Image courtesy of Robbert Frank Hagens, TBB Photo Contest

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# Wind and Electricity Storage from an European perspective

Catalysing the energy transition

# Accelerating sustainable energy innovation

Offices across Europe and in Boston

500+ partners

28 shareholders

Activities in 18 countries

480+ products supported

€560m EIT InnoEnergy investment

# Structuring the energy value chain in Europe

Battery industry value chain with the European Battery Alliance

Green Hydrogen value chain with the European Green Hydrogen Acceleration Centre

Solar PV value chain with the European Solar Initiative

# 100% renewable will require stationary storage



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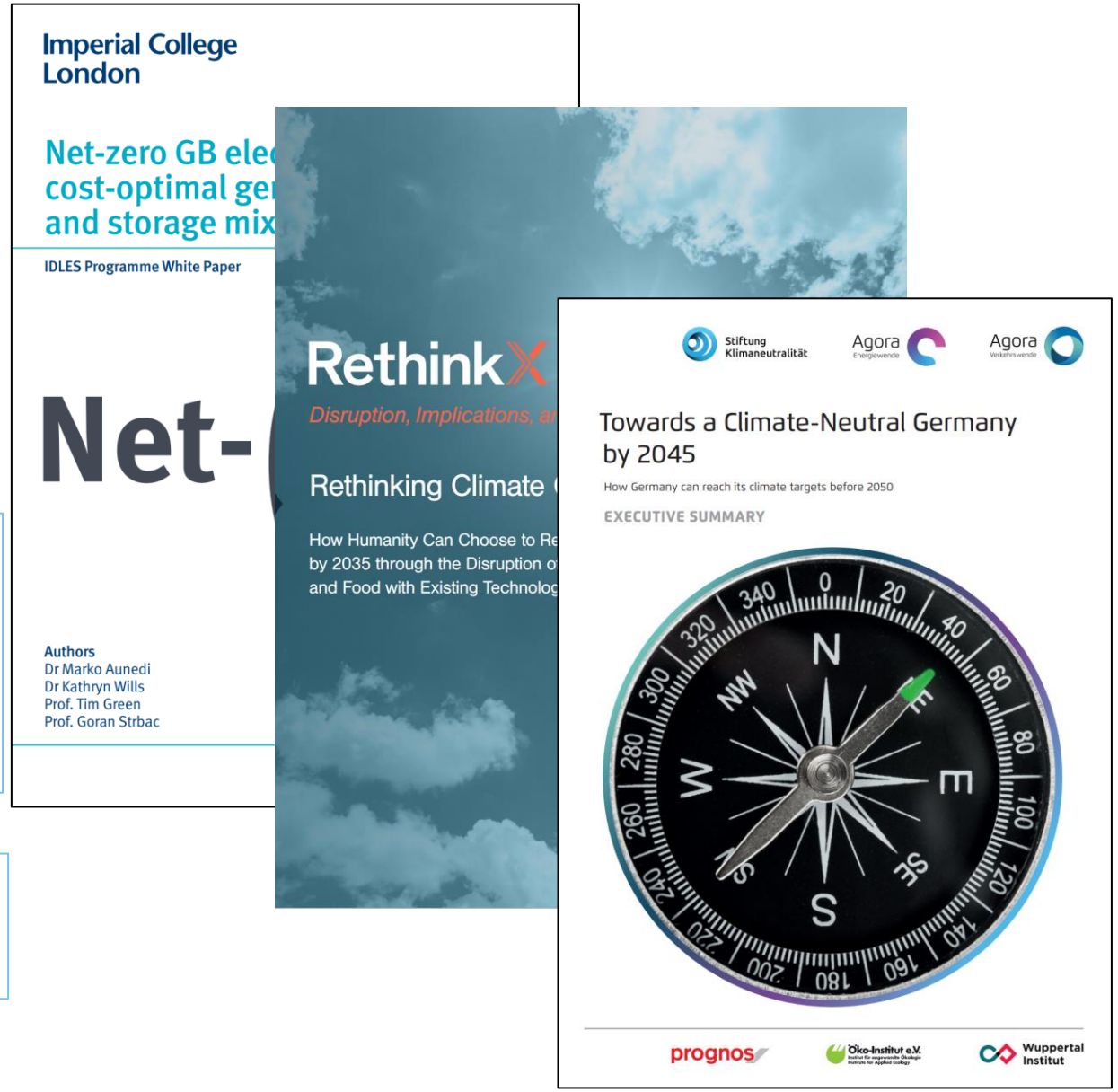
How much and what type of storage?
Is it really possible?
Will the value chain hold up?


> A decarbonised electricity system would require the UK to have 24 GW of long-duration storage capacity – eight times what is currently installed



