6th International Conference on Smart Energy Systems
6-7 October 2020
#SESAAU2020

Wind + sun for 100% RE heating of buildings

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Conclusion :
A 24 hour storage systems allows 99,5% Renewable Energy Autonomy for a heat pump

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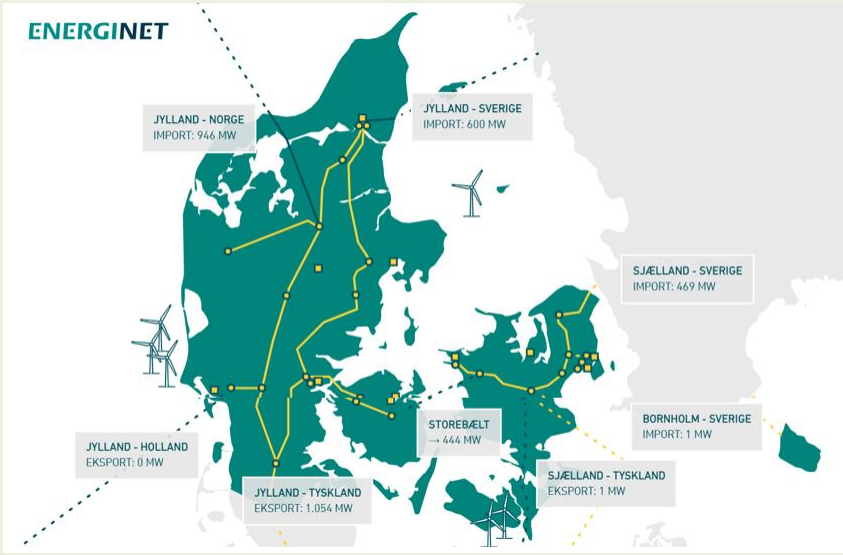
Convert fossil fuels to electric heat pumps in Denmark over 10 years :

- ❑ 380.000 houses with gas fired boilers
- ❑ 80.000 houses with oil fired boilers



Challenges

- ❑ Use of a high percentage renewable electricity
- ❑ Avoid extensive investments in grid enhancement (3 billion DKR versus 30 billion DKR)

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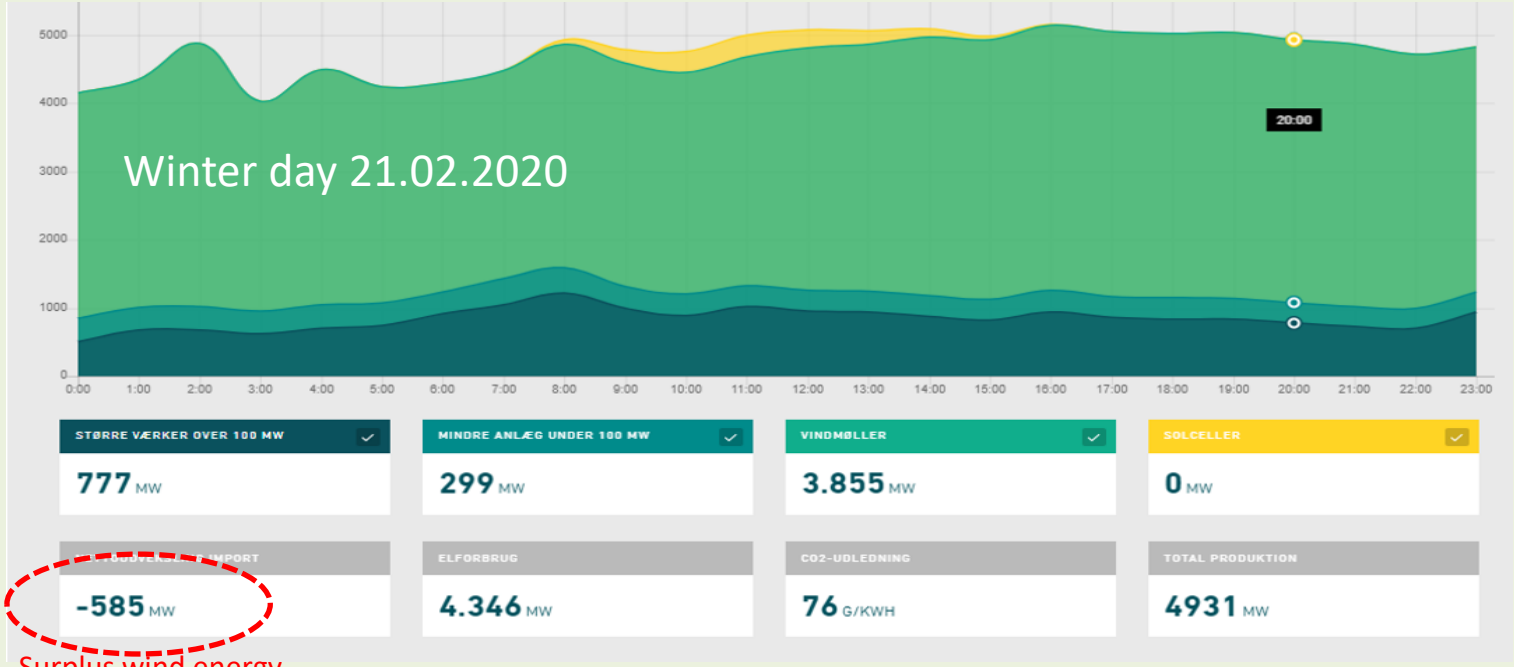
Flexible heat pumps are needed

