Food & Bio Cluster
Denmark

LESSONS LEARNED FROM THE DANISH BIOGAS INDUSTRY

– ORGANIC WASTE AS A RESOURCE

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Food & Bio Cluster Denmark is your gateway to one of the most sustainable and productive agrifood and bioresource countries in the world.
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Biogas Go Global

When we collaborate, we innovate and grow

Food & Bio Cluster Denmark is the meeting point and platform for innovation and knowledge collaboration.

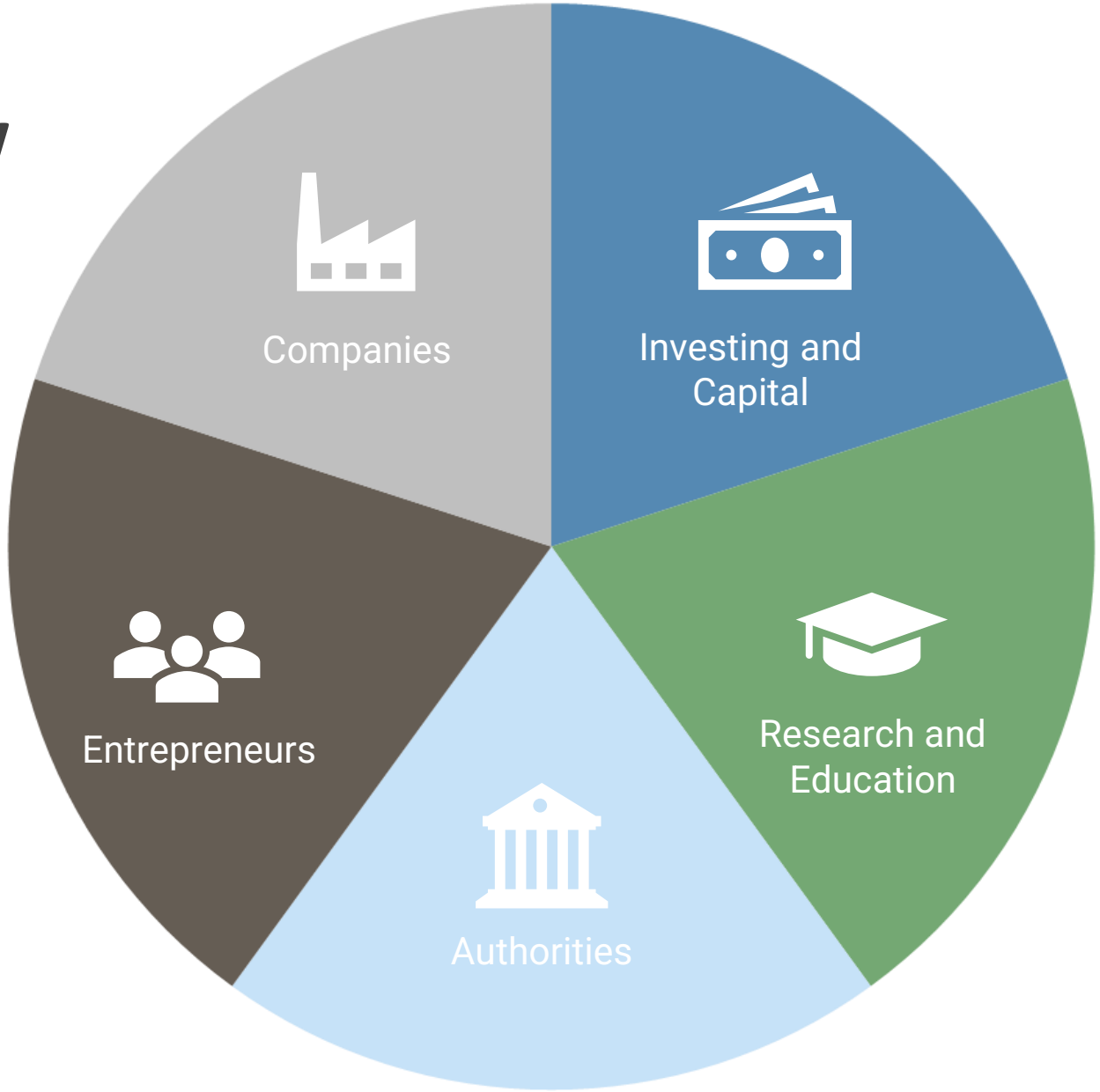

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Foto: Food Nation

Food & Bio Cluster Denmark in numbers

16000
Contacts in the agrifood sector

+5000
organisations globally

Partners in
65
countries

+40
Smart brains

9
Locations in Danmark

+456
Members

+180
events a year

+8800
followers on LinkedIn

3
Copenhagen
Aarhus
Viborg
Incubators. +50 startups in house

+260
M € project portfolio

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Denmark

Foto: Food Nation

Members that drive ag-environment- and biogas innovation

AMMONGAS

BIO GASCLEAN

Anaergia
Fueling a Sustainable World

LANDBRUG FØDEVARER

Nordic Green Engineering
Secure and sustainable energy

GEMIDAN ECOGI

nature energy

Arla

Combigas®
Complete biogas solutions

Consibio

MÅNSSON

Food & Bio Cluster Denmark

Foto: Food Nation

Members that drive ag-environment- and biogas innovation

N2 — Applied

SEGES INNOVATION

Ambient Carbon

AgroGas

MARIPURE
LIVESTOCK RE-EMISSIONED

BioCover a|s DATA

Stiesdal

AquaGreen

MASH MAKES

AgroGas

BioMass.dk
Valueadding biomasses

DevLabs
Chemical and Environmental Sensor Solutions

Food & Bio Cluster Denmark

RENEWABLE ENERGY & CIRCULARITY

- 2/3 of all renewable energy in Denmark is bioenergy. 34% of all energy production is RE.
- Goal: Climate neutral by 2050 – 70% by 2030 (baseline: 1990)
- All organic household waste to be collected by 2023.
- Green policies: Overall strong political consensus across the 10 parties in the Parlament.
- Triple Helix Cooperation key!

WHY BIOGAS?

