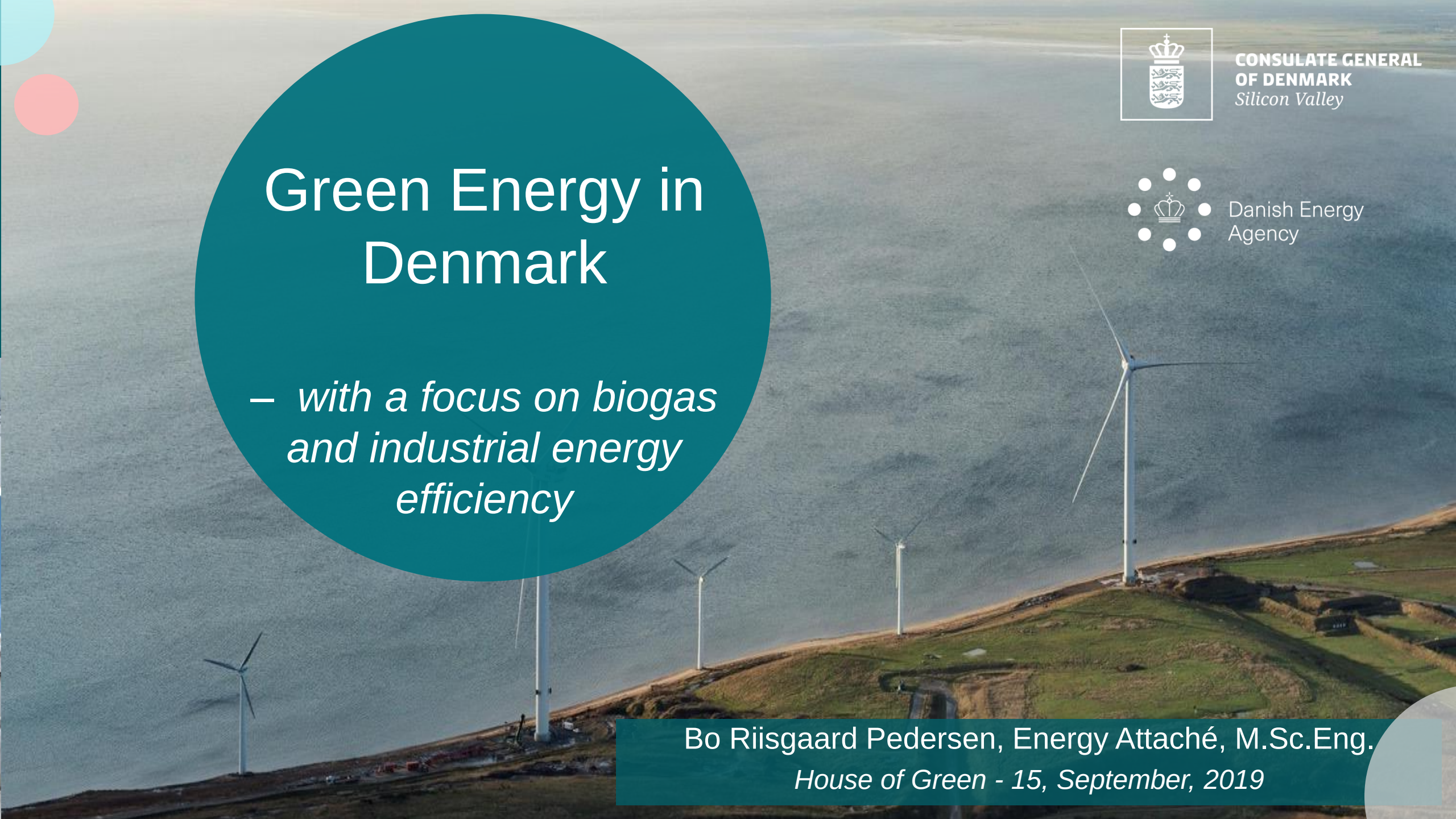

CONSULATE GENERAL OF DENMARK
Silicon Valley

Danish Energy Agency

Green Energy in Denmark

– with a focus on biogas and industrial energy efficiency

Bo Riisgaard Pedersen, Energy Attaché, M.Sc.Eng.

House of Green - 15, September, 2019

CONSULATE GENERAL OF DENMARK
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Danish Energy Agency

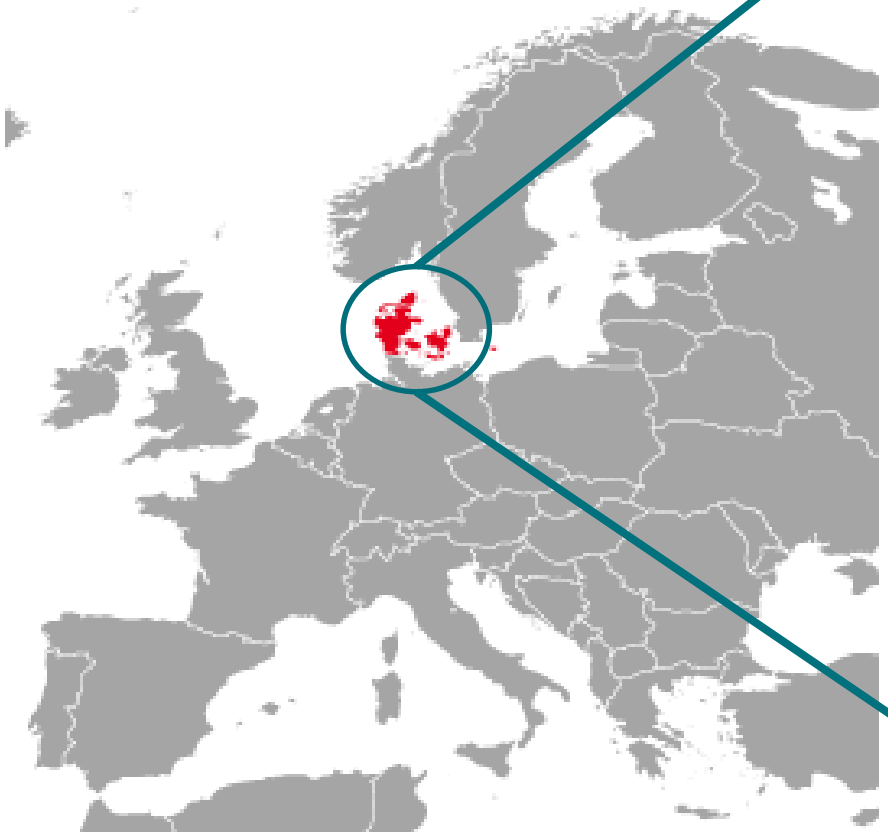
Agenda

1. Introduction, the Danish Energy Agency and the Danish energy highlights

2. Brief facts on Danish energy efficiency achievements

3. Biogas production, use and regulation in Denmark

So, where is Denmark?



Denmark

Population: 5.7 million

Area: 16,577 square miles

Coastline: 4536 miles

Land use: 2/3 of land area used for agriculture

Water Source: 100% ground water

Government: Constitutional monarchy.

GDP per capita (2017): 56.307 USD (~5 % lower than US)

Energy Consumption per Capita:

105 million BTU (CA:199 million BTU)

One of the world's **happiest** nations according to UN, OECD

⇕

One of the most energy-efficient economies in the EU

Energy, water and waste

Energy
Long-term goal of 100 pct. independent of fossil fuels by 2050. 70 pct. reduction of GHG 2030 (no coal).

Currently 64 % RE in the electricity system (2017) and 34 % RE total in the energy system (2017)

Water
Water consumption reduced by 40% since 1980

Waste management
Currently 58% of waste is recycled, 37% waste incineration and 5% is deposited landfill. The least percentage of landfilling in EU.

