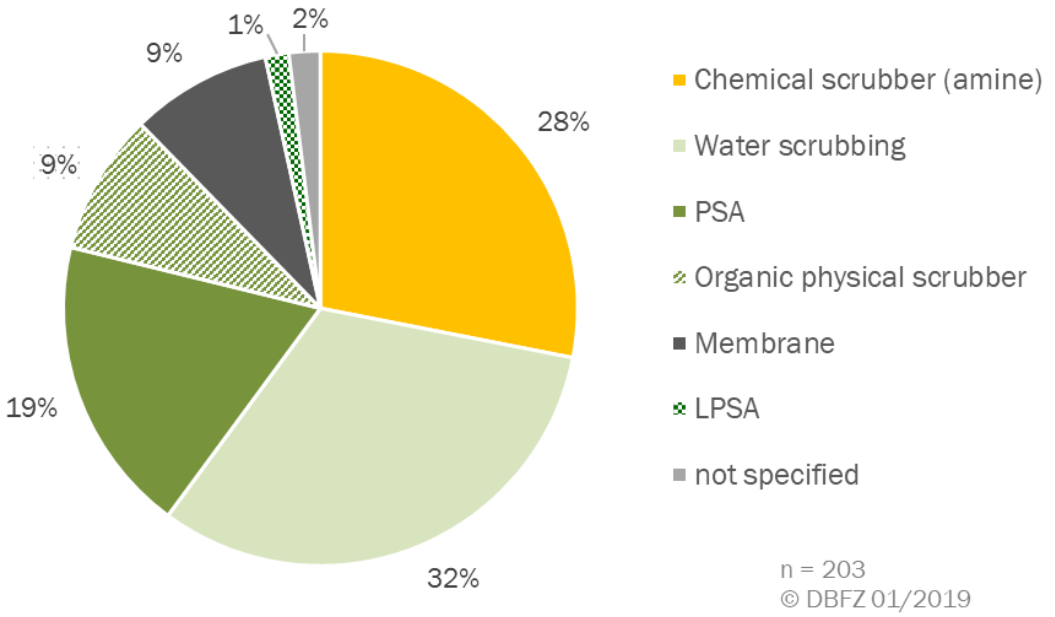
Biogas and Biomethane production and utilization in Germany

- ~ 10 billion m^3 biogas production incl. biomethane (> 100 TWh_{Hs})
- Feed-in of biomethane around 10 TWh_{Hs}
- Biogas and biomethane primarily used in the CHP sector
- Biomethane as a transportation fuel is primarily generated from waste and residues; Biomethane as a fuel plays a minor role, but is increasing; in total in 2020: ~884 GWh (compared to 389 GWh in 2018) (BMWi 2021)



References: DBFZ 2021, based on data from BMWI (2021) and dena (2021).
BMWi (2021): Time series for the development of renewable energy sources in Germany, based on statistical data from the Working Group on Renewable Energy-Statistics (AGEE-Stat), as of 02/2021.

Biomethane - Used upgrading technology



- predominantly technologies used water scrubber, pressure swing adsorption and chemical scrubber
- In comparison to preceding years membrane separation technologies have been utilized increasingly
- Different manufacturers of biogas upgrading plants operate at the market using several upgrading technologies.
- All technologies available for smaller upgrading capacities (~ 50 -350m^3_{STP} raw biogas /h)

References: DBFZ biomethane plants' database as of 01/2019.
Daniel-Gromke, J., Denysenko, V., Liebetrau, J. (2019): Germany's experience with biogas and biomethane. In: Mathieu, C. and Eyl-Mazzega, M-A (eds.), "Biogas and biomethane in Europe: Lessons from Denmark, Germany and Italy", Études de l'Ifri, Ifri, April 2019.

Biogas: More up-to-date than ever before?!