Agri-environment
Less smell and leaching
Less methane and laughing gas slip
Higher availability of nutrients
Proper handling of food waste

Energy
Renewable, storable gas that replace fossil fuels in transport and high temp. industries
Enables companies to be green
Opportunities to integrate wind power in the gas system

Economy
Jobs through local value chains
Energy independence

THE DANISH APPROACH

Circular economy
Urban-rural “cooperation”
Co-digestion: Agri-, food-, industrial wastes
Recirculation of nutrients - high value for organic farming
AD is much more than just energy

Technology & Process
Economy of scale, but no size fits all
Mainly thermophilic processes in CSTR
Flexible plants putting gas to the grid

Ownership & Management
Biomass suppliers co-invest but now also pro-investors
Long contracts and partnerships on feedstock and digestate
Operation is key and not a part time job!

Denmark chose AD & biogas as a management strategy for its organic waste streams from industry, agriculture and households because it’s a natural biological process that yields not only nutrient rich fertilizer, but also renewable energy.

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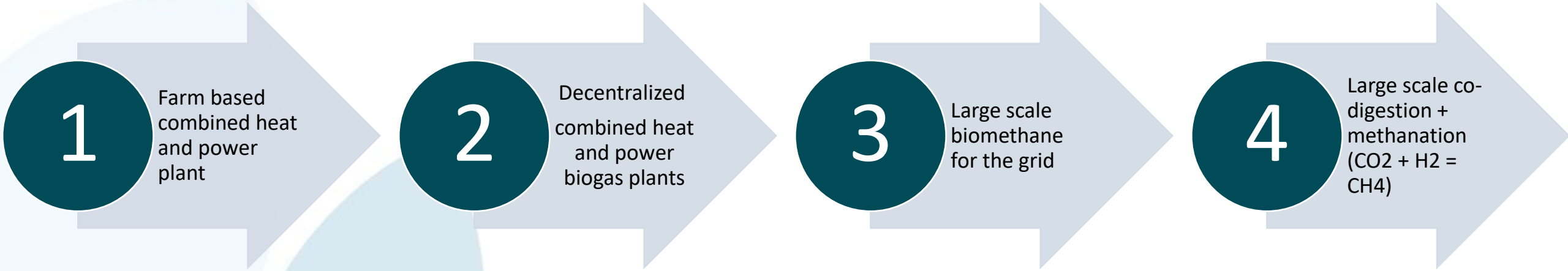
From farm based to large scale methanation

1st to 4th generation biogas plants



10.000 tons feedstock/plant/year

1.000.000 tons

70ties 80ties 90ties 00s 10s 20ties Near future

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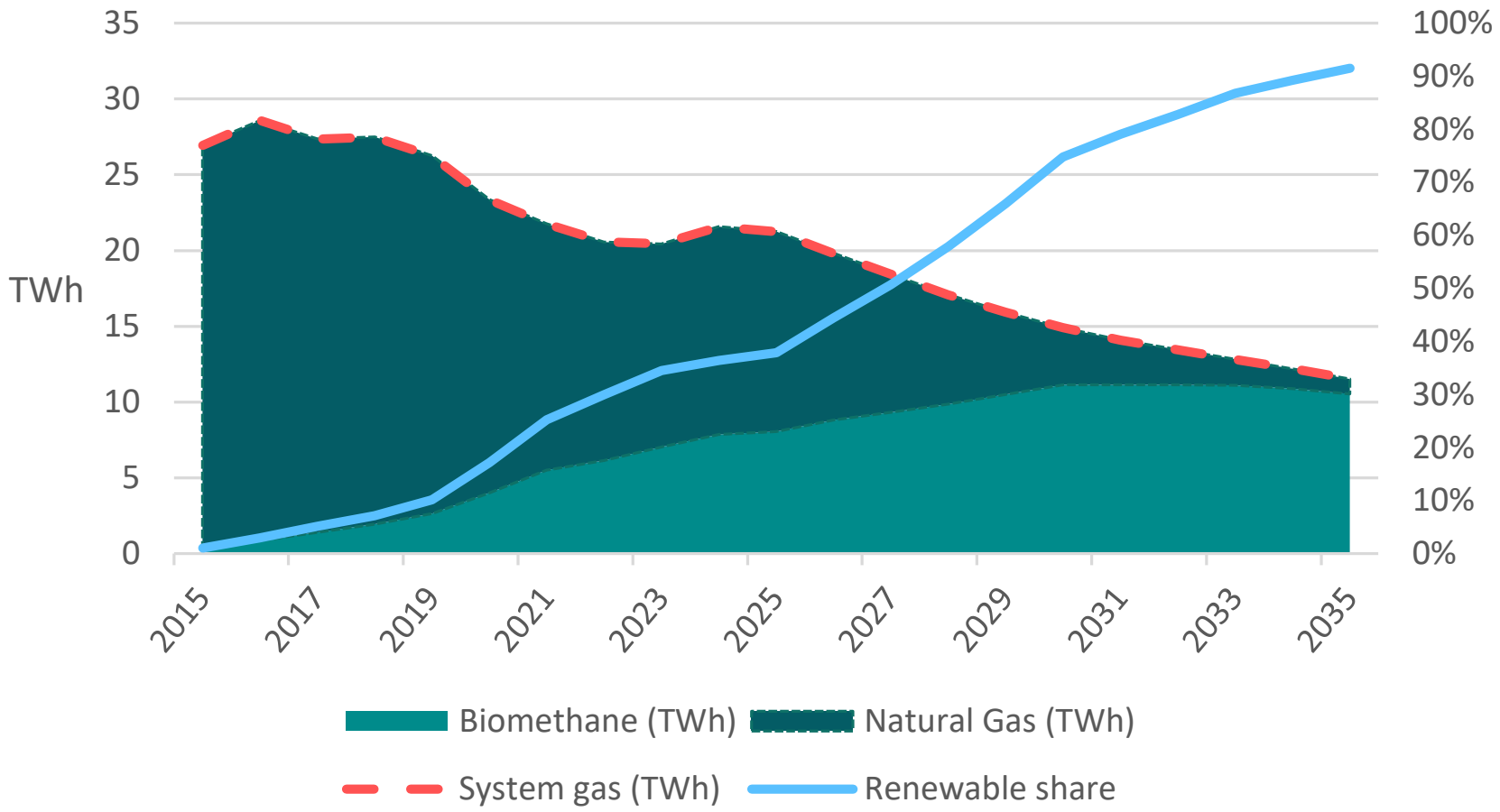
A 100% green gas grid by 2027?

