energy storage

IEA Technology Collaboration Programme

COUNTRY REPORT
Denmark

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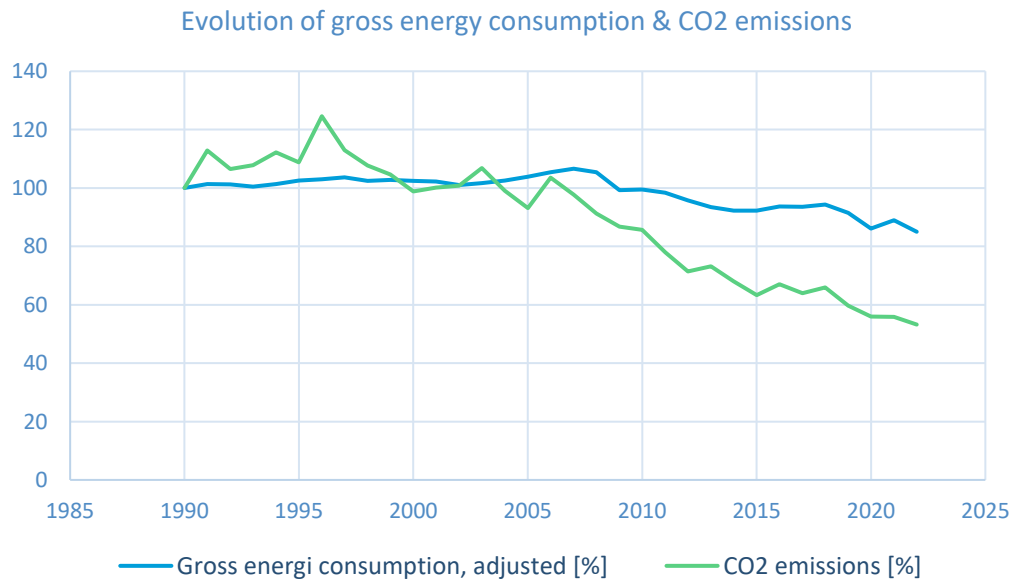
XC97 in Lyon, June 2024

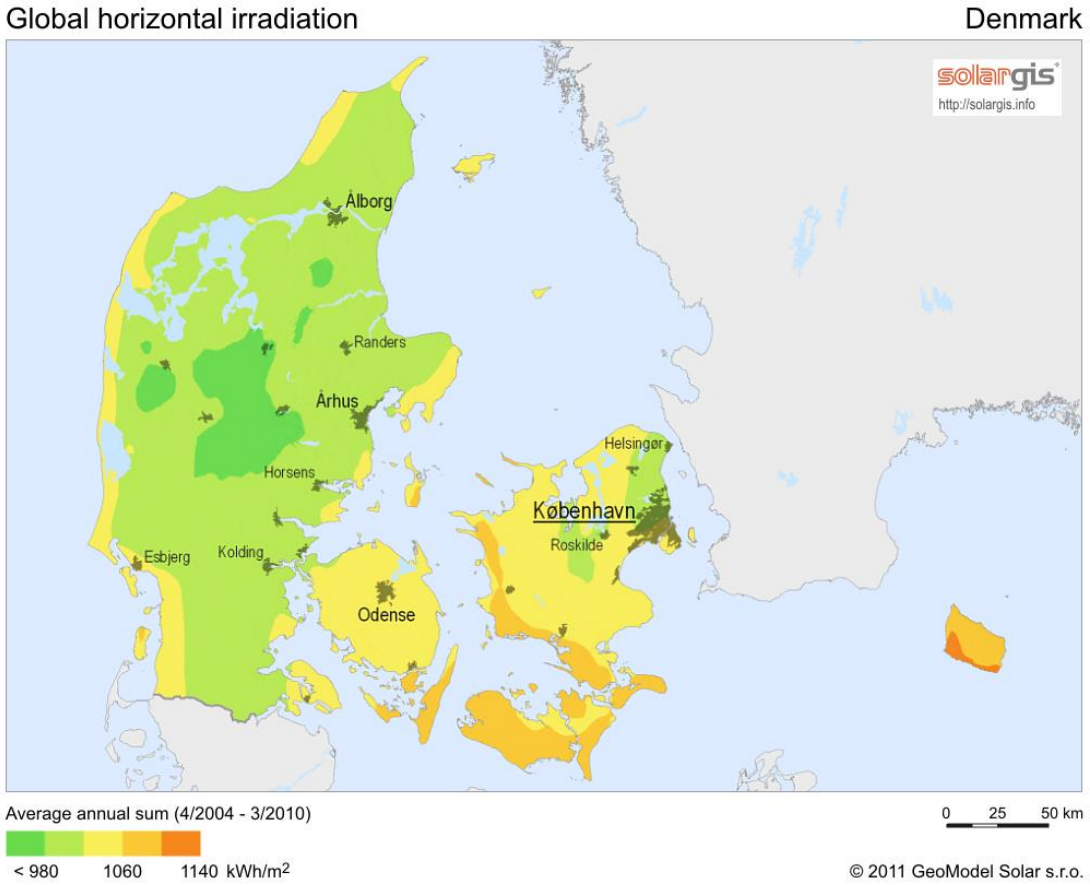
Country Specific information

- 5.966 mio inhabitants
- 43,094 km²

(excl. Greenland and Faroe Islands)

