PERSPECTIVES FOR RENEWABLE ENERGY IN THE DANISH ENERGY SYSTEM

CITIES Workshop: Integration of prosumer buildings in energy systems

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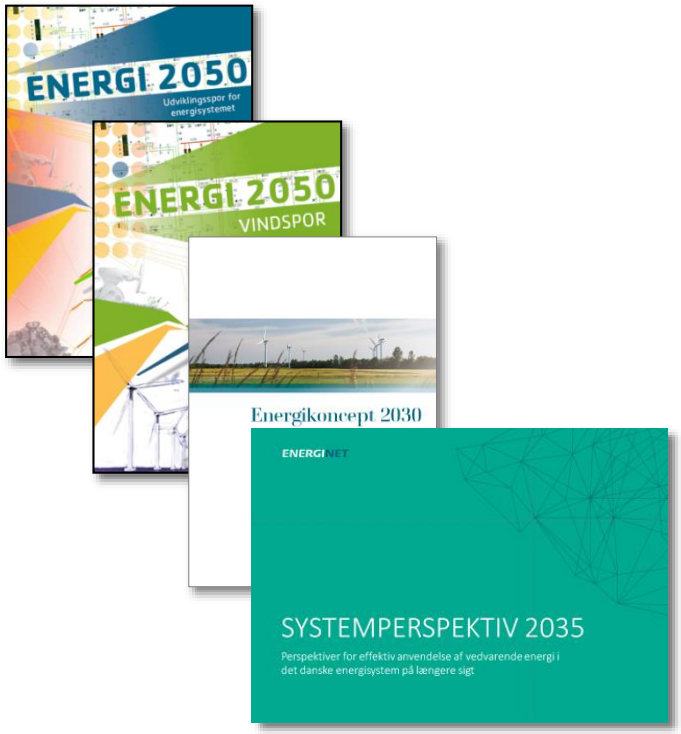
NEW ANALYSIS: SYSTEM PERSPECTIVE 2035



Long-term scenario analyses across energy systems

Why long-term analyses for the entire energy system?

- Ensure efficient operation and dimensioning of the el- and gas transmission system
- Contribute to an efficient green energy transition towards 2050

Link to System Perspective 2035: www.energinet.dk/sys35

INTEGRATION OF +50% RENEWABLE ENERGY

Instruments

El-integration – El as end consumption

El-integration over distances: Grid expansion

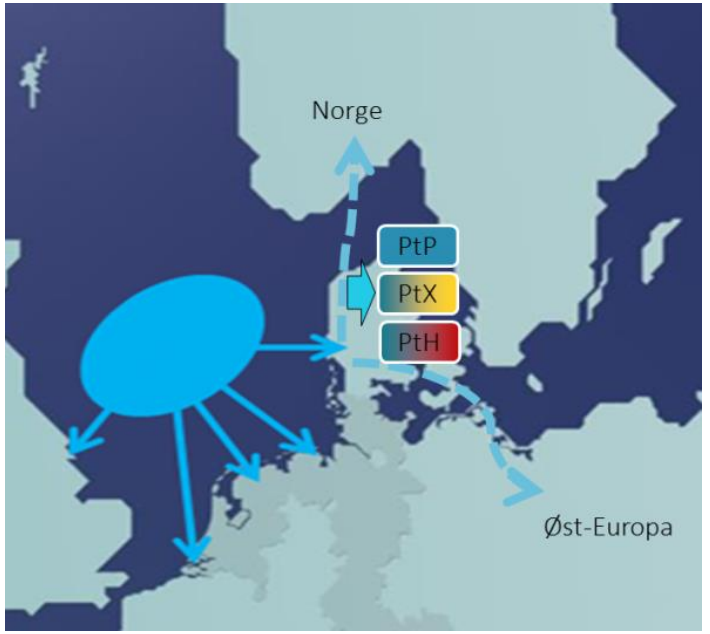
1. El-integration with Nordic hydro power
2. El-integration between NW Europe and Eastern Europe

El-integration over time: Elec. To elec. storage

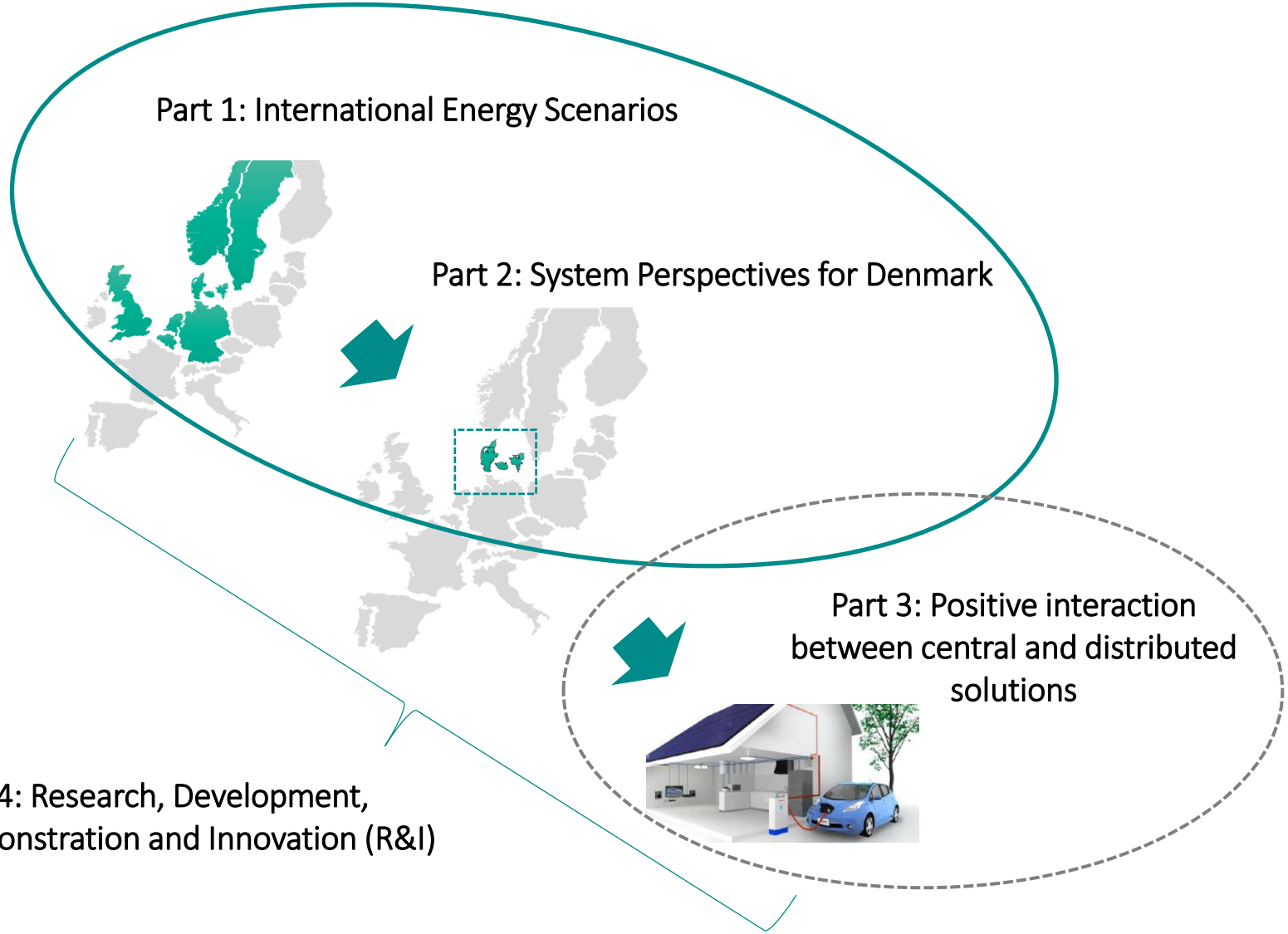
3. Elec. Storages (e.g. batteries, CAES etc.)