Decline in use of gas, increase in biomethane production



Source: Danish Energy Agency

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Framework conditions that made it happen

Political leadership is needed to recognize the socioeconomic value of biogas

Green growth 2009	Energy agreement 2012	Ressource strategy 2013	Climate law 2019
○ Investment grants for biogas	○ Improved FiT (power) ○ New FiT upgrading, transportation, process and heat	○ In 2023 reuse 50 % of household waste	○ 70 % reduction of greenhouse gas emissions by 2030 ○ Climate partnerships

Broad agreements across political parties is de-risking investments

Mix of Agri + Environmental + Energy policies

Trust and collaboration between public and private stakeholders

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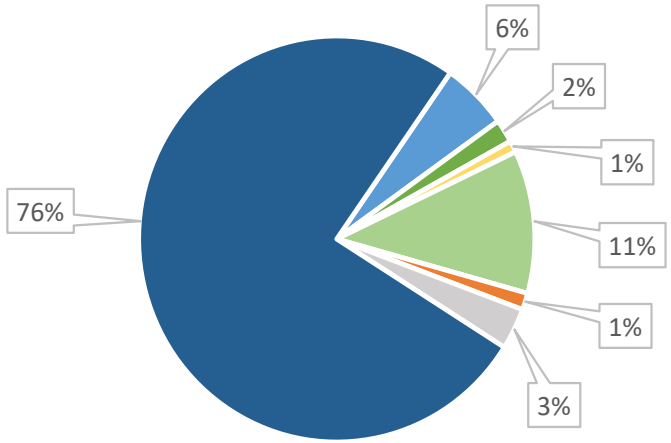
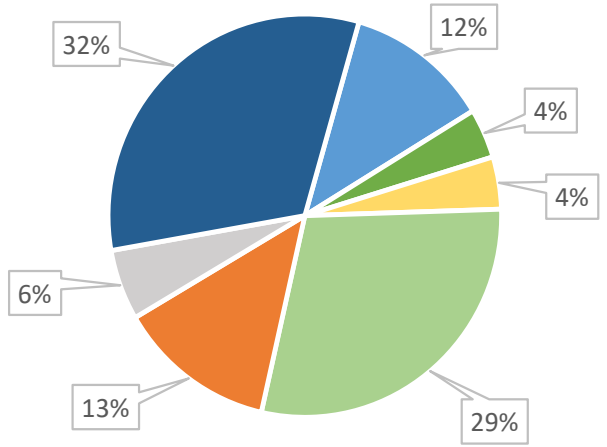
Sustainable co-digestion

The core of the Danish biogas model

Relative share of different biomasses - pct of total input



Share of total gas production attributable to different biomasses



Slurry/manure
Energy crops
Other crops/residues
Straw
Industrial waste
Glycerol
Urban waste

Use of energy crops

- Maximum of 12 % energy crops (wet input) in order to get support (*Energy crops: maize/corn, cereals, sugar beets, jerusalem artichokes, grass*).
- Average around 4%, but risk of increasing usage.
- Maximum will be reduced further next year, and continue to decrease towards 2024 (4 %)
- Maize ends in 2025
- Plans for further reductions
- 2.5 pct. methane leakage from biogas plants
- New initiative in preparation.

Source: Danish Energy Agency

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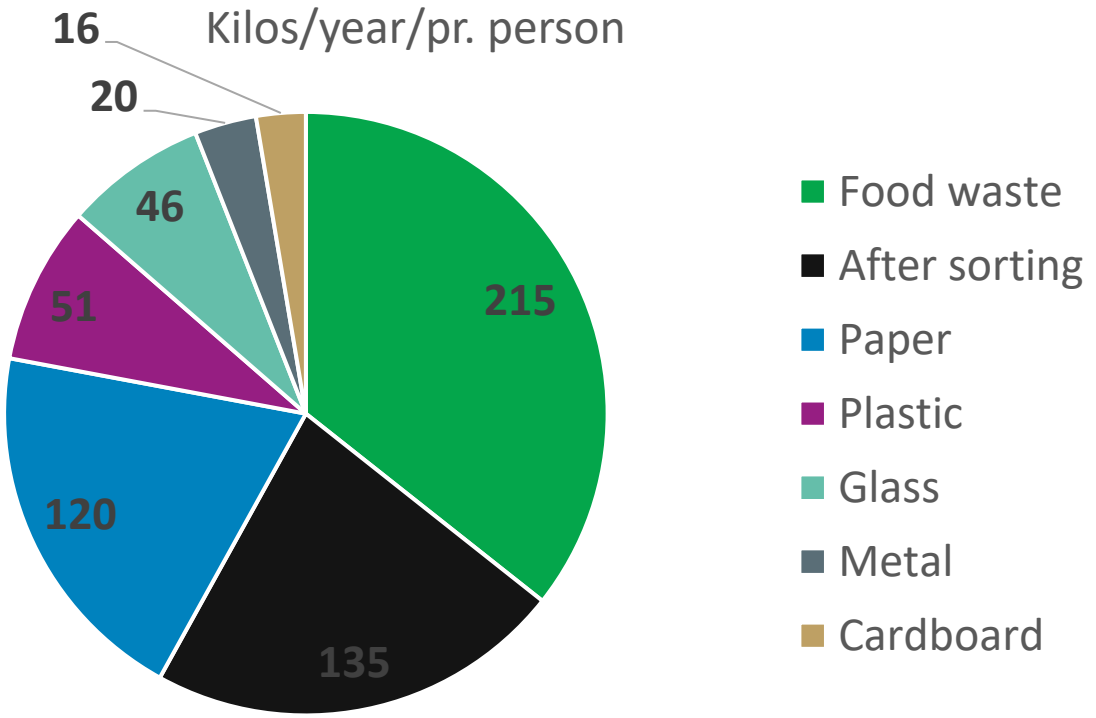
Waste in Danish households