The current situation

Dependence on energy

- The German economy is significantly dependent on gas imports, which has become visible to society as a whole in the context of the Ukraine war
- Gas shortages can affect industrial processes, the electricity grid and, most recently, households

Biogas comes into focus as a (partial) solution

- EU biomethane target for 2030 (REPPowerEU plan):
  - 35 billion cubic metres of biomethane
  - Currently 3 billion cubic metres
- Government plans to focus on biomethane through EEG adjustment
- Residual and waste materials are in focus, but cultivated biomass is also coming back into the discussion

Framework

Reference to natural gas consumption

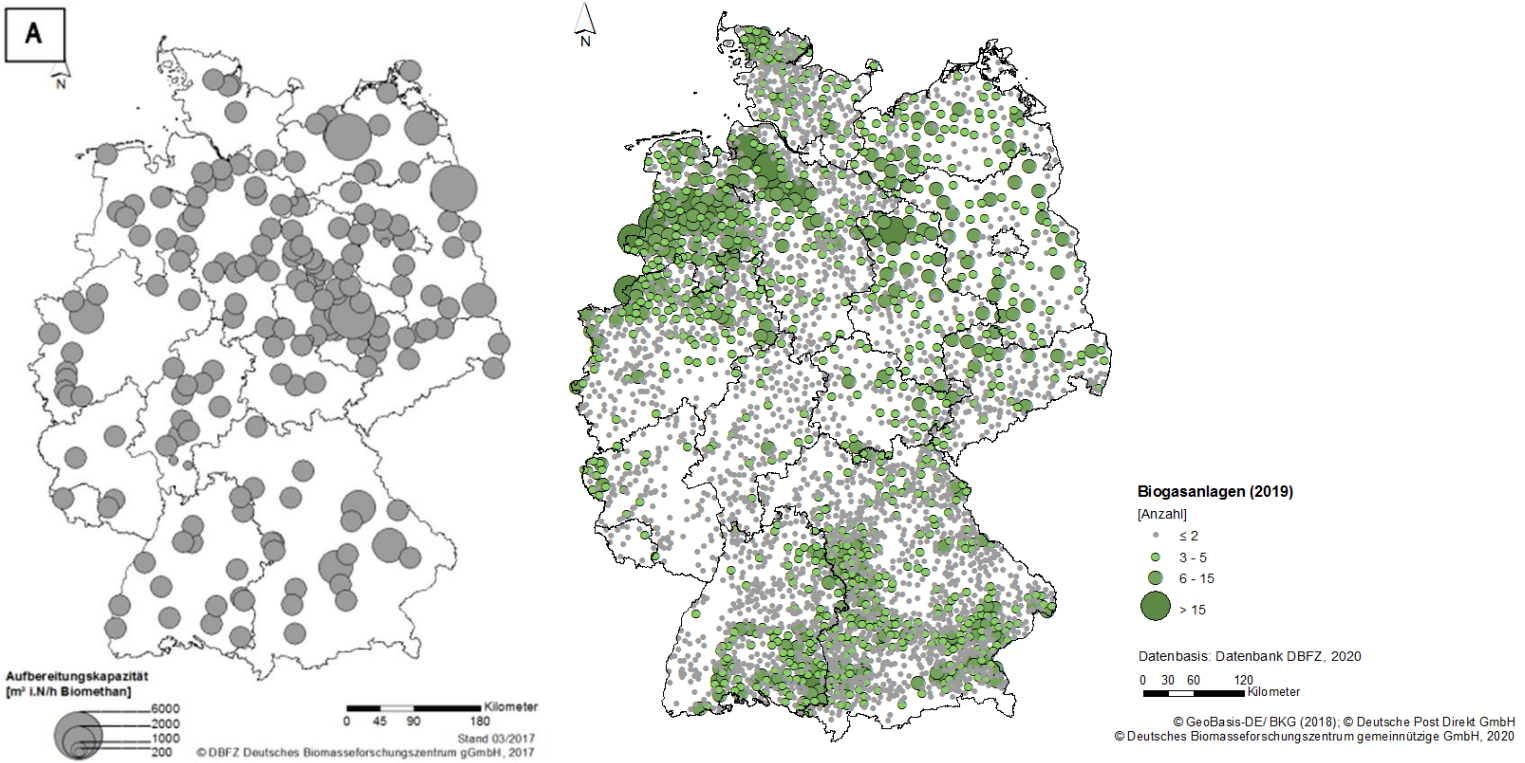
- Currently, the amount of biogas produced in Germany corresponds to approx. 9 % of the natural gas consumed in 2021 (biogas not biomethane)
- Currently, the amount of Biomethane produced in Germany corresponds to approx. 1.2 % of the natural gas consumed in 2021

