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Future of bioenergy in German's energy system – the TRANSBIO project

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Fachagentur Nachwachsende Rohstoffe e.V.

IZES Institut für
ZukunftsEnergie- und
Stoffstromsysteme

Agenda

IZES: brief introduction

Biomass in energy and beyond, 2nd Phase Financing & TRANSBIO

TRANSBIO: a Delphi Survey

TRANSBIO, Delphi & overall conclusions

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IZES gGmbH

- 65 staff in main office (Saarbrücken, Germany)
- Berlin office: 4 additional staff
- Not for profit organization, mainly owned by the federal state of Saarland (70%)
- Application-oriented research & development, systemic research of new energy and material flows
- 5 departments
 - Energy markets
 - Material flow systems
 - Infrastructure in municipalities
 - Technical innovation
 - Environmental psychology



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Biomass in final energy use in 2022 in Germany

Electricity

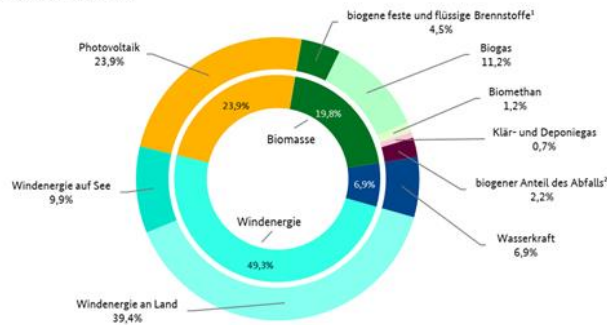
Heating & Cooling (H&C)

Transport



Bruttostromerzeugung aus erneuerbaren Energien in Deutschland im Jahr 2022

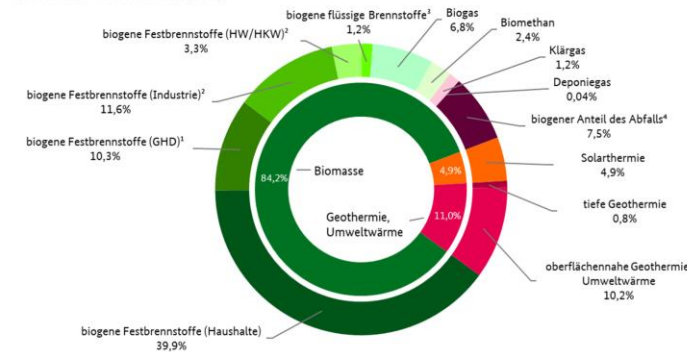
Gesamt: 254 Terawattstunden (TWh)



¹ inkl. Klärschlamm; ² biogener Anteil des Abfalls in Abfallverbrennungsanlagen mit 50 % angesetzt
Hinweis: Stromerzeugung aus Geothermie aufgrund sehr geringer Mengen (0,1%) nicht dargestellt
Quelle: Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Stand: Februar 2023

Endenergieverbrauch erneuerbarer Energien für Wärme und Kälte in Deutschland im Jahr 2022

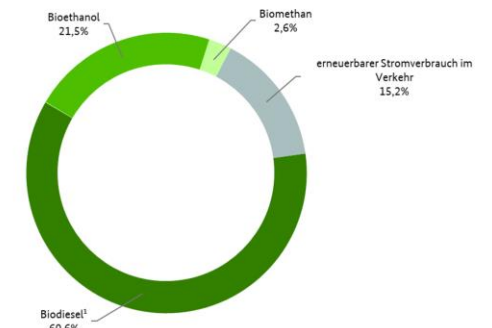
Gesamt: 200,5 Terawattstunden (TWh)



¹ GHD = Gewerbe, Handel, Dienstleistungen; ² inkl. Klärschlamm und Holzkohle; ³ inkl. Biokraftstoffverbrauch für Land- und Forstwirtschaft, Baugewerbe und Militär;
⁴ biogener Anteil des Abfalls in Abfallverbrennungsanlagen mit 50 % angesetzt
Quelle: Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Stand: Februar 2023

Endenergieverbrauch erneuerbarer Energien im Verkehrssektor in Deutschland im Jahr 2022

Gesamt: 40,4 Terawattstunden (TWh)



¹ Verbrauch von Biodiesel (inklusive HVO) im Verkehrssektor (ohne Land- und Forstwirtschaft, Baugewerbe und Militär)
Hinweis: Beitrag von Pflanzenöl (0,05%) aufgrund der geringen Menge nicht dargestellt
Quelle: Arbeitsgruppe Erneuerbare Energien-Statistik (AGEE-Stat); Stand: Februar 2023