Share of household waste recycled: 48% (2016)
2022-target: 50%

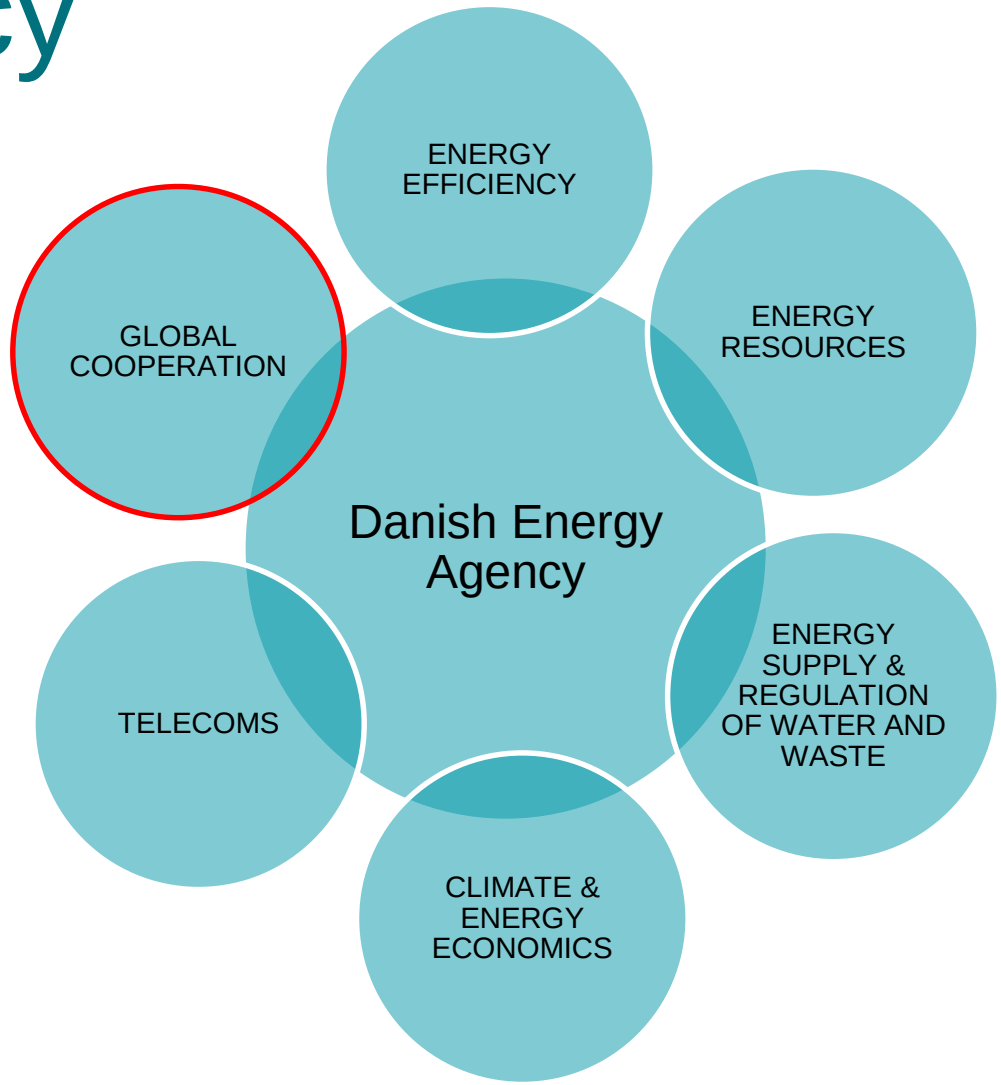
Danish Energy Agency

Established in 1976

Agency under the Ministry of Climate, Energy and Utilities

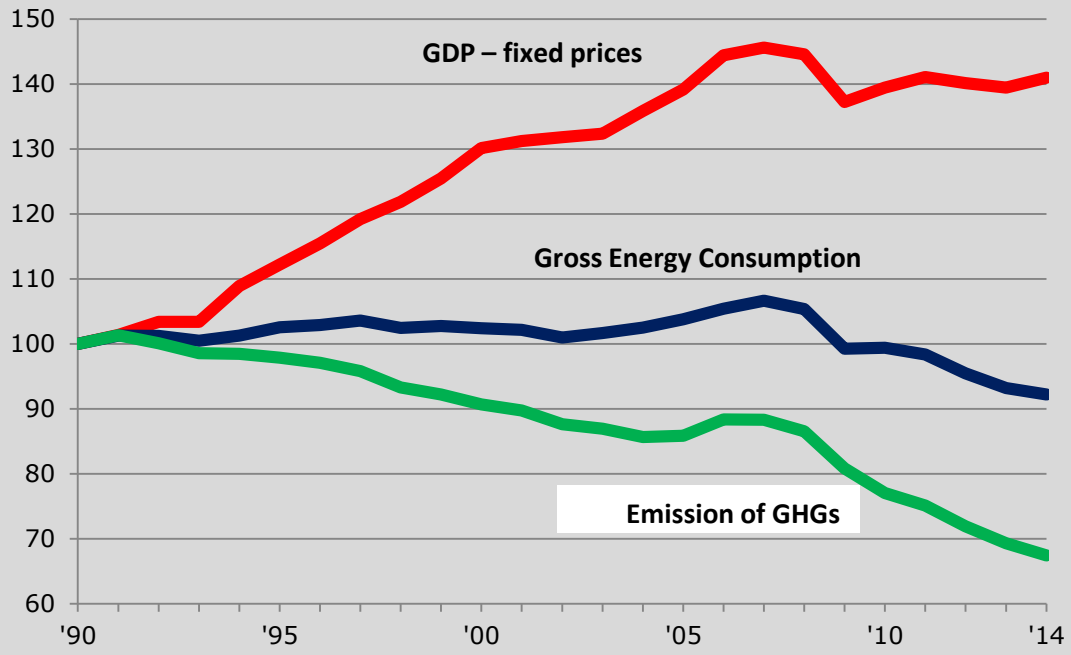
Responsibilities:

Responsible for tasks linked to energy planning, production, supply and consumption, as well as Danish efforts to reduce carbon emissions. The Agency engages both domestically and internationally.



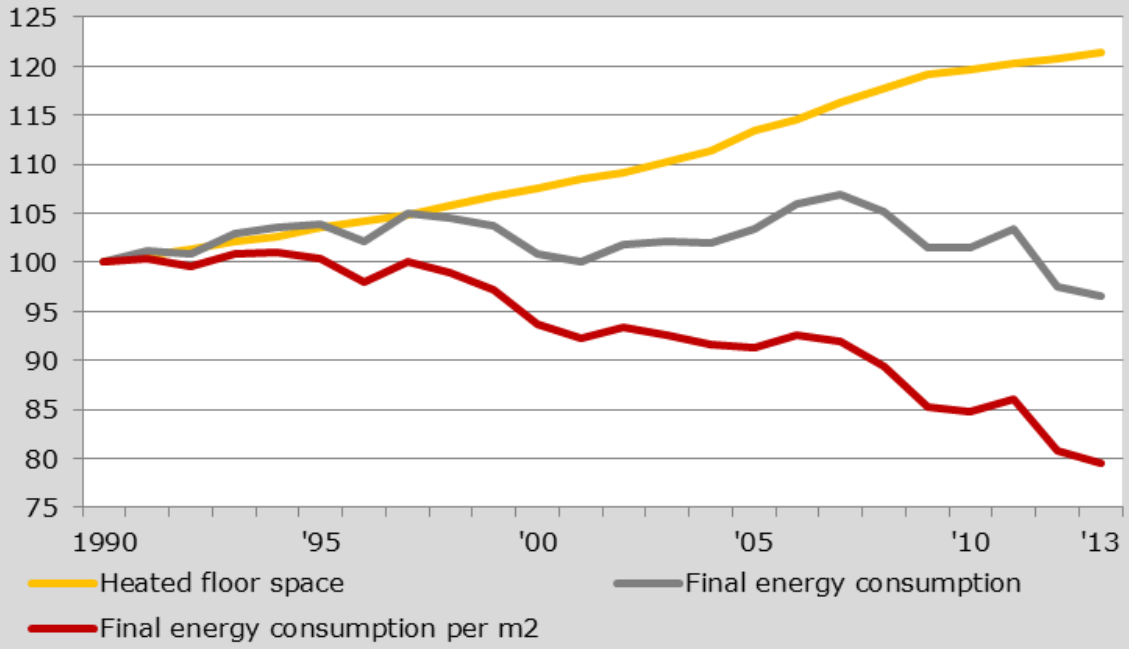
Danish energy highlights

- The world's highest share of new renewables (non-hydro) in electricity generation – 64 % in 2017.
- 43 % share of wind power in electricity generation (2017).
- Very high degree of energy security (99,996% for electricity).
- Electricity prices among the lowest in the EU.
- … while maintaining economic growth and reducing GHG emissions.

