INTEGRATED GAS AND ELECTRICITY PLANNING

… or the story of sector coupling

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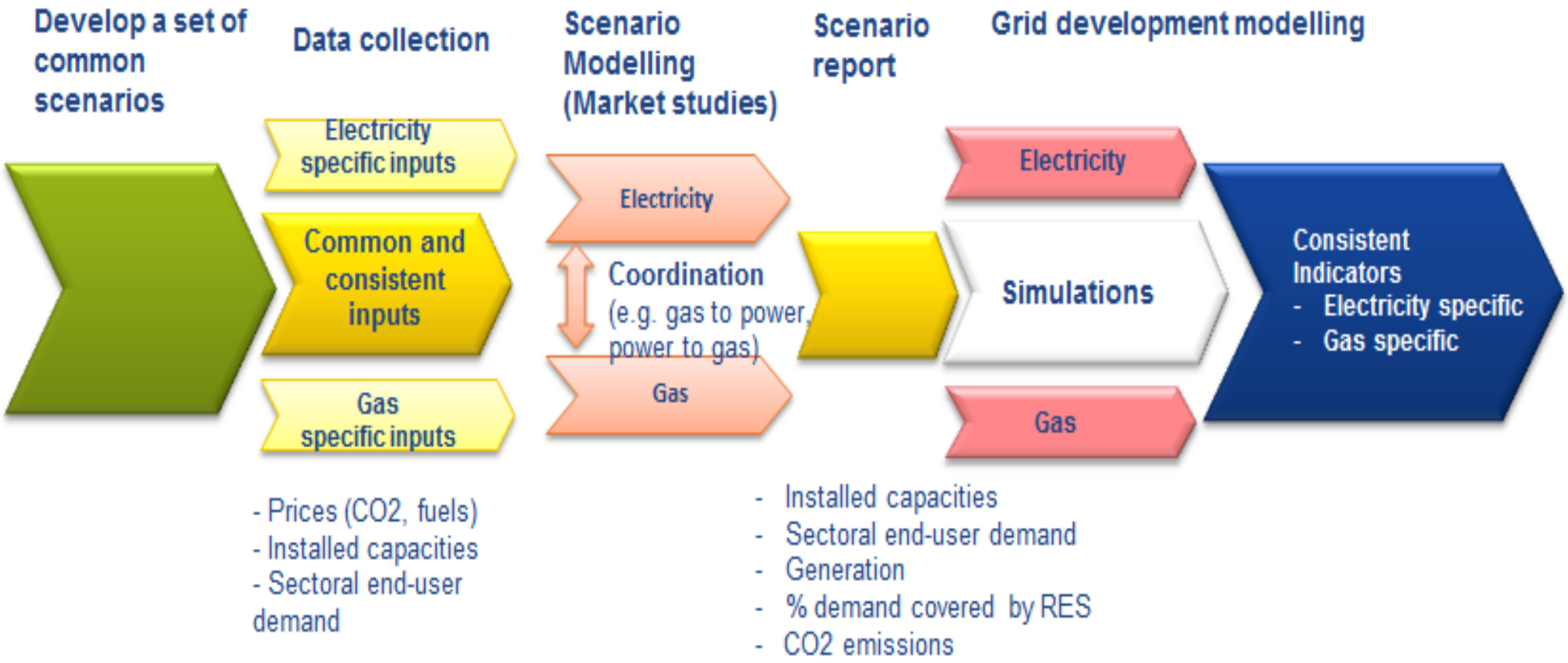
ESIG Spring Technical Workshop, Albuquerque, March19-21, 2019

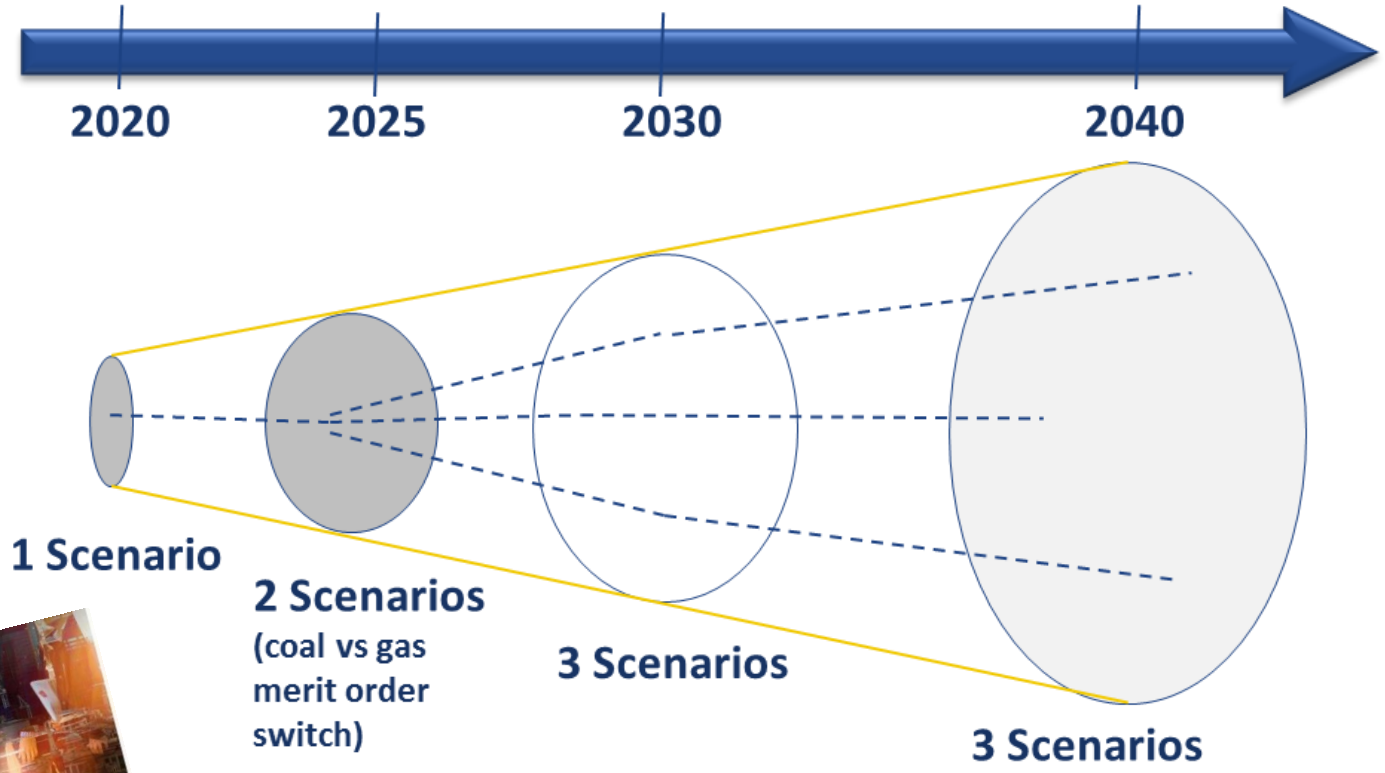
DRIVERS IN EUROPE

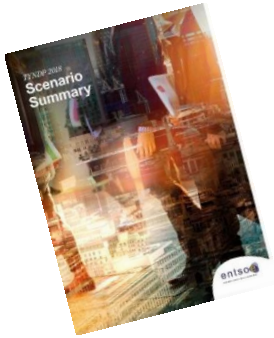
- **2013**: European regulation (EC 347/2013) requiring ”interlinked model”:
  - ENTSOs infrastructure plans for el and gas (TYNDPs) 2018 applying joint scenarios
  - Can gas infrastructure replace el-infrastructure expansion? Joint ENTSOs investigations..
- **2015:** Paris Agreement: CO2 reduction to achieve the 1.5 degree target by2050
  - All sectors to decarbonize
  - EU: Power sector until 2040, other sectors following
- **2018:** Greta

THE ENTSOS INTERLINKED MODEL



EUROPEAN EL AND GAS TYNDPS* BUILD ON THE SAME SCENARIOS





*Ten-Year-Network-Development Plan

Main update compared to TYNDP16

Cooperation

entsoe
Reliable Sustainable Connected
entsog
european network of transmission system operators for gas

Key factors:

- *Transport*
- *Heating*
- *Power*
- *Renewable Gases*

Find the TYNDPs here:
http://tyndp.entsoe.eu/
https://www.entsog.eu/tyndp#

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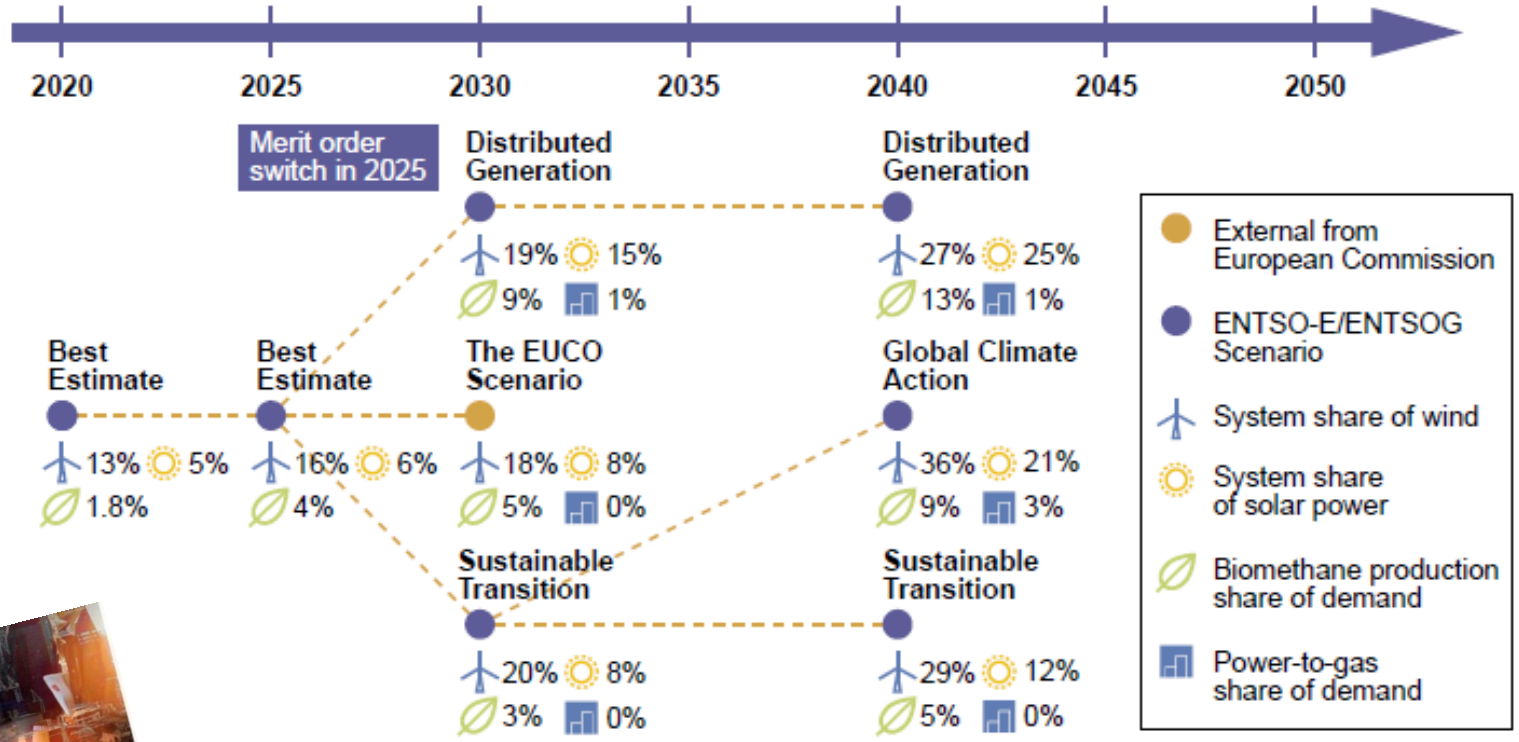

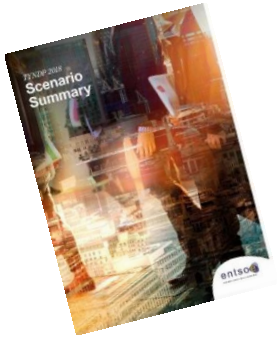

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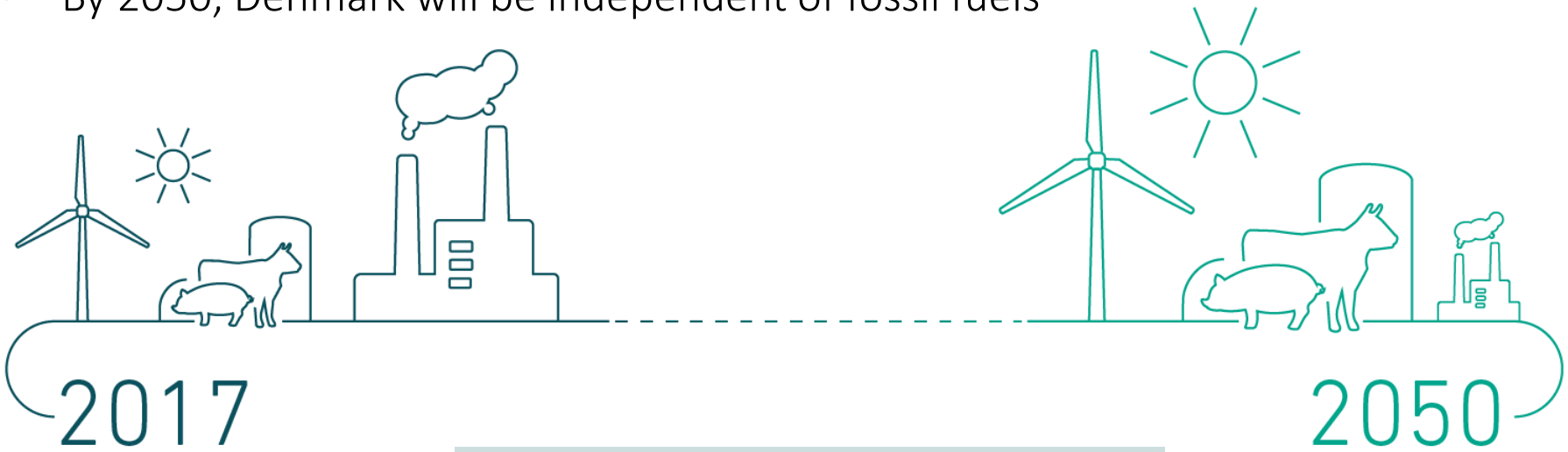
DENMARK – THE BASICS:
THE ENERGY SYSTEM IN DENMARK IS CHANGING

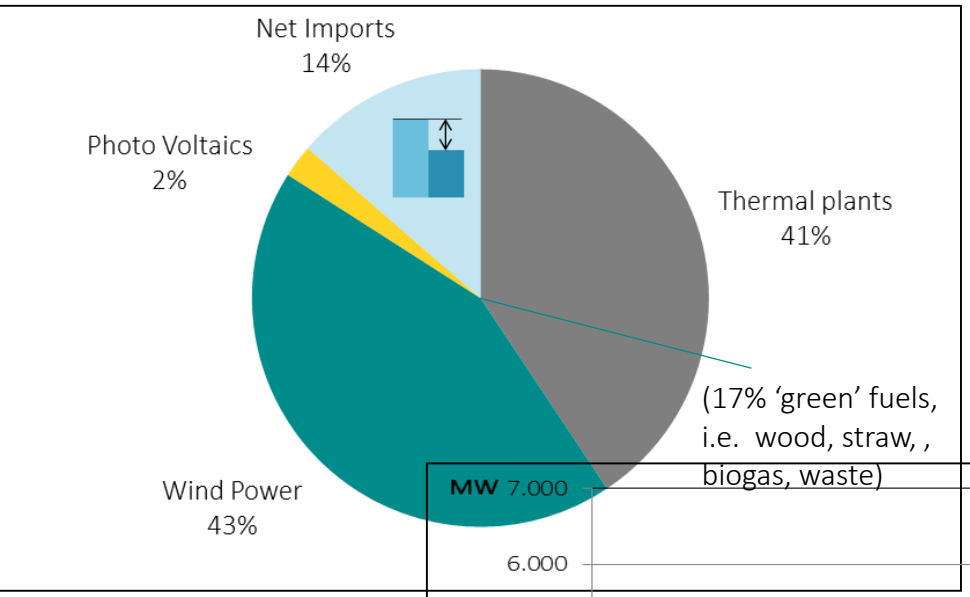
- By 2020, wind power will constitute 50% of the electricity consumption
- By 2030, renewable energy will constitute 50% of the energy consumption
- By 2050, Denmark will be independent of fossil fuels



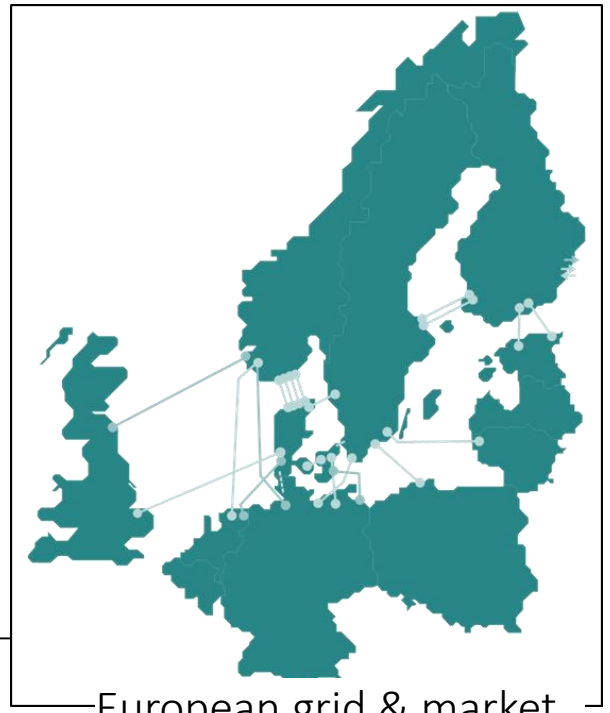
Strategic commitments of Energinet:

- Security of supply
- Efficient green transition
- Healthy investment climate

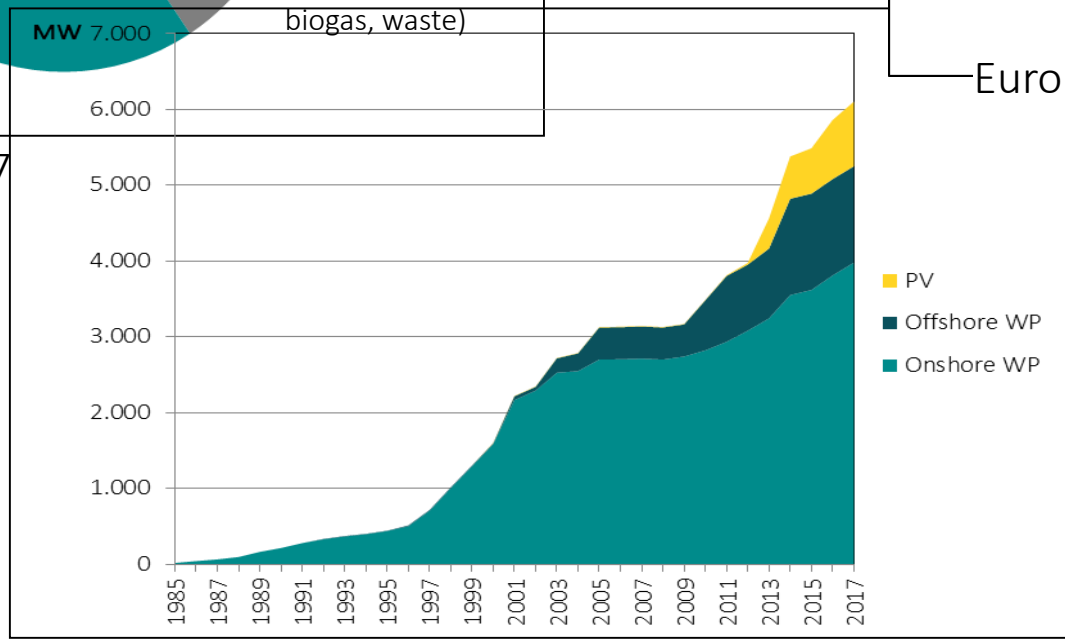
THE DANISH POWER SYSTEM
- MAIN CHARACTERISTICS



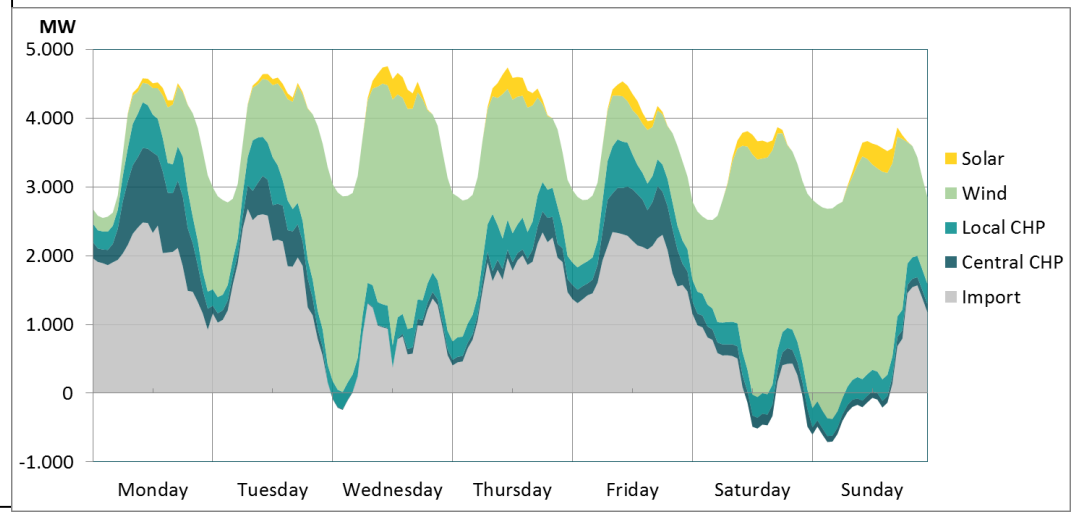
Energy balance 2017



European grid & market



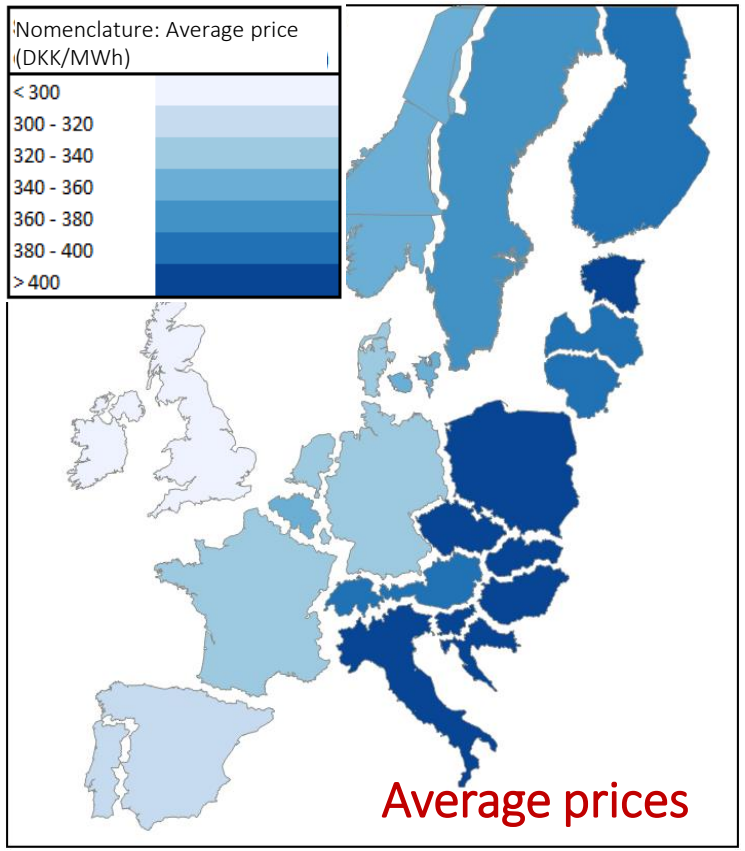
Wind power and PV

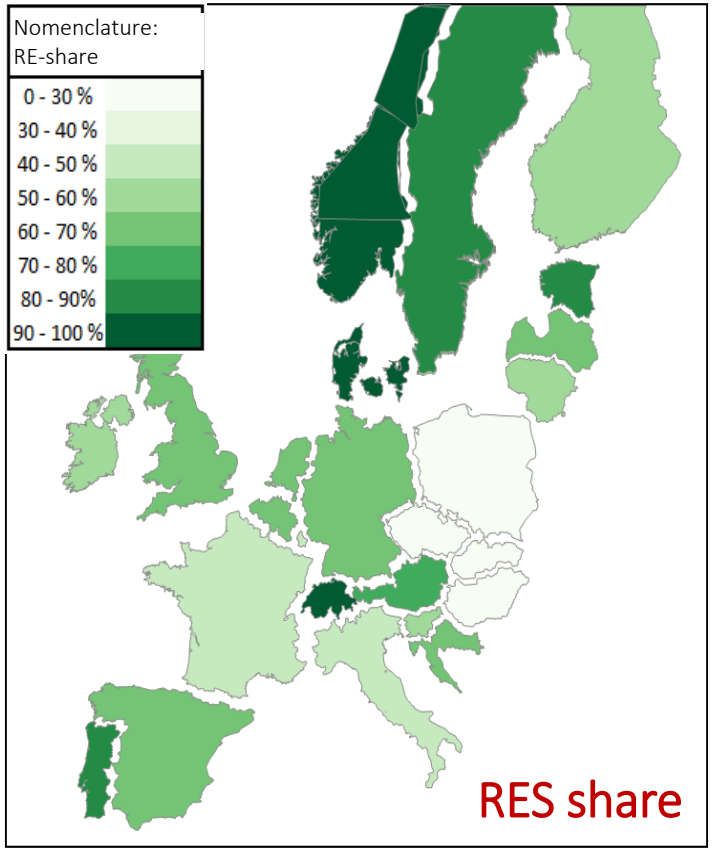


Hourly Dispatch – 51% VRES

SECTOR COUPLING IN A EUROPEAN PERSPECTIVE

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

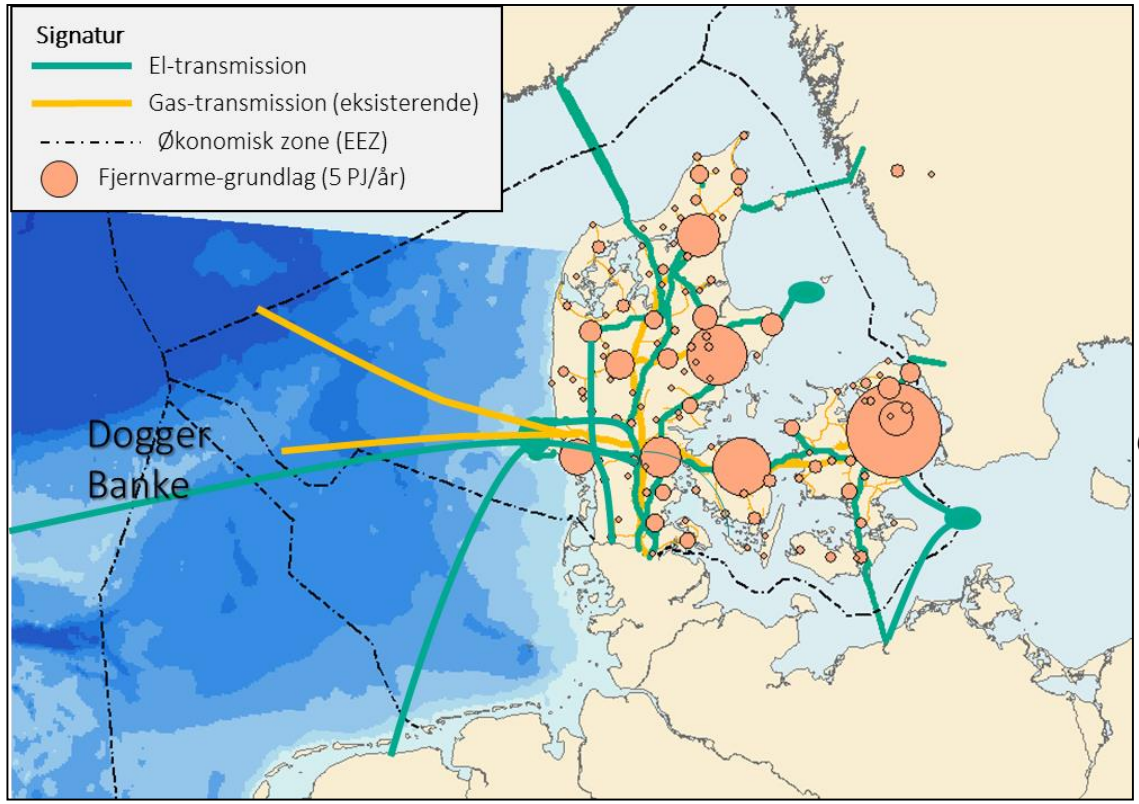




ST 2040 Scenario

North Sea region in focus for PtG/PtX

SECTOR COUPLING IN A EUROPEAN PERSPECTIVE



Danish Strengths for P2G/P2X

EL

Competitive prices
high security of supply
High VRES share in el-system
(for VRES –P2X produkter)

Gas

Gas-grid and cavern storage facilitates VRES-gas (H2, Syngas, Methane)

District Heating

Income by Heat sale (DH)

Bio/Carbon

Strengths around biomass/biogas treatment (carbon)

Infrastructure to Denmark as Energy Hub – interaction el-gas-heat

DK has some strengths in integrating North Sea VRES potentials into an el,gas,heat system

WHY SHOULD PTG/ PTX SUDDENLY BECOME ECONOMICALLY EFFICIENT?

What are the drivers?

- Decreasing costs for wind and solar - LCoE is decisive!
- Increased focus at large scale integration of wind and solar in the electricity market and electricity grid
- Big scale industrializing of electrolysis technology has started
- Increasing demand for green P2X products

It's not longer a question of access to competitive RES,
but the challenge is in storing, converting and efficient integration of RES.

HOW MUCH OFFSHORE WIND DOES A CONTAINERSHIP NEED?

Rough estimate – from offshore wind via electrolysis to ammonia as marine fuel oil

How many of MÆRSK's Triple E container ships can Horns Reef 3 (407MW) keep on sailing for a year?

2 ships!

It would need 50 GW offshore wind to replace marine fuel oil by green ammonia for the whole MÆRSK fleet.

This would be 9 x today's DK total wind capacity

or 39x today's DK offshore wind capacity.