- Overall RE-share in electricity production: 44% (254 TWh)
- Biomass (50 TWh) ranked 3rd:
 - share in total el. production: 9%
 - RE-share el. production: 20%
 - Most important: biogas: 5% / 11%

- Overall RE-share in final energy consumption H&C: 17% (201 TWh)
- Biomass (169 TWh) ranked 1st:
 - share in total H&C: 15%
 - RE-share: 84%
 - Most important: solid biomass in HH: 7% / 40%

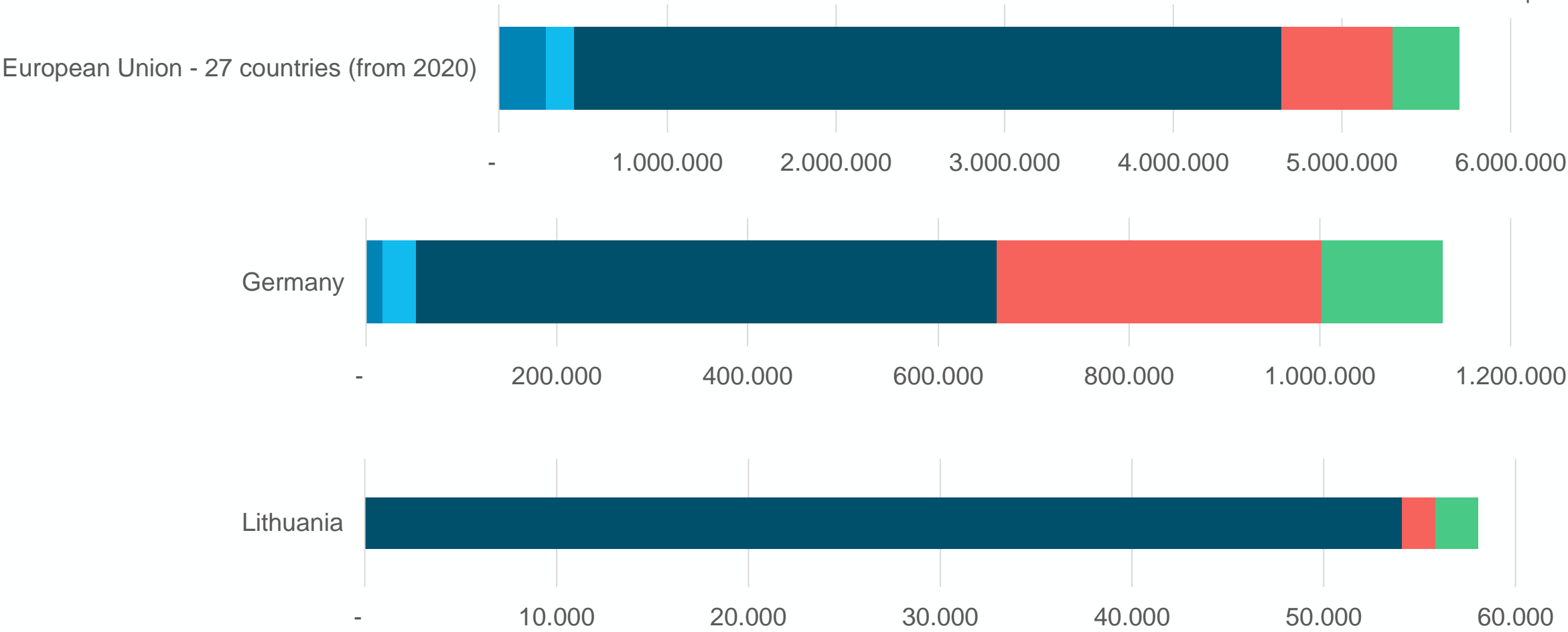
- Overall RE-share in final energy: 7% (40 TWh)
- Biomass (34 TWh) ranked 1st:
 - share in total: 6%
 - RE-share: 85%
 - Most important: biodiesel: 4% / 60%

Bioenergy in Europe, Germany and Lithuania: Share of energy from renewable sources [nrg_ind_ren]

