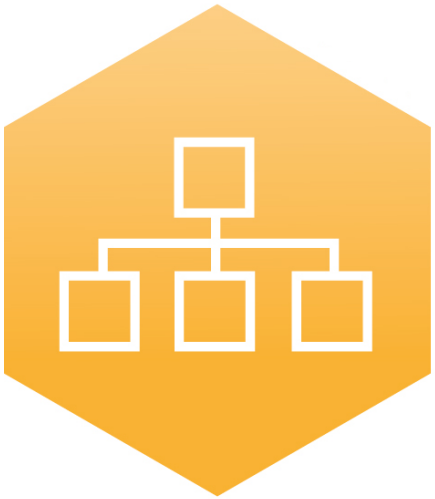
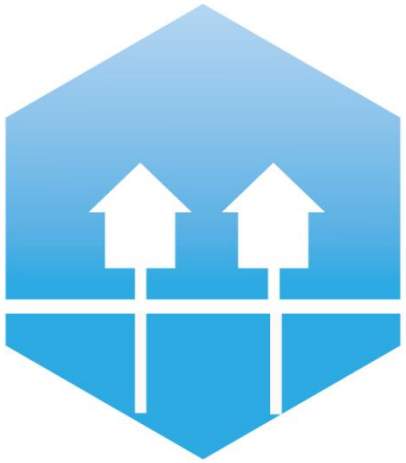
International Conference on Smart Energy Systems and 4th Generation District Heating
Copenhagen, 25-26 August 2015

Energy system integration with efficient use of high temperature excess heat





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4DH
4th Generation District Heating
Technologies and Systems

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A total system analysis

– Towards a competitive energy system based on renewables

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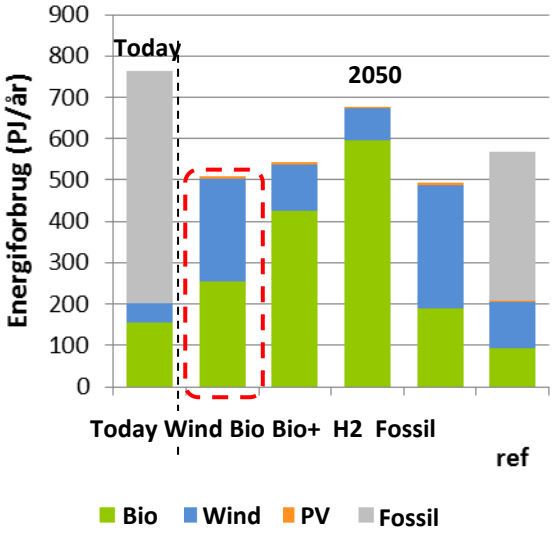
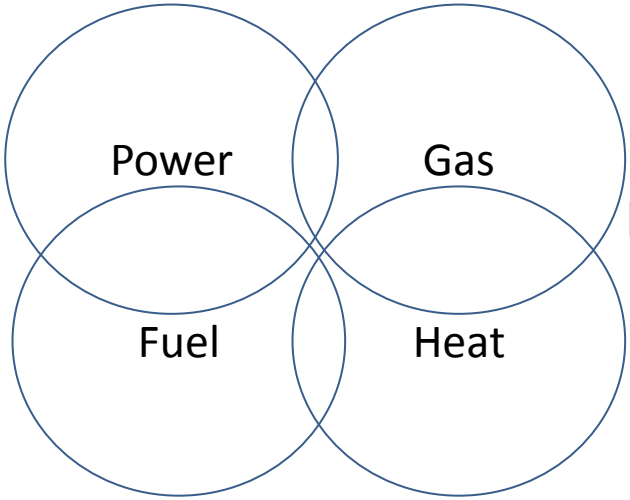
Energy ressources

Energy system

Energy services





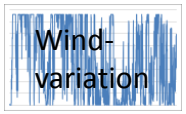
- ❑ Heating
- ❑ Proces heat
- ❑ Electrical services
  (Light, cooling, it, proces etc.)
- ❑ Transport

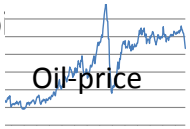
- ***System development towards a fossil free system is analysed***
- ***In wind scenario a sustainable amount of biomass is estimated as the national bio- and waste ressources***

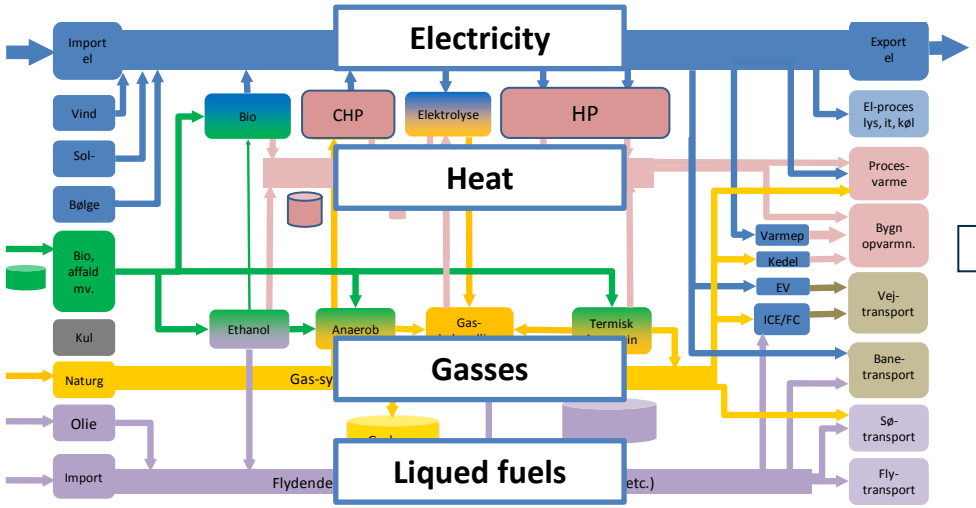
Energy system performance evaluated by simulation

