ELCON

Biogas Training

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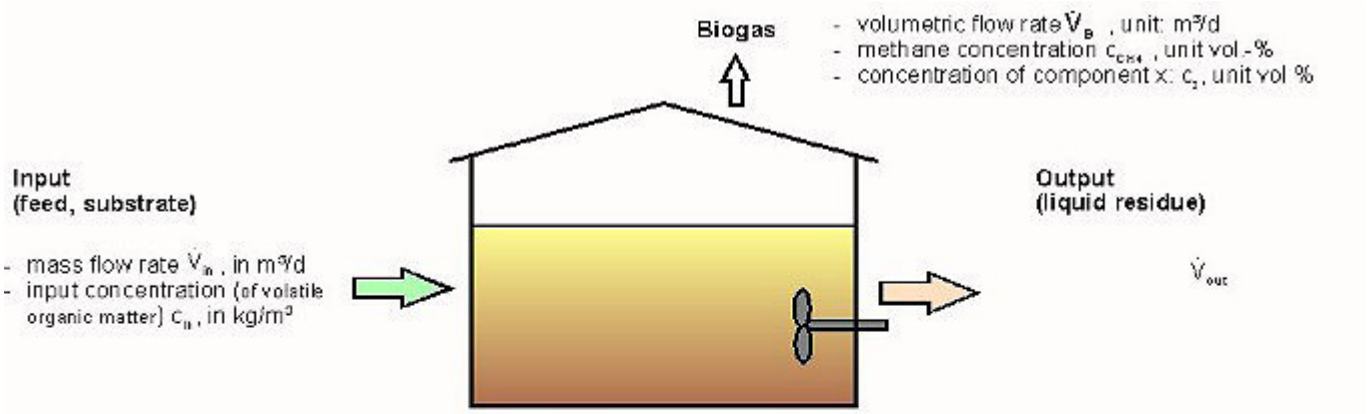
“Biogas - a success story in Germany Strategies worldwide for the future"

1. Introduction
2. Development in substrates, costs and plant technology
3. Why upgrading to Biomethane
4. Advantages of Biogasproduction
5. The Need for flexible backup Solutions
6. Summary and Outlook
7. Best practice and impressions

1. Introduction

Video - Animation of a Biogas Plant

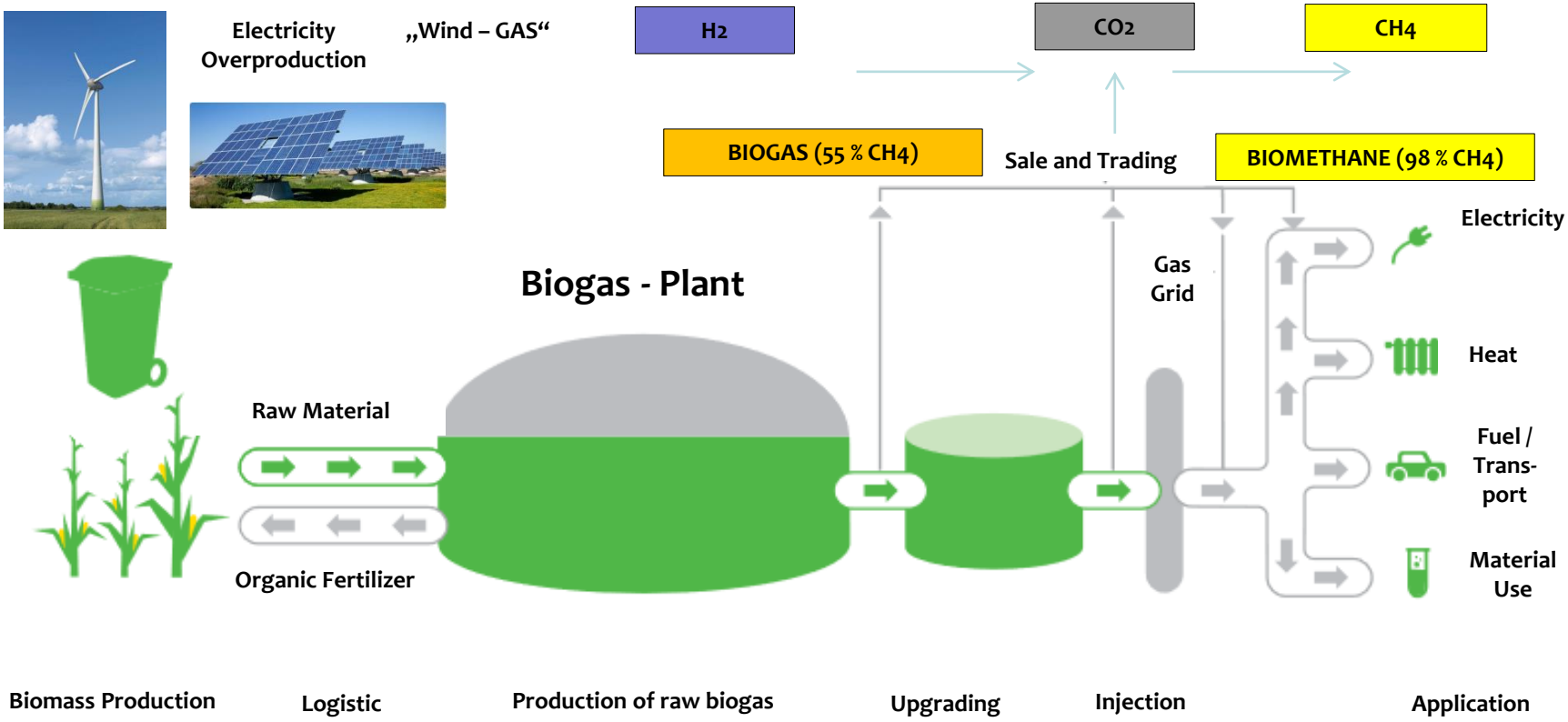
1. Introduction



Load parameters		performance parameters	
hydraulic retention time HRT, unit: d	$HRT = \frac{V_R}{\dot{V}_{in}}$	Biogas yield Y_B, unit m³/kg	$Y_B = \frac{\dot{V}_B}{\dot{V}_{in} * (c_{in} - c_{out})}$
organic load rate OLR, unit kg/(m³ *d)	$OLR = \frac{\dot{V}_{in} * c_{in}}{V_R} = \frac{\dot{m}_{VS\_in}}{V_R}$	methane yield Y_{CH4}, in m³/kg	$Y_{CH4} = \frac{\dot{V}_B * c_{CH4}}{\dot{V}_{in} * (c_{in} - c_{out})}$
sludge load rate SLR, unit kg/(kg*d)	$SLR = \frac{OLR}{c_{out}} = \frac{\dot{V}_{in} * c_{in}}{V_R * c_{out}}$	Biogas productivity r_B, unit m³/(m³ *d)	$r_B = \frac{\dot{V}_B}{V_R} = y_B * OLR$
		specific Biogas productivity r_{BS}, unit m³/(kg *d)	$r_{BS} = \frac{\dot{V}_B}{V_R * c_{out}}$

