The need for market data and market solutions in the heating sector to obtain an efficient integration with the electricity market

Cities & AffaldVarme Aarhus & Aarhus University dept. of engineering

2017-01-12

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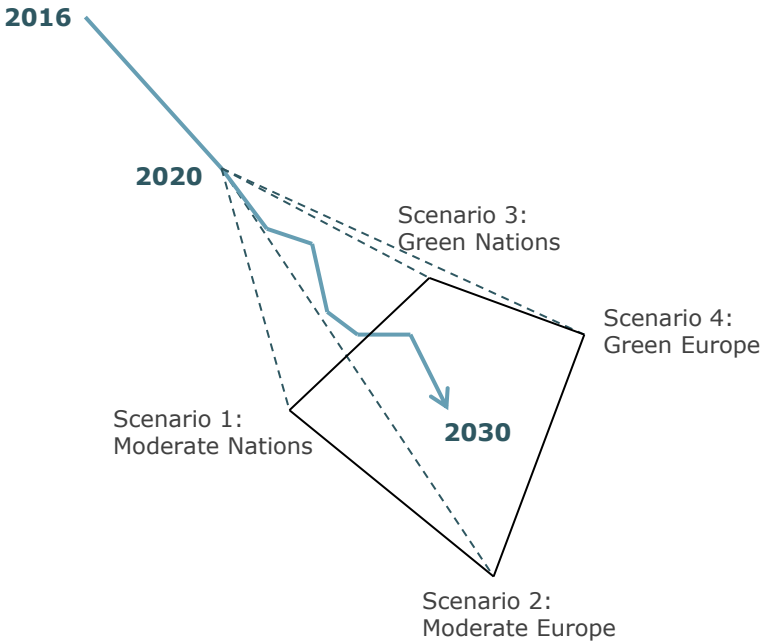
Agenda

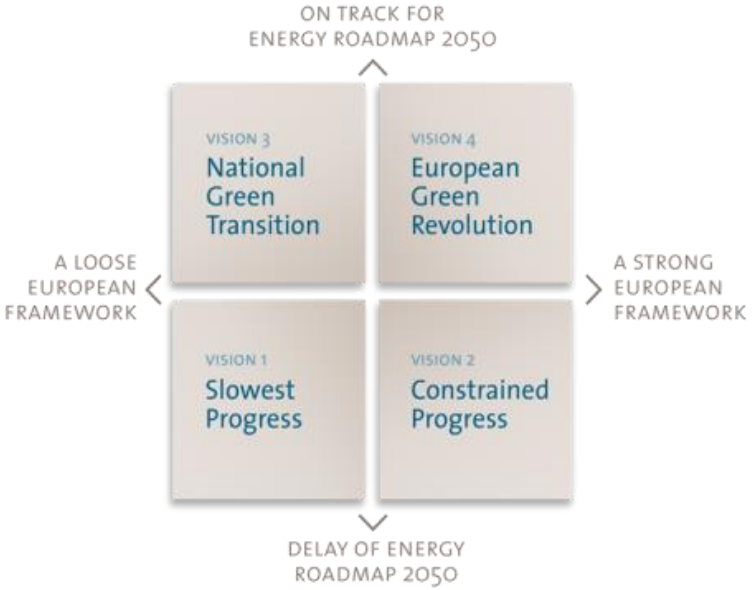
1. Framework conditions
   – scenarios for analysis of City solutions
2. Analysed Power-Heat-Gas-Fuel solutions (City)
3. Market solutions to control the system integration
4. The need for data in the heating system
5. Questions

Uncertainties in international framework conditions (fuel and CO2-prices, focus on green energy etc.)

- *A need for scenarios to handle uncertainties*

Scenarios – to cope with an uncertain future





Danish scenarios based on ENTSO-E European scenarios

Energinet.dk scenarios towards 2030

ENERGINET.DK

Scenario 3 – Green Nations

- Danmark showcase for transition towards ”Well below 2 degr.” target
- Low international cooperation but many countries are ambitios
- IEA 450 PPM price level (low fuel and high CO2 prices)

