BIOMETHANE PRODUCTION: CURRENT STATE, PERSPECTIVES, FEEDSTOCK, AND ECONOMIC EVALUATION IN AUSTRIA AND THE CZECH REPUBLIC

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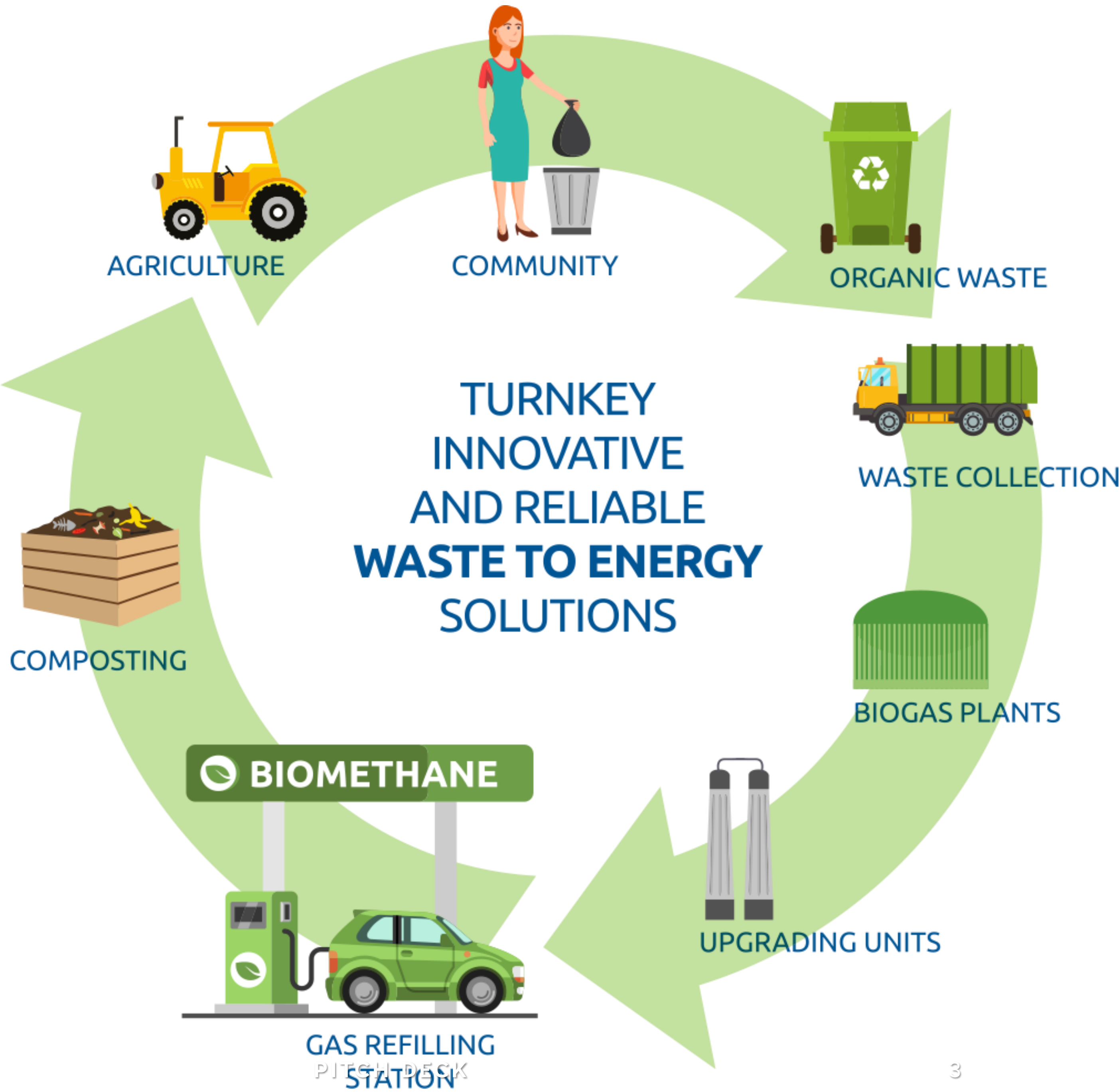
INDEX

