



Flex4RES

Flexible Nordic Energy Systems



Smart regulatory framework conditions for smart energy systems?

Incentives for flexible district heating in the Nordic countries

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Emilie Rosenlund Soysal (Research Assistant), Klaus Skytte (Head of
Energy Economics and Regulation), Ole Jess Olsen (Emeritus)*

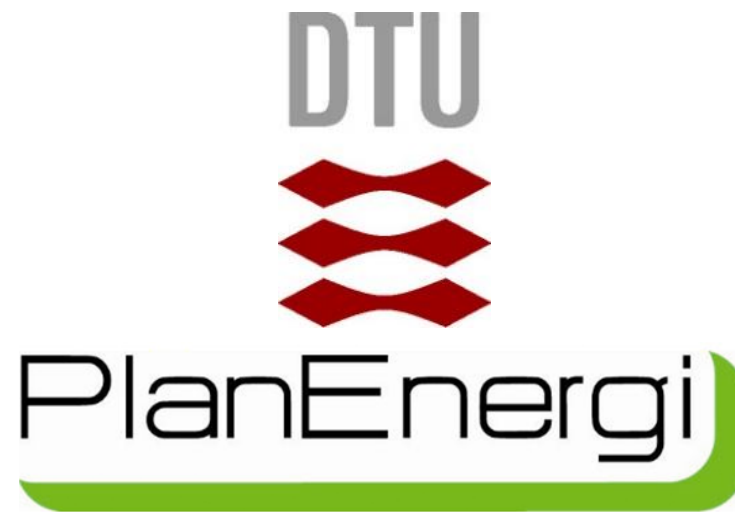


Nordic Energy Research

Background

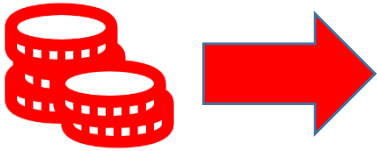


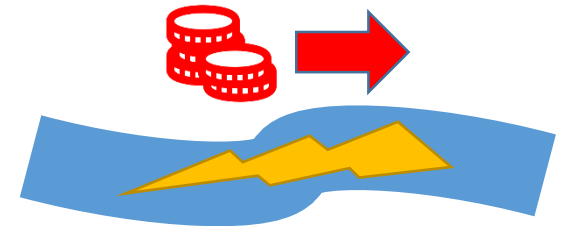
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Research Questions: Will new plants be flexible?

Incentives for investment and operation from

- Taxes 
- Subsidies 
- Electricity distribution grid tariffs



And what role do heat storages play?