Energy ressource → **Energy system** → **Energy service**

- Wind
- Solar
- Biomass
- Natural gas
- Fossil o
- Coal
- Etc…







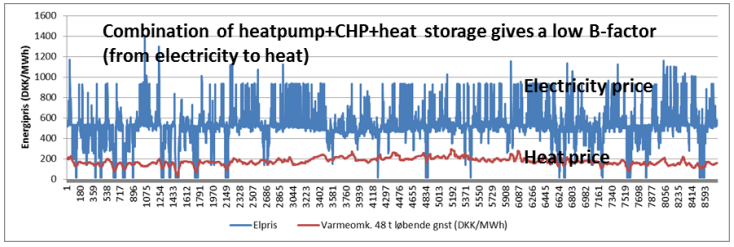
- Building heating
- Proces-heat
- Cooling
- Light, IT etc.
- Transport

Total performance for system evaluated. (technical and economical)

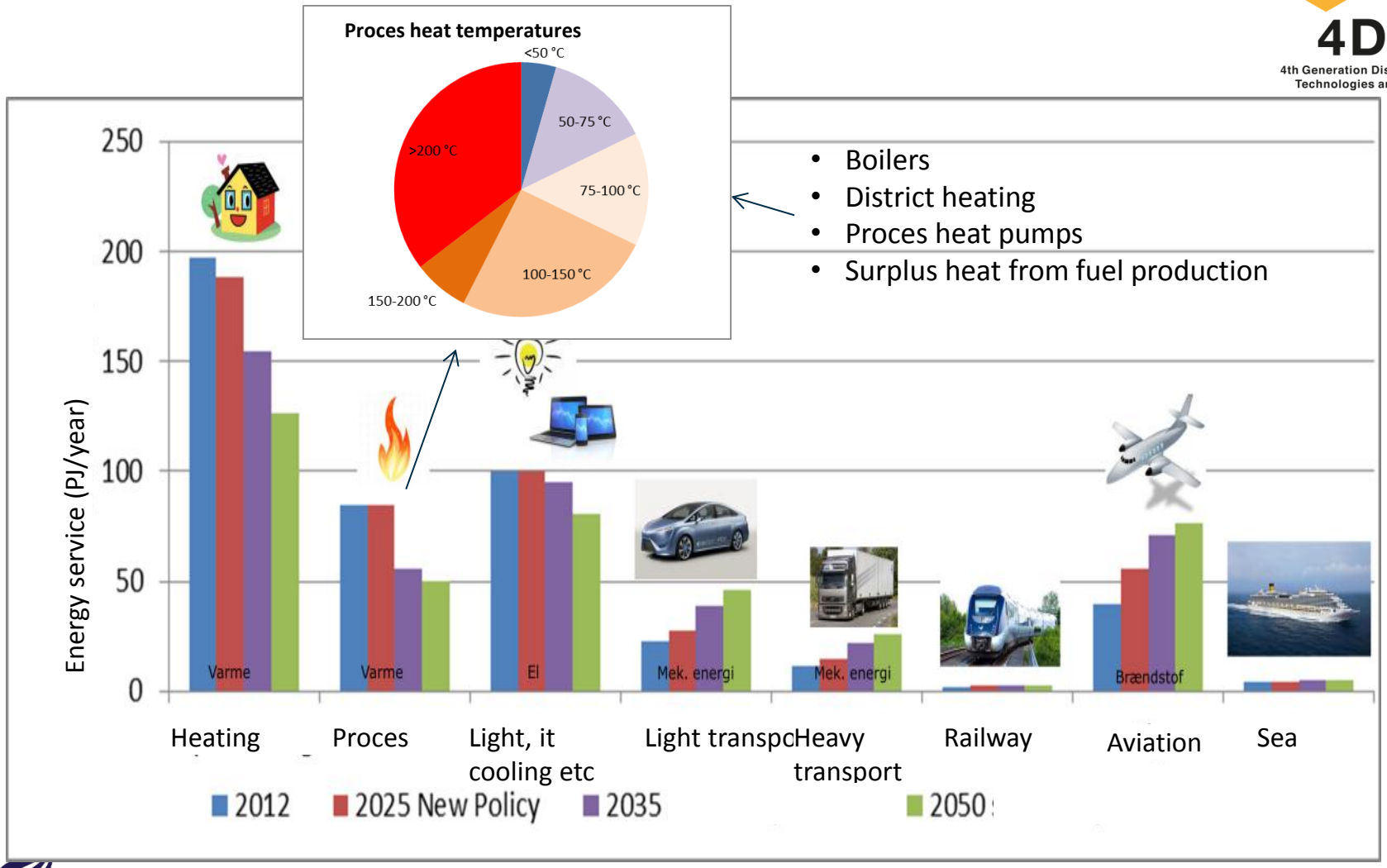
System property to "**damp**" step on ressource prices *(low β-faktors)*