Restriction for Biometane

- Not every CHP-plant will be able to feed biomethane into the grid.
- Economic conditions: High agricultural prices may make biogas production uneconomical

Biogas: Spatial aspects

Spatial distribution of biogas and biomethane plants



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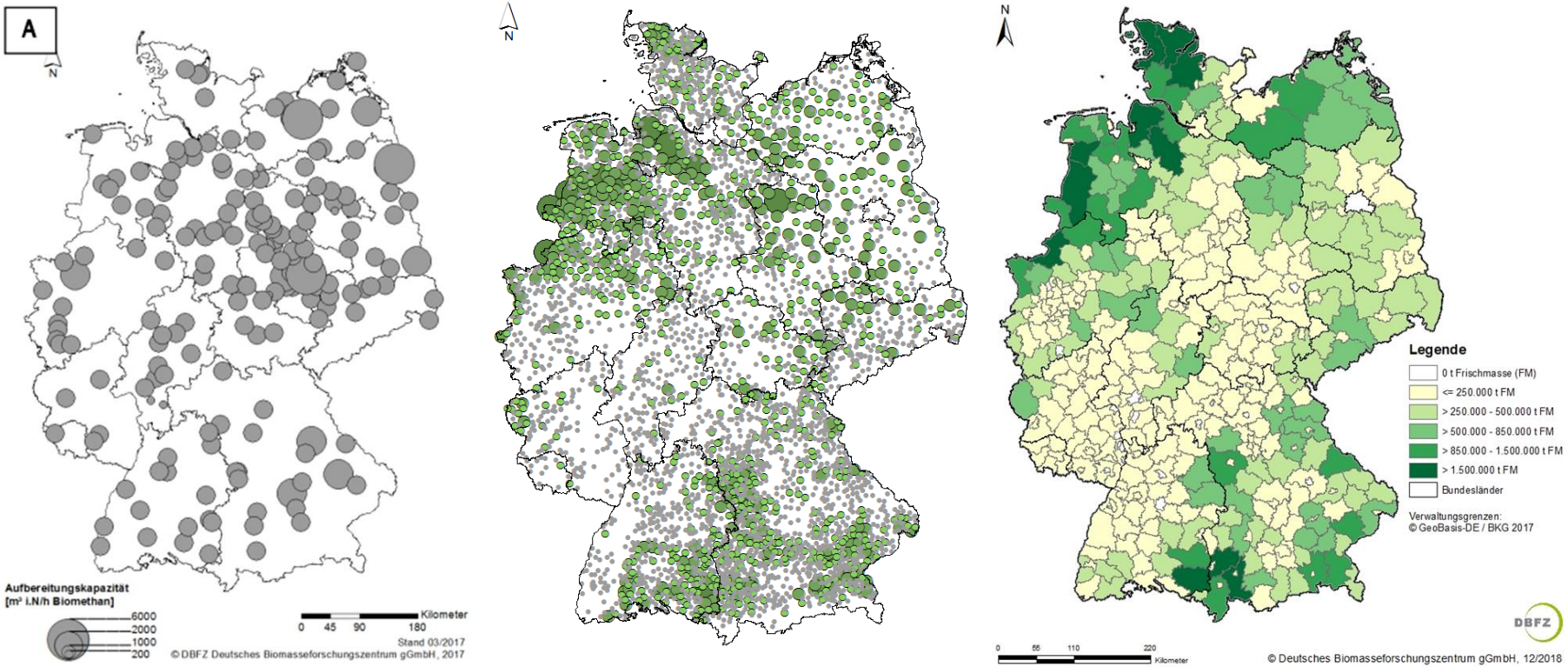

