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Policy brief

Biogas and Capacity Markets – On the Role of Biomass as a Flexi- bility Option in the Electricity Sector

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On biomass as flexibility option in the electricity sector

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Summary

- Biogas plants currently provide approximately 6.8 GW of electricity generation capacity. About 4.5 GW of this capacity enable flexible electricity generation. If the current plant fleet's flexibility factor would be raised to four, additional flexible capacity of approximately 7 GW could be provided.
- In addition to such simple estimates of technological potential, energy system models can help determine the cost-effective contribution of biogas to capacity markets. However, these models are subject to high levels of uncertainty due to dynamic technological and cost developments (such as those related to hydrogen and demand-side management). Therefore, the findings based on these models should be treated with caution and updated regularly.
- Current modeling results suggest that biogas can make a significant contribution to cost-effective security of supply in the electricity sector over the long term. This requires expanding biogas electricity capacity to 11 GW. Highly flexible biomethane plants can also support the energy transition in the electricity sector, but they are associated with higher cost risks compared to biogas plants.
- While biogas should play a greater role in Germany's capacity markets, replacing new flexible gas and hydrogen power plants that are currently planned by the federal government entirely would not be cost-effective. If these power plants were substituted, the costs of the energy transition could rise by more than €5 billion by 2030. By 2050, the additional costs could even total up to €46 billion—in part because this would require biomass that would then be unavailable for climate protection in other sectors.
- The model results suggest that the planned tenders for natural gas and hydrogen power plants are proportionate to the potential contributions of biogas in capacity markets. Natural gas power plants and biogas plants can therefore—provided there is sufficient availability of hydrogen in the future—be viewed as complementary options rather than alternatives.
- If additional advantages of biogas plants over natural gas or hydrogen power plants are taken into account—such as greater independence from energy imports and contributions to strengthening rural areas—it may be reasonable to replace more natural gas with biogas in the electricity sector. In the long term, a greater role for biogas could also be helpful if less hydrogen is available in the future than is currently expected.
- In principle, biomass-based electricity should be promoted more extensively through capacity markets to ensure competition with alternative flexibility options. This would allow for a better identification of the efficient level of required biogas capacity, unlike under the current Renewable Energy Act.

1. Background: Demand for flexible power generation

The energy transition in Germany is being driven primarily by wind and solar energy. However, additional technologies and measures are needed to bridge periods of low wind and low sunlight. In addition to energy storage systems and mechanisms for adjusting electricity demand, flexible natural gas power plants—which could be powered by hydrogen in the future—are under discussion. While the need for flexible solutions is widely recognized, estimates regarding the role of natural gas power plants vary. After the previous federal government had planned to put up to 10 GW of capacity out to tender, the coalition agreement of the current federal government set a target of up to 20 GW. In January 2026, an agreement was reached with the European Commission—which must approve support measures for these power plants under state aid law—for 10 GW for natural gas power plants and 2 GW for additional flexibility options. The government’s draft of the Electricity Supply Security and Capacity Act (StromVKG), which is intended to provide the legal basis for corresponding tenders, calls for 9 GW for gas-fired power plants and an additional 2 GW for other flexibility options.¹

Although this establishes a political and legal framework for tendering flexible capacity, the scale of new gas-fired power plants continues to be called into question. The reasons for this include the high costs of building new power plants and the associated use of climate-damaging natural gas, with corresponding drawbacks for energy security. The uncertain future availability of hydrogen also poses a challenge to the climate-friendly operation of such power plants in the future.²

Flexible biogas and biomethane plants are being discussed as a potentially more cost-effective and domestically available alternative. Currently, these plants provide electricity market capacity of approximately 6.8 GW, with about 4.5 GW meeting the technical requirements for flexible power generation. This capacity can be substantially expanded, in some cases without the need for additional biomass. This raises the question of whether—and to what extent—biomass plants can serve as an alternative to gas- or hydrogen-fired power plants.

¹ Bundesregierung (2026): Gesetzentwurf der Bundesregierung - Entwurf eines Gesetzes zur Sicherung der Versorgungssicherheit Strom und zur Bereitstellung neuer Kapazitäten und zur Änderung der Besonderen Gebührenverordnung BNetzA, <https://dserver.bundestag.de/btd/21/062/2106279.pdf>.