Source: www.dabec.de

1. Introduction

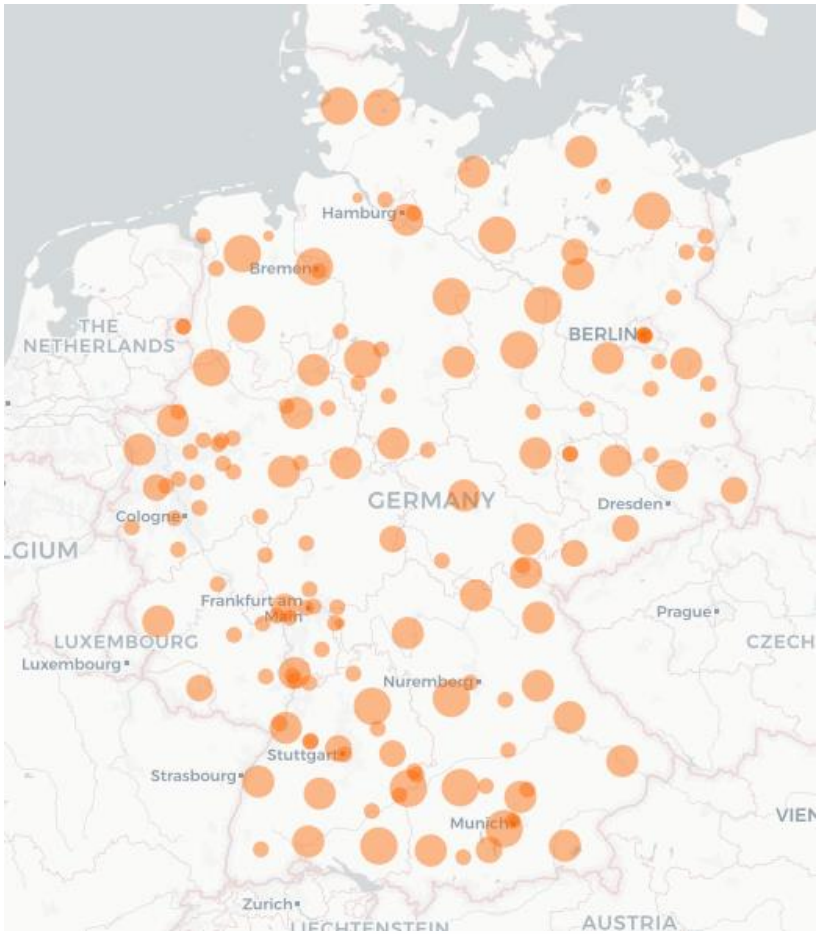


Source: www.dabec.de

1. Introduction – How Germany Generates it`s ren. electricity

CarbonBrief
CLEAR ON CLIMATE

Source: www.carbonbrief.org



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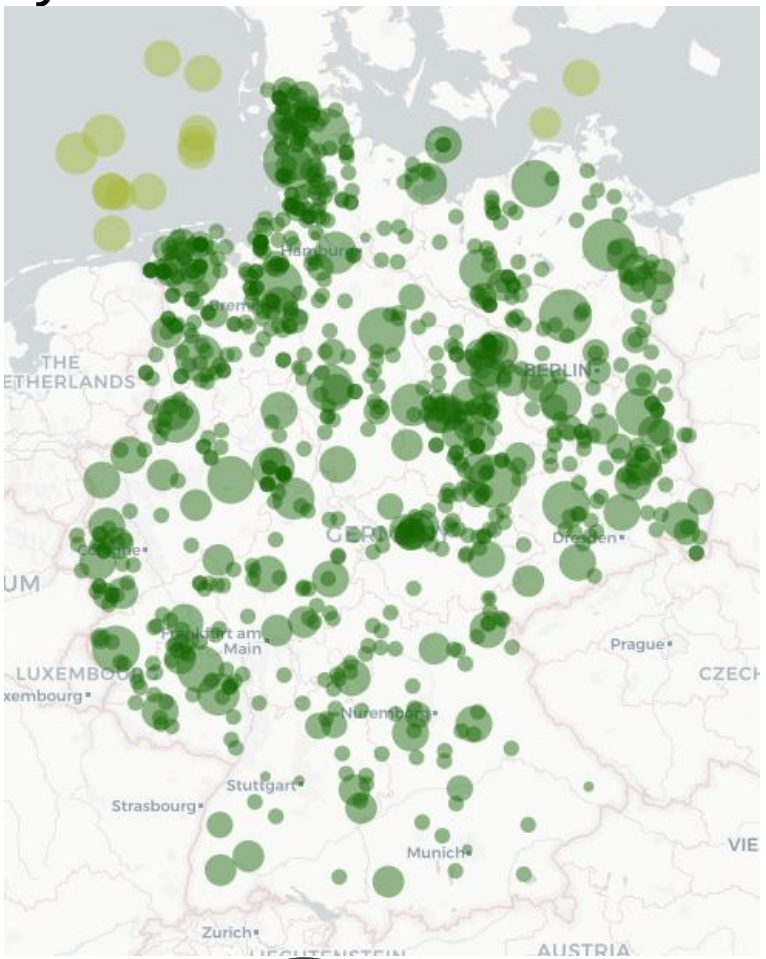
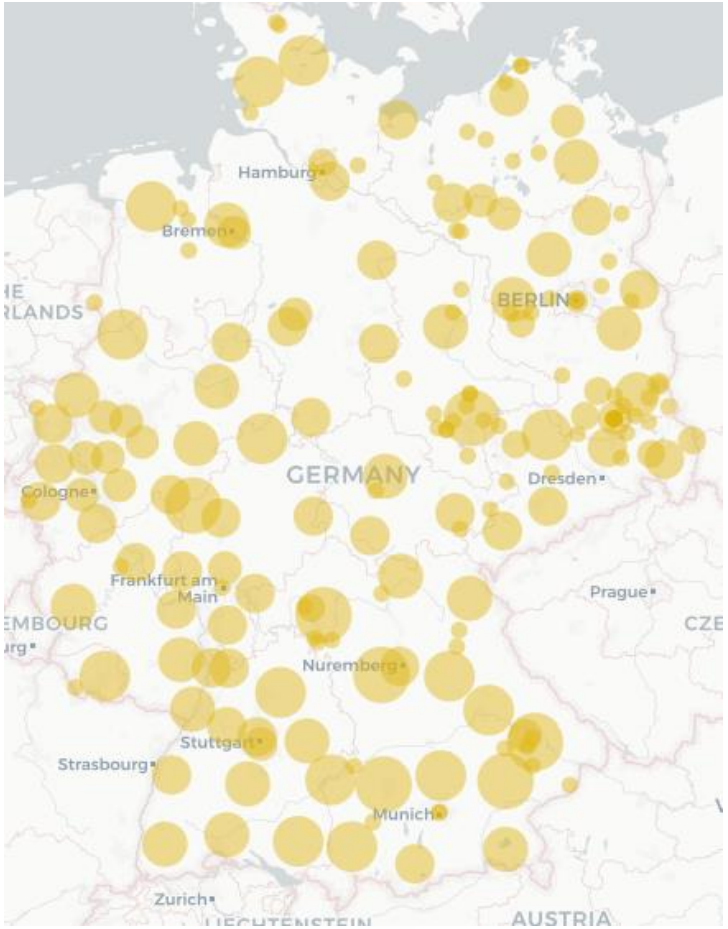


1. Introduction – How Germany Generates it`s ren. electricity

ENERGY | September 20. 2016. 7:00

CarbonBrief
CLEAR ON CLIMATE

Source: www.carbonbrief.org



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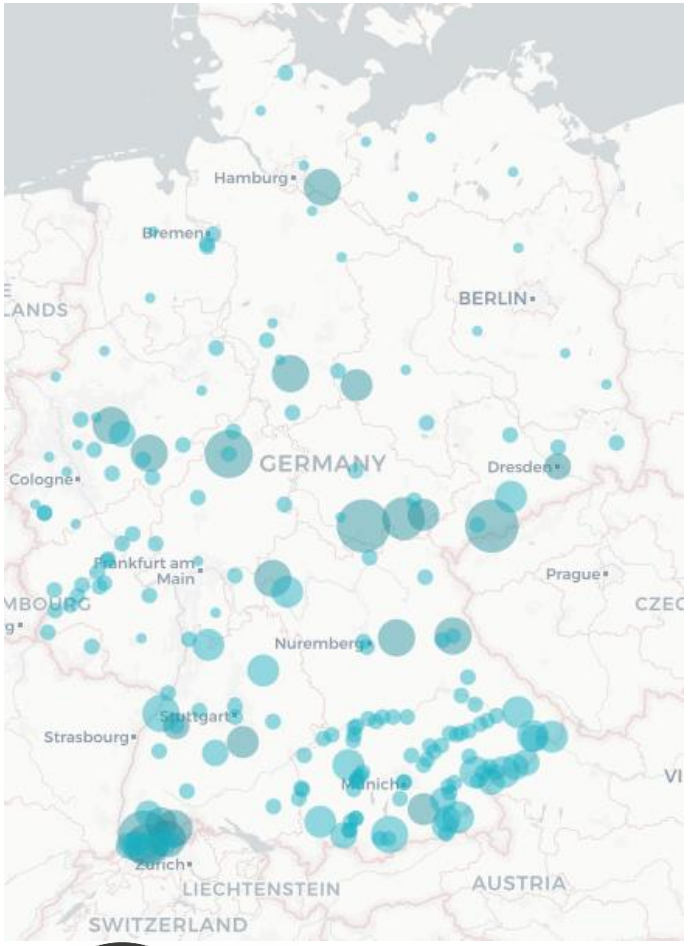
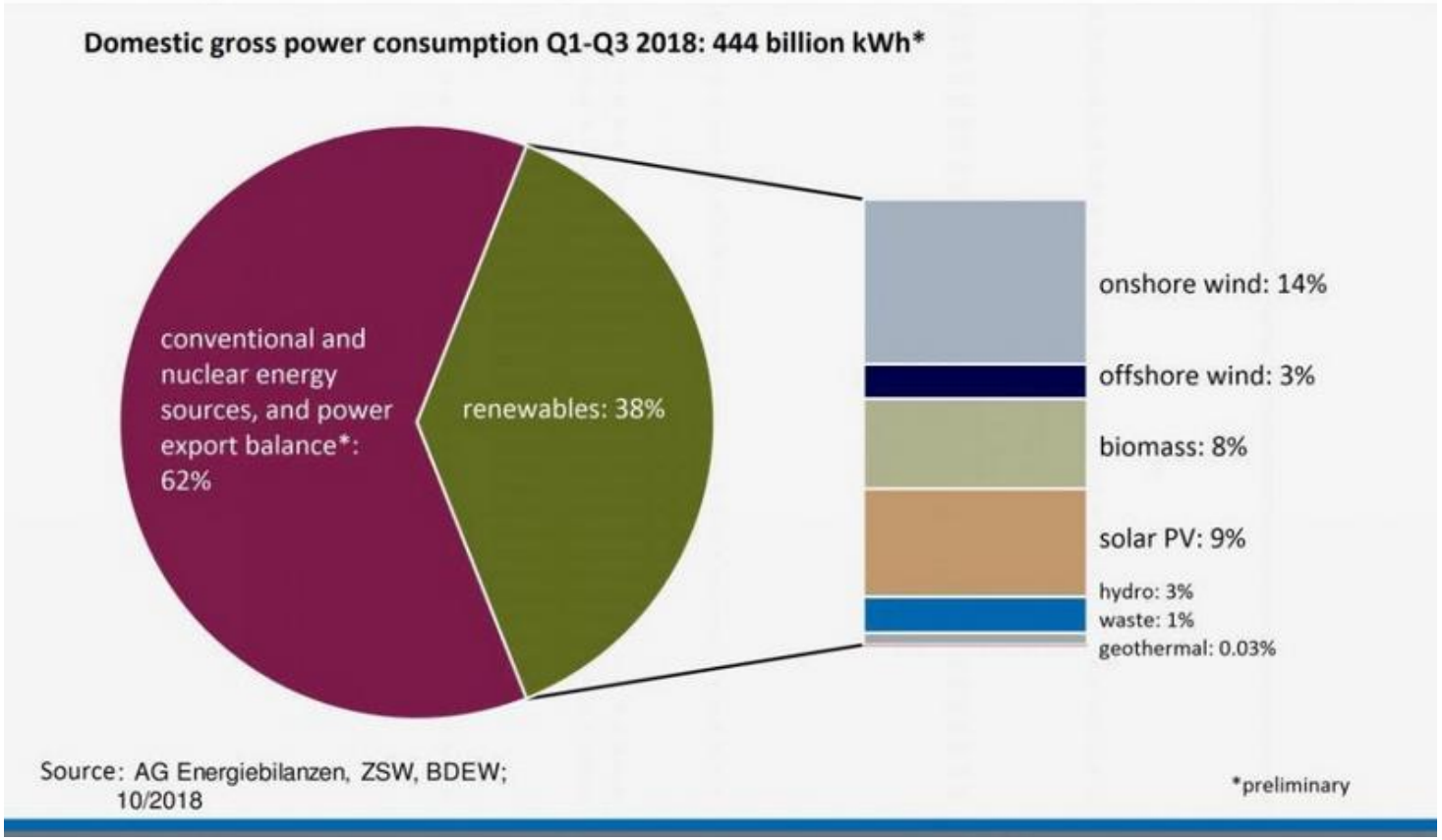


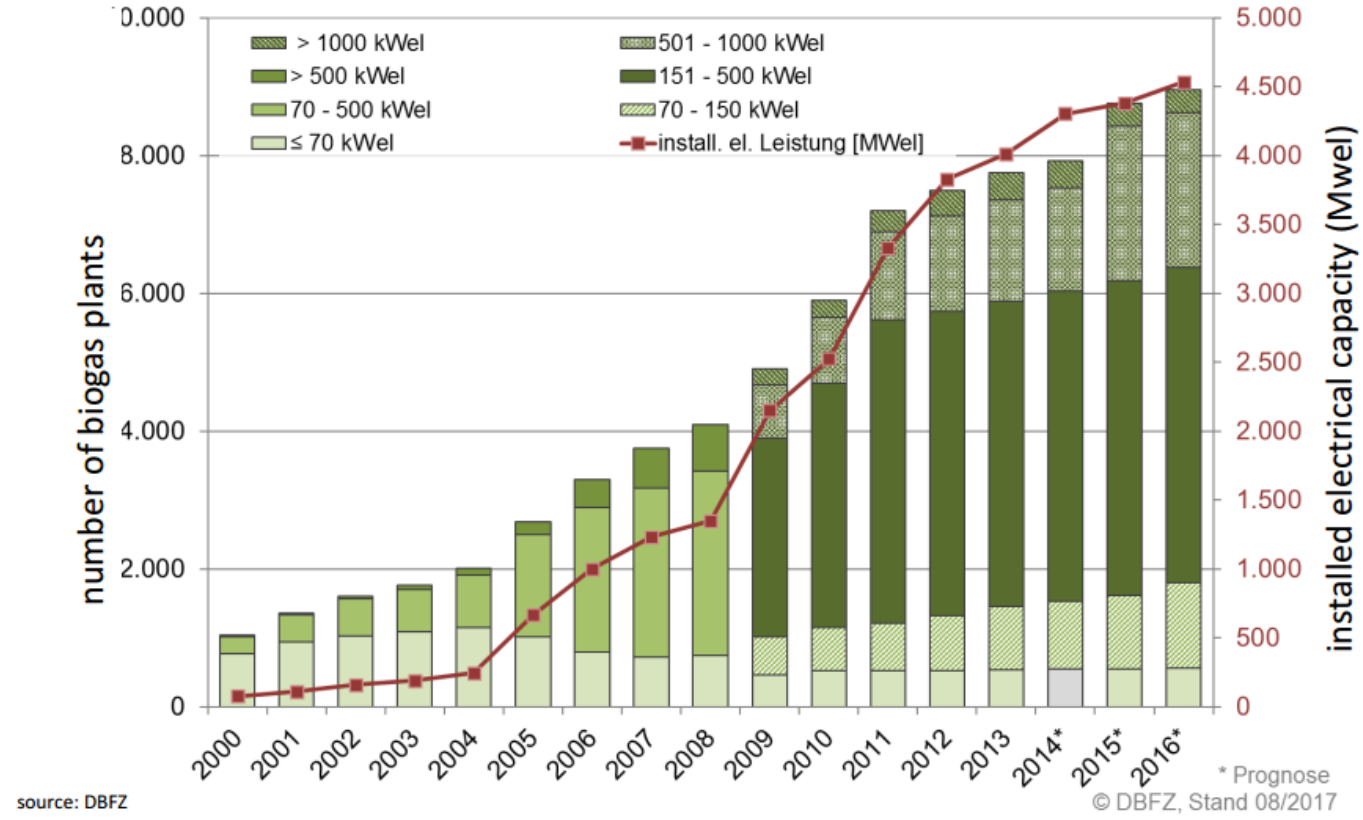
“Biogas - a success story in Germany Strategies worldwide for the future"

Renewables' contribution to covering electricity consumption in Germany

bdew
Energie. Wasser. Leben.



