SYSTEMPERSPEKTIV 2035
- Analyse af lagring i energisystemet

Møde i ATV ved DTU 2018-03-21

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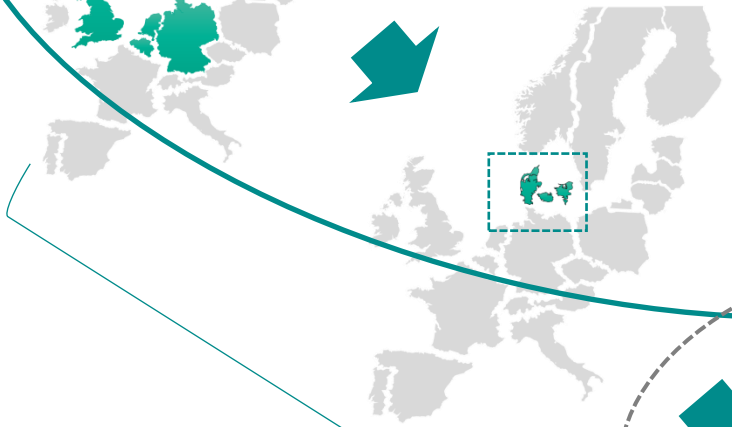
STRUCTURE

Part 1: International Energy Scenarios

Part 2: System Perspectives for Denmark



Part 3: Positive interaction between central and distributed solutions

Part 4: Research, Development, Demonstration and Innovation (R&I)

3 EUROPEAN ENERGY SCENARIOS

Content of the 3 European TYNDP 2018-scenarios

GCA-scenario (Global Climate Action)

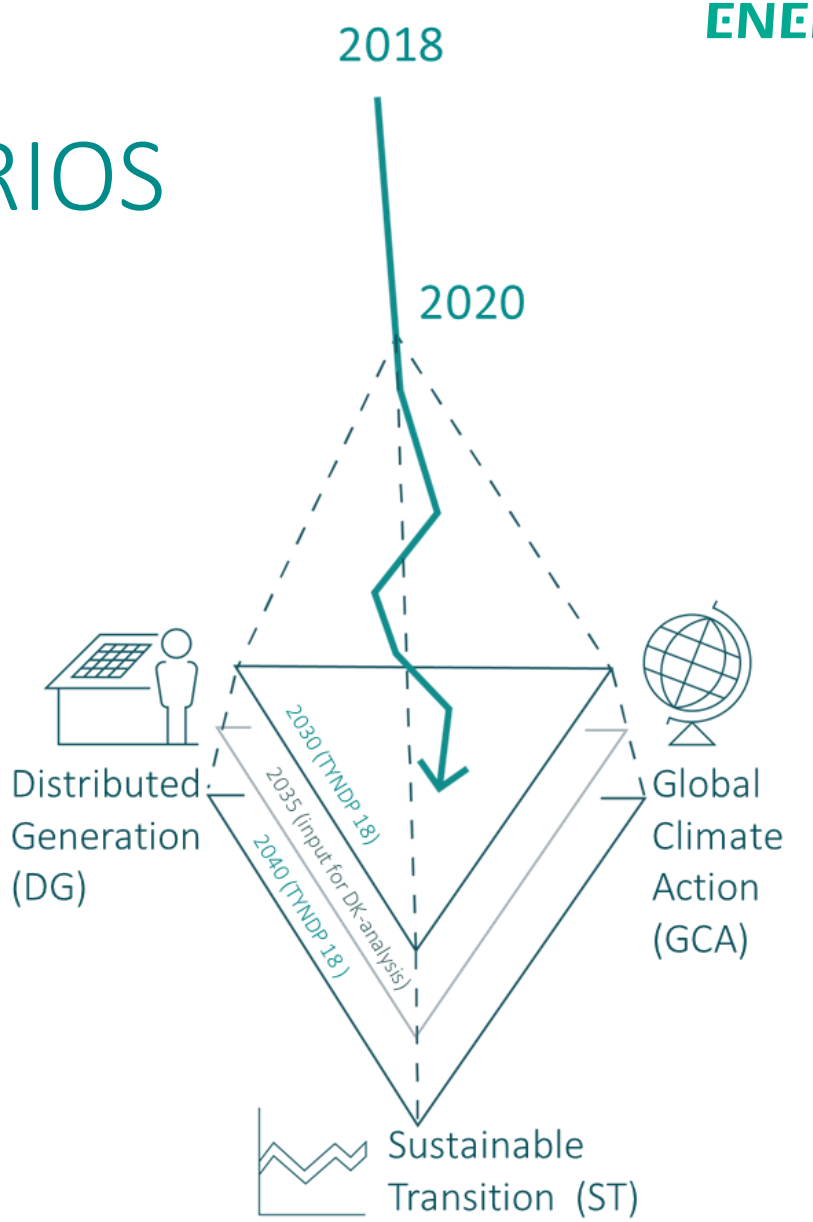
- "On track" with EU climate targets
- Strong international, green cooperation and regulation
- Moderate oil price – very high CO_2-price (IEA 450 PPM)
- 50 pct. electricity from wind and sun in Europe in 2040

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)



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- Moderate oil price – very high CO_2-price (IEA 450 PPM)
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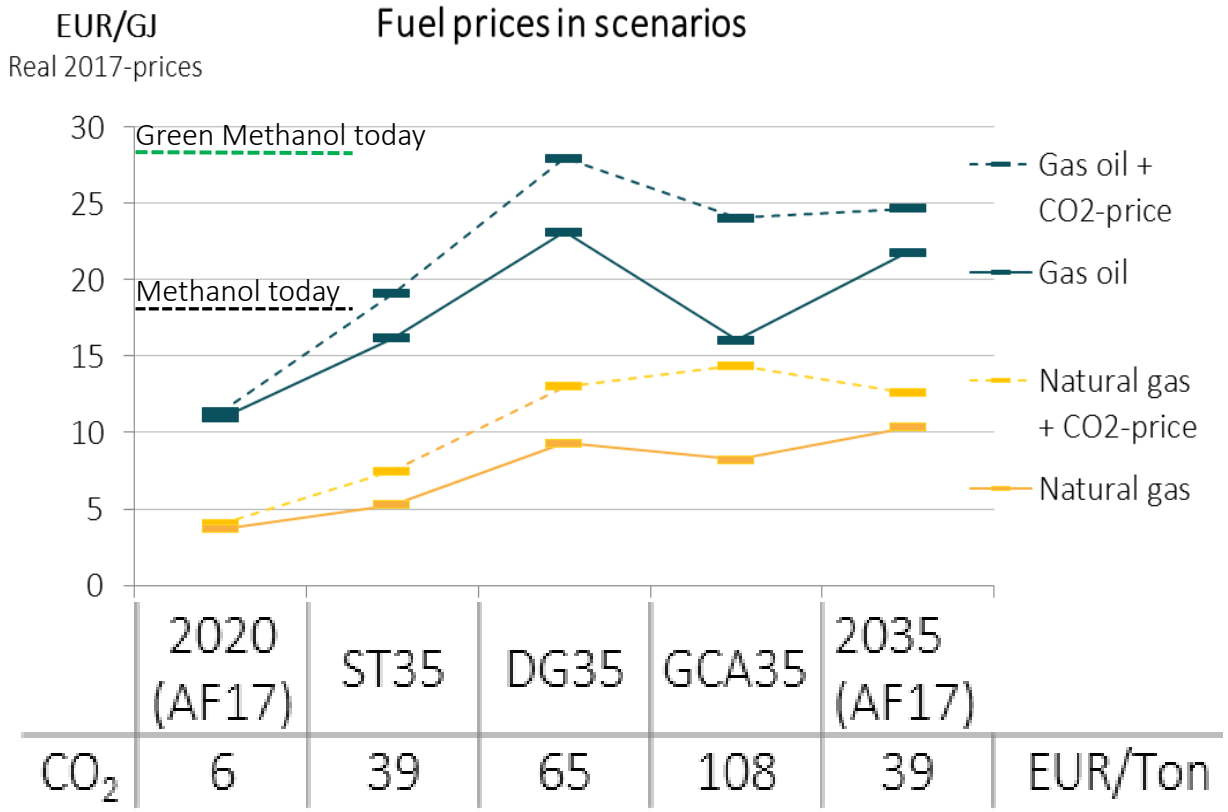
DG-scenario (Distributed Generation)

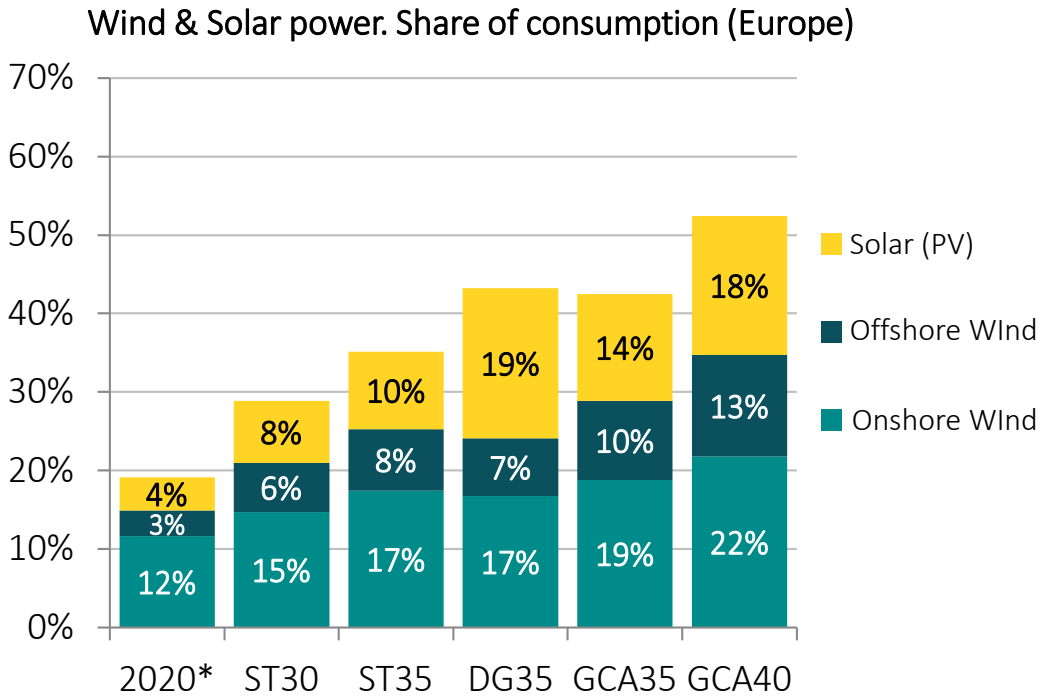
- "On track" with EU climate targets
- Wide spread local distributed solutions (solar/batteries)
- High oil price (IEA New Policy) – high CO_2-price
- 50 pct. electricity from wind and sun in Europe in 2040

