

# IEA Workshop – Biogas Sustainability Governance and Stakeholders

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IEA Workshop, 18-19.05.2017, Gothenburg



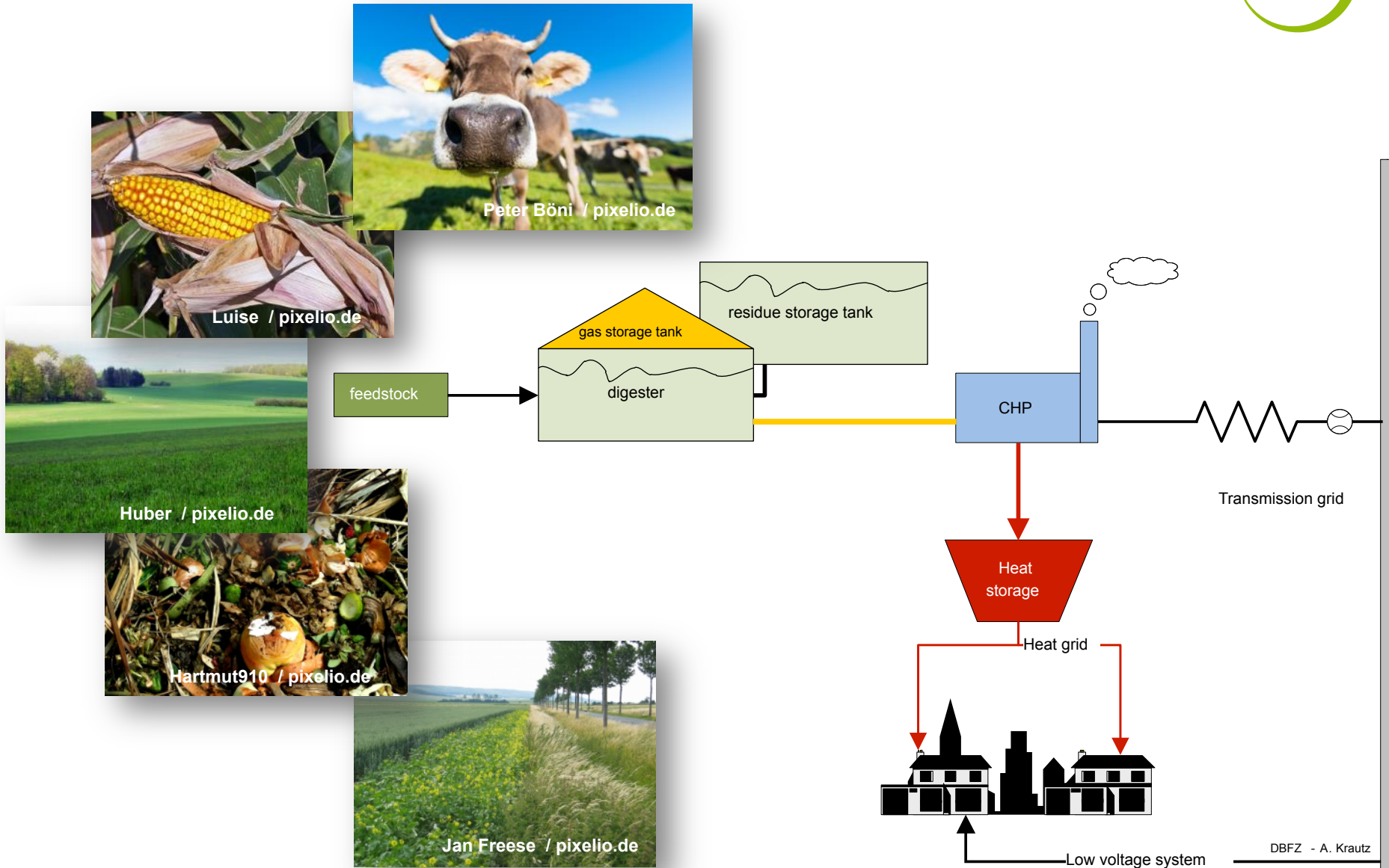
# Biogas Cases for O2 and O3 - Approach

- As Germany has a well advanced biogas sector, not a single plant is analyzed but the sector in general with two showcases
- The same situation analysis is used for O2 and O3
- The Danish biogas sector is also included as show case
- Additional countries are envisaged to be included (e.g. The Netherlands, UK and Italy)
- Master thesis in progress for support of the work





# What's Biogas again?



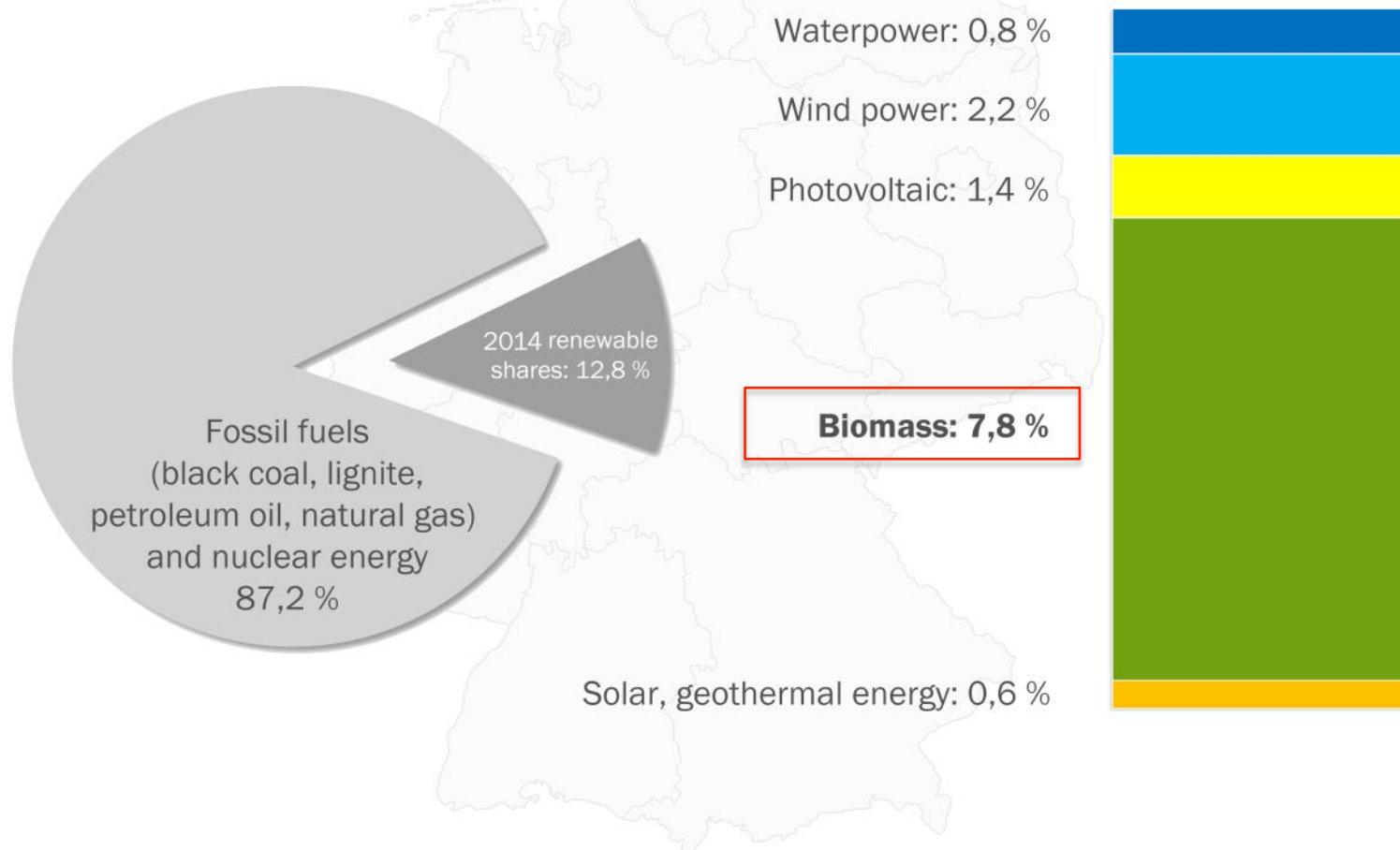


# Case Study Germany – Biogas Sector



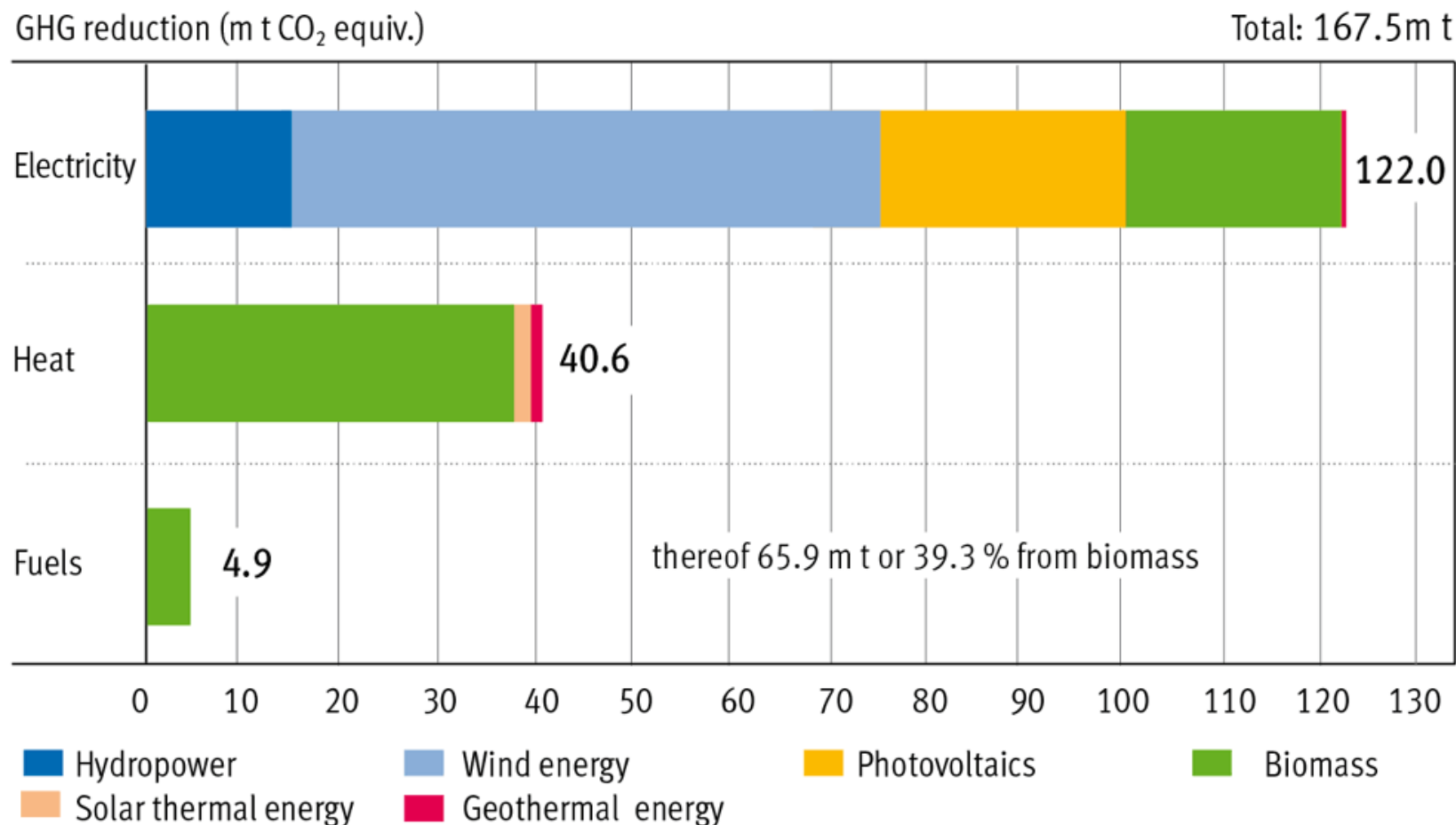
# Biomass in the national energy system

## Share of renewable energies in final energy consumption in 2014





# GHG reduction through bioenergy



GHG: Greenhouse gas

Source: BMWi, AGEE-Stat (February 2016)

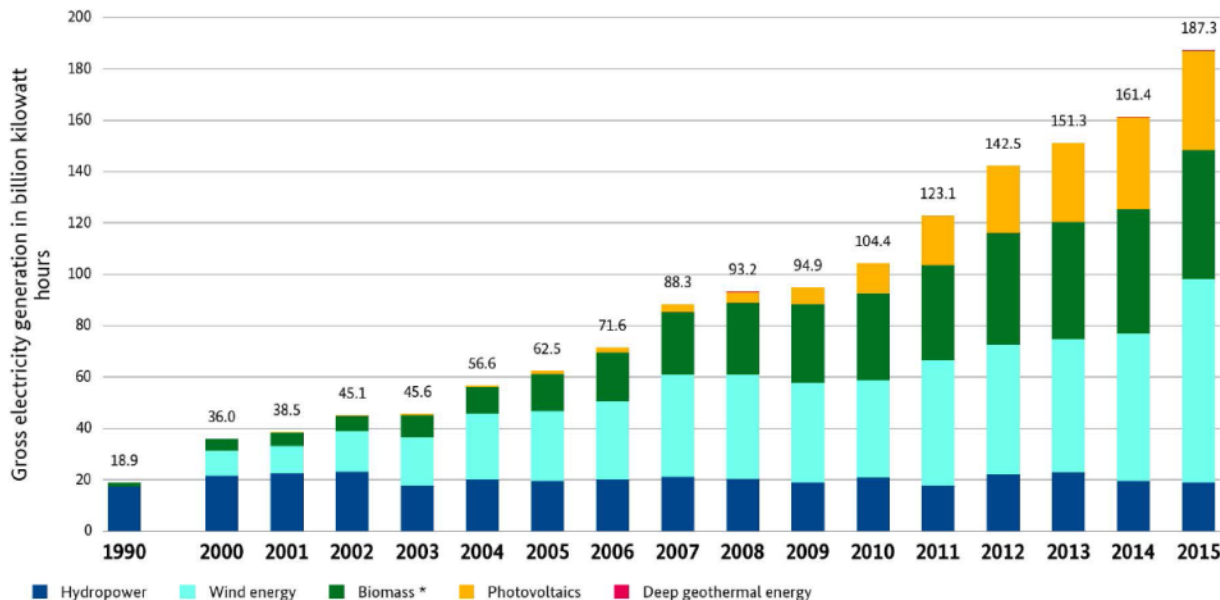
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# Development of Renewable Power



Development of renewables-based electricity generation 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 August 2016; all figures provisional

Renewable share of gross electricity consumption was 31.6 % in 2015.  
→ > 80 % in 2050

More than 25 % of renewable electricity generation from biomass (2/3 biogas).

Source: Development of renewable energy sources in Germany 2015 (BMWi, AGEE-Stat).