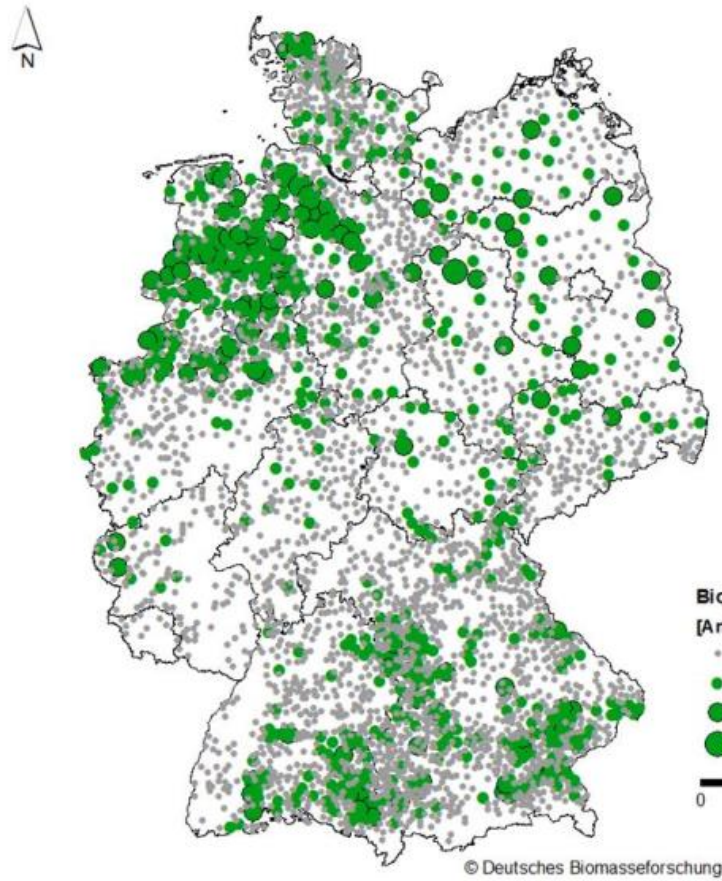
Status Quo of Biogas Production in Germany



source: DBFZ

“Biogas - a success story in Germany Strategies worldwide for the future"

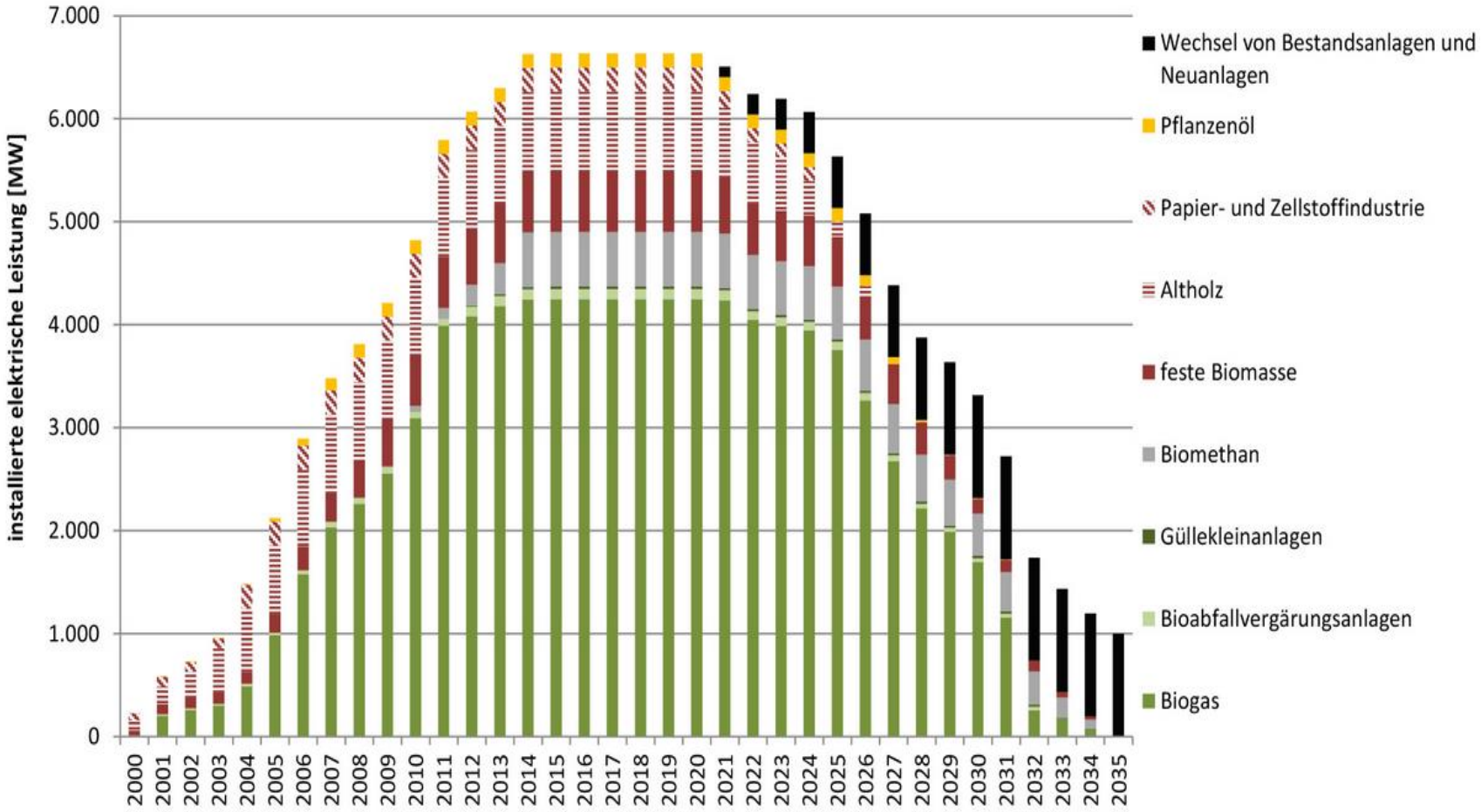
Status Quo of Biogas Production in Germany



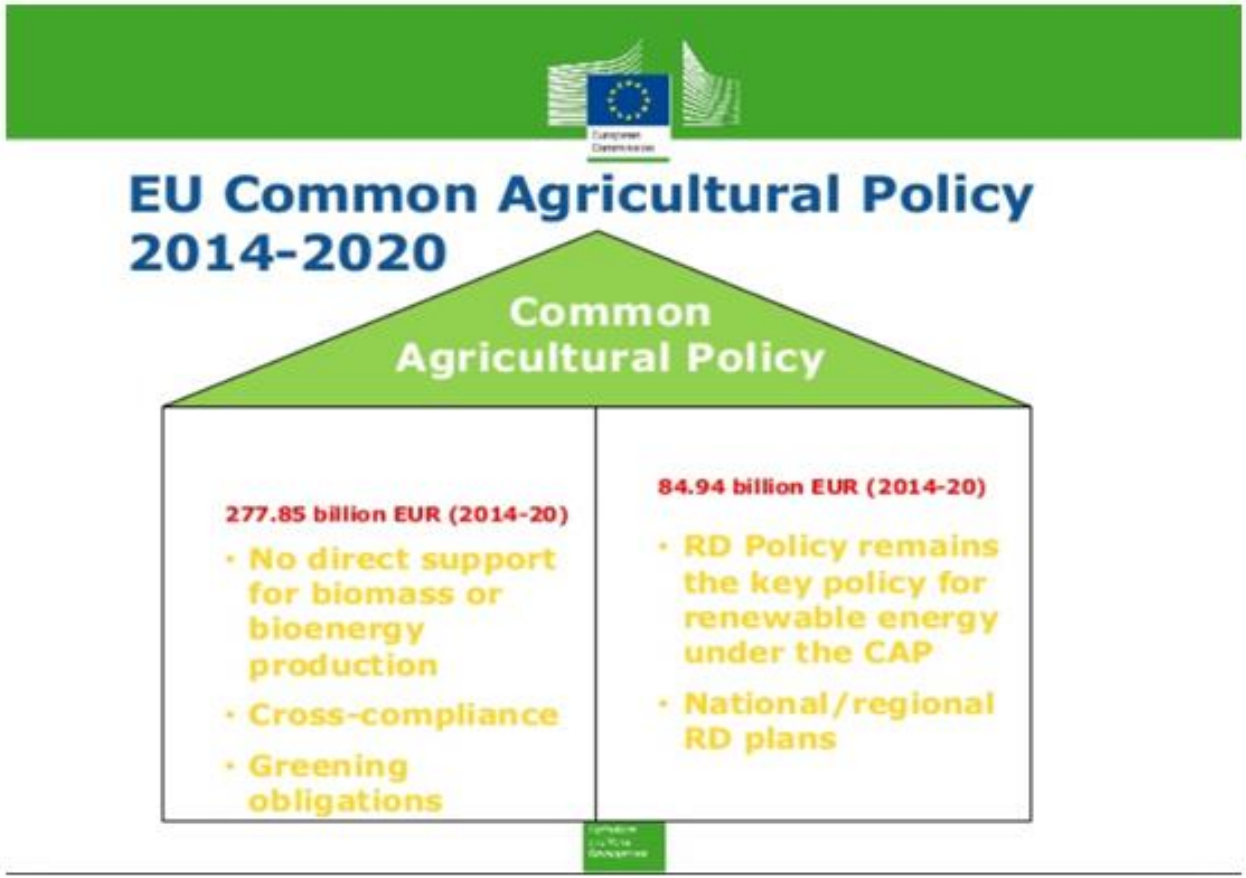
- 8.200 agricultural plants, with 560 small scale manure based plants (< 75 kW)
- 135 municipal biowaste biogas plants with more then 90 % municipal biowaste
- 200 plants with partly using municipal biowaste
- 196 biogas upgrading plants

source: DBFZ

Future Outlook / Number of Biogasplants in Germany



“Biogas - a success story in Germany Strategies worldwide for the future"



Mayor Questions for the next decade:

1. The post 2030 targets proposed by the EU - Commission

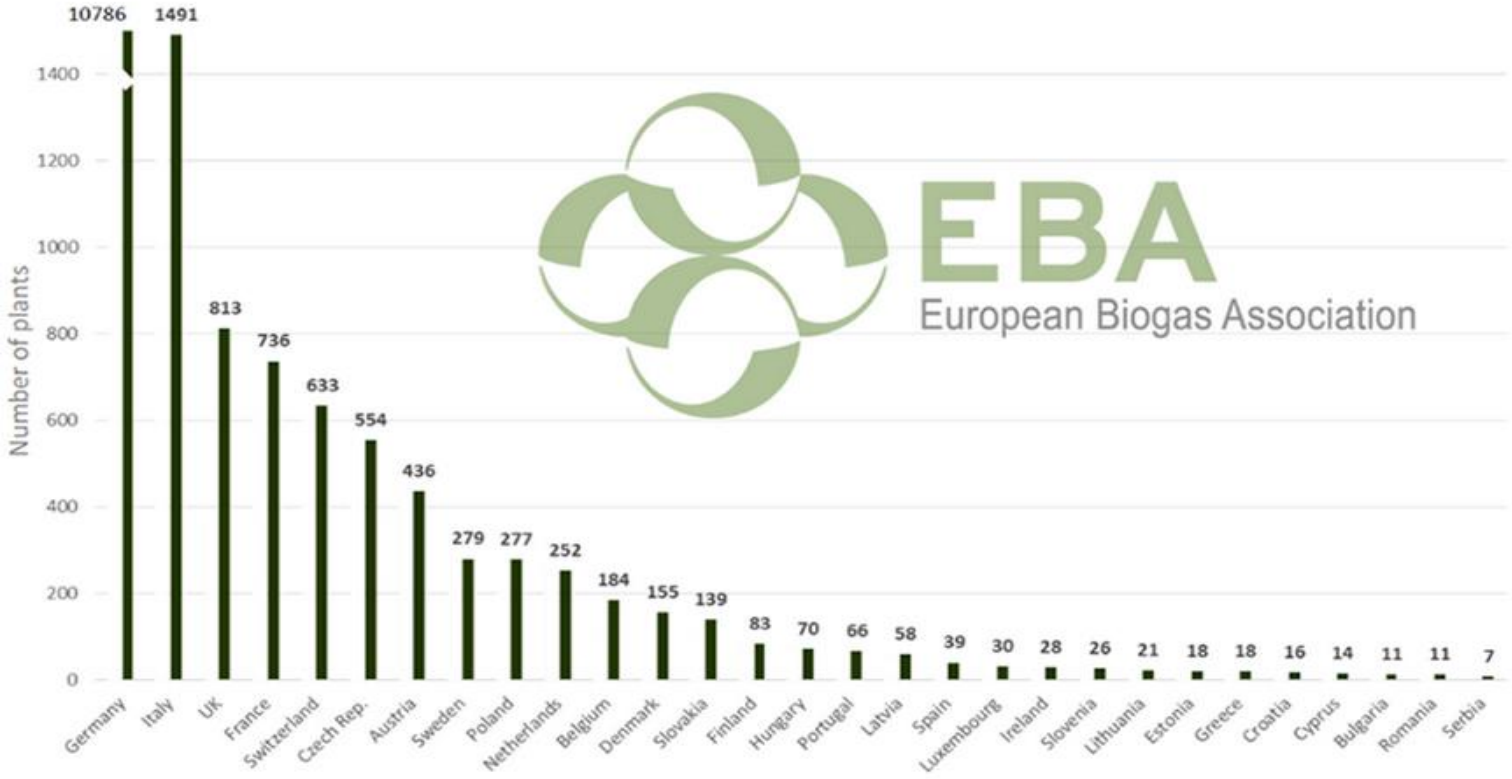
2. Biogas production costs

3. Harmonisation of legal requirements (Waste, Wastewater, Agriculture, Environment, Energy)

4. The sustainability criteria

5. The cross-border trade / International Selling

Biogas Plants: Europe per 2016/12 : 17.240 BGP – 8.293 $MW_{el.}$



2. Development in substrates, costs and technology

Biogas from landfill operations

Source: Hickory Ridge Landfill, Atlanta, GA; USA

Obstacles:

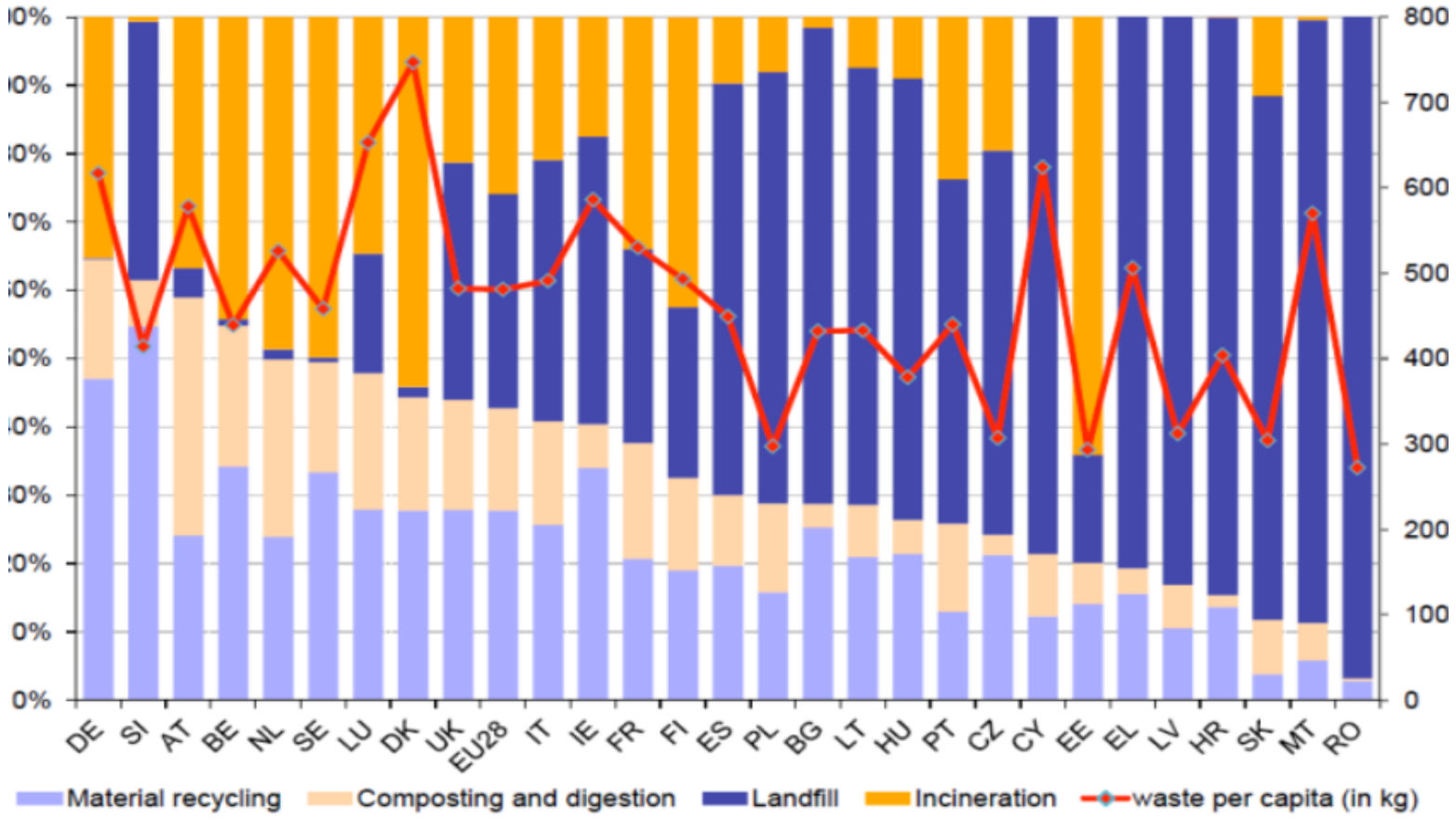
Gas Cleaning
(Quality and Impurities - siloxanes, organic solvents)

Continuous Gasflow Management – CHP Modules

Very high investment / Suited for developing countries?

Limited potential – Competing with Incineration

Municipal waste treatment methods and waste per inhabitant in EU 28 (2013)



2. Development in substrates, costs and technology

Biogas from wastewater treatment

Source: Copenhagen Wastewater Treatment Plant, DK

Obstacles:

Nutrient Recycling
(P!, N,K))

Optimisation of sludge treatment

Dewatering

Spreading on agricultural land

Limited Potential

Very high investment costs

2. Development in substrates, costs and technology

Biogas from household / municipal wastes

Source: GICON Bioenergie GmbH, Vancouver, CA; 2016

Obstacles:

Security of supply

Methane Content in Biogas

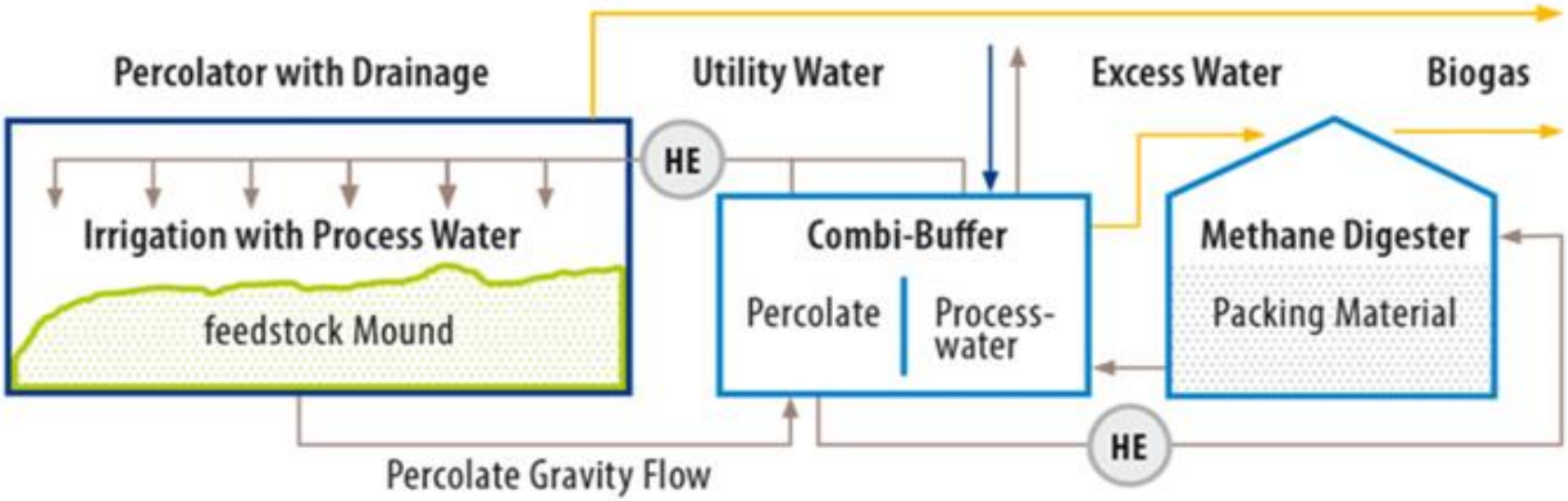
Seasonal changings in Substrates

Suited Digester Systems

Pre Handling and Treatment

Very high investment costs

2. Development in substrates, costs and technology



Source: GICON Bioenergie GmbH, Vancouver, CA; 2016

2. Development in substrates, costs and technology

Plastic & Metal Removal!