1. Introduction
2. Available feedstocks
3. Biogas production technologies
4. Biomethane production
5. Biomethane in the EU
   - 5.1. Austrian scheme
   - 5.2. Czech Republic scheme
   - 5.3. Long-term visions for Austria and the Czech Republic
6. Results and conclusions

1. INTRODUCTION



2. AVAILABLE FEEDSTOCKS

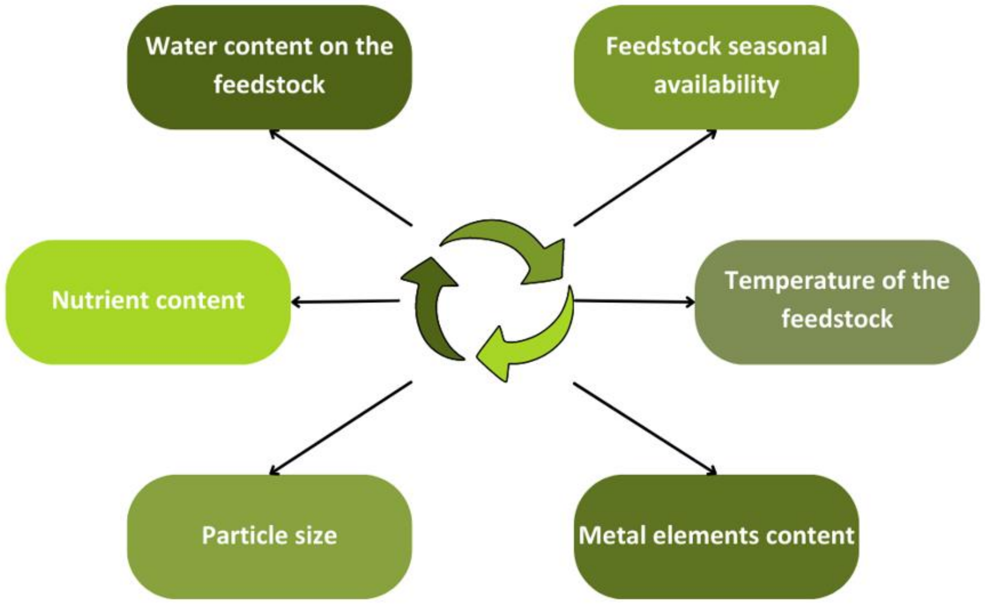
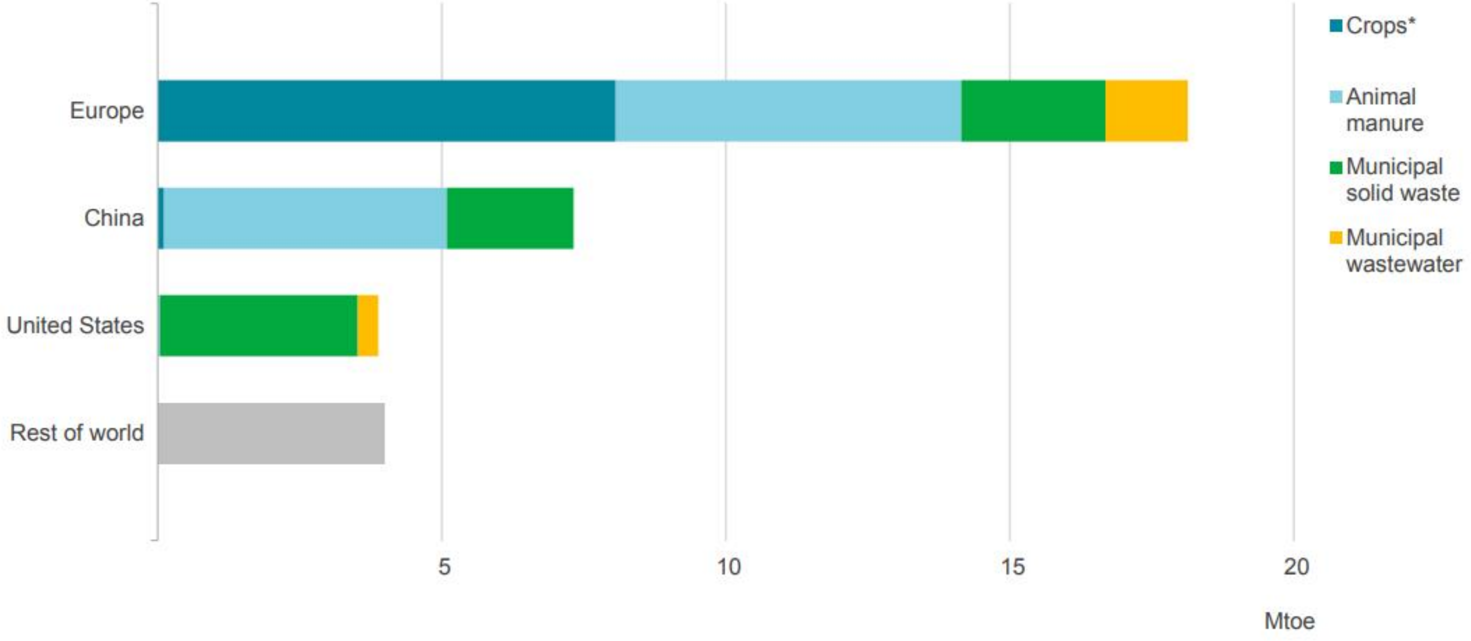