² Wettingfeld, M.; Fiedler, S. (2025): 20 GW Gaskraftwerke bis 2030 - Was kostet die Erweiterung der Kraftwerksstrategie?, Kurzanalyse im Auftrag des BUND, https://foes.de/publikationen/2025/2025-04_FOES_BUND_Kraftwerkskosten.pdf; Bundesrechnungshof (2025): Umsetzung der Wasserstoffstrategie des Bundes, Bericht nach § 99 BHO, https://www.bundesrechnungshof.de/606374507ecf28c3e0df891fe2d7a11733baf513/0c28d600-e5fb-e73c-1be6-3e0395ec75ac/tap2_gnlsws_dec/wasserstoffstrategie-volltext.pdf; Willich, C. (2024): Hydrogen as an Energy Carrier—An Overview over Technology, Status, and Challenges in Germany, J 7, 546–570, <https://doi.org/10.3390/j7040033>.

The following section therefore examines the contribution that biomass can make to the energy transition in the electricity sector. First, it outlines the potential offered by the expansion (upgrading) of existing biogas plants. We then examine what contribution these plants can realistically make when, in addition to technical potential, costs of energy supply and competing biomass demands from other sectors are taken into account. In other words, we will determine which biomass-based electricity generation capacities are cost-effective from an economic perspective.

2. Electricity from biomass: potential based on existing plants

In September 2025, a study indicated that Germany’s biogas potential would, in theory, be sufficient to almost completely replace natural gas as a flexibility solution.³ Since the infrastructure required for this is already largely in place—including thousands of biogas plants and several hundred biomethane plants—the need for natural gas-fired power plants could be significantly reduced.

The study focused primarily on how much electricity can be generated from biomass. However, when considering plant capacity—which is the key factor for capacity markets—a different picture may emerge. This can be illustrated using two simplified technical scenarios for (further) increasing the flexibility of the existing plant fleet:

- “Upward Flexibility” Scenario: In this scenario, additional power generation capacity (combined heat and power plants) is added, enabling a more flexible distribution over time of the same total amount of electricity produced.
- “Downward Flexibility” Scenario: In this scenario, the current total capacity remains constant. Flexibility in electricity production is achieved by reducing electricity generation—that is, by limiting production to periods of high demand. This scenario includes the decommissioning of inefficient facilities, with their capacity replaced by the construction of new, more efficient plants.

³ Matschoss, P. et al. (2025): Zukunftsaussichten der Biogasbranche. Studie für den Fachverband Biogas (FvB), <https://izes.eu/wp-content/uploads/20251125-IZES-FvB-Studie-web.pdf>.

Both scenarios are based on the following assumptions and data:

- The current installed capacity totals 6.8 GW (biogas and biomethane). Annual electricity production corresponds to an average capacity utilization of 3.4 GW.
- Plants that produce biomethane for other markets, such as the transportation sector, are not included here. Capacities for generating electricity from solid biomass and vegetable oil are also excluded.
- In accordance with the guidelines of the legislative “Biomass Package 2025,” a gradual reduction in operating hours that are eligible for remuneration under the Renewable Energy Act is assumed (increasing the average overcapacity factor of around 2 to a factor of 4). For simplicity, this overcapacity is assumed to apply to the entire installed base.
- For simplicity’s sake, the higher efficiency that may result from the construction of larger capacities is not taken into account.

Table 1 shows that, under these assumptions, “Upward Flexibility” at existing sites could provide additional capacity of approximately 7 GW in the medium term (2030). Combined with the 6.8 GW already available, this results in a total capacity of 13.7 GW. In the case of “Downward Flexibility” achieved by reducing the utilization of existing plants, a 4-fold increase in capacity would lead to a stabilization of the current capacity of 6.8 GW. If capacity is increased by more than 4-fold, output increases accordingly.