- Heat pumps will only use electricity when it is abundantly available and green



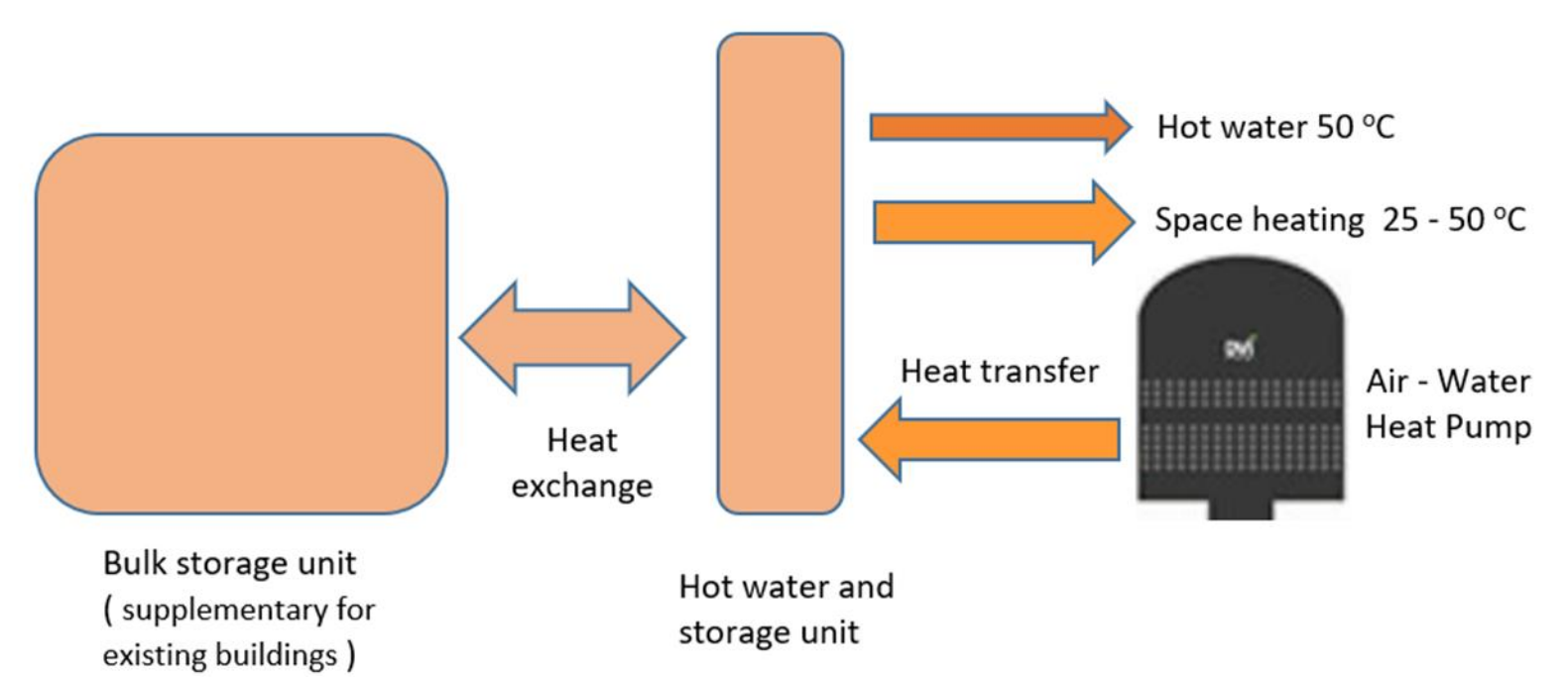
Surplus wind energy

- Heat pumps will only use electricity when