Figure 1. Factors affecting the feedstock properties and suitability for biogas production by the anaerobic digestion process. Information obtained from: [1], [2]

WATER CONTENT ON THE FEEDSTOCK	Considerable amount of water and low inorganic matter are preferred
FEEDSTOCK SEASONAL AVAILABILITY	Seasonal availability of organic matter can influence the biogas production process. Composition variation
TEMPERATURE OF THE FEEDSTOCK	Temperature control is fundamental. Very high inlet temperatures can affect the microbes in the digestor
PARTICLE SIZE	Reduced size is preferred. However, fine particles may provoke the declination of the system
NUTRIENT CONTENT	*Macronutrients (C, N, S)*: stabilization of the cells, synthesis of proteins, and energy transfer. *Micronutrients (Mg, Co, Ni, Zn)*: facilitate the microorganisms' reproduction
METAL ELEMENTS CONTENT	Inhibit the digestion process and interfere with the enzyme's functionality

2. AVAILABLE FEEDSTOCKS

- Europe → largest producer of biomethane. Mainly produced from crop residues and animal manure.
- China → primary feedstock: animal manure and MSW. High number of installed household digesters
- United States → biogas production based on landfill gas collection from MSW



* Crops include energy crops, crop residues and sequential crops.
Note: 1 Mtoe = 11.63 terawatt-hours (TWh) = 41.9 petajoules (PJ).

Figure 2. Biogas or biomethane production by feedstock source, 2018. Source: [3]

3. BIOGAS PRODUCTION TECHNOLOGIES

WHAT IS ANAEROBIC DIGESTION?