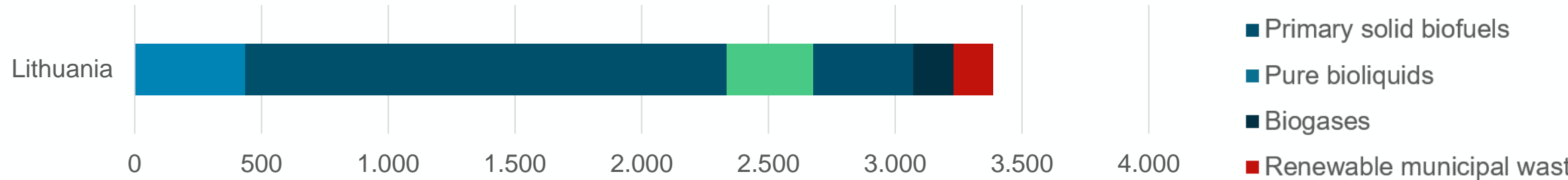
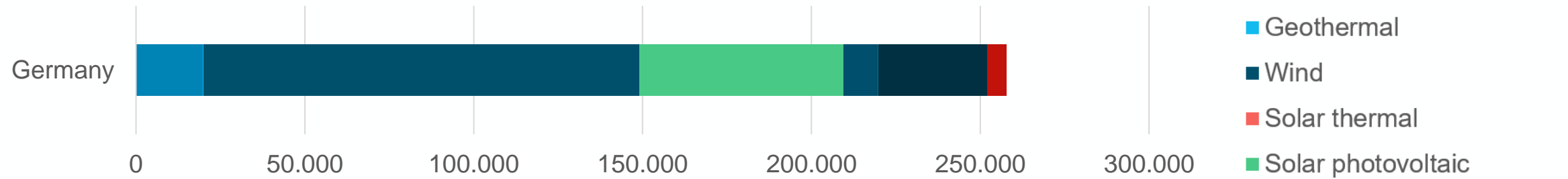
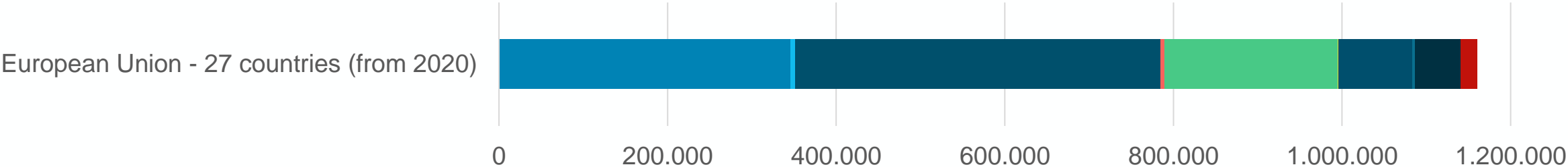
GEO (Labels)	European Union - 27 countries (from 2020)	Germany	Lithuania
Renewable energy sources	23,020	20,796	29,599
Renewable energy sources in transport	9,619	9,941	6,677
Renewable energy sources in electricity	41,174	47,637	26,461
Renewable energy sources in heating and cooling	24,811	17,485	51,540

Bioenergy in Europe, Germany and Lithuania: Supply, transformation and consumption of renewables and wastes [nrg_cb_rw] – inland consumption in terajoule

- Geothermal
- Solar thermal
- Primary solid biofuels
- Biogases
- Renewable municipal waste



**Bioenergy in Europe, Germany and Lithuania:
 Use of renewables for electricity - details [nrg_ind_ured] - Gross electricity production -
 Renewable Energy Directive , Gigawatthour**



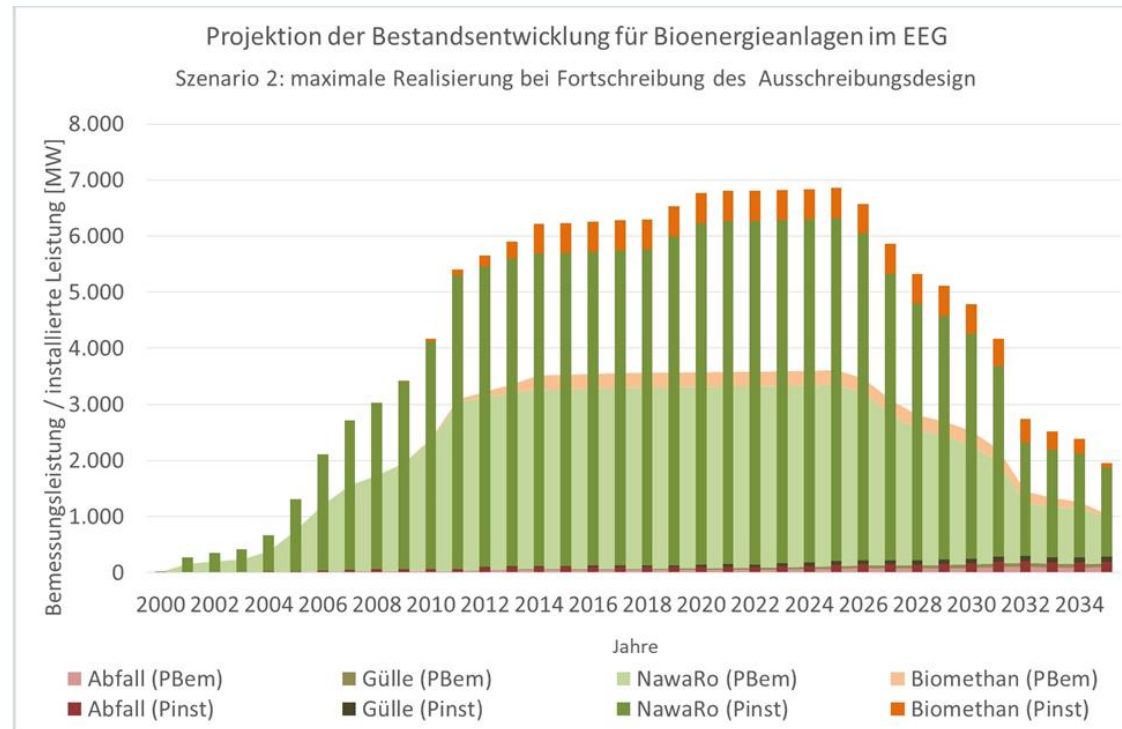
- Hydro
- Geothermal
- Wind
- Solar thermal
- Solar photovoltaic
- Tide, wave, ocean
- Primary solid biofuels
- Pure bioliquids
- Biogases
- Renewable municipal waste