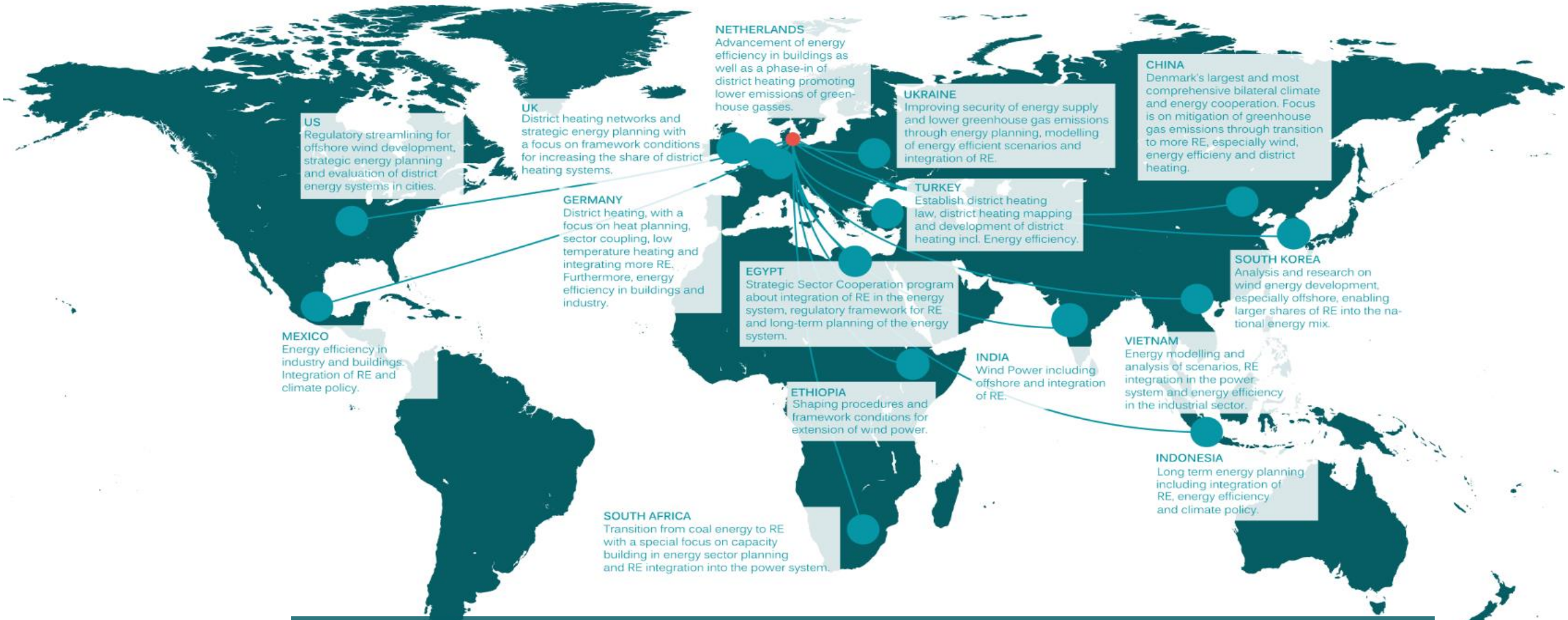


Danish energy highlights

- Energy consumption per GDP-unit is lower than in any other EU-country.
- World leader in advanced energy technologies - district heating and CHP, wind, biomass, energy saving technologies.
- Energy efficiency **-** heating demand per m^2 reduced by 45 pct. since 1975.
- **District energy is a cornerstone in the Danish energy system – enabled by local heat planning!**



Global Cooperation



Partner countries cover more than 60 pct. of global GHG emissions and more than 50 pct. of world population.

Cooperation is done through posted advisors/attachés backed by experts at DEA

The energy cooperation with California

Existing cooperation agreement on offshore wind with CEC and lately also cooperation within energy efficiency.

EE pilot:

Industrial EE in the dairy processing industry focusing on re-use of heat, process optimization etc. to reduce GHG emissions and improve economic competitiveness through new EE technologies.

Specialized in-depth 2-day audit with resulting proposed projects to apply for CECs' FPIP funding (not a requirement).

Energy efficiency has delivered in Denmark

Danish Energy Agency

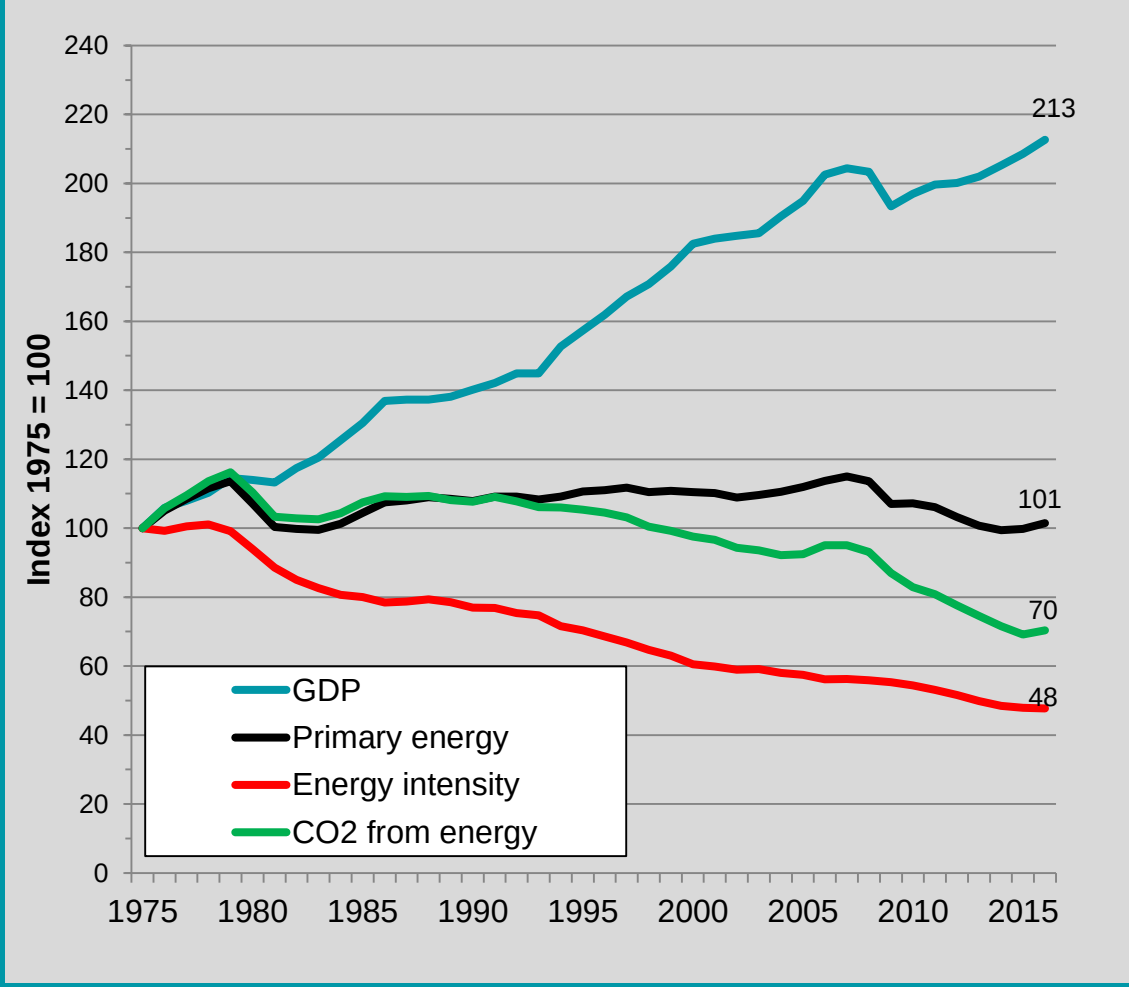
The Danish de-coupling is closely linked to increased energy efficiency