COP21 · CMP11
PARIS 2015

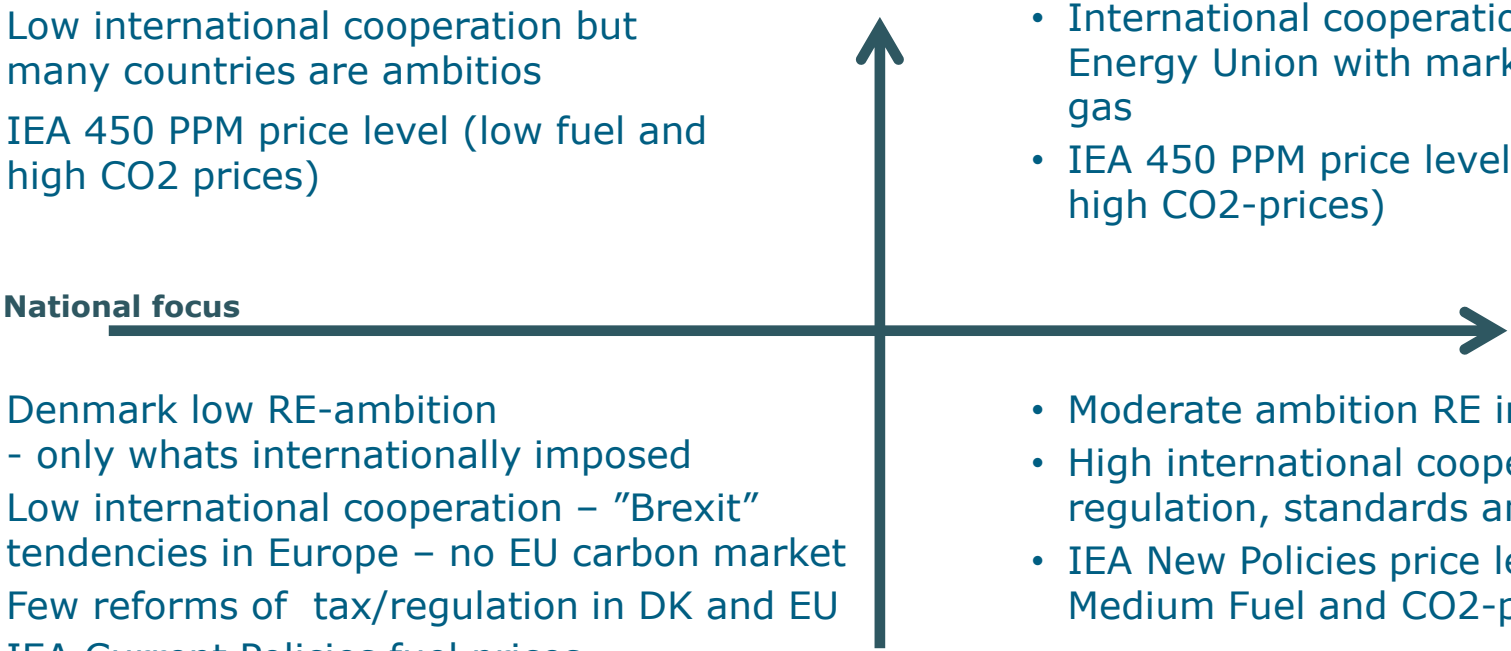
High focus RE

Scenario 4 – Green Europe

- EU showcase for Green transition (COP21) – Energy Union
- International cooperation in EU – Energy Union with markets for Green gas
- IEA 450 PPM price level (low fuel and high CO2-prices)

National focus

EU
Energy Union



- Denmark low RE-ambition
  - only whats internationally imposed
- Low international cooperation – ”Brexit” tendencies in Europe – no EU carbon market
- Few reforms of tax/regulation in DK and EU
- IEA Current Policies fuel prices
  - High fuel-prices and low CO2-prices

- Moderate ambition RE in EU and DK
- High international cooperation – EU regulation, standards and grid codes
- IEA New Policies price level Medium Fuel and CO2-prices

Low focus RE

Scenario 1 – Moderate Nations

Scenario 2 – Moderate Europe

Scenarios – power, heat and fuel production in scenarios

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Scenario 3 – Green Nations

- Traditional CHP units
- **Power/heat integrated biorefineries**
- Large heat pumps
- Individual heat pumps

Scenario 4 – Green Europe

- Traditional CHP units
- **Power/heat integrated biorefineries**
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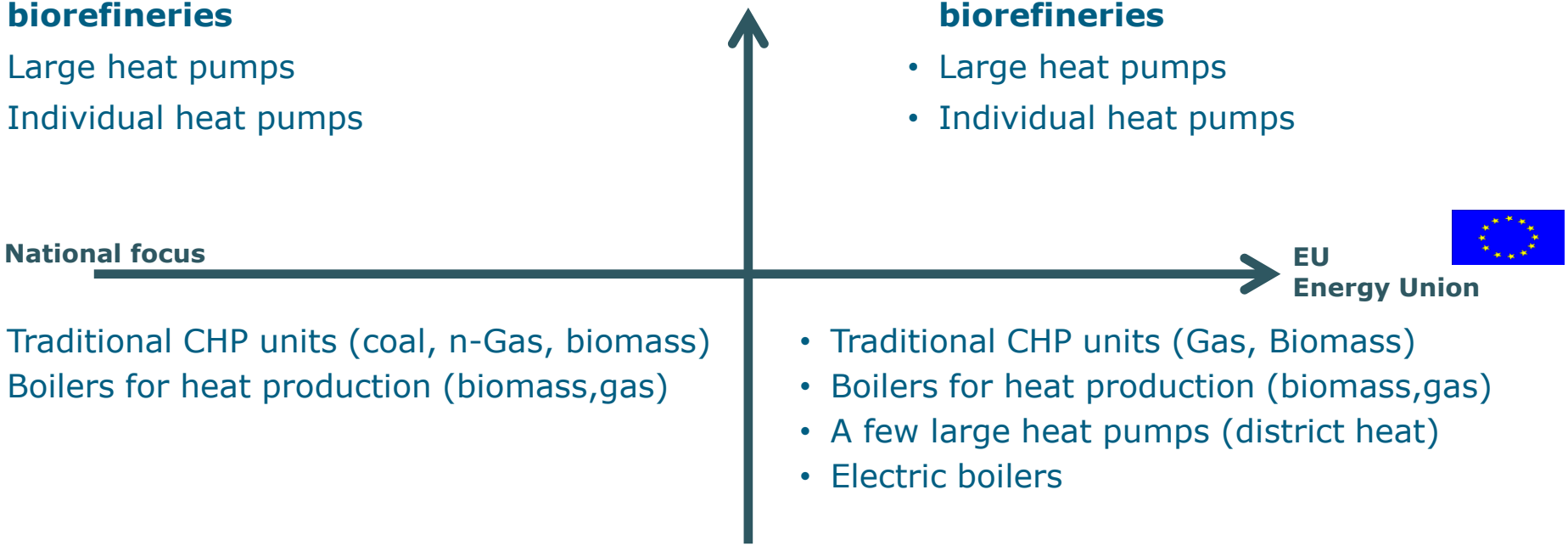
High focus RE