Biomass in energy & beyond

- Energy
 - Large shares in renewable electricity (20%), heat (84%) and transport (84%) in 2022
 - System services in electricity: flexible production to back up wind & solar PV; balancing power
 - Biogas capacities as substitute to natural gas capacities
- Beyond Energy (when incentives are in place)
 - system service: nature conservation, residue disposal
 - further services in agriculture and forestry
- Regulation: dependences on regulatory context / societal consensus about bioenergy
 - Business areas & system services need to be economically viable
 - Reliable and sufficiently high CO₂-price path (specific German context: better FIT conditions)
 - Bioenergy considered expensive compared to wind and solar PV but provides additional services

German Regulation & 2nd Phase of Bioenergy Financing: TRANSBIO

- German Feed-In-Tariff (FIT, aka „EEG“) for 20 years
- 2005-2010: strong increase in (mainly agricultural) biogas capacities, feeding electricity into the grid
- Today: EEG runs out (aka „Post-EEG-Question“)
- 2015-2022 number of „larger“ studies: new business cases, new products, necessary political conditions ...
- Project TRANSBIO (2021-2024): the future of Bioenergy
 - Operator’s view: what to do after 20 years?
 - Systemic view: What it’s role in GHG neutrality?
- TRANSBIO’s task
 - synthesis of the different studies -> e.g. „Synopsis“
 - communication to stakeholders (operators, politics, energy business) -> e.g. „Delphi survey“



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Methodical Background

Oracle of Delphi



Quelle: picture-alliance/dpa über BR.de

Origin

- Operations Research, 1953: oral Delphi Befragungs-surveys, military purposes
- Today: written or online surveys

Delphi-Methode

- „The Delphi method, a form of expert survey, evaluates the answers of the individually interviewed experts and then sends them the aggregated results (usually anonymously). Anyone who repeats this process several times [...] will ultimately receive a common judgment from all experts [...].“ (Kornmeier 2021, p. 74)

Delphi survey: approach & procedure

Comparative survey

- between energy and bioenergy experts .
- “Role of bioenergy (biogas & solid biomass) on the path to GHG neutrality”

Three energy system-related topics:

- electricity system,
- heat system,
- gas & fuel market

Three overarching topics:

- Agriculture,
- solid biomass / forestry,
- biogenic residues and waste materials

February 2022

- First Dialogue forum: Development of questions through focus group interviews

April 2022

- 1st round of survey under PWG

Juni 2022

- 2nd round of survey under PAG

September 2022

- 3rd round with larger group of experts

Januar 2023

- Final survey to validate results

Delphi survey: results on energy system related topics

Most validated statements

Electricity

- Flexibility,
- power reserve for fluctuating renewables

Gas

- Limited capacity
- Multifunctional in energy and material use

Heat

- Process heat
- Security of supply
- Sector coupling

Differences between groups

Electricity

- Bioenergy experts see more chances and less shortages

Gas

- Energy experts see priority of material use
- Bioenergy experts see chance of seasonal storage

Heat

- Bioenergy experts see regional added value
- Energy experts fear inefficient use

Delphi-survey: overarching topics

Agriculture topic area

- Multifunctionality (GHG reduction, fertilizer production)
- Vulnerability (climate change risks)

