



**TEKNOLOGISK
INSTITUT**



**Electrification
includes batteries**

Anders C. S. Jensen

Green Energy systems



**Advanced fuels and
emissions**

4 people soon to be 6



Electronics and batteries

14 people



BioEnergy and CCUS

10 people

Electrification and batteries

Batteries play a key role in the green transition

- Mobility
 - EV, busses and trucks
 - Ferries
 - Ebike
 - Air planes



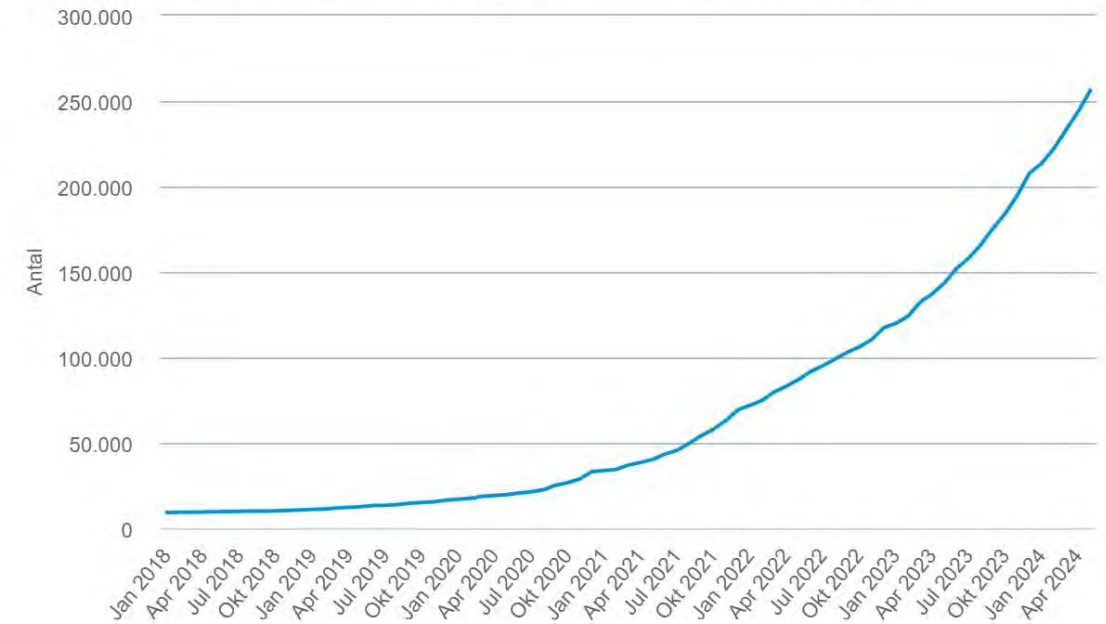
EVs in Denmark

Batteries play a key role in the green transition

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Bestand af motorkøretøjer

Drivmiddel: El | Brugerforhold: I alt | Køretøjstype: Køretøjer i alt | Område: Hele landet:



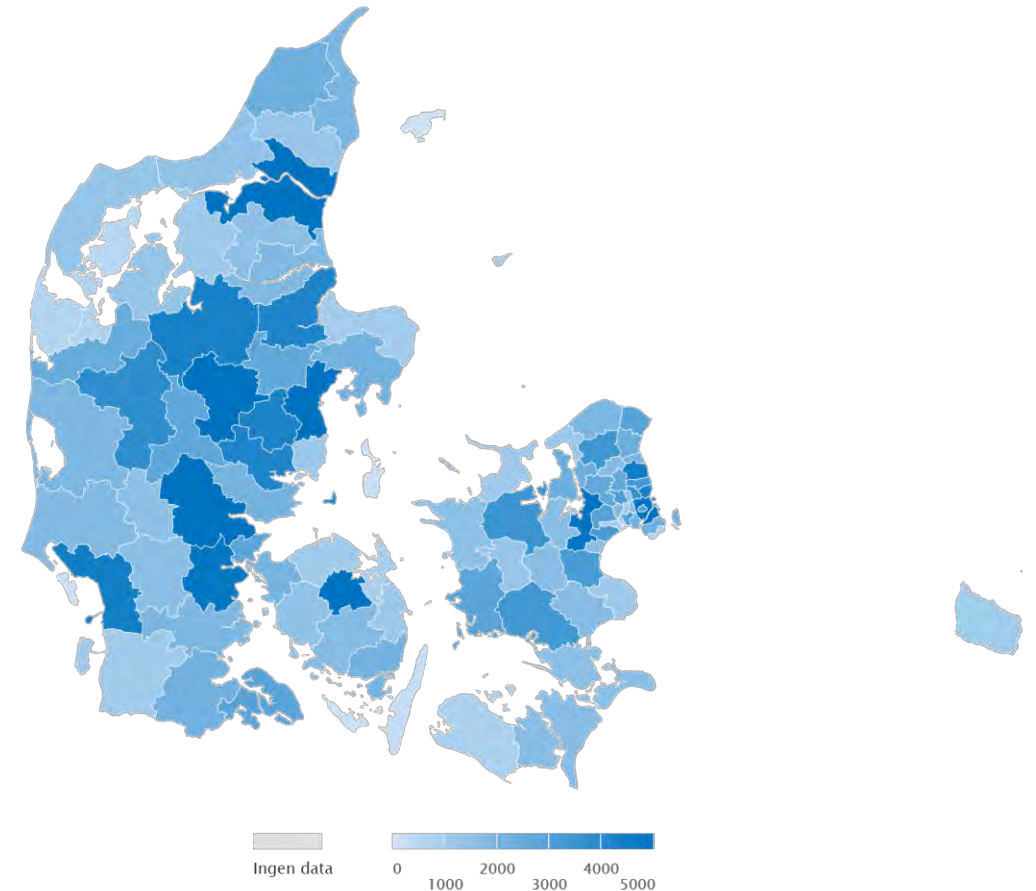
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Bestand af motorkøretøjer

Enhed: Antal | Køretøjer i alt | I alt | El | 2024M05



Danmarks Statistik, www.statistikbanken.dk/bil54

Eferries

Batteries play a key role in the green transition

- Mobility
 - EV, busses and trucks
 - Ferries
 - Ebike
 - Airplanes

First fully Electrical ferry in 2019
4.5 MWh, 4 MW charging capacity



First DTI BESS grid scale project

Batteries play a key role in the green transition

- Mobility
 - EV, busses and trucks
 - Ferries
 - Ebike
 - Airplanes
- Grid storage
 - Utility scale
 - residential

Project 2014-2016
1.6 MW/0.4 MWh



Final report
ForskEL project no. 10739



**DANISH
TECHNOLOGICAL
INSTITUTE**

Energi Danmark

Vestas

Smile Project (2017-2021)

3 sites:

Samsø (200 kWh):