Price inkl. hedging = Price excl. hedging + Price hedging

= Price exc. hedging + β_n x (Ressource price hedging– Ressource price excl. hedging)

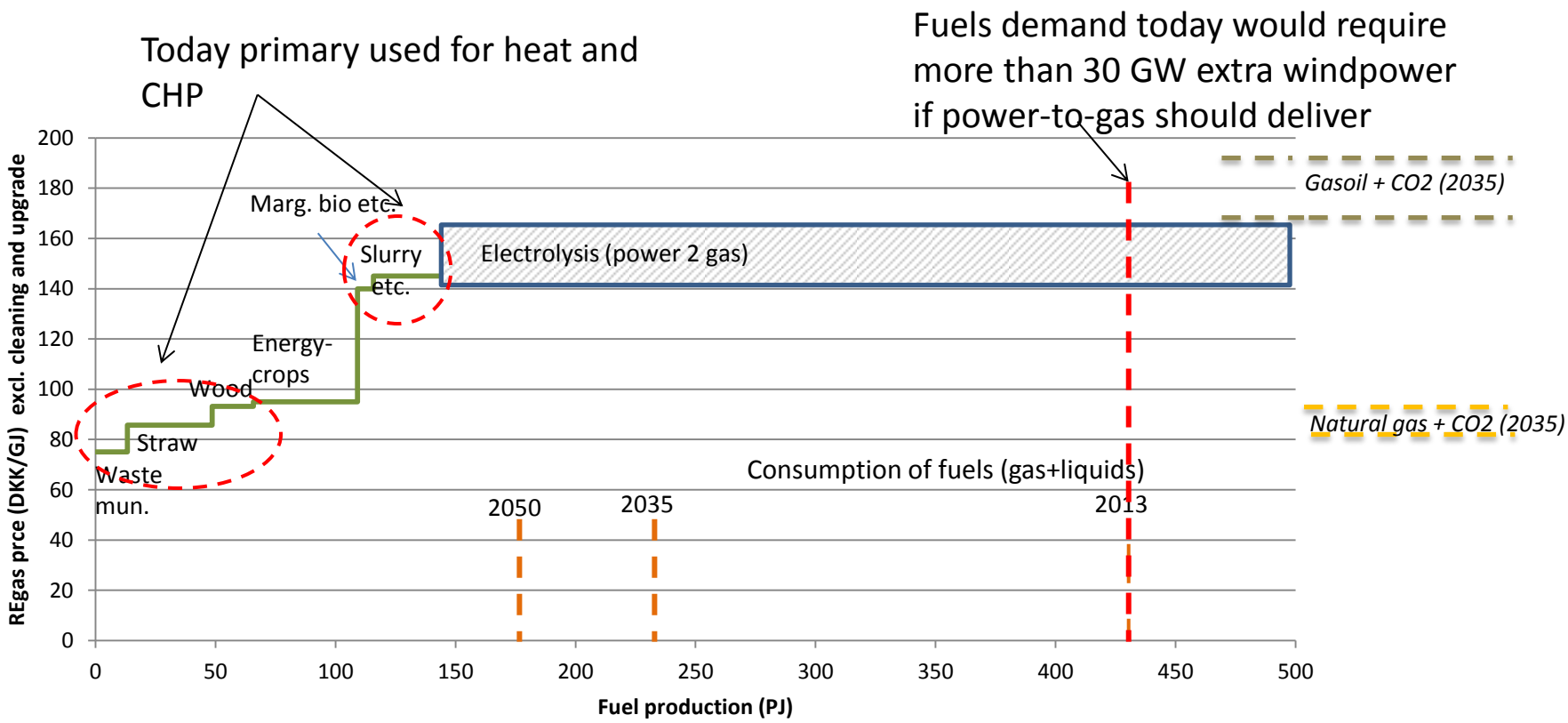


Energy services – towards 2025, 2035 and 2050



Ressources and cost for fuels

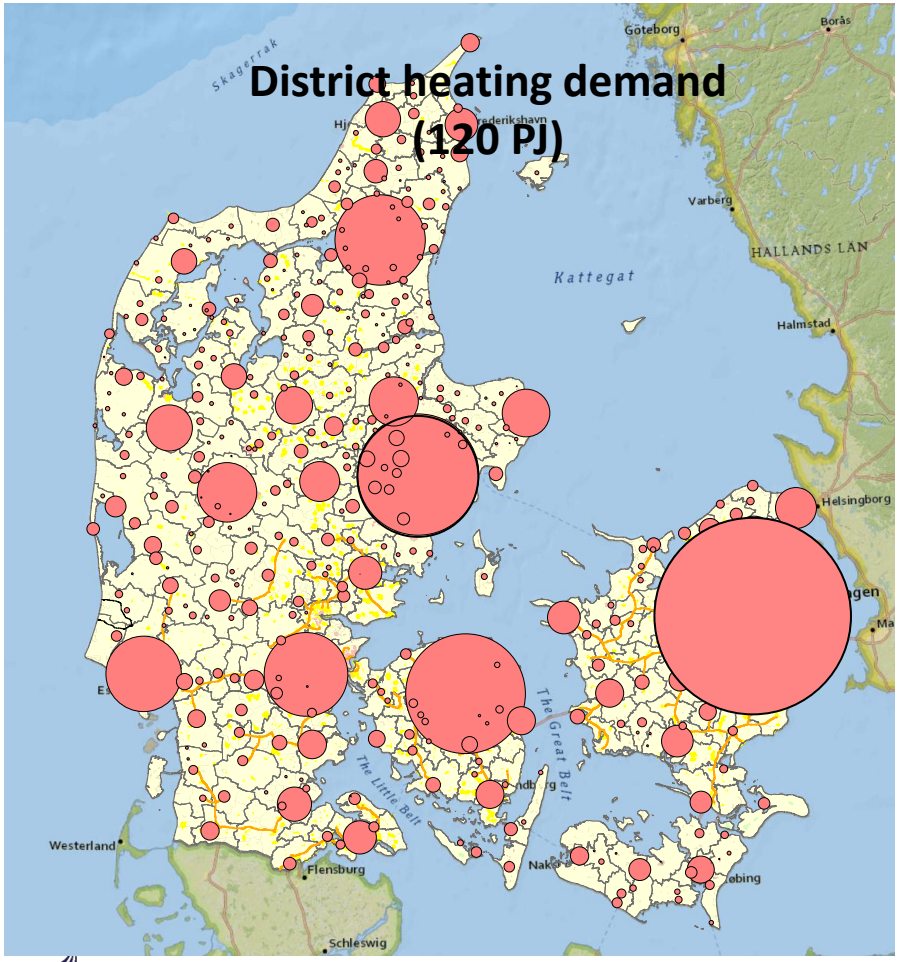
(2030 if all biomass is allocated to fuels)