Conversion of electricity for other purposes - electrification

4. Electricity to heat and thermal storages
5. Electricity for transport
6. Electricity for high-value products (elektrolysis/PtG/PtX)



STRUCTURE OF THE ANALYSIS



APPLIED EUROPEAN ENERGY SCENARIOS

GCA-scenario (Global Climate Action)

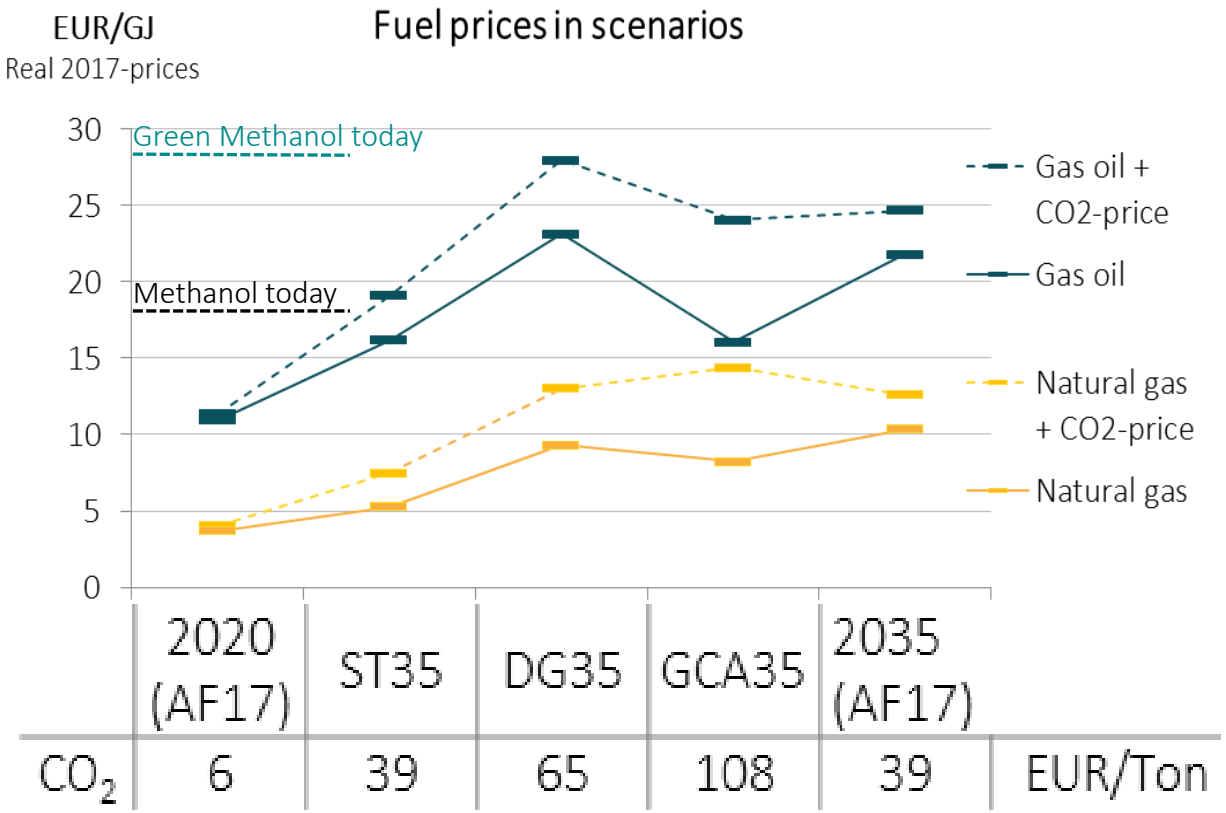
- "On track" with EU climate targets
- Strong international, green cooperation and regulation
- Moderate oil price – very high CO_2-price (IEA 450 PPM)
- 50 pct. electricity from wind and sun in Europe in 2040

DG-scenario (Distributed Generation)

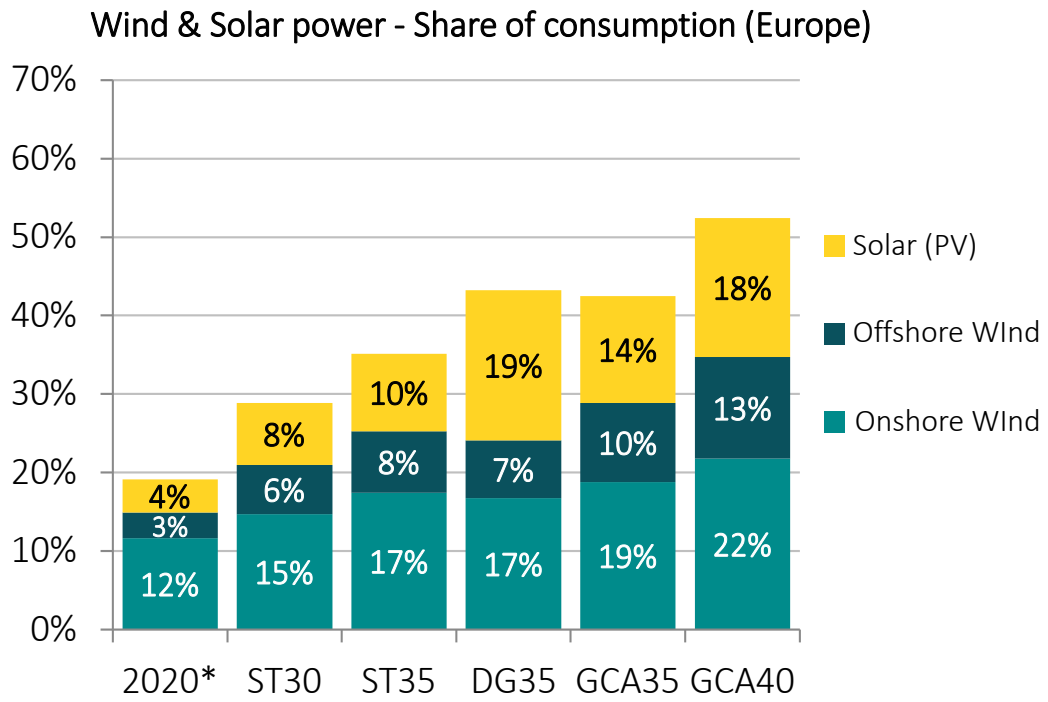
- "(On track)" with EU climate targets
- A very high use of distributed solutions (solar/batteries)
- High oil price (IEA New Policy) – high CO_2-price
- 50 pct. electricity from wind and sun in Europe in 2040

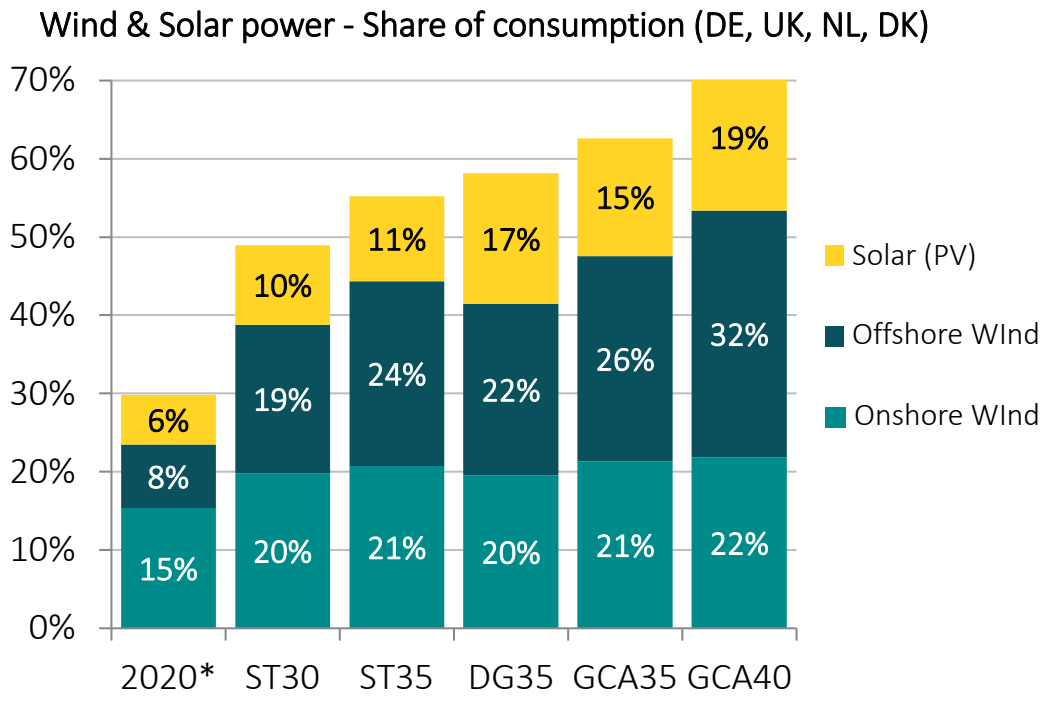
ST-scenario (Sustainable Transition)

- "Not on track (but almost)" with EU climate targets
- Low oil and natural gas prices
- Moderate CO_2-price(IEA Low Oil price scenario)