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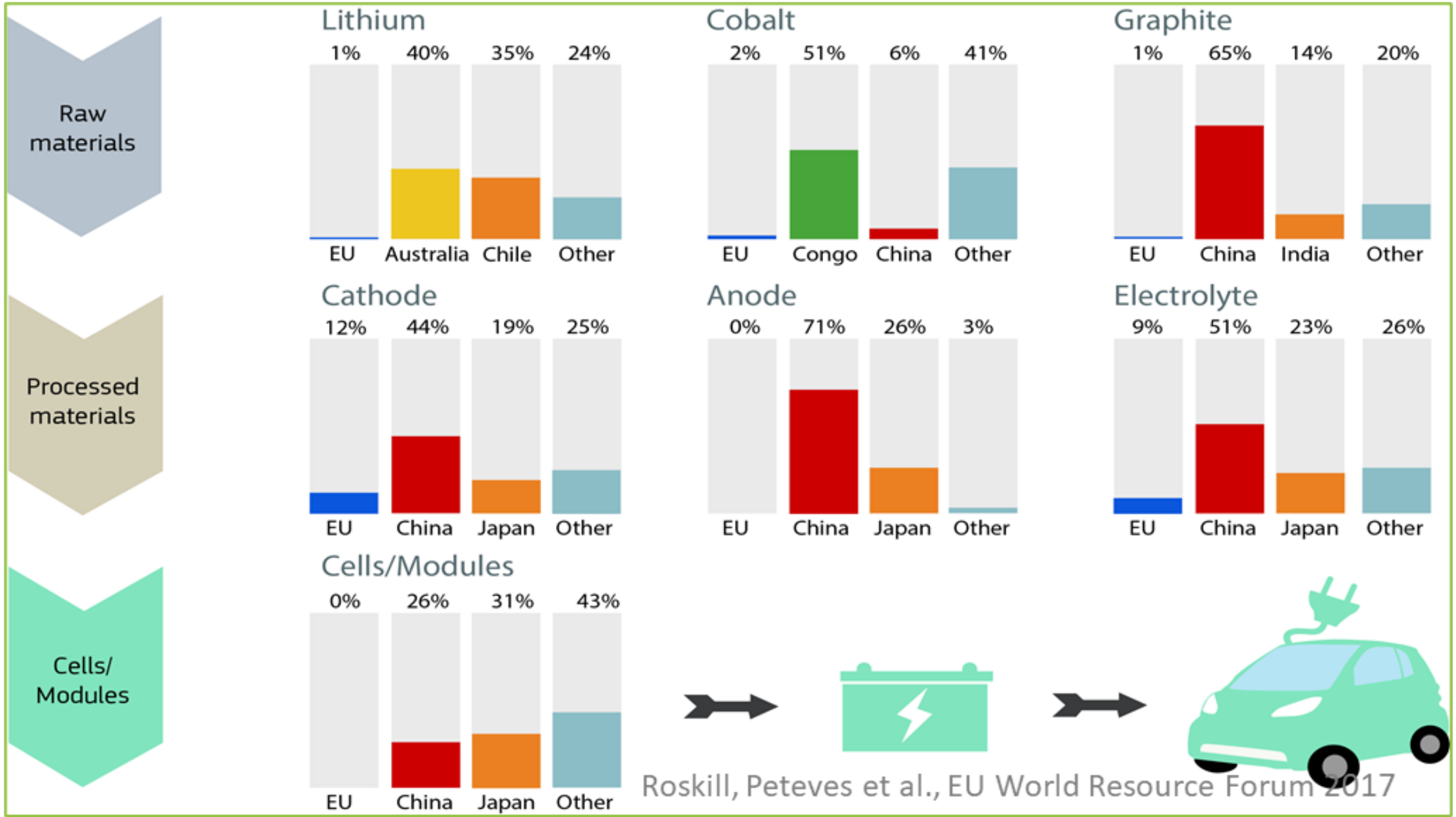
# Tremendous mobilisation in record time of the Li-Ion battery value chain

# The starting point in 2017 – Looked rather bleak




Roskill, Peteves et al., EU World Resource Forum 2017

# 2022: 45 + ongoing and planned lithium battery cell factories in Europe

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**NORTHVOLT ETT**
In operation, first cell produced 2021, up to 60 GWh

**NORTHVOLT Labs**
In operation, 0,5 GWh

**Beyonder**
Announced, up to 10 GWh

**MORROW**
Announced, planned start 2021, up to 32 GWh

**AMTE Power**
announced, up to 2 GWh

**Northvolt/ Volvo Cars**
announced, planned start 2025, up to 50 GWh

**ENVISION AESC**
In operation, 1,9 GWh

**ENVISION AESC/Nissan**
Announced, up to 25 GWh

**BRITISHVOLT**
Announced, planned start 2021, up to 30 GWh

**VERKOR/Renault**
up to 50 GWh

**ENVISION AESC/Renault**
Announced, up to 24 GWh

**ACC France (Total/Stellantis/Mercedes)**
IPCEI project, Start 2022, up to 24 GWh

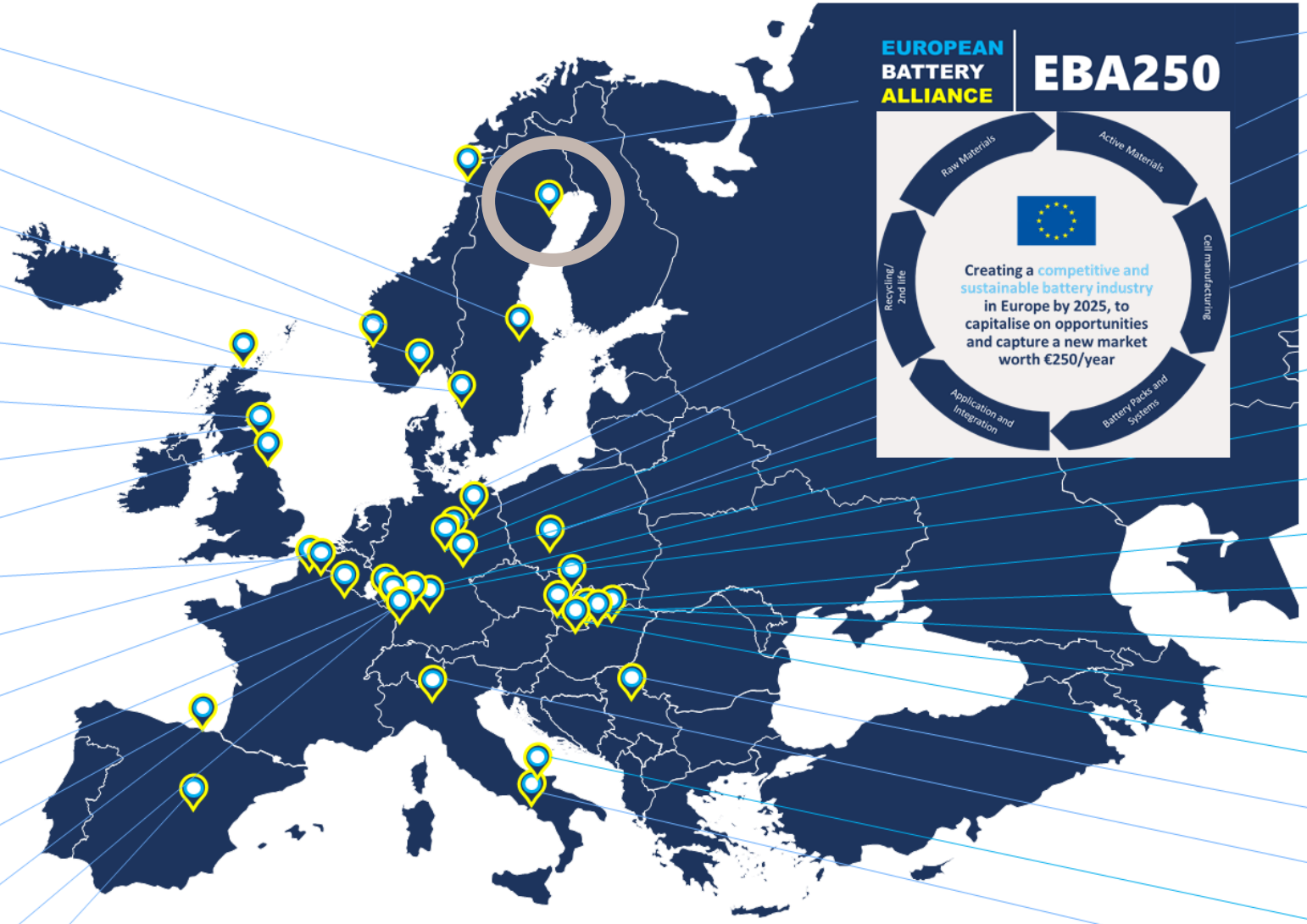
**ACC Germany (Total/Stellantis/Mercedes)**
IPCEI project, Start 2021, up to 24 GWh