A significant demand for fuels – biomass is essential for producing high amount of fuels

Integration with heat is essential

- building heating and proces heat



Sector	Total	Low and medium high temp proces (PJ)	Very high temp (PJ)
Cement	9116	5782	3329
Agriculture	7961	5840	183
Milk products	3330	2769	0
Paint and soap	3081	2778	0
Mining and quarrying	2850	2375	164
Sugar	2733	2455	0
Wood	2724	2041	93
Green houses etc.	2601	2172	0
Concrete, bricks etc.	2291	1512	472
Food/slaughterhouses	1848	1207	471
Paper	1784	1602	0
Mineral wool	1670	0	1666
Other food	1636	1235	201
Metal	1470	0	1448
Bitumen etc.	1331	1317	0
Tiles/bricks etc.	1310	375	935
Beverages	1309	1153	0
Bakery	1287	1212	0
Medicin	1258	1039	0
Glass and ceramics	1250	158	1066
Feed production	1160	1160	0
Furniture	1086	283	0
Fish industry etc.	1022	963	0
Metal products	955	402	330
Enzymes and fertilizers	671	505	59
Basic chemicals	527	442	0

RE-gas as feedstock for fuels etc.

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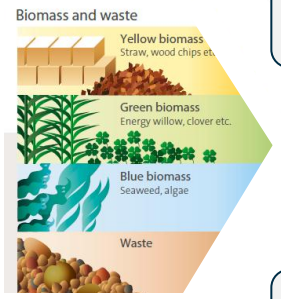


RE-gas

Biogas Anaerob

Methan

H_2O

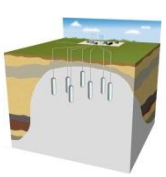
400-600 °C

>500 °C

Thermal gasification

Electrolysis *Alkal./SOEC*

Syntesis gas



Power/heat
Industry
Transport
etc.

200-300 °C Methanol

200-300 °C DME

>200 °C Synt. Gasoline/ diesel

Hydrogen

Transport
Industry
etc.

PE plast etc.