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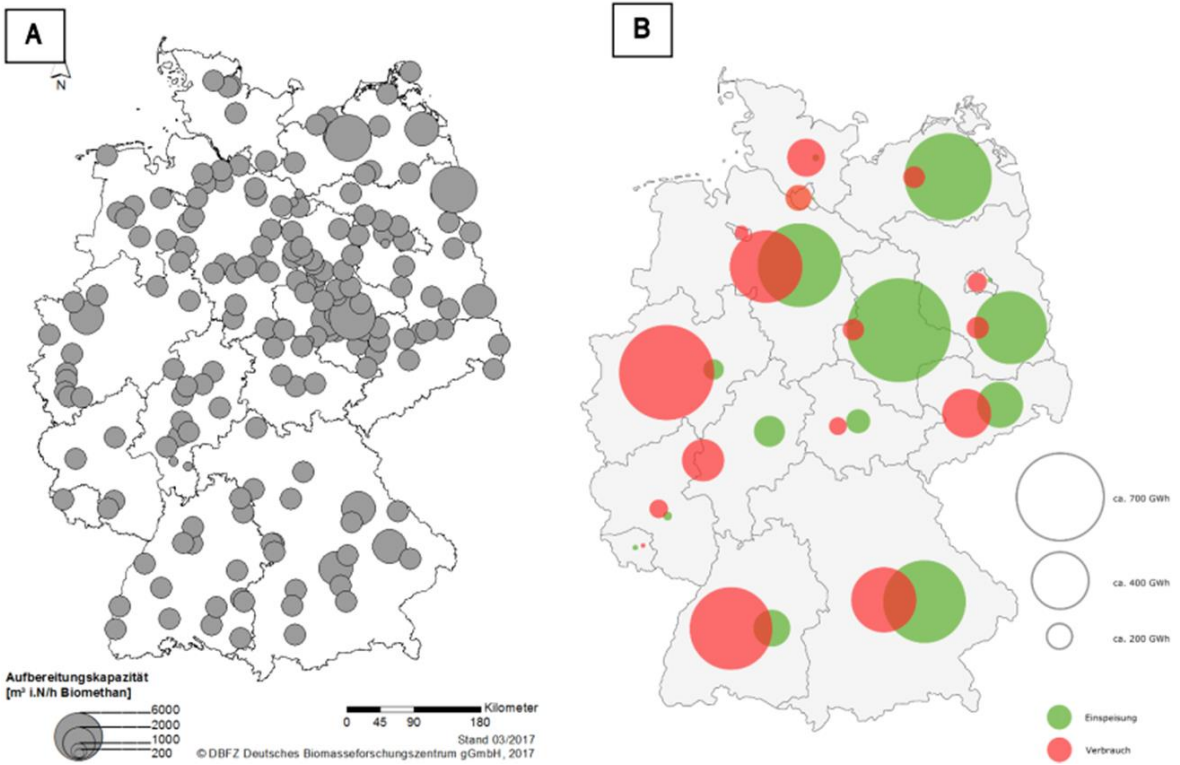
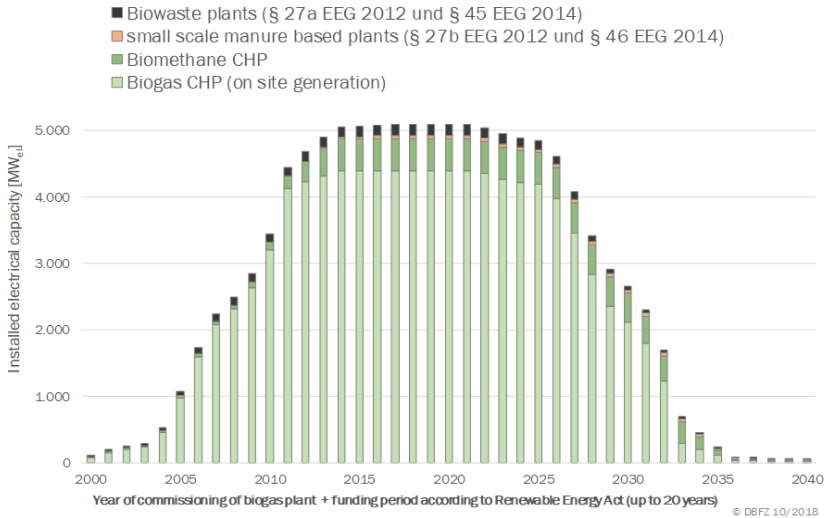