National focus

EU Energy Union



- Traditional CHP units (coal, n-Gas, biomass)
- Boilers for heat production (biomass,gas)

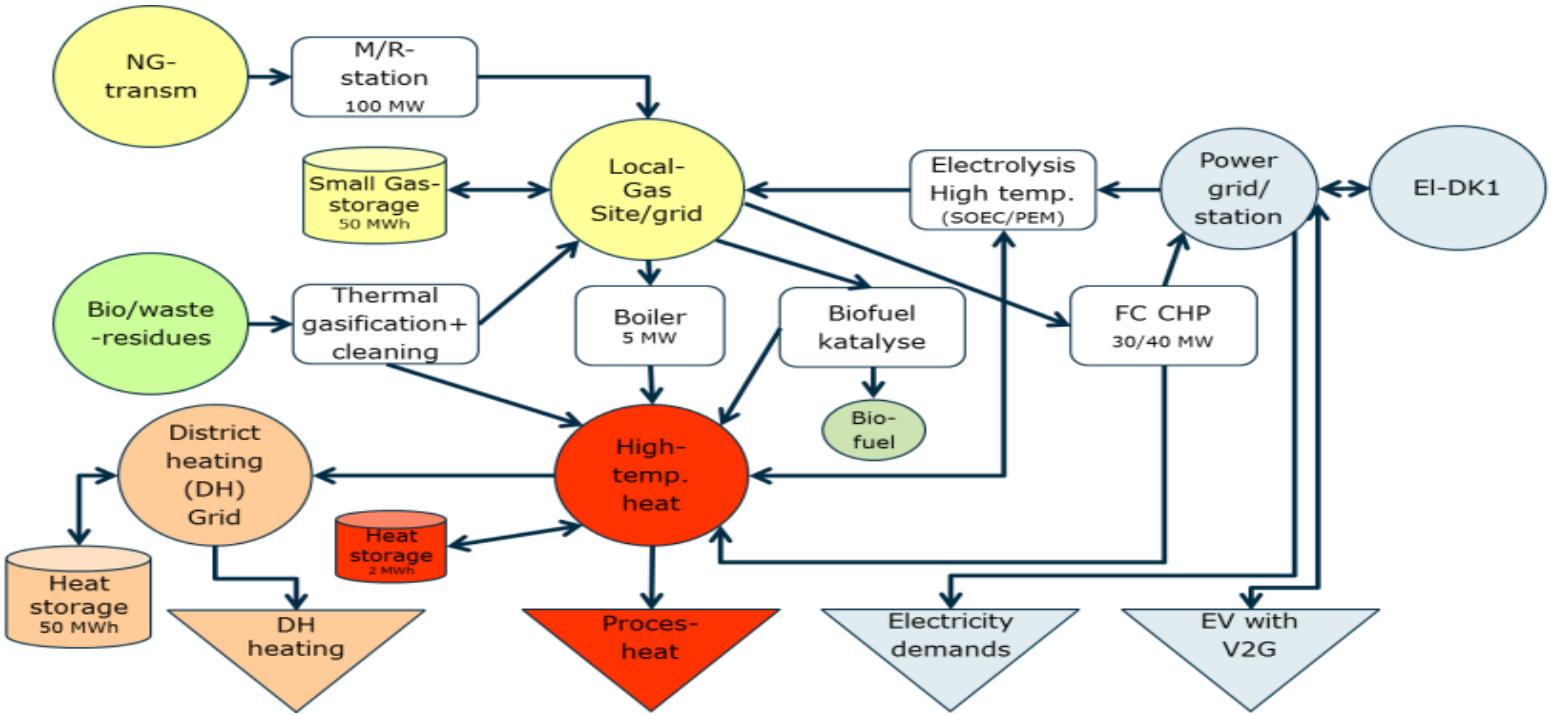
- Traditional CHP units (Gas, Biomass)
- Boilers for heat production (biomass,gas)
- A few large heat pumps (district heat)
- Electric boilers

Low focus RE

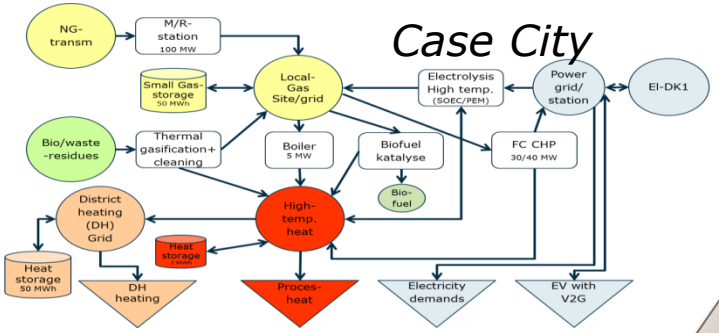
Scenario 1 – Moderate Nations

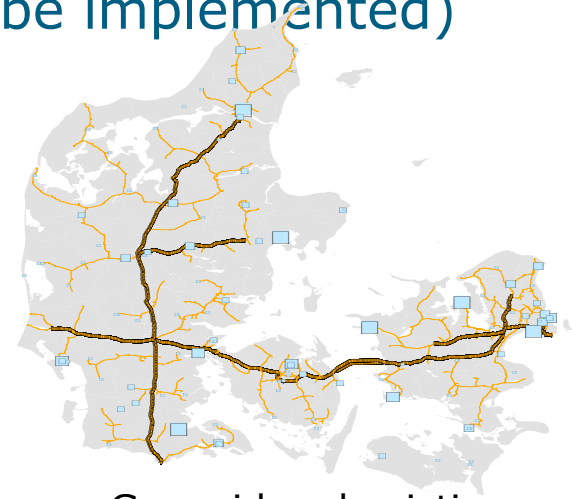
Scenario 2 – Moderate Europe

Example on power/heat bio refinery (case 2035)