ELECTRIFICATION AND SECTOR COUPLING

ENERGINET

System Perspective 2035 – Electrification and Sector Coupling

ENTSO-E/G
TYNDP18 scenarios

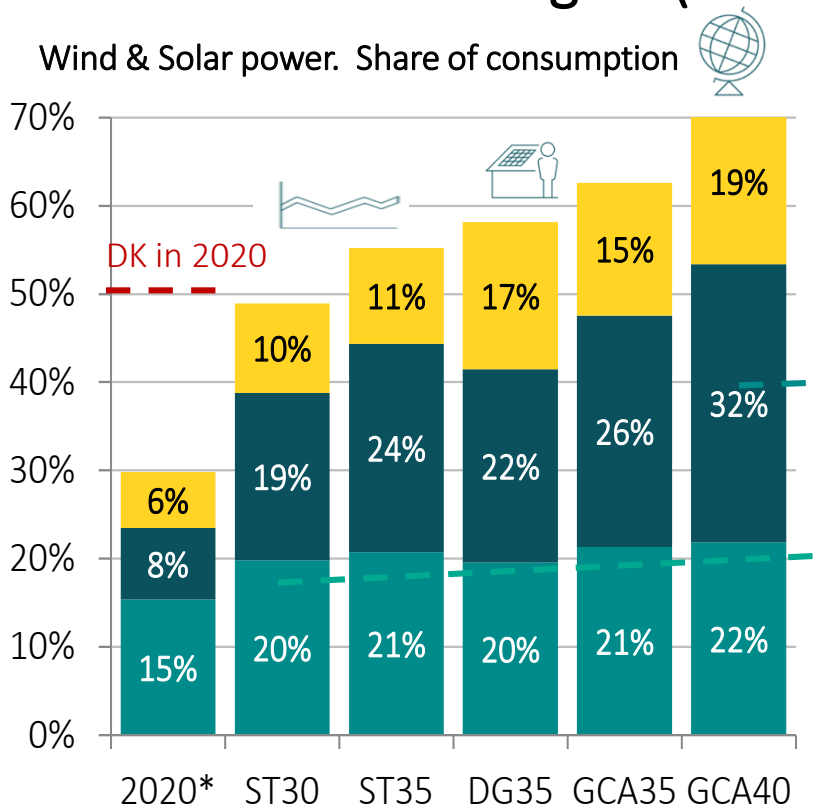
1: International Energy Scenarios

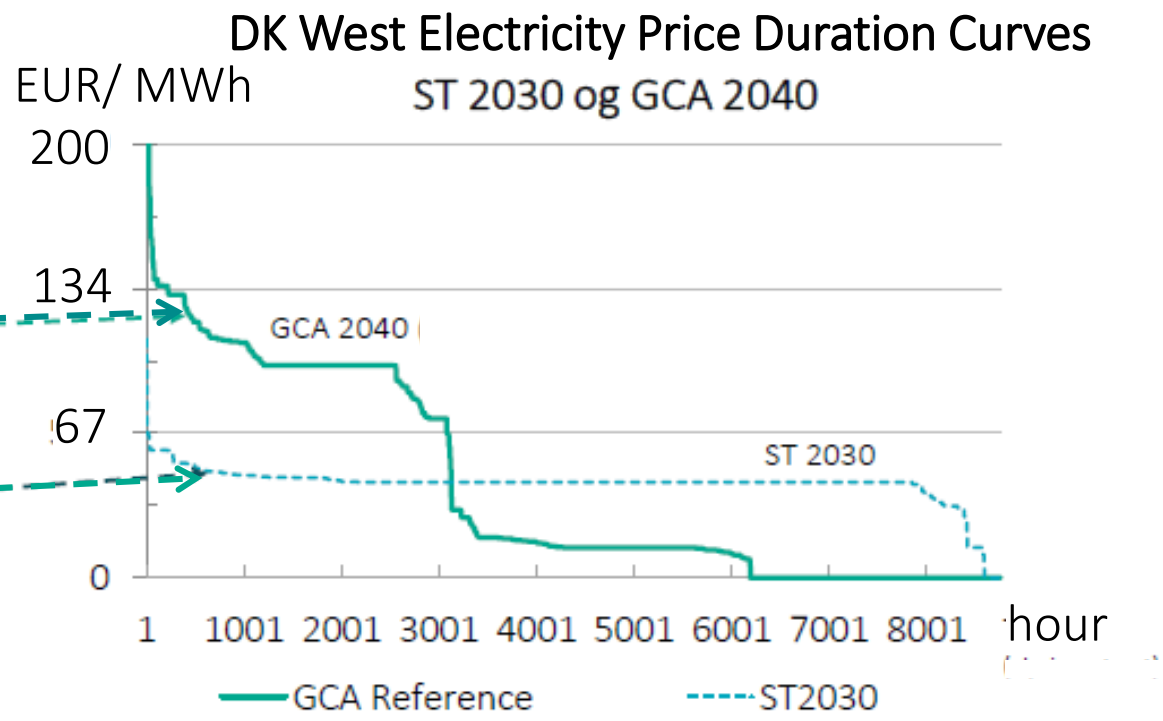
2: System Perspectives for Denmark

3: Interaction between Distributed and central ressources

MORE WIND & SOLAR POWER DECREASES EL-PRICES

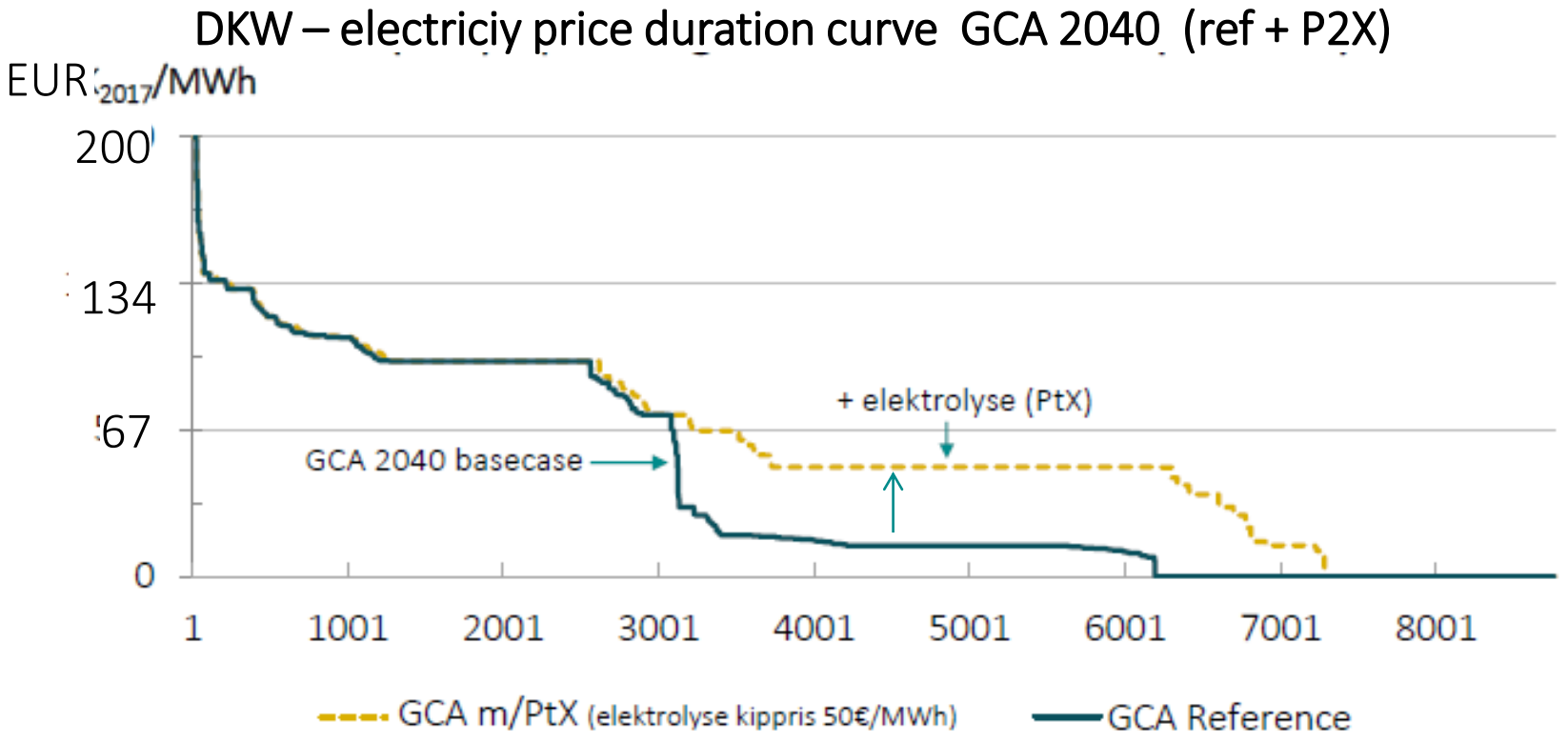
North-sea region (DE. UK, NL, DK)





- GCA 2040: many hours with 0 price / low prices
- Markets value of var-RES does not match production costs
- Average settlement price for offshore wind and PV is 40 €/ MWh in ST2030, but only 20 €/MWh in GCA 2040

P2X CAN INCREASE THE VALUE OF WIND/ PV



No P2X in the basecase.

In P2X scenario there is:

- 750 MW electrolysis in DK
- Ca 26 GW in DE, UK, NL and DK in total

The average annual settlement price for wind and PV in DKW increases from ~20 €/ MWh to 40 €/ MWh in the P2X scenario

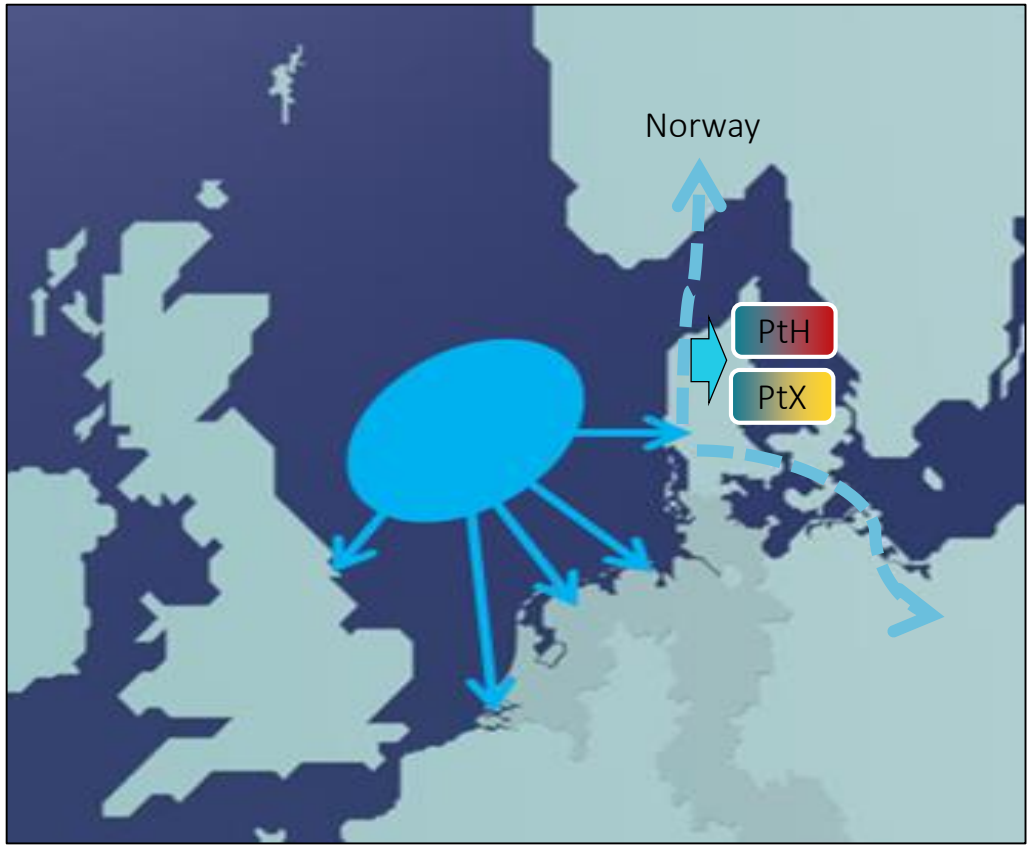
MORE OPPORTUNITIES OF SECTOR COUPLING

El, heat, gas and products

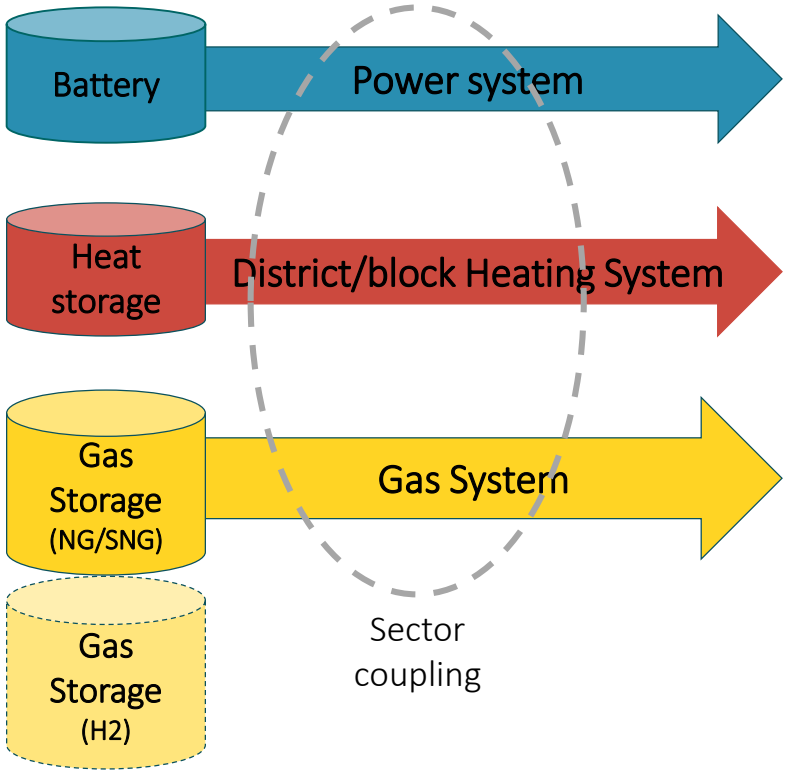
- P2G/X delivers high temperature heat, which could be used in P2G or steam turbine => could deliver regulating power, AS or peak load capacity.
- Reduction of need for traditional power plants in standby at low energy prices to ensure AS
- Reduction of (n-1) reserve? … utilization of transmission grid could be increased if these plants would deliver traditional (n-1) reserve.