- Biomethane production and consumption differ in their spatial aspects
- Proximity to gas pipelines is relevant in determining whether a plant can feed biomethane into the grid

(3) Financial support system

Development of Biogas in case of the end of FiT- Period after 20 years



- Expansion of biogas production in Germany mainly driven by the Renewable Energy Sources Act (EEG)
- Until 2016: fixed feed-in-tariff for 20 years
- Since 2017: switch to the tender (pay-as-bid)
- By 2030, end of FiT for a large number of existing biogas plants, biogas plants go out of operation
- Possibility for existing plants to get follow-up funding for another 10 years in case of successful participation in tender
- EEG 2021: Expansion volume and bidding values of the tenders have been increased, at the same time higher requirements for the flexible operation of the plants have been defined.

References: Daniel-Gromke et al. 2017, DBFZ-Report No.30, based on database from BNetzA 2016 with development until 2016 and without additional constructions from 2017.

Renewable Energy Sources Act (EEG) 2021
New regulations 1/2

- **Determination and increase of annual tender volume until 2028**
  - 600 MW/a for biomass
  - additional 150 MW/a for biomethane CHP (from 2022 exclusively for "southern region")

- **Adjustment of maximum bidding value:**
  - Existing plants 18.4 ct/kWhe, new plants 16.4 ct/kWhe
  - Bonus for small plants (< 500 kW) in the tenders 2021 - 2025: +0.5 ct/kWhe

- **Introduction of "southern quota" in the regular tender segment** (§ 39d EEG 2021) from 2022 onwards 50% of the capacity awarded in the southern region

- **Adjustment of tender design (80% rule):** in case of less bids than tender volume, only 80% of the lowest bidding values will be considered)

Renewable Energy Sources Act (EEG) 2021
New regulations 2/2

- **Introduction of a new tender segment for new high flexible biomethane CHP plants** (max. 1300 h per year); tender quantity of 150 MW in „southern regions“ in order to avoid network bottlenecks
- Flexibility cap („Flexibilitätsdeckel“) is canceled
- For reaching a flexible operation of plants, 45% full-load hours are compensated.
- **Flexibility compensation raised** from 40 to 65 Euro per kW (new installations); existing 50 €/kW
- Small manure plants segment for plants with an installed capacity of up to 150 kW (currently 75 kW)
- Extension of compensation for plants in small manure plant segment, in preparation (ordinance in EEG)

Results of the biomass auctions

Date of auction	Volume of auction, [MW_e]	Number of awarded plants, [n]	Awarded installed el. capacity, [MW_e]	Max. bidding value, [c/kWh_e] (new vs. existing plants)	Average, volume-weighted bidding value [c/kWh_e]
09/ 2017	122.4	21[3)]	27.5	14.88 / 16.90	14.30
09/ 2018	225.8	79	76.5	14.73/ 16.73	14.73
04/ 2019	133.3[1)]	19	25.5	14.58 / 16.56	12.34
11/ 2019	133.3[2)]	50	56.7	14.58 / 16.56	12,47
04/ 2020	168	38	90	14.44/ 16,40	13.99
11/2020	168	19	28,5	14.44/16.40	14.85
03/2021	300	38	34	16,40/ 18.40	17.02
09/2021	275	73	70	16.40/ 18.40	17.48

So far: volume of auction not used, no substantial cost reduction; higher share of solid biomass with lower bidding value; increasing average bidding value