- Gross energy consumption 692 PJ in 2022

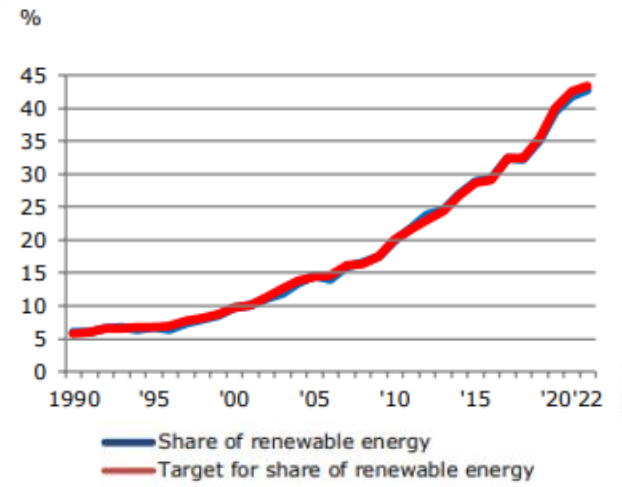




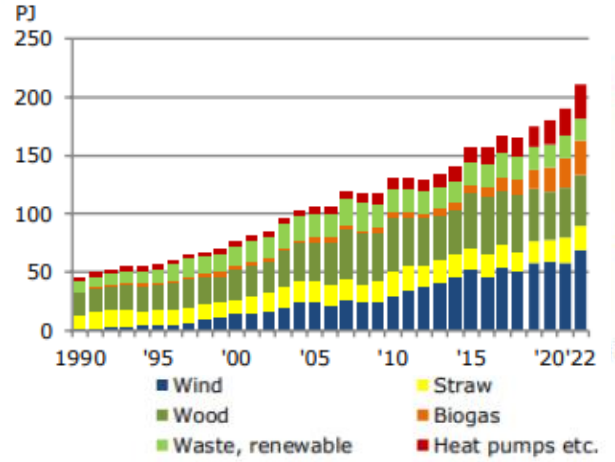
Country Specific Information

- Data from 2022

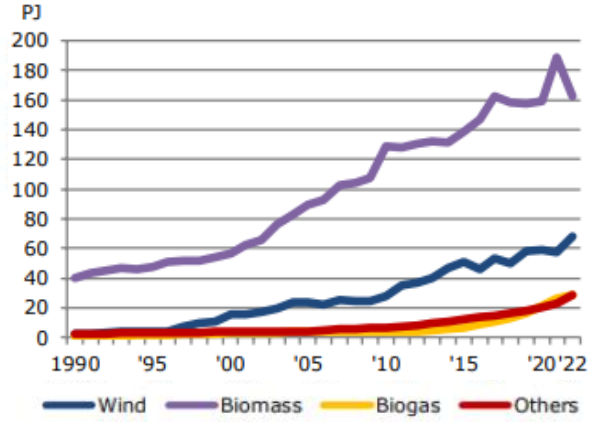
Share of renewable energy according to the EU method of calculation



Production of renewable energy by energy product



Renewable energy - consumption by energy product



RDD Information

- **Overall green research strategies:** 4 priorities. Among these Carbon Capture Utilization or Storage (CCUS) and Green fuels for transport (PtX)

- **Challenges and focus areas (EUDP):** More green electricity, energy efficiency, transport of people and light goods, heavy transport and PtX, heat and thermal storages, green process electricity, flexible use of electricity, CO_2 capture, storage and utilization

- **Funding (EUDP):** 73 M€ in 2023

EUDP is a program for Energy development and demonstration

- **Funding (Innovation Fund):** app. 40 M€/year

Innovation Fund is a program for development of new and innovative technologies

EUDP & Innovation Fund are financed by the Danish state

Energy Storage Landscape

- **Research:** Danish technical University, Aalborg University, University of Southern Denmark (mainly PtX), Aarhus University, Danish Technological Institute (system integration & materials)

- **Industries:** Aalborg CSP (PTES and molten salt TES), Hyme Energy (Hydroxide salts TES up to 700 °C), Heliac (Rock high-temperature TES), Aquanamic (Underground Pumped Hydro), visblue (Vanadium redox flow batteries), Topsoe (PtX: production of electrofuels)