Table 1: Technical Potential for Flexible Electricity Generation Capacity from Biomass

Scenario assumptions	Technology	Upward flexibility	Downward flexibility
Current rated power capacity (GW)		3,4	3,4
Factor capacity maintenance		1	0,5
Potential: 4-fold increase (GW)*	CHP plant	13,7	6,8
Potential: 4-fold increase + fuel cell (GW)	Fuel cell	25	13

*: Current minimum flexibility requirement according to the German Renewable Energy Act

With regard to plant-related potential, it should be noted that reversible fuel cell technology could significantly increase the efficiency of biogas utilization—and thus electricity

generation capacity—in the future. The average fuel efficiency, which currently stands at around 40 %, could increase to 70–80 %. This means that, theoretically, current capacities could be increased to up to 25 GW. Additional capacities are also conceivable if new biomass sources are tapped or if e-methane is produced using CO₂ from biogas.

If we consider only the technical potential for expanding capacity at today's biomass plants, this could replace the currently planned capacity of natural gas and hydrogen power plants. However, this would also require substantial investments in existing and new plant sites. The associated costs could be higher than those for building additional gas-fired power plants that will be operated with hydrogen in the future. This aspect is examined in more detail in the following section.

3. Electricity from biomass: cost-effective contribution

Apart from technical feasibility, the costs of flexible power generation are an important factor in developing capacity markets. Costs affect the affordability of energy supply and, consequently, public acceptance of climate policy. For more than a decade, the UFZ and DBFZ have therefore been developing model-based scenarios for the cost-effective use of biomass. Unlike many common energy system models, which either do not account for biomass at all or represent it only in a highly simplified form, these models take into account more than a hundred different bioenergy technologies as well as a wide variety of biomass types.⁴ While earlier model versions initially analyzed only energy uses, the current generation of models also accounts for material uses in the wood and horticulture sectors as well as in the chemical industry.⁵ The climate policy requirement for negative emissions is also incorporated. In the electricity sector. Regarding electricity, only the coverage of residual load is modeled. This means that the inefficient use of biomass for continuous electricity generation (“base load operation”) is ruled out a priori, and this resource is considered in the model exclusively as a flexibility option.

⁴ Jordan, M. et al. (2023): The controversial role of energy crops in the future German energy system: The trade offs of a phase-out and allocation priorities of the remaining biomass residues, *Energy Rep.* 10 , 3848 – 3858, <https://www.sciencedirect.com/science/article/pii/S2352484723014890>. Meisel, K., et al. (2024): Quo vadis, biomass? Long-term scenarios of an optimal energetic use of biomass for the German energy transition, *Int. J. Energy Res.* 2024 , art. 6687376, <https://onlinelibrary.wiley.com/doi/10.1155/2024/6687376>.

⁵ Meisel, K.; Jordan, M.; Günther, S.; Cyffka, K.-F.; Röder, L. S.; Wollnik, R.; Karras, T.; Schindler, H.; Thrän, D. (2026): Szenarien zum optimalen Einsatz von Biomasse in der Bioökonomie bis 2050, Leipzig: DBFZ. VIII, 9-59 S. (DBFZ-Report, 56), DOI: 10.48480/17m2-3058, <https://www.dbfz.de/pressemediathek/publikationsreihen-des-dbfz/dbfz-reports/dbfz-report-nr-56>.

The extent to which biomass can contribute cost-effectively to flexible electricity generation depends heavily on whether energy crops continue to be used. In model scenarios in which the use of energy crops remains at current levels, it is cost-effective to expand the contribution of biogas plants to flexible electricity generation from the current 4.5 GW to 11 GW by 2050. If the use of energy crops is excluded from support measures, only 4 GW of biogas is cost-optimal due to the higher costs of biogenic waste and residues.

If the construction of new natural gas power plants is excluded from the model, this can indeed be offset by biomass plants. However, partly because the additional biomass required for this would then be lacking for climate protection in other sectors, this significantly increases the costs of the energy transition. Between 2027 and 2030 alone, this results in cumulative additional costs of €5.14 billion across all sectors. If natural gas and hydrogen are phased out in the electricity sector in favor of biogas over the long term, the additional costs rise to as much as 46 billion €. For climate protection, it is therefore more cost-effective to use natural gas power plants as a bridge solution and offset the resulting greenhouse gas emissions through measures in other sectors than to avoid these emissions through biogas plants.