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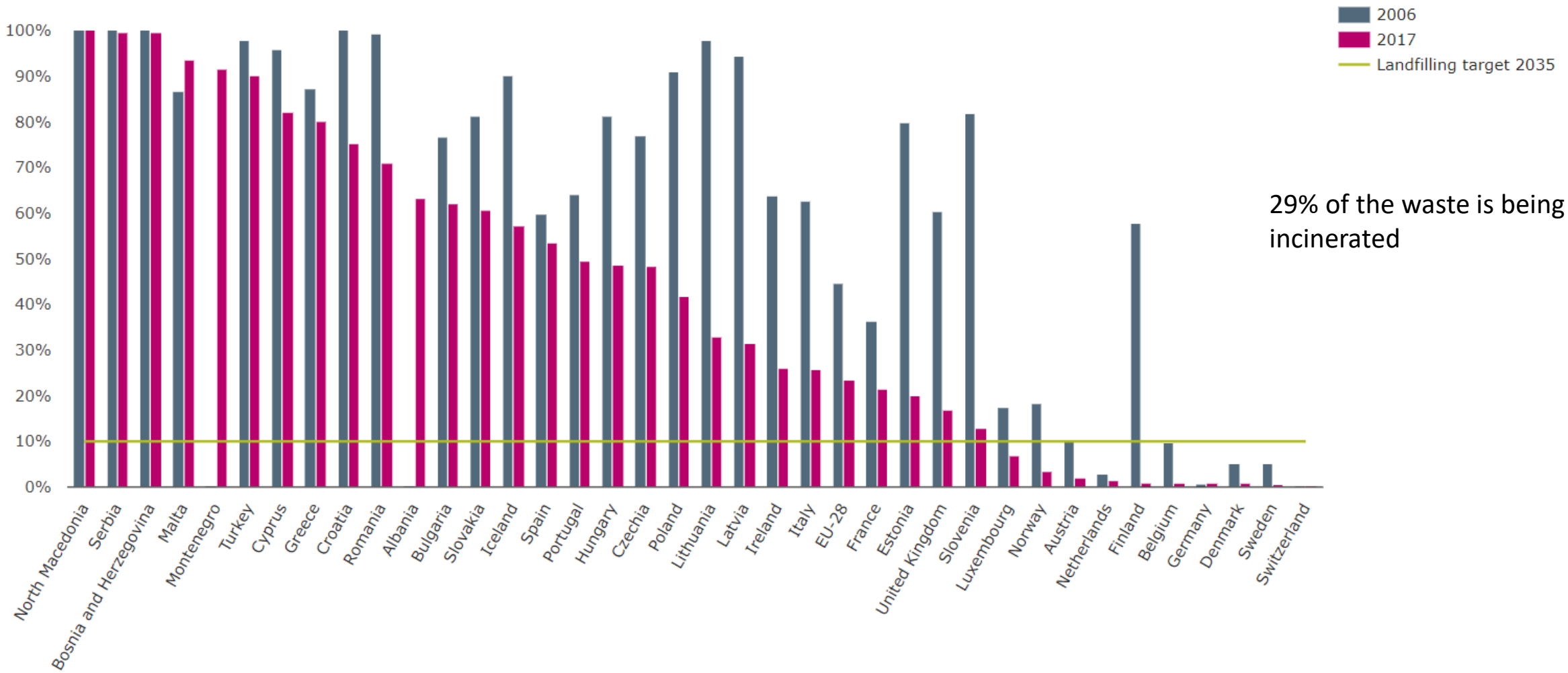
Almost no landfilling in Denmark

But a lot of waste is being generated

Chart — Municipal waste landfill rates in Europe by country



29% of the waste is being incinerated

Foodwaste for biogas

GEMIDAN AS

Quality control

Food → Food Waste → Pretreatment → Biogas Plant

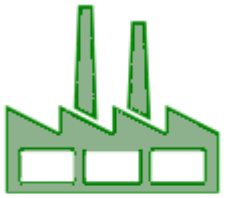
Nutrients

CH4

CH4

CO2

H2



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Feedstock quality and regulation on monitoring biopulp – physical impurities

- Farming manure – no physical impurities
- Food waste from service sector – some physical impurities
- **Food industry – few physical impurities**
- **Households – the challenge…..**

- Daily sampling mixed to monthly sample.
- Content limits:
  - Plastic, glass og composit materials, > 2 mm:
  - 0,5 weight % of impurities of dry matter
  - Plastic, > 2 mm: 0,15 weight % of dry matter
  - 1 cm2 / % dry matter in 1 liter biopulp.