MUCH MORE WIND & SOLAR POWER IN ALL SCENARIOS

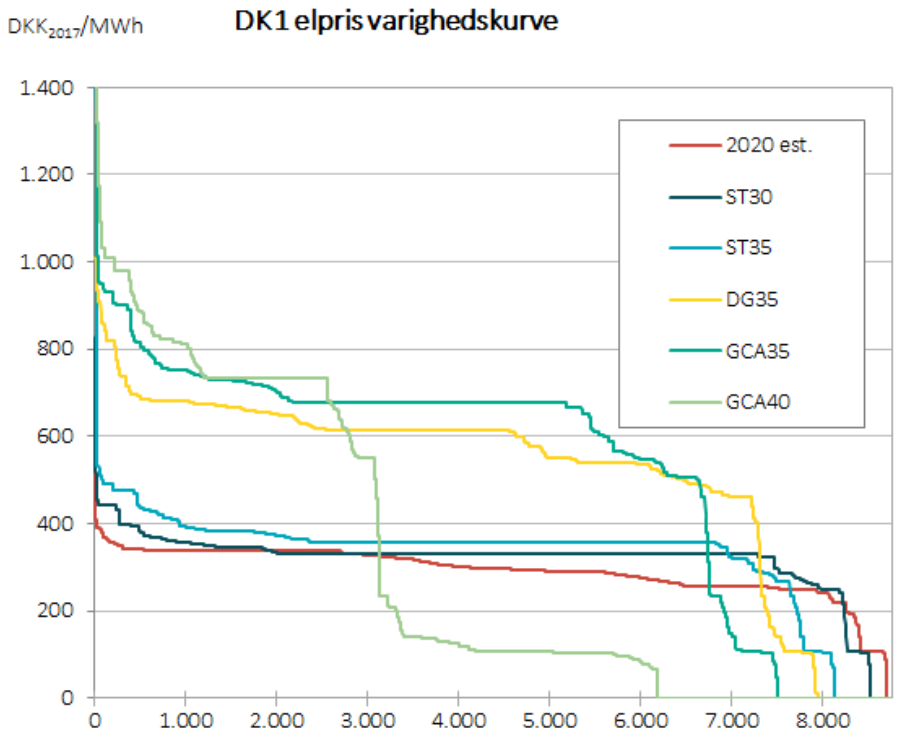


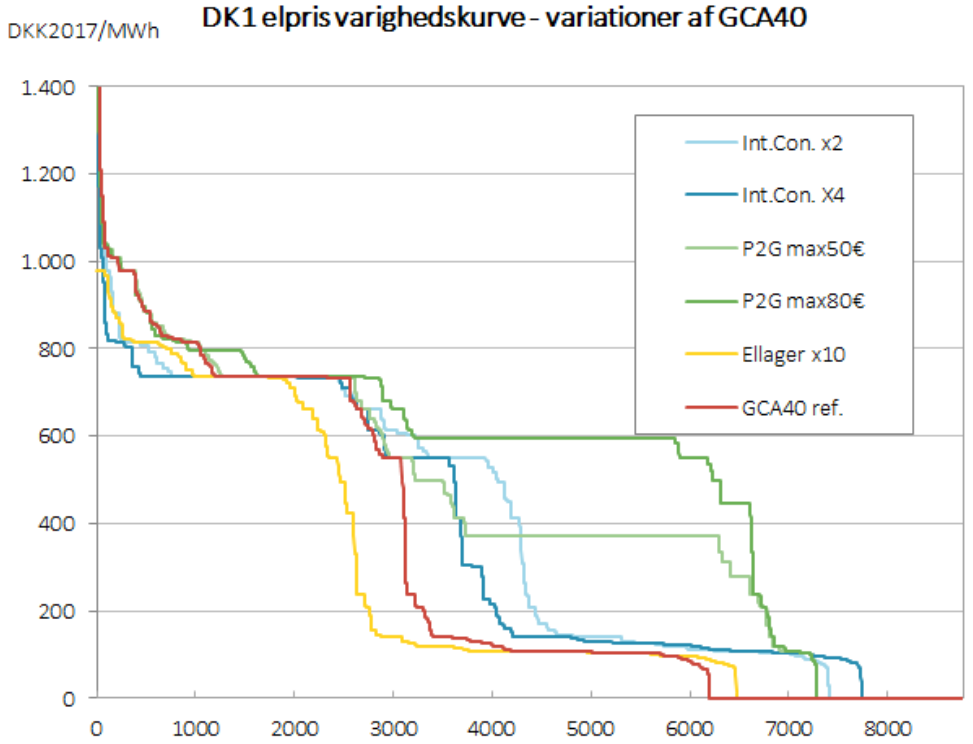


*2020: Energinet Analyseforudsætninger 2017

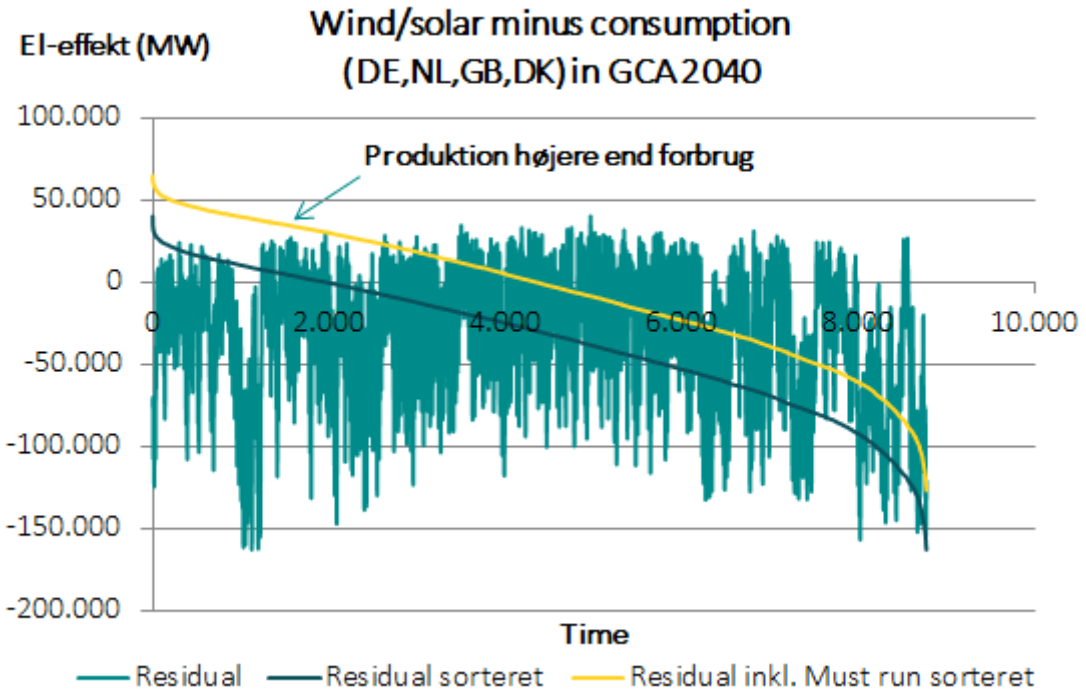
DENMARK AFTER 2030

More hours with low and high electricity prices



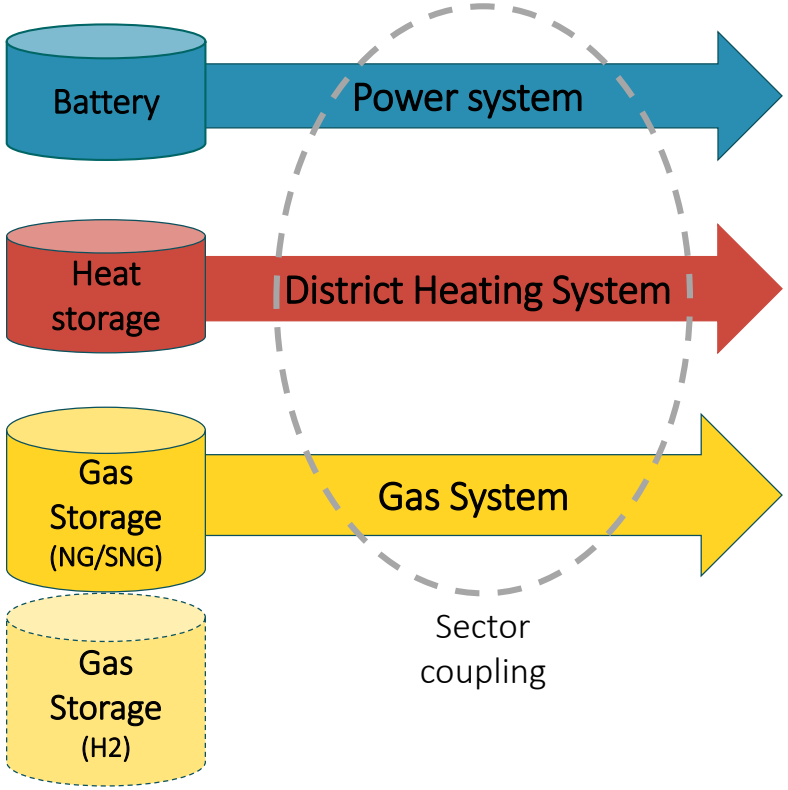


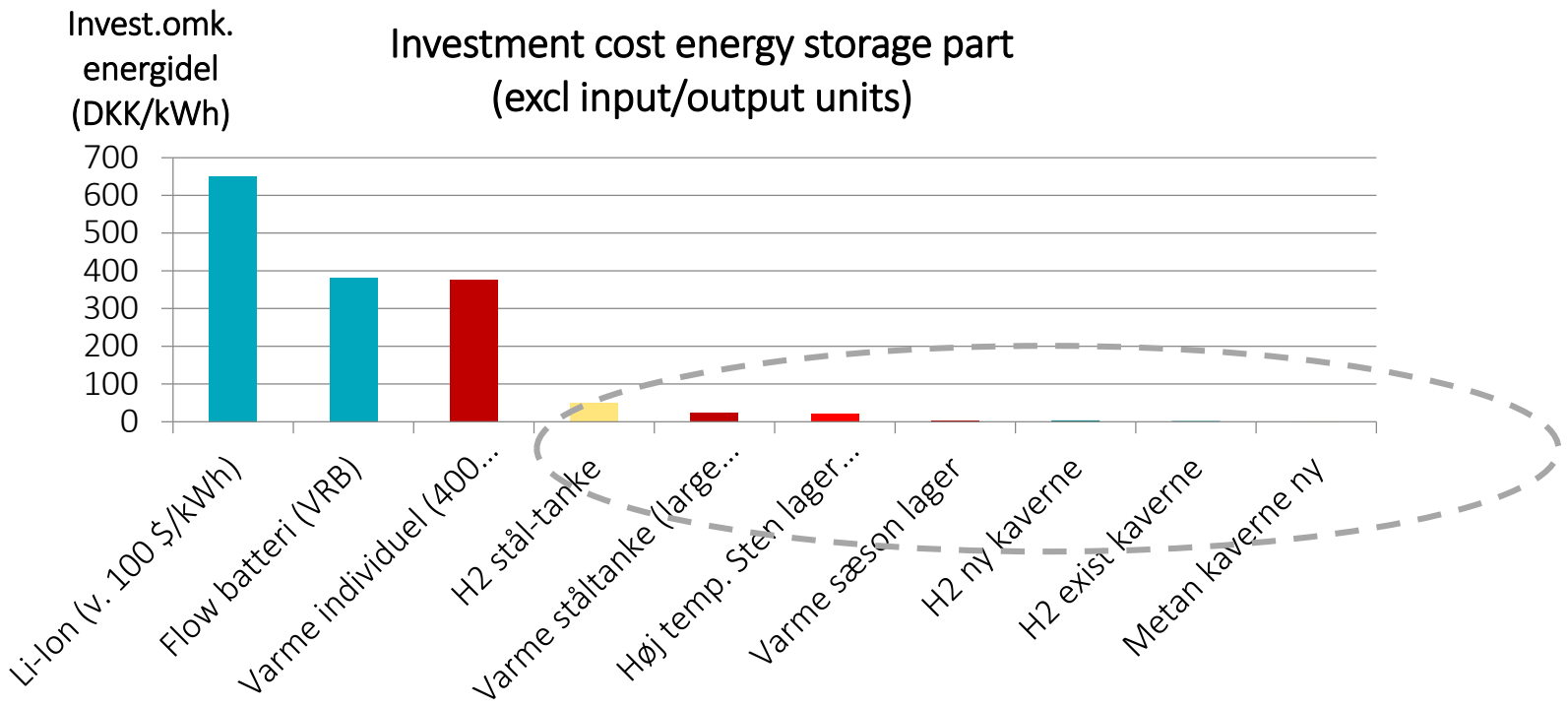
NORTH SEA REGION SYSTEM BALANCING



- Need for hour/daily balancing for wind/solar fluctuations
- Need for ancillery services incl. Inertia to operate without thermal units