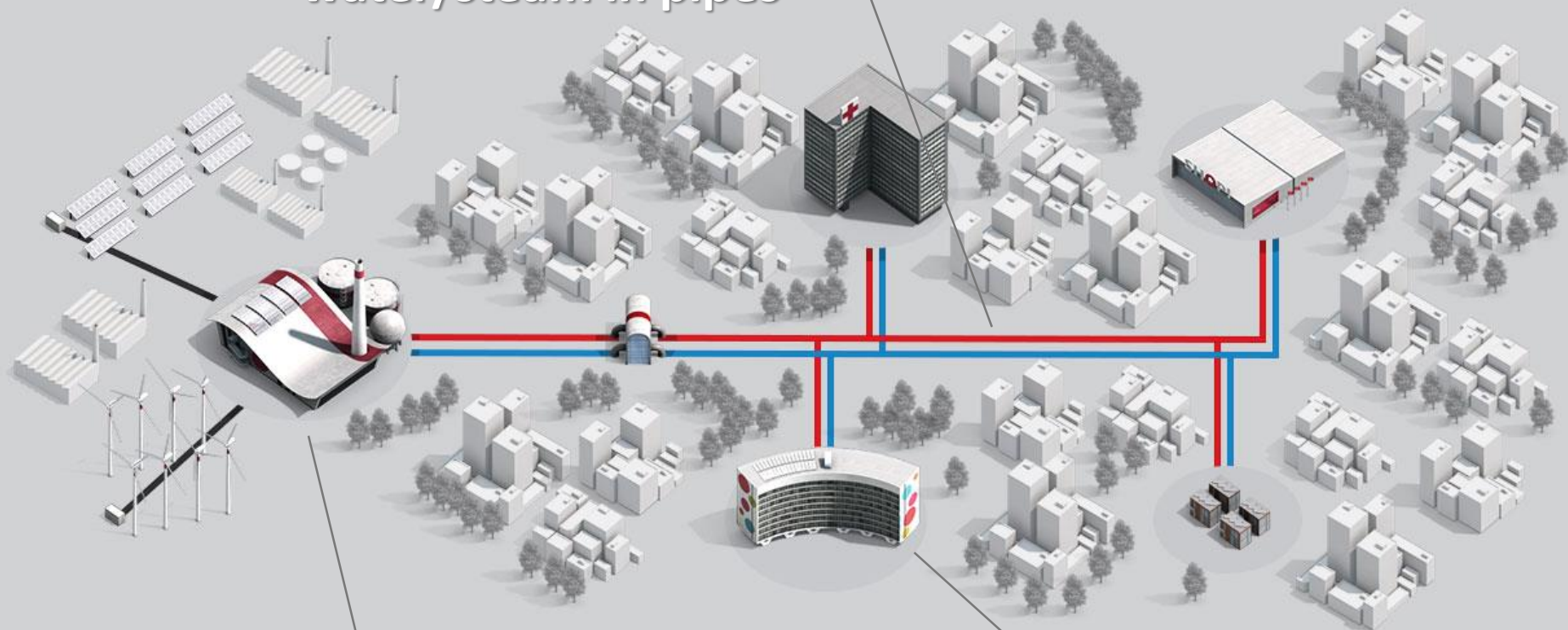


Q&A: What is district heating and cooling?



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Warm or cold
water/steam in pipes