>500 °C Fertilizer

Legend:
CH4
H2
CO

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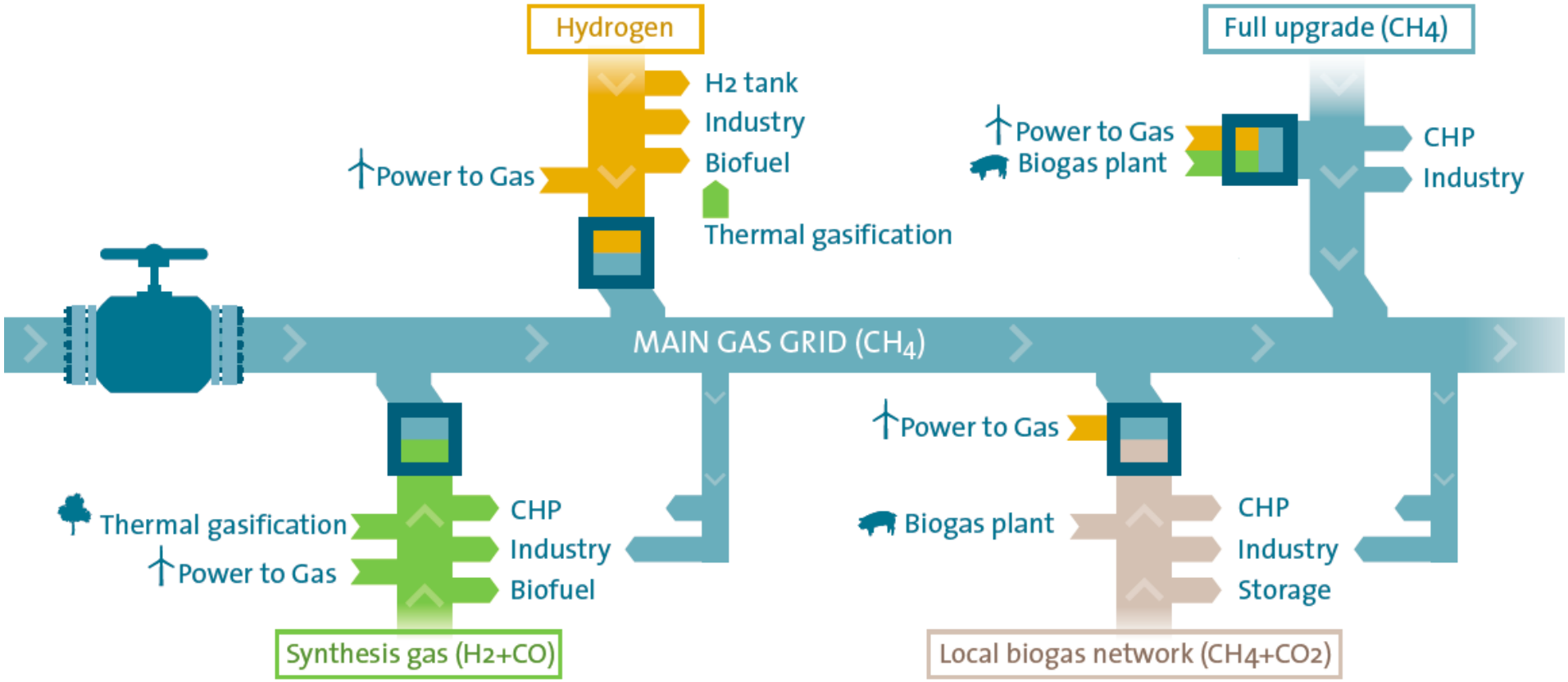
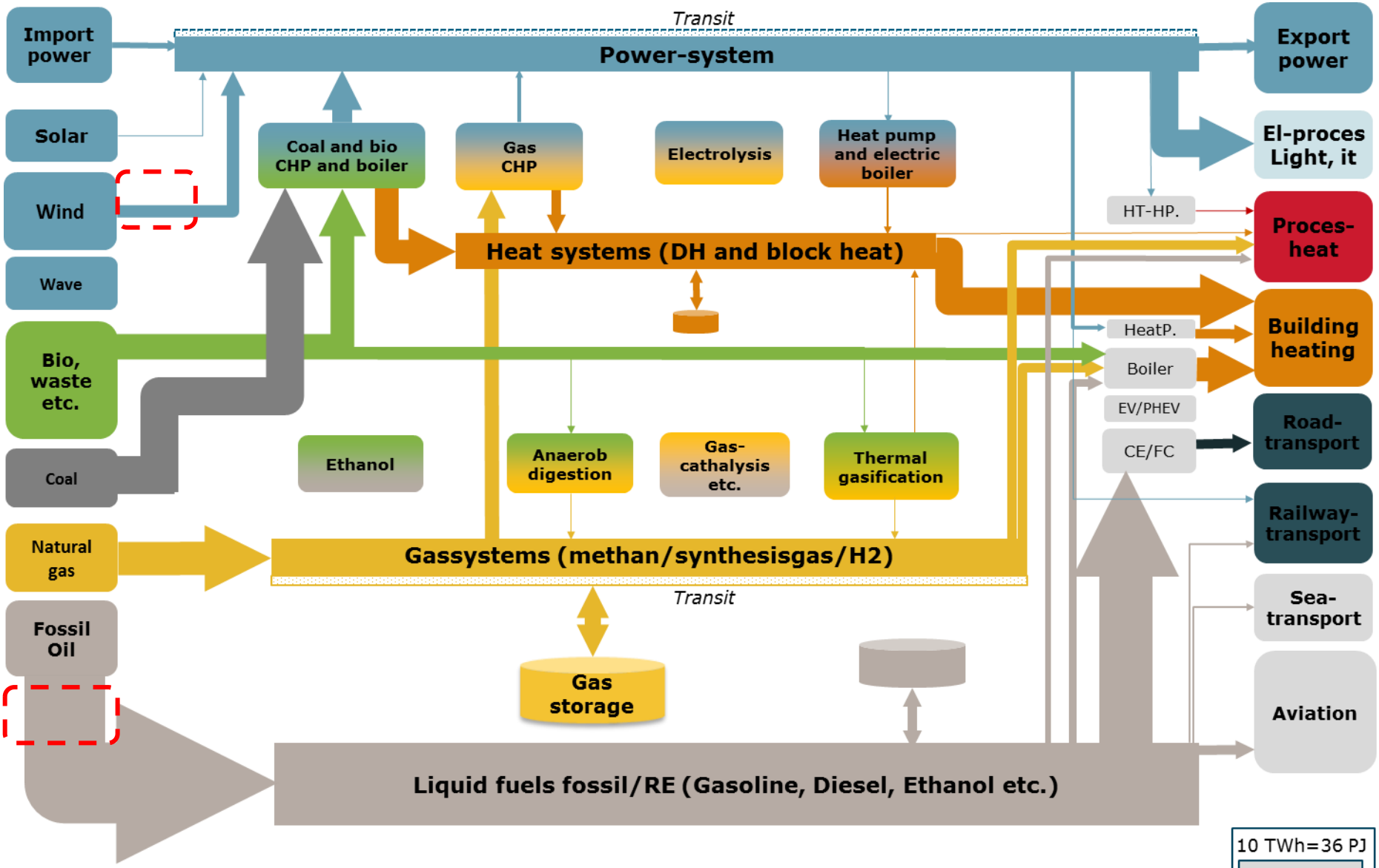
Integration of local and national gas-system