In addition to biogas plants, highly flexible biomethane plants could theoretically help meet residual demand. However, current modeling suggests that the effective contribution of this technology option is associated with particularly high uncertainties and cost risks. Risks related to a potential decommissioning of the gas networks have not yet been taken into account. The model shows the use of biomethane by combining high capacities with a utilization rate that is still significantly below the capacity currently eligible for support under the Renewable Energy Act. In other words, electricity from biomethane will only be competitive for a few hours a year, but this requires substantial investments in plant technology as well as the continued operation of gas grids. If gas grids are decommissioned in the future, biomethane plants could turn out to be a costly misinvestment. Flexibility options independent of the gas grid, such as electricity storage or demand-side management, may therefore be a less risky alternative.

It is true that, even in the case of biogas, the cost-optimal contribution to electricity generation depends heavily on various factors—such as future hydrogen price levels or the development of flexibility options on the consumer side (demand-side management). Nevertheless, the model results for biogas—unlike those for biomethane—strongly indicate that the costs of the energy transition can be reduced through a significant increase in flexible capacity. The model shows a parallel expansion of capacity for both natural gas and hydrogen power plants as well as flexible biogas plants. An expansion of biomass-based capacity is therefore not necessarily at odds with the construction of new natural gas power plants. Rather, biogas plants can be viewed as a complement to natural gas power plants.

Figure 1 compares the plant-specific potentials (previous section) and the cost-effective contribution of biogas with existing and planned additional capacities of natural gas and hydrogen power plants. As with many other energy needs, it becomes clear that biomass can

- If using energy plants in the electricity sector becomes politically undesirable in the future, the costs of decarbonizing the electricity sector will rise significantly. In this case, the efficient contribution of biomass to the capacity market would stagnate at current levels, which would mean higher demand for natural gas or hydrogen, for example.
- If criteria other than cost—such as energy security and the revitalization of rural areas—are taken into account, giving greater weight to biomass plants in capacity markets can be plausible.

In any case, when it comes to biomass, the focus should be on maintaining efficient plant sites that offer flexible electricity generation combined with heat utilization. This process can best be ensured through a competitive bidding process for capacity. This allows for the identification of inefficient sites and the development of new, more efficient sites (particularly those with heat utilization). Such sites also contribute to long-term value creation in rural areas. A consistent effort to further increase the flexibility of biomass plants that are still operated in base-load mode should be a priority. Support under the Renewable Energy Act should therefore continue along the path of increased flexibility that has already been embarked upon. In the medium and long term, supporting biomass electricity through capacity markets is preferable, with a few exceptions such as small-scale manure-based plants. Unlike the Renewable Energy Act, capacity markets enable competition among the various flexibility options. As a result, the efficient level of biomass-based generation capacity can be determined by the market and will therefore no longer depend on political decisions.

To ensure a smooth transition for existing biomass plants from the Renewable Energy Act to a capacity-market-based policy support, it may be advisable to take into account, when determining the scope of the relevant tenders, which capacities are gradually being phased out of the current support regime. This would enable continued operation while leveraging investments already made. When opening capacity markets to biomethane plants, the future availability of gas networks should also be taken into account to avoid misinvestments.

The German federal government's plan to hold separate tenders for natural gas and hydrogen power plants and alternatives such as biomass plants may be reasonable in order to account for the greater need for innovation in hydrogen-based solutions and to avoid jeopardizing the necessary scaling of related capacities. In this context, it is important that a transition from natural gas to hydrogen be contractually guaranteed in the tendering process for gas-fired power plants in order to stimulate the ramp-up of hydrogen and preclude subsequent continued operation using natural gas.

At the same time, it should be noted that there is also potential for innovation in biomass plants, for example through the widespread adoption of reversible fuel cells. This technology could not only significantly increase the efficiency of electricity generation from biogas but also further solidify Germany's position as a technology leader. For this reason as well, the role of biomass should receive greater attention in the future electricity market.

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