# The development of biogas plants in Germany

EEG 2000

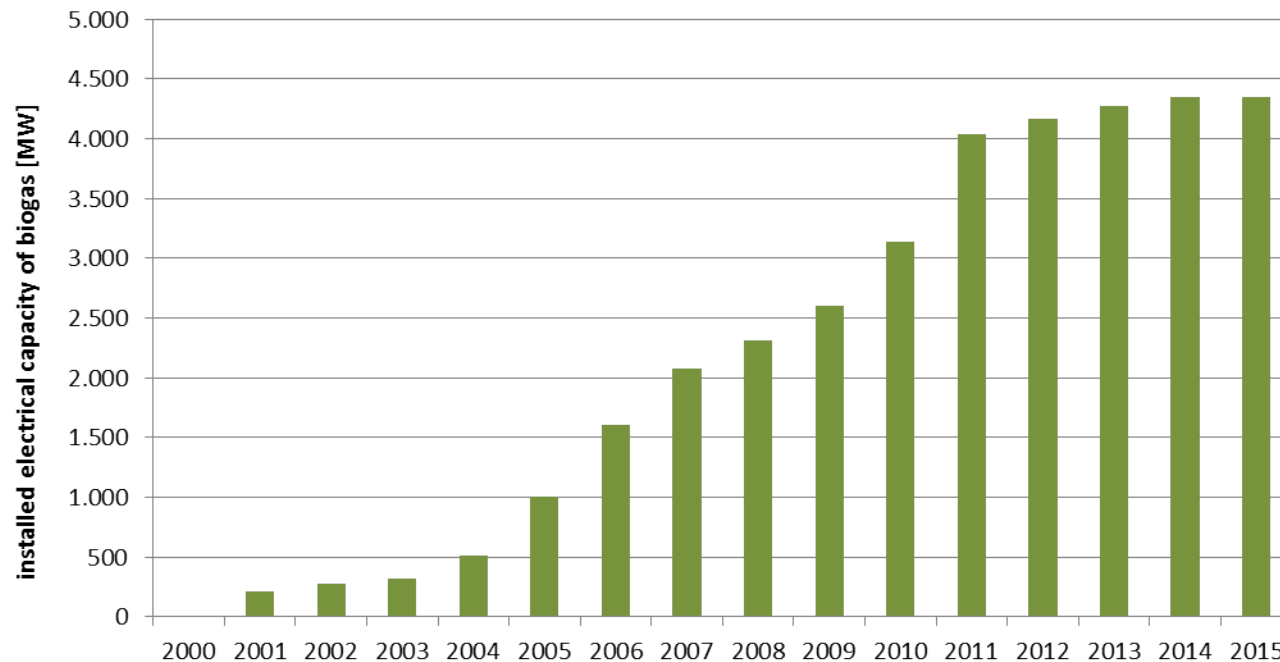
EEG 2004

EEG 2009

EEG 2012

EEG 2014

EEG 2017



?

What is the optimal capacity of biogas plants?

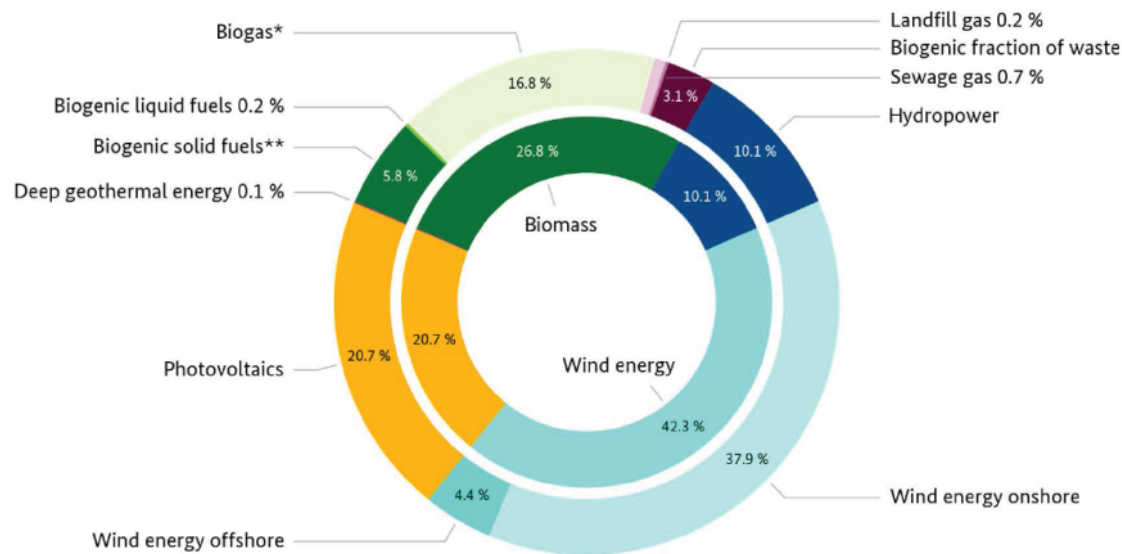
Source: DBFZ (2016)



# From Built-up to Transition – New Tasks

## Renewables-based electricity generation in Germany 2015

Total: 187.3 billion kilowatt hours



Two thirds of renewable electricity generation is from (intermittent) photovoltaic and wind power plants.

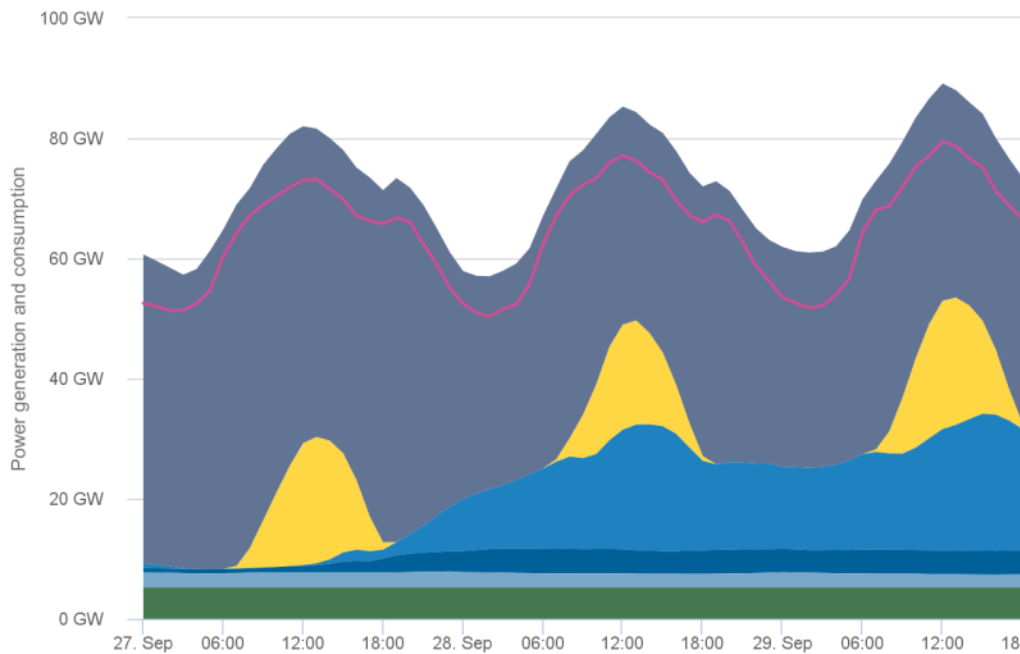
Biogas is the most important controllable renewable energy source.

\* incl. biomethane, \*\* incl. sewage sludge; BMWi based on Working Group on Renewable Energy-Statistics (AGEE-Stat); as at August 2016; all figures provisional

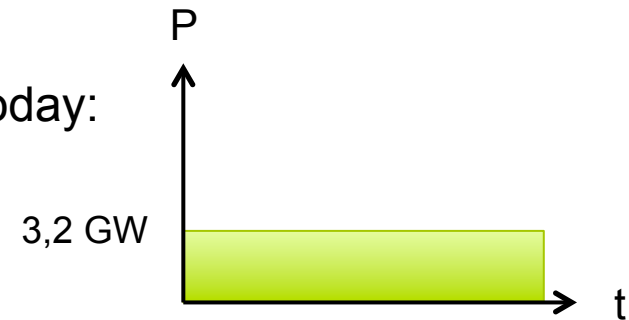
Source: Development of renewable energy sources in Germany 2015 (BMWi, AGEE-Stat).



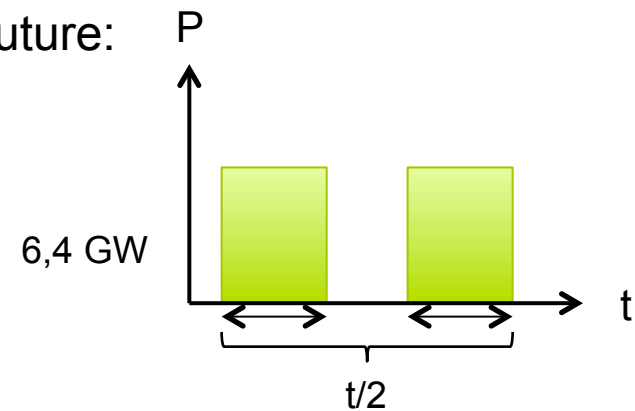
# Biogas Plants Market Integration



Today:



Future:



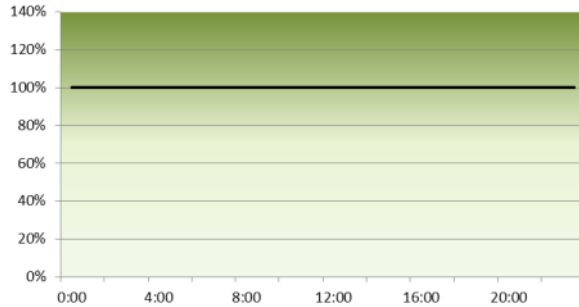
Conventional power plants Series 3 Solar Wind Onshore Wind Offshore Water Biomass Electricity Consumption Estimated Electricity Consumption  
 Hard coal Lignite Nuclear Pumped hydro Natural gas Other

Agora Energiewende; Current to: 25.10.2016, 09:45

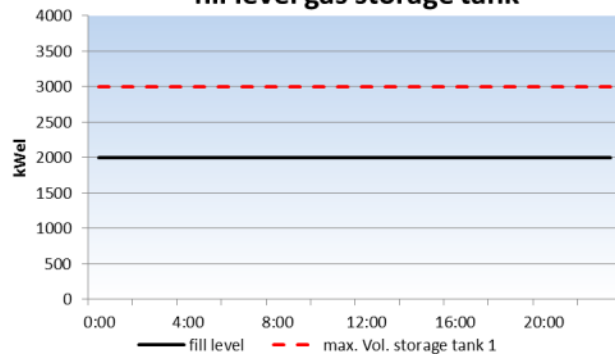


# Traditional Biogas Systems

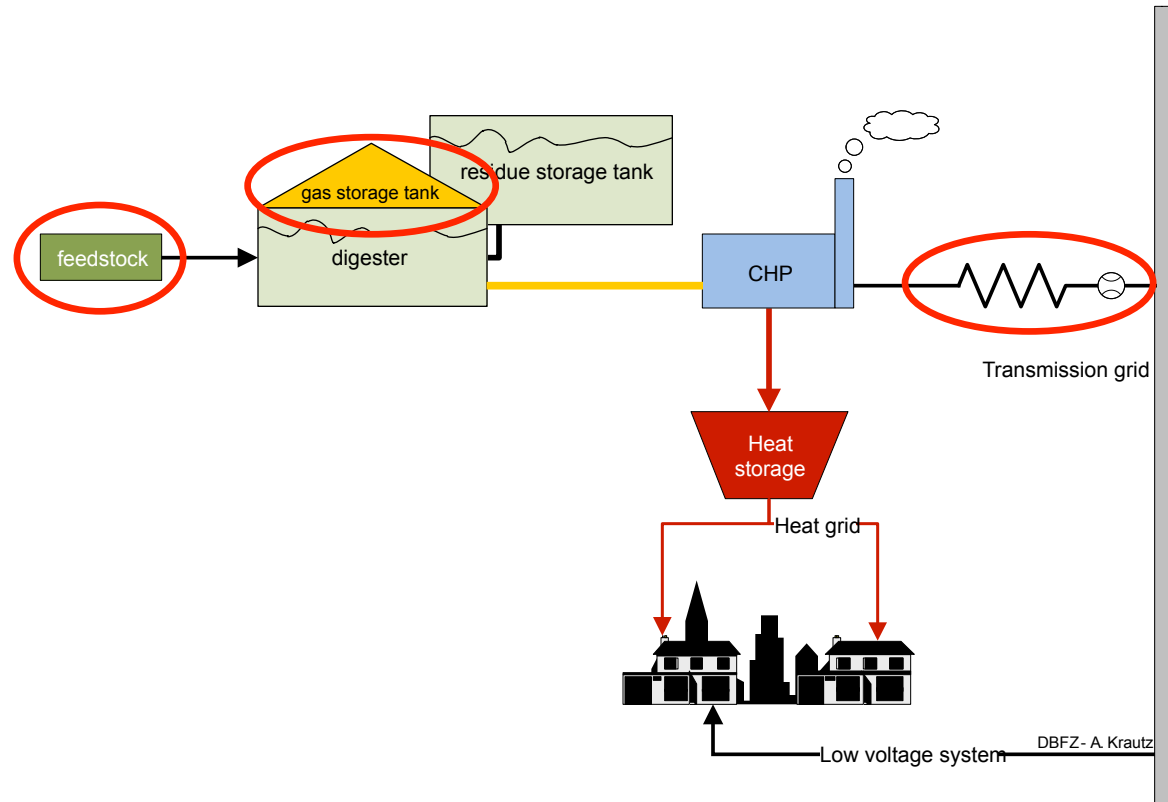
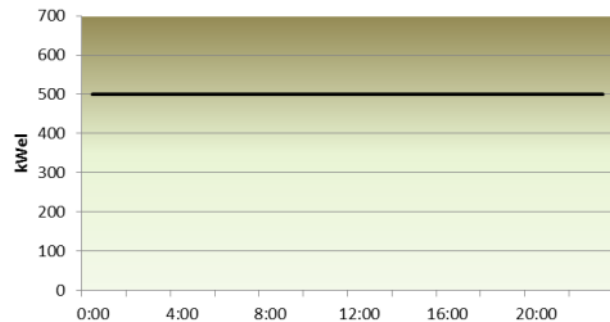
Feeding