- Need for strong grid and sector-coupling to integrate RE in longer periods with high wind/solar production

SECTOR COUPLING TO GET ACCESS TO LOW COST STORAGE CAPACITY

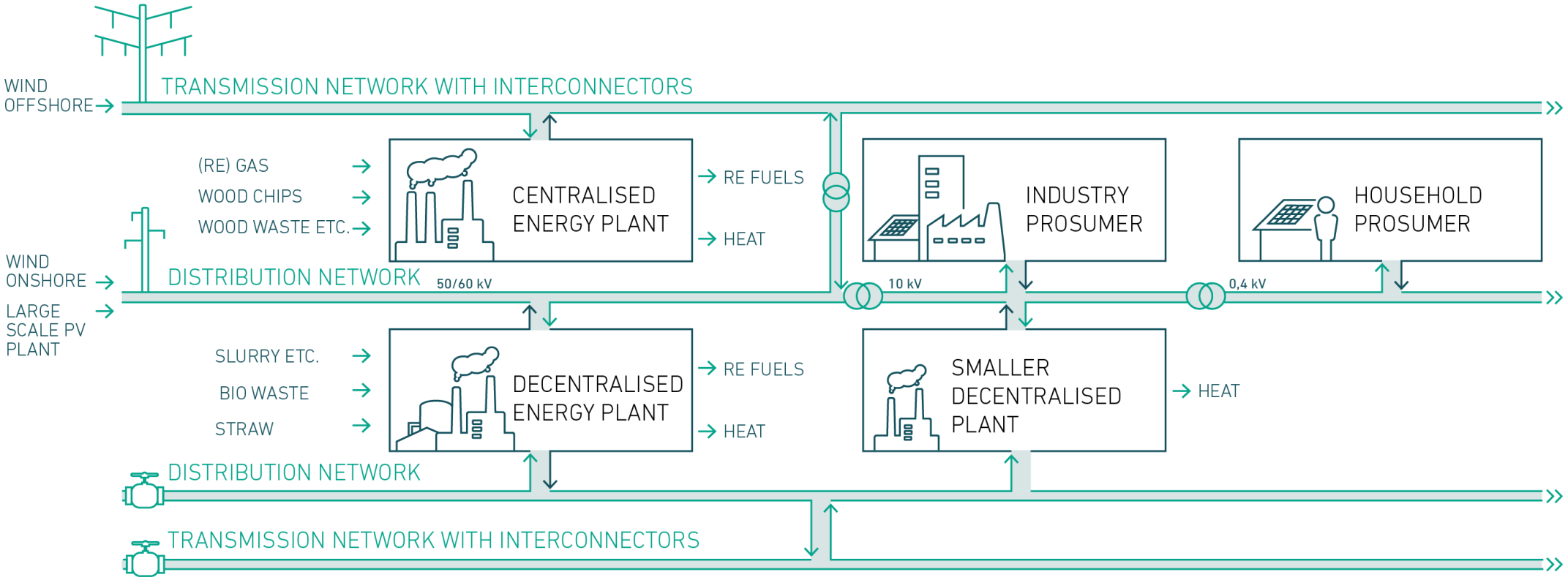




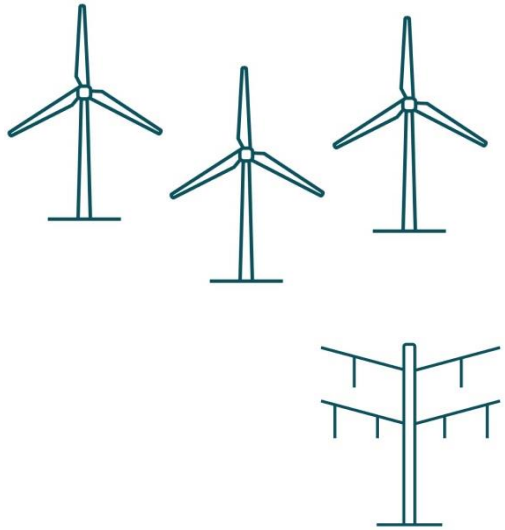
- Battery storage is essential for hourly balancing – but too expensive for large scale storage
- Sector coupling to gas and heat can deliver more cost effective large scale storage
- Essential to analyse cost effective sector couplings!