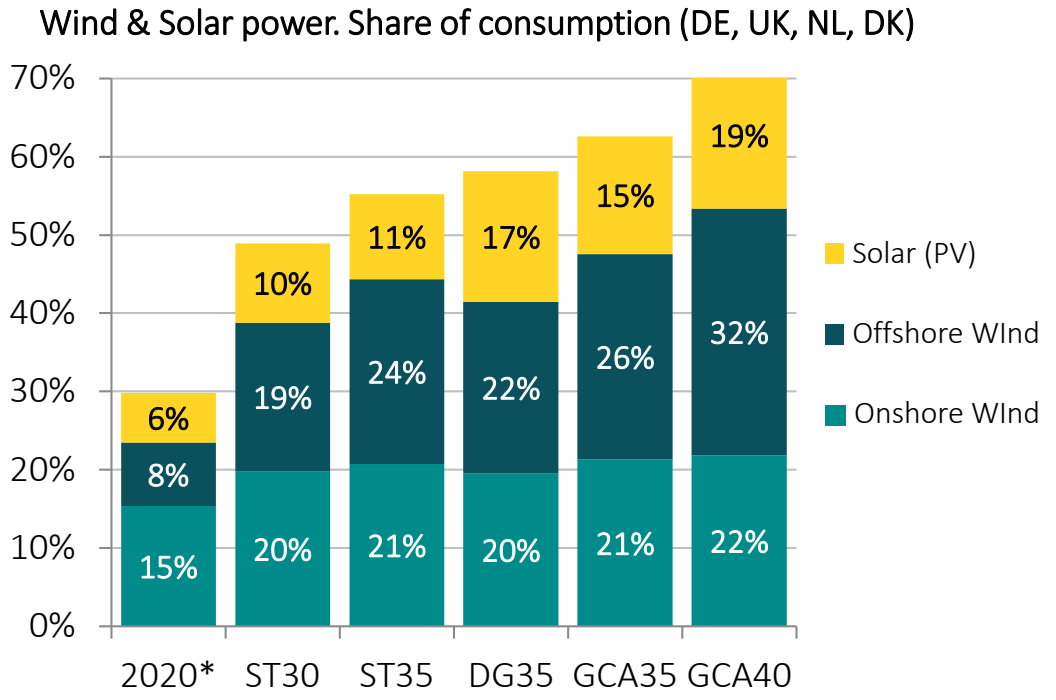
ST-scenario (Sustainable Transition)

- "Almost on track" with EU climate targets
- Low oil and natural gas prices
- Moderate CO_2-price(IEA Low Oil price scenario)

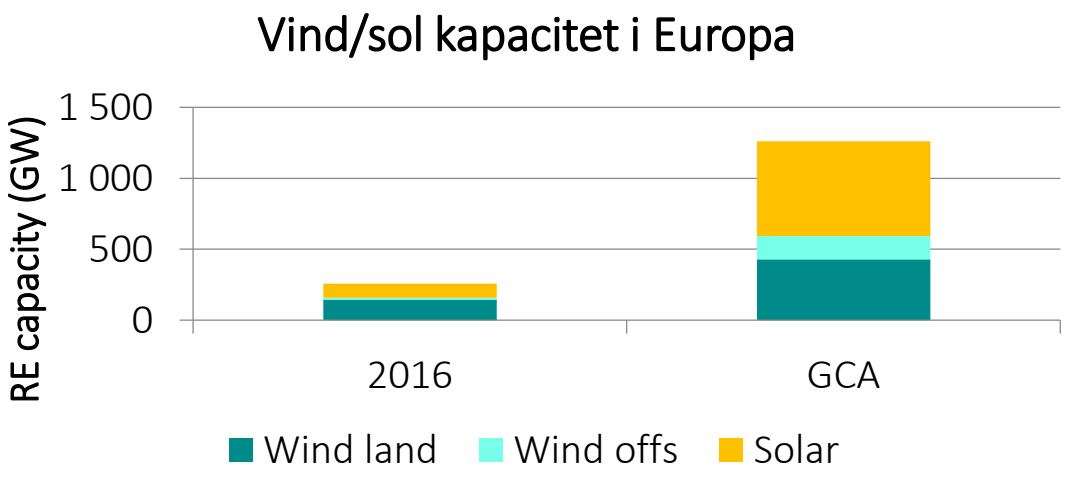


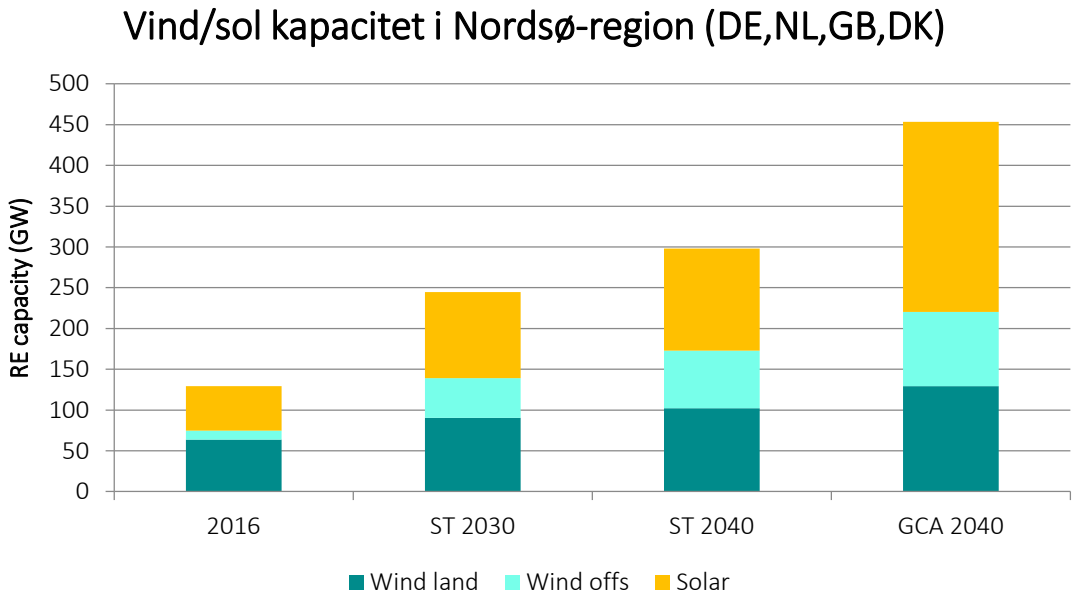
MUCH MORE WIND & SOLAR POWER IN ALL SCENARIOS

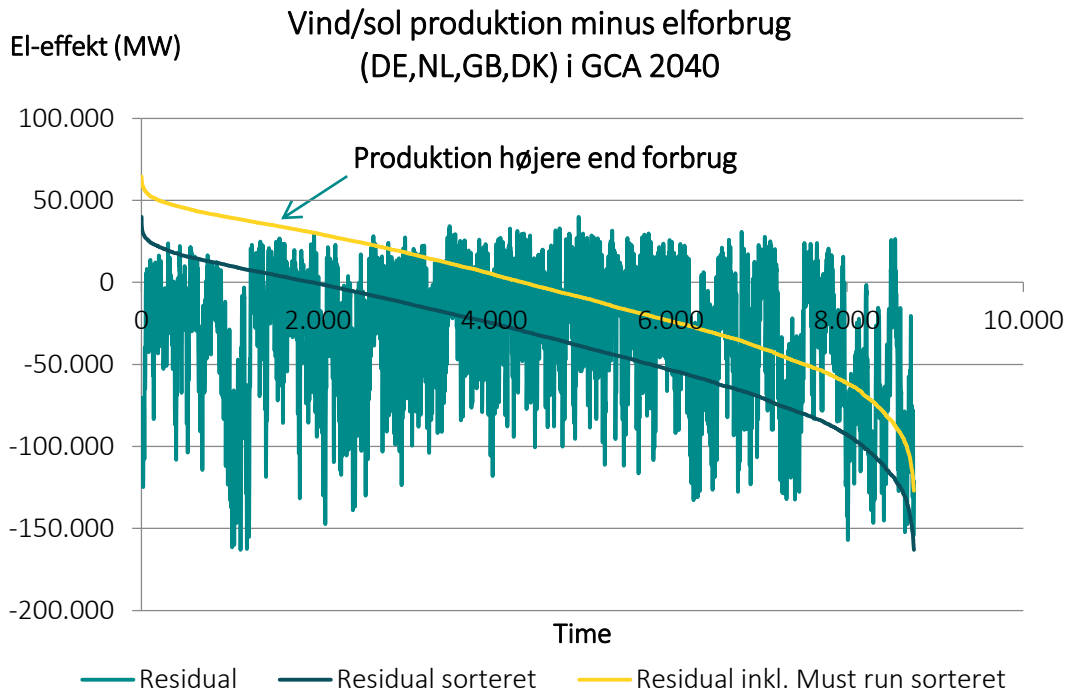




NORDSØ-REGIONEN







- Behov for time/døgn lagring af fluktuationer
- Behov for systembærende egenskaber så termisk kan nedreguleres
- Behov for integration af el i andre sektorer i perioder med høj vind/sol

SOLUTIONS FOR EFFICIENT INTEGRATION OF +50 PCT. WIND/SOLAR

Power-integration – Power as final energy service

Over distance: Power Grid Expansion

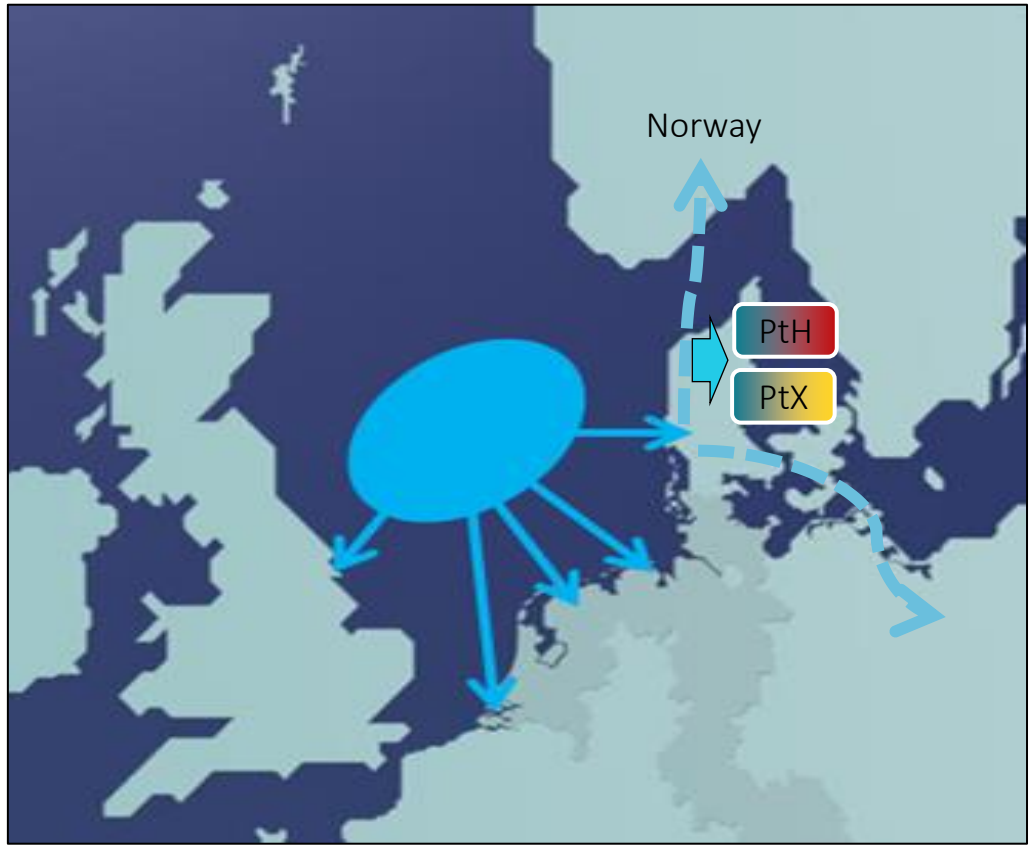
1. (Further) integration with Nordic hydro
2. Integration between Western and Eastern Europe