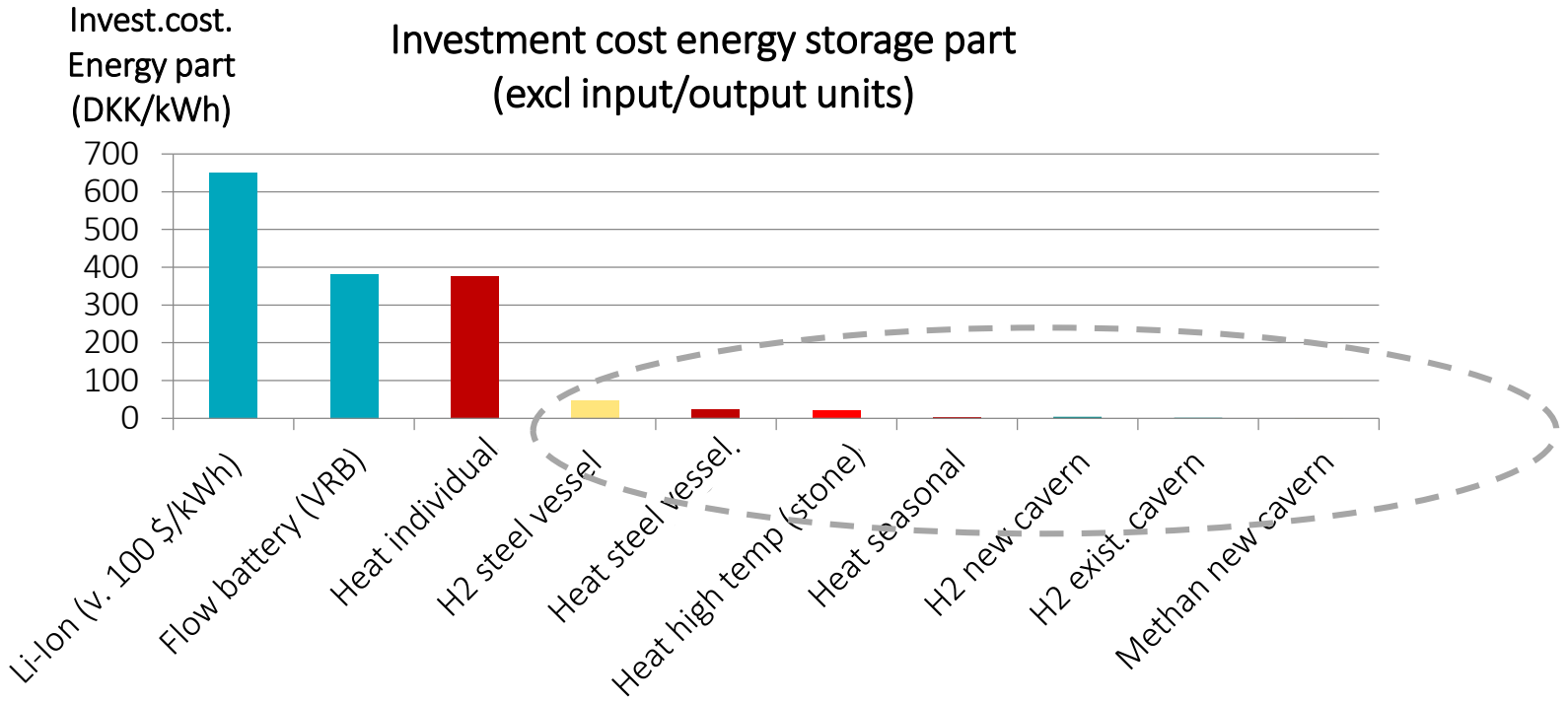
SOME SOLUTIONS FOR INTEGRATION OF NORTH SEA WIND/SOLAR

1. Stronger international grid
2. Electricity Storage (batteries etc)
3. Power-to-heat with heat-storage
4. Power-to-X
   (RES-gas, RES-fuels, ammonia etc.)



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 -> access to low cost large scale storage