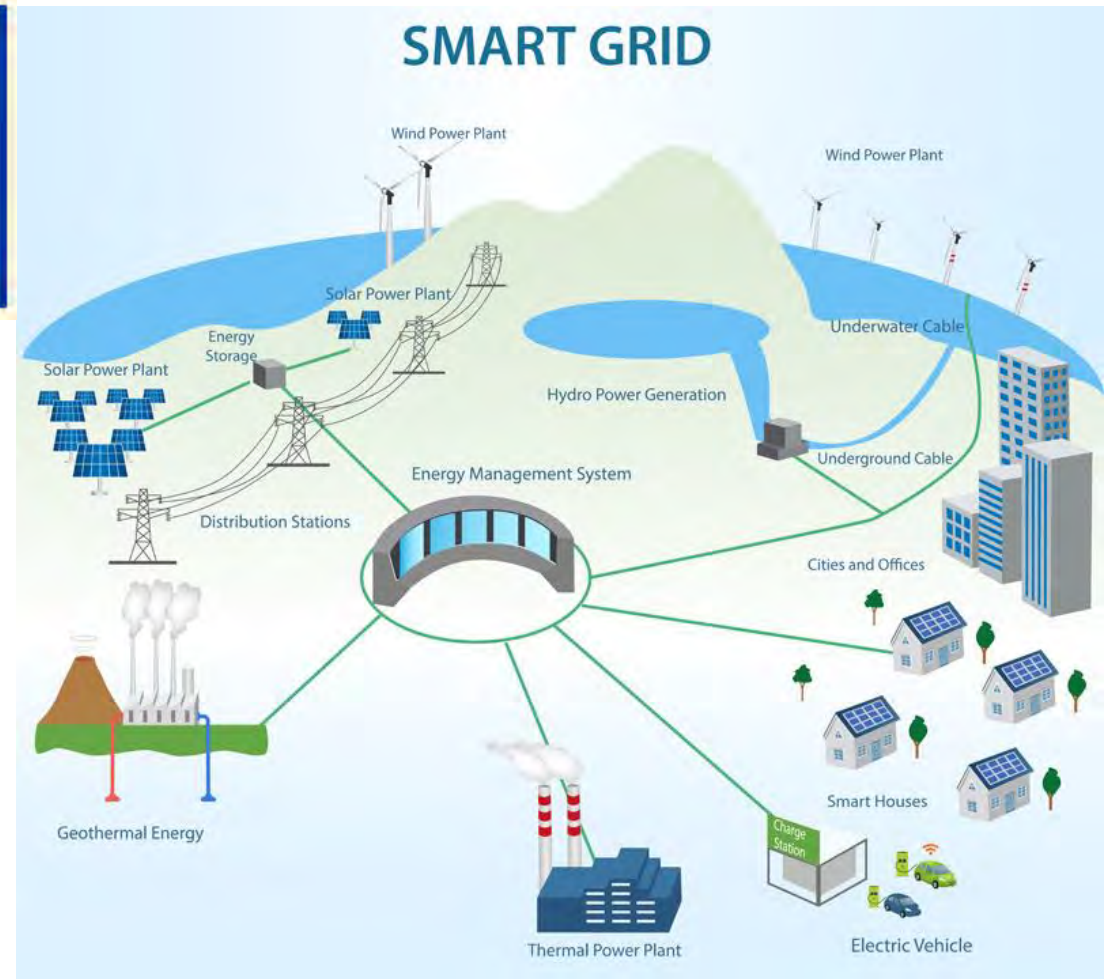
- Commercial Marina
 - Improved self consumption

Madeira (80 kWh + 7x5 kWh):

- Commercial and residential
 - Grid reinforcement and PV self consumption

Orkney (7x5 kWh):

- residential
 - Combat energy poverty



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731249.

Alight Project(2020-2025)

Making CPH airport carbon neutral

- 15.4 mio. EUR, 12 mio. from the EU
- 18 partners
- 3 key areas
 - Sustainable aviation fuel
 - Renewable energy sources
 - **Smart energy**



Alight Project(2020-2025)



Smart energy

- Electrifying ground fleet
 - In progress
- Demonstrating BESS on site
 - In progress
- V2G and utility services
 - Report available on website (<https://alight-aviation.eu/>)

Table 6 Payback time of a battery with a cost of 800 k€ performing only arbitrage

	A-high	A-low	B-high	B-low	C
2017	613 years	676 years	809 years	930 years	1757 years
2018	336 years	359 years	407 years	451 years	721 years
2019	507 years	566 years	668 years	762 years	1551 years
2020	200 years	216 years	245 years	273 years	479 years
2021	56 years	59 years	63 years	66 years	82 years
2022	18 years	18 years	19 years	20 years	23 years