- **Associations:** DaCES (Danish Center for Energy Storage), Energy Cluster Denmark (all energy technologies), Brintbranchen (Hydrogen and PtX)

Policies & Market

- **Specific ES policies:** there is not a specific storage policy, but Danish Energy Agency has financed a whitebook on energy storages in 2019 and EUDP and Innovation fund has thermal storages as high priority. Storage is also targeted in the Danish government's strategy for PtX, first with the aim of contributing to the Danish energy transition, and an ambition to be part of an international market within PtX

- **Grants, legislation, regulations:** Ambitious Climate-law (voted in 2020): reduction of 70% of CO_2 emissions by 2030 compared with 1990 levels, climate neutral by 2050. Grants to research, demonstration & development projects. Heavy tax on fossil fuels

- **Trends:** more and more focus on storages as a key technology in a future Danish energy system with increased renewable energy production from e.g. wind and solar power. Storages are seen in a system integration perspective

Top 3 cases/projects:

1. FLEX_TES Flexible Thermal Energy Storage

- **Aim: Development and demonstration of 70,000 m^3 PTES in Copenhagen serving 3 waste incineration and 4 CHP plants in Greater Copenhagen**

Energy content 3,300 MWh, temp. 90 °C, in-and outlet capacity 30 MW, app. 25 cycles/year. Budget 12 M€

Climate effect: Prevent 6,200 tons of CO_2/year

In operation since February 2023

- **An EUDP subsidy (2 M€) is used to ensure:**

A cover and liner solution matching the temperatures and expected usage of the system – and which may last at least 20 years

Monitoring program

Optimisation of the use and control of the storage

Development of new business models

- **Partners: VEKS, HTF, PlanEnergi, Ea Energy Analyses, DTU**
- **https://planenergi.eu/projects/hoje-taastrup-greater-copenhagen/**

Photo: Ioannis Sifnaios

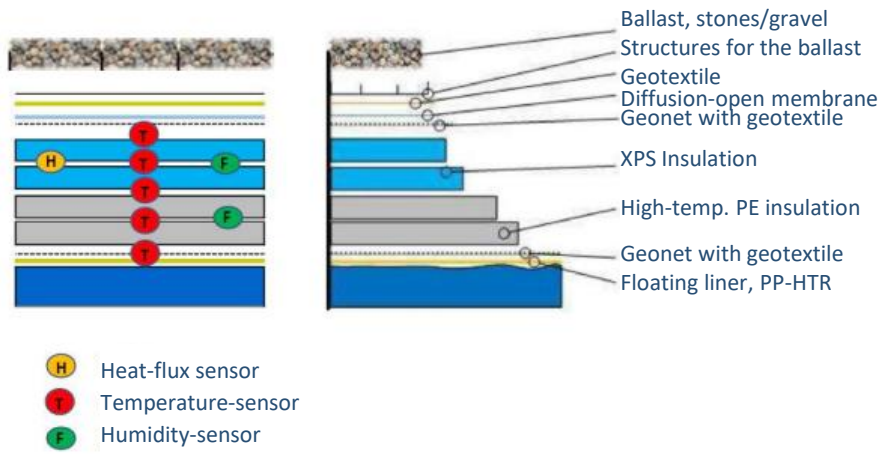


Figure 21: Location of sensors between the individual insulation layers

Top 3 cases/projects:

2. REDDAP Renewable Dynamic Distributed Ammonia Plant

- **Aim: To build a 10 MW green ammonia plant directly coupled to local wind and solar power generation.**

Output: More than 5,000 tons green ammonia annually from renewable power.