Over time: Power-to-Power Storage

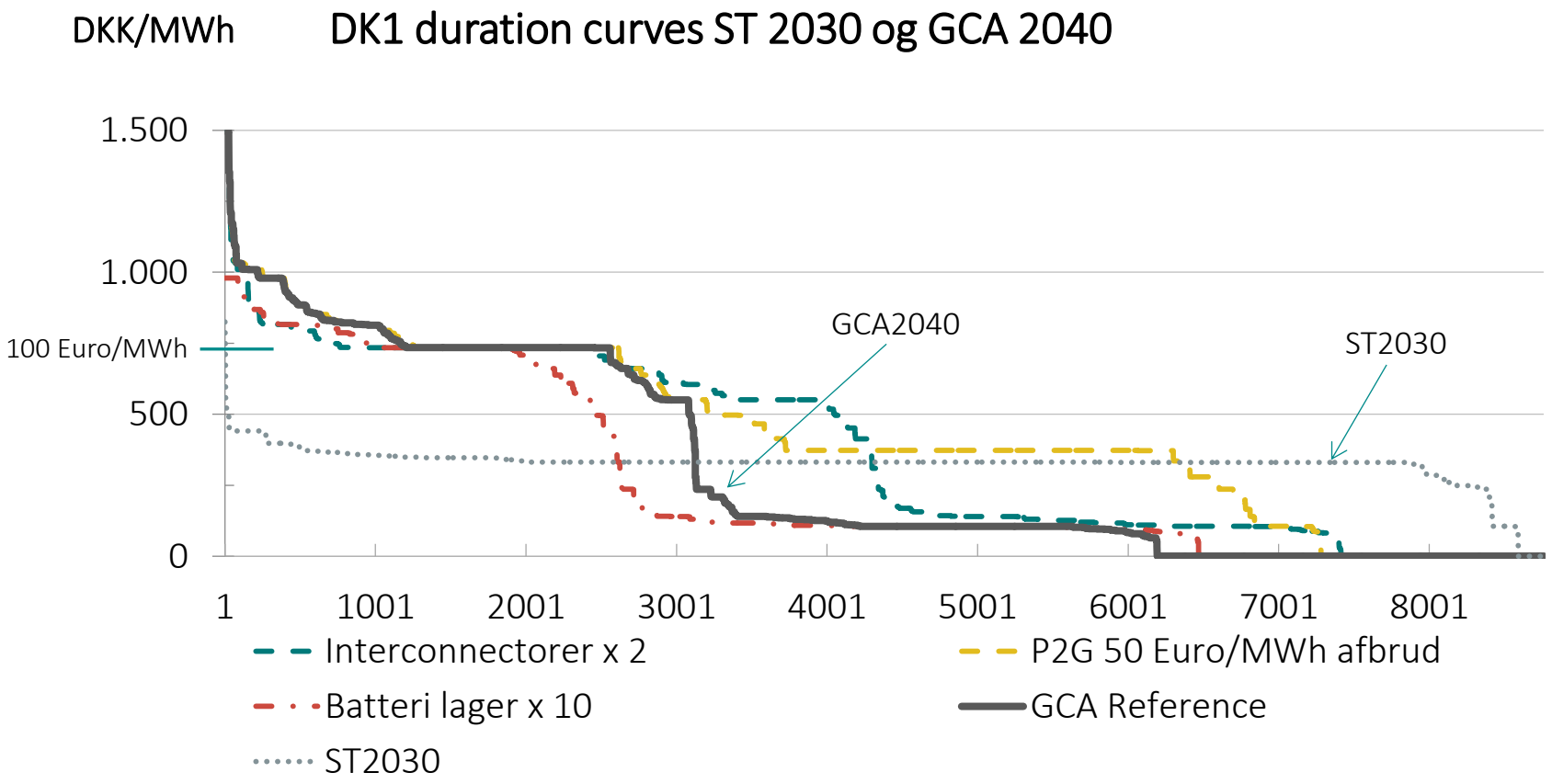
3. Eg. Battery, CAES, Fly Wheels, Pumped Hydro

Conversion of power for other purposes - electrification

4. Power-to-Heat and Thermal Storage PtH
5. Power for Transport
6. Power for high value Products (Electrolysis / PtG / PtX) PtX



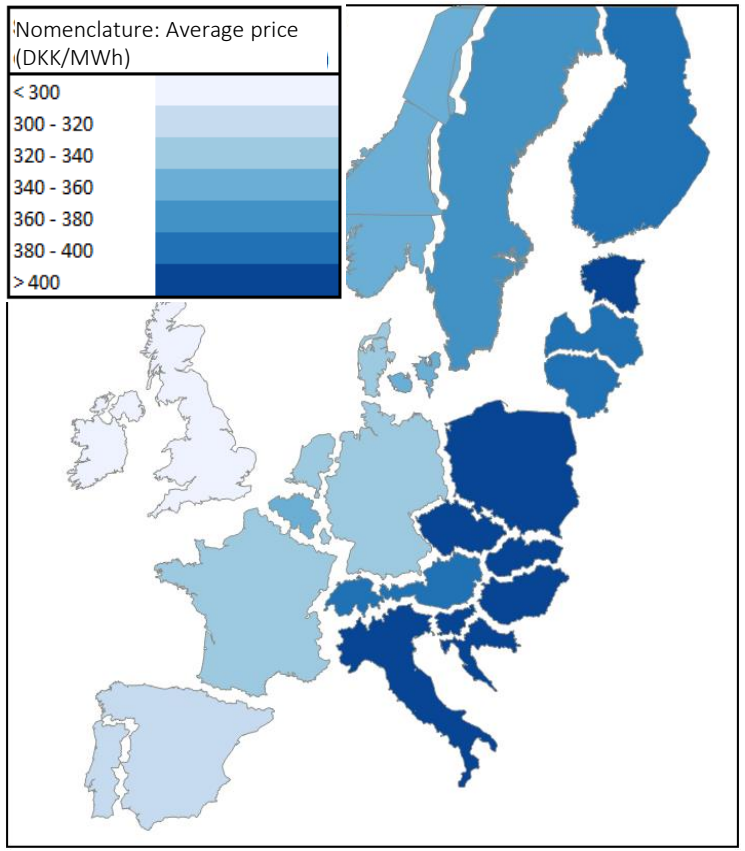
SOLUTIONS TO INCREASE VALUE OF WIND/SOLAR

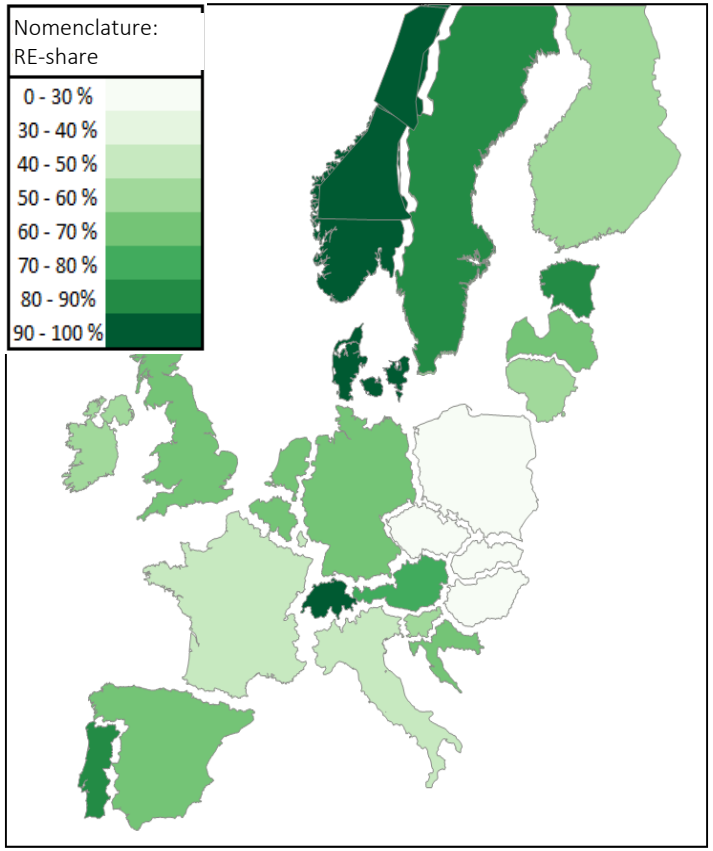


- Power price more fluctuating and especially in GCA low power prices identified
- Solutions with sector-coupling, ICL and battery storage analysed

POWER-TO-GAS IN A EUROPEAN PERSPECTIVE

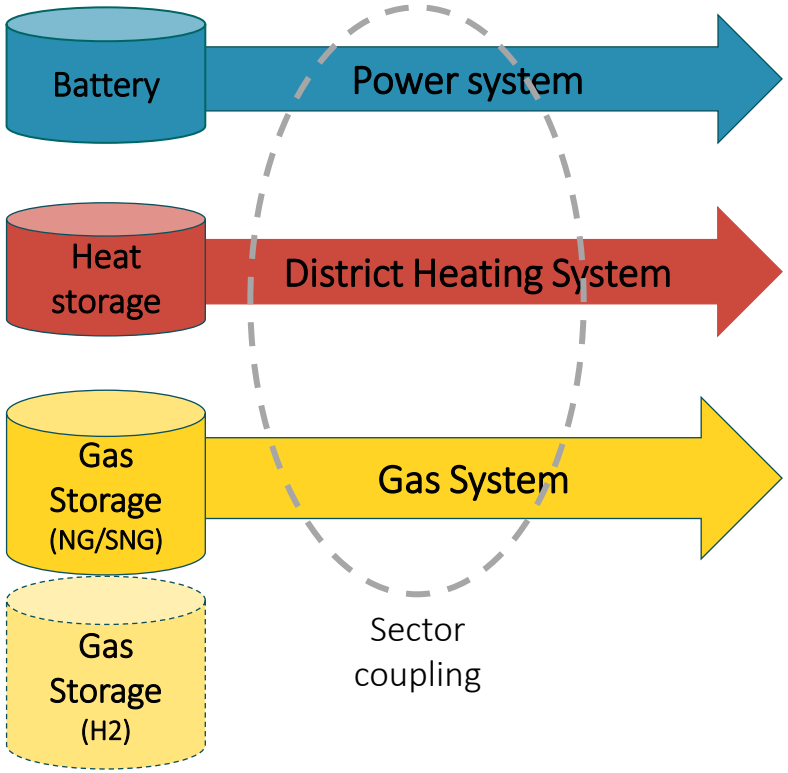
Wind and Sun in Western Europe keeps power prices lower in the whole region