**SVOLT**
Planned start 2023, up to 24 GWh

**Basquevolt, Spain**
Announced, start 2025, up to 10 GWh

**LECLANCHÉ/ENERIS**
Small scale operation (0,3 GWh), up to 1 GWh

**VW, Spain**
Announced, up to 20 GWh




**FREYR**
Announced, planned start 2023, up to 20 GWh

**TESLA**
Start 2022, up to 125 GWh

**CATL**
Start 2022, up to 80 GWh

**Volkswagen**
Start 2022, up to 40 GWh

**LG ES**
In operation, 24 GWh, up to 67 GWh

**FARASIS/Mercedes**
Announced, delayed to 2024 up to 10 GWh

**CELLFORCE/Porsche**
Announced, up to 1 GWh

**VARTA**
IPCEI project, Start 2021, up to 5 GWh

**MES**
Started 2020, up to 15 GWh

**SAMSUNG**
Start 2018, up to 30 GWh

**SK Innovation**
In operation, 7,5 GWh

**SK Innovation**
Started 2021, up to 10 GWh

**SK Innovation**
Announced, start 2028, up to 30 GWh

**INOBAT**
Announced, up to 30 GWh

**ElevenES**
Announced, up to 16 GWh

**ITALVOLT**
Announced, up to 70 GWh

**ACC Italy (Total/Stellantis/Mercedes)**
Announced, up to 16 GWh

**FAAM/FIB**
IPCEI project, Production started small scale, up to 8 GWh

**Volkswagen, Eastern Europe**
Announced, location TBD, up to 10 GWh

Under construction/ in operation
Planned, partially financed
Announced, financial status unclear

Source: EBA250 Observatory monitoring of public announcements on Li-Ion cell production capacity

# Increased electrification targets increase demand forecasts

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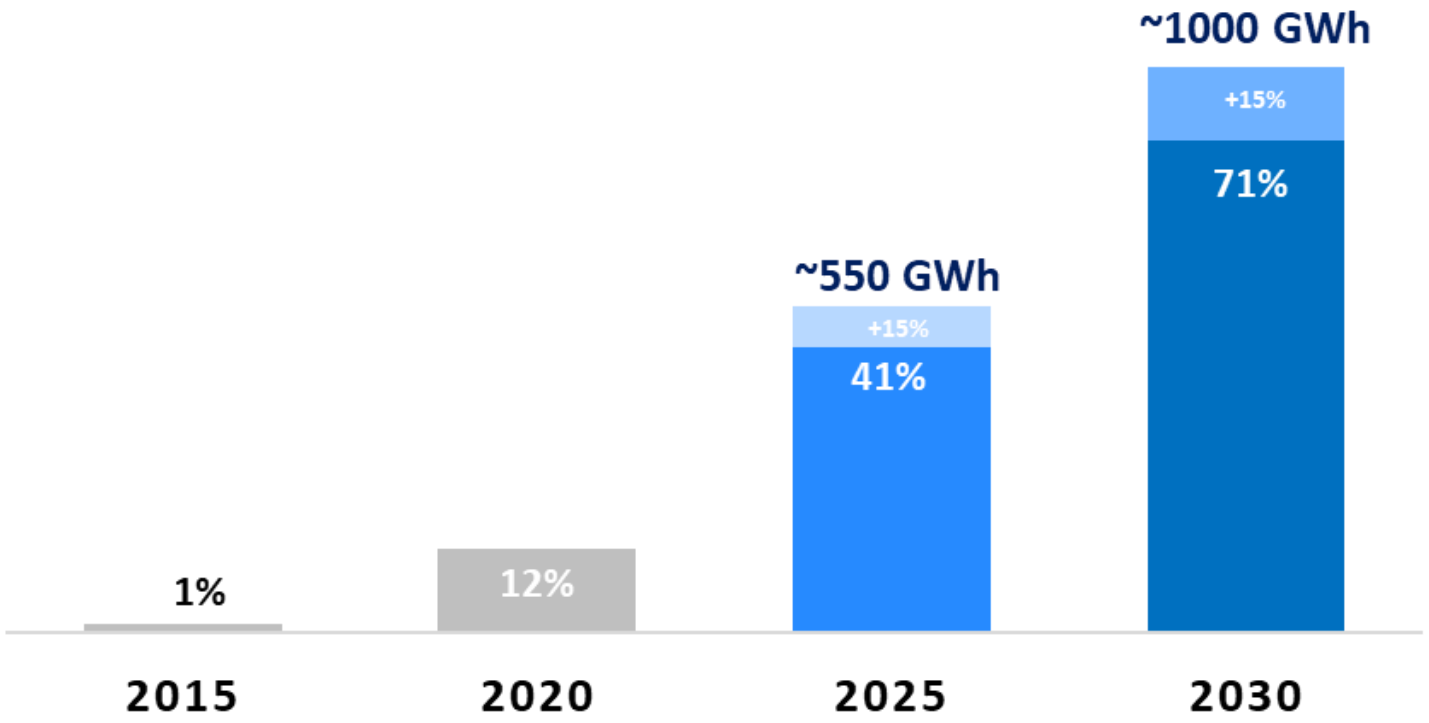
## Volume-averaged Europe forecast EV+PHEV sales forecast, including 15% for other sectors (HDV, busses, yellow machines etc...