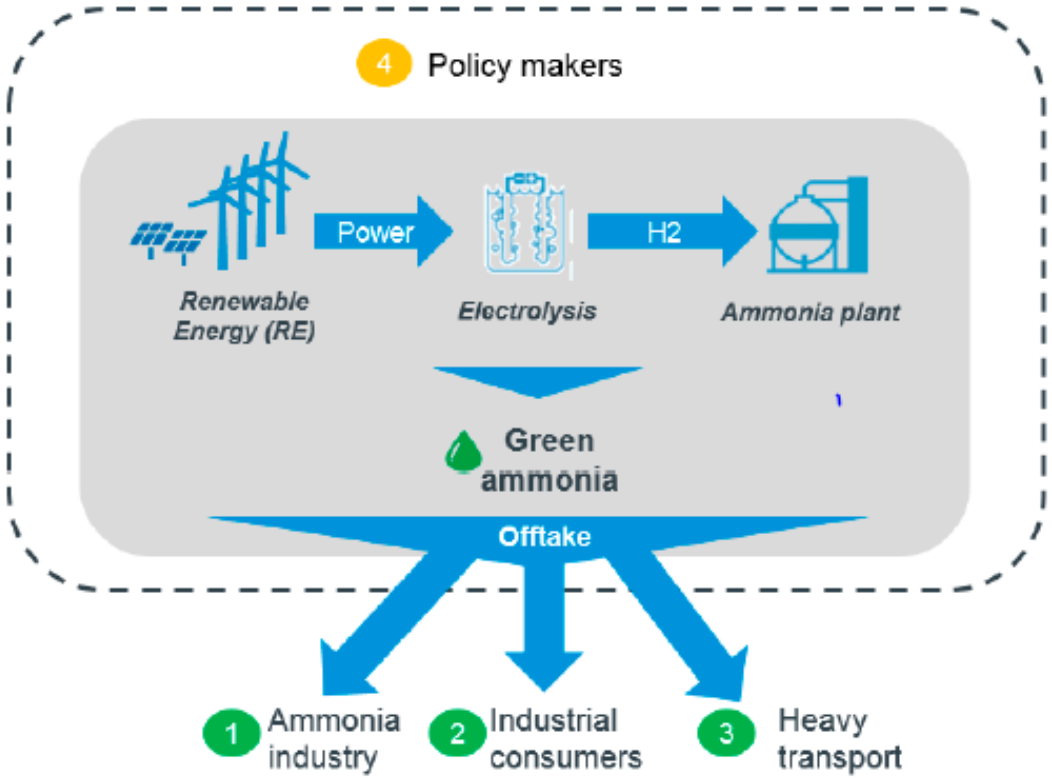
Climate effect: Prevent 8,200 tons of CO_2/year

Power supply: 12 MW from six existing V80-2.0 MW Vestas wind turbines and 50 MW new solar panels.

Budget 27 M€, EUDP subsidy 11 M€

Expected operation in 2024

- **Partners: Topsoe, Vestas and Skovgaard Invest**



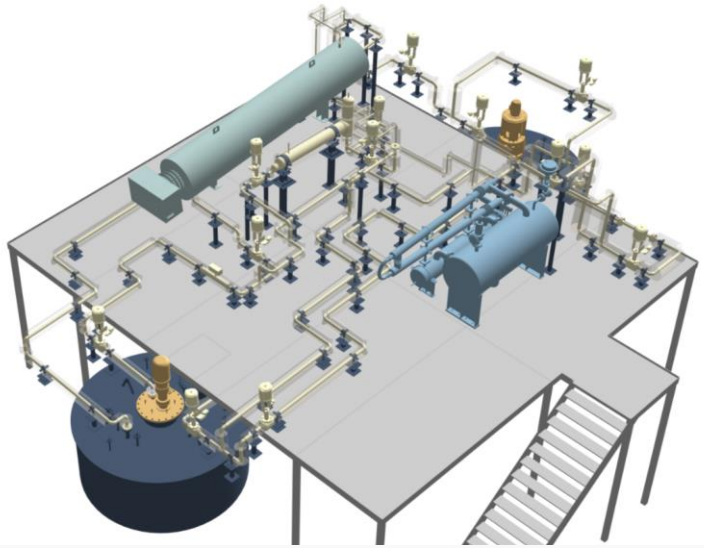
- https://stateofgreen.com/en/solutions/reddap-the-worlds-first-dynamic-green-ammonia-plant/

Top 3 cases/projects:

3. MOSS Molten Salt Storage

- **MOSS is a new type of cost-efficient molten salt storage based on hydroxide salts, which will make molten salt storage commercially viable. It is based on a patented technology on how to control corrosive salts and use their superior characteristics for giga-sized storage. The initial use case will be in combined heat-and-power production. The first commercial plant is expected to be built in 2024.**

In compact storage tanks, MOSS can store 1 GWh of energy (or more) up to 700 °C and use this to even out daily peaks in consumption and to store for up to 2 weeks to bridge periods of weak wind. For each 1 GWh storage plant in operation, MOSS will deliver annual $C0_2$-reductions of 32,000 tons/year. Project budget 3.6 M€. EUDP subsidy 1.8 M€



Salt storage tanks	Heat exchanger	Electrical heaters	Pumps
Two tanks, one of 350°C molten salt & one of < 700°C molten salt.	Used for steam generation extracting heat from our system. (Discharging)	The electrical heaters are used to inject energy into the system. (Charging)	The pumps move the salt around the system.

- **Partners: HYME Energy, Seaborg, Alfa Laval, DIN Forsyning, Sulzer Management, Kirt Thorsen, Aalborg University, Energy Cluster Denmark**
- **https://www.hyme.energy/project/moss**

The Energy Storage TCP

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