fill level gas storage tank



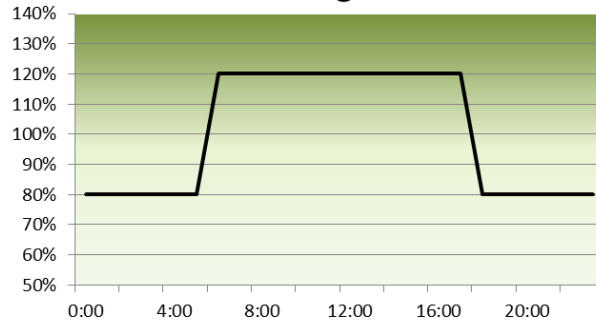
Feed-in



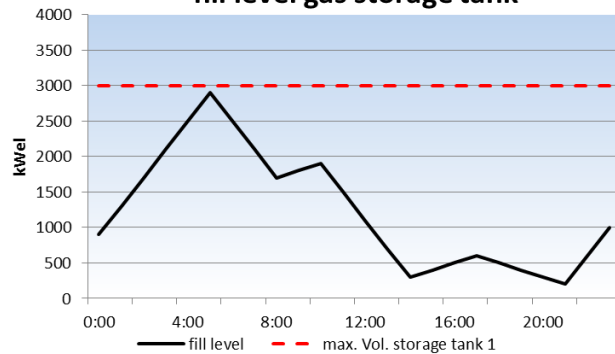


# Flexible Biogas System – Feed Management

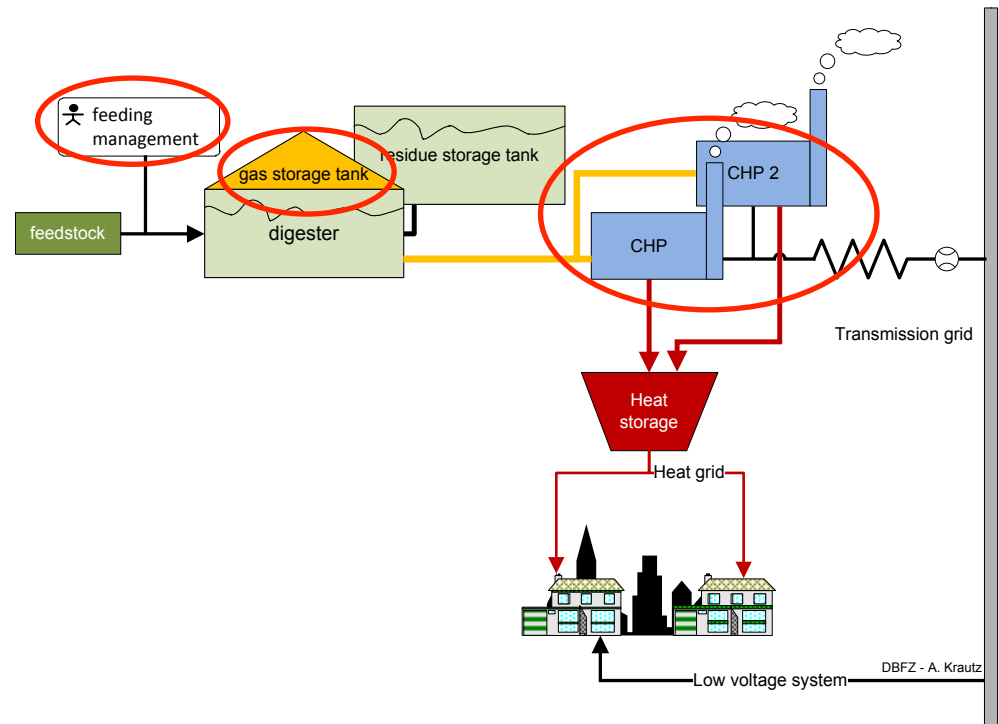
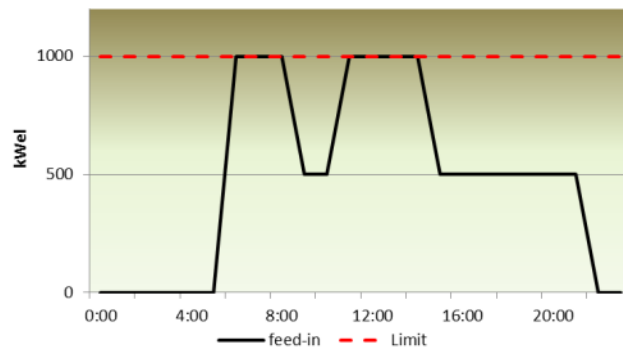
feeding



fill level gas storage tank

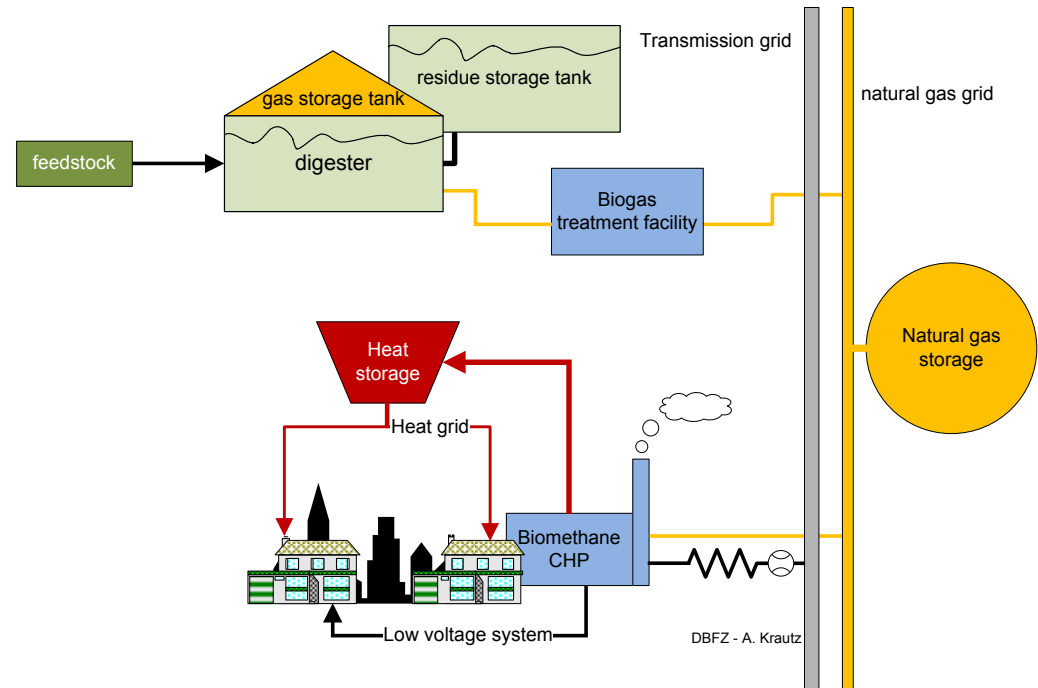
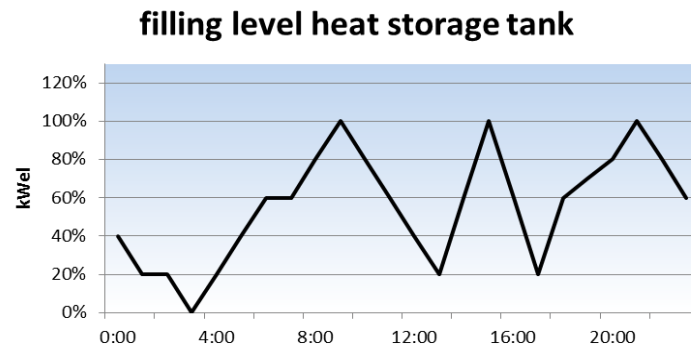
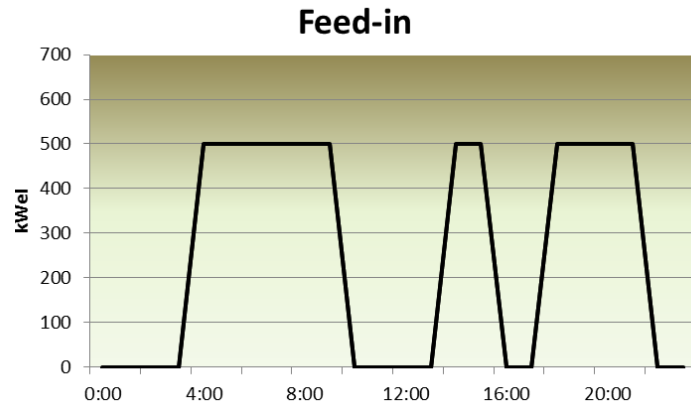


feed-in





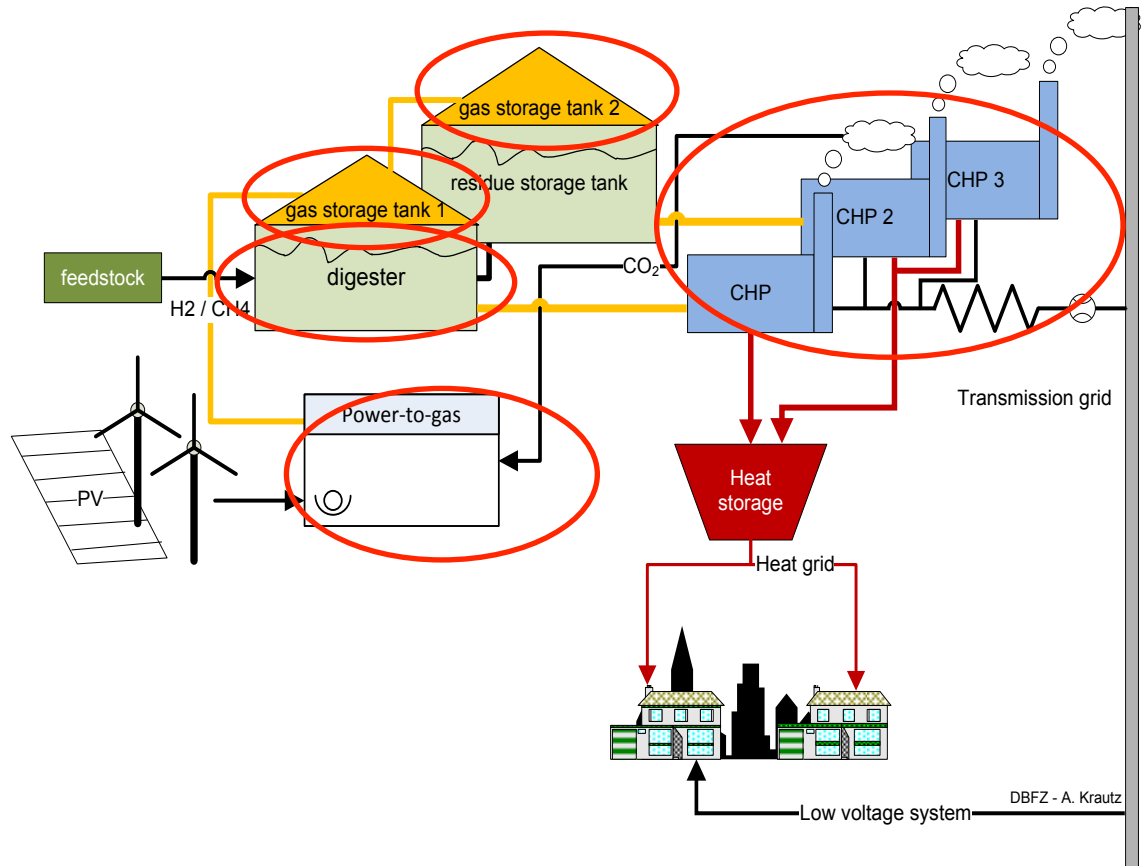
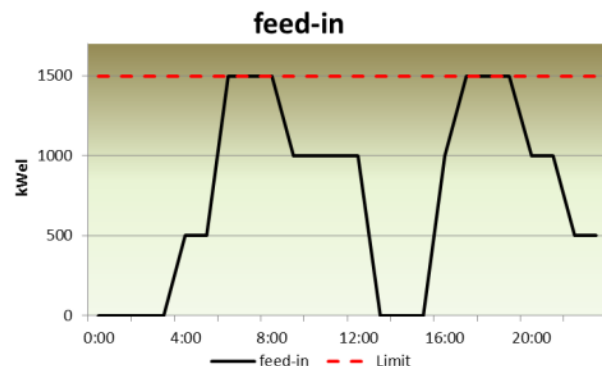
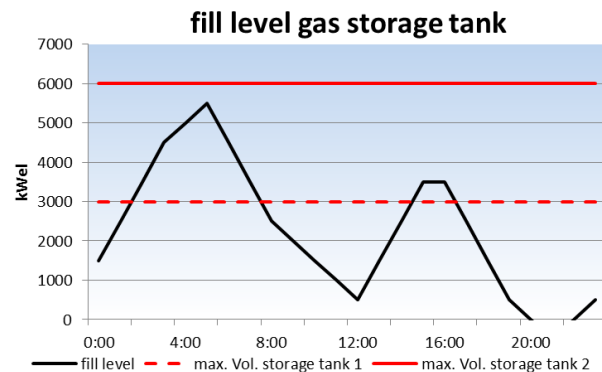
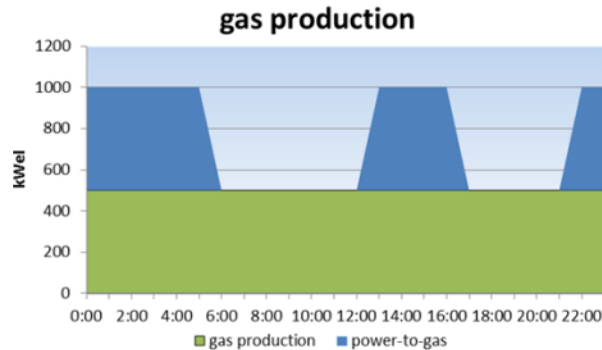
# Flexible Biogas System - Grid injection of biomethane



- Normal operation – heat demand controlled
- Natural gas grid - long term storage



# Flexible Biogas System – Combination with Power-to-Gas





# Biomass in the German energy system

## Focus: waste and residues

Biomass potentials from Waste and residues  
And their actual use – Status quo in Germany  
77 Single biomasses have been considered  
*Time references are not uniform*