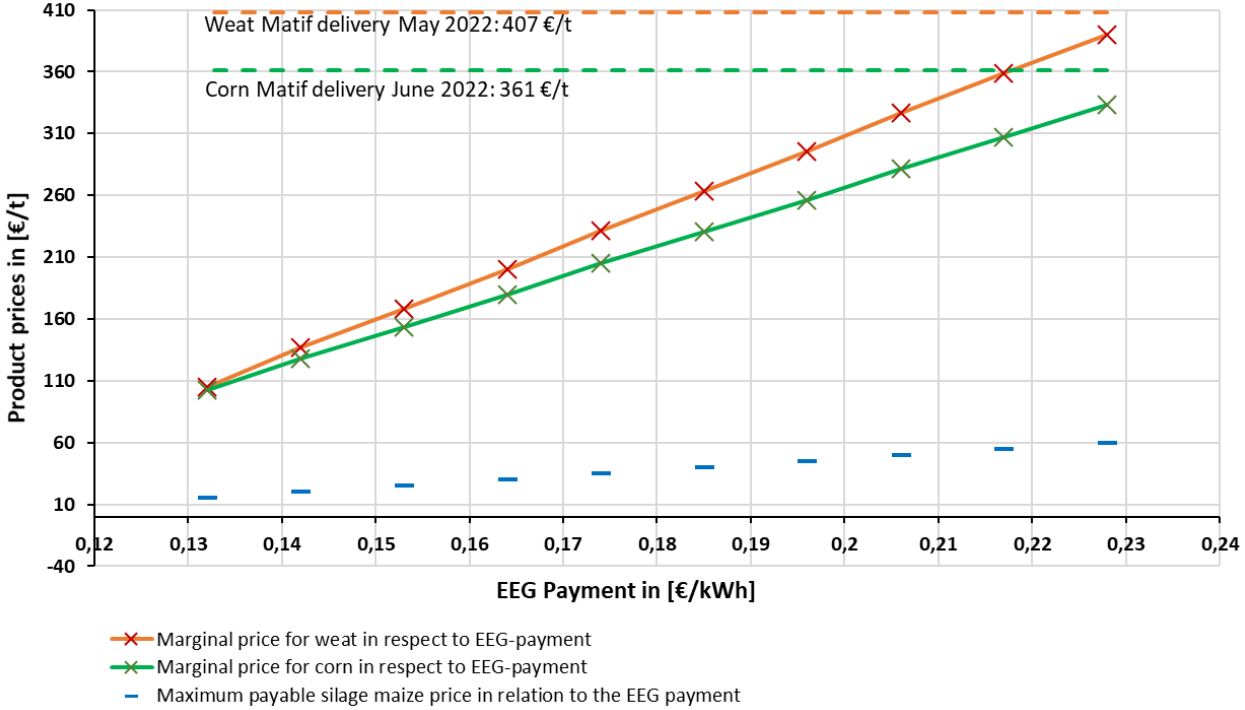
Source: BNetzA, statistics of biomass auctions between 2017 -2021.
https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/Ausschreibungen/Biomasse/BeendeteAusschreibungen/start.html (accessed 25.11.2021)

Prospects for biogas/biomethane

- Due to economic aspects focus on larger biogas plants or merged biogas plants to provide biomethane (> 250 m^3/h biogas) → up to 20 % of existing on-site conversion plants suitable
- Higher production costs for biomethane allow a higher flexibility with regard to place, time and kind of final use. Biogas and biomethane are particularly useful where other renewable energies are no alternative.
- Biomethane has high GHG savings compared to fossil and alternative transportation fuels → incentives RED-II especially for biomethane based on waste and residues, move to fuel sector?
- It is assumed, that the majority of operators will continue to operate the plant by participating in EEG tenders
- Expansion volume and bidding values of the tenders have been increased, at the same time higher requirements for the flexible operation of the plants have been defined.
- Special tender in EEG-2021: "highly flexible biomethane CHP" especially interesting for larger CHP units (150 MW/a volume)

Outlook for biogas development: Agricultural producer prices

Marginal prices of alternative cultivation options



- Question: At what product price for alternative cultivation options does silage maize become unattractive as a biogas substrate?
- Question: How much can the typical German biogas plant pay for silo maize at a certain EEG remuneration in order to cover its costs?
- Question: How does this relate to current agricultural prices?
- Methodology: Process comparison of cultivation options assuming a standardised biogas plant.

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Smart Bioenergy – Innovations for a sustainable future

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