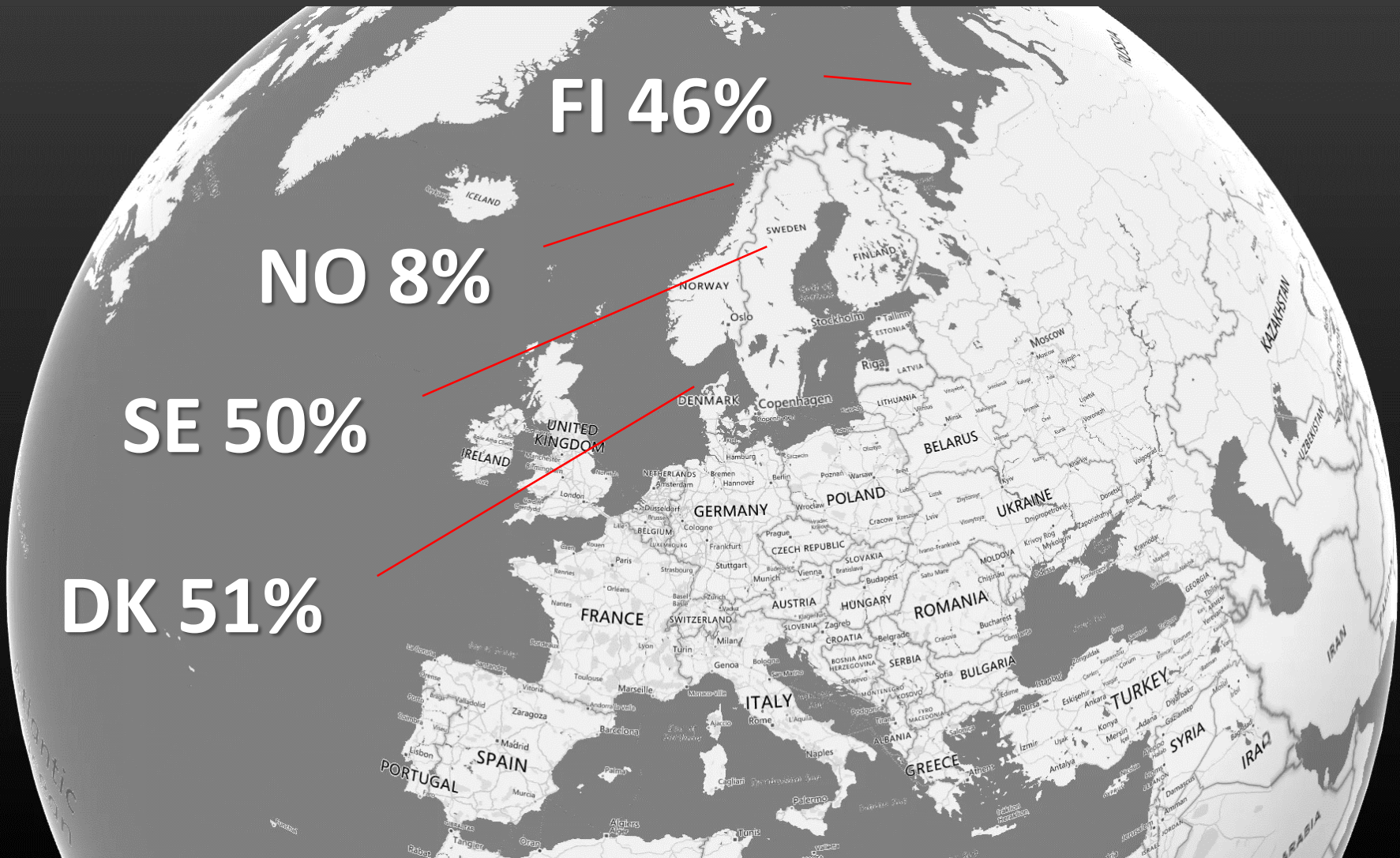
From a multitude
of heat sources

Transmitted to
consumers

District heating share of heat supply in 2014



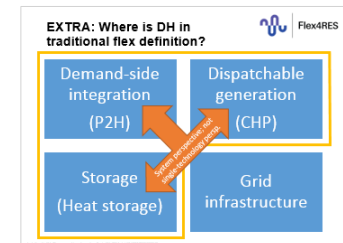
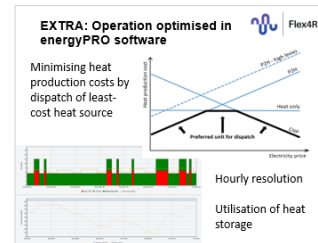
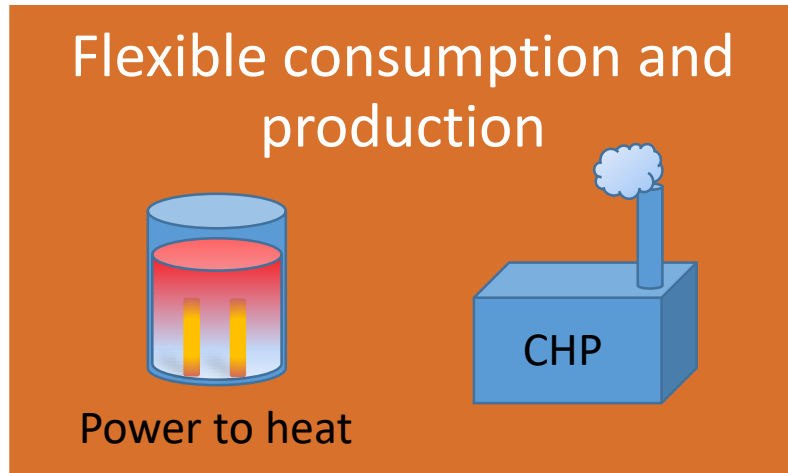
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Approach: Investor perspective on 4 types of 12 MW DH plant

Which configuration provides the lowest levelised cost of heat (LCOH)?

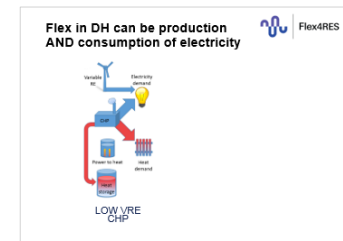


Modelling approach

Defining flexibility #1

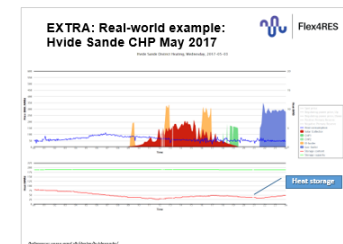
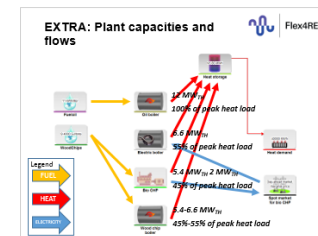
EXTRA: Input-data and assumptions used in the study

CATEGORY	INPUT
Year of investment	2015
Economic lifetime	20 years – in operation 2016-2035
Investment costs	The Norwegian Water Resources and Energy Directorate, Normatut i energipriser, Oslo, 2015
Temperatures	Climate Forecast System Reanalysis (CFSR) data from each capital region
Electricity tariffs	Based on the capital region
Taxes and additional charges	National authorities – 2015
Fuel costs	National statistics – 2015, except oil which is set at average common price
Electricity spot prices	Market data – 2015 projected using Nordic Energy Technology Perspectives
Discount rate	4% (equivalent to Danish CBA requirement)



Input data #1

Defining flexibility #2



Input data #2

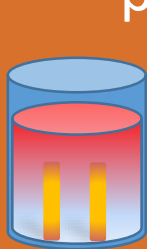
Real-world DH flexibility



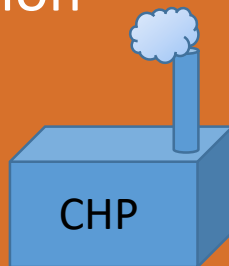
Approach: Investor perspective on 4 types of 12 MW DH plant