Prehandling and Processing

Source: DABEC Bioenergy Consulting, Bergsträßer Kompost GmbH; 2015

2. Development in substrates, costs and technology

Biogas from agricultural wastes

Source: GEA - Maabjerg Bioenergy Jens Bach; 2016

Obstacles:

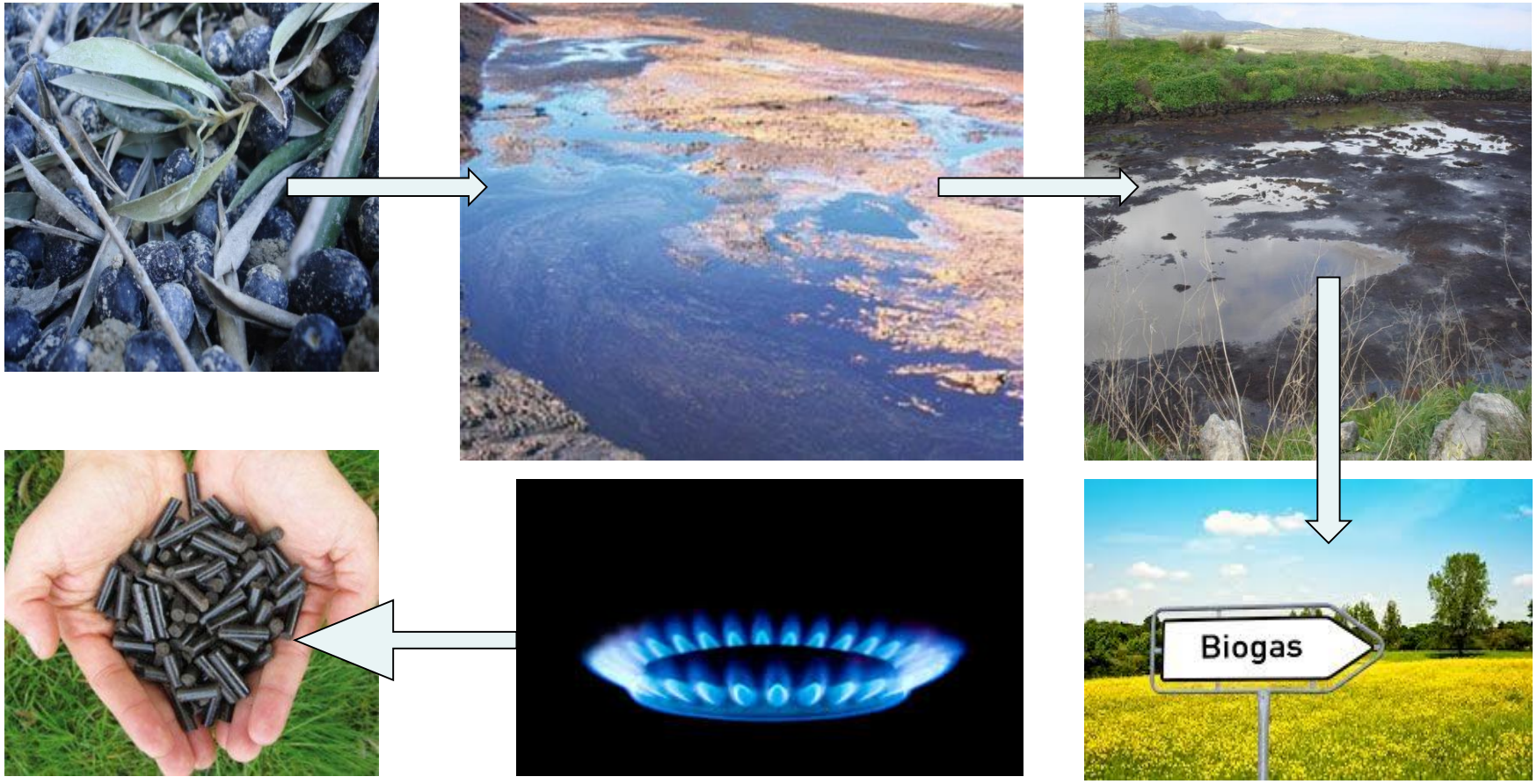
Biomass supply and storage

Biomass transport costs (Water content!)

Cleaning and Upgrading to avoid heat / energy losses

Material Handling

Understanding in biological process - Blackboxing



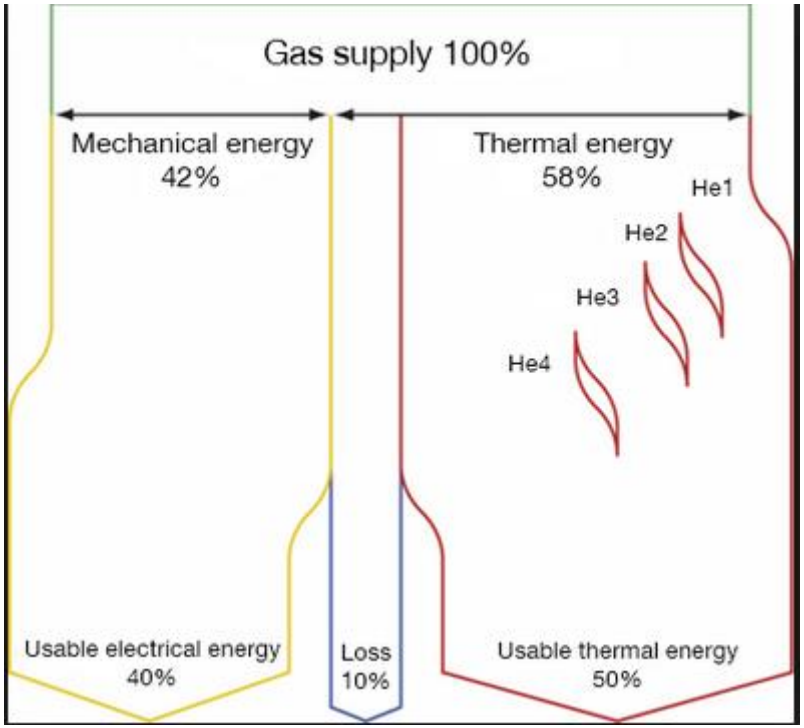
Source: Fraunhofer-Institut IGB, 2014.

2. Development in substrates, costs and technology

Developments – substrates for biogas plants

1. Increased range of substrates
2. Concepts for small scale agricultural BGP`s for by products handling
3. Processing methods for structurous and fibre containing substrates
4. Processing methods for lignocellulosic substrates
5. Increased yields from substrates, increased technical availability
6. New mechanical, thermal, chemical, biological pretreatment
7. Reducing losses through better farming systems / storage
8. Energy crops breeding / energy crops farming systems

3. Why upgrading to biomethane ?



Source: DABEC Bioenergy Consulting; 2017

Waste Heat in most of BGP`s in significant amount

3. Why upgrading to biomethane ?

Source: DABEC Bioenergy Consulting; 2015

Waste Heat in most of BGP`s in significant amount

3. Why upgrading to biomethane ?

Biomethane Production – Reduce Waste Heat

Source: DABEC Bioenergy Consulting; 2016

Biomethane Production – Technology

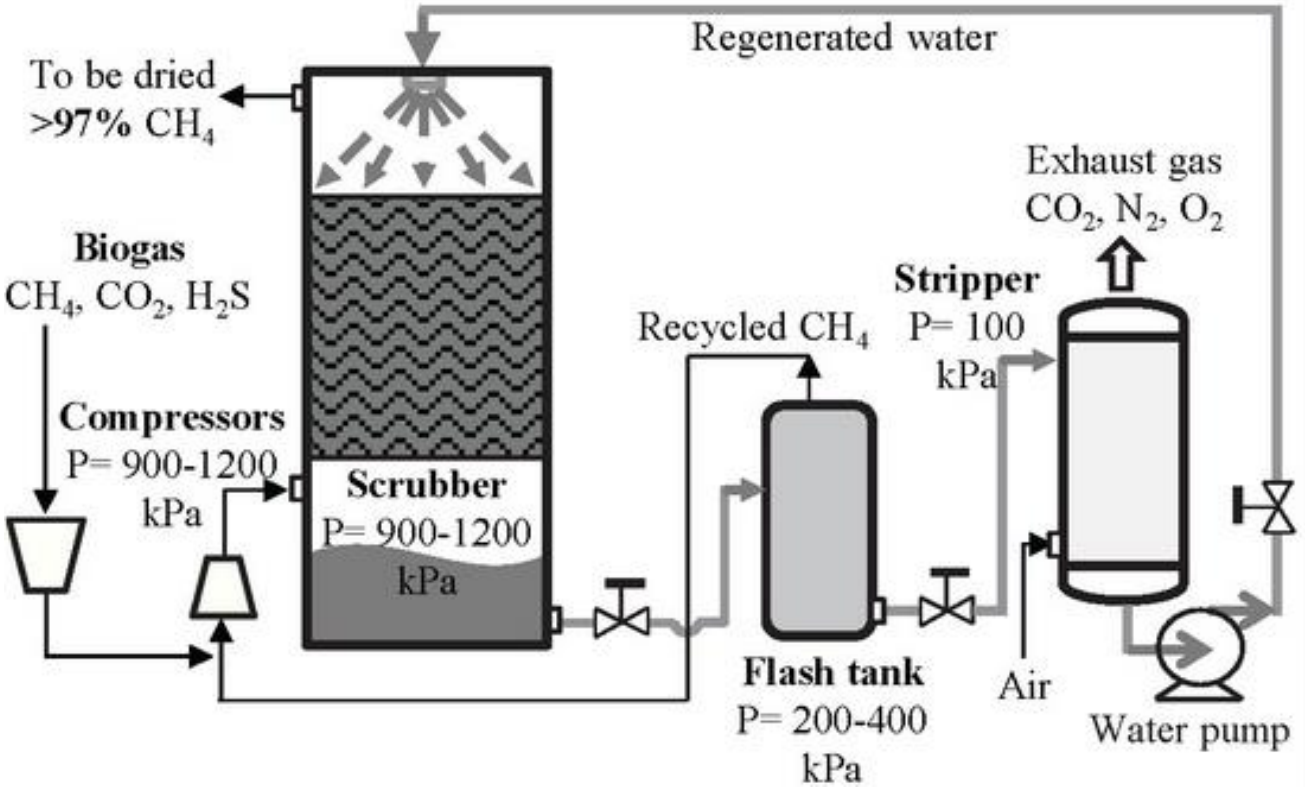
Method	Number of plants	Ave. CH_4 purity, %
Water scrubbing	107	96.1
Pressure swing adsorption	55	95.8
Chemical absorption	53	94.6
Membrane permeation	22	90.3
Cryogenic process	1	88.0

Character	Unit	AD biogas	Landfill biogas	Natural gas
CH_4	vol%	53–70	30–65	81–89
CO_2	vol%	30–50	25–47	0.67–1
N_2	vol%	2–6	<1–17	0.28–14
O_2	vol%	0–5	<1–3	0
C_2+ Hydrocarbons	vol%	0	0	3.5–9.4
H_2	vol%	0	0–3	NA
H_2S	ppm	0–2000	30–500	0–2.9
NH_3	ppm	<100	0–5	0
Chlorines	mg/Nm³	<0.25	0.3–225	NA
Siloxanes	µg/g-DW	<0.08–0.5	<0.3–36	NA