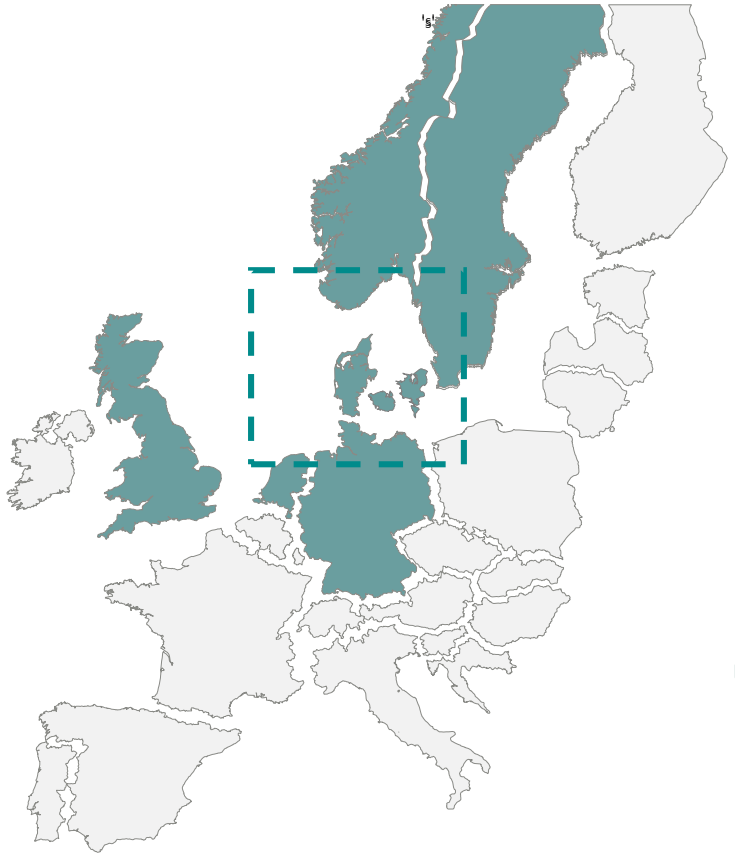
"For all the growth in battery installations that BNEF is forecasting, the total volume of grid-connected batteries by 2030 will be sufficient to meet the world's power needs for just 7,5 minutes" *Michael Liebreich, Bloomberg New Energy Finance, March, 2018*

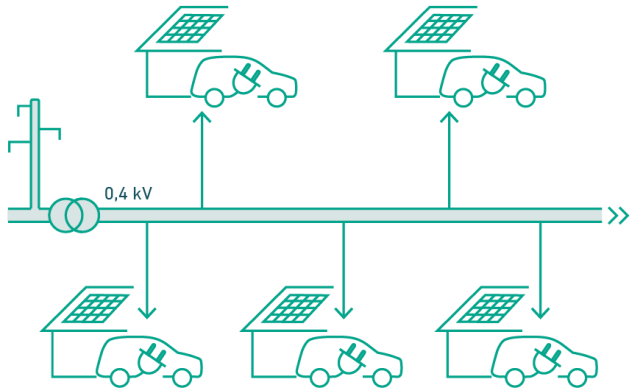
EFFICIENT RELATION BETWEEN AND CO-EXISTENCE OF LARGE SCALE- AND DISTRIBUTED SOLUTIONS



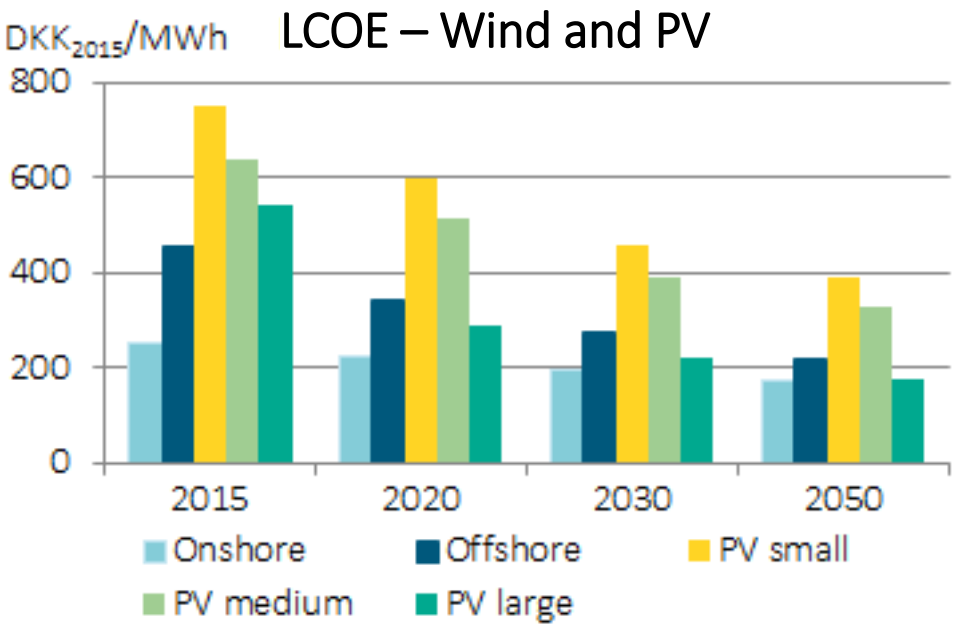
ANALYSIS OF DISTRIBUTED RESOURCES

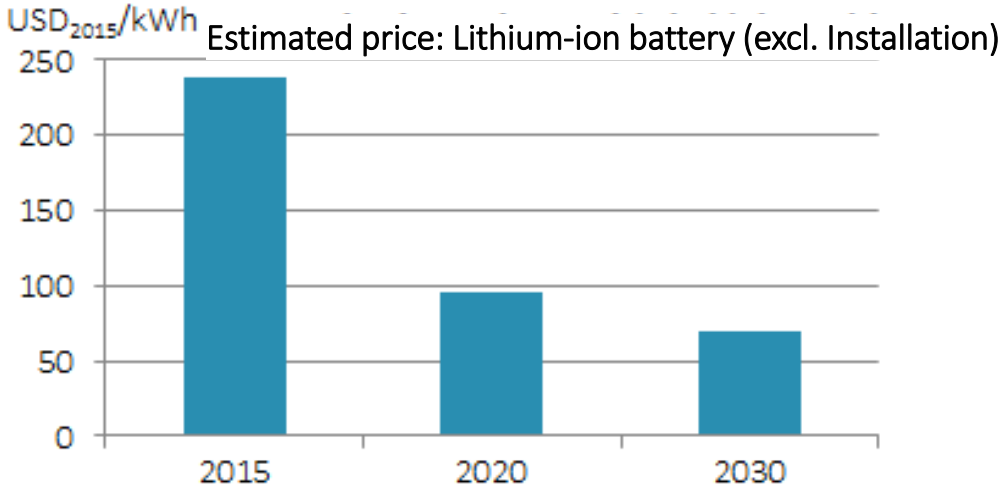






ANALYSIS OF INVESTMENTS IN DISTRIBUTED RESOURCES





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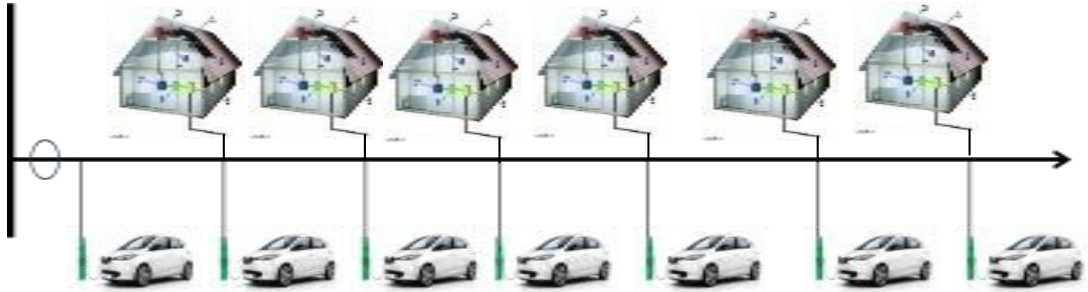