- A process where microbial organisms biodegrade organic matter
- The products are a **gas mixture** conformed mainly of methane (CH_4, up to 75%), carbon dioxide (CO_2, up to 50%), and trace gases, and a **semisolid compound**.
- Different reactions between the bacteria and organic substrate occur

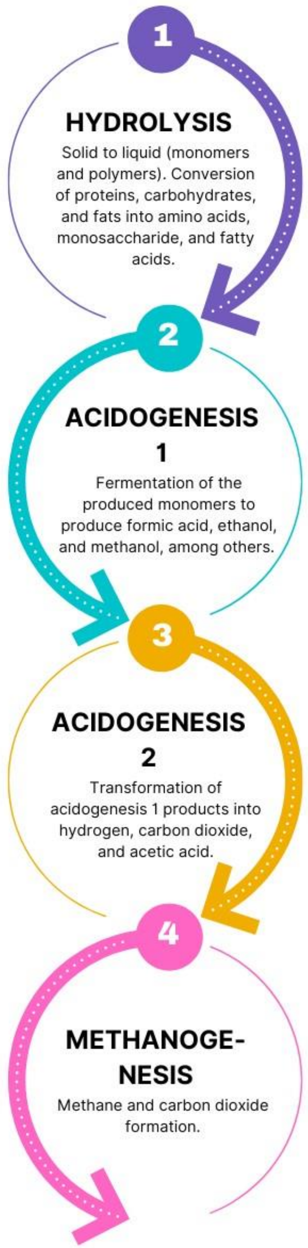


Figure 3. Anaerobic Digestion conversion reactions.

Information obtained from [4]

ANAEROBIC DIGESTION TECHNOLOGIES

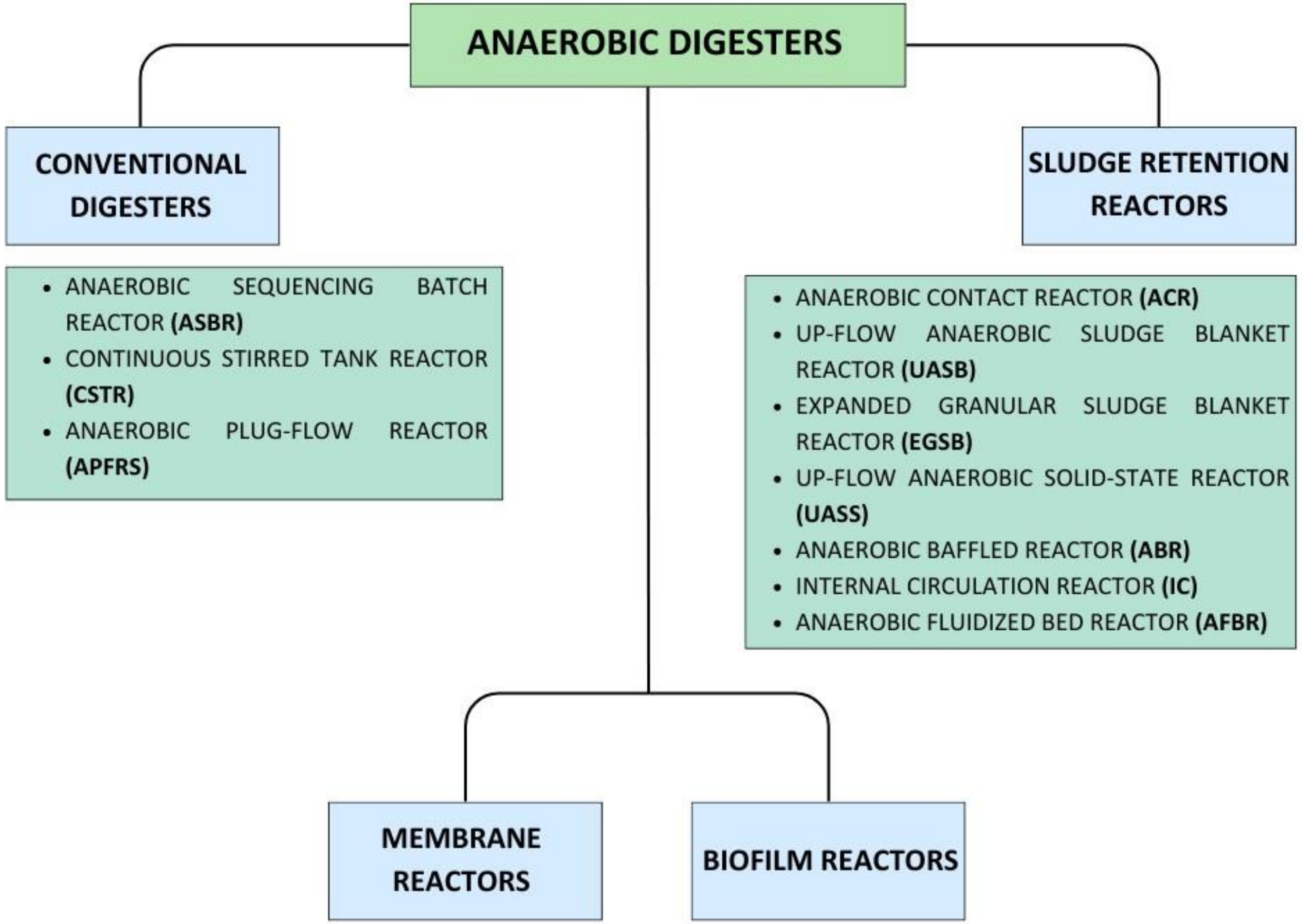
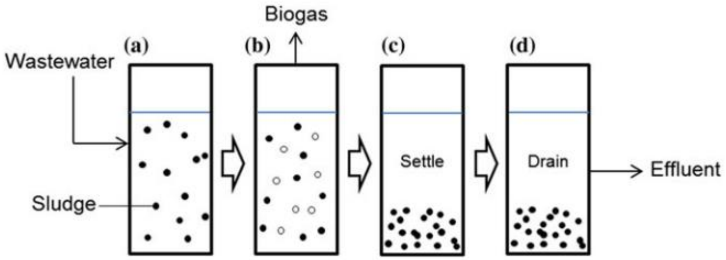