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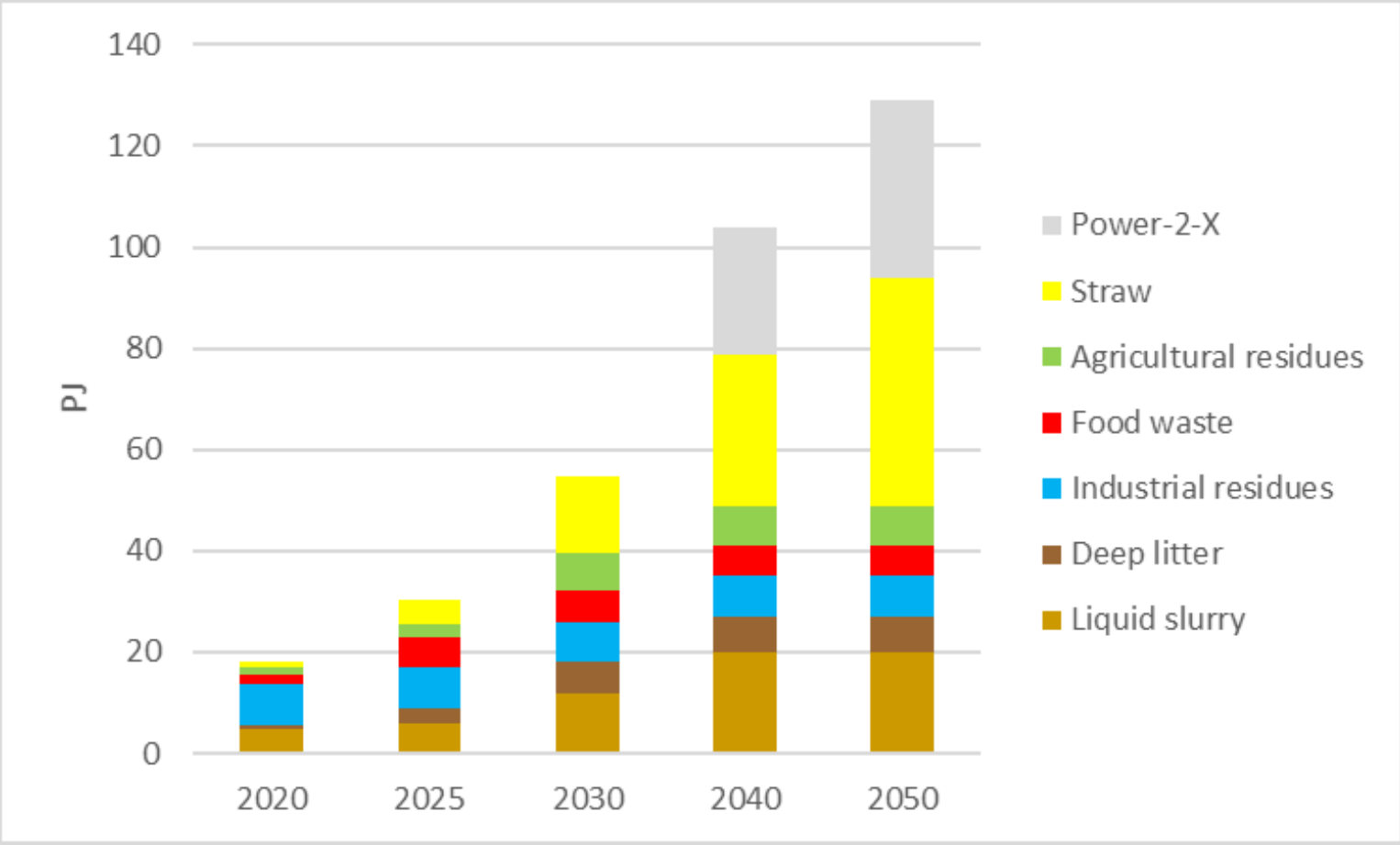
Future: net exporter of biomethane

Through increased used of manure, deep litter, straw. P2X integration.



Source: Danish Energy Agency

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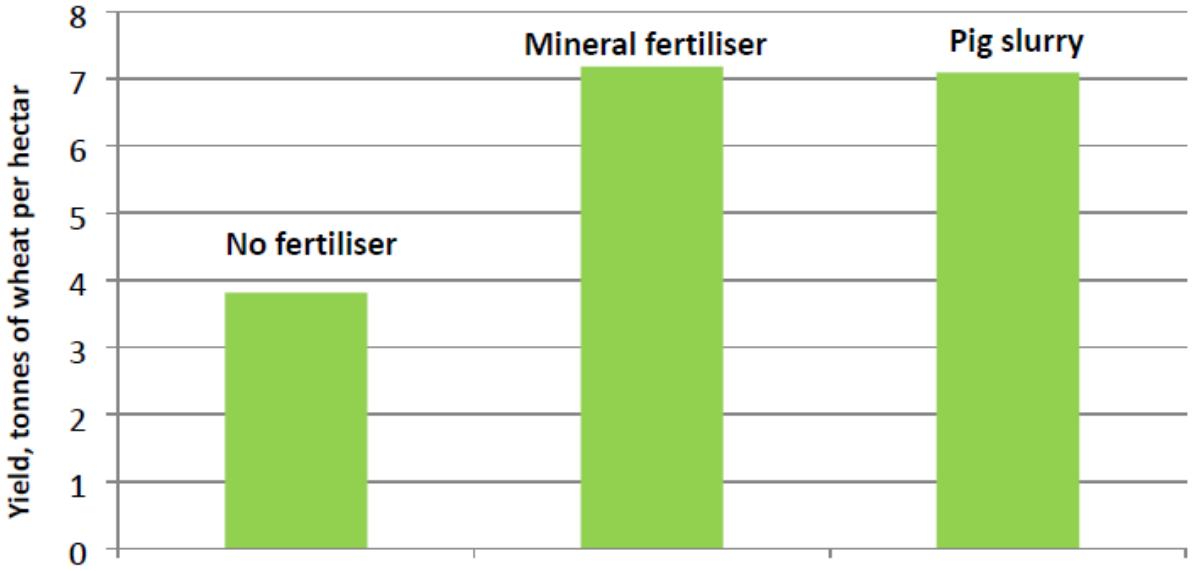
Increased valorization of feedstock

Recirculation of nitrogen is more important than ever. Food waste is a source.