there is free capacity in the grid.

- **The solution** : A heat pump with a thermal storage system

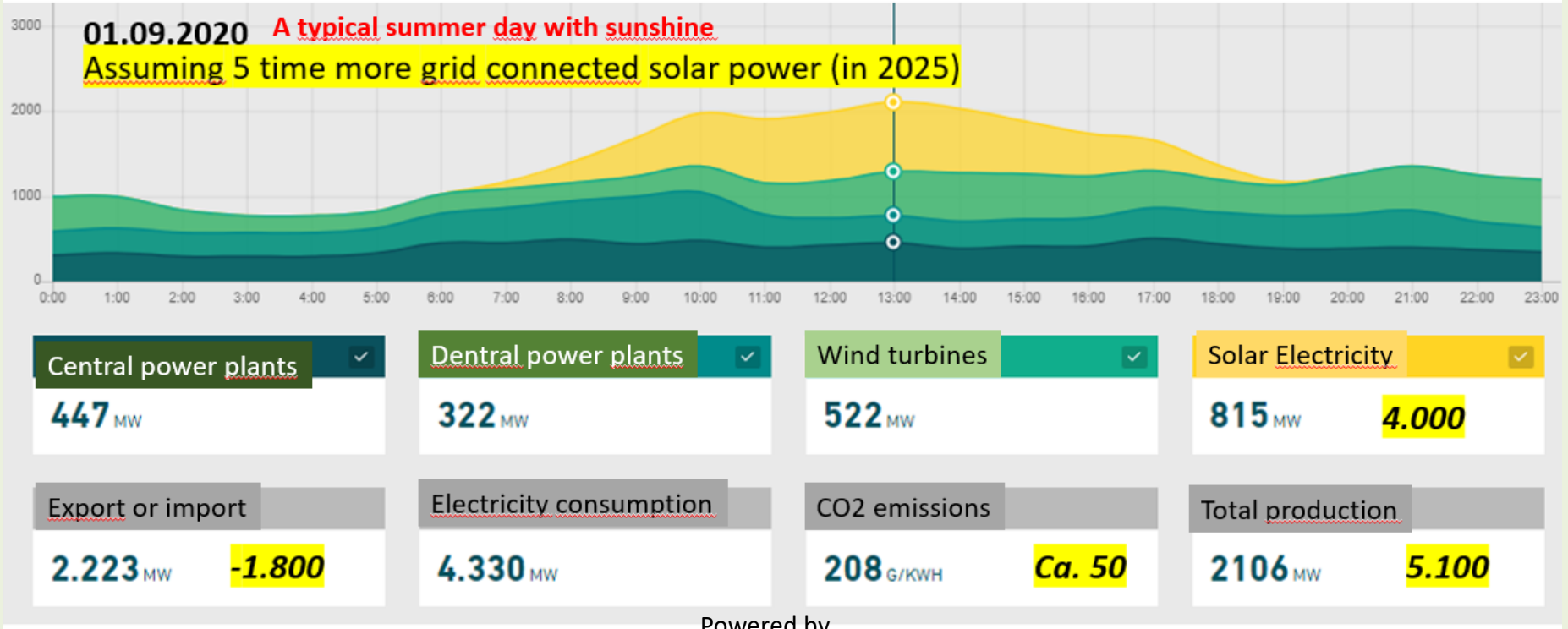
A compact heat storage system has been developed :