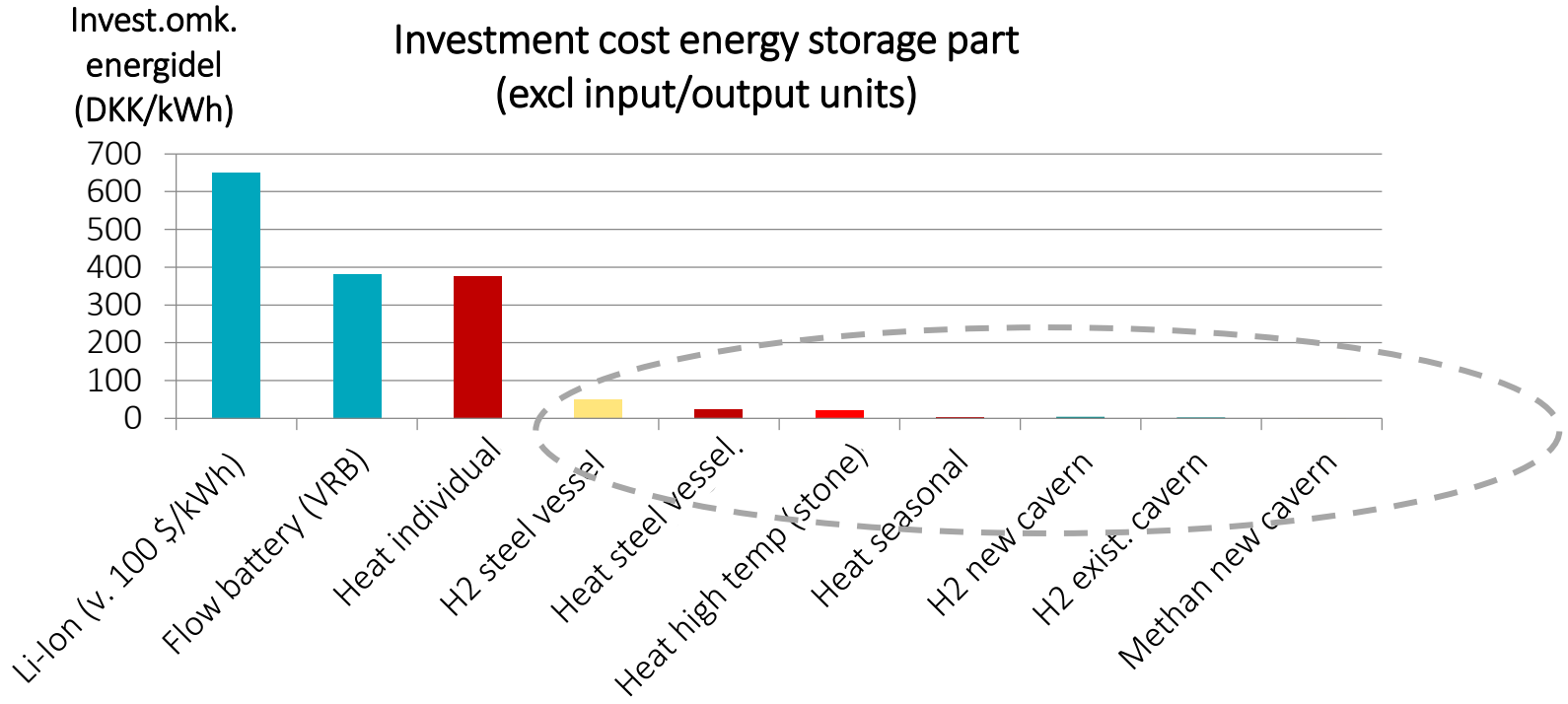




North Sea region in focus for PtG/PtX

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*

DENMARK – SYSTEM ANALYSIS 2035

ANALYSIS OF SYSTEM INTEGRATION

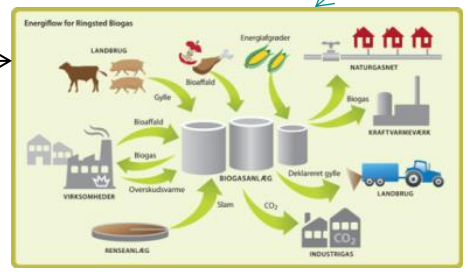
Type 0: Local Prosumer
Building with PV, Battery, EV, (heat pump)

Type 1: Decentralised DH-plant

Heat pump + Gas-CHP + Gas-boiler (peak) + heat storage

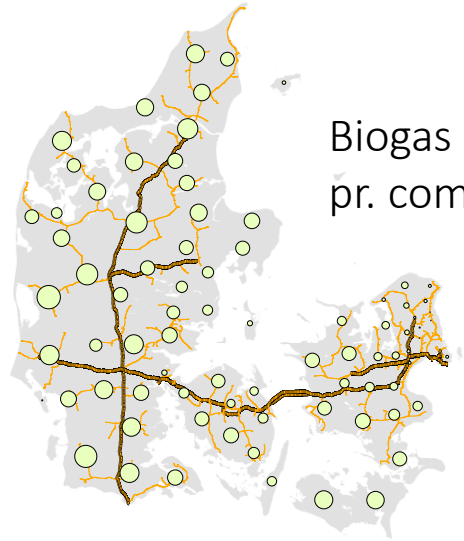
Type 2 : Decentralised energy plant (biogas with PtG/PtX)

Biogas + Gas-CHP + PtG (electrolysis) + Heat pump +
Fuel catalysis (SNG/MeOH) + storage facilities

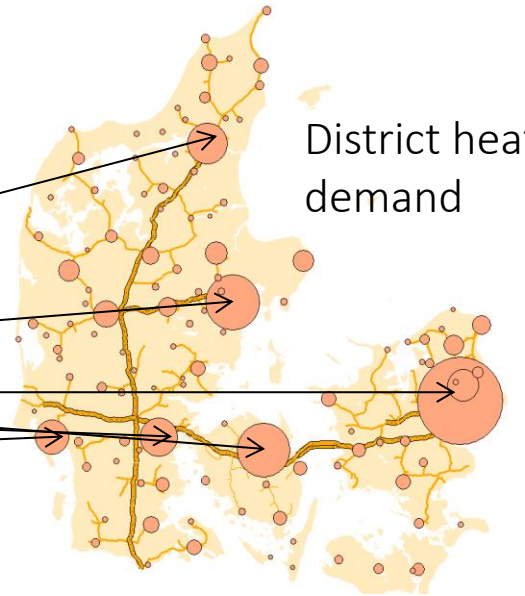


Type 3: Large central plant with PtG/PtX

Thermal gasification + PtG + Fuel catalysis (PtX)+ Heat pump + storage



Biogas potential
pr. community



District heating
demand

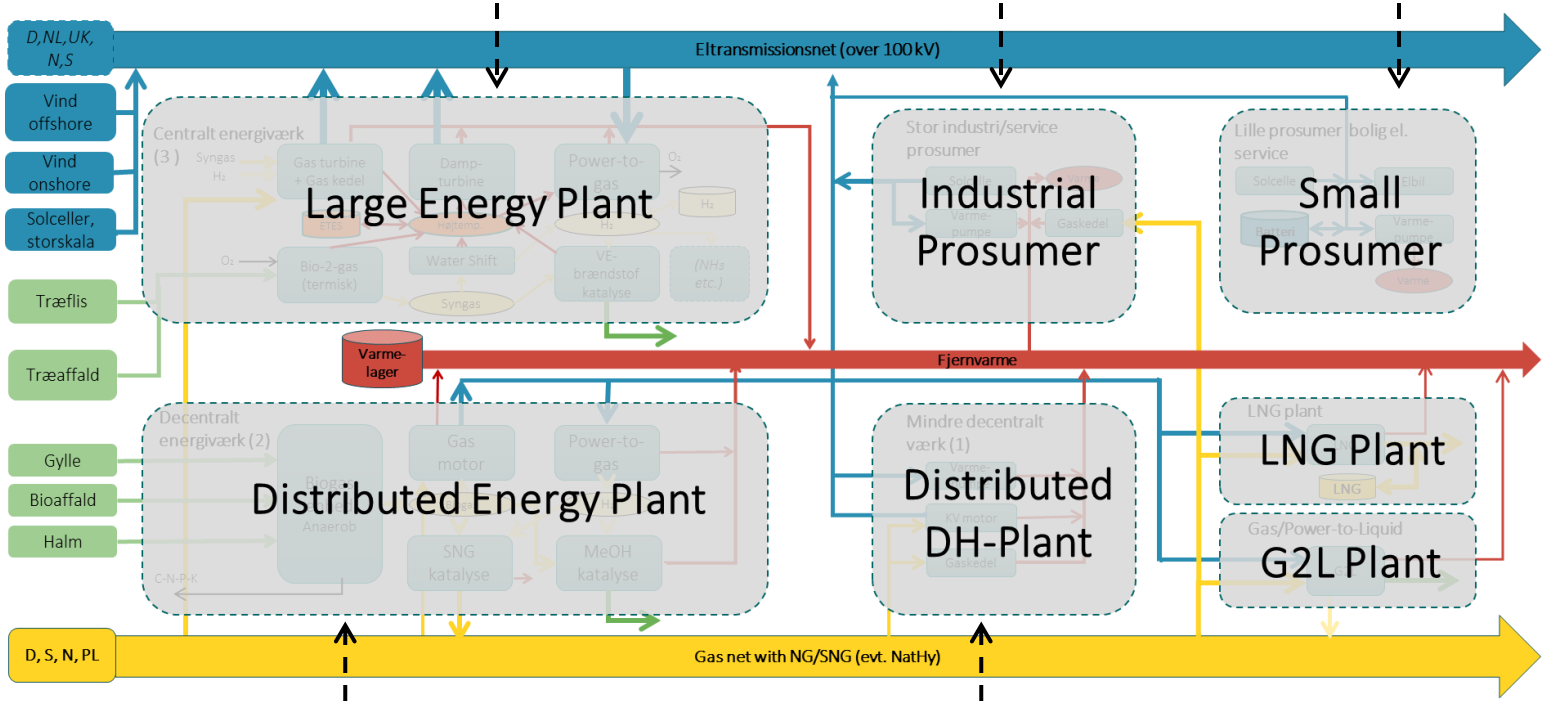
SYSTEM MODELLERING (REDUCED)