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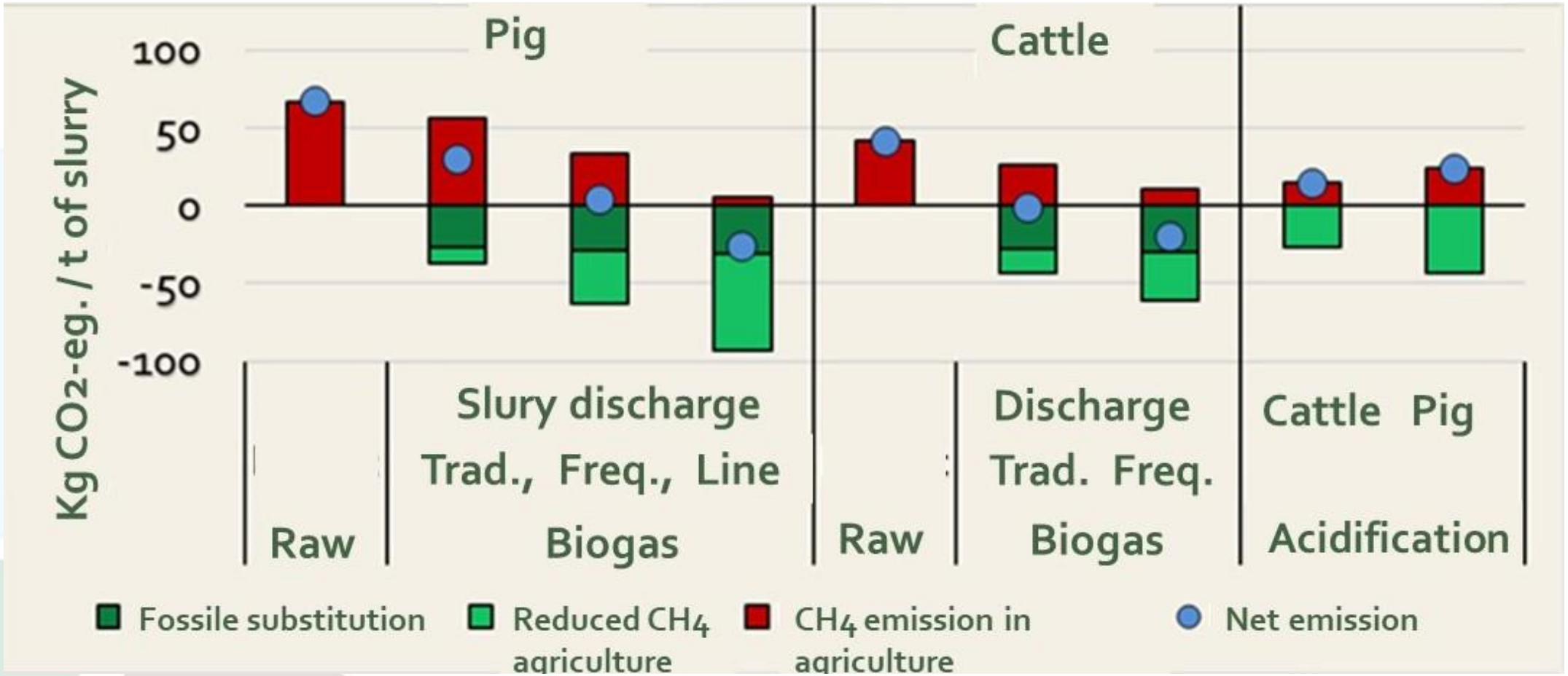
Frequent discharge of manure in housing is important



Source: Biogas Danmark

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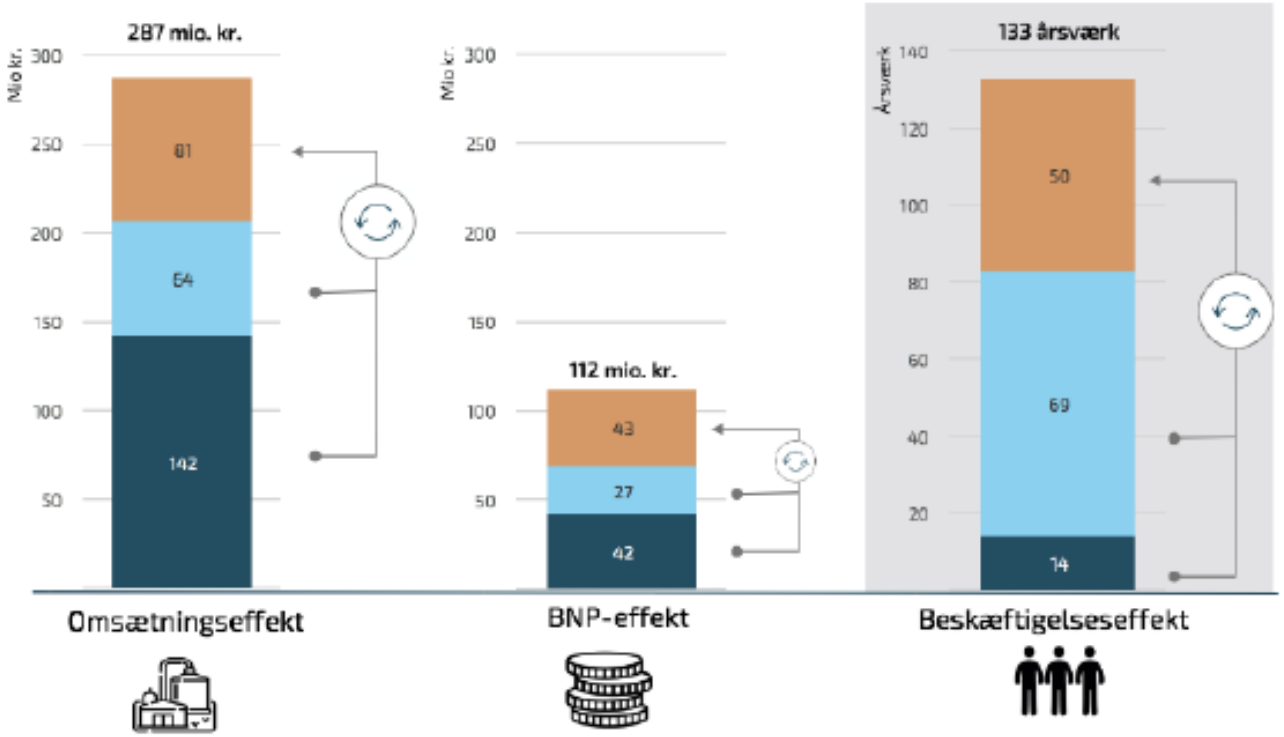
Think globally, act locally

The danish biogas model creates long term jobs.