End-use efficiency

- Better insulation of buildings
- More efficient appliances etc.
- Higher efficiency in industry

Efficiency of energy supply

- Especially increased use of combined heat and power production – CHP
- More efficient power plants and individual boilers
- More renewable energy (wind)

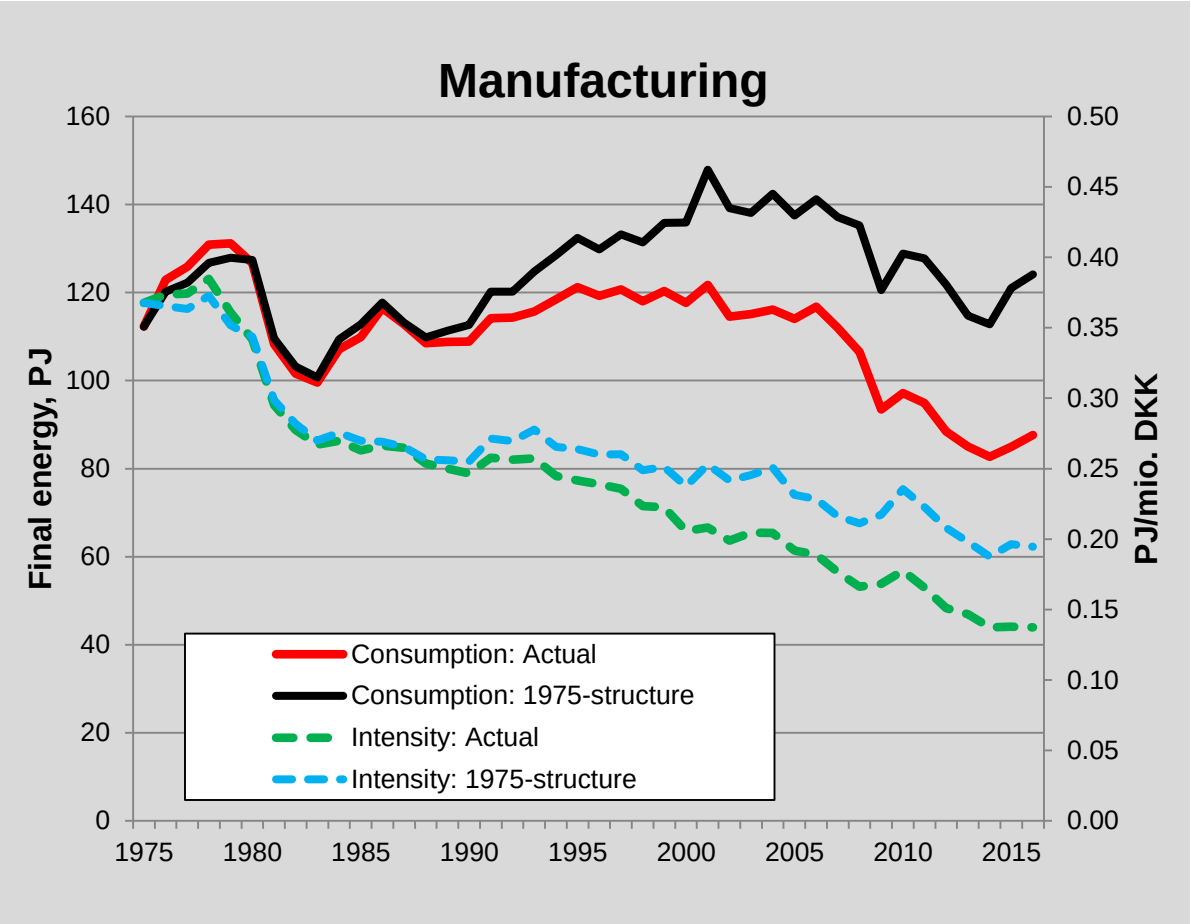


Efficiency improvements in industry

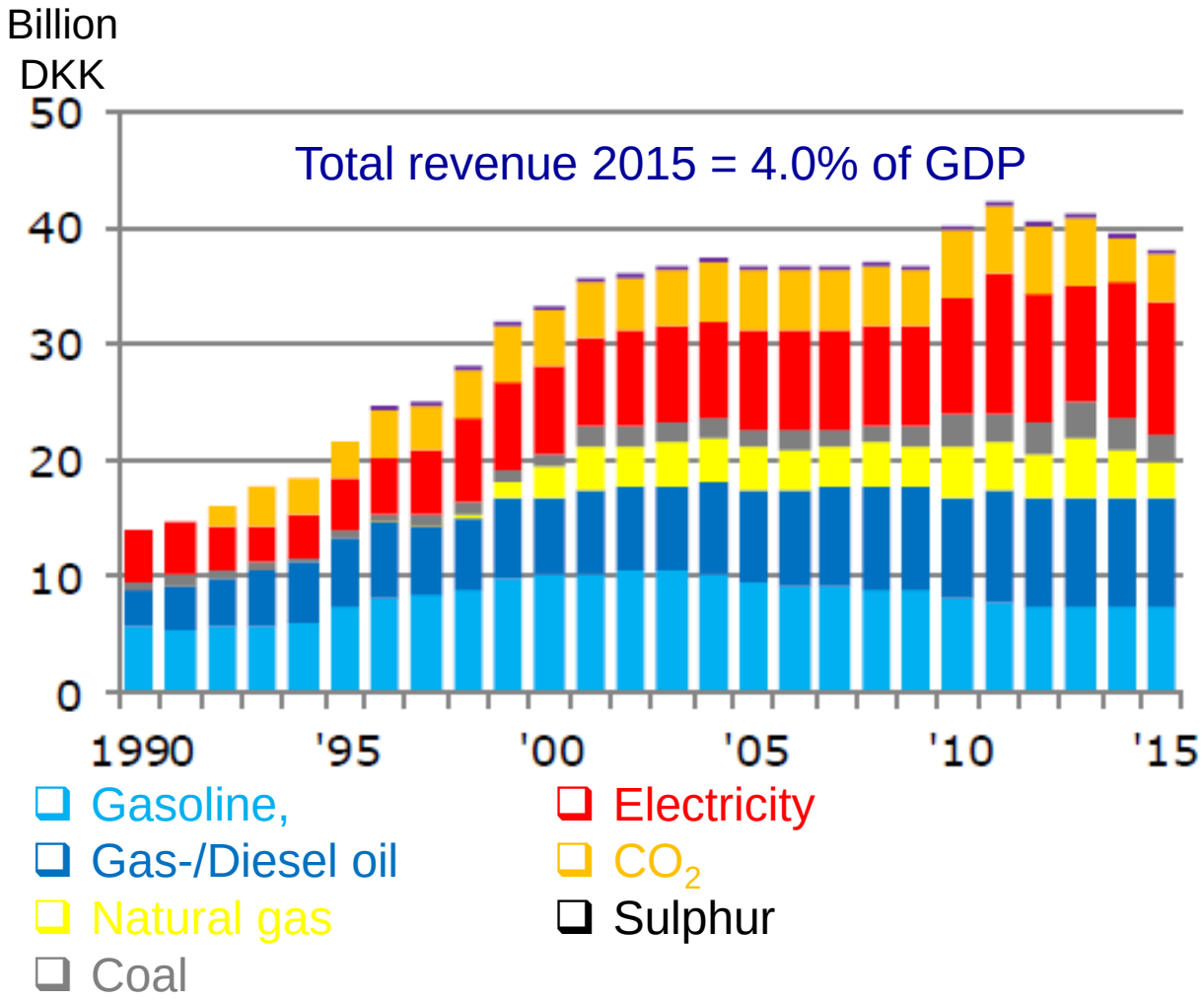
- Strong EE improvements
  - Especially 1979-1983 and 1993-2016
  - A part of this is due to structural changes and energy prices