| Group | 2020 | 2025 | 2030 |
|---|---|---|---|
| Volkswagen Group | 11% | 40% | 60% |
| Stellantis | 7% | 40% | 70% |
| Renault-Nissan-Mitsubishi | 16% | 45% | 70% |
| Daimler | 2% | 25% | 100% |
| BMW | 17% | 25% | 50% |
| Ford | 1% | 90% | 100% |
| Hyundai | 13% | 30% | 60% |
| Toyota | 5% | 20% | 30% |
| Jaguar-Landrover | 9% | 30% | 60% |
| Tesla | 100% | 100% | 100% |
| VolvoCars | 29% | 50% | 100% |
| **Total** | **12%** | **41%** | **71%** |

OEM Announcements

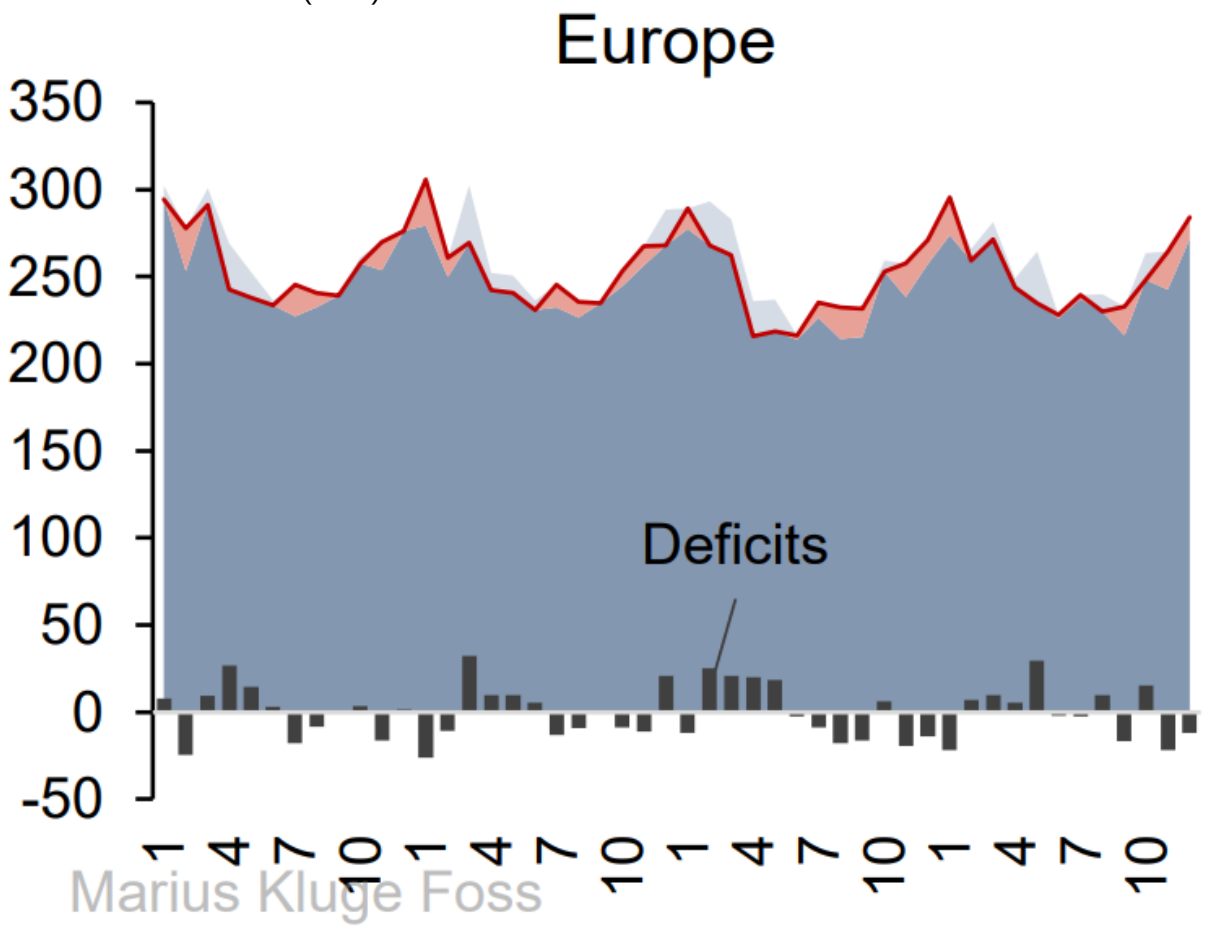
EBA250 estimates

Funded by the European Union

# Will we see the same growth on stationary storage?

# To what extent is Long Duration Electric Storage needed ?

**Monthly 100% low carbon electricity generation and load**
Terawatt-hours (TWh)




Source: Rystad Energy

In LDES we consider shifting generation, not by a couple of hours, but from **one month to another**, and even from **one season to another**.

Simulation of monthly deficits in a system where **solar and wind have been scaled to replace fossil-based sources**. Data from 2018-2021.

In Europe **generation and load follow each other quite well**, thereby limiting the need for seasonal storage.