"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

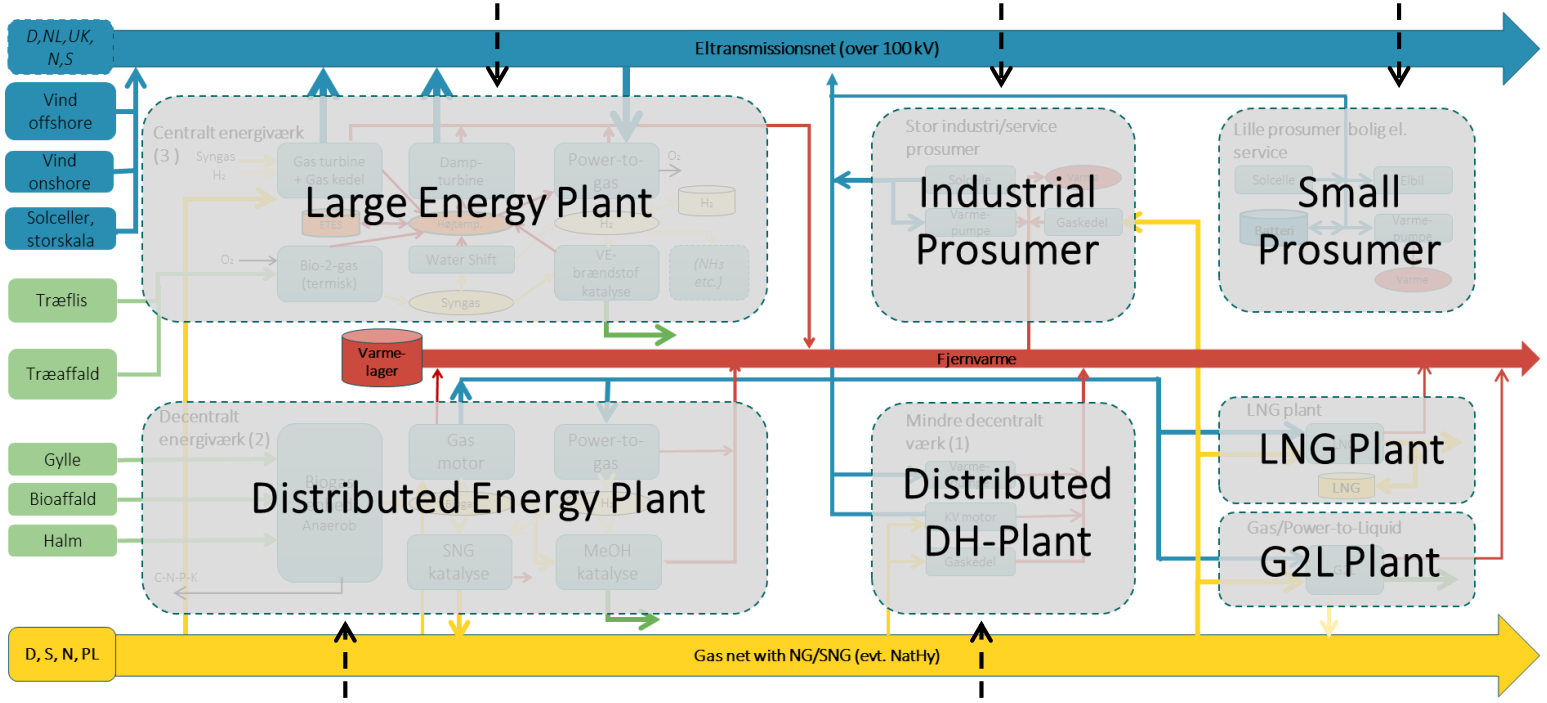
SYSTEM MODELING

ENERGINET

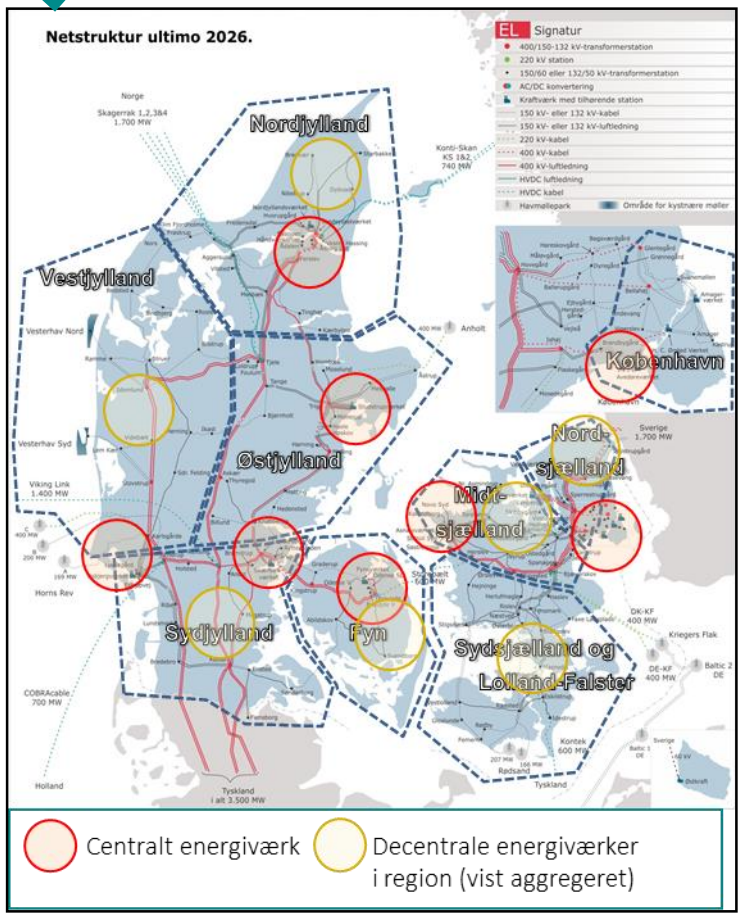
Central Energy Plant

Industry/service

Local Prosumer



Energy plants simulated in grid areas

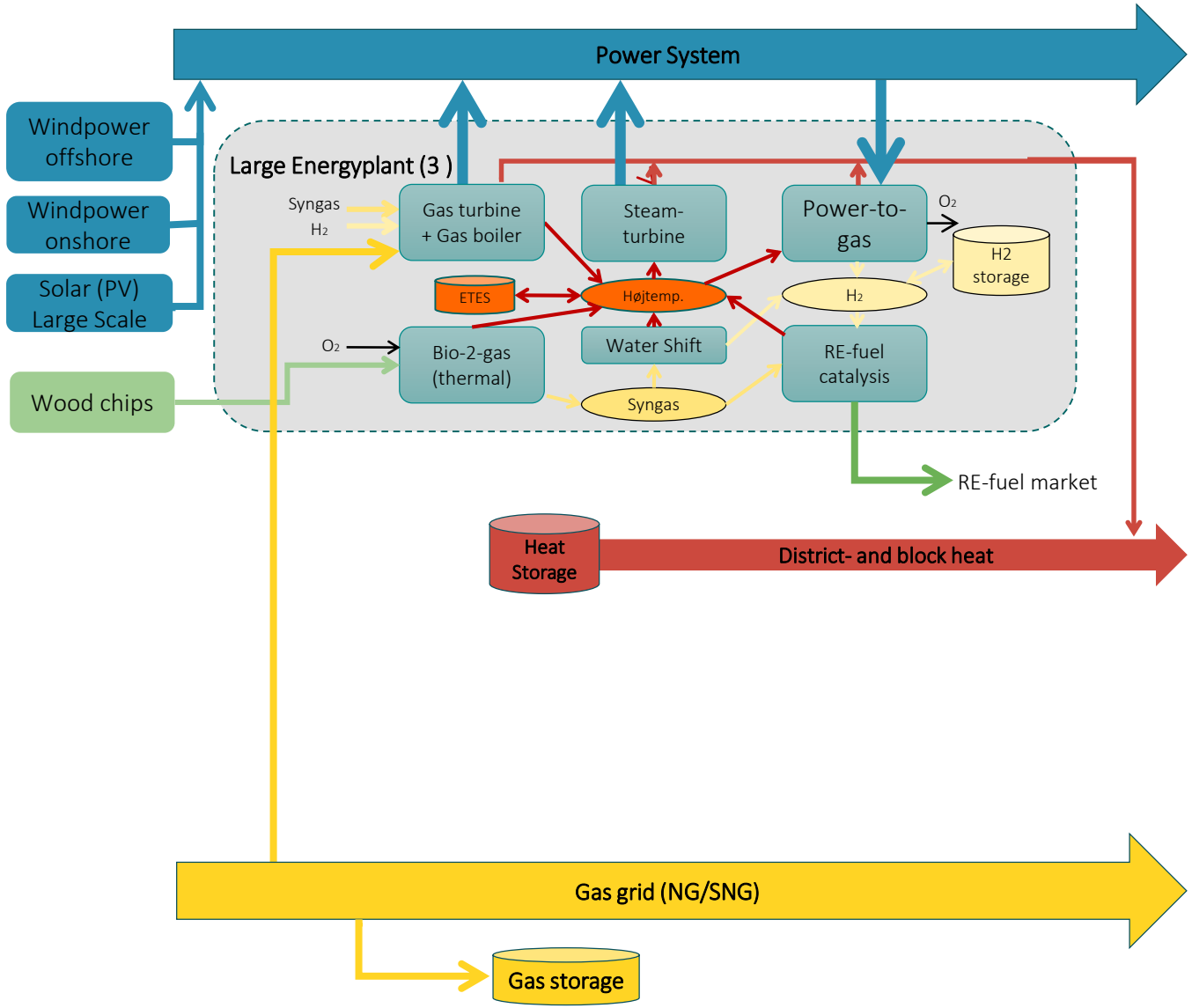


Distributed biogas/biofuel

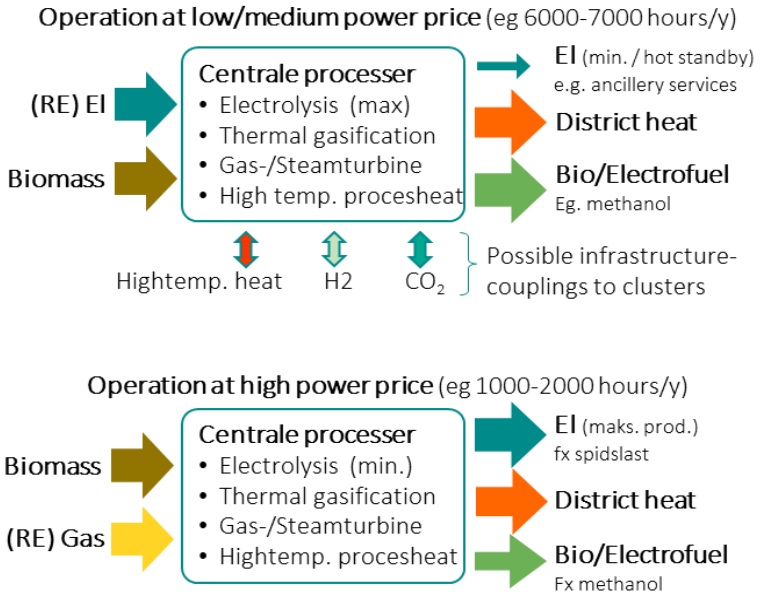
Distributed CHP/Heatpump

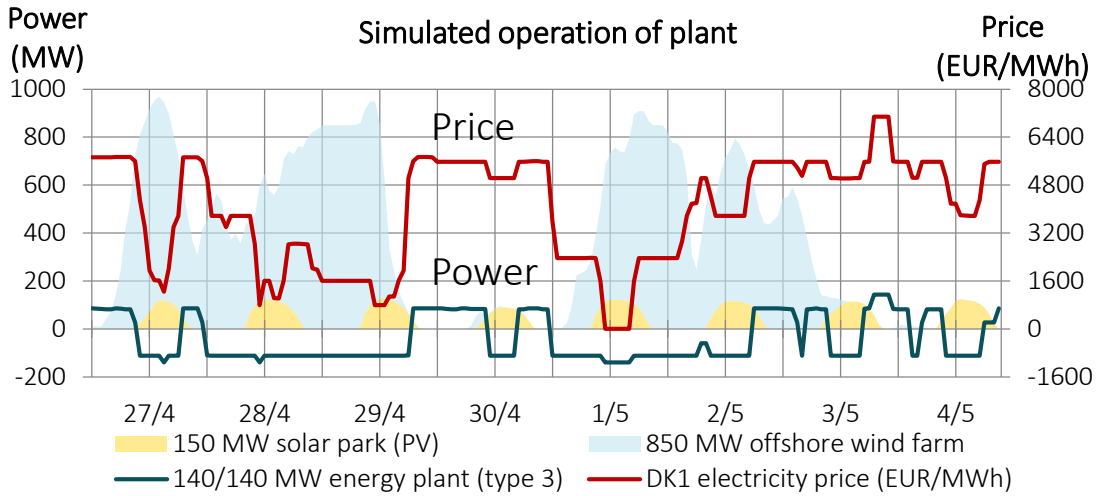
CASE SIMULATION OPTIMIZED PLANT GCA

ENERGINET

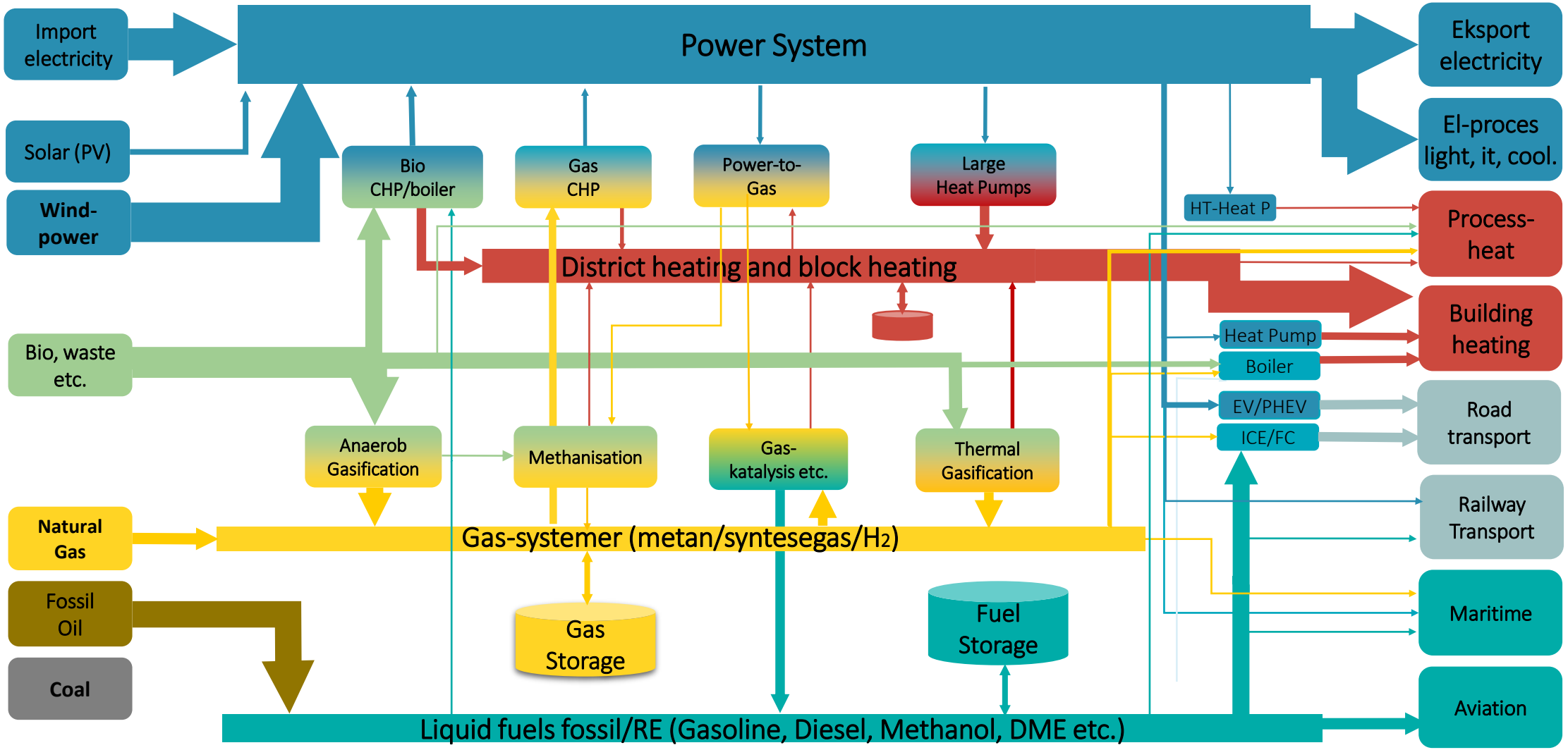


Principle illustration Energy plant