	Actual	1975-structure
1975-2016	-2,4%	-1,5%
1993-2016	-2,7%	-1,5%

- But also due to effective policies and regulatory measures

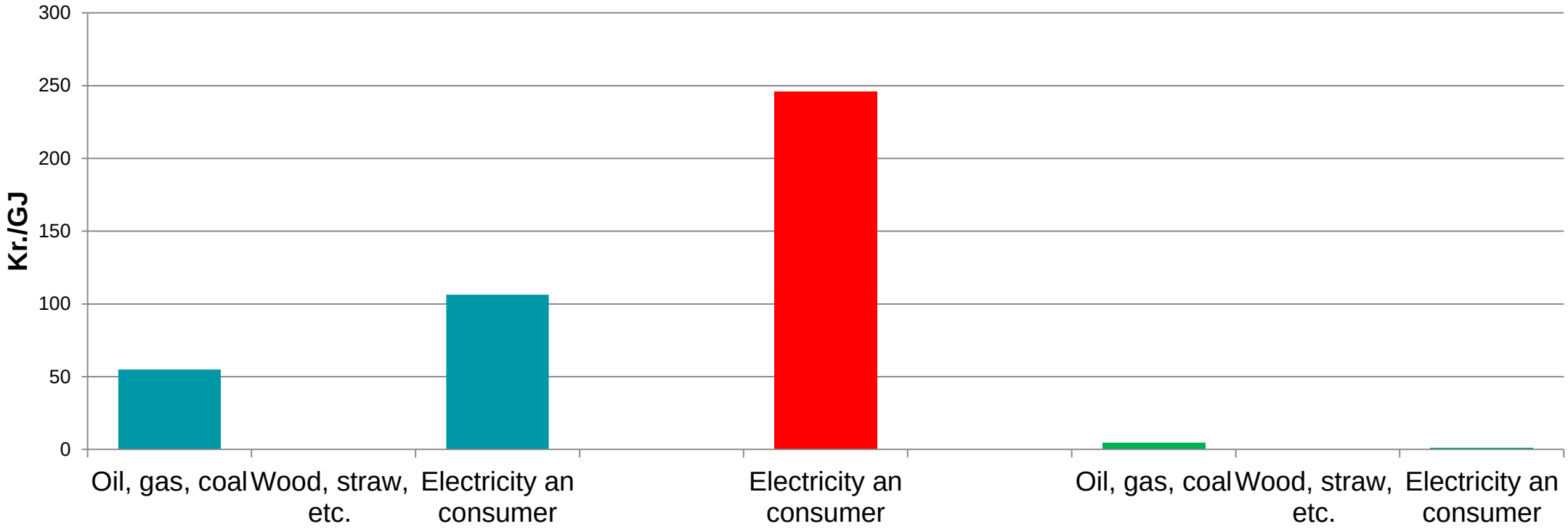


Energy taxes



- Taxes on energy increase the value of energy savings and the incentive for energy efficiency
- Energy prices do not reflect the long-term costs of pollution and CO_2-emissions: Energy taxes may compensate for this.
- Energy taxes may also ease the acceptance of more stringent energy efficiency regulation
- **Denmark introduced a CO_2 tax in 1992**

Energy taxes (2017) (Horizontal measure)



Heating

Appliances, etc.

Industry, etc.

Energy Efficiency Obligations

Danish Energy Agency

Supporting implementation of EE

- Savings in existing buildings and industry are complicated
- Energy companies are close to the consumers and cover all part of a country

Has been a secure and stable way to finance energy savings activities

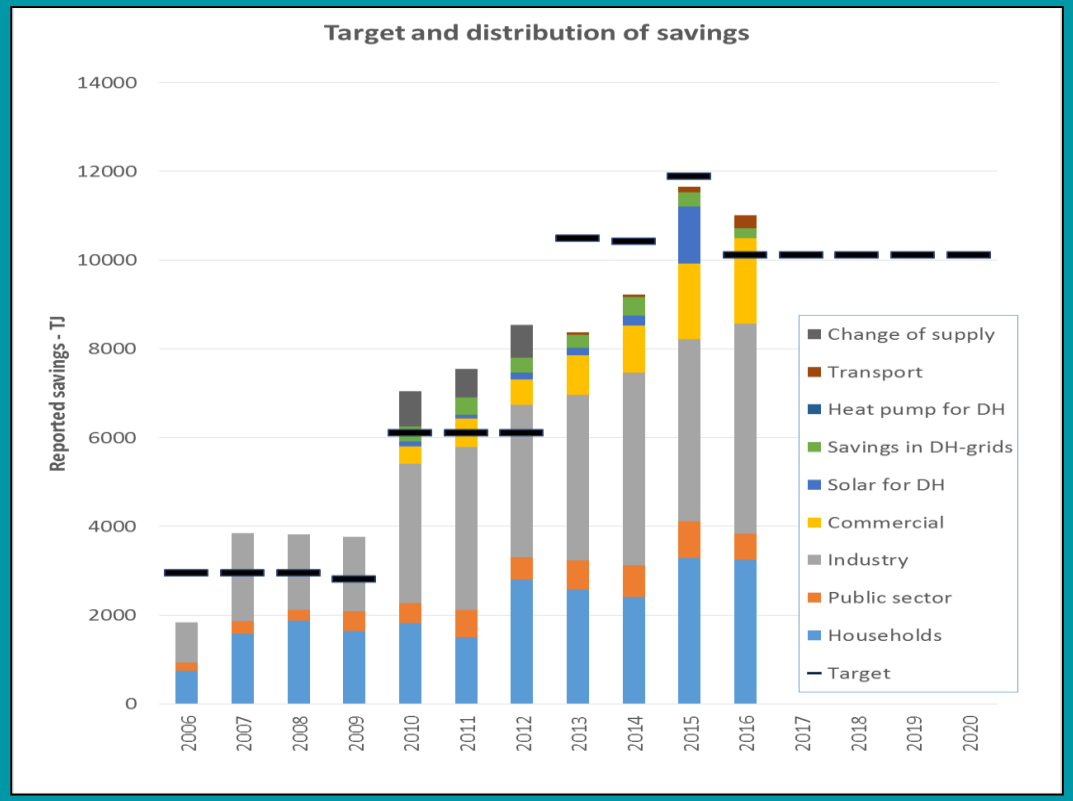
- Difficult to get funding on the national budget

Transformation of the utilities to energy service providers

- Provides energy services to the costumers in a cheap way
- Strong and effective measure but some issues with compliance