**151.1 Mio. t DM** Theoretical potential

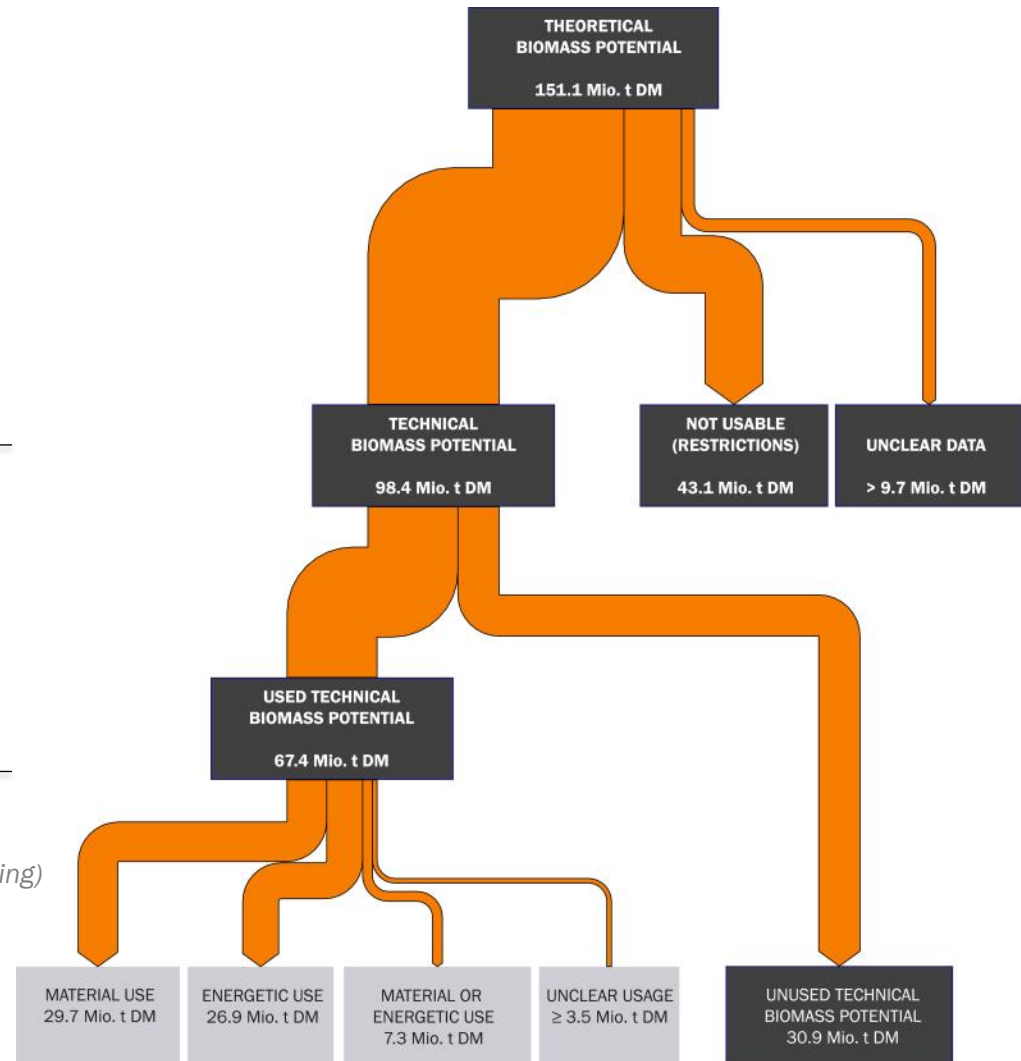
- 43.1 Mio. t DM Not usable (Restriction)
- 9.7 Mio. t DM Unclear data

**= 98.4 Mio. t DM** Technical potential

- 29.7 Mio. t DM Material use
- 26.9 Mio. t DM Energetic use
- 7.3 Mio. t DM Material or energetic use
- 3.5 Mio. t DM Unclear usage

**= 30.9 Mio. t TS** Unused potential

*(Discrepancies due to rounding)*



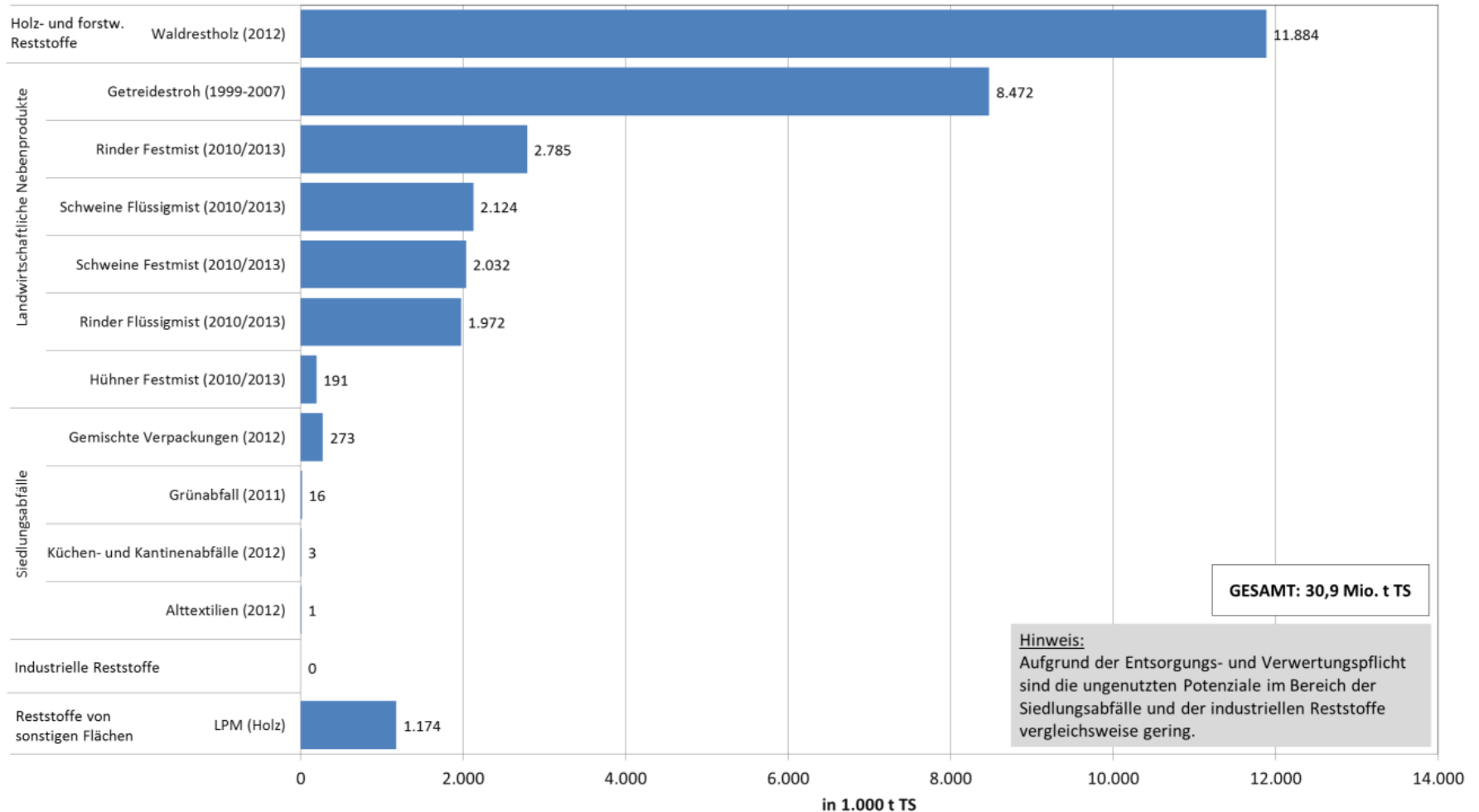


# Unused Potentials in Detail

## UNGENUTZTE TECHNISCHE BIOMASSE-RESTSTOFFPOTENZIALE IN DEUTSCHLAND

Gesamtübersicht

Zeitbezüge nicht einheitlich





# German Biogas Sector – Governing Sustainability

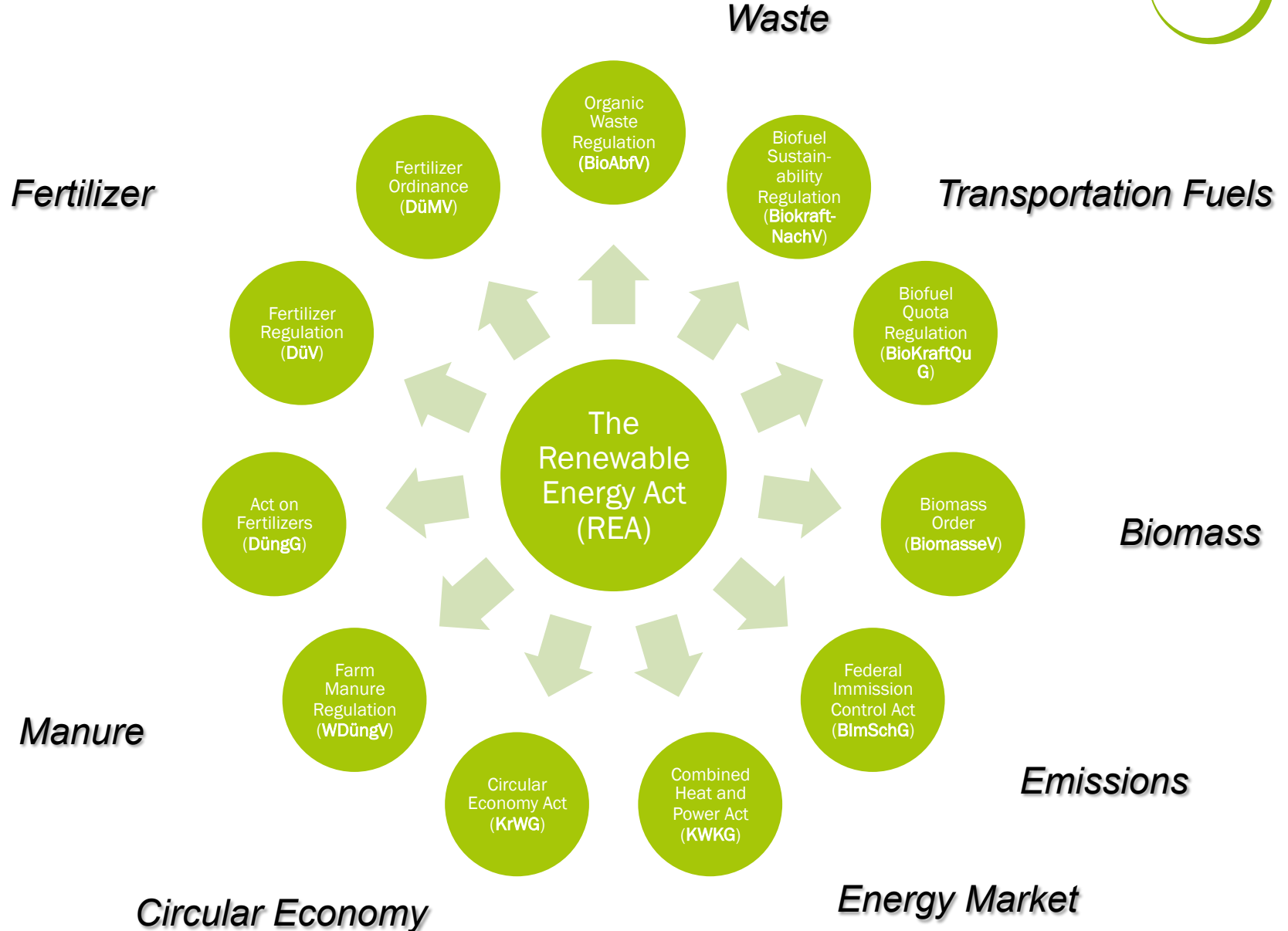


- Development of biogas sector in Germany is described
- Two representative show cases are elaborated, including the effects of market and framework development, especially the REA (EEG)
  - Agricultural plant processing manure and corn to produce power and heat (CHP, 500 kW<sub>el</sub>)
  - Municipal plant, processing organic waste to produce biomethane to mainly fuel vehicles
- Analysis of 12 laws and regulations, including REA, which affect the sustainability of the biogas sector along the value chains up to final products of power, heat and transportation fuel



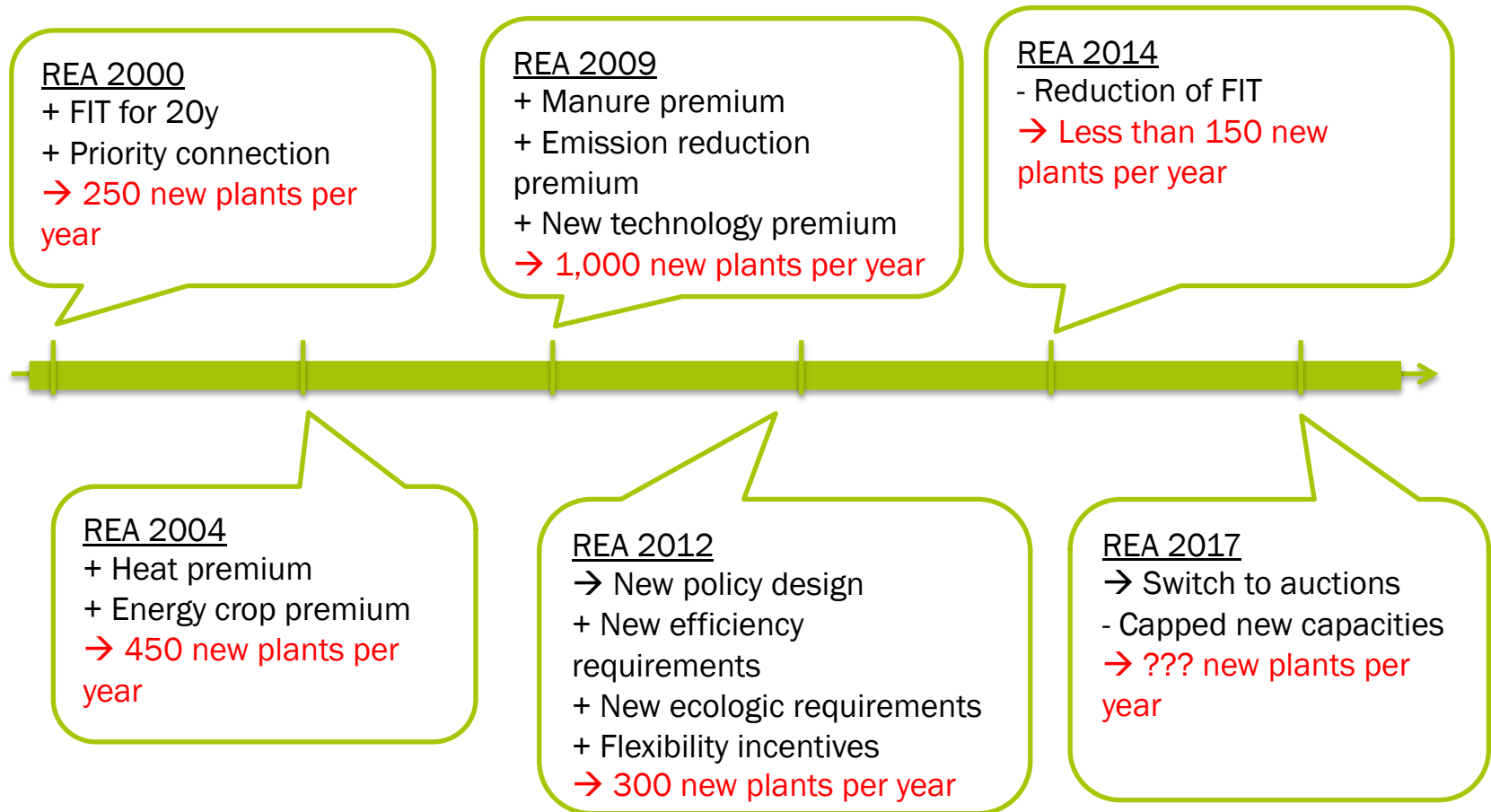


# The regulatory plethora





# The Renewable Energy Act (REA)



Source: DBFZ, based on German Biogas Association, Dr. Stefan Rauh



# REA 2017 details for biogas auction



- Joint tendering for existing and new plants.
- All bioenergy power plants >150 kW are required to participate in tenders.
- No distinction between installed capacity, feedstocks etc.