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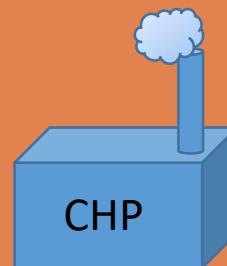
Flexible consumption and
production



Power to heat



Flexible production



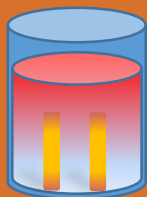
Biomass boiler



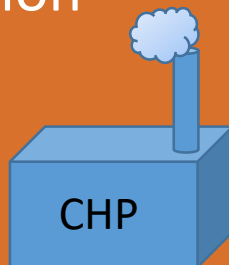
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Flexible consumption and
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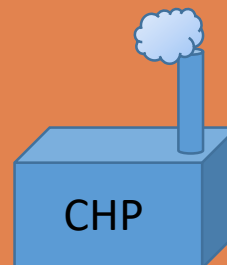


Power to heat



CHP

Flexible production

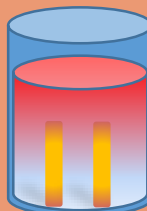


CHP



Biomass boiler

Flexible consumption



Power to heat



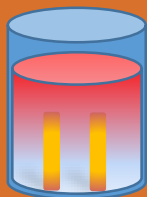
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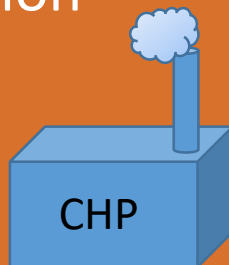
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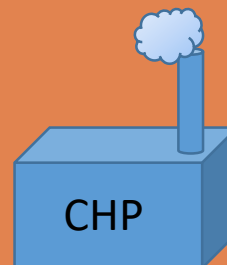


Power to heat



CHP

Flexible production

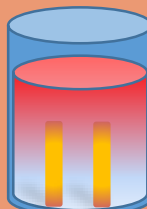


CHP



Biomass boiler

Flexible consumption



Power to heat



Biomass boiler

Inflexible



Biomass boiler

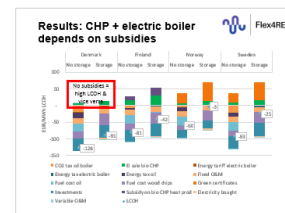


Results: Danish framework hampers investment in flexibility

LCOH: Production cost of heat, before revenue from consumers

Technology setup	Grid tariff type	Storage	DK
Wood chip CHP + wood boiler	Capacity charge		-97
Wood chip CHP + wood boiler			-108
Wood chip CHP + EB			-91
Wood chip CHP + EB			-128
Wood chip CHP + EB	Energy charge		-91
Wood chip CHP + EB			-128
Wood chip boiler			-73
Wood chip boiler			-86
Wood chip boiler + EB	Capacity charge		-99
Wood chip boiler + EB			-104
Wood chip boiler + EB	Energy charge		-99
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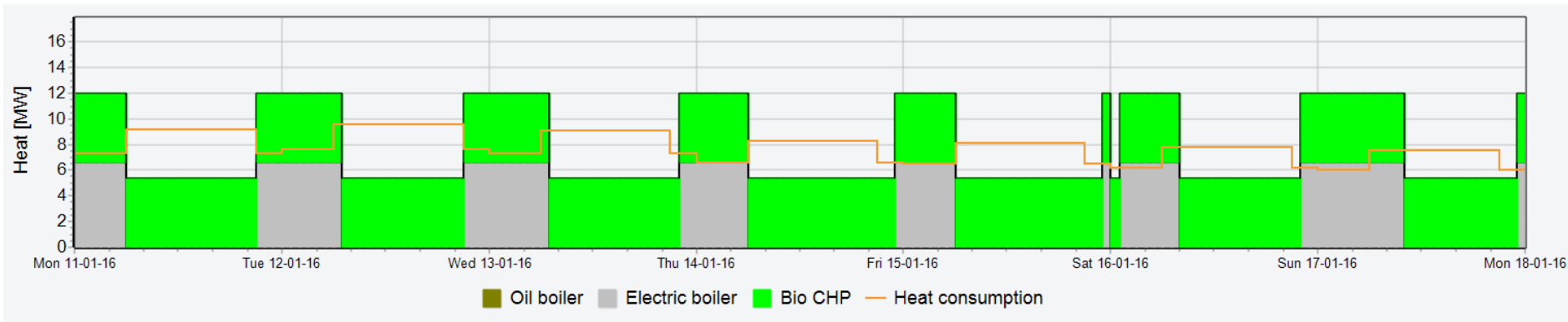