The current Danish program will end by 2020

- A new competitive tendering scheme will take over



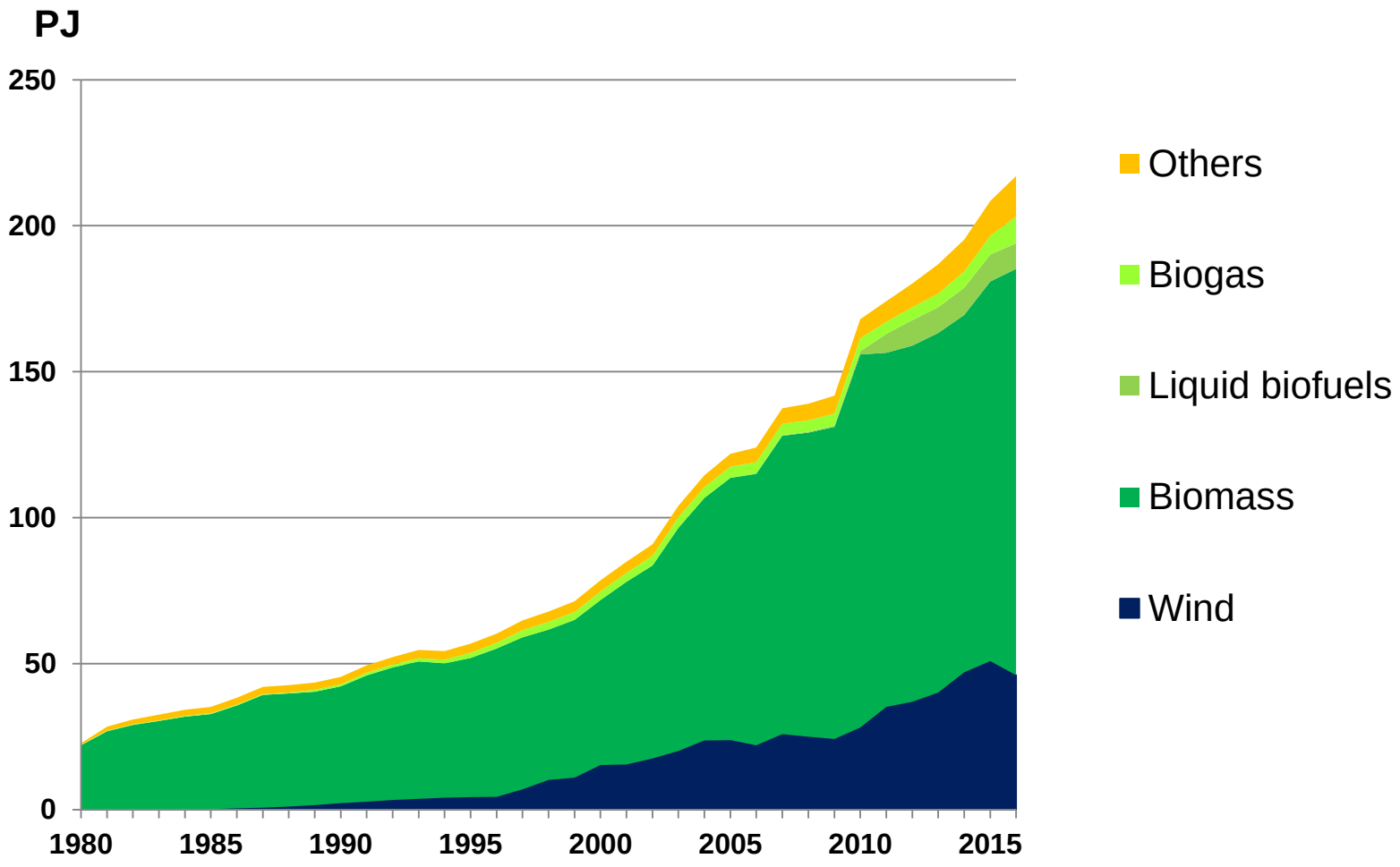
EU front-runner in biogas

In 2018 renewable natural gas constituted 8% of the Danish gas consumption.

- 33 plants connected to the grid
- Mainly produced from manure and waste products
- Danish renewable natural gas in high demand in neighboring countries (SE & DE).

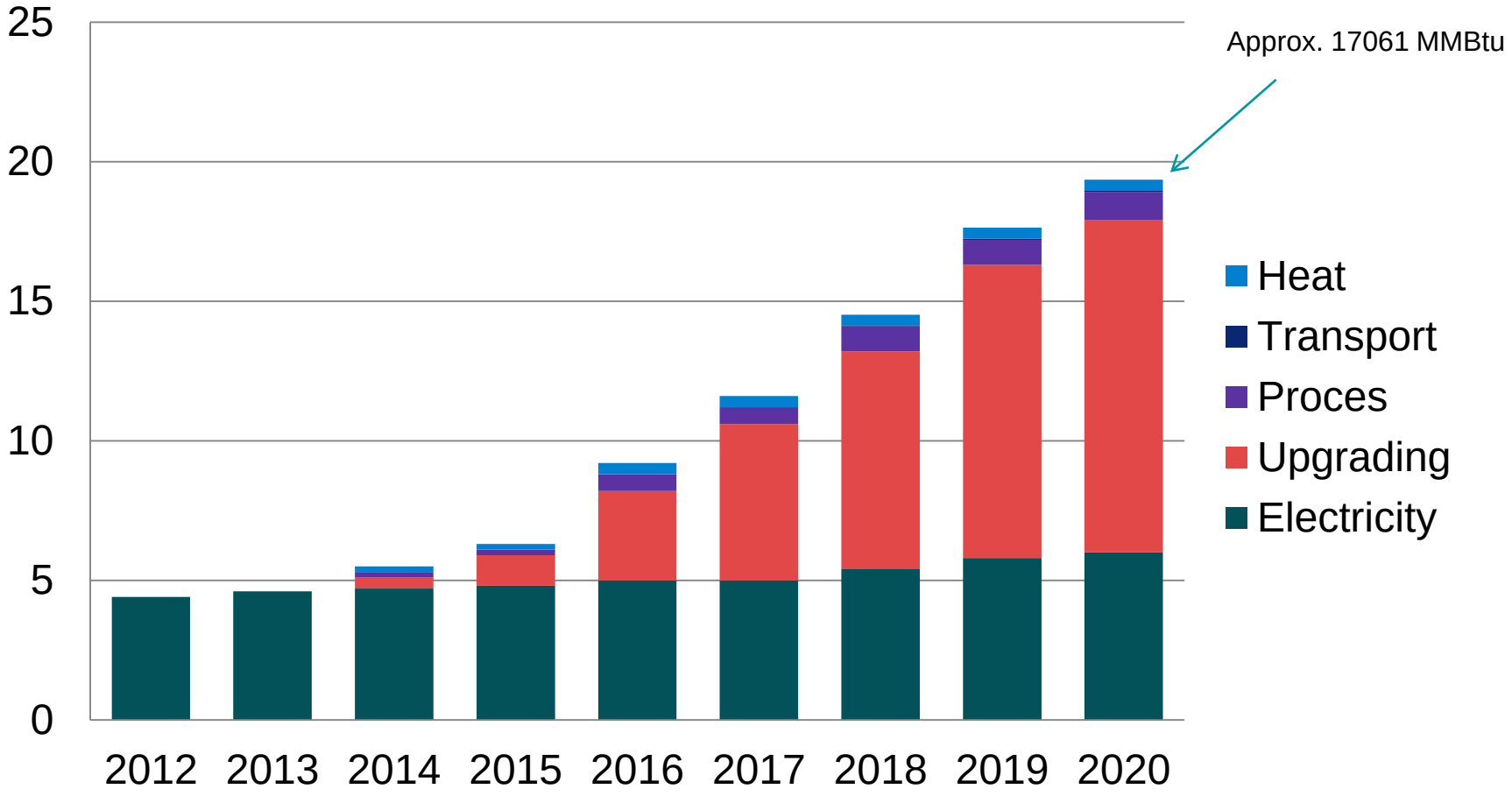
Denmark is the country in Europe with the highest share of renewable natural gas in the gas grid.