ENERGINET

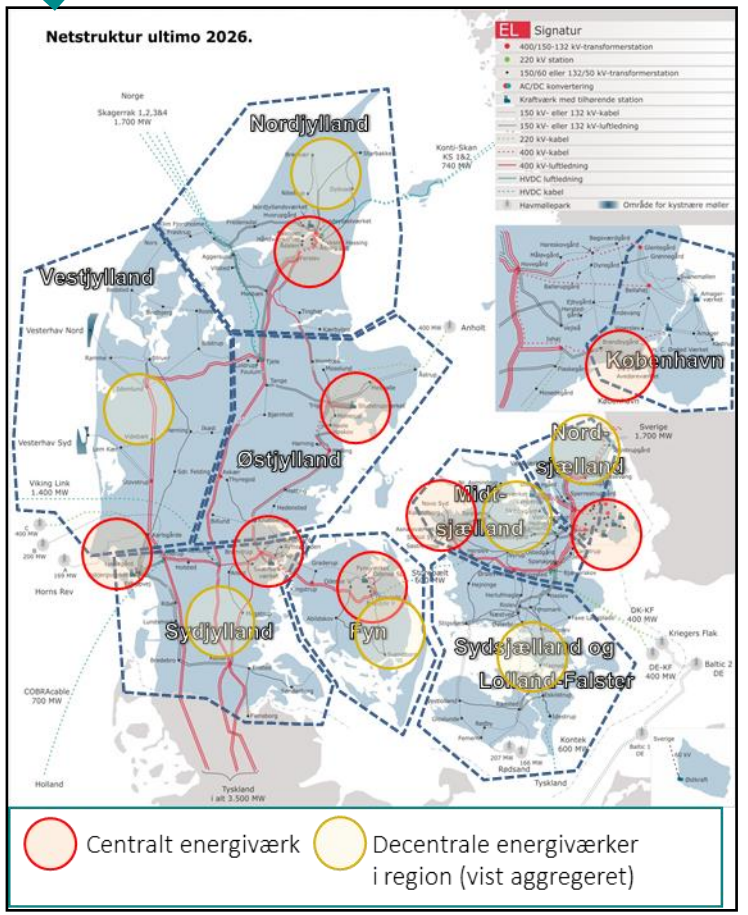
Central Energy Plant

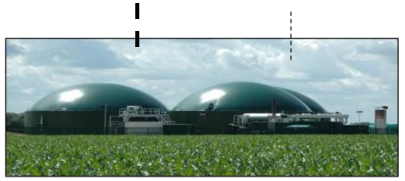
Industry/service

Local Prosumer



Energy plants simulated in grid areas

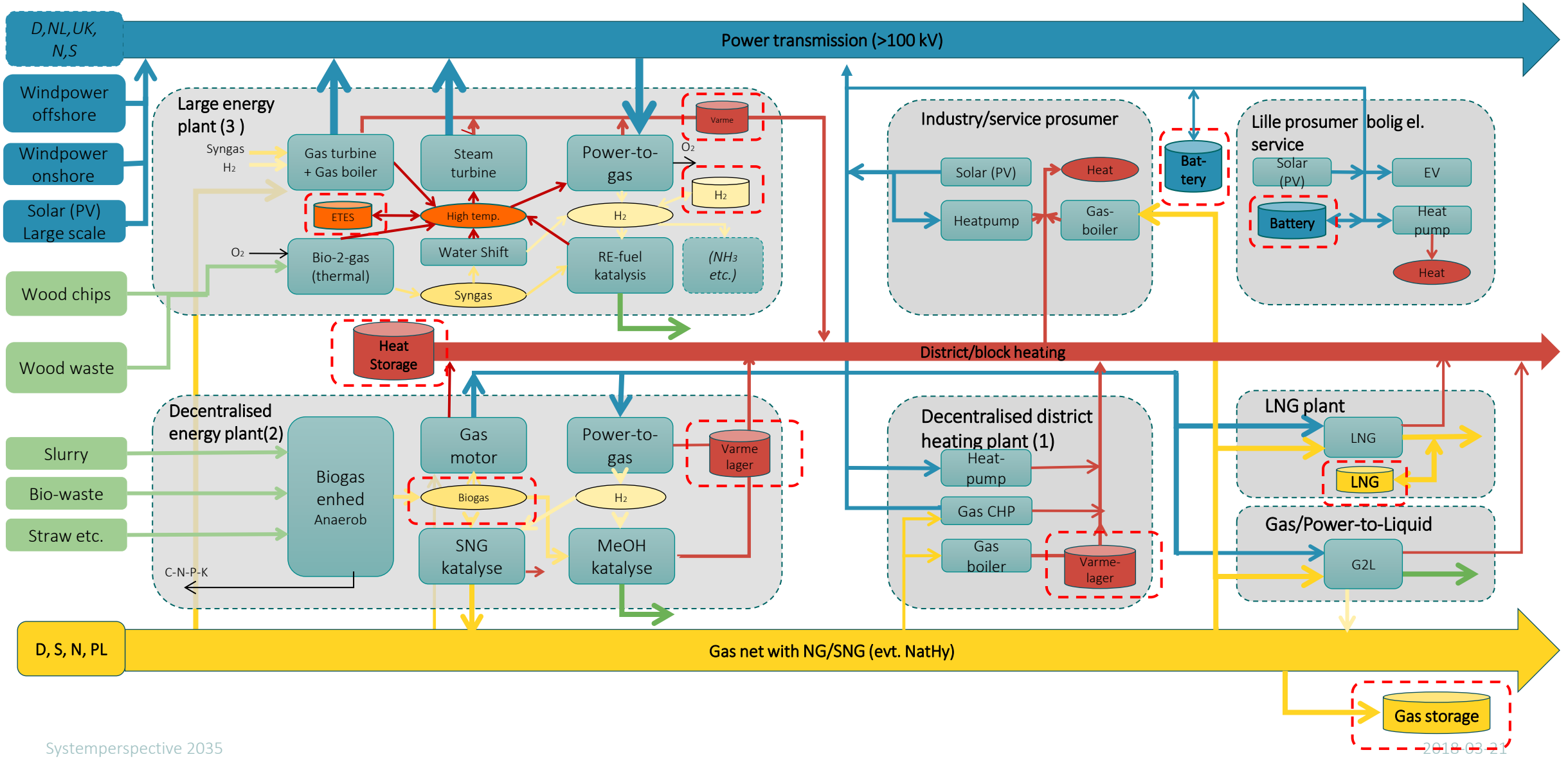




Distributed biogas based Energy Plant

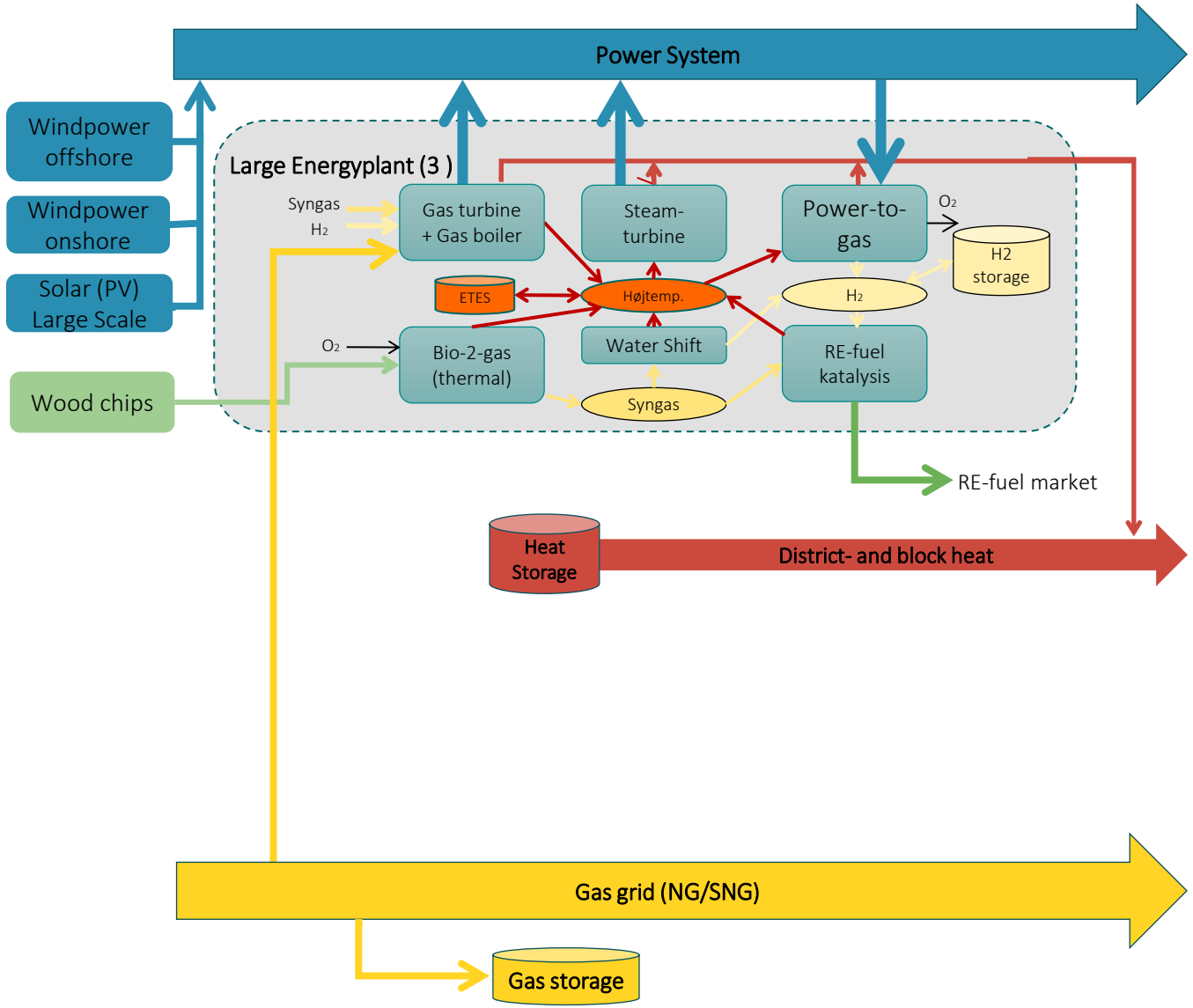
Distributed DH-plant

SIMULATION OF SYSTEM AND LEAST COST ANALYSIS



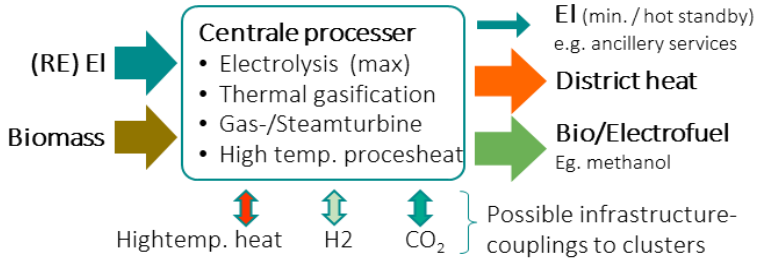
CASE SIMULATION OPTIMIZED PLANT GCA

ENERGINET

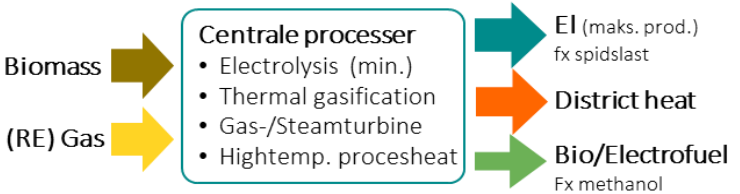


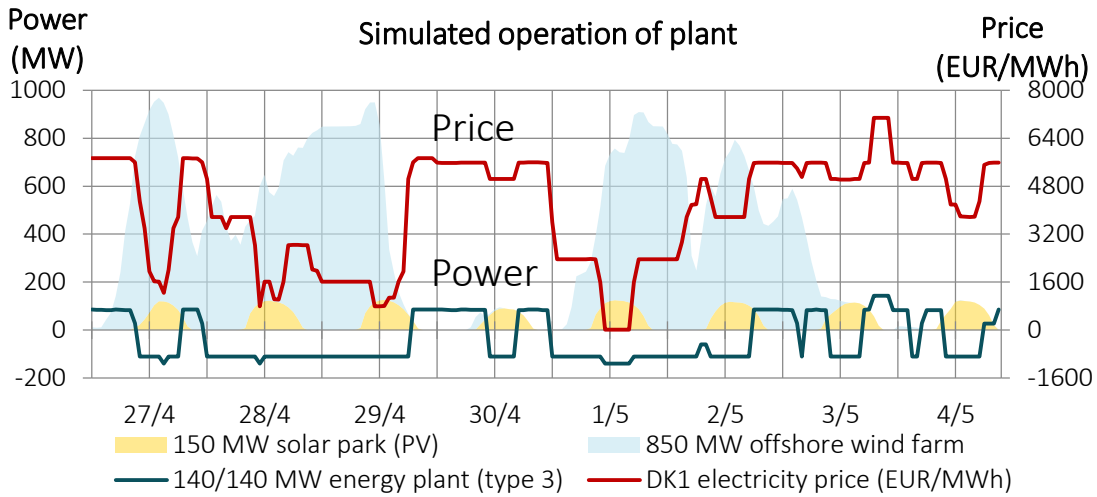
Principle illustration Energy plant

Operation at low/medium power price (eg 6000-7000 hours/y)

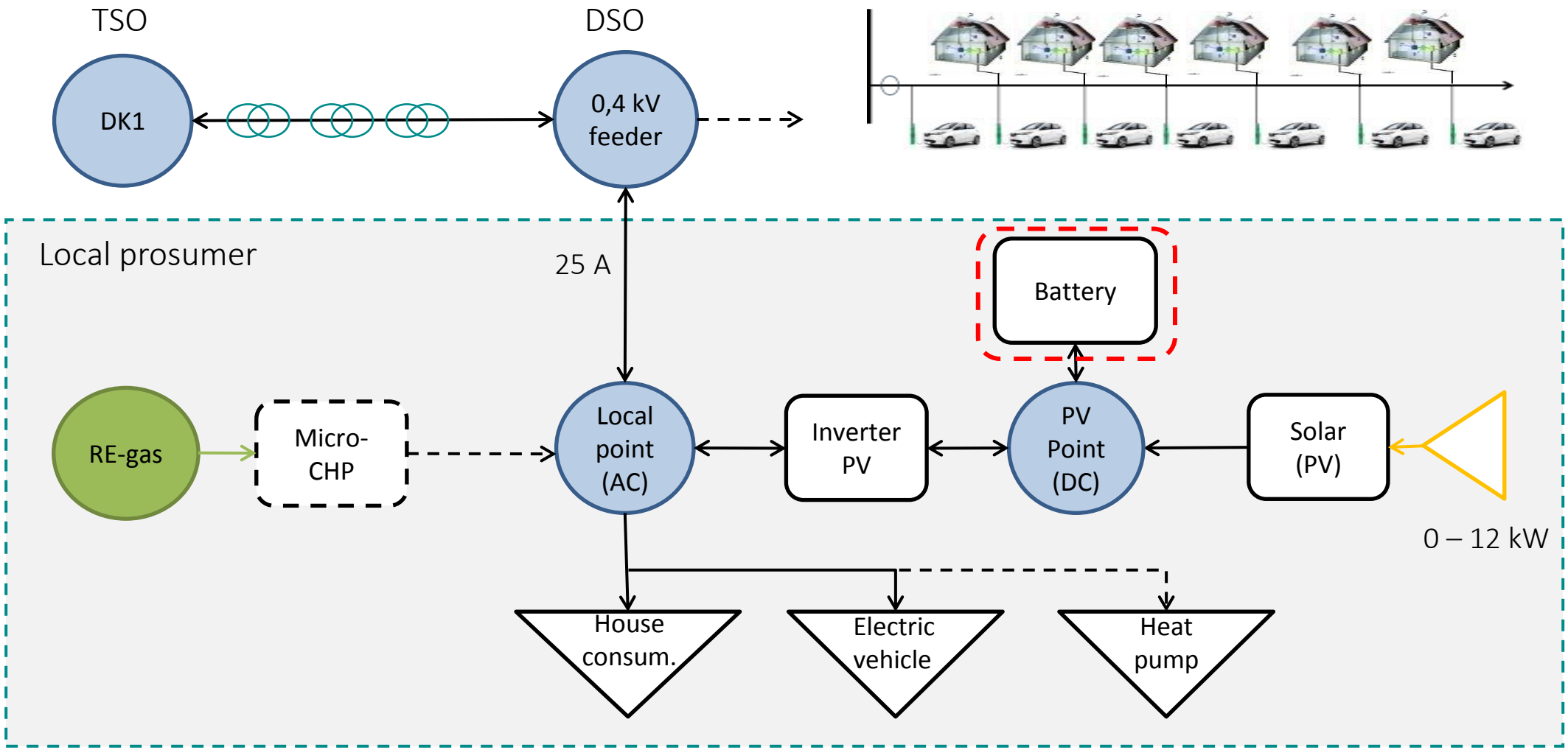