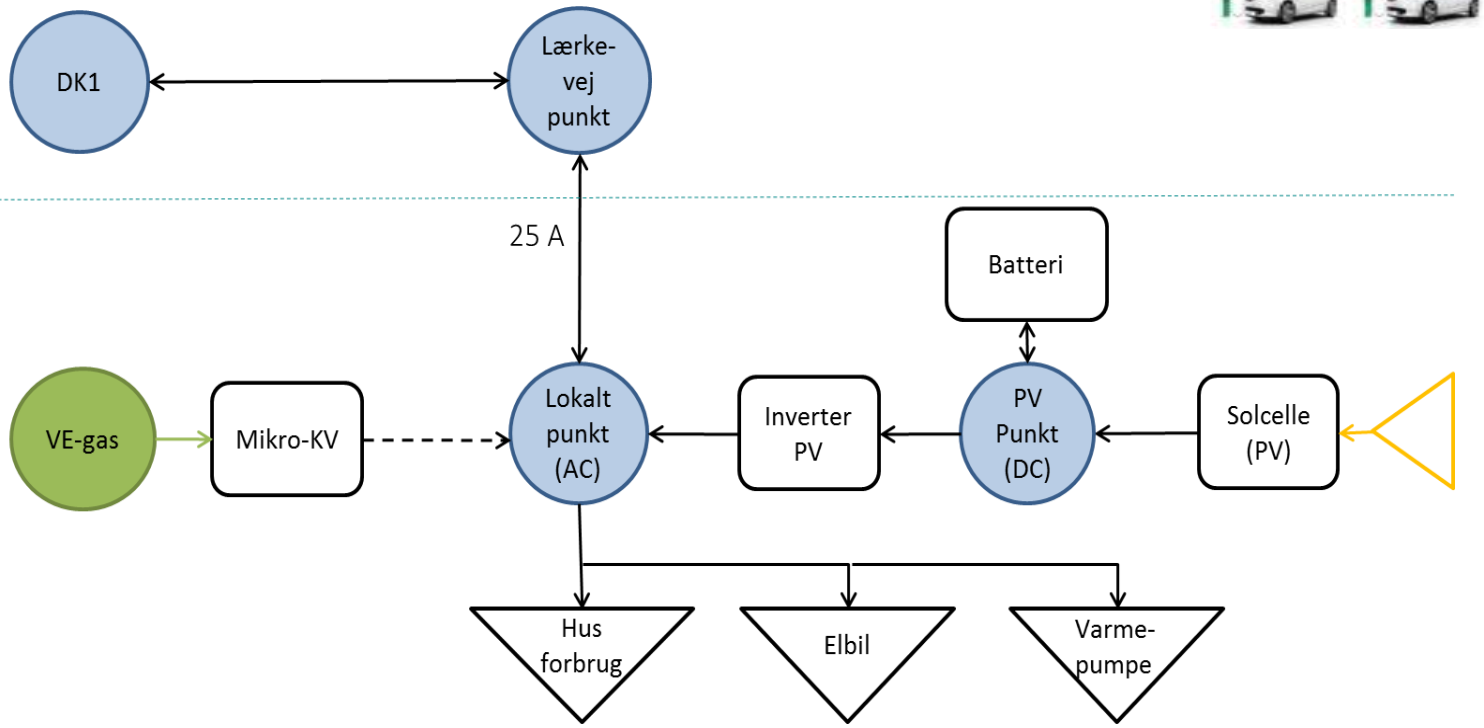

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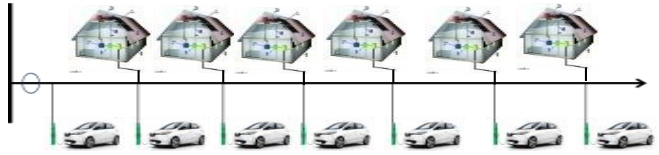
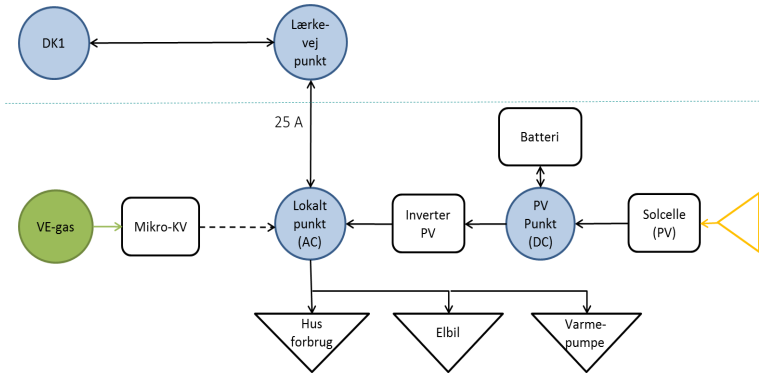


	H.1	H.2	H.3	H.4	H.5	H.6	H.7	H.8	H.9	H.10
Annual cons., classic el *(MWh)*	4.7	3.1	3.1	4.1	4.4	4.8	5.00	5.3	5.6	5.6
Annual cons., EV *(MWh)*	5.2	0	7.0	5.2	5.2	5.2	3.0	3.0	5.2	5.2
Battery size, EV *(kWh)*	80	0	80	80	80	80	40	80	40	80
EV charging profile	CP1	0	CP1	CP1	CP1	CP1	CP2	CP2	CP2	CP2
Invest PV capacity *(kW)*	12,0	5,1	12,0	12,0	12,0	12,0	11,7	11,1	12,0	12,0
Invested battery storage *(kWh)*	23,3	9,2	25,9	24,1	23,9	24,9	12,9	11,2	12,9	13,8

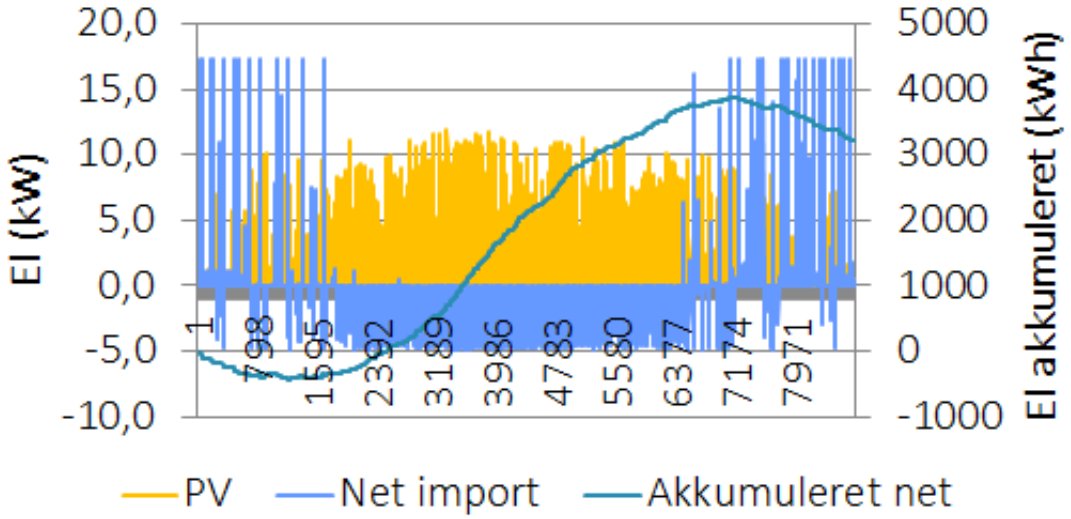


Assumed available power:

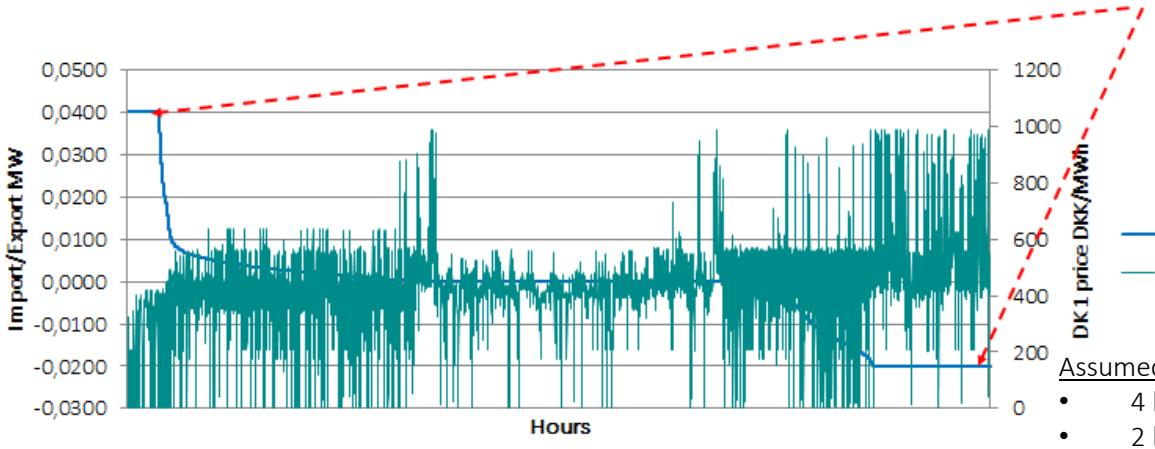
- 4 kW uptake per house
- 2 kW feed-in per house

- The model typically investing in 12 kW PV and 15-25 kWh battery storage
- The prosumer becomes net-exporter of electricity
- Total off-grid solutions does not seem economically attractive. Not even if the price for PV and batteries decline further.