Consumption of RE by fuel

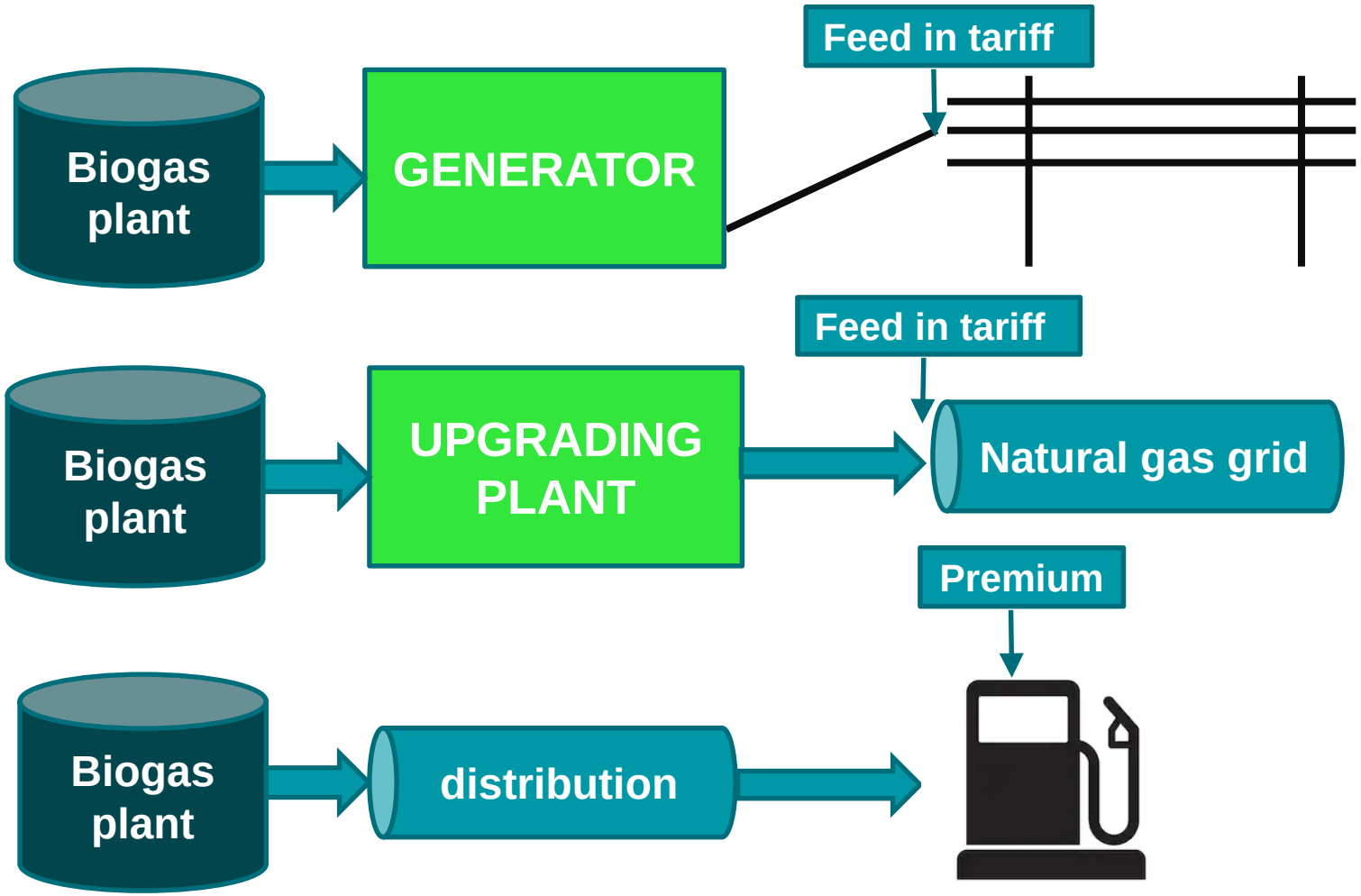


Biogas production and use in Denmark

2012-2020 (PJ).



Funding system in Denmark



Support schemes

	Support (DKK/GJ)	Support (USD /GJ)
Upgrading national gas grid	115	17,7
Process	75	11,5
Transport	75	11,5
Heat	36	5,53
	DKK/kWh	**USD cent/kWh**
Electricity fixed price	1,153	17,7
Electricity feed-in tarif	0,791	12,2

Sustainability criteria

In order to get support you are not allowed to use more than 12 % energy crops in your biogas production (weight input).

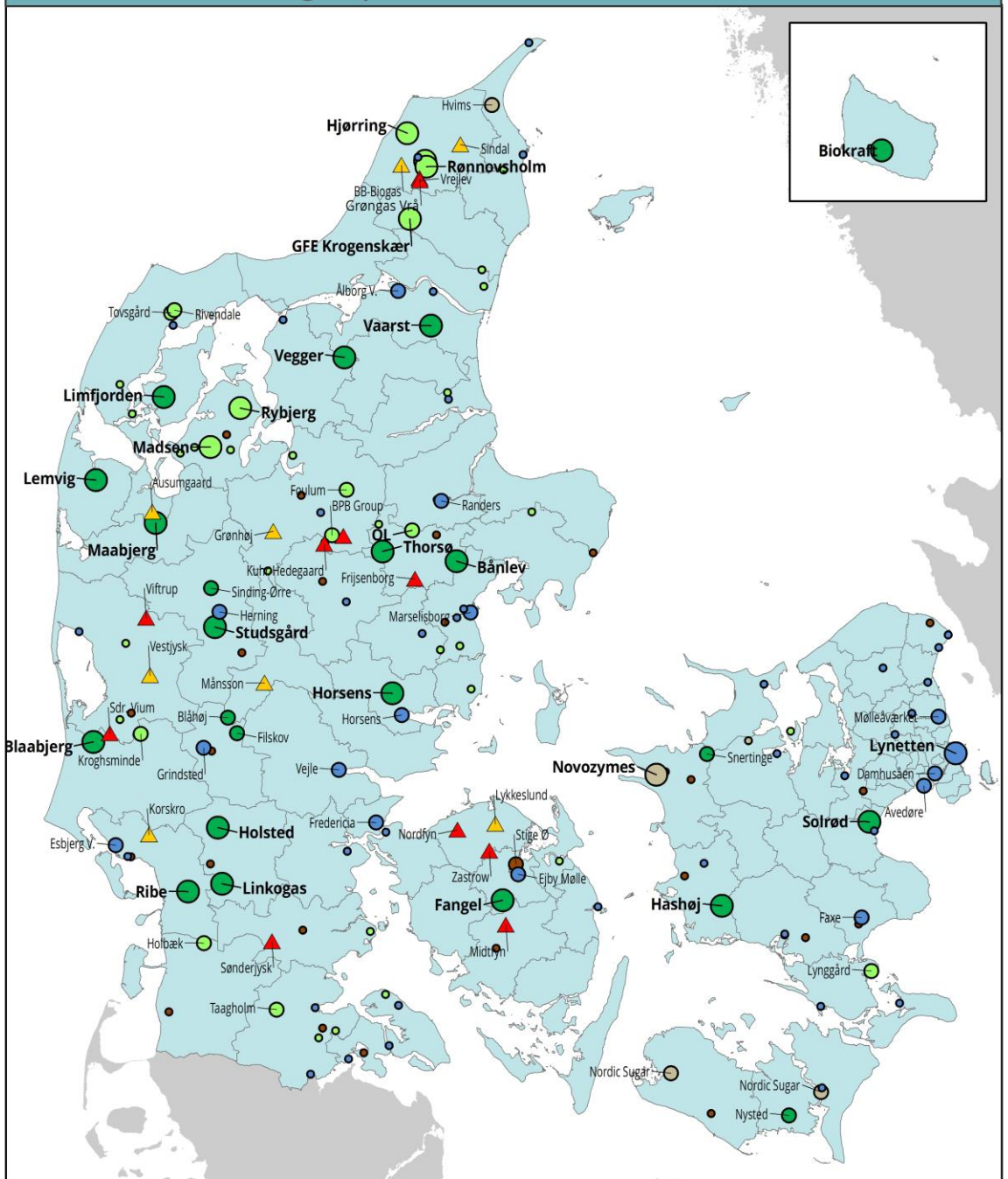
After 2020 most likely lower

Energy crops: maize/corn, cereals, sugar beets, jerusalem artichokes, grass

New subsidy scheme for biogas and other green gasses

- 240 million DKK annually from 2021-23 to biogas and other green gasses for upgrading, transport and industrial processes.
- Based on tenders/auction with price ceilings.
- Unspecified amount are earmarked for organic biogas.