Figure 4. Anaerobic digesters. Information obtained from [5]

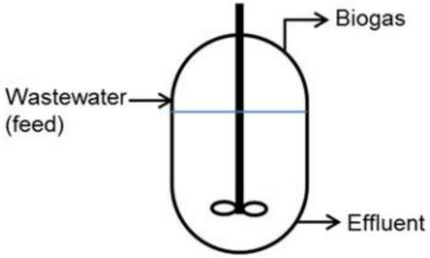
3. BIOGAS PRODUCTION TECHNOLOGIES

CONVENTIONAL DIGESTERS



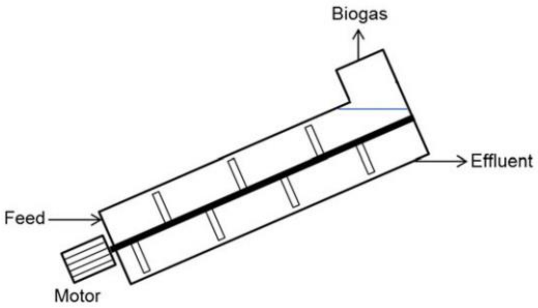
ANAEROBIC SEQUENCING BATCH REACTOR (ASBR)

High residence times
Low volume flows



CONTINUOUS STIRRED TANK REACTOR (CSTR)

Continuous insertion of substrate
Parameter uniformity and system simplicity
High residence times and energy



ANAEROBIC PLUG-FLOW REACTOR

Higher biogas conversion efficiency
Excellent stability and efficiency

Source of images [5]

4. BIOMETHANE PRODUCTION

Biogas composition:

- Methane (CH_4, up to 75%)
- Carbon dioxide (CO_2, up to 50%)
- Nitrogen (N_2, 0-3%)
- Water vapor (H_2O, 5-10%)
- Oxygen (O_2, 0-1%)
- Hydrogen sulfide (H_2S, 0-10000ppm)
- Ammonia (NH_3, up to 200 mg/m3)
- Siloxanes (up to 40 mg/m3)

Gas grids require a minimum methane purity of 95% and low or no impurities → Biogas must be upgraded to biomethane