OPERATION OF SMALL PROSUMERS IN THE 2030 CASE



Example of congestions at Lærkevej at high PV prod



Assumed available power:

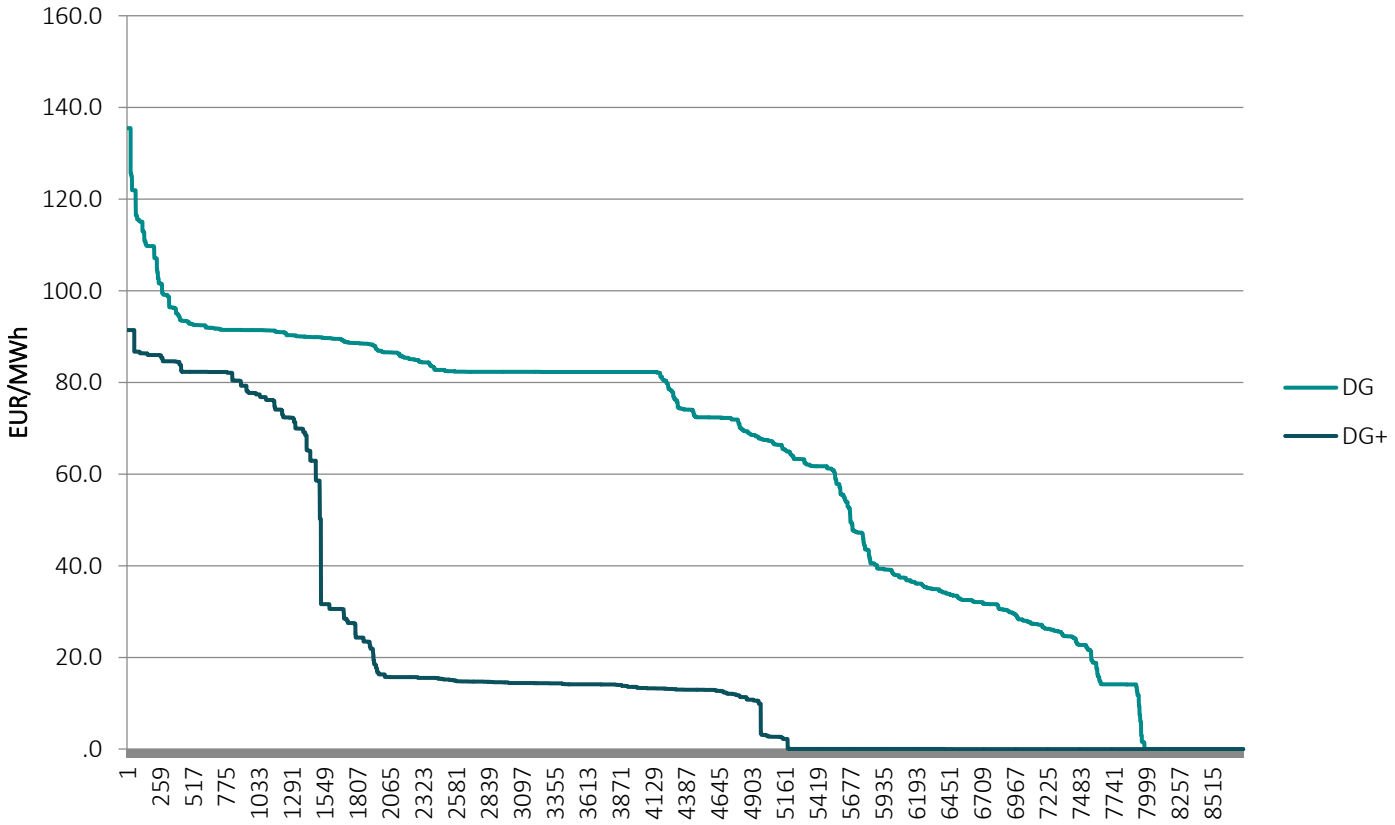
- 4 kW uptake per house
- 2 kW feed-in per house

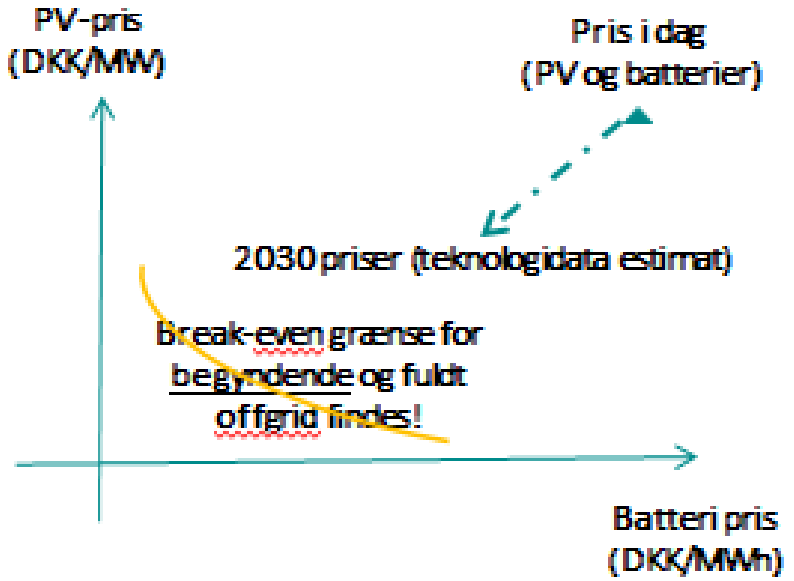
- Large surplus of electricity during the summer.
- ”Storage” from the system: approx. 4 MWh
- Needed storage during winter: 1-1.5 MWh

- Congestions in the electricity network can occur at times with high PV production or at times with simultaneously charging EV’s (at large power draws from the net)