Operation at high power price (eg 1000-2000 hours/y)

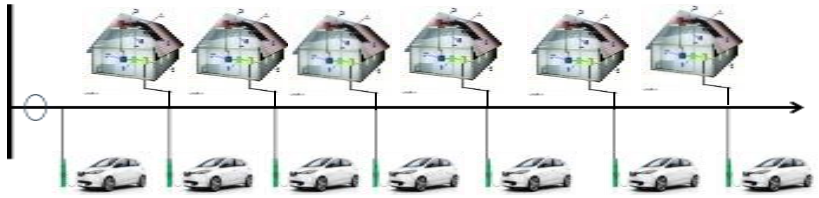




LOCAL PROSUMERS – INVESTMENT ANALYSIS



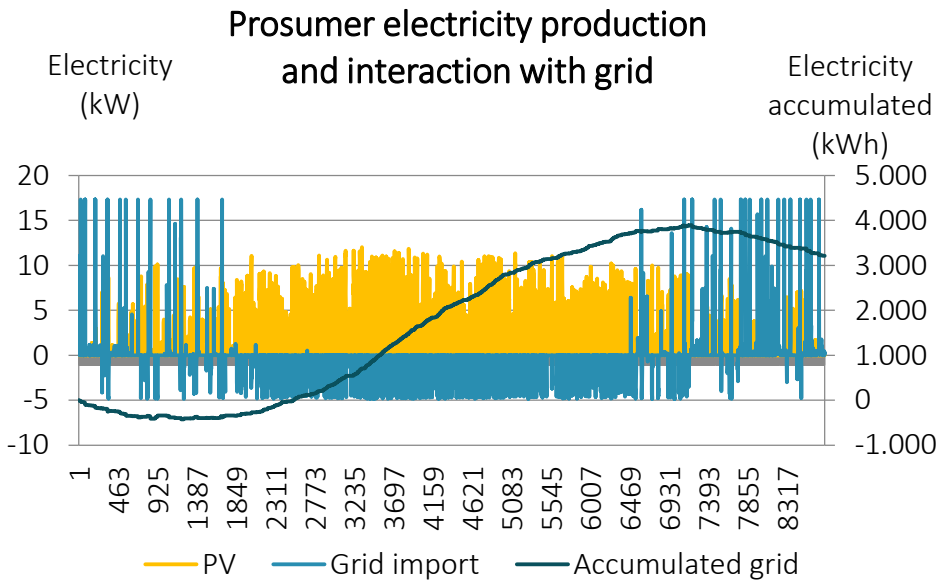
ANALYSIS OF INVESTEMENT IN DISTRIBUTED PRODUCTION

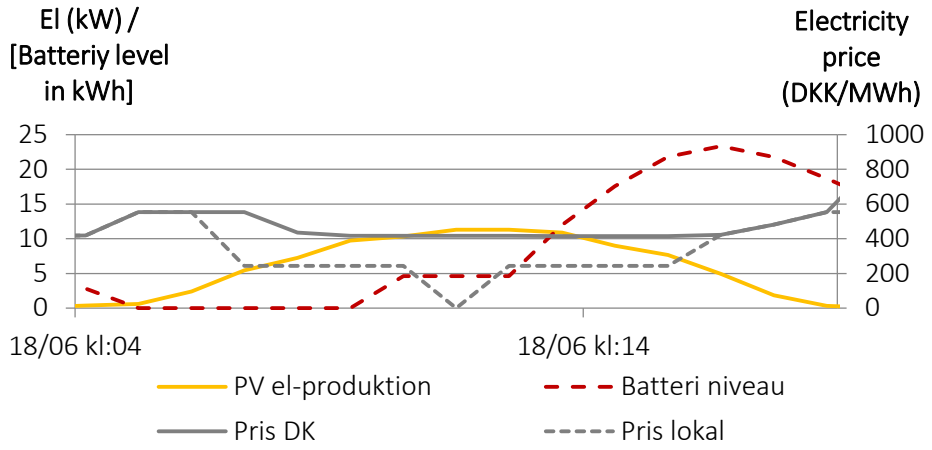


	H.1	H.2	H.3	H.4	H.5	H.6	H.7	H.8	H.9	H.10
Annual consumption Classic consumption (MWh)	4.7	3.1	3.1	4.1	4.4	4.8	5.00	5.3	5.6	5.6
Annual consumption EV (MWh)	5.2	0	7.0	5.2	5.2	5.2	3.0	3.0	5.2	5.2
Battery size EV (kWh)	80	0	80	80	80	80	40	80	40	80
PV (kW)	12,0	5,1	12,0	12,0	12,0	12,0	11,7	11,1	12,0	12,0
Battery size local storage (kWh)	23,3	9,2	25,9	24,1	23,9	24,9	12,9	11,2	12,9	13,8