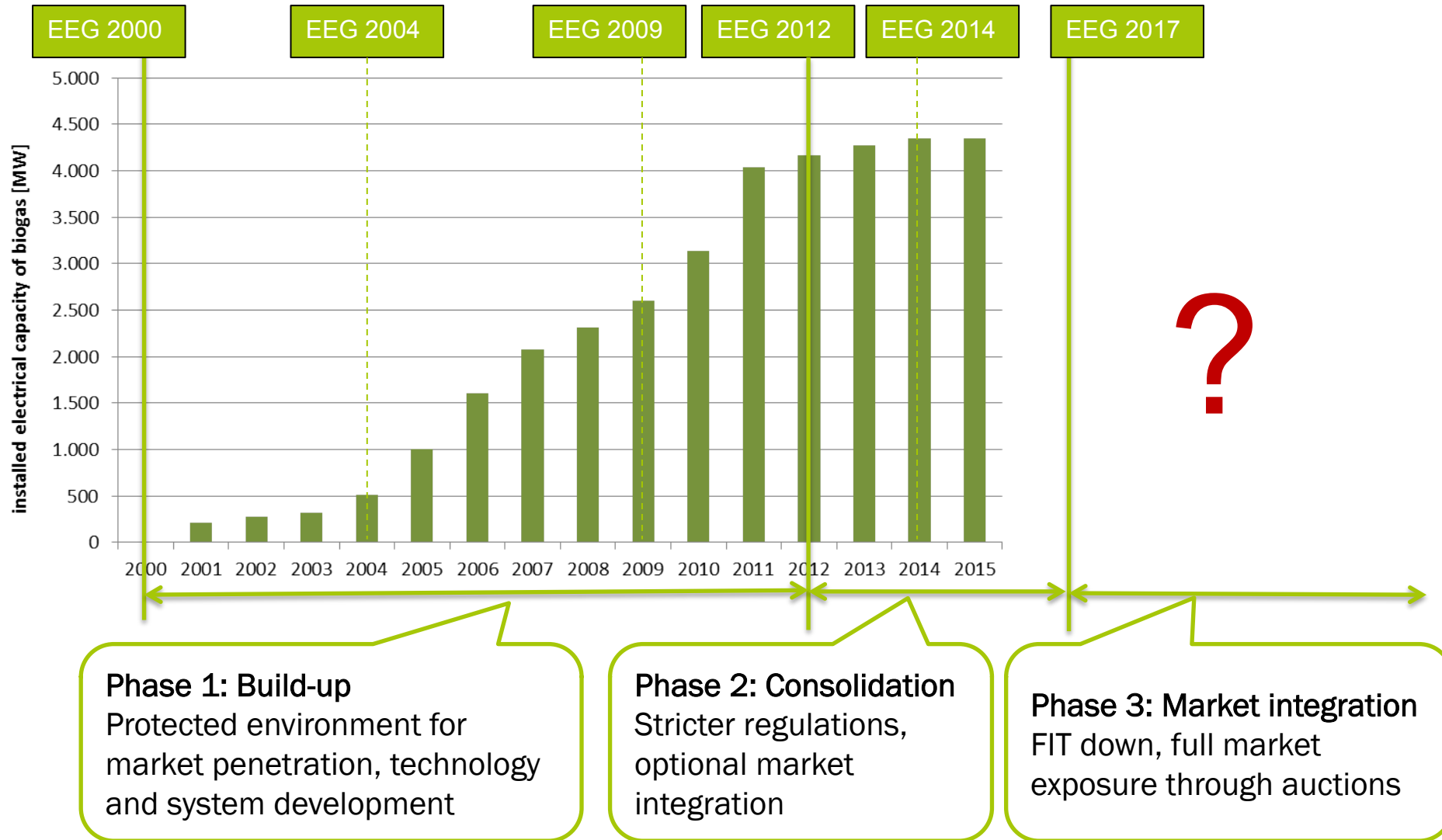
## Maximum bid limits

Existing plants: 16,9 ct/kWh, 10 years of remuneration

New plants: 14,88 ct/kWh, 20 years of remuneration

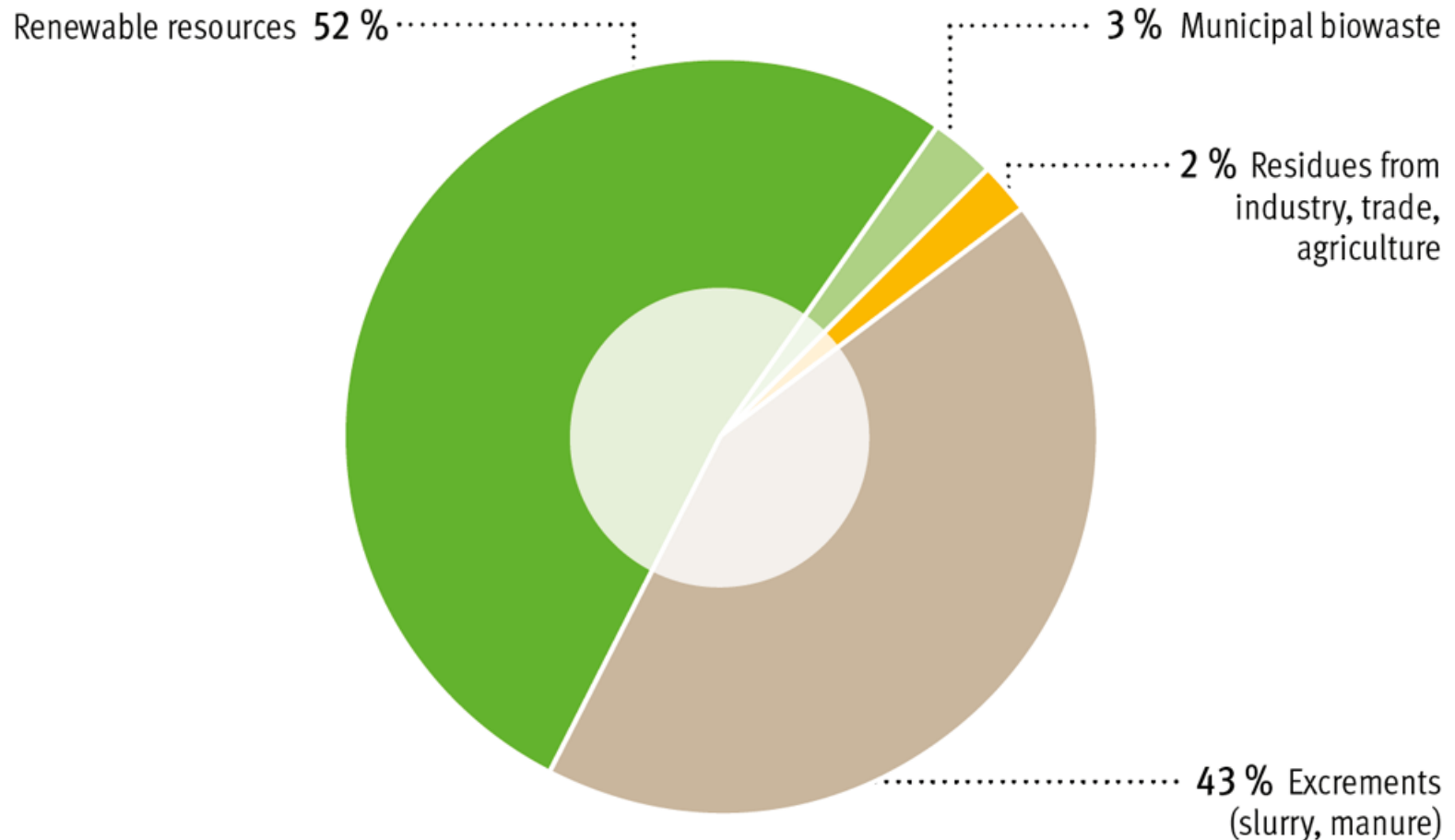


# Market Phases in Relation with REA (EEG)



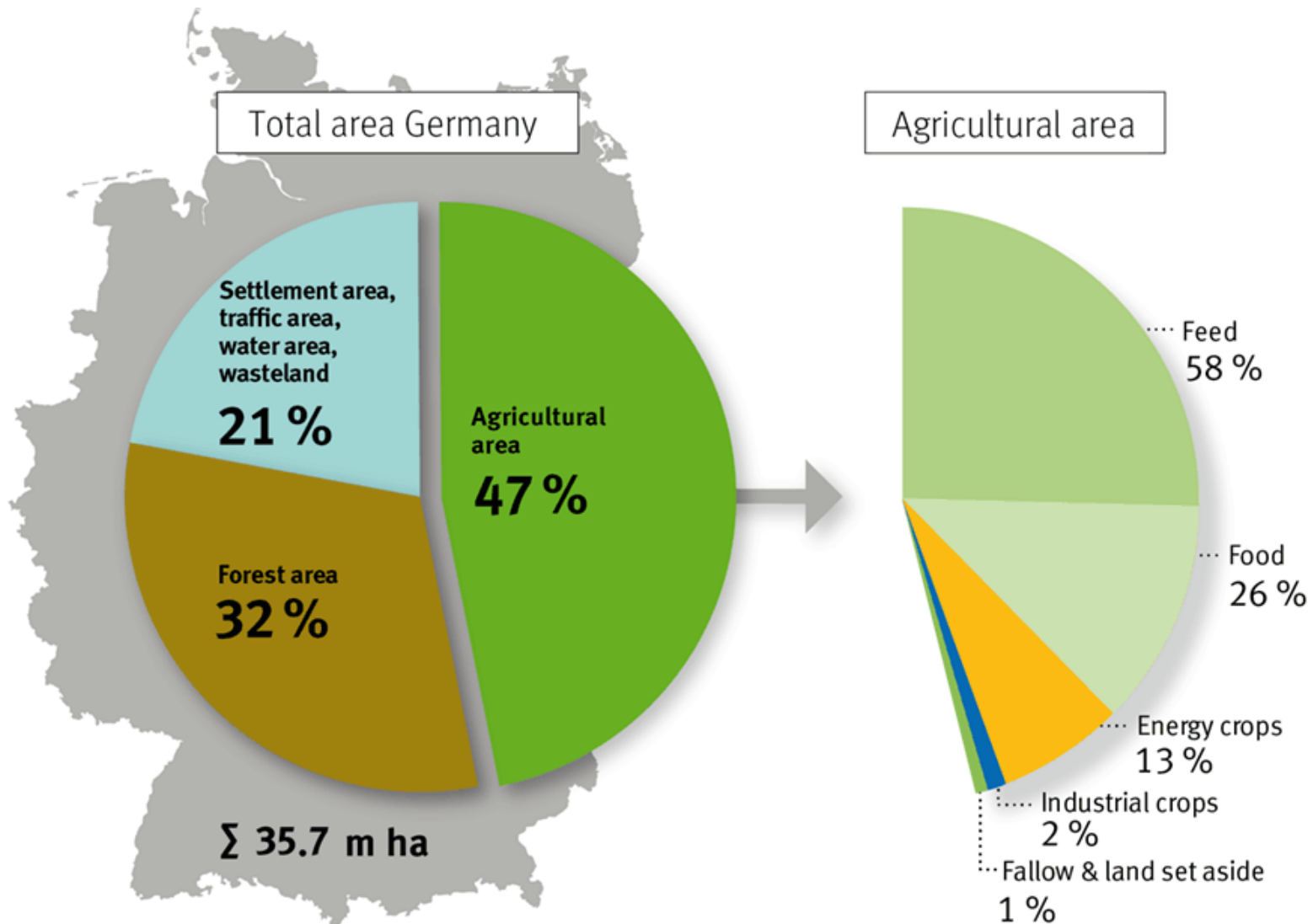


# Average substrates use in Germany (mass based)





# Land Usage in Germany

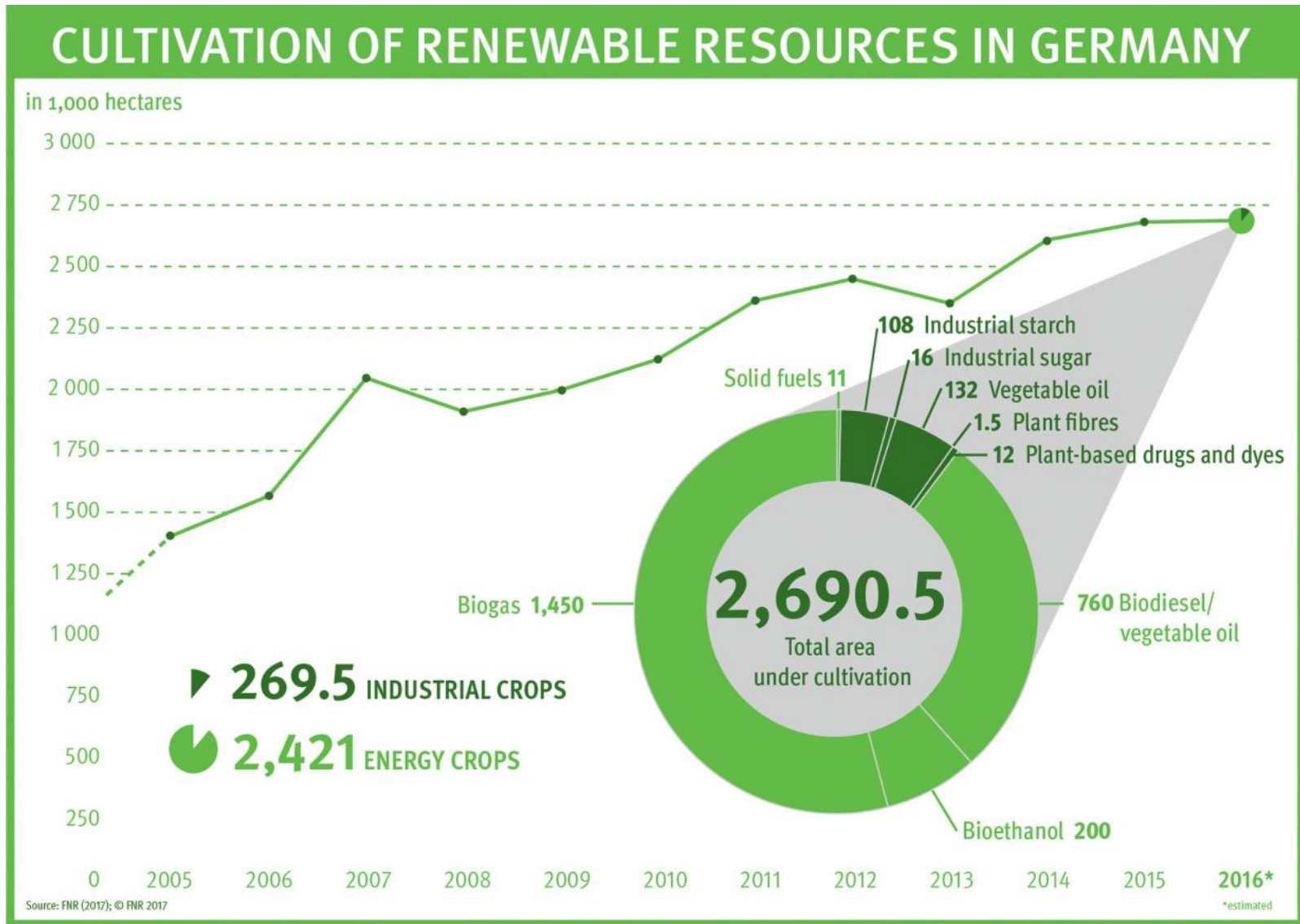


Source: FNR based on Statistisches Bundesamt, BMEL (2015)