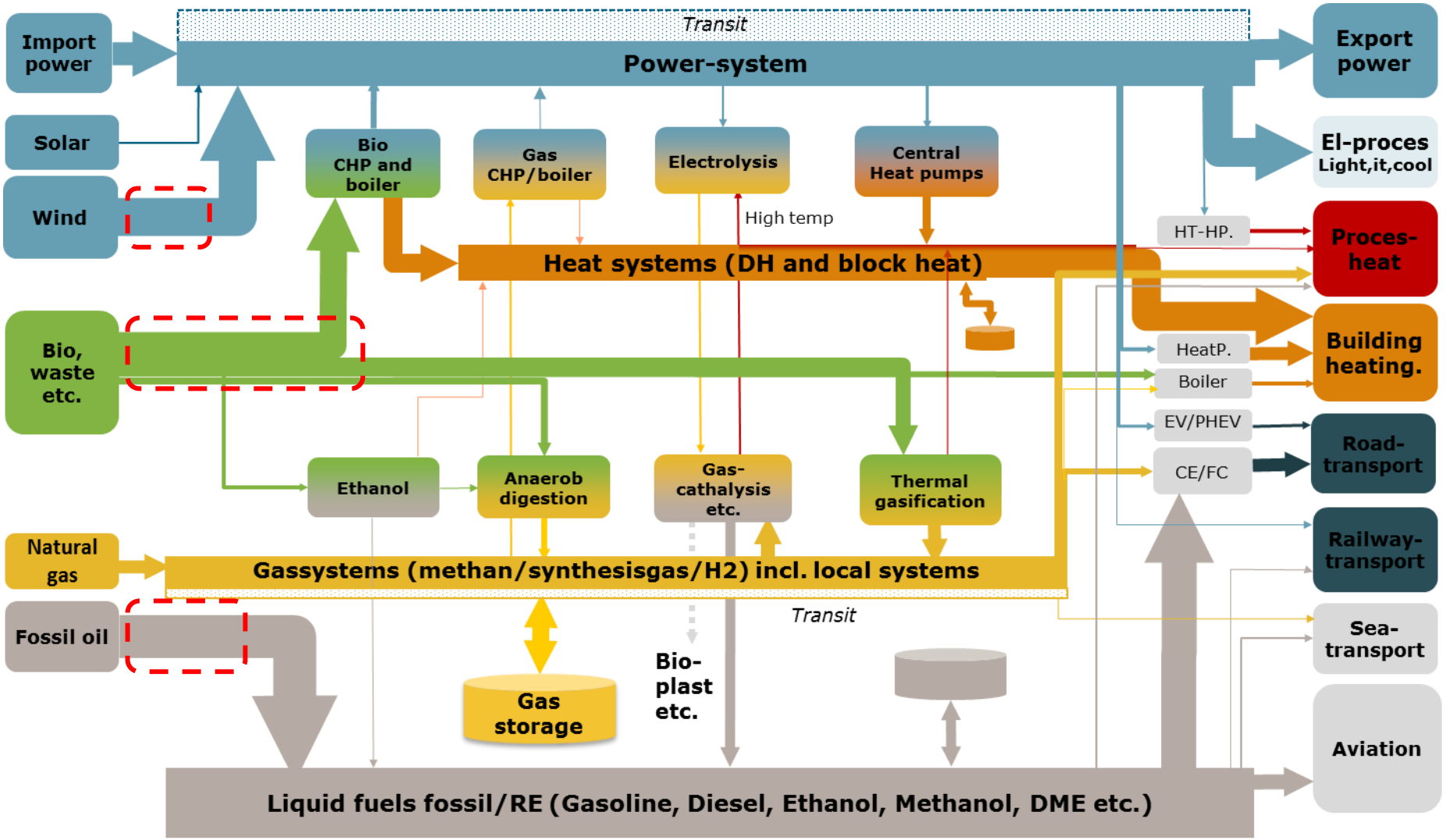


New types of RE gasses to be integrated – essential to handle sub-nets with other gas-specification