Alight Project(2020-2025)

Smart energy

- Electrifying ground fleet
 - In progress
- Demonstrating BESS on site
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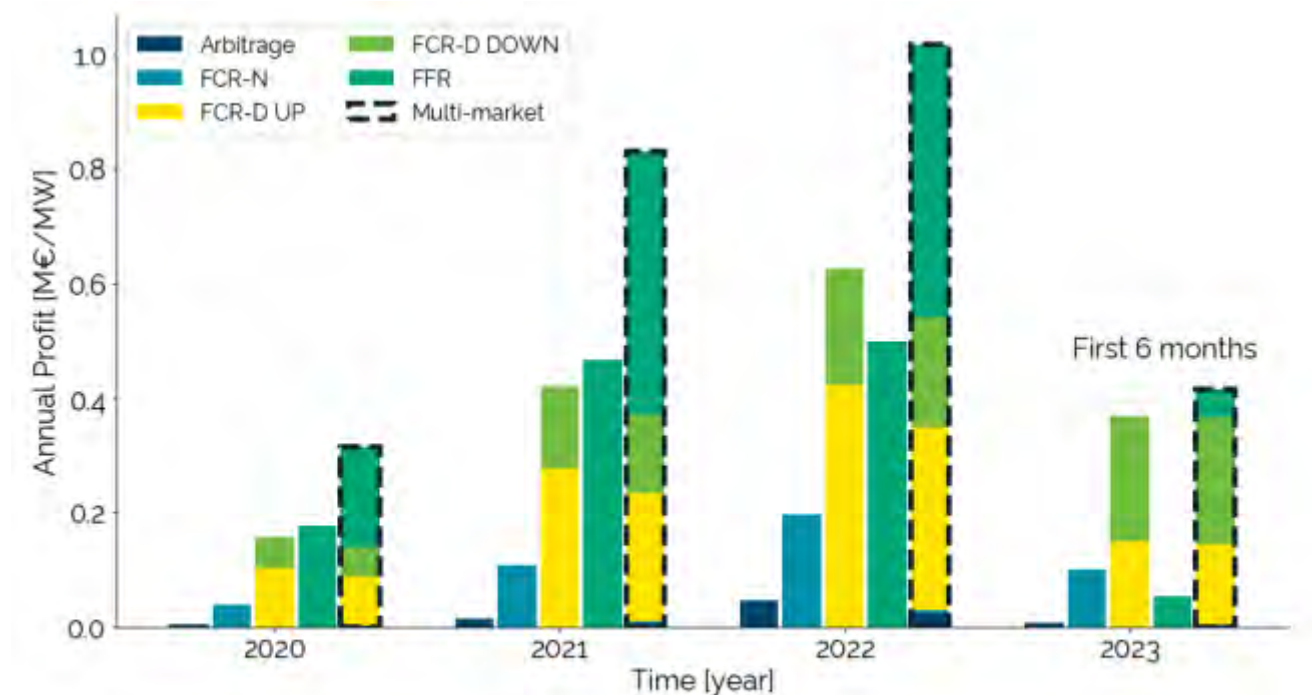


Figure 24 Annual profit of delivering stand-alone services; Arbitrage, FFR, FCR-D Up + FCR-D Down and FCR-N, as well as the optimal combination of services



2LIPP Project(2023-2026)

Can we make it easier to place these systems on the grid and can we be more circular?

Reuse all existing infrastructure on a power for partial or complete conversion to a storage site.

Reuse of

- Grid access
- Electrical connections
- Know-how
- Space



This project (2LIPP) has received funding from the European Union's Horizon Europe programme under grant agreement No. 101096672.