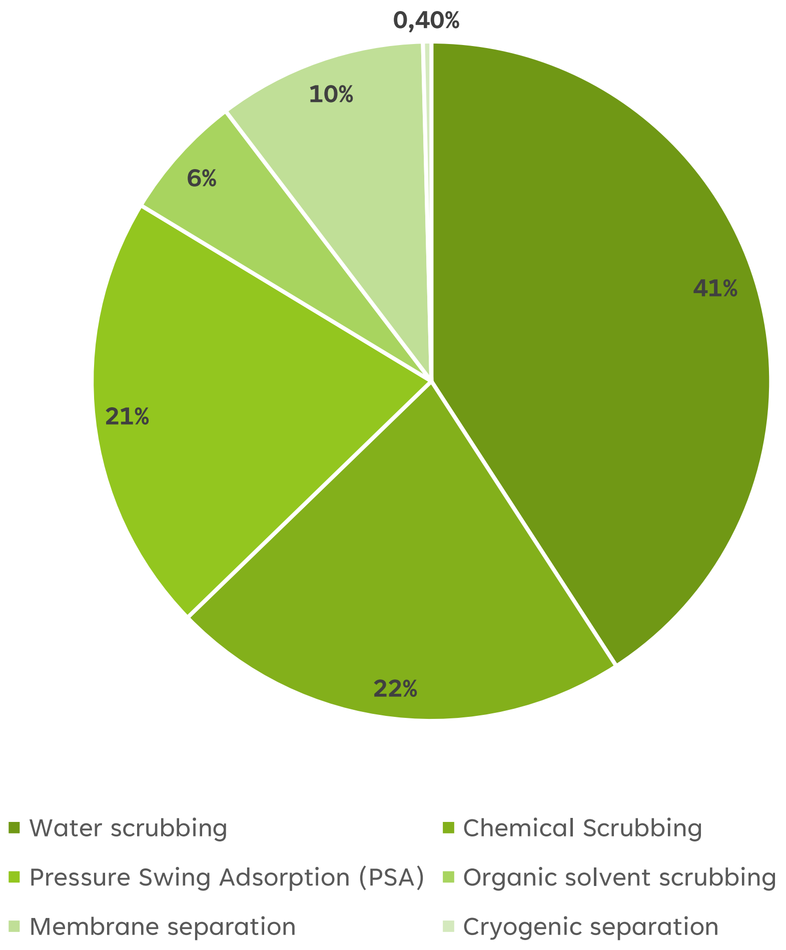


Figure 5. Biogas upgrading technologies. Source: [5]

4. BIOMETHANE PRODUCTION

MOST COMMON TECHNOLOGIES

WATER SCRUBBING

Water as a reactive agent
Relatively high pressures of around 6 to 10 bar
Regeneration of water on a stripping column

CHEMICAL SCRUBBING

Similar configuration to water scrubbing
Uses a chemical solvent (e.g., KOH, NaOH, or K_2CO_3) to absorb H_2S and CO_2

PRESSURE SWING ADSORPTION (PSA)

The contaminant is removed by alternating adsorption and desorption steps
Four column configuration
High biomethane purity and efficiency

5. BIOMETHANE IN THE EU

- Vital role in future
- Goal = 35 BMC by 2030
- REPowerEU, Fit for 55, Green Deal