Source: Ohio State University, USA; 2014

3. Why upgrading to biomethane ?

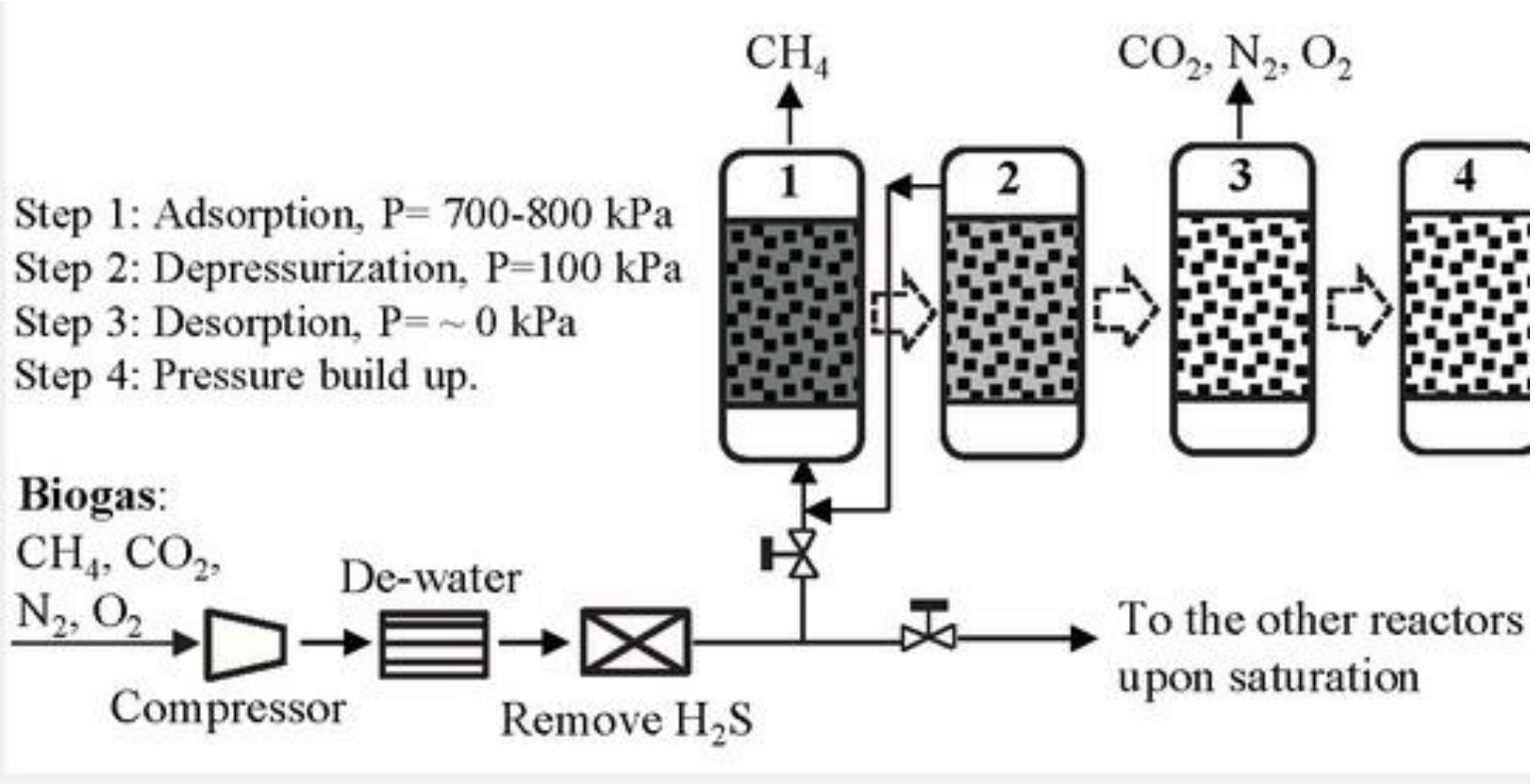
Biomethane Production – Water Scrubbing



Source: Ohio State University, USA; 2014

3. Why upgrading to biomethane ?

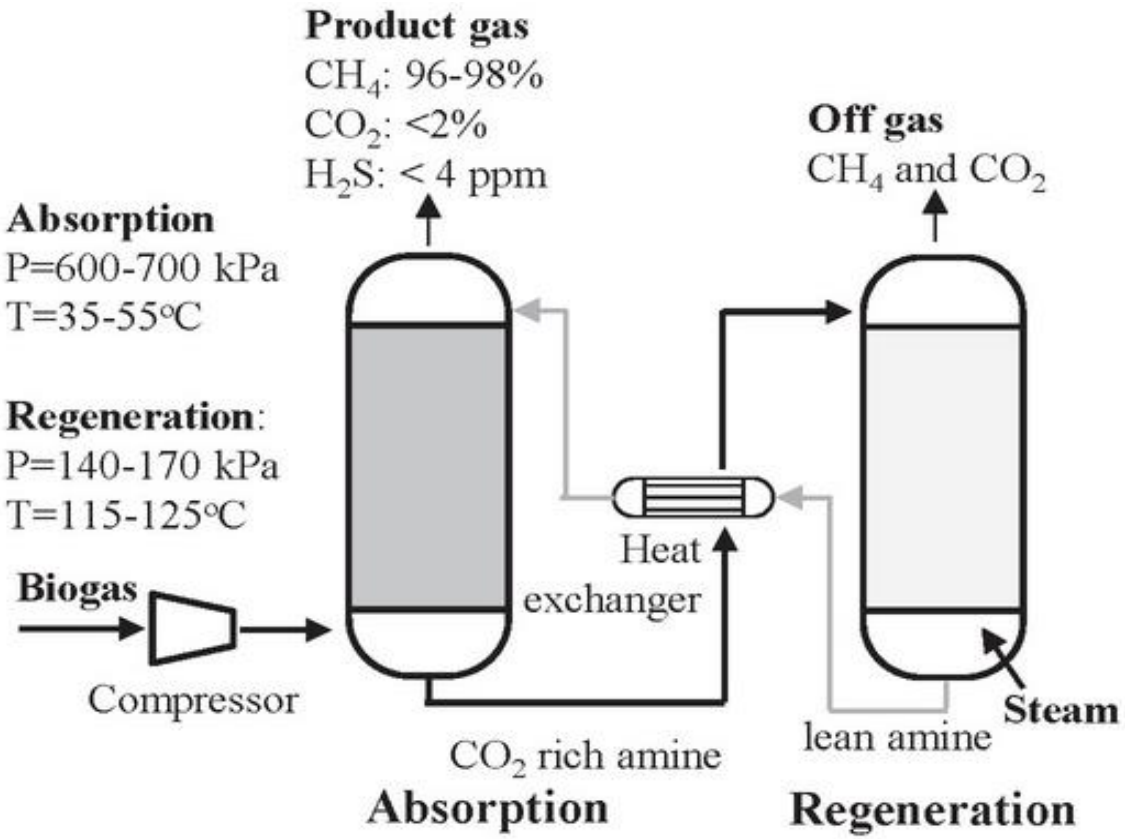
Biomethane Production – PSA



Source: Ohio State University, USA; 2014

3. Why upgrading to biomethane ?

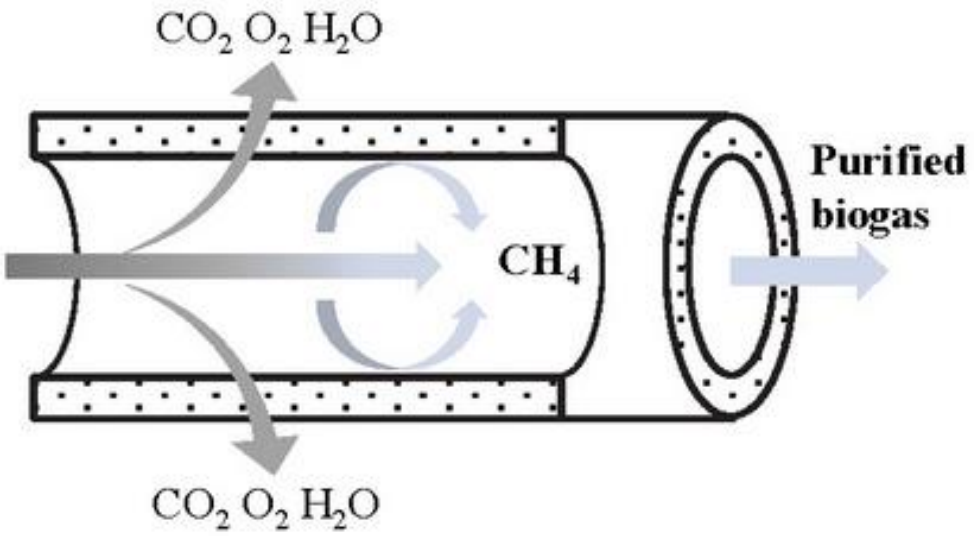
Biomethane Production – Amine Absorption



Source: Ohio State University, USA; 2014

3. Why upgrading to biomethane ?

Biomethane Production – Membrane Permeation



Source: Ohio State University, USA; 2014

4. Advantages of Biogasproduction

- Biogas can provide electricity, heating, cooling and fuel




- Biogas can be stored easily (Cheap - Batterie for Energy Systems)