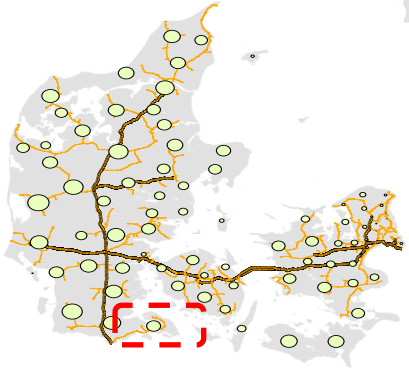
From case ”Cities” to national solutions (to be implemented)



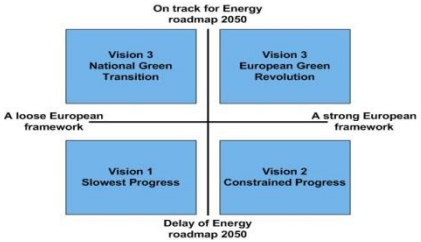


Gas grid and existing
Power plant capacity

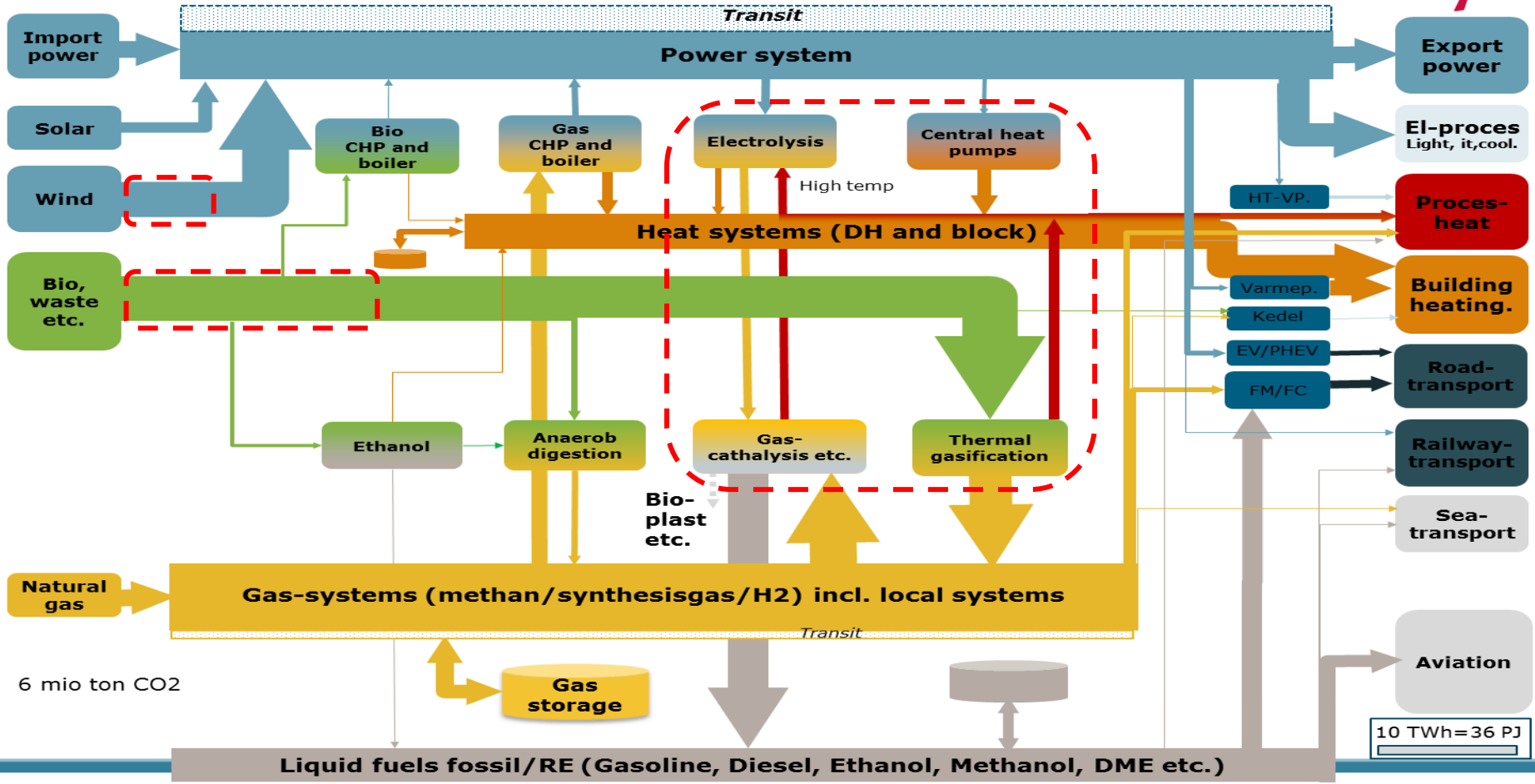
Heat demands



Biogas ressources



Post 2030 - feasibility study 2035 – reduced fossil oil demand



Feasibility study 2035+ – reduced fossil oil demand

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Import power

Solar

Wind

Bio, waste etc.