- Investering i distribueret produktion og lagring (solceller og batterier) analyseret
- Typical investment in up to 12 kW PV and 15-25 kWh battery
- Offgrid seems not to economical realistic, even with further reduced prices on batteries and PV

OPERATION OF SMALL PROSUMERS IN CASE

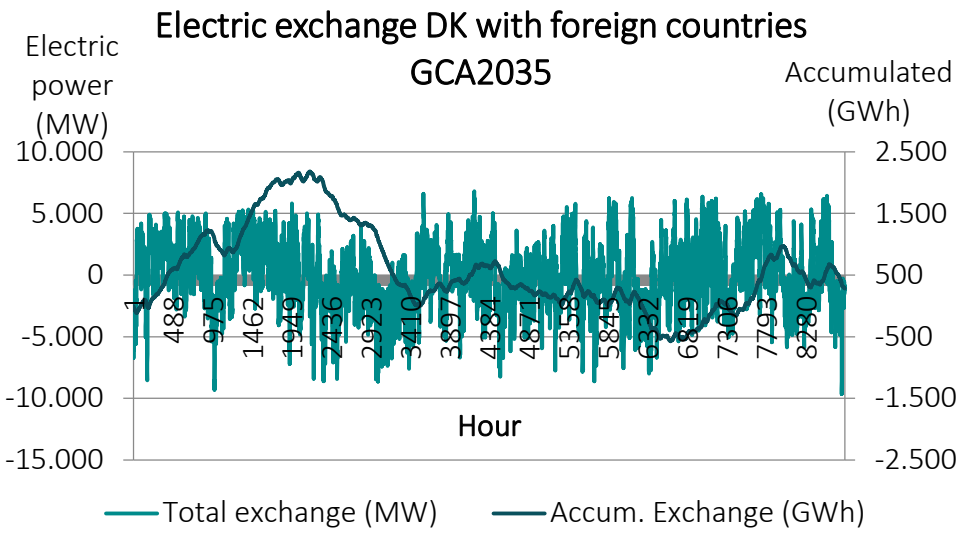


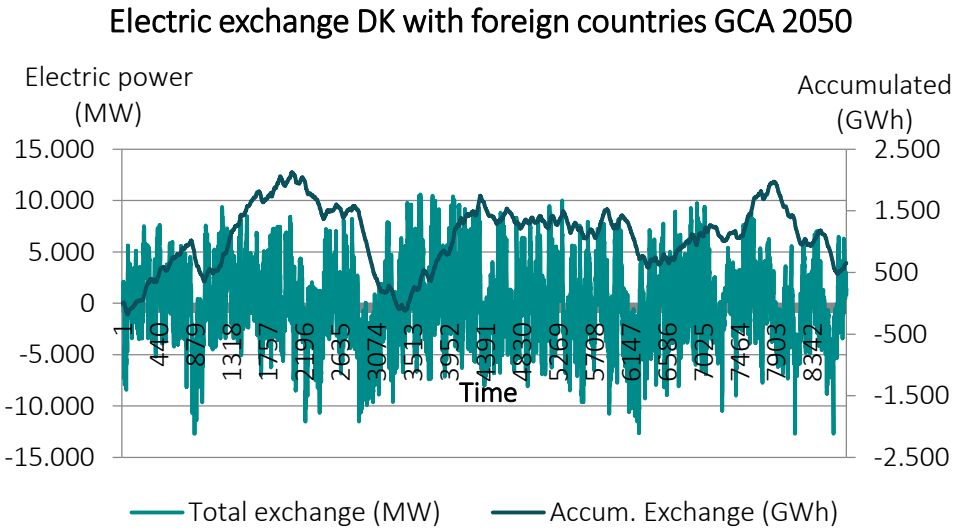


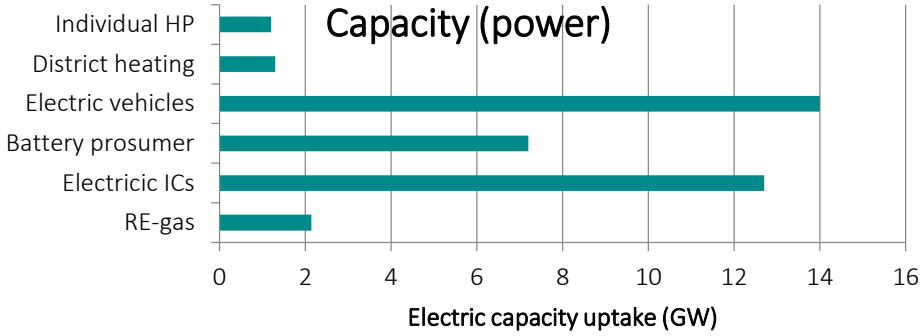
- Large excess of power during summer
- ”Storage” from power-system approx. 4 MWh
- ”Storage” during winther approx. 1-1,5 MWh

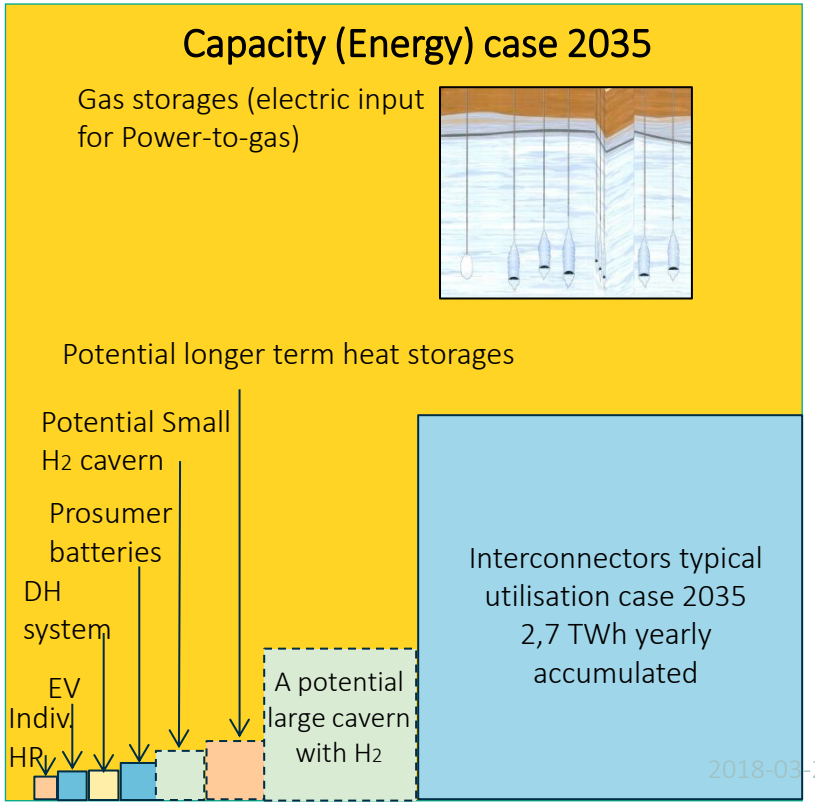
- Bottlenecks in grid might appear in hours with high PV production or simultaneos EV-charging
- A need for TSO/DSO SmartGrid to handle bottlenecks