Energy flow - 2014



2035 - Reference with fossil free power and heat system



14 mio ton CO2

10 TWh=36 PJ

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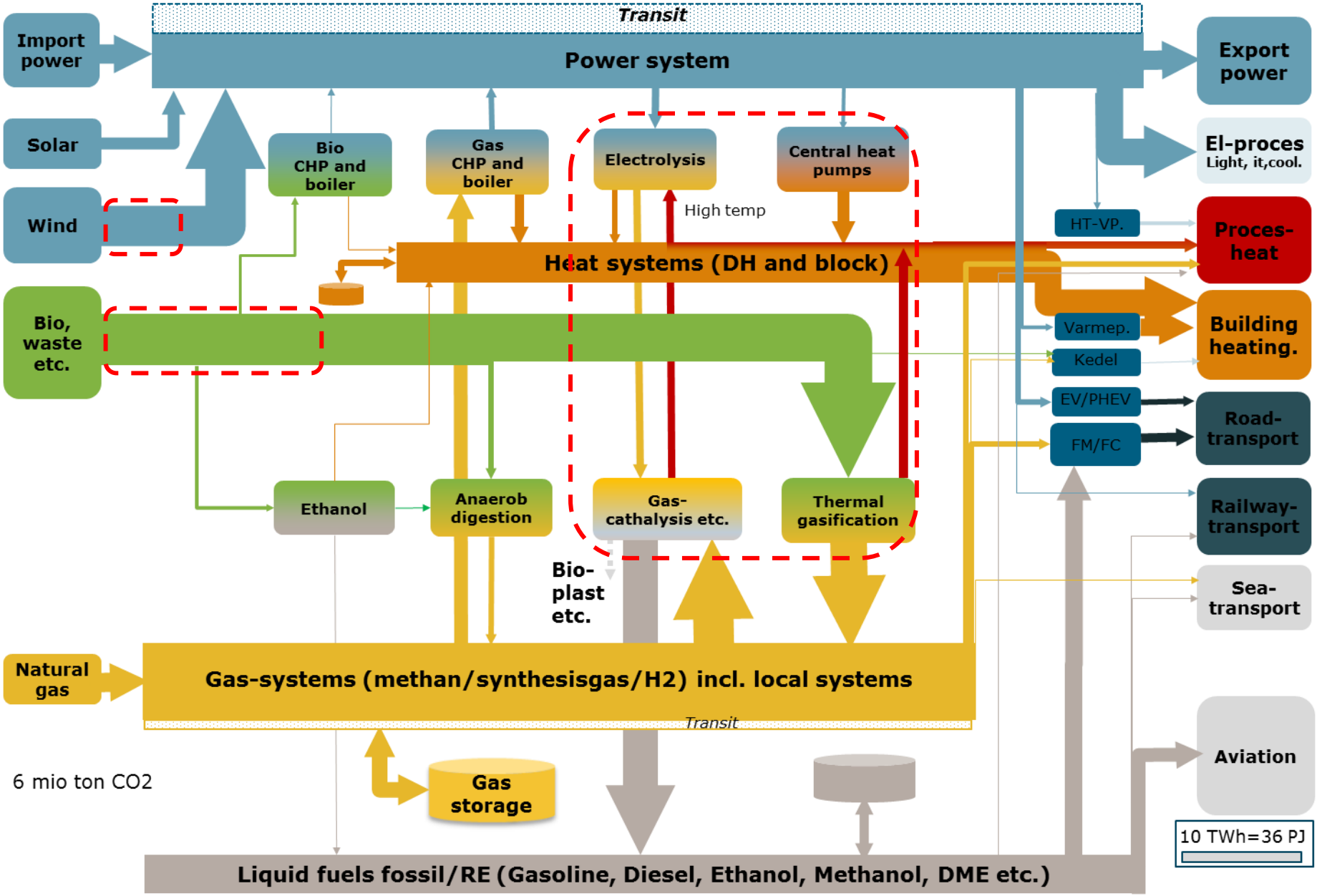
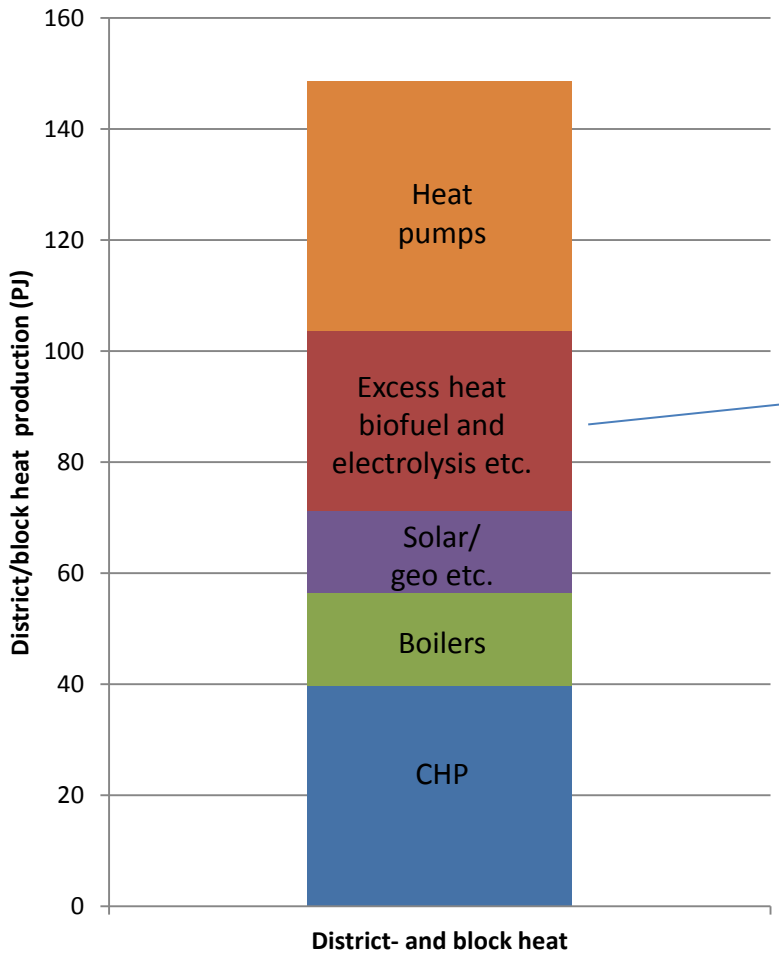
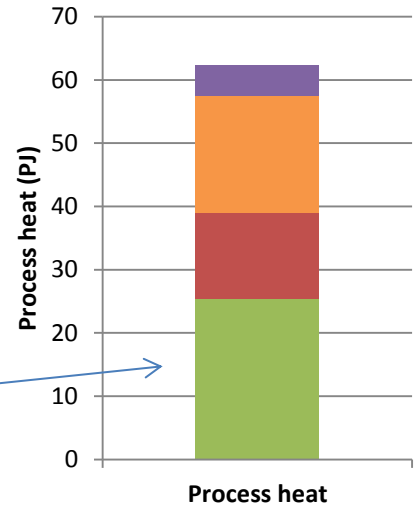
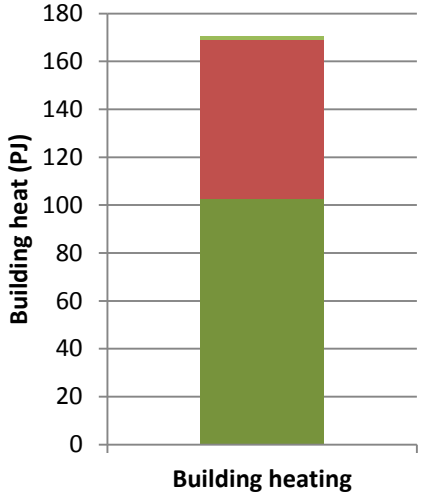
Feasibility study 2035 – reduced fossil oil demand