Natural gas

Transit

Power system

Export power

Bio

Gas

Central heat

El-proces

Transit

Gas storage

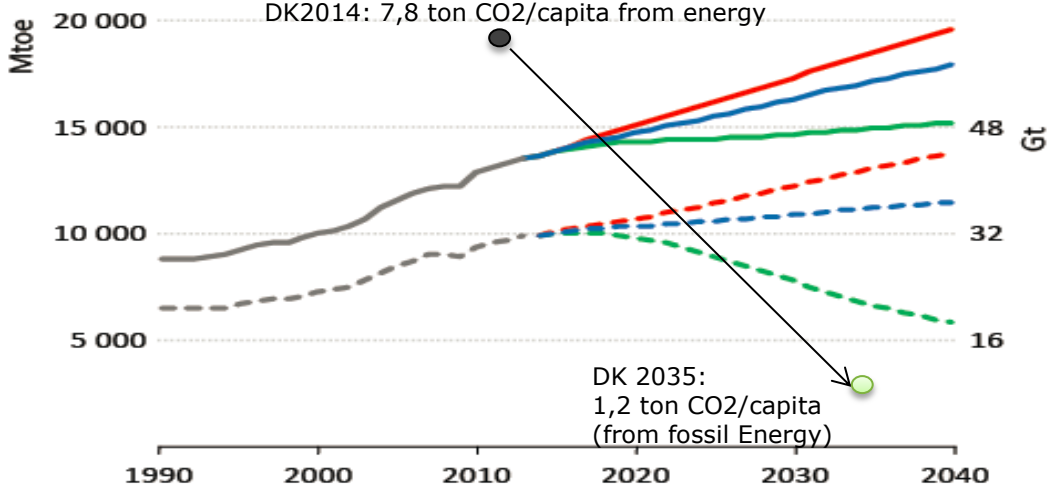
Aviation

10 TWh=36 PJ

Liquid fuels fossil/RE (Gasoline, Diesel, Ethanol, Methanol, DME etc.)