€46 mio in turnover effects

€ 18 mio in BNP/y

€ 133 jobs in one plant



Nature Energy Korskro

710.000ton biomass – 22 mio m3 CH4

130 **€** mio investment

Creates/maintain 133 jobs in the areas

Source: Damvad Analytics

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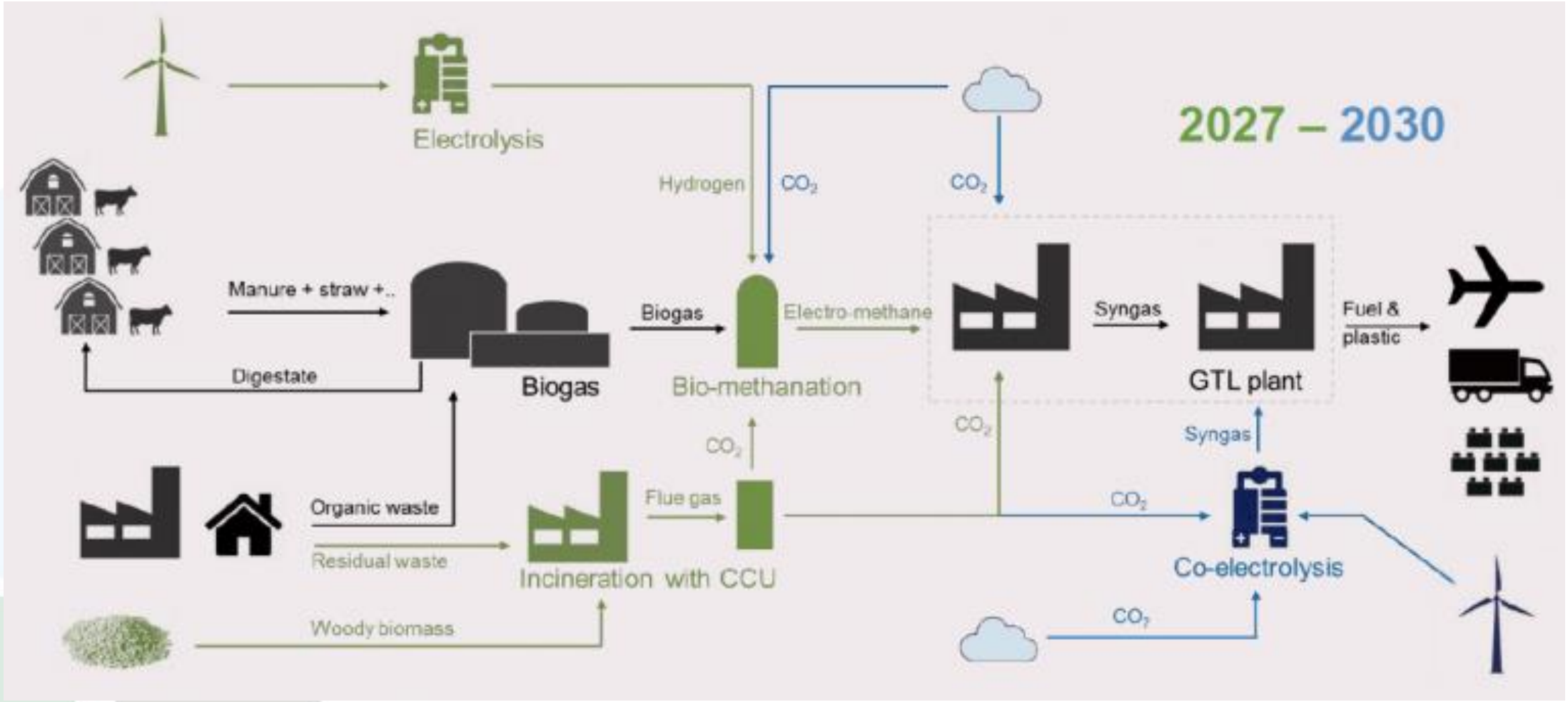
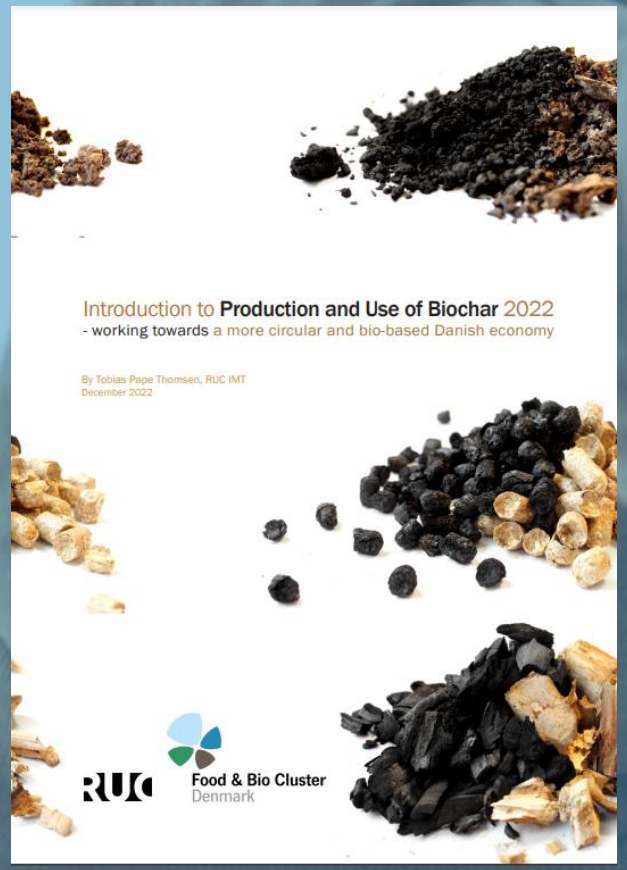
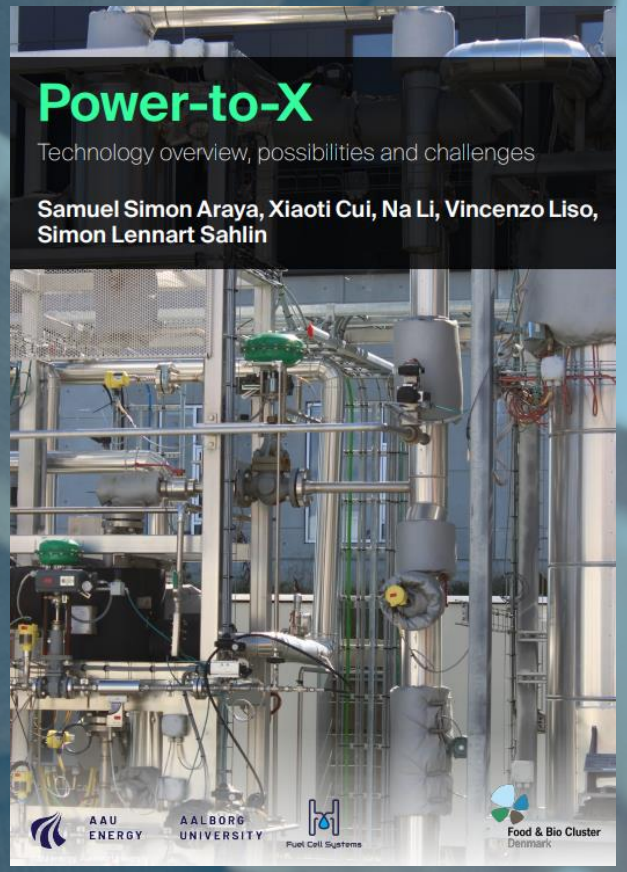
What does the future hold?