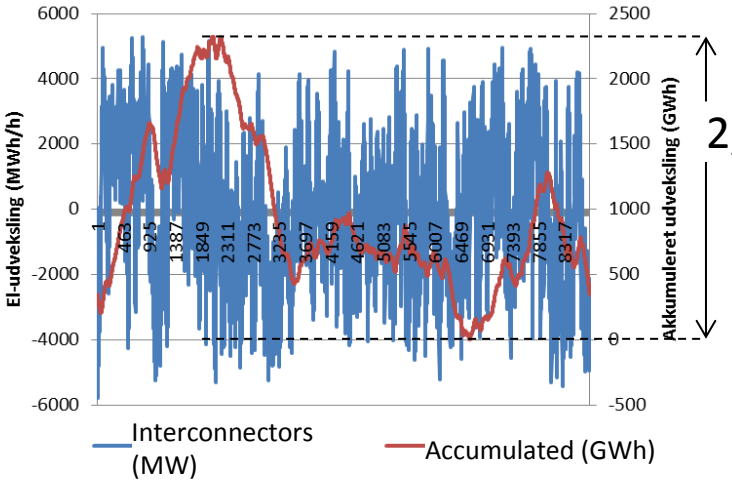
Production and consumption of heat – case study 2035+



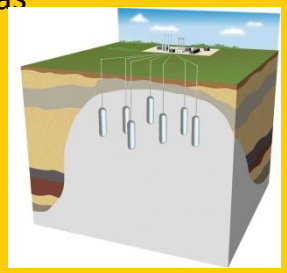


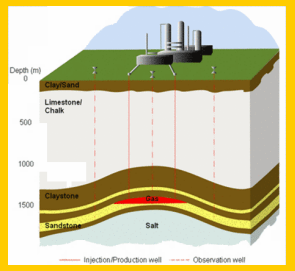


Storage capacity and system balancing – case 2035



Gas storage (11 TWh methan-gas)
Energy input to power-to-gas

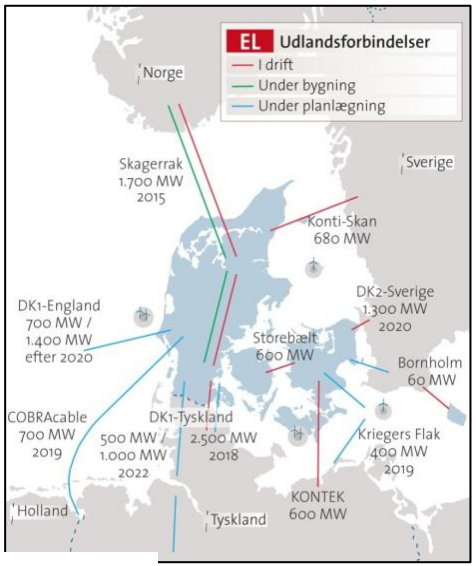


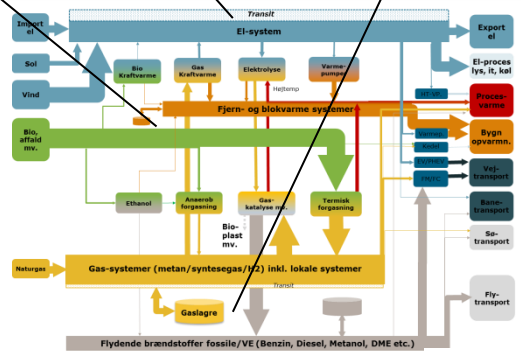


Interconnectors yearly accumulated case 2035 (2,3 TWh)

District heat+storage

Indivi. heat pump
El- og plugin hybrid
case 2035





Summing up

- Efficient integration with heating system can increase energy system efficiency, economy and increase robustness against fluctuating ressource prices (beta-factors in energy system)

- High temperature heat pumps has potential to deliver proces heat up to 120 degr.

- Use of high temperature excess heat from fuel production relevant as proces heat

- A need for further technical and geografical analysis of high temperature integration in the energy system.

Thank you for attention

Read more at:
www.energinet.dk/energianalyser

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