Obstacles

- different level on EU level
- prices

Ways to increase biomethane

- sustainable + food, agriculture, forestry
- subsidies, share costs

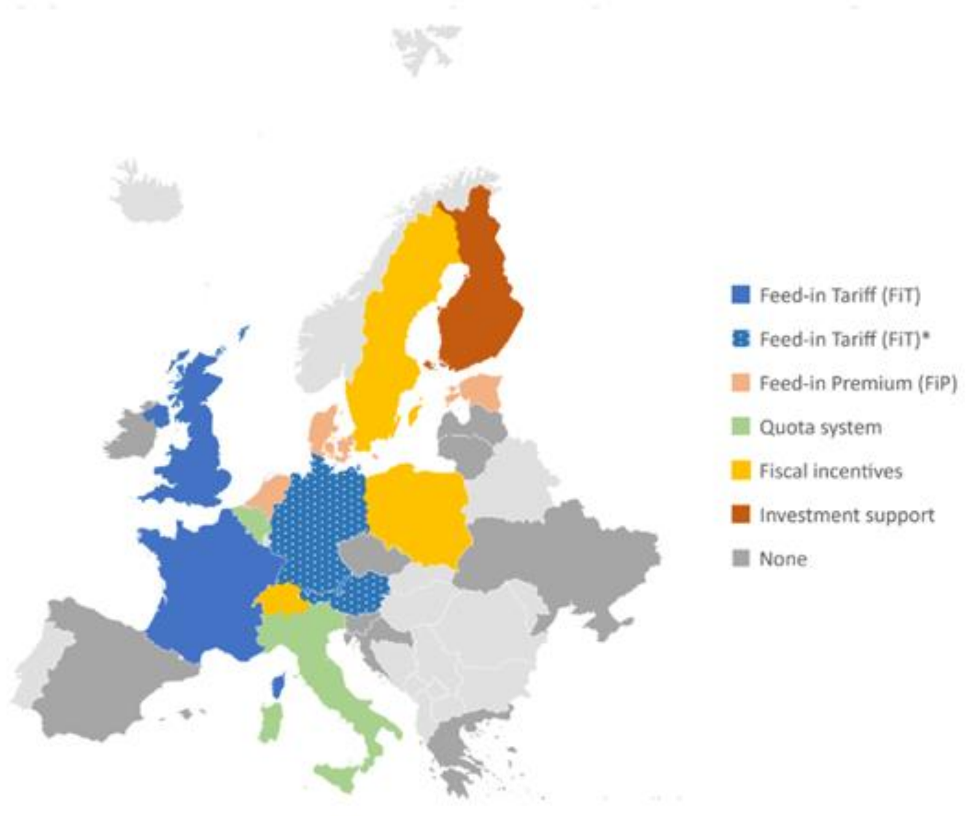


Figure 6. Support schemes in place per country. Source: [6]

DIFFERENCES AMONG EU MEMBER STATES

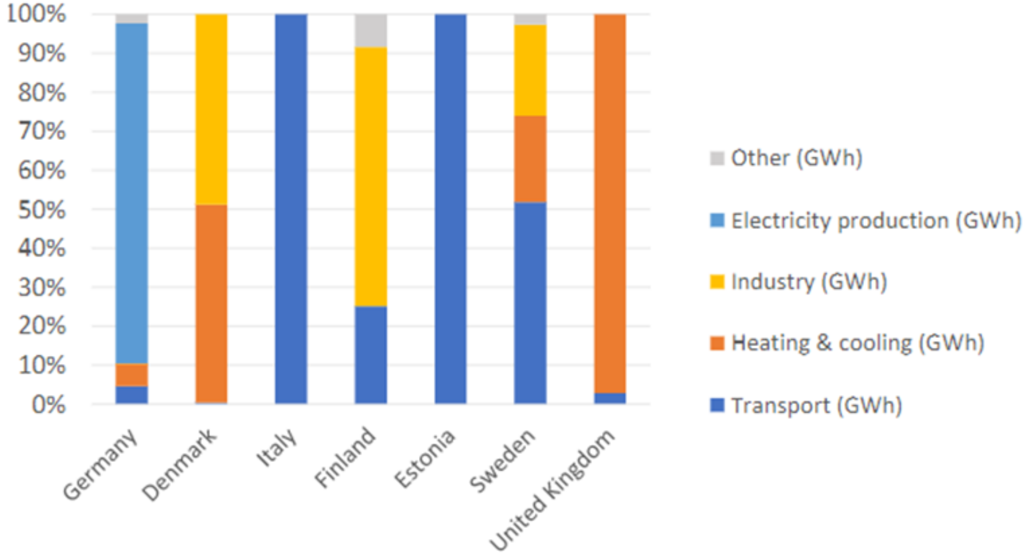


Figure 7. Consumption of biomethane per sector and per country (for countries where data is available). Source: [6]