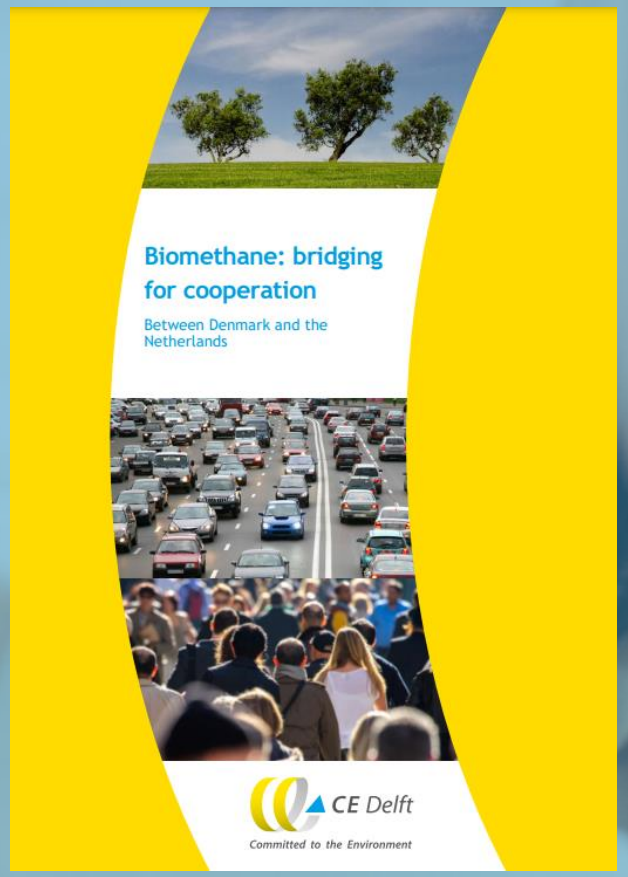
Cross sector synergies: Increased use of CO_2



Selected reports







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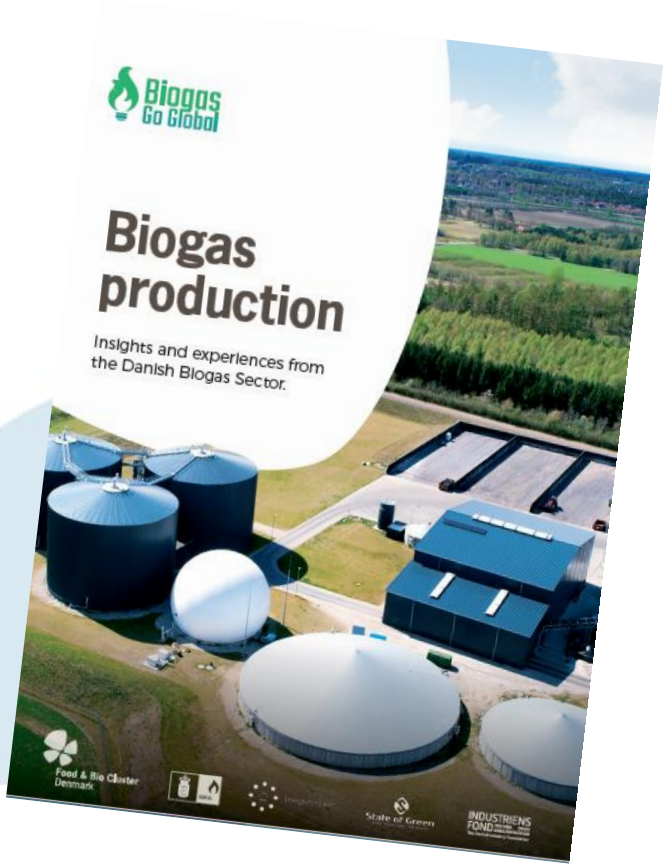
Want an one-point entry to one of the most efficient and large biogas sector in the world?

- Environmental benefits
- Pretreatment of biomass: Straw, grass, food waste
- Good use of digestate
- Upgrade of biogas to natural gas quality
- Power-2-X: Wind & Solar power integration

Download for free here via www.biogasgoglobal.com



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Biogas Process Optimization

Real-time monitoring of 1000+ volatile compounds and gases in the fermentation liquid

- Reducing the risk of shutdown due to foaming or acification
- Actionable insight using data: Precise and continuously optimization
- Tested with E.On.

SpectroBiogas
Real-time analysis

Clover grass for feed protein and biogas

Biorefining the future. First full scale grass protein factory

- Using clovergrass for pig feed partly replacing imported soy.
- Sidestream for biogas production
- Early demonstration at Aarhus University Foulum funded by Food & Bio Cluster Denmark. Full scale plant at Ausumgaard (estate).

AUSUM 1778 GAARD 1901

Foodgrade CO_2

CO_2 capture at Nature Energy Korskro.

- Supplies 25% of CO2 used in Denmark
- Labelled green CO2 by industrial gas company

STRANDMØLLEN

nature energy

Farm scale AD

- Designed for 10.000 tons manure/y.
- Local heat and power production and use + climate credits.
- Using the available manure on famr and using the existing manure infrastructure.
- Fast modular based construction

GREENFARM™

Sensor-Based Methane Leak Detection

- Customizable sensors
- User-friendly dashboards for easy data visualization.

DevLabs

Chemical and Environmental Sensor Solutions

Biological methanation of CO_2

Power-2-X: Bio E-Fuel technology from BiogasClean.

- Low pressure and temperature biological methanation process
- Increase the methane content in biogas to +97-98%, i.e. the biogas production increases by up to 78%

BIO GASCLEAN | Innovative solutions for efficient production of biogas and e-fuels