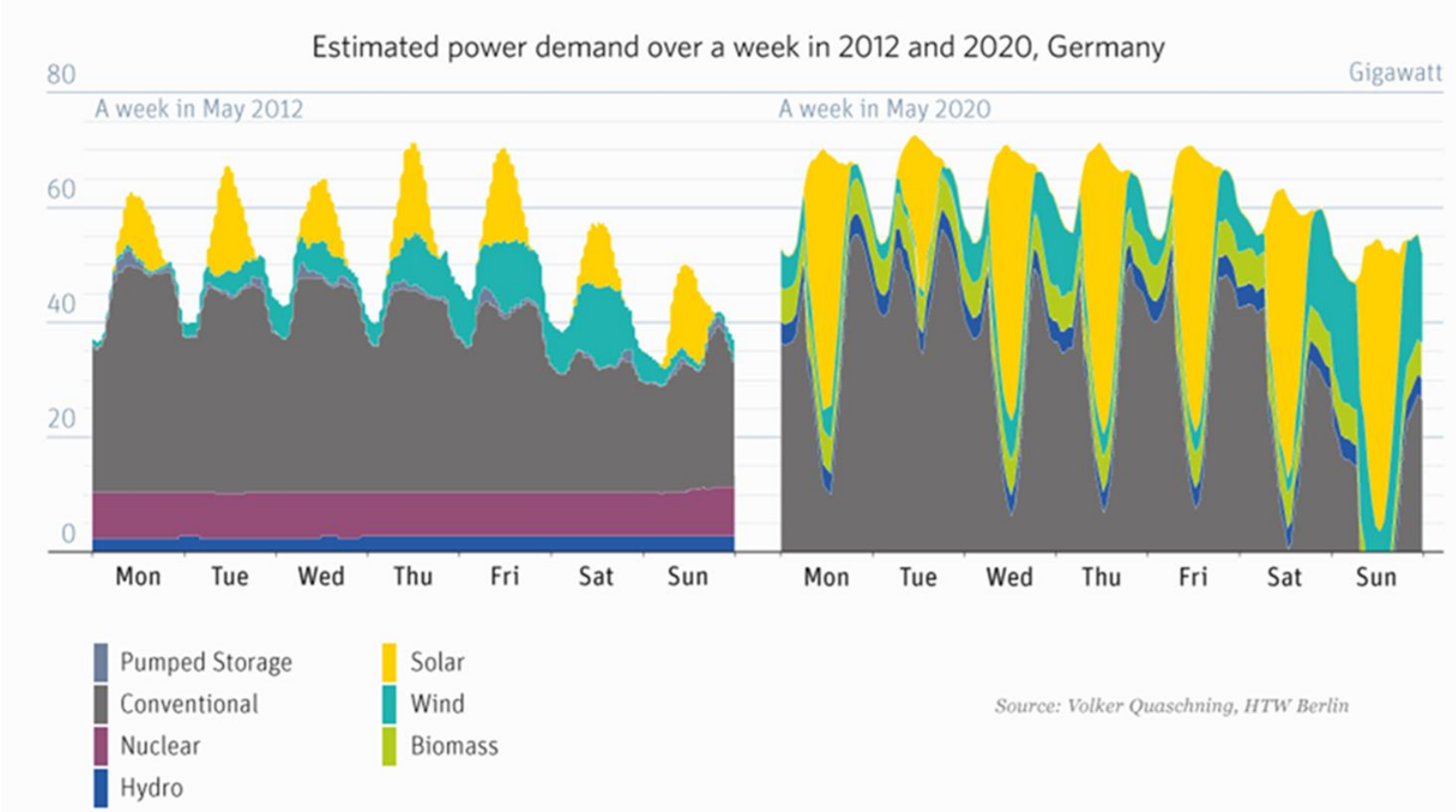


- Biogas Plants can provide system service regulation

4. Advantages of Biogasproduction

Source: DABEC Bioenergy Consulting, 2017

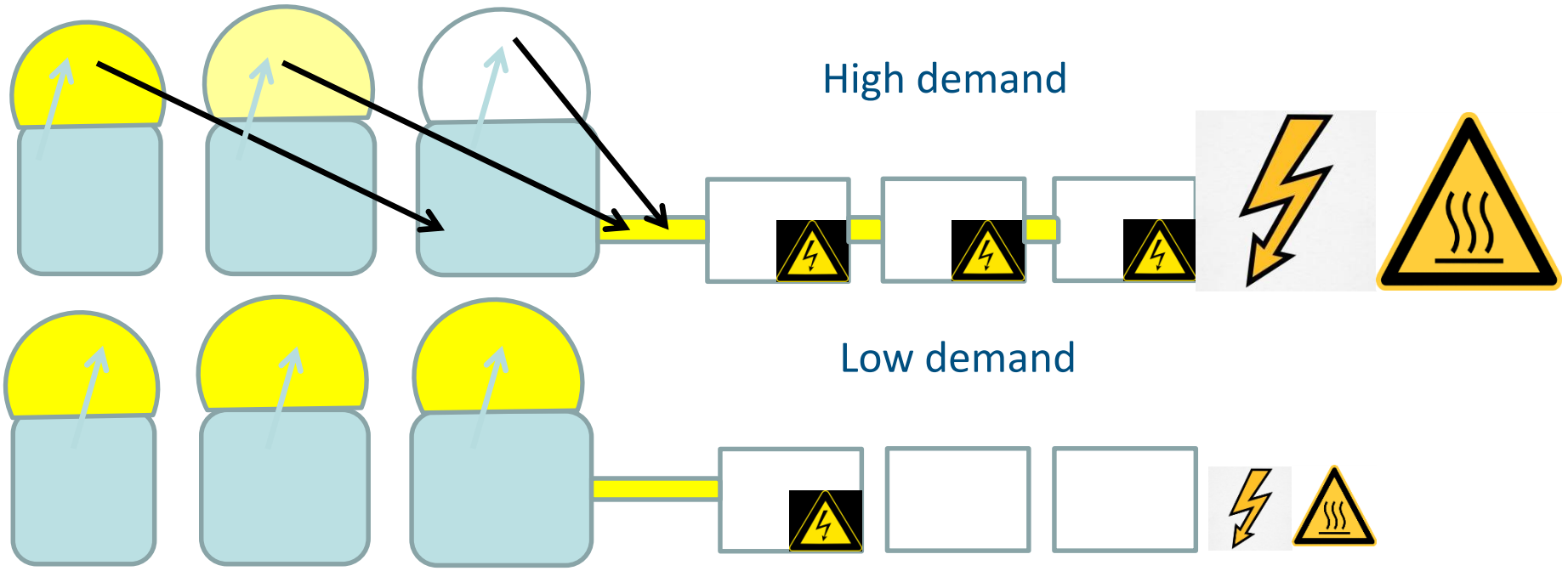
5. The need for flexible backup solutions



5. The need for flexible backup solutions

Flexibility in practical implementation:

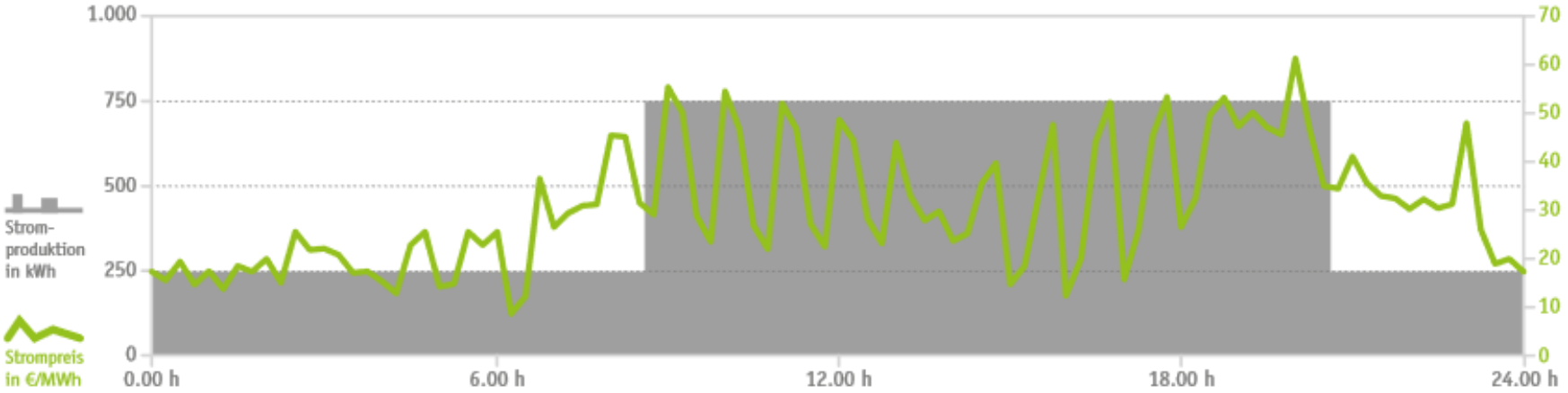
Need – based production with continuous or flexible supply



Source: DABEC Bioenergy Consulting, 2017

5. The need for flexible backup solutions

Flexibility in practical implementation:

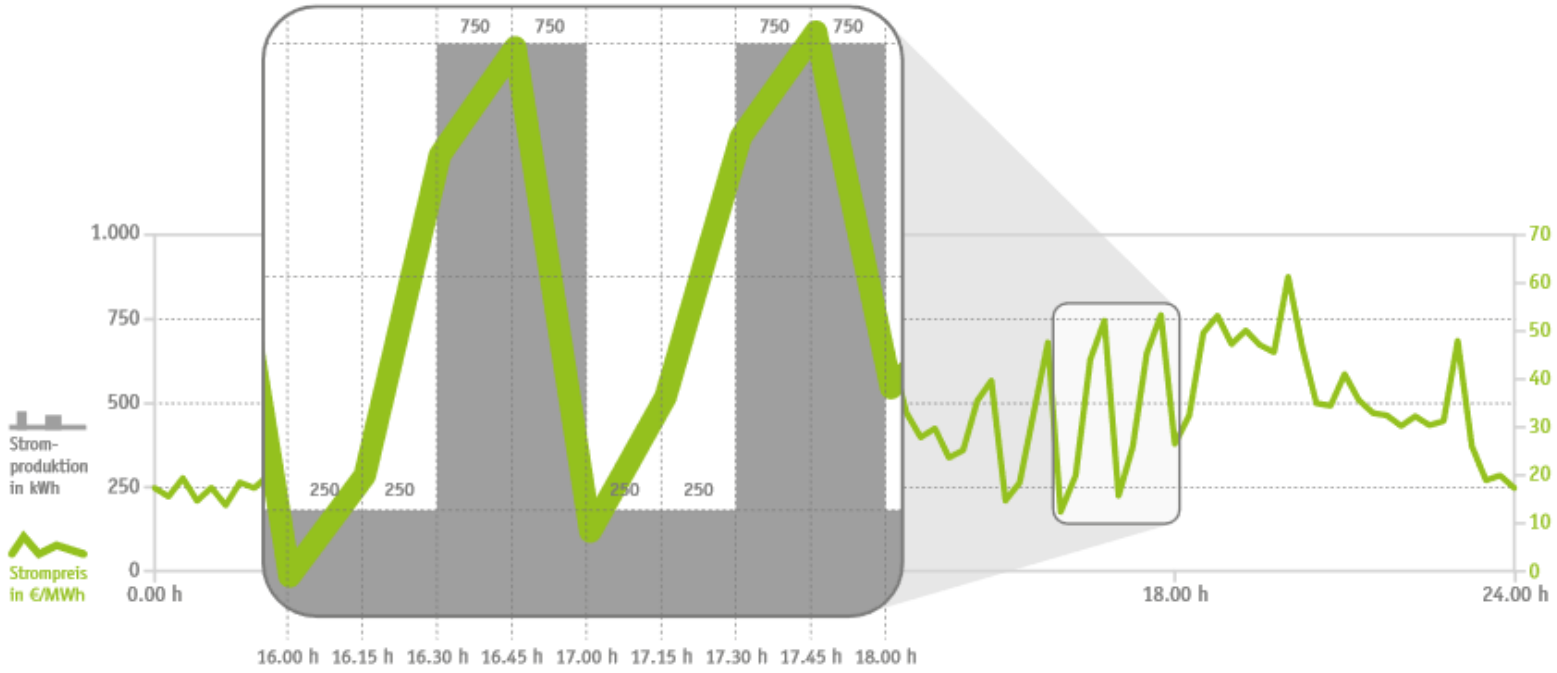


STAGE I

Source: DABEC Bioenergy Consulting, 2017

5. The need for flexible backup solutions

Flexibility in practical implementation:



STAGE II

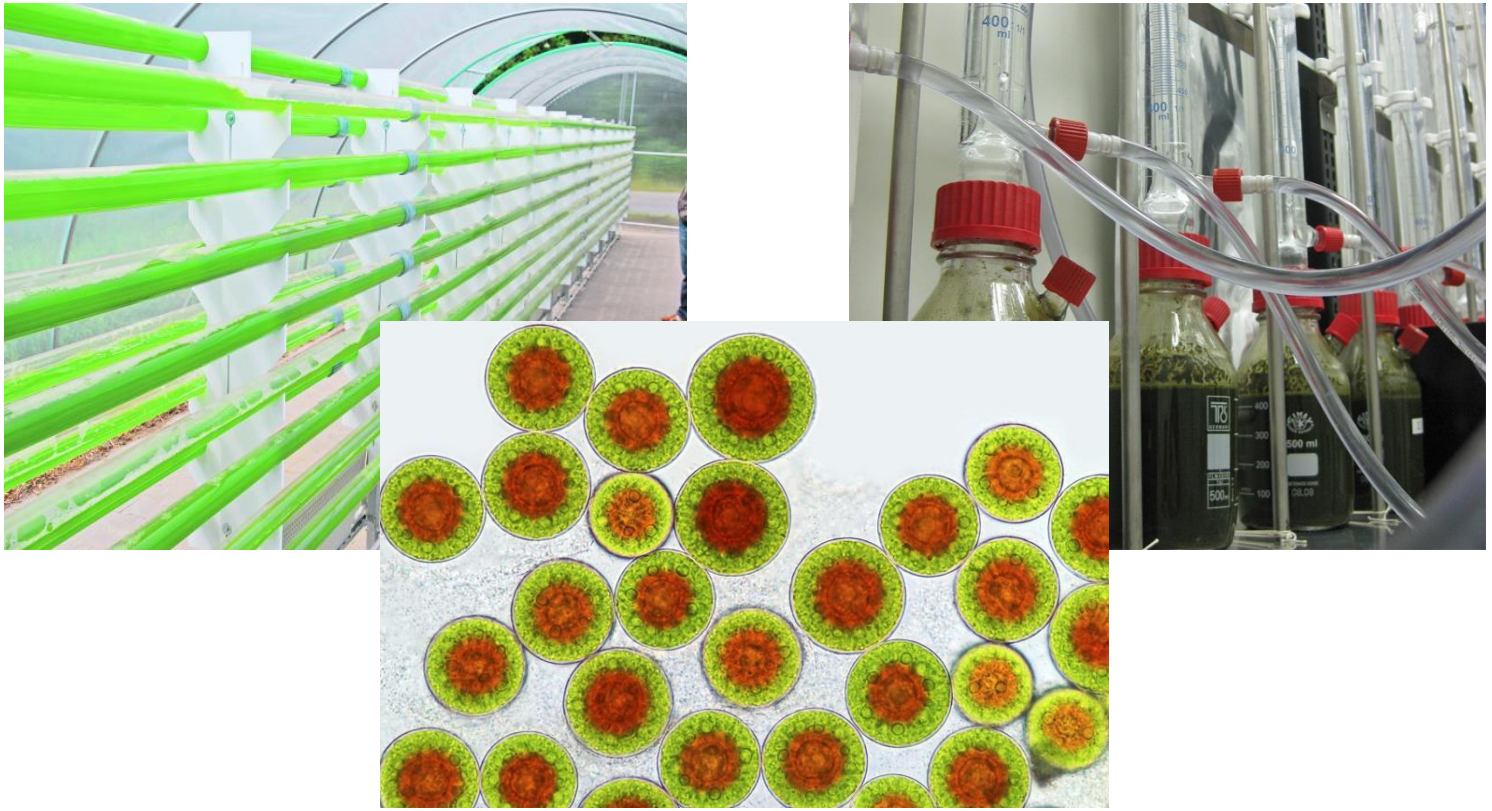
Source: DABEC Bioenergy Consulting, 2017