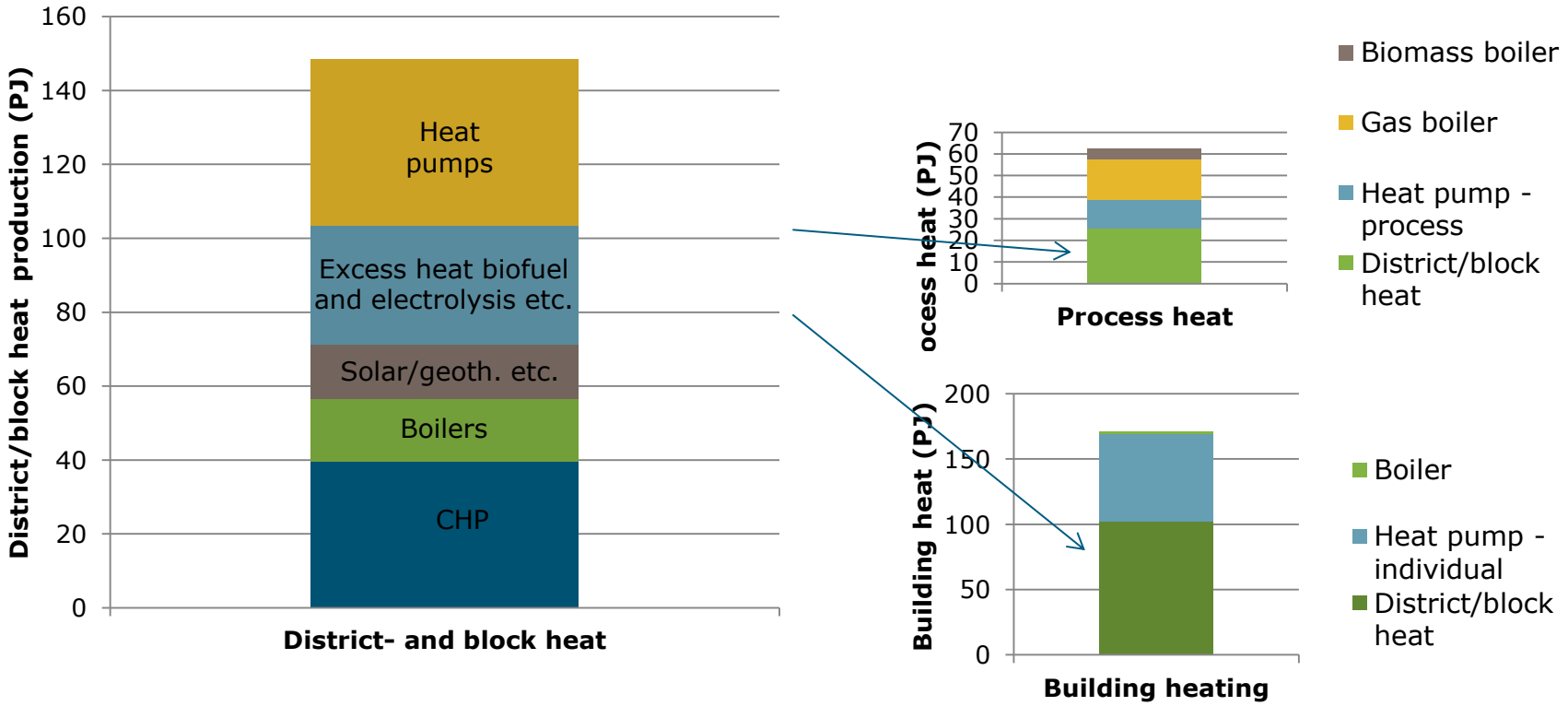
6 mio ton CO2

Figure 2.1 ▷ World primary energy demand and CO_2 emissions by scenario

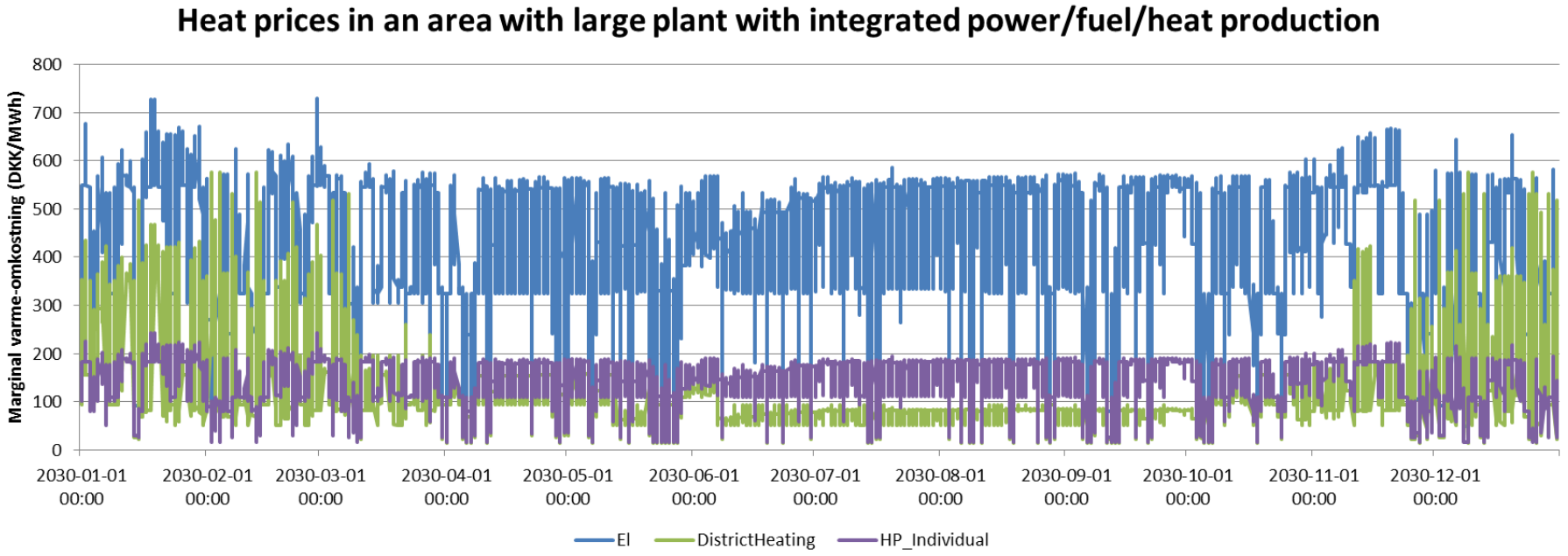


Case with straw used for biogas

Production and consumption of heat – case study 2035+



Examples of heat and power prices in a 2035 case simulation ! (large plant with integrated power/heat/Fuel production)



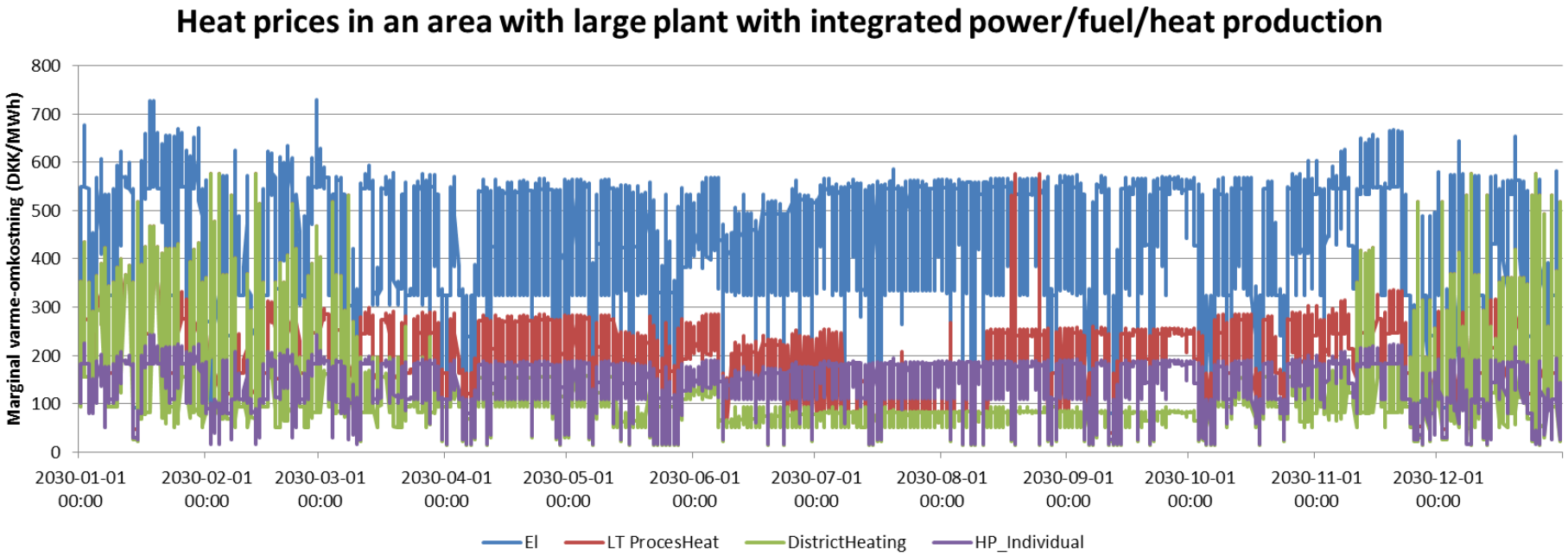
Individual climate units to produce heat in hours with low electricity prices ?