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2LIPP Project(2023-2026)

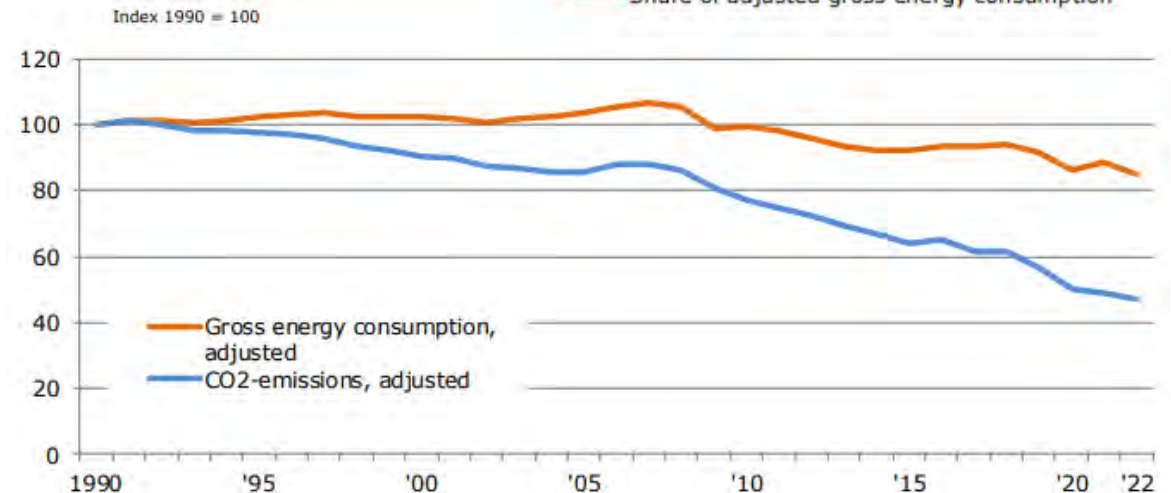
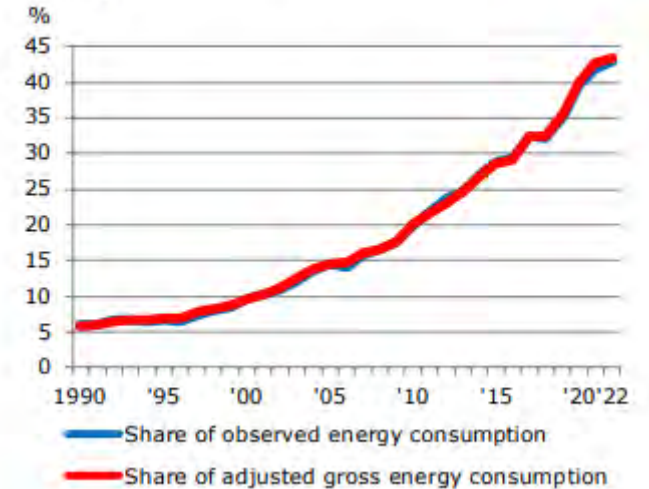
Large increase in renewable energy giving less spinning reserves in the grid.

More storage is needed to address dunkelflaute periods

Currently 12-24 months to bring large scale BESS on grid.