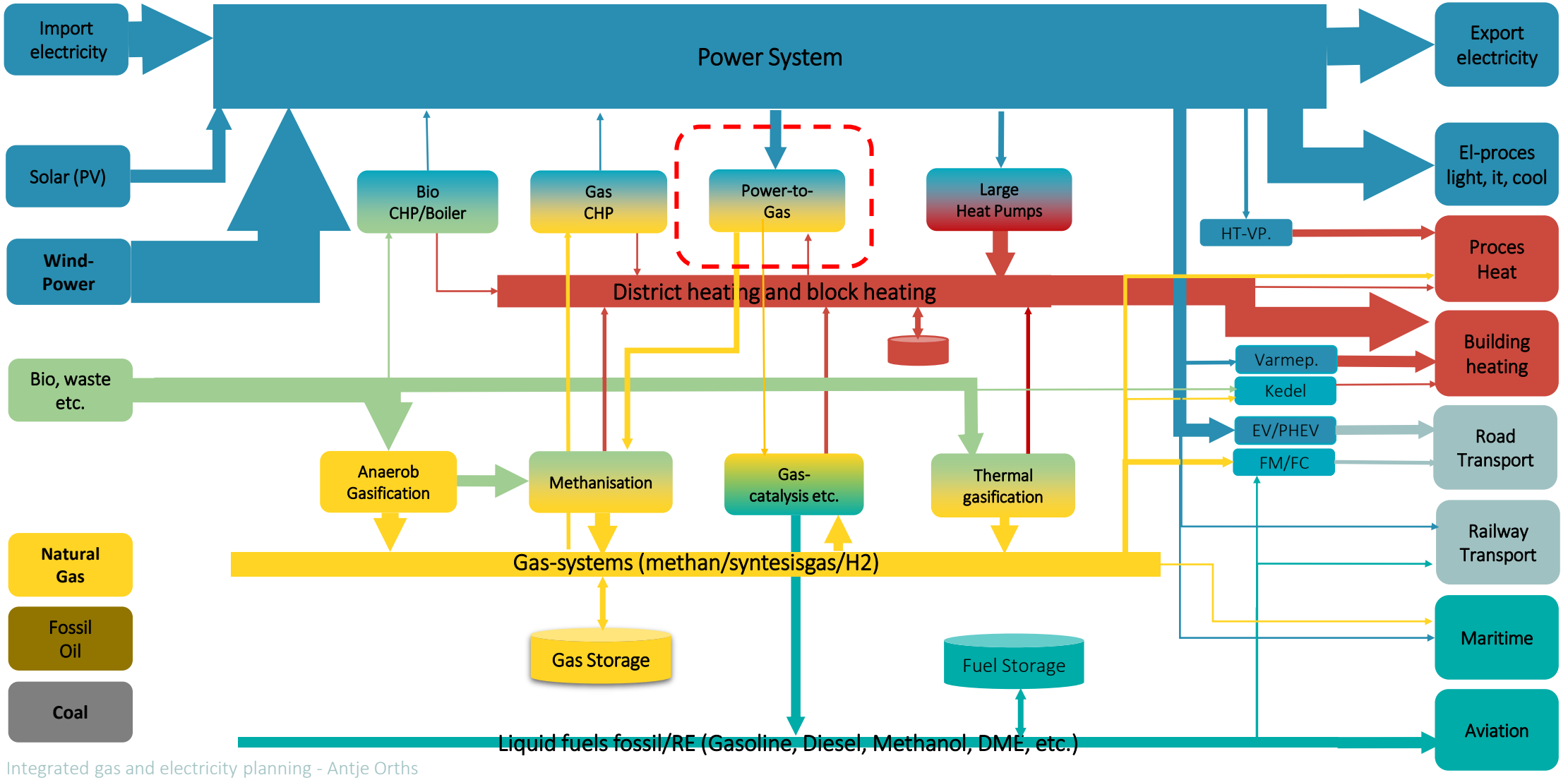




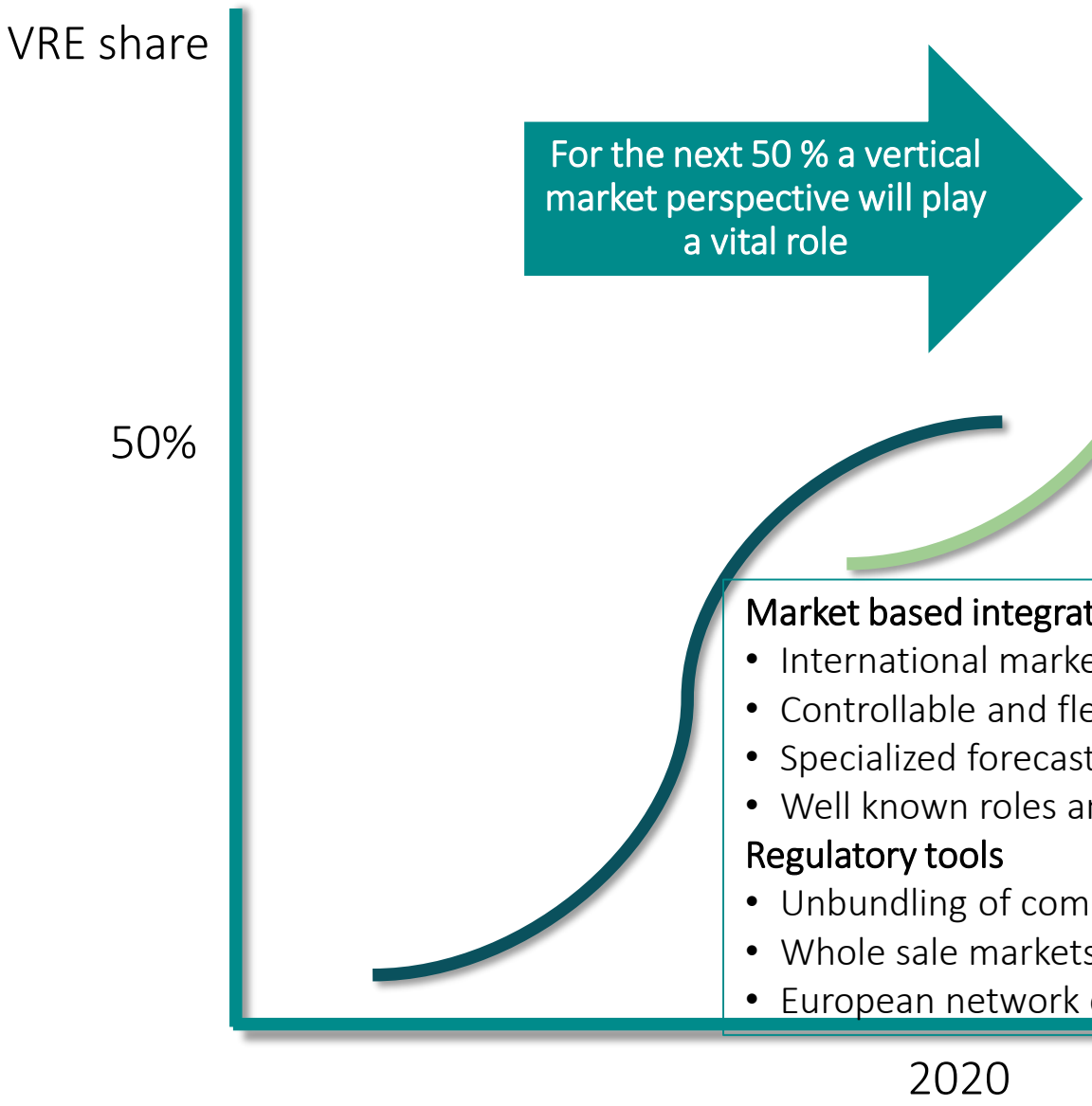
GCA 2035 – SIMULATED ANNUAL ENERGY FLOW I DENMARK



GCA 2050 – SIMULATED ANNUAL ENERGY FLOW I DENMARK



SUMMARY – TRAVELLING FROM 50% TO 100% VRE



For the next 50 % a vertical market perspective will play a vital role

Market based integration – horizontal

- International markets and strong transmission grids
- Controllable and flexible generation
- Specialized forecasting and operational planning tools
- Well known roles and business models

Regulatory tools

- Unbundling of companies
- Whole sale markets
- European network codes

Market based integration – vertical

- Sector Coupling
- Activation of demand side via decentralized markets
- New market players and business models
- Temporal integration – storage

Regulatory tools

- Deregulation of electricity market roles
- Retail markets
- Coupling of market places in supply sector
- Digital market processes – free data and low transaction costs

THANK YOU!

http://WWW.ENERGINET.DK/sys35

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