Some questions

- Use of local climate units (heat pumps/cooling) integrated with DH
- Delivery from commercial buildings with cooling units

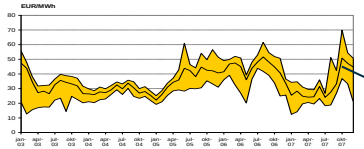
- Delivery of heat to DH ?
  - Need for data
  - Marginal price/value at delivery point
  - Temperature levels for delivery at DH point and value of delivery
- Market solutions to integrate power and heat
- Use of big data technology on DH data collection to identify
- How to combine ”2016” metered data with Scenario 2030 data ?

Examples of heat and power prices in a 2035 case simulation ! (large plant with integrated power/heat/Fuel production)



A need for a market solutions in heat and power to handle fluctuating prices

Analysis of Energy System dynamics
- including power TSO/DSO (and potentially heat market)



Day-ahead

System-balance (e.g. 5 min)

Reg.

DSO D-LMP

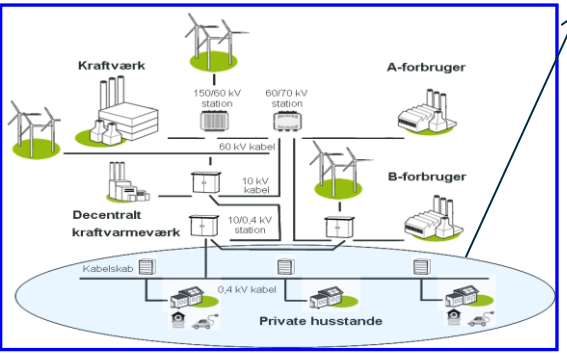
Reg.

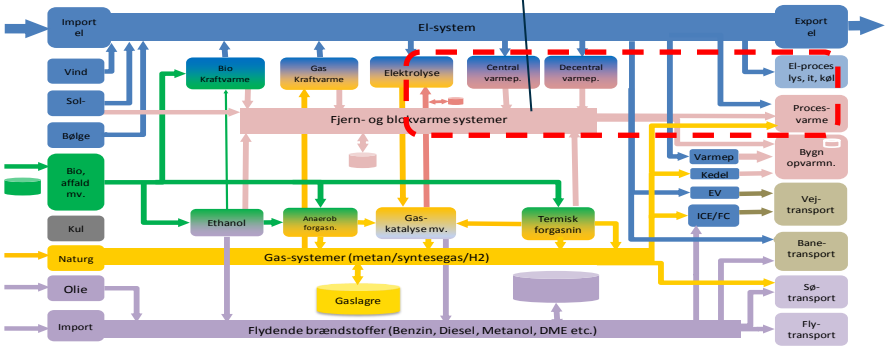
Energy conversion units
- Electric vehicles
- Heat pumps/Climate units
- Other flexible units