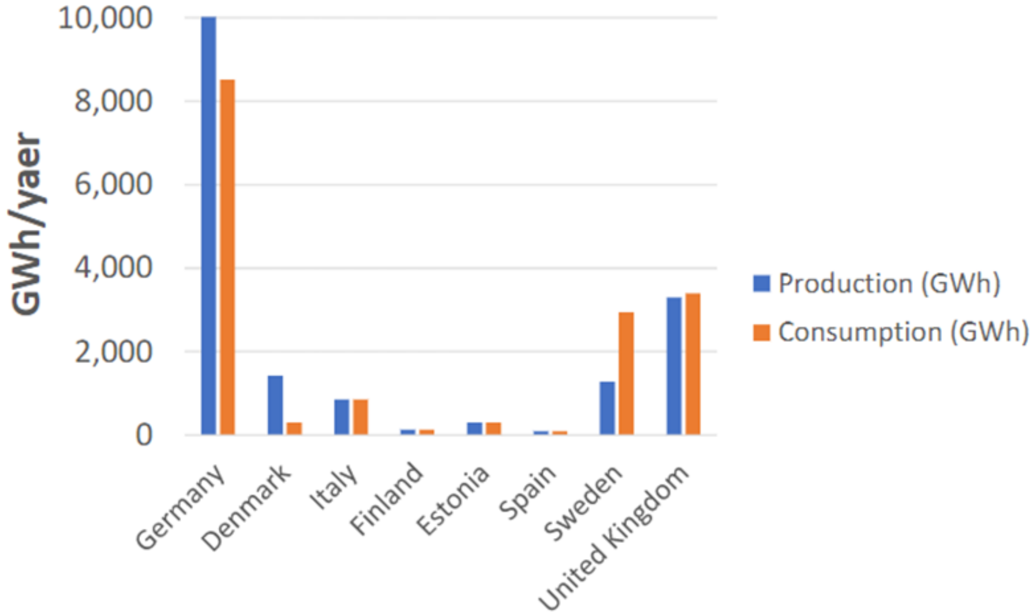


Figure 8. Total biomethane production compared to total biomethane consumption per country. Source: [6]

5.1. BIOMETHANE IN AUSTRIA

- 2005 - biomethane power plant
- Subsidy system = Feed-in Tariffs
- Legislative background
- Registry system is working

But...

- Not fully developed, production is used for various purposes
- Local subsidies, cost-sharing
- Still space for improvement

5.2. BIOMETHANE IN THE CZECH REPUBLIC

- Biomethane = future
- Particular strategy for biomethane is missing
- Regulatory and subsidiary framework
- Market not developed
- Long-term visions
  - to strengthen the production
  - legislative background
  - subsidiary framework

5.4. LONG-TERM VISIONS FOR AUSTRIA AND THE CZECH REPUBLIC

THE CZECH REPUBLIC

TO STRENGTHEN THE PRODUCTION

LEGISLATIVE BACKGROUND

SUBSIDIARY FRAMEWORK

X

AUSTRIA

MORE EFFECTIVE USE OF WASTE

TO STRENGTHEN PRODUCTION

PUBLIC DEBATE

6. RESULTS AND CONCLUSION

1. Biomethane has the potential to cover the future gas demand while solving significant challenges
2. A wide range of feedstock can be utilized
3. The conventional technologies ASBR, CSTR, and APFRS are the simplest and most cost-effective for biogas production
4. Other technologies such as membrane-based digesters have higher efficiencies but higher costs
5. Differences among the EU
6. Biomethane is more developed in Austria than in the Czech Republic

THANK YOU

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