# What would a fully renewables-based energy system look like?

## Case Germany



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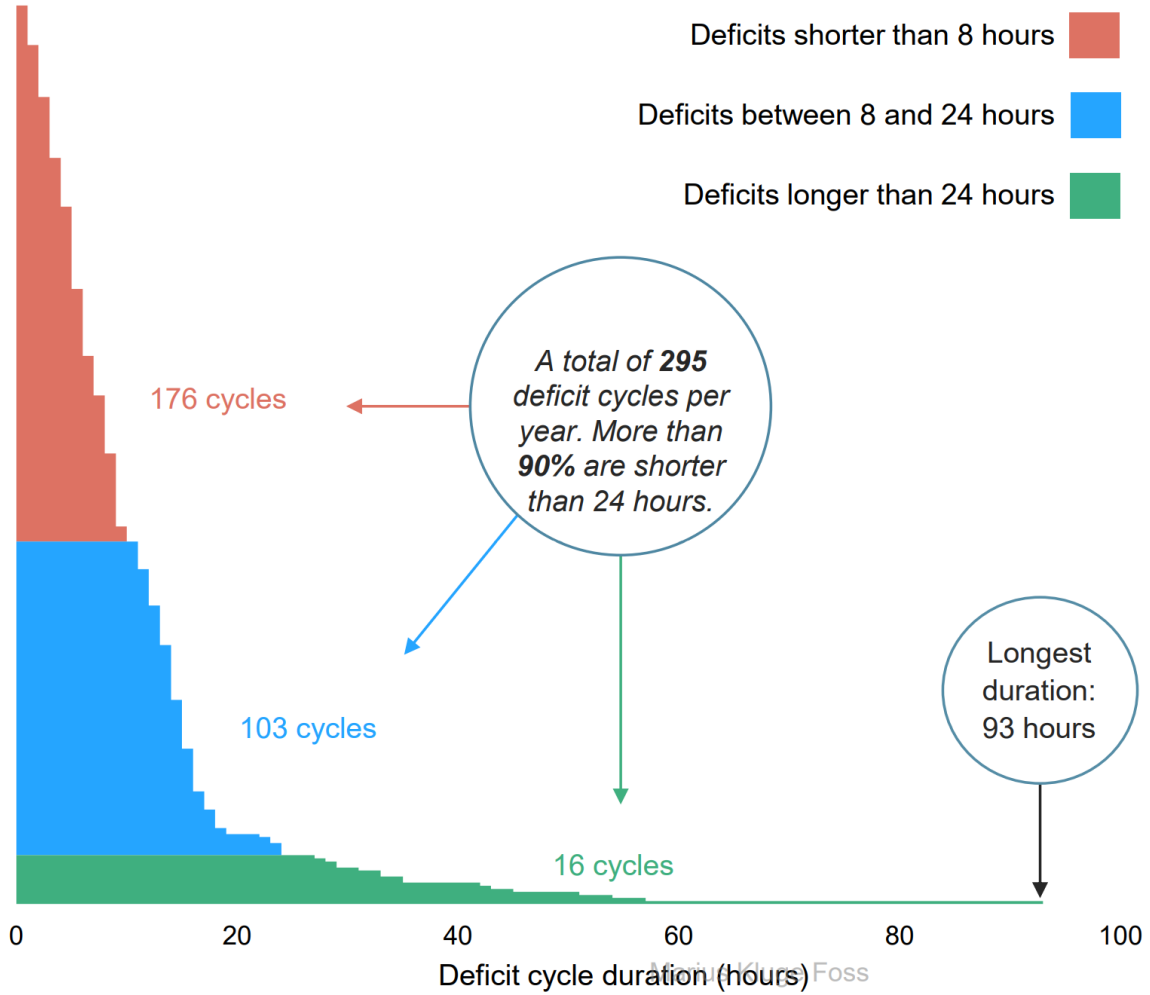
**Distribution of the deficit cycles in a fully decarbonized German electricity grid**

Renewable capacity scaled **to** provide 150% of annual demand




Source: Rystad Energy

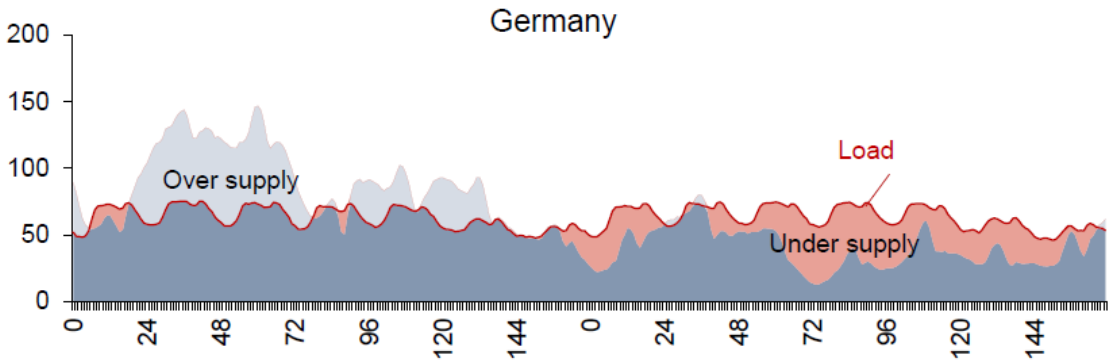
Overbuild of RES solves a large part of the LDES.

Batteries will be able to solve a large part of the storage demand.