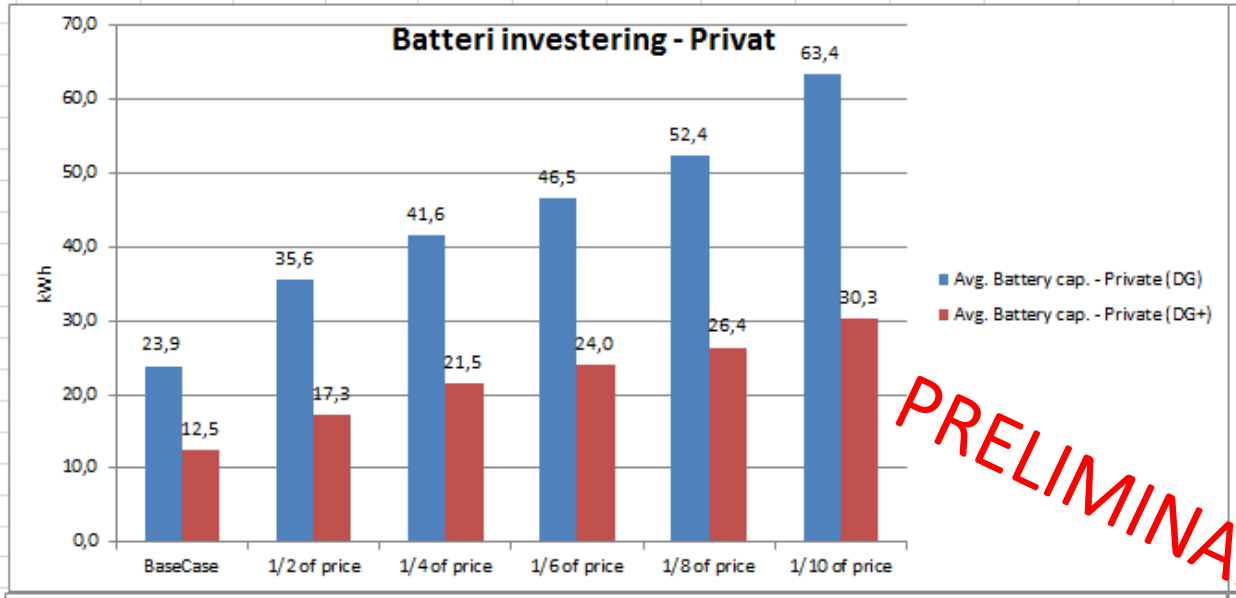
EFFECT OF PV/BATTERY DEVELOPMENT ON SYSTEM

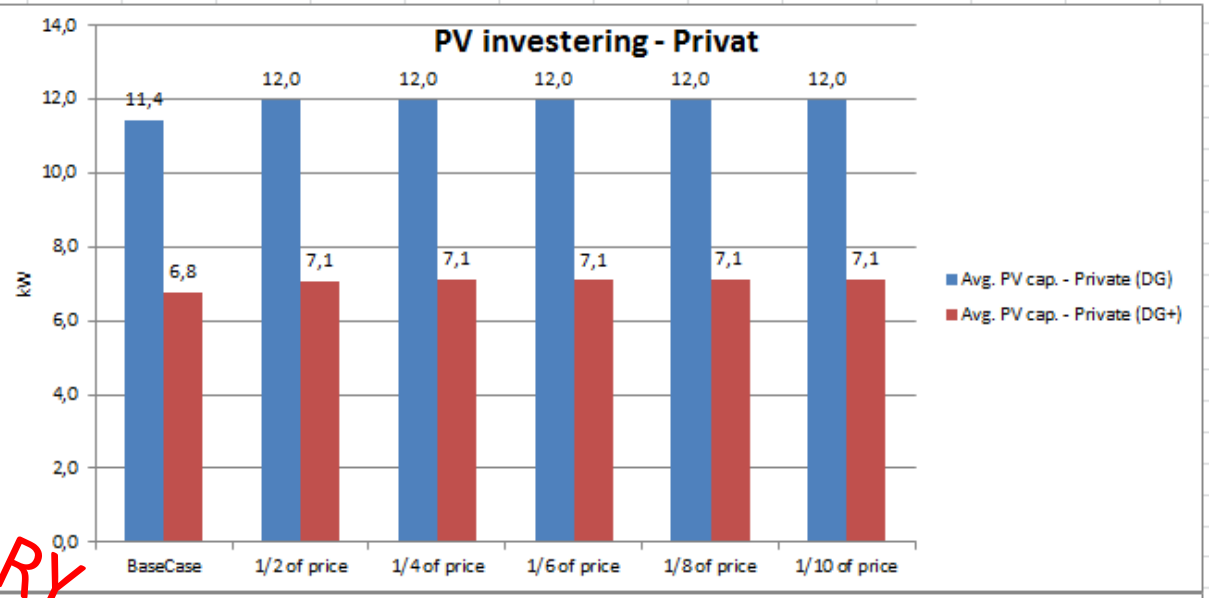
What is break even for off grid and how does it influence the grid and solutions based on offshore wind power?



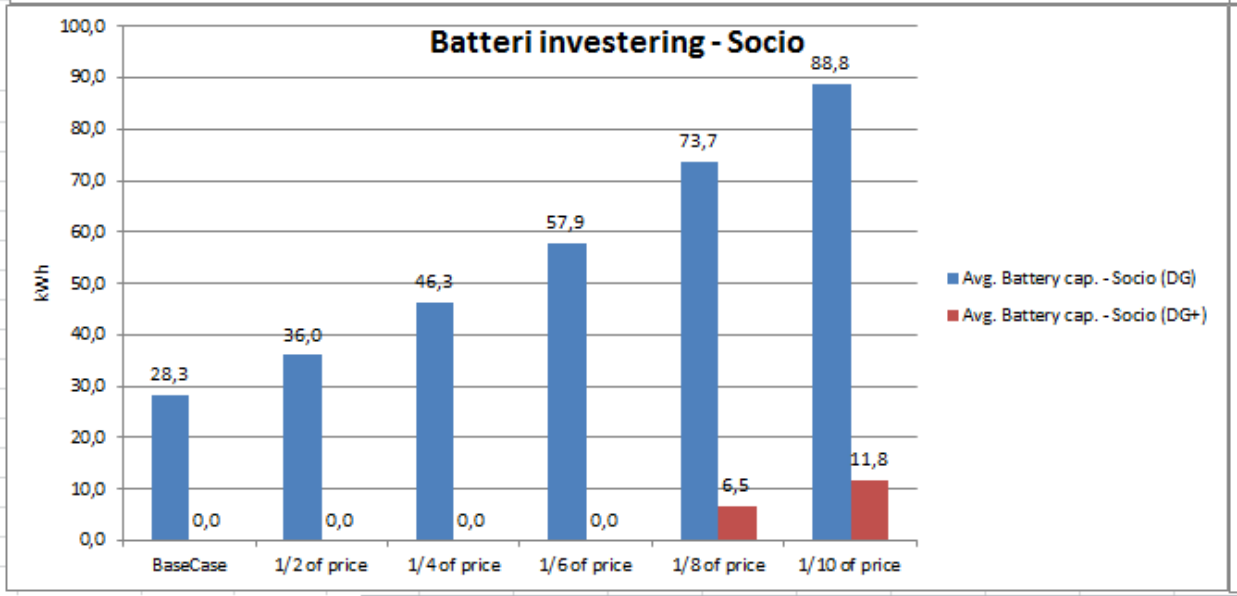


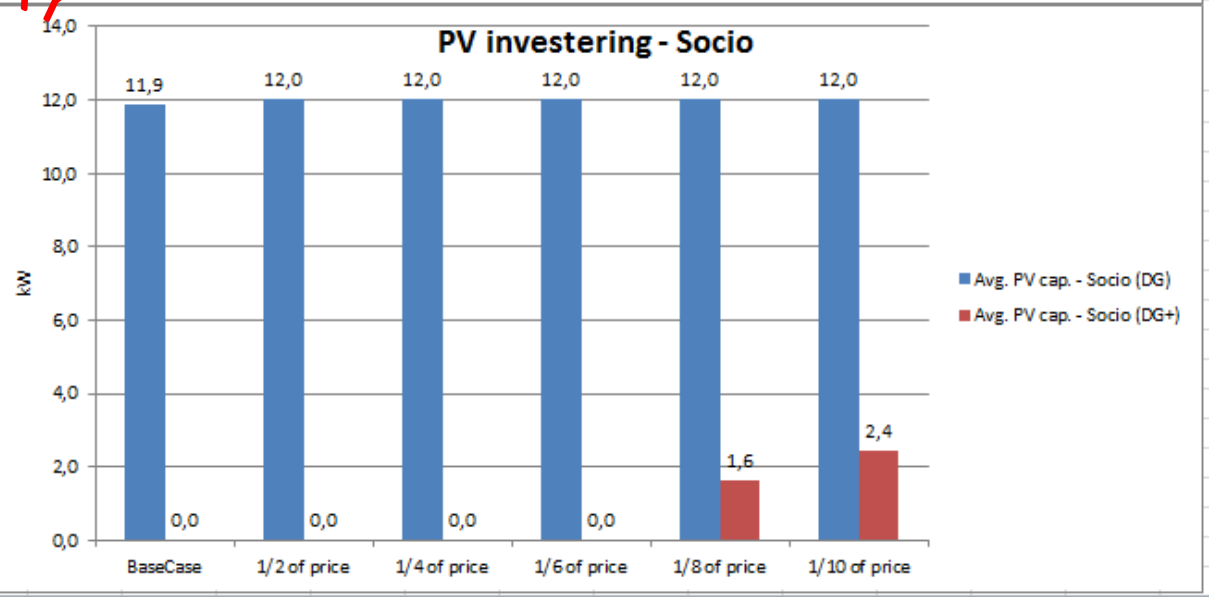
Reduction of batt prices (1/2, ¼, …) at fixed PV prices





PRELIMINARY





SUMMING UP

ENERGINET

European Agenda sets a framework

- ENTSO-E/G show significant increase of wind/solar in NS-region in al scenarios
  More than 50% RE => Need for sector coupling

Electrification and sector coupling are essential

- A strong power grid is needed
- Sector coupling to the gas, heat, fuel and transport sector is essential for integration of RE
- Large scale solutions (offshore wind, strong grid, PtG/PtX) can co-exist with distributed solutions (prosumers: PV, battery)

Prosumer analysis

- Investing in around 12 kW PV and 9-26 kWh battery
- With changing prices for PV/batteries the investment changes => if DK neighbours does the same (lower prices), the driver for PV/batt investments is lower
- Total off-grid solutions does not seem economically attractive. Not even if the price for PV and batteries decline further.


THANK YOU FOR THE ATTENTION
www.energinet.dk/sys35