- ✓ New buildings : 600 liter hot water storage unit 600 x 600 x 2200 mm
- ✓ Existing buildings : 600 liter unit plus one or two 1000 liter bulk storage units
- ✓ Storage units are made of recycled PE plastic
- ✓ Storage system is optimised for low temperature operation for maximum COP



A typical summer day with sunshine

- During summertime, grid connected solar power is expected to increase by 5 times in 2025
- As shown below, this means that there will be a surplus of renewable electricity in the electric grid on a sunny day.



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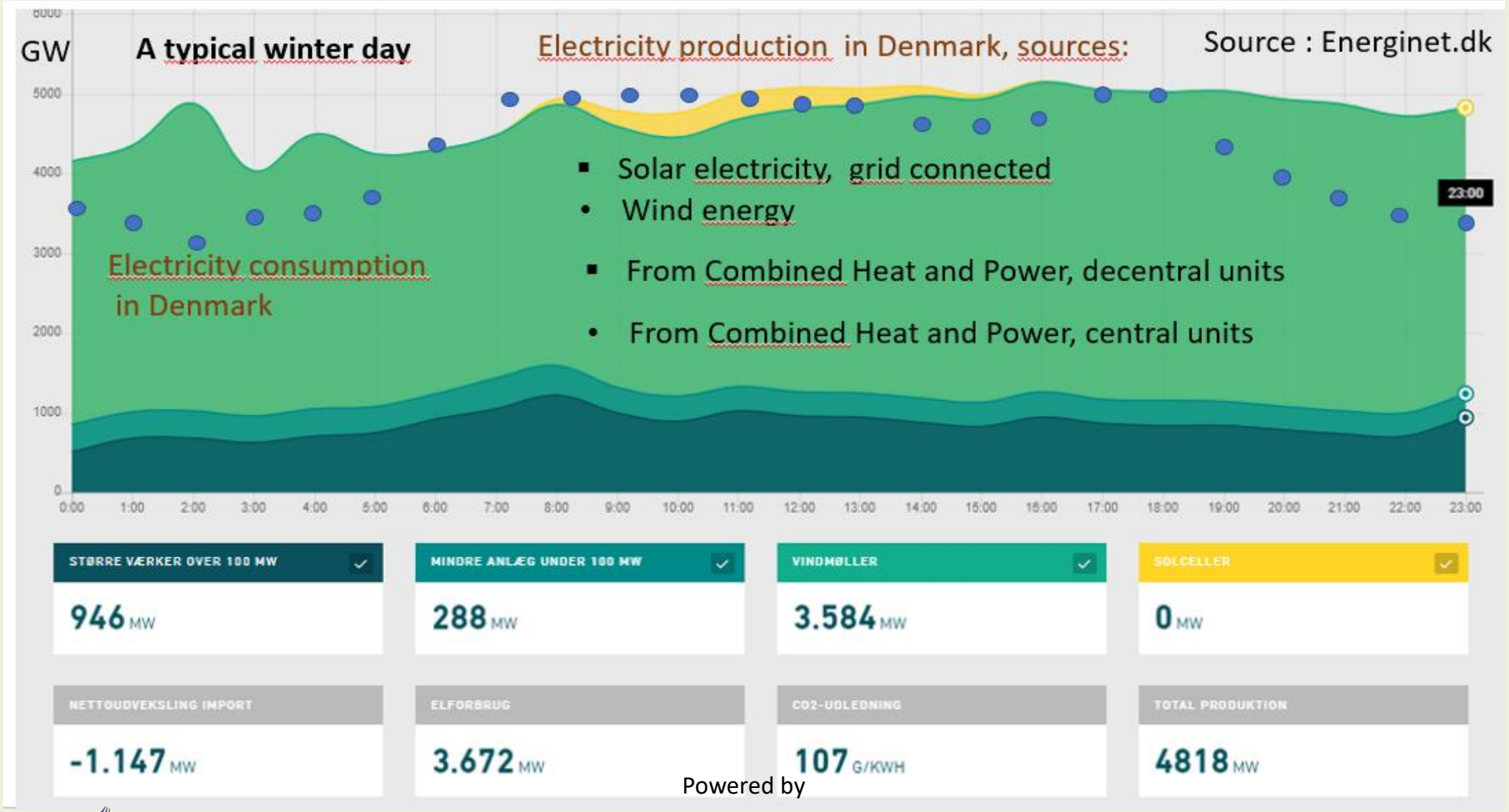