Topic area solid biomass / forestry

- Necessary reliable certification
- Value of woody biomass as a carbon sink & as a building material (replacement of CO₂-intensive building materials)

topic area biogenic residues and waste materials

- Energetic use of biogenic residues and waste materials
- Lack of legal clarity. Regulations on energy use

Delphi survey: research & communication needs, conclusion

- Research needs
 - Interdependencies between sectors (e.g. energy-material), competition for use
 - Seasonal electricity generation, natural gas infrastructure, GHG reduction in agriculture.
 - Residue potential, evaluation of certification systems
- Communication needs
 - Technological differentiation (e.g. size classes), differentiation of wood import & use vs. use of domestic wood
 - Importance of high energy densities
 - Complexity, terminology, definitions & practice-relevant core messages
- Conclusion
 - Consensus among energy and bioenergy experts on key aspects of the survey
 - Lack of consistent, transparent, long-term legal standards
 - Lack of basic understanding of complex relationships in politics and media

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TRANSBIO, Delphi & overall conclusions for regulation

- Regulatory & general issues
 - „Strategically preserve“ capacities (once built under FIT) for RE-production & lowering system costs
 - Better incentives for flexibility
 - Different business areas have different infrastructural prerequisites (gas & heat networks)
- GHG-reduction: better incentives, esp. for biomethane (promotion of pooling and others)
- Specific recommendations for specific business areas
 - Abandonment of regulatory barriers
 - Some regulatory frameworks for innovative business models do not exist yet
- General business environment: too low power & heat prices (despite recent turbulences) due to low CO₂-Prices

TRANSBIO, Delphi & overall conclusions for operators

- First of all: large differences between plants, individual solutions & early planning necessary
- General Strategy I: If possible, stay with electricity and heat production (CHP) & German second phase FIT
 - Usually requires investments in higher capacity (depending on plant & region) for more flexible electricity production and different mix of feedstock (more residues, less crops)
 - important: better usage / marketing of heat
 - FIT as base income; additional income from power (spot, balancing power) and heat
- General Strategy II: Switch to biomethane, esp. If chances for strategy I are low
 - single plant or pooling of several (economies of scale); injection into gas grid or gas station
 - Also dependent on local circumstances (topography, proximity to gas grid)
 - Income: partly (very) dependent on regulation
 - Revenues from selling biomethane (grid or gas station)
 - Additional revenues: different GHG reductions from different feedstocks

Literature

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- BMWK/AGEEStat 2023: Zeitreihen zur Entwicklung der Erneuerbaren Energien in Deutschland, Stand: Februar 2023
- Dotzauer et al. 2021: BE20plus, Schlussbericht. DEBFZ, IER, IZES, Next Kraftwerke, Uni Hohenheim, UFZ
- Matschoss et al. 2019: MakroBiogas, Endbericht, DEBFZ, IZES, UFZ
- Matschoss & Wern 2022: Welchen Beitrag kann Bioenergie zur Treibhausgasneutralität leisten? – ein Transfer- und Kommunikationsprojekt. Energiewirtschaftliche Tagesfragen 72, Jg. 2022, Heft 6, S. 34-5;
https://www.researchgate.net/publication/361261057_Welchen_Beitrag_kann_Bioenergie_zur_Treibhausgasneutralitaet_leisten_-_Transbio_ein_Transfer-und_Kommunikationsprojekt
- Matschoss, Gapp-Schmeling & Wern 2024: Der Beitrag der Bioenergie zur Treibhausgasneutralität – Umfrageergebnisse des TRANSBIO-Projekts. Energiewirtschaftliche Tagesfragen 74, Jg. 2024, Heft 1-2, S. 65-8;
https://www.researchgate.net/publication/378100026_Der_Beitrag_der_Bioenergie_zur_Treibhausgasneutralitaet_-_Umfrageergebnisse_des_TRANSBIO-Projekts
- TRANSBIO-Projekt: <https://www.dbfz.de/transbio>

Thank you for your attention!

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Transbio – Transfer working group for bioenergy systems in the future energy system

- Project partners: university of Stuttgart (IER), DBFZ, KTBL
- From 2021 until 2024
- Funded by FNR, German federal ministry of agriculture
- Central question: What could be the function of bioenergy in the future energy system?
- Methods: Scenario analysis, content analysis of studies, new databases, Delphy analysis of different stakeholders
- Results:

database for scientists and politicians <https://datalab.dbfz.de/befuture/>

database for operators of biogas installation <https://www.zukunftbiogas.de/>

further publications <https://www.izes.de/de/projekte/transbio>