STORAGE SIMULATION AND CAPACITY

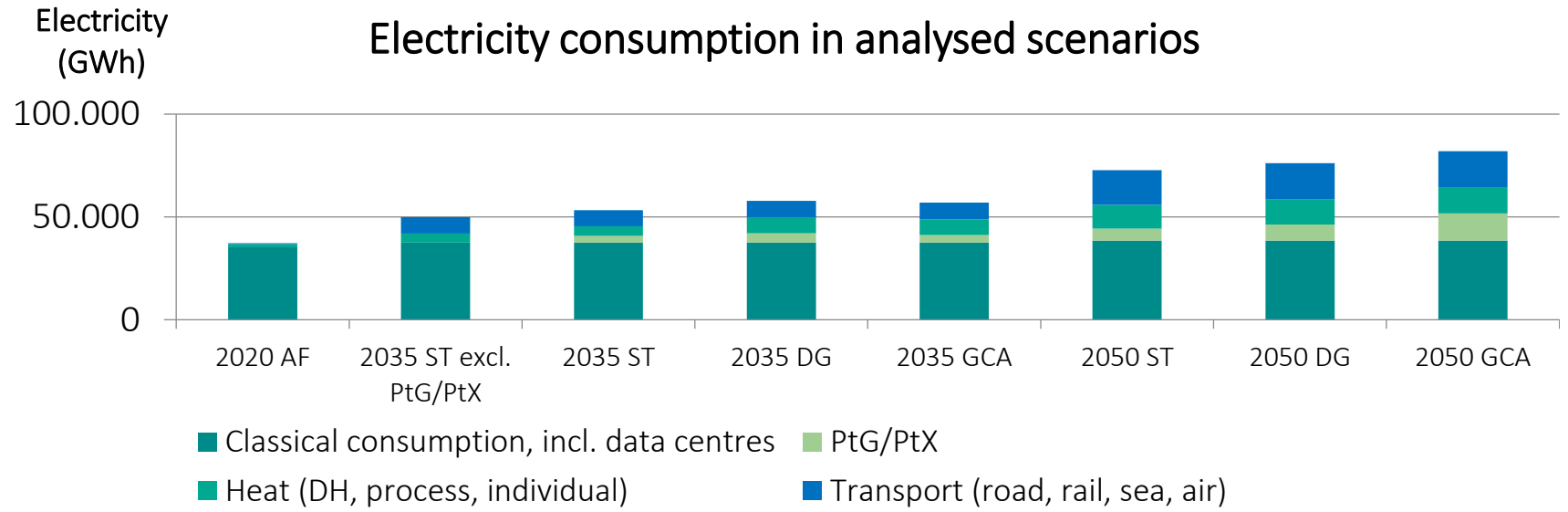


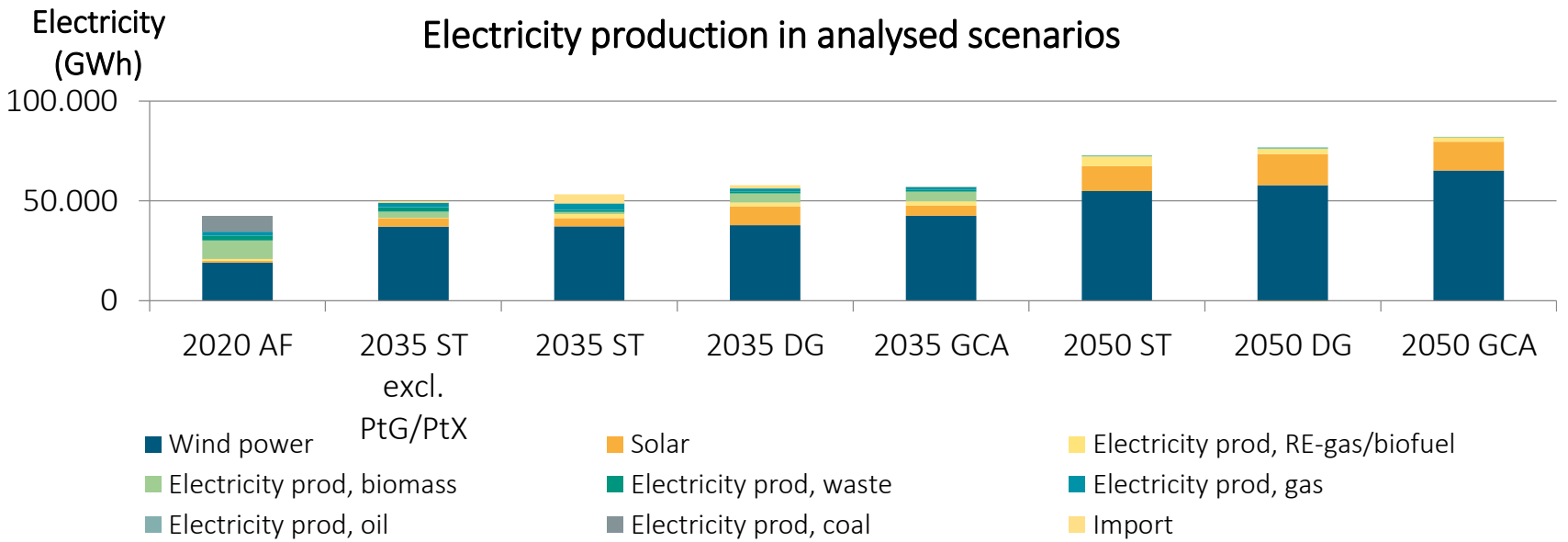




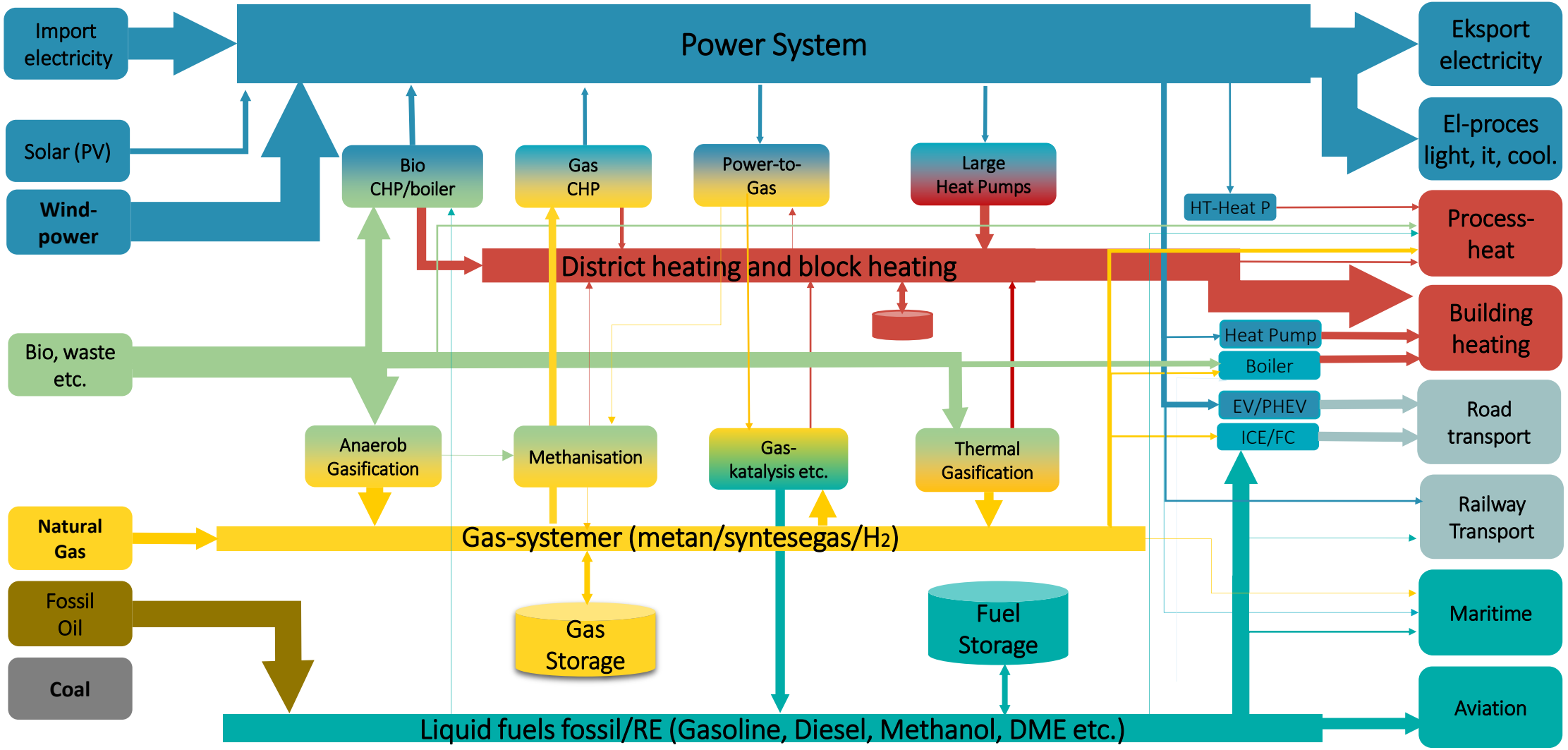


ELECTRICITY BALANCE IN ANALYSED SCENARIOS

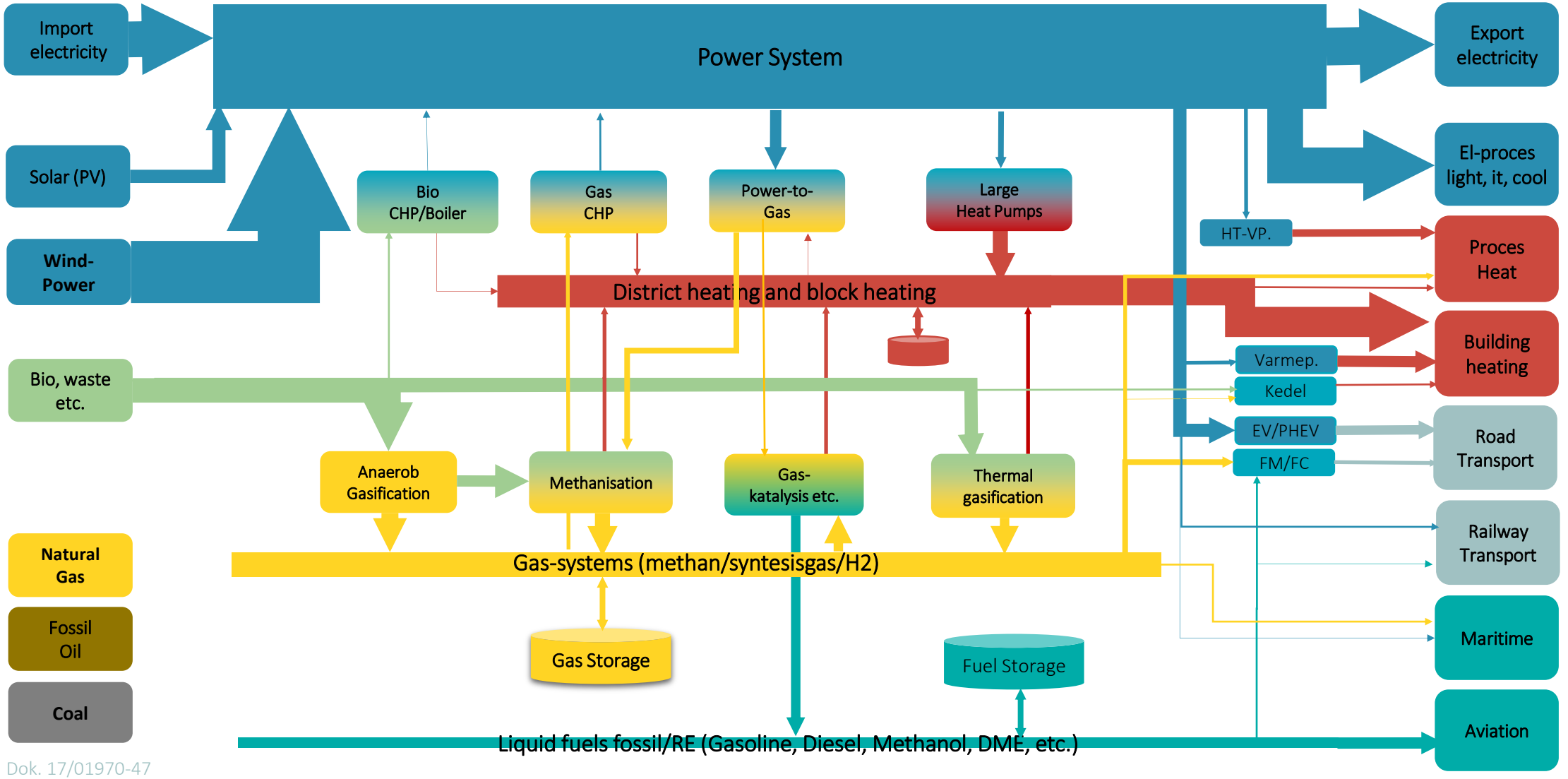




GCA 2035 – SIMULATED ANNUAL ENERGY FLOW



GCA 2050 – SIMULATED ANNUAL ENERGY FLOW



SUMMING UP

ENERGINET

European Agenda sets a framework

- Ambitios plans in EU for reduction of climate gases towards 2050 setplan
- Huge wind-ressources in North Sea region essential for EU 2050 setplan
- 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 essential

- A strong power-grid is needed
- Sector coupling to gas, heat, fuel and transport sector essential for integration
- Large scale solutions (offshore wind, strong grid, PtG/PtX) can be combined with small prosumers (PV, battery)

Position of strenghs for Denmark

- Competitive RE-power prices
- Gas-system and biogas (carbon) ressources
- Potential for gas storage in salt caverns (incl. H2)
- District heating (value of PtX excess proces heat)
- Knowledge on biomass processing and handling (carbon source)

R&D&I international/national

A need for R&I to get a full mature technology in sector integration and storage technologies

- Thermal (incl. High temp)
- PtG/PtX with chemical storage
- Batteries”*everywhere*” in system and know-ledge on battery optimised system operation


THANK YOU FOR THE ATTENTION
http://WWW.ENERGINET.DK/sys35