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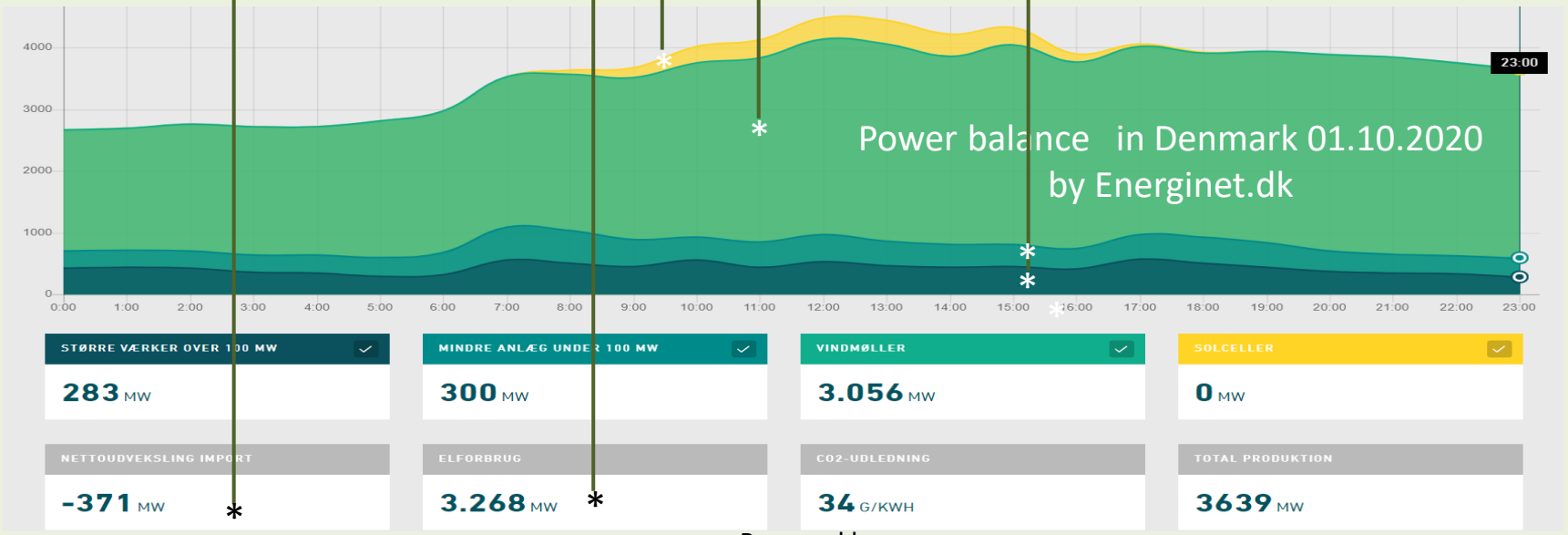
Analysis of one year of power grid data from Enerignet.dk

- ❑ Electricity production from central and decentral power plants
- ❑ Electricity production from wind energy
- ❑ Electricity production from solar energy
- ❑ Electricity consumption
- ❑ Import or export of electricity