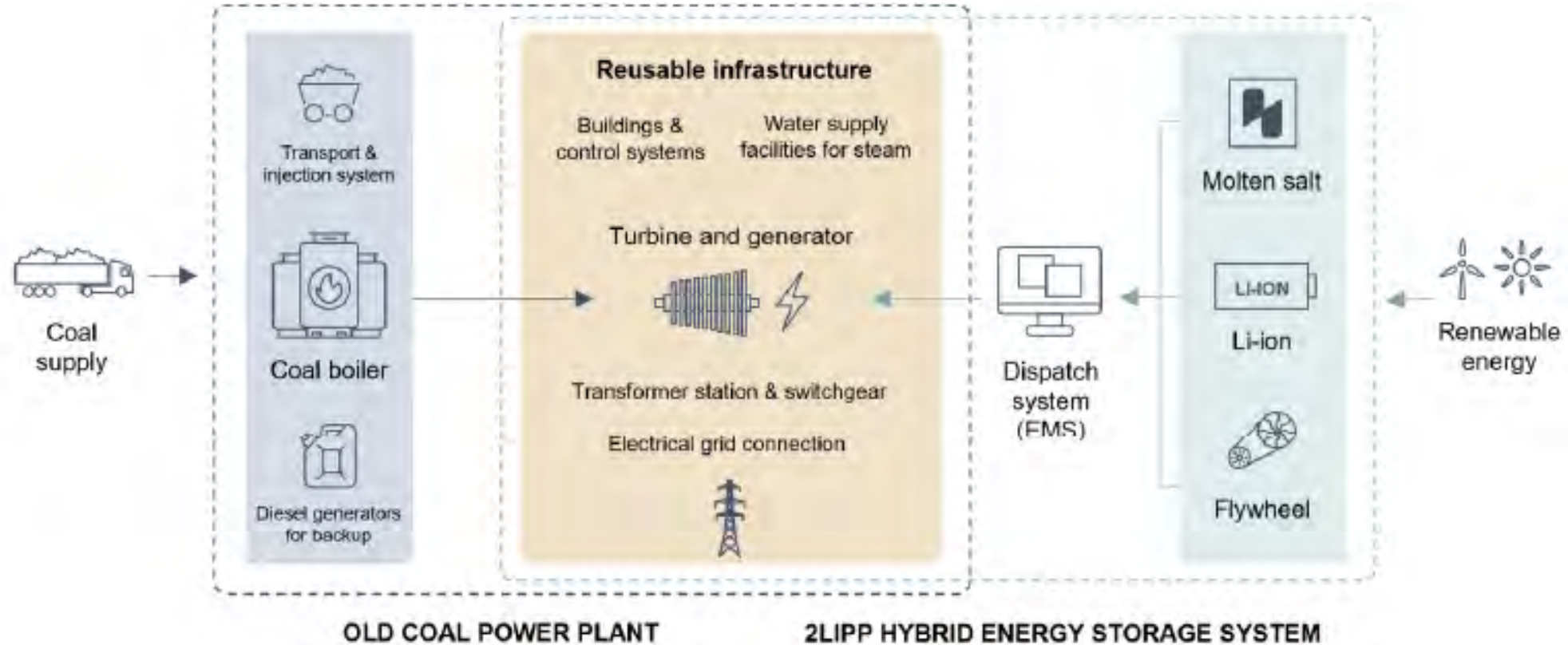
10 MWh storage multi system approach

Renewable energy - share of total energy consumption



Source: Danish energy agency

2LIPP Project(2023-2026)



Over 500 GW capacity in Europe
1.200 Billion EUR in assets

QuinteQ's Flywheel

Innovations

- Endless cycles, 30 years lifetime
- Focus on speed, rather than mass
- Compact, containerized system
- fast response for balancing & frequency regulation
- Modular design, adaptable to local puzzle.
- Kinetic battery, not chemical, fully recyclable

Value for 2LIPP & other power plants

- Fast response to protect and extend life of other storage technologies
- Energy trading (FCR)
- Generator bridging, UPS opportunities

Other market applications

- Peakshaving tower cranes in **construction** to avoid excessive generators
- Peakshaving harbour cranes to enable **port** electrification
- Peakshaving **rail** and **light rail** to reduce avoid voltage dips
- Stabilizing supply and demand to support **microgrids**



PLS BESS system and energy director

Second life BESS system

Medium time scale storage

AI based energy optimization

Aim 800 kWh/200 kW

EMS with ability to optimize 3 separate systems continuously



Hyme Molten salt

Sodium Hydroxide salt storage

Charging

Electricity to heat through electrical heaters.