Same value chain as for automotive – good and bad

**Hourly 100% low carbon electricity generation and load**

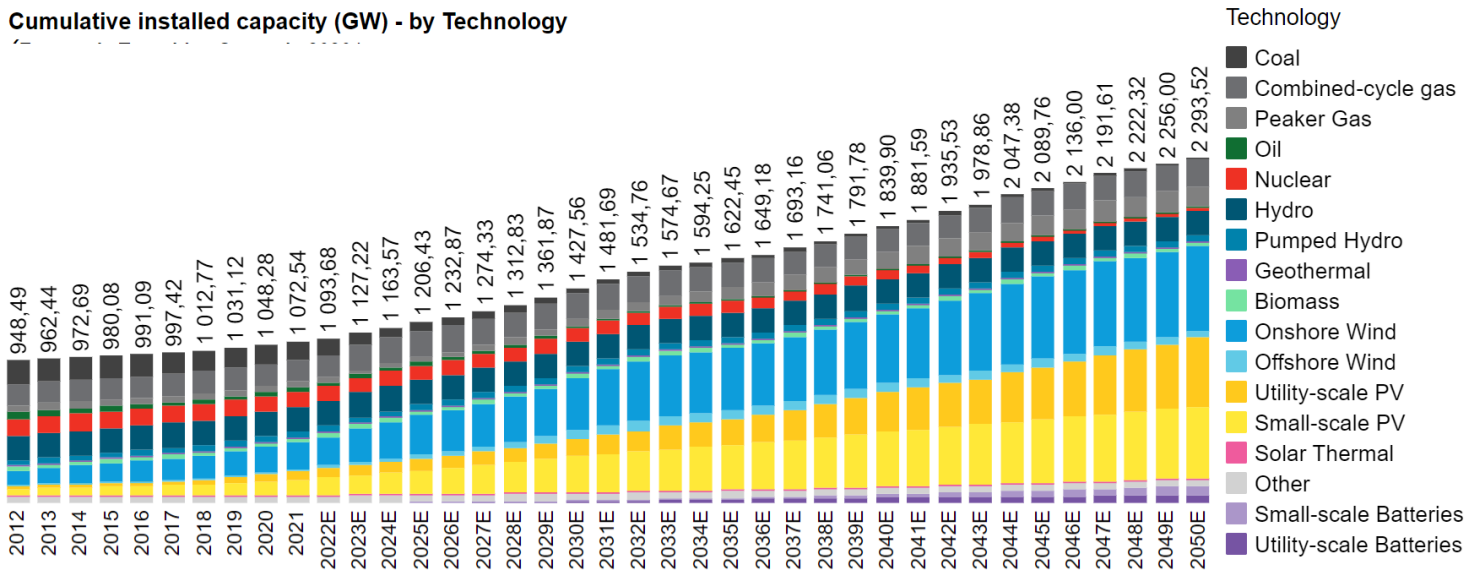
Gigawatt-hours (GWh)



Funded by the European Union

# Good news, but still some major issues

- **Overbuild as a strategy would work in a ”copper plated system” we will still have problems to deliver the renewable power to the location of the consumer**
- **The forecasted rapid increase in demand will require a massive additional renewable generation - doable but far from consumption**




Source: BNEF

# So what is missing in the analysis?



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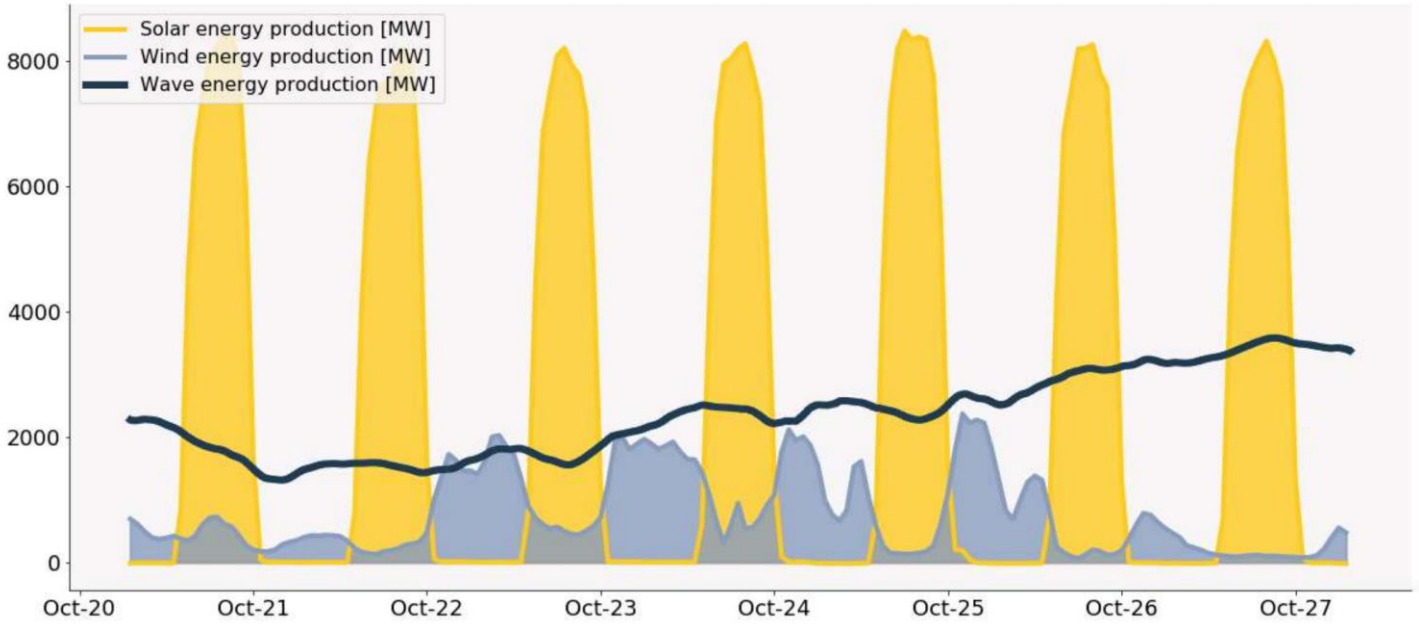
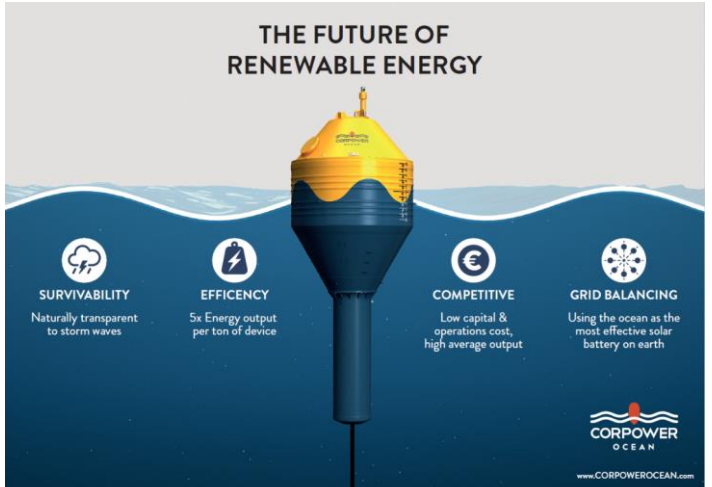
Additional renewable generation operating out of phase with wind and solar