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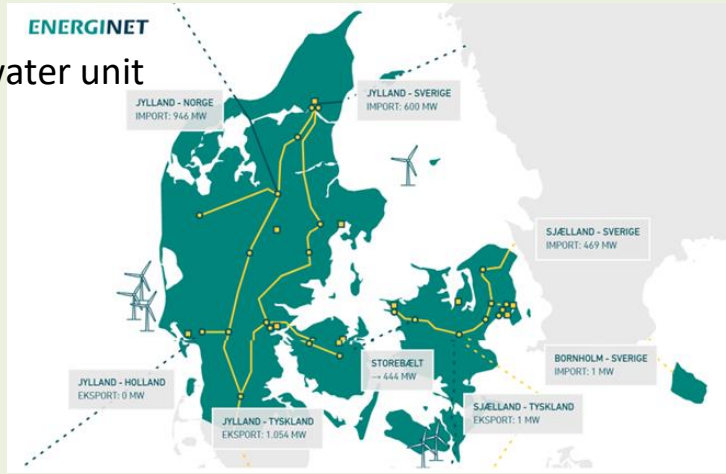
One year 01.02.2019 – 31.01.2020 Hourly data from Energinet*



- ❑ A storage system with 1 m^3 bulk storage plus 0,6 m3 central hot water unit
- ❑ Charging time : 3 – 5 hours at any time during 24 hours
  when RE electricity is available
- ❑ Storage temperature : 20 °C to 42 °C
  (20 °C to 65 °C when needed for 48 hours storage)
- ✓ **RE autonomy is achieved during 99,5 % of days through the year**
  Two days, in September and in October with only partial charging with RE electricity
- ✓ **On an annual basis, more than 99,5% of electricity consumption is RE electricity**
- ✓ **All electricity is consumed during periods when there is ample capacity in the grid**

* Raw data provided by Maibrit Vester Bundesen, Energinet.dk

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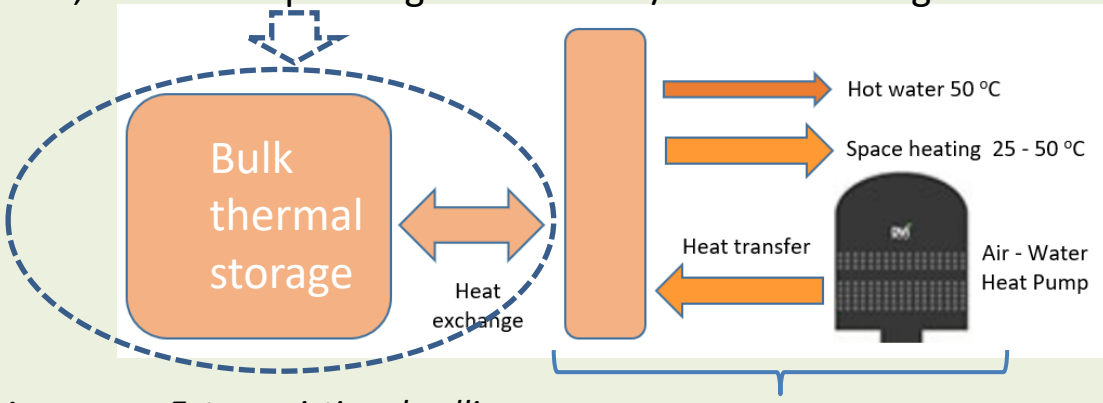
Conclusions

- ✓ A 24/48 hour storage systems allows the heat pump to use RE electricity during 99.5% time
- ✓ Extra costs for the storage system is 6 – 11,000 DKR depending on heat load/size of dwelling
  - ✓ New dwellings : No extra costs
- ➢ Green electricity must be cheap, i.e. without taxes
- ➢ Black electricity must me more expensive
- ✓ Installation of a heat pump with thermal storage will be very attractive
- ✓ A win-win for the society and the building owner



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