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# Effects on land use

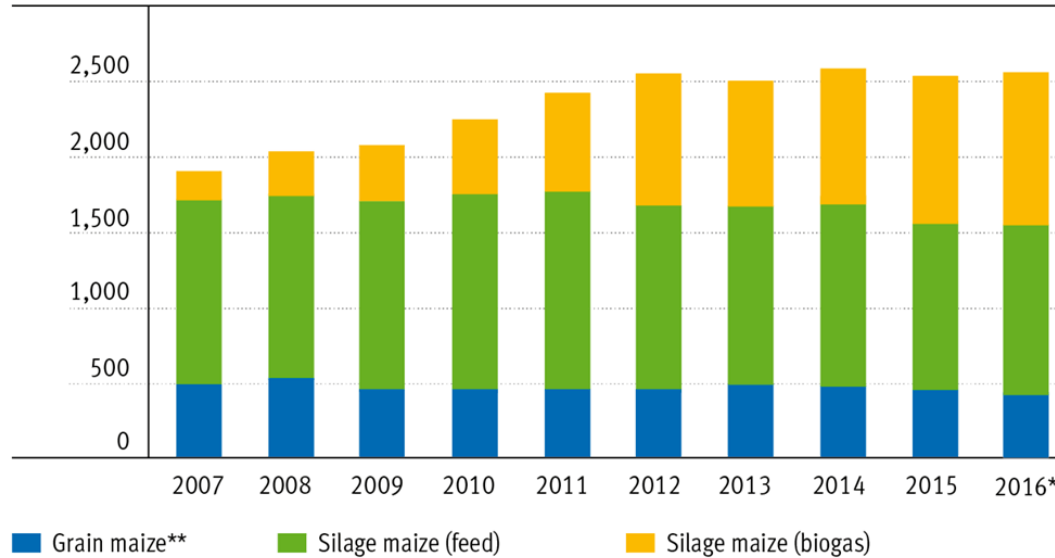




# Effects on Maize cultivation



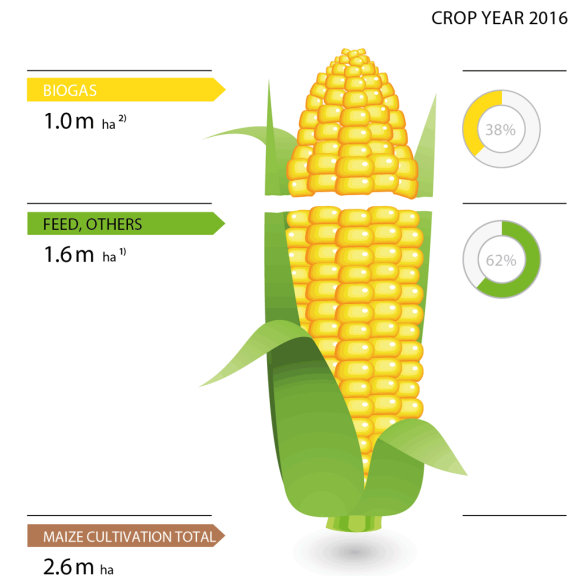
in 1,000 hectare



\* outlook; \*\* approx. 85 % feed, 6 % industry (starch), 5 % energy (ethanol), 3 % losses, 1 % seed

Source: FNR according Stat. Bundesamt, AFC, DMK

© FNR 2017

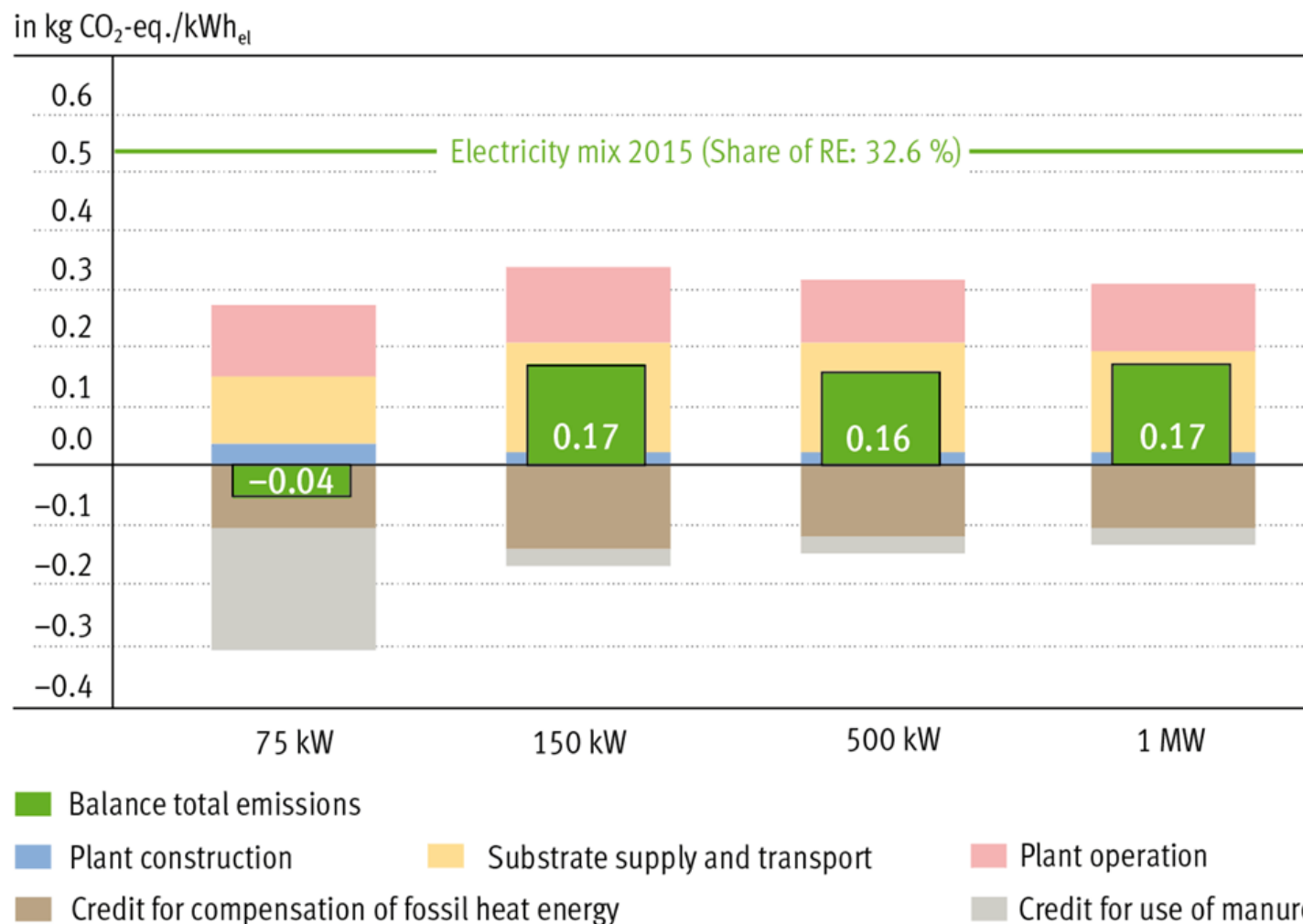


Source: \*Statistisches Bundesamt (2017), \*\*DMK, FNR e. V.

© 2017



# GHG emissions compared to power average



Source: KTBL (2011), UBA, AGEE-Stat (2016)

© FNR 2016



# Next steps analysis of sustainability governance for biogas in Germany



- Feedback from other case studies, O1 and stakeholder from this meeting on relevant and measurable sustainability issues
- Agreement within group on sustainability criteria to ensure comparability
- Deeper Analysis of Sustainability Governance on agreed aspects using showcases
- Aspects:
  - Drafting of laws with commenting of stakeholders
  - Constant monitoring on effects of regulation
  - Other known unknowns and unknown unknowns of perception



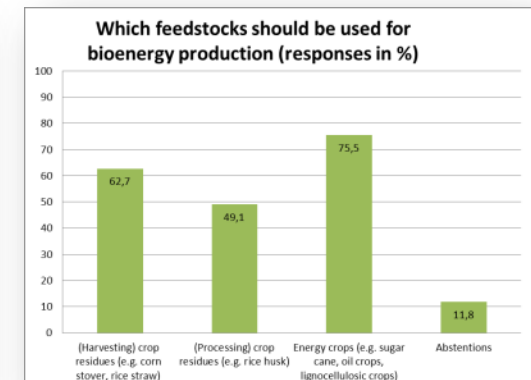
# German Biogas Sector – Stakeholder Analysis



# Biogas in O3: Stakeholder analysis



- Literature review in progress (continuous task)
- Collection of stakeholders commenting on laws and regulation drafts
- A questionnaire has been sent out to 743 out of ~ 8000 biogas plant operators – 110 replies (15%), further stakeholders mentioned
- Online survey prepared, to be sent out after stakeholder workshop
- Danish version planned for second half of 2017





# DBFZ Monitoring Report

## Results from the Biogas Survey 2015



- Germany has 7703 on-site conversion biogas plants with a combined installed capacity of ~3500 MW<sub>el</sub>, as of 31.12.2014
- 6827 plants received the survey  
828 replies → response rate 12%
- Plant input material was to 43% manure and to 52% renewable resources, of which 73% is maize silage
- 89% of plants use wet fermentation procedure
- New plant construction has stagnated, due to amendment of the Renewable Energies Act in 2014
  - New plants are mostly small (75kW<sub>el</sub>), with a feedstock of manure and organic waste and will have a combined newly installed capacity of about 10 MW<sub>el</sub> compared to 250 MW<sub>el</sub> newly installed capacity in 2014





# Questionnaire – General Information



- 743 sendings to German biogas plant operators
- 110 respondents
- response rate of 14,8 %
- 10 questions with different levels:
  - strongly agree: 1 score
  - agree: 2 score
  - neutral: 3 score
  - disagree: 4 score
  - strongly disagree: 5 score

**IEA Bioenergy**

Fragebogen – Steuerung von Nachhaltigkeit

A. Welche landwirtschaftlichen Rohstoffe sollten für die Bioenergieproduktion verwendet werden?

☐ Reststoffe aus der Ernte (z.B. Mais- oder Weizenstroh)

☐ Reststoffe aus der Verarbeitung (z.B. Rapseis)

☐ Energiepflanzen (z.B. Ölplanken, Zuckerrüben, Mais, holzartige Energiepflanzen), im Umfang von:

☐  $\leq 1\%$  der landwirtschaftlichen Nutzfläche

☐  $\leq 5\%$  der landwirtschaftlichen Nutzfläche

☐  $\leq 7\%$  der landwirtschaftlichen Nutzfläche

☐ auf marginalen oder degradierten Flächen

B. Einschätzung der verstärkten Unterstützung von Bioenergie (Bitte geben Sie an, in welchem Maß Sie zustimmen.)

	Stimme voll zu	Stimme zu	Neutral	Stimme eher nicht zu	Stimme gar nicht zu
1. Nachhaltigkeitsbestimmungen sollten für alle Biomassearten verbindlich sein, unabhängig vom Einsatz.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Derzeitige Systeme zur Zertifizierung von Nachhaltigkeit sind transparent und effektiv.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Bioenergie sollte reguliert werden auf...					
...lokaler Ebene	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...nationaler Ebene	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
...internationaler Ebene	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Die Koordination der Lieferkette (vom Rohstoff bis Endnutzung) ist eines der größten Hindernisse für die Sicherstellung der Nachhaltigkeit der Bioenergieproduktion. Welche Modelle könnten die Koordination verbessern?

Hersteller-basierte Koordination (ein versammeltes Unternehmen ist für die Datensammlung über die gesamte Lieferkette verantwortlich)

Biomasseproduzenten-basierte Koordination (Land- und Forstwirte sind für die Datensammlung über die gesamte Lieferkette verantwortlich)

Eine Mischung aus beiden

5. Wie sollte die Nachhaltigkeit von Bioenergie-Lieferketten nachgewiesen werden?

Ein Nachweis ist nicht nötig

Biomasse- oder Bioenergieproduzenten ausweisen und berichten eigenverantwortlich

Unabhängige Zertifizierung durch die Prüfung Dritter, basierend auf Nachhaltigkeitsstandards