Wave power is 15 years behind wind but starting to catch up




Source: Corpower



# So what is missing in the analysis?



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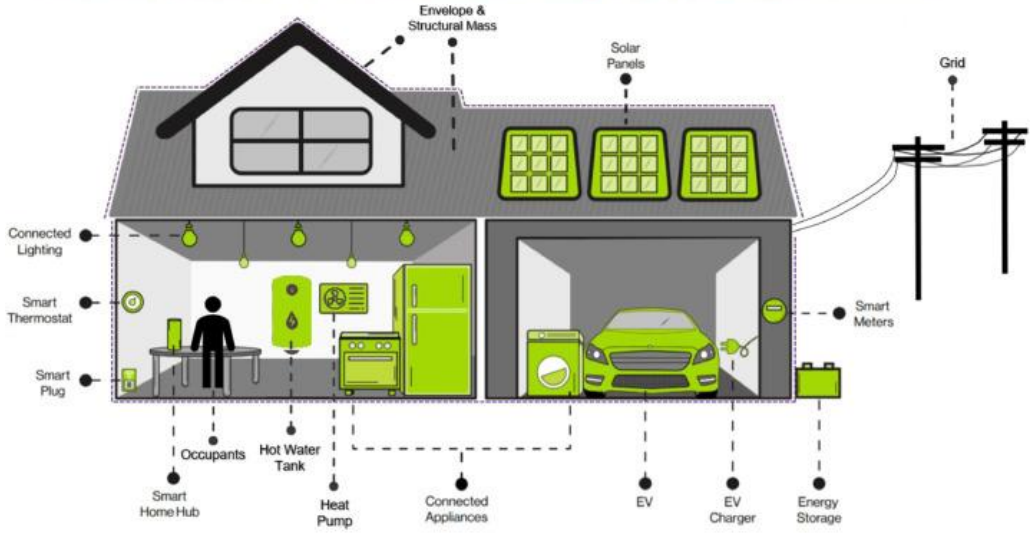
Flexible consumption is leading the way on all scales including the new $CO_2$ free industries

SVENSKA KRAFTNÄT

Start > Utveckling av kraftsystemet > Forskning och utveckling > Pågående FoU-projekt > sthlmflex



# So what is missing in the analysis?



Funded by the European Union

Location of the new loads near the generation and not the other way around

Fertiberia

VERKOR


northvolt®

HYBRIT
FOSSIL-FREE STEEL

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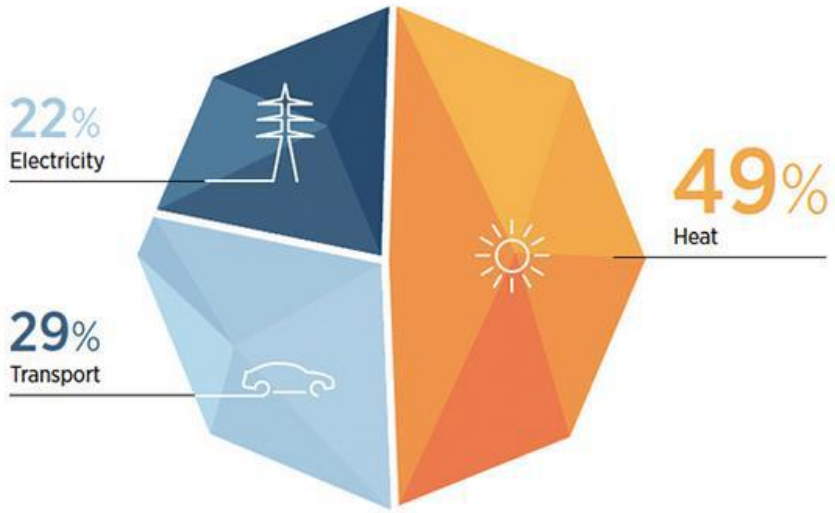
# So limited demand for long duration storage but still some will be needed. What are the options?

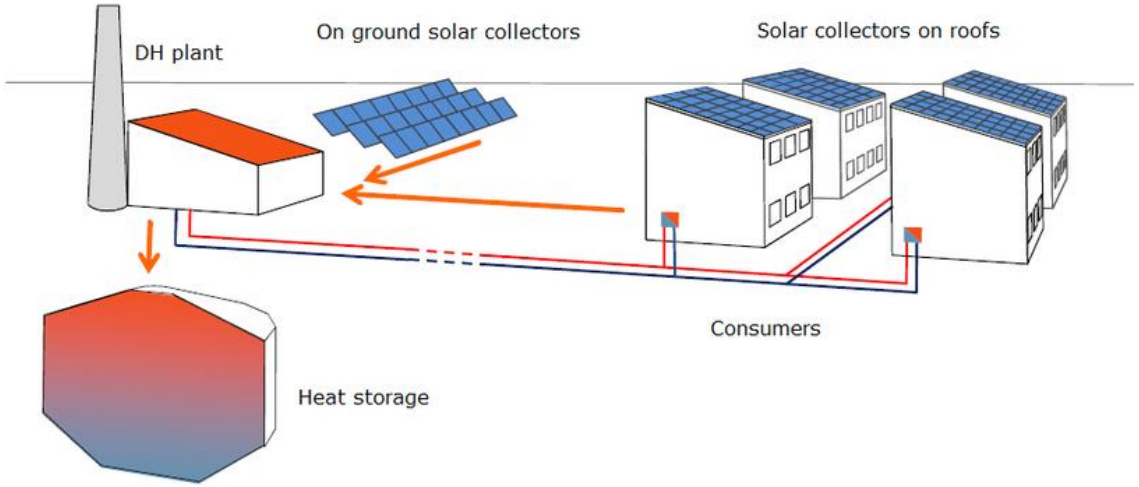
## Decarbonisation of District Heating Systems

**Figure 1.1** Total final energy consumption, by final energy use, 2018




Source: IEA, 2020a; IEA, 2020b.

Note: Consistent with statistical conventions and current data availability, the category "heat" includes electricity used for heating. The category "electricity" includes electricity used for cooling.