G_1

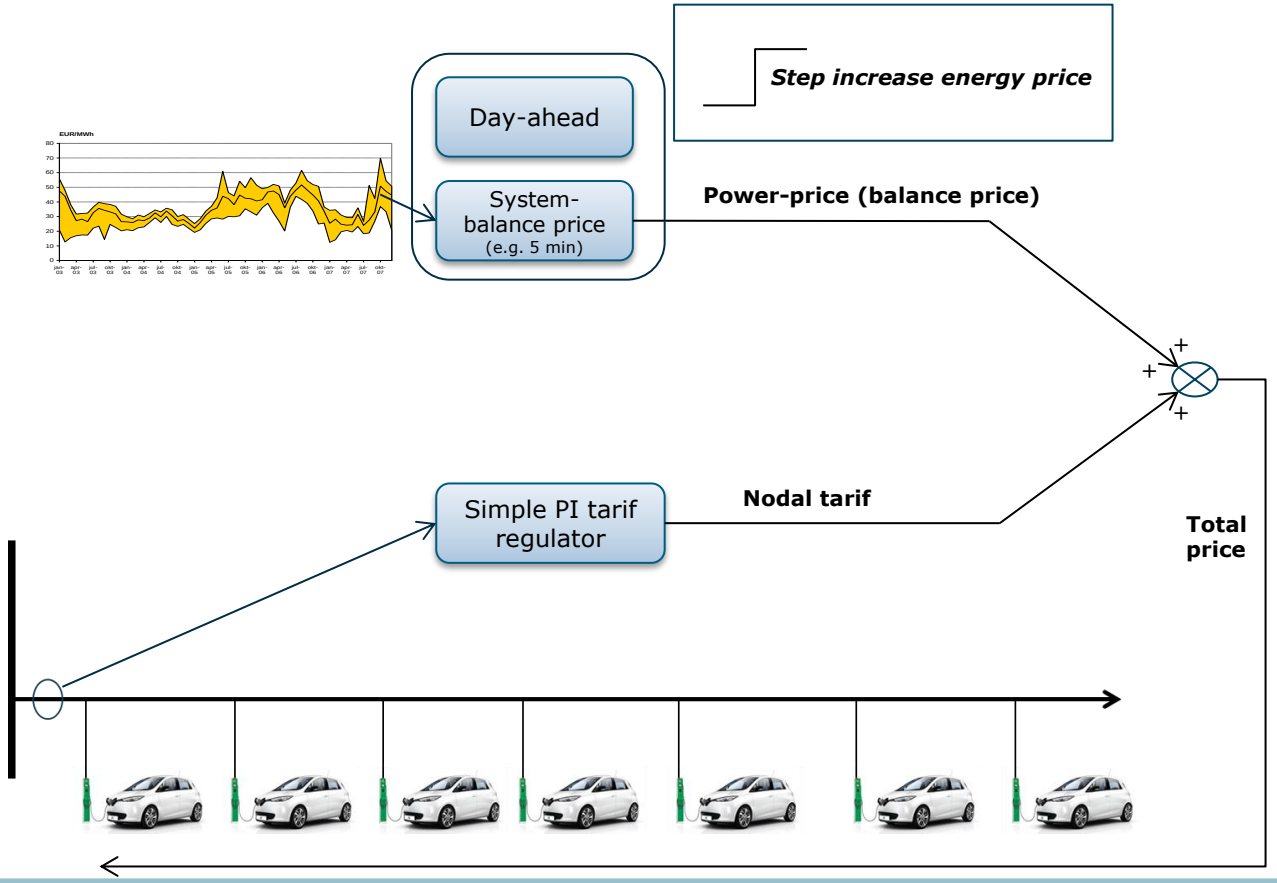
G_2

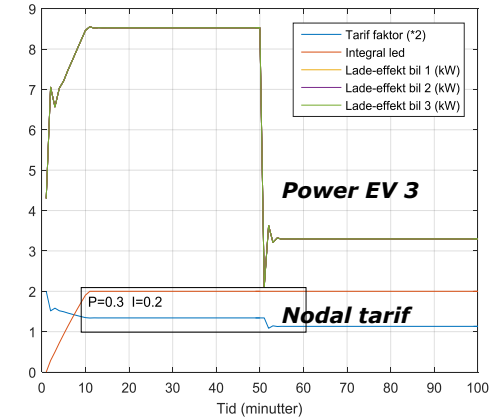
G_n

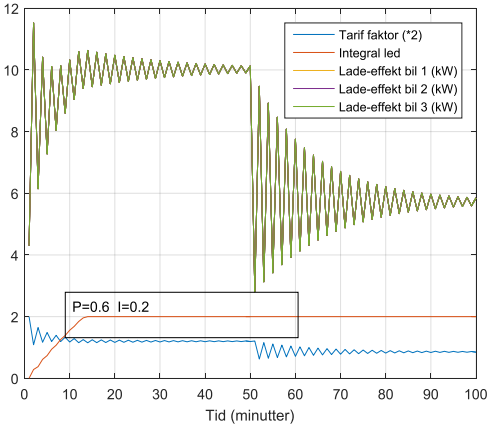




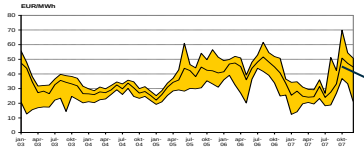
Analysis of Energy System dynamics – step response







Analysis of Energy System dynamics
- including power TSO/DSO (and potentially heat market)



Day-ahead

System-balance (e.g. 5 min)

C

MPC input ?

System identification (Data mining, AI)

MPC input ?

C

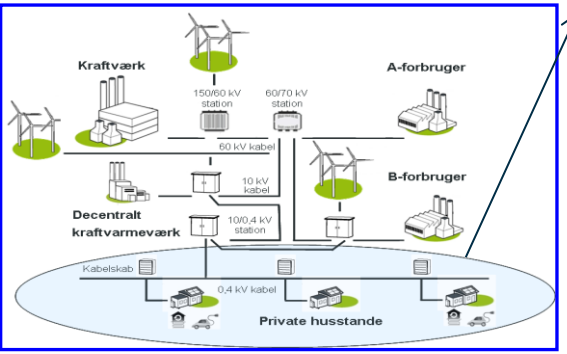
DSO D-LMP

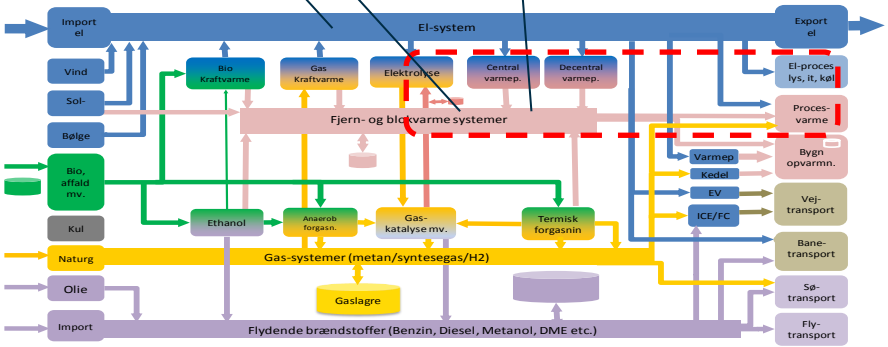
Energy conversion units
- Electric vehicles
- Heat pumps/Climate units
- Other flexible units

G_1

G_2

G_n





Summing up

- In the high RE scenarios (3,4) there is a number of energy conversion processes (bio-to-fuel, power-to-gas, CHP) producing waste heat
- Production price (marginal) for power, heat and gas-price are fluctuating
- There is a need for an intelligent heating system with dynamic pricing for heat (high/low temperature)
- Big data methodology, data-mining and AI could lead to deeper knowledge on system response related to state-parameters in the heating system
- The knowledge form system-identification could be used to controlling/market solutions in power and heat systems (E-MPC etc.)

Thank you for attention
Link: www.energinet.dk/energianalyser