6. Summary and Outlook

- Overall agreement in policy and economic standpoints that biogas is essential in future energy, waste management and agrarian developement
- Sophisticated status of research and technology developement
- Expected overall rise in Biogas and Biomethane production worldwide
- Interesting new developement especially in waste treatment technologies

6. Summary and Outlook

Biogasproduction from Algae Production



Source: DABEC Bioenergy Consulting, 2017

6. Summary and Outlook

Source: DABEC Bioenergy Consulting, 2017

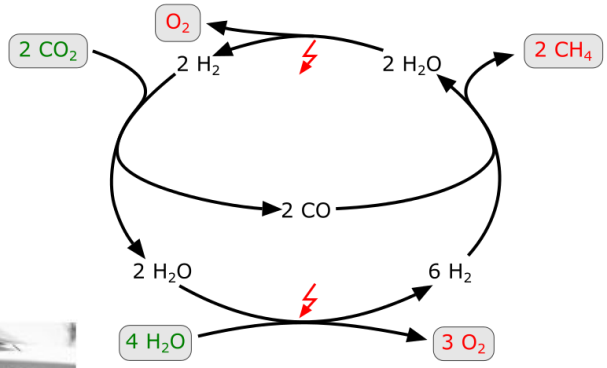
Algae - Oil

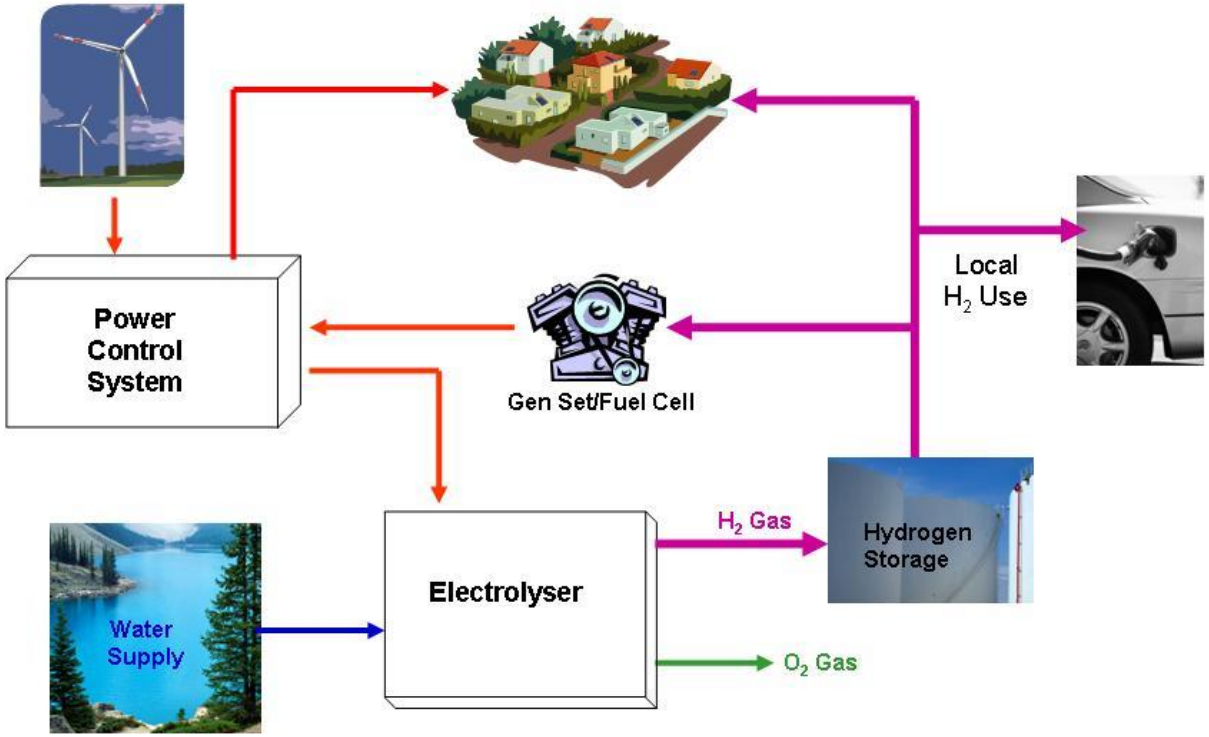
Biokerosene

Biogas

6. Summary and Outlook

PtG – Power to Gas





Source: DABEC Bioenergy Consulting, 2017

6. Summary and Outlook

- Use of waste for biogas – future is essential
- Energy Storage very important
- !! Power Supply must remain affordable!!
- Future Energy Systems with high share of renewables only possible together with Water, Wind, Photovoltaic, Geothermal Power and Biogas

6. Summary and Outlook

- In future : Higher demands for flexibility in energy production and storage
- Biogas technology is on of the key – system for growing share of RES
- Various biogas utilization purposes (heat, elec., steam, fuel, ….)
- Careful process – control systems with online measurements optimize the process and flexible the biogas production
- Professional and safe operation is essential
- Last decade gives significant economies of scale and techn. progress
- Competition between food production vs. Biogas Plants not conductive

7. Best practise and Impressions

Example 1:

BGP Dresden – Klotzsche

Owner: Public Municipalty

Substrates: Manure, Silage

Storage Capacity: 8 hours
1 Gasmotor
Power Capacity: 834 $kW_{el.}$
Heating of Dresden Airport

Source: www.dabec.de

7. Best practise and Impressions

Example 2:

BGP Türkheim - Schönbrunn

Owner: Private

Substrates: Kitchen waste

Storage Capacity: 6 hours
3 Gasmotors
Power Capacity: 960 $kW_{el.}$
Heating of Stables and private Homes

7. Best practise and Impressions

Example 3:

BGP Bremker

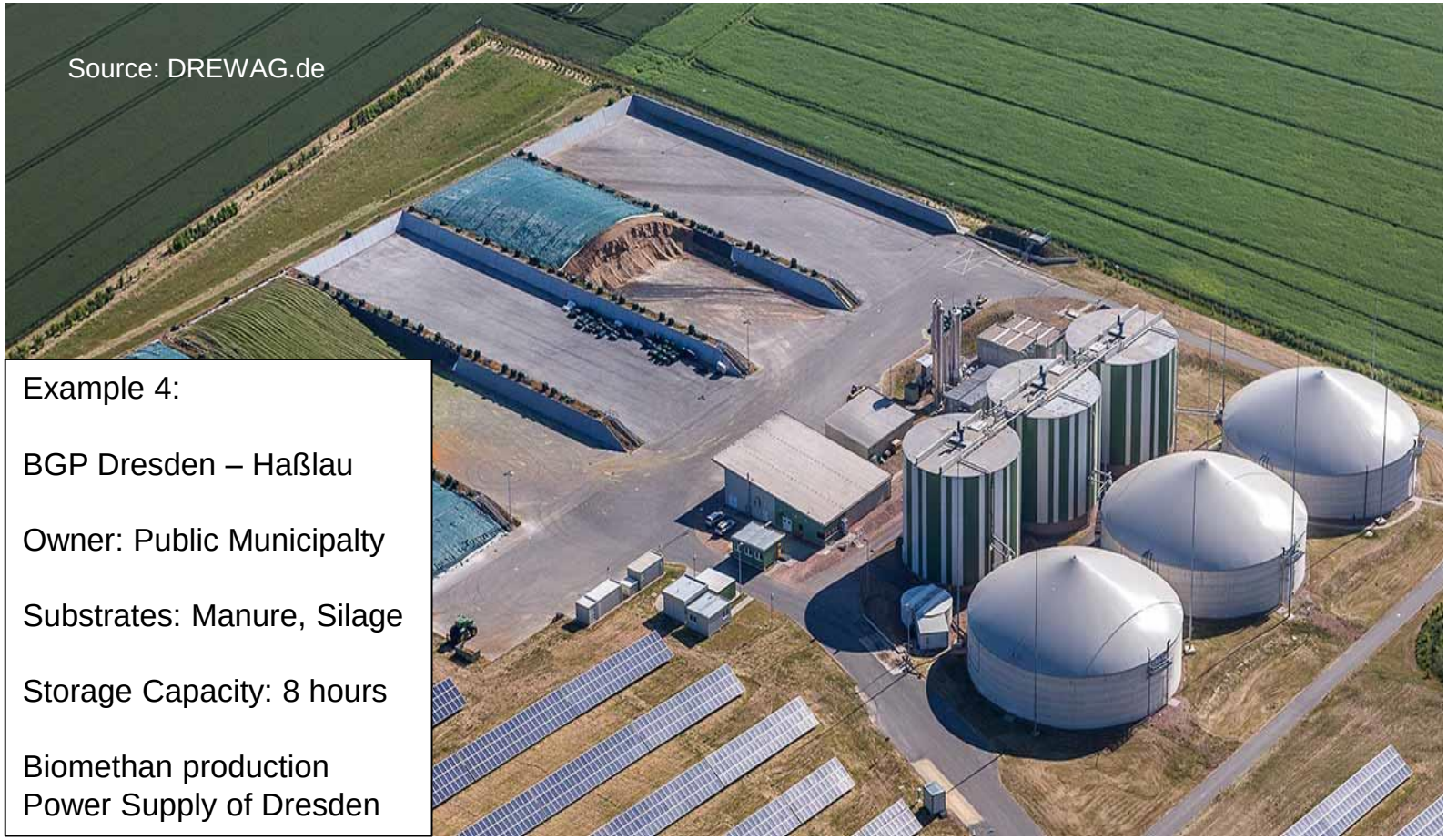
Owner: Private

Substrates: Kitchen waste, Residues, Green Wastes

Storage Capacity: 1 hours
1 Gasmotors
Power Capacity: 75 $kW_{el.}$
Heating of public school and private Homes

Source: Agrikomp.de

7. Best practise and Impressions



Example 4:

BGP Dresden – Haßlau

Owner: Public Municipalty

Substrates: Manure, Silage

Storage Capacity: 8 hours

Biomethan production
Power Supply of Dresden

7. Best practise and Impressions

EECOPALSA Biogas Project, Honduras

- Installed capacity: 1 MW
- Solved environmental problems of wastewater and lack of irrigation
- Registered as a Gold Standard CDM Project
- Environmental Excellence Award 2007

Source: Eecopalsa, Honduras, 2006 (a biogas project from BIOTEC INT. Belgium)

7. Best practise and Impressions

BIO-ENERGY IN FAMILY FARMING

A NEW SUSTAINABLE PERSPECTIVE FOR THE RURAL SECTOR IN BRAZIL

PUBLISHED: SEPTEMBER 2013

Table 1: Costs and investments to implement the Cooperative

Operational Cost	R$ 52,072.50 per year
Total Investment Cost - Biodigesters	R$ 685,096.00
Investment for Each Farm - Biodigester	R$ 16,714.54
Main Gas Pipeline (~ 22 km)	R$ 134,860.50
Gas Pipeline on Each Property	R$ 3,289.28
Generator and Related Equipment	R$ 150,360.00

NOTE: 1 US$ = 2.25 R$; 1€ = 2.97 R$

Ajuricaba hydro basin and rural properties

7. Best practise and Impressions

Source: IEA Bioenergy Task 37

Source: IEA Bioenergy Task 37

Laying of part of the 22-km biogas pipeline

7. Best practise and Impressions

Table 2: TABLE 2 The analysis of the economic viability of the project presents the following indicators:

Indicator	Output
Payback Time	7 years
Current Liquid Value	R$ 244,548.97
Internal Return Rate	18.30%
Cost Benefit Index	30% of the investment
Return of Investment	15.70%
Net Annual Return	2.30%

Centralised combined heat and power plant (CHP),
supplied with biogas through pipeline from distributed small scale plants

Muchas gracias por su atención!

Si tiene alguna pregunta o comentario, no dude en ponerse en contacto conmigo electrónicamente en jan.adolph@dabec.de