Sonstiges: \_\_\_\_\_

6. Die Einhaltung aller Formen der Nachhaltigkeitsstandards von Bioenergie sollten sein:

verpflichtend

freiwillig

Eine Mischung aus beiden

7. Entscheidungen politischer Entscheidungsträger sollten stärker auf wissenschaftlichen Informationen basieren.

1

**IEA Bioenergy**

Fragebogen – Steuerung von Nachhaltigkeit

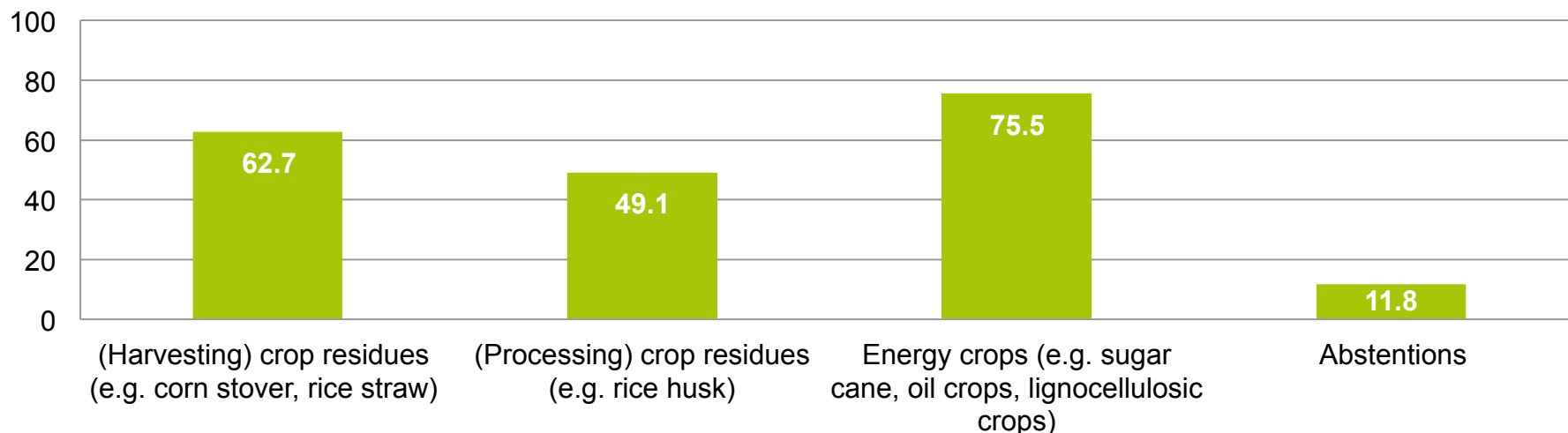


# Questionnaire – Preliminary Results

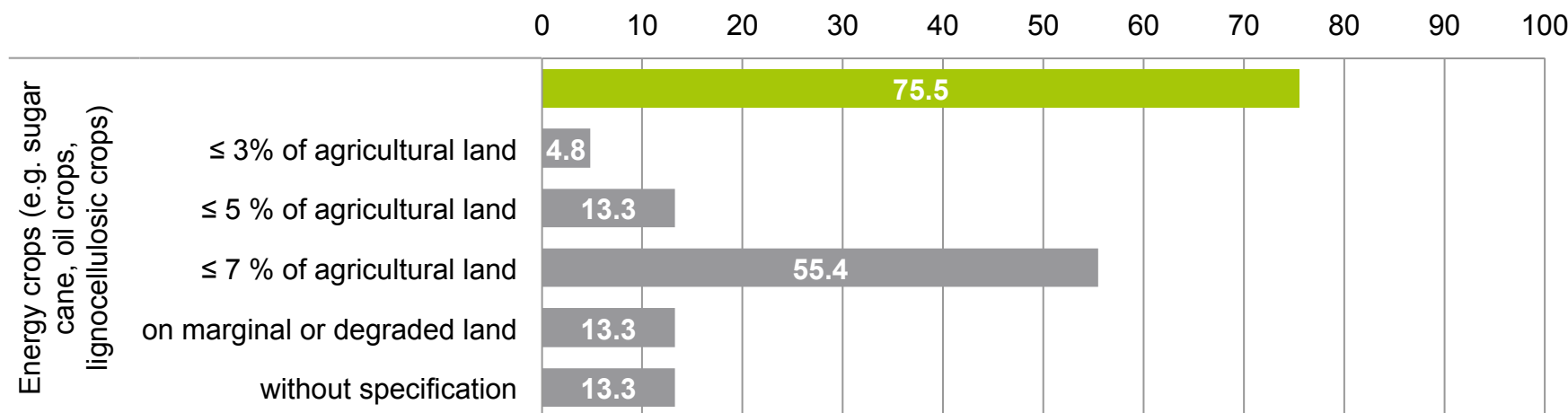
## Questions Section A



**Which feedstocks should be used for bioenergy production (responses\* in %)**



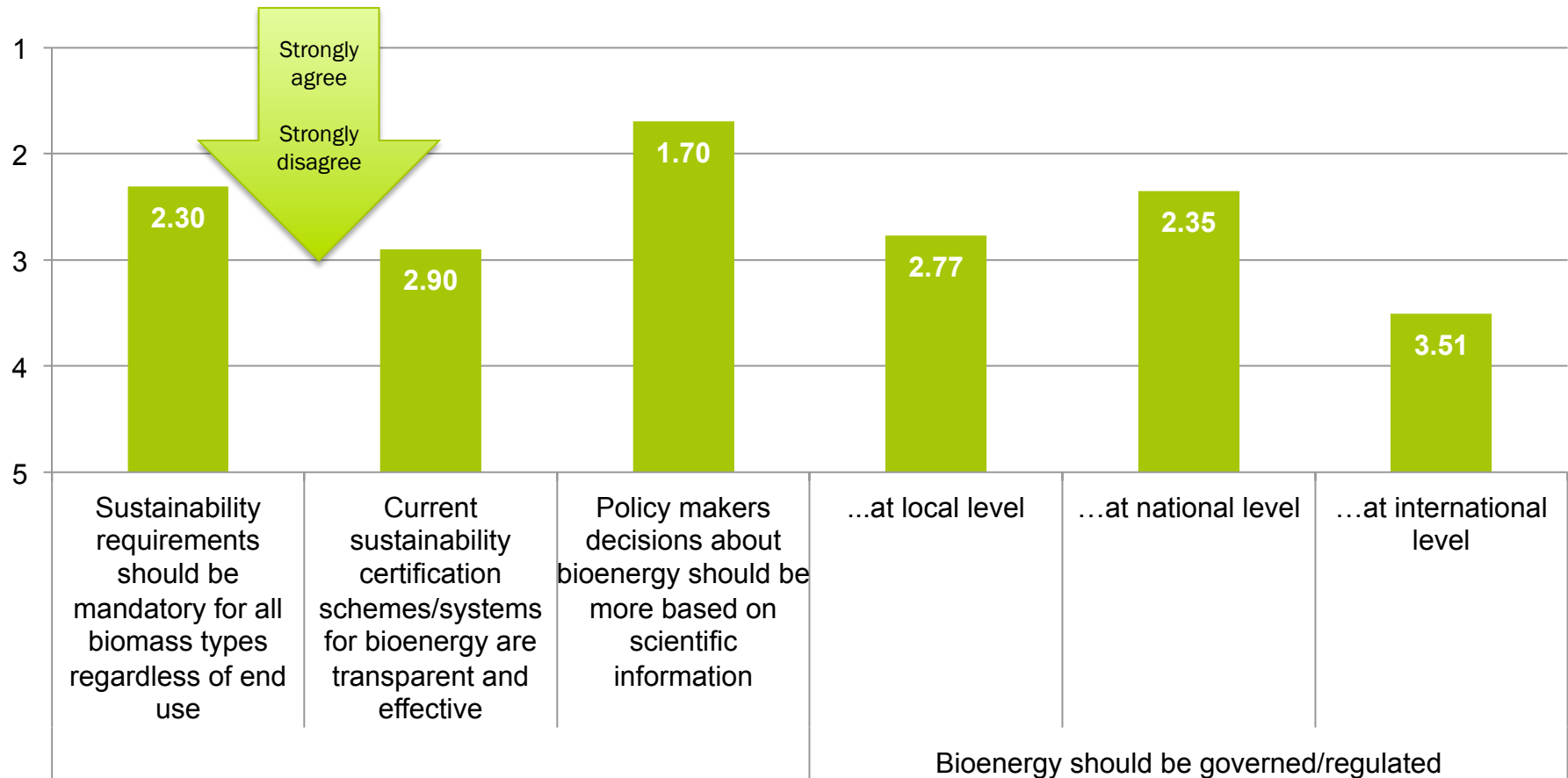
**Extent of Energy Crop Land Use (responses\* in %)**





# Questionnaire – Preliminary Results

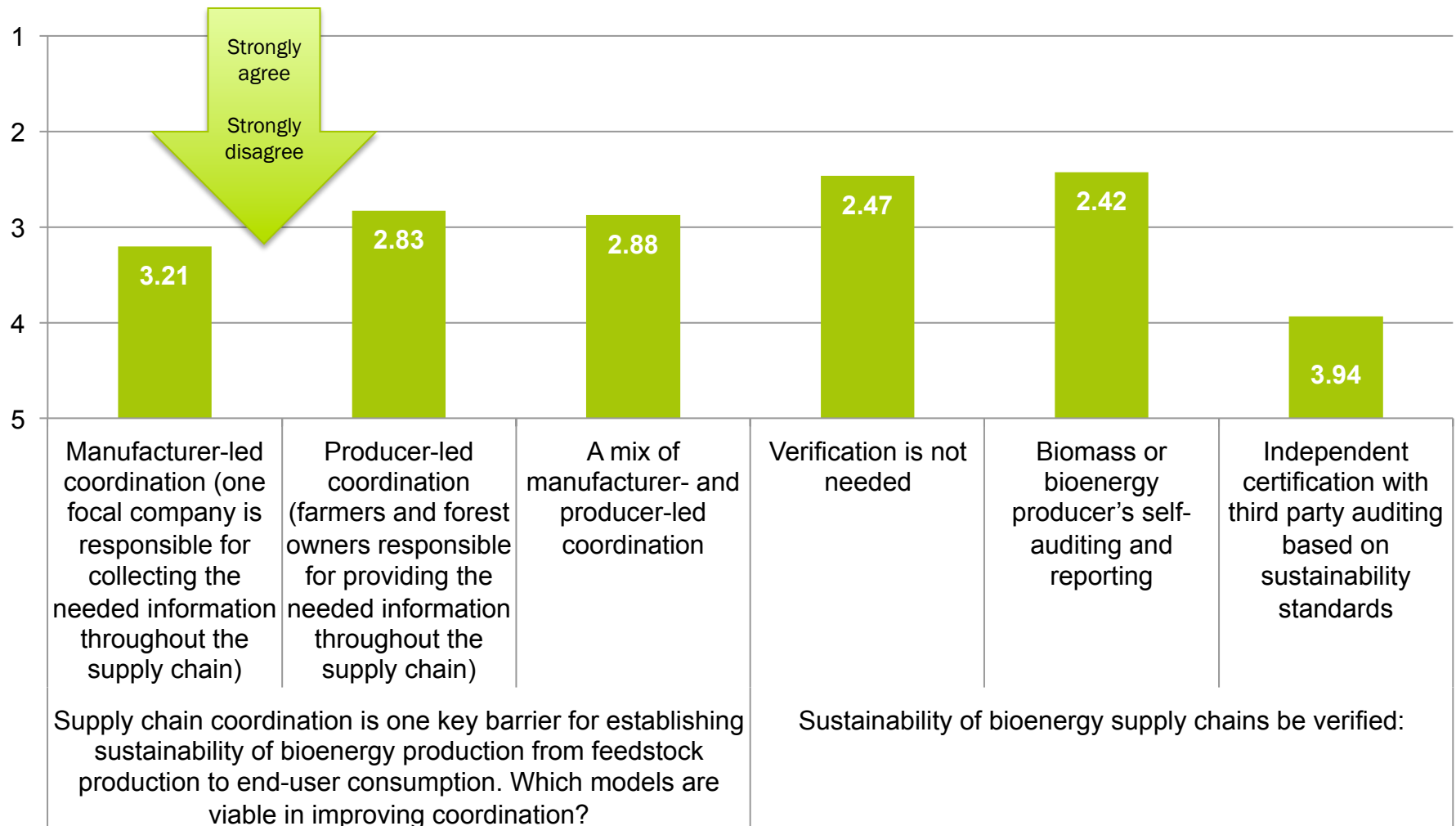
## Question Section B





# Questionnaire – Preliminary Results

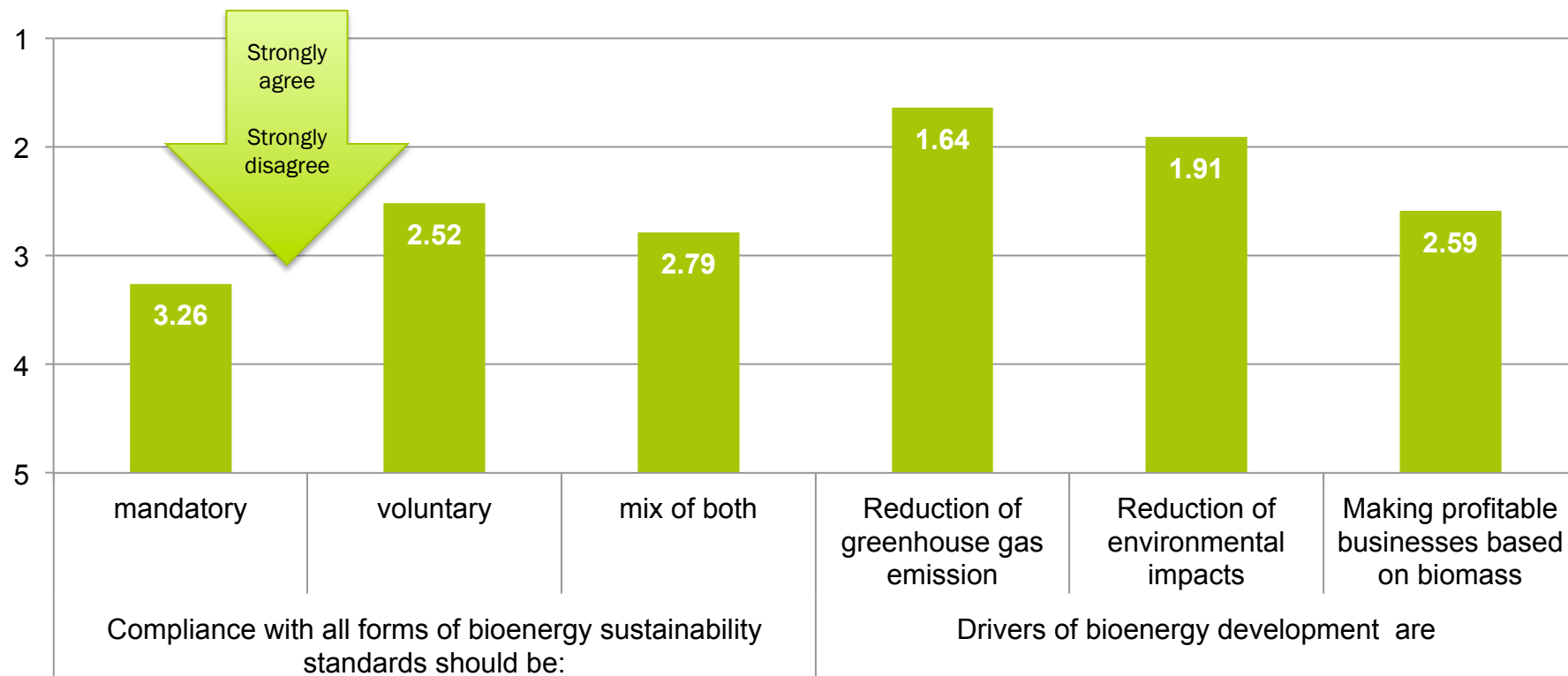
## Question Section B continued (1)





# Questionnaire – Preliminary Results

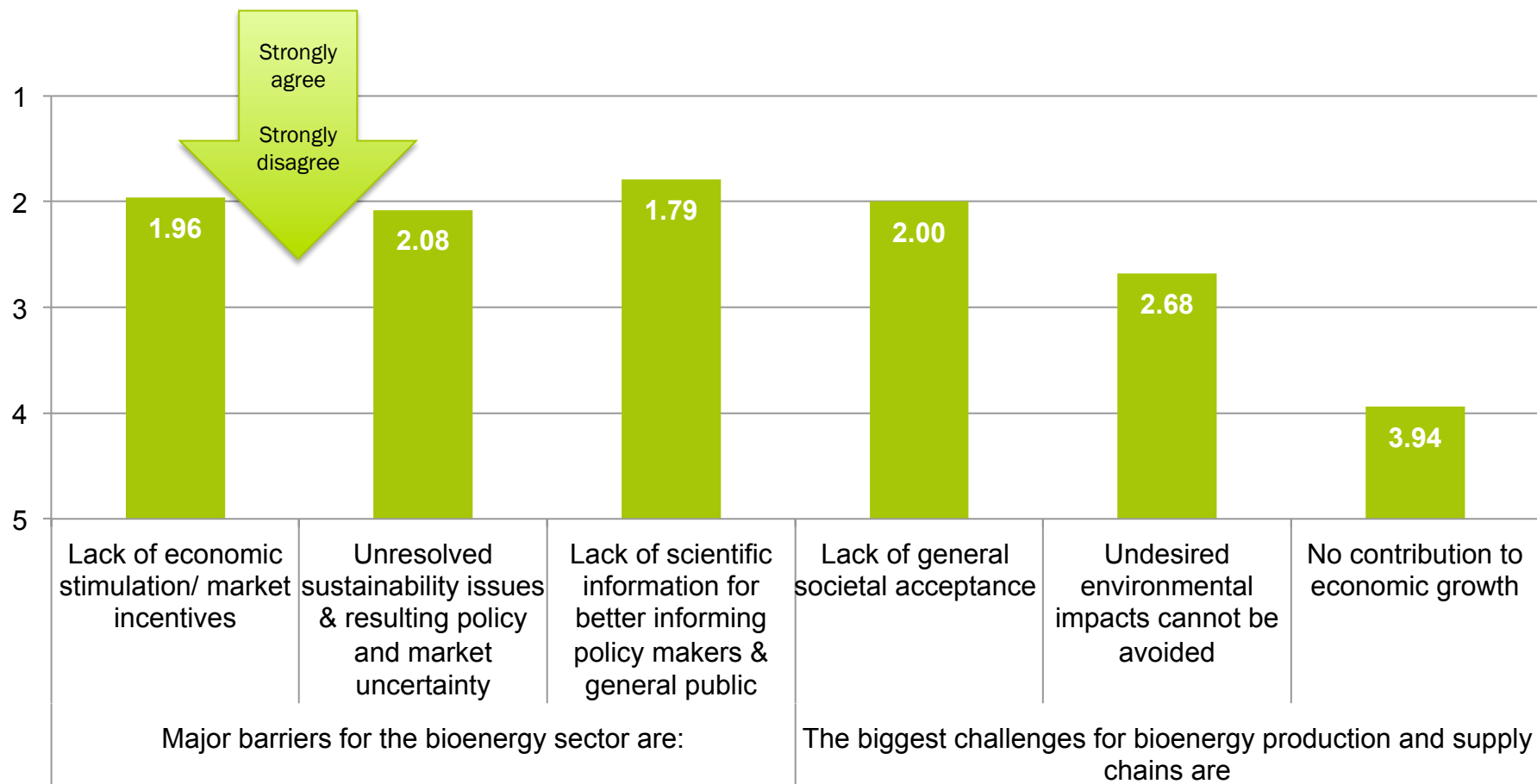
## Question Section B continued (2)