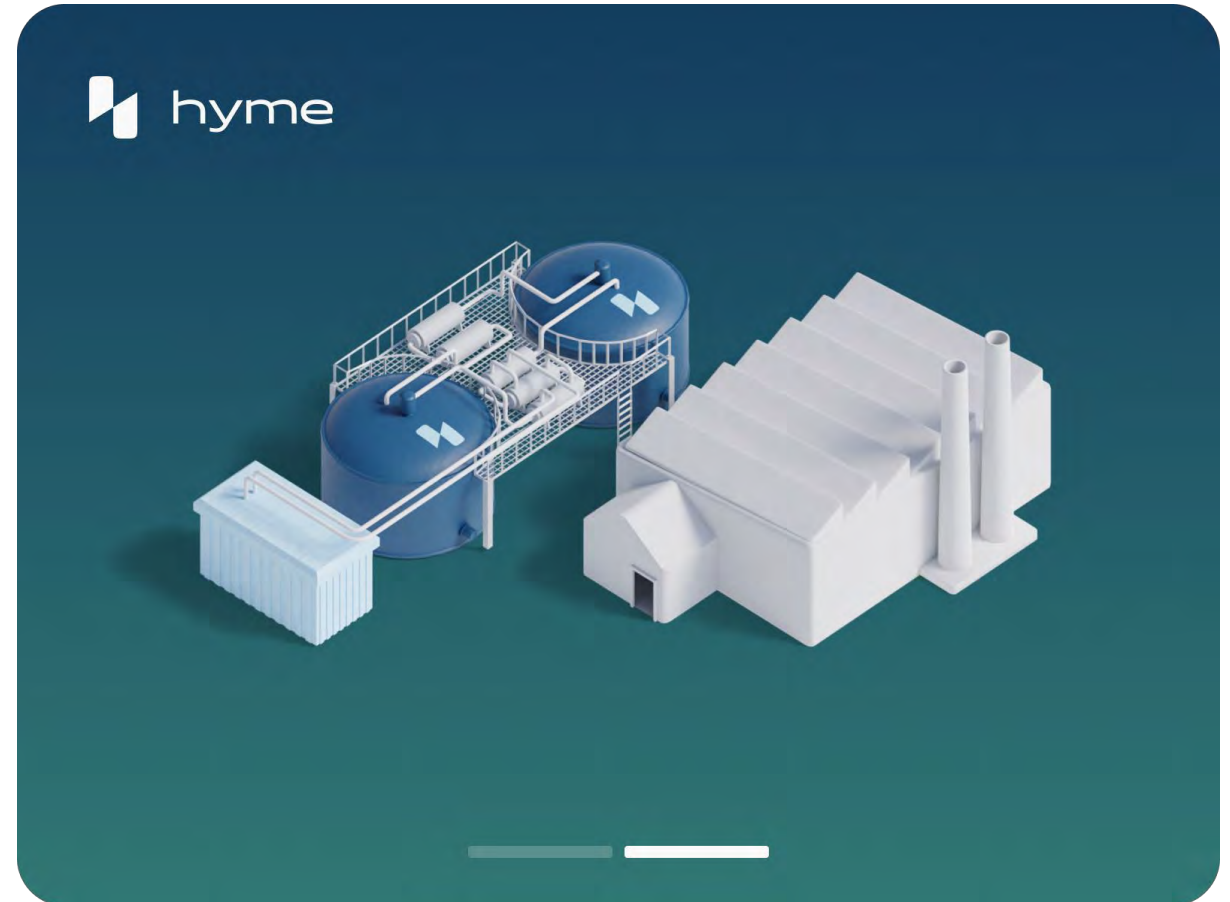
350 °C to 700 °C heat cycle

High efficiency and long storage

Discharging

Heat to steam (electricity) or heat to heat (district heating) energy release

Decoupled power and energy units.





2LIPP Project(2023-2026)

Status 2024

System are being installed

Flywheel and BESS system online in fall 2024

Regulations and grid approval is challenging

Integration is none trivial



Questions?