Coal or gas is still a dominating fuel for DH in CEE. Solar Heating with seasonal storge competitive solution

# Energy Island well become hubs for off shore wind as well as P2X

Source: Energinet.dk

# New unintrusive pumped hydro



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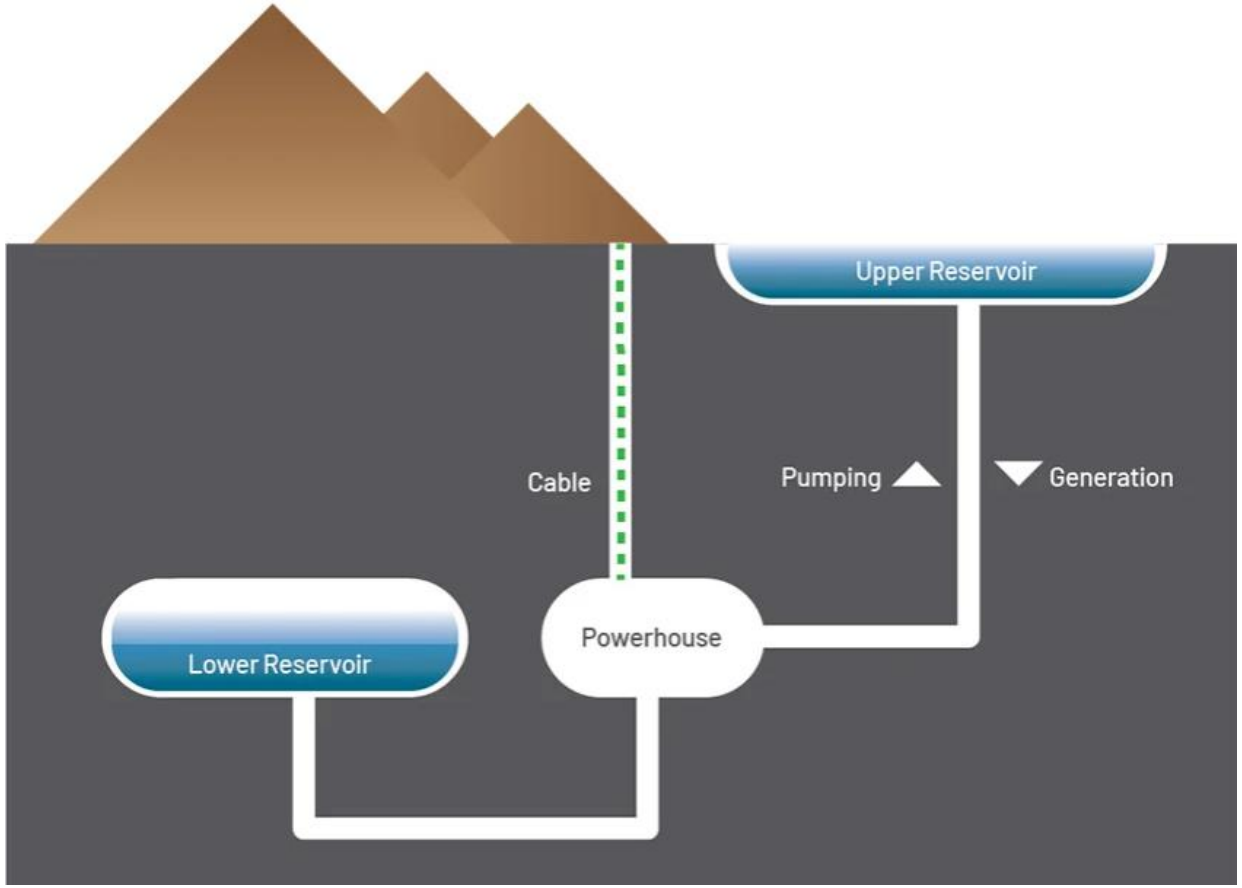
- Largest LDES facilities today are pumped storage
- Limited locations for traditional pumped storage
- Large number of decommissioned mines which presents an opportunity




Source: Mine storage International

# Battery technologies



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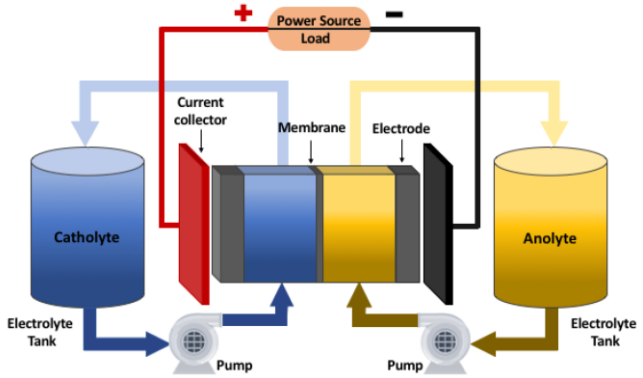
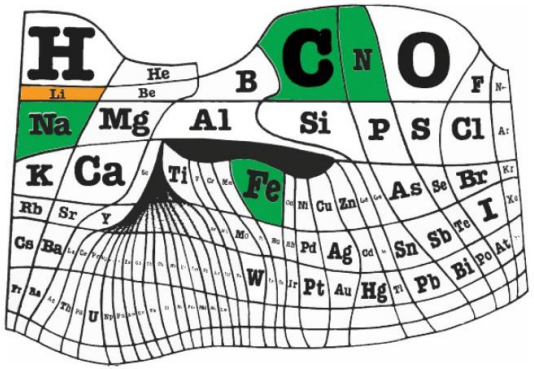
- Redox Flow batteries
  - Vanadium, Bromine, Iron, Organic




- New battery chemistries
  - Na-ion, Al, S




# Summary



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- **Less need for Long Duration Energy Storage (LDES) – most storage applications up to 24 hours if system is overbuilt by 150 %**
- **Further reducing the need for storage**
  - New renewable generation sources evening out the intermittency: Wave power, floating wind
  - Making use of “low hanging” flexibility resources as well as the new industrial flexibility
  - Location of new heavy consumption close to RES generation
- **Long Duration Electric Storage options**
  - Heat Storage
  - Hydrogen for industrial use or P2X
  - Pumped hydro in mines
  - New battery chemistries
- **It is possible and the technology is available!**