Biogasproducenter i Danmark



Plant type

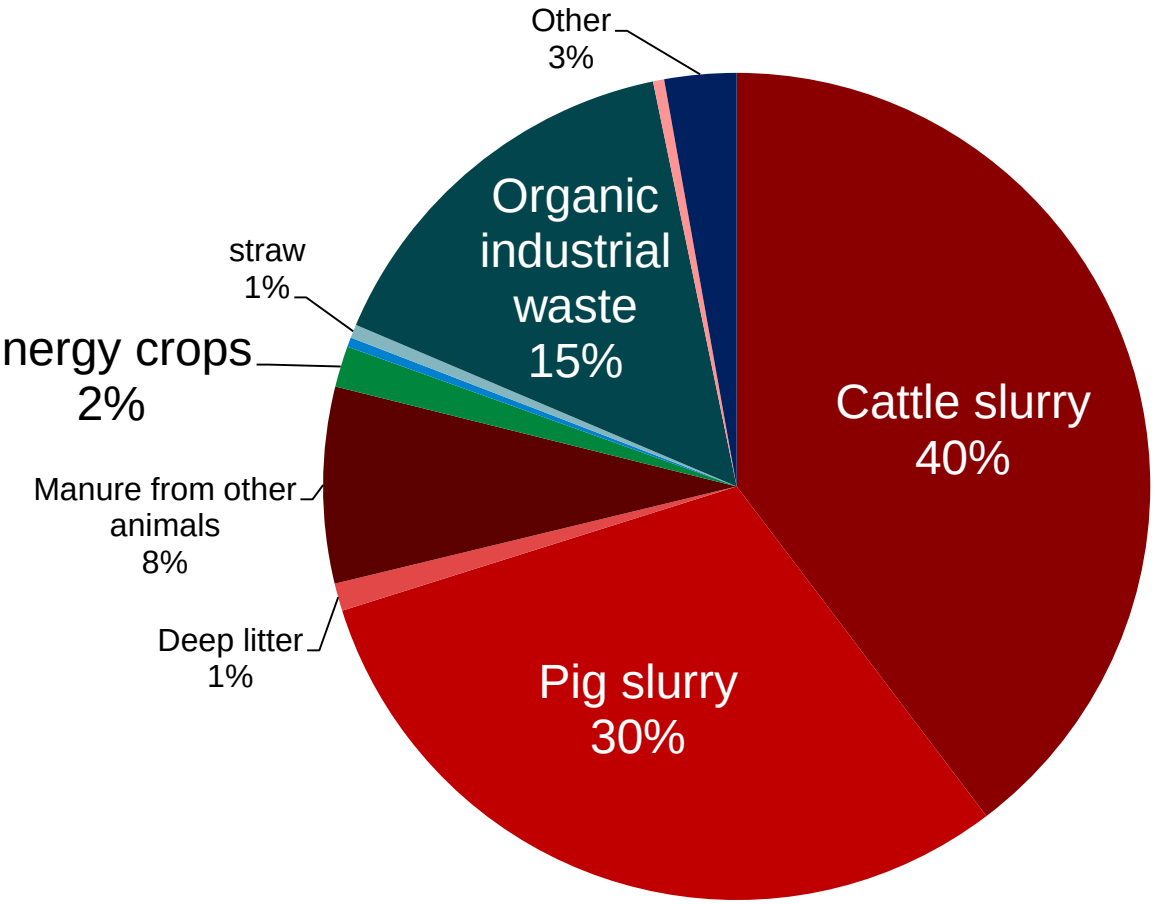
- WWT
- Industry
- Landfill
- Centralized (multi farms)
- Farm

Production size (TJ/Year)

- 0 - 20 (unnamed in map)
- 21 - 100
- 101 - 400

- Under construction
- New plant

Feedstocks in biogas plants



Average mix of feedstocks in agricultural biogas plants

Co-digestion is at the heart of the Danish biogas model

Enhanced gas production:

- Higher yield per m3 feedstock adding energy rich organic waste with slurry

Supply diversity:

- Centralized plants receive wastes from many industries which is more manageable than digesters on each industry.

Stable digestion process:

- Co-digestion with slurry makes digestion of waste more stable.

Lifestock manure
Liquid slurry/Deep litter

Organic residues from agriculture, households, industry, servicesector

Advantages of co-digestion: From a fertilizer point of view

Danish fertilizer regulation:

- Livestock manure is allowed to be used untreated on agricultural land.
- Nutrients in manure and slurry required to be used as fertilizers on crop land.
- Ceiling of N and P per hectare that can legally be applied to agricultural land.

…which incentivizes utilization of degassed digestate:

- Better utlisation of N
- Reducted of leaching
- Redistribution of P through separation
- Reduction of mineral fertiliser

Advantages of co-digestion:
- From a circular economy point of view

Danish waste regulation:

- Ban on organic landfills 1997
- 50% recycling of Danish MSW by 2022
- Waste hierarchy 2020
- DEPA concludes that MSW based digestate does not pose health or contamination risks

…which incentivizes utilization of MSW for biogas production:

- Fees for industrial waste treatment => Co-digestion
- Organic MSW => Co-digestion
- Biogas before incineration
- Recycling of nutrients

Elimination of impurities & pathogens makes MSW digestate a safe fertilizer

Removal of physical impurities through bio pulping (Gemidan Ecogi):

- Threshold limit 0,5% (dry matter)
  - Plastic <2mm: 0,0052 %
  - Other impurities: 0,0148 %

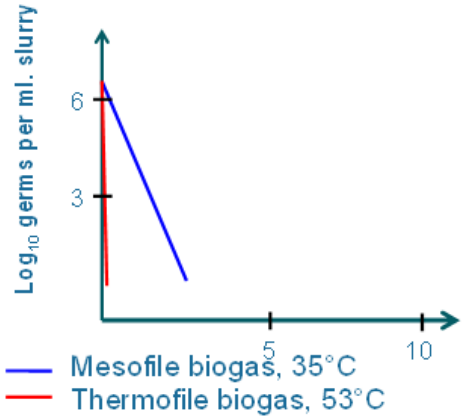
Heavy metals & anthropogenics (Gemidan Ecogi):

- Heavy metal: <10% compared to threshold limits
- Anthropogenics: <15% compared to treshold limits

Removal of pathogens:

- Hygienisation requirement: 70 degrees C in 1 hour
- <5 germs pr. ml slurry

The food waste pretreatment plant manufactured by Gemidan Ecogi at AffaldPlus processes 27,500 tons/year of packaged food. The output is a biopulp (inset) with solids content of about 17%.



Date	Before	After
Mar. 18	1,300,000	<5
May 13	140,000	<5
July 15	690,000	<5
Sept. 9	9,000,000	<5
Nov. 11	62,000	<5

Test results from Ribe Biogas, bacteria per ml. slurry

Thank you!

Energistyrelsen

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Additional slides

Danish Energy Agency

Mandatory Energy Audits in large companies (EU)

- Energy Efficiency Directive (EED)
  - Article 8: all companies that are not a SME have to make an energy audit every 4 years
    - Non SME's: More than 250 persons or an annual turnover over EUR 50 million and an annual balance sheet over EUR 43 million.
  - Energy audit includes
    - Buildings - Processes - Transport
  - ISO 50001 and DS/EN 16247 1-4 as standard for energy audit
  - Main objective is to identify energy saving potentials