# Questionnaire – Preliminary Results

## Question Section B continued (3)



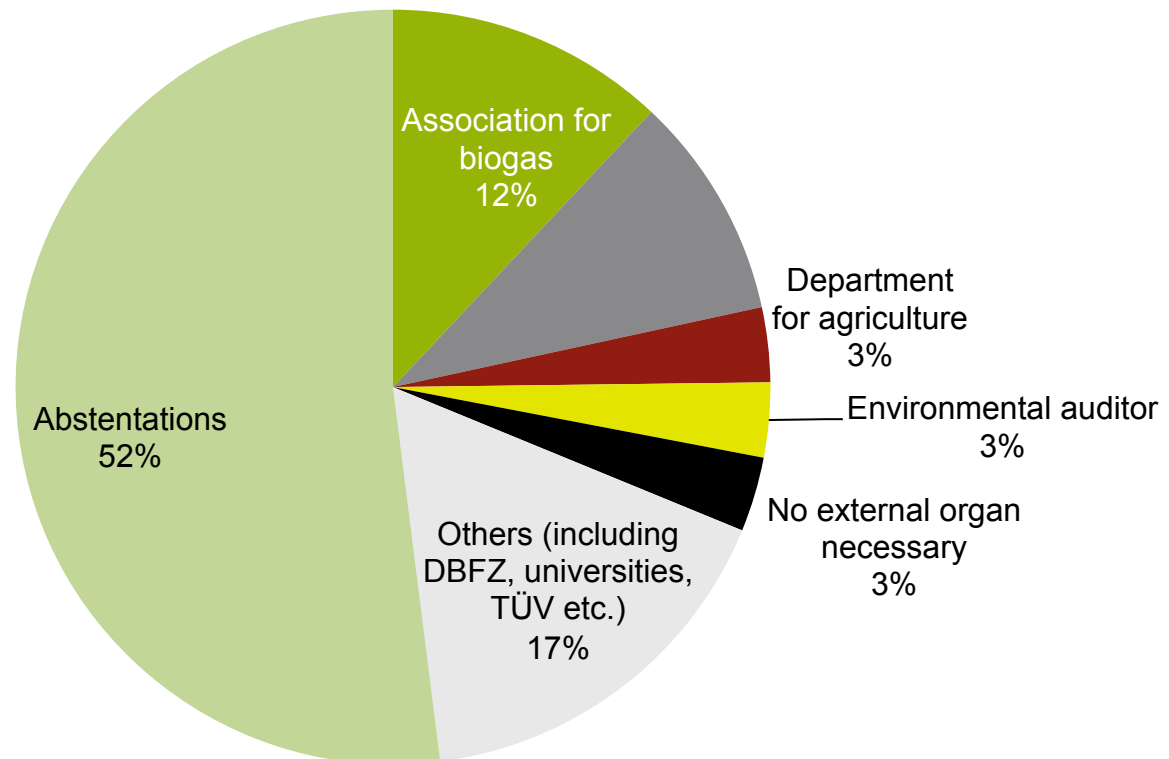


# Questionnaire – Preliminary Results

## Question Section C




**Which institutions, companies, facilities etc. do you view as important for regulating, implementing and monitoring sustainability criteria in the biogas sector?**





# Next Steps for Stakeholder Analysis in the German Biogas Sector

- Online survey will be sent to other stakeholder groups
- Expert interviews will be held with selected stakeholders

Deutsches Biomasseforschungszentrum  IEA Nachhaltigkeit Biogas

Antwortschlüssel: 100%

Allgemeine Fragen

	Trifft voll zu	Trifft eher zu	Teils teils	Trifft weniger zu	Trifft nicht zu	keine Antwort
Ich bin gut über die Entwicklungen im Biogassektor informiert	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Meiner Meinung nach ist die Allgemeinheit ausreichend über die Entwicklungen im Biogassektor informiert	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Die Allgemeinheit muss stärker in die Entwicklung des Biogassektors einbezogen werden, besonders in Regionen mit Biogasproduktionspotentialen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich glaube, dass die öffentliche Meinung wichtiger für das Entstehen von Biogasprojekten ist, als eine sachliche Basis oder wissenschaftliche Informationen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ich habe eine positive Auffassung von Biogas allgemein	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Ich würde die Entwicklung von Biogas unterstützen, wenn sie...

	Trifft voll zu	Trifft eher zu	Teils teils	Trifft weniger zu	Trifft nicht zu	keine Antwort
...die Versorgungssicherheit von Energie erhöht	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...lokale Arbeitsplätze und wirtschaftliche Entwicklung schafft	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...Luft- und Wasserverschmutzung mindert	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...die Flächenverwendung und Wälderanwendung von Materialien verstärkt (dabei Abfall verringert)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...Boden- und Waldmanagement verbessert	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...Biodiversität und Ökosystemdienstleistungen erhält	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Sonstige Gründe, warum ich die Entwicklung von Biogas unterstützen würde:

	Trifft voll zu	Trifft eher zu	Teils teils	Trifft weniger zu	Trifft nicht zu
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**?** Bitte Ihre Antworten in die Kästchen hinter der Wertung eintragen. Mehrfachnennungen können mit ";" getrennt werden.

Ich würde gegen die Entwicklung von Biogas sein, wenn sie...

	Trifft voll zu	Trifft eher zu	Teils teils	Trifft weniger zu	Trifft nicht zu	keine Antwort
...indirekt zu Landnutzungsänderungen führt	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...Treibhausgasemissionen nicht reduziert	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...um Menschenersatz konsumiert	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...Wälder ausbeutet oder zur Erhaltung führt	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...zu Konflikten im Landschafts-Bau	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
...lokale Arbeitsbedingungen nicht verbessert	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Sonstige Gründe, warum ich gegen die Entwicklung von Biogas sein würde:

	Trifft voll zu	Trifft eher zu	Teils teils	Trifft weniger zu	Trifft nicht zu
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

**?** Bitte Ihre Antworten in die Kästchen hinter der Wertung eintragen. Mehrfachnennungen können mit ";" getrennt werden.

[Liffrage verlassen und Antworten speichern](#) [System beenden](#) [Weiter](#)



# Potential Stakeholders



- Feedstock producers (farmers)
- Digestate (fertilizer) users
- Logistic service providers
- AD and CHP technology providers
- Certification institutes (e.g. TÜV)
- Policy makers
- Research institutes
- Chamber of agriculture
- Association for biogas



# Development of the Danish biogas sector

Teodorita Al Seadi, Biosantech



# The impact of governance on the deployment and environmental sustainability of manure-based centralised biogas production in Denmark

## Overall aim:

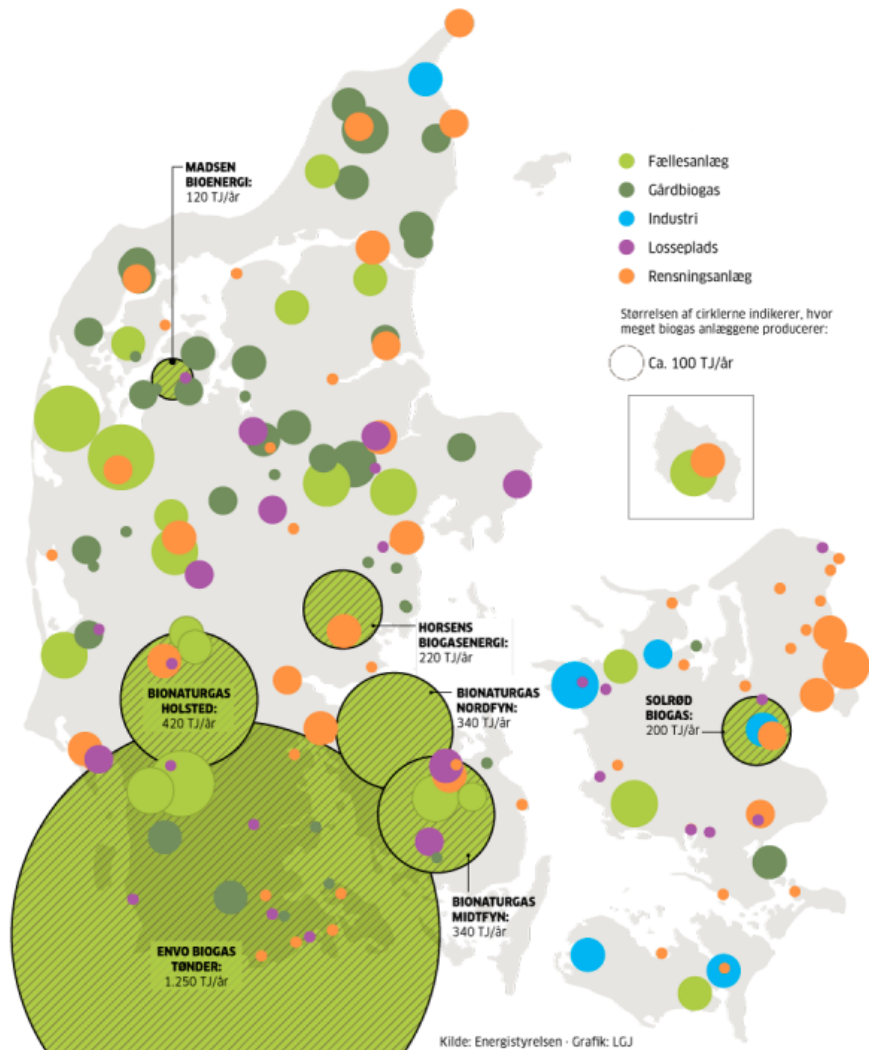
- Contribute to the understanding of drivers of governance systems for environmental sustainability of the manure-based centralised biogas supply chains in Denmark
- Gather knowledge on how legitimacy and effectiveness of such governance can be improved

## Content:

1. Deployment of the centralised manure based biogas supply chain in Denmark.
2. Environmental sustainability issues in relation to centralised manure based biogas - benefits and challenges
3. How selected environmental sustainability issues are addressed by Danish policies and governance systems – short historical overview
4. Enforcement, compliance and performance of the selected policies and governance systems
5. Discussion of relationship between policy approaches, enforcement systems, and the administrative and economic burdens, and effectiveness on-the-ground.
6. Lessons learned



## Geographical distribution of the centralised manure based biogas plants in Denmark



- Centralised manure-based biogas plants  
(hatched = new plants)
  - Farm manure-based biogas plants
  - Industrial biogas plants
  - Landfill
  - Wastewater treatment plant
- NB:** The size of the circles indicates the biogas production capacity of the plant

Denmark aims to treat 50 % of the produced manure in biogas plants by 2024, and to become independent from fossil fuels by 2050.

Brutto energy consumption in Denmark was of 720 PJ in 2015, of which RES represented 28,6%. Biogas provided in the same year 1,1% of the actual energy consumption in Denmark.



# Analysed governance systems (G) for environmental sustainability

## G1: Sustainability of AD feedstock

- "Grøn vækst" / Energy crops vs wastes, by-products and residues

## G2: Management of animal manure and slurries

- Harmony rules.

## G3: Organic waste management

- "Denmark without waste" -resource strategy up to 2022.

## G4: Sustainability of biogas plant operation

- Hygiene and sanitation
- Voluntary control of methane emissions
- Digestate analyse

## G5: Biogas utilisation and biogas based energy production

- Varmeforsyningsloven

## G6: Recycling digestate from biogas plants as biofertiliser

- Quality management of digestate through feedstock control, sanitation, value limits for heavy metals and for organic pollutants, product declaration)
- Danish frameworks and principles (see also G2)
- Guidelines for good agricultural practices



## Classification of the applied governance

- The **Gs** are cocktails of laws, regulations, rules, guidelines, principles etc.
- Classification of governance systems requires thus a detailed analysis of each group of legislations, regulations, rules etc.
- Simple classification criteria:
  - Mandatory and Voluntary
  - or
  - Direct and Indirect



## Legislative / regulative frames impacting the Danish biogas sector

### EU

- The Waste Framework Directive
- By-product Regulation
- RES Directive
- EIA Directive
- The Habitats Directive
- Nitrate Directive
- Water Framework Directive

### Ministry of the Environment

- Planning Act
- EIA Decree
- Habitat Ordinance
- Environmental Protection Law
- Sludge Ordinance
- Waste Ordinance
- Resource Strategy
- Nature Agency biogas mobile team

### Climate, Energy and Building Ministry

- The Renewable Energy Law
- Heat supply and project Ordinance
- Electricity Supply
- Natural gas law
- Climate Plan
- Strategic energy planning
- RE in the process

### Ministry of Food

- Support /ha agriculture
- Rural development
- Statutory order for fertilizer and plant cover

### Economy-94 and Ministry of Internal Affairs

- Local Proxy Rules

### Ministry of Taxation

- Tax Laws



# Working Hypothesis – Discussion!



- Additional case studies for The Netherlands, UK and Italy envisaged
- Hypothesis I: comparable legal frameworks in Europe except for Renewable Energy implementation
- Hypothesis II: different implementation phases result in different
  - Perceptions
  - Governance portfolios
  - Sustainability debate
- Hypothesis III: comparable stakeholders (domains, groups) in European countries
- Hypothesis IV: Perception of sustainability is embedded in a multitude of decision making criteria



## Smart Bioenergy – innovations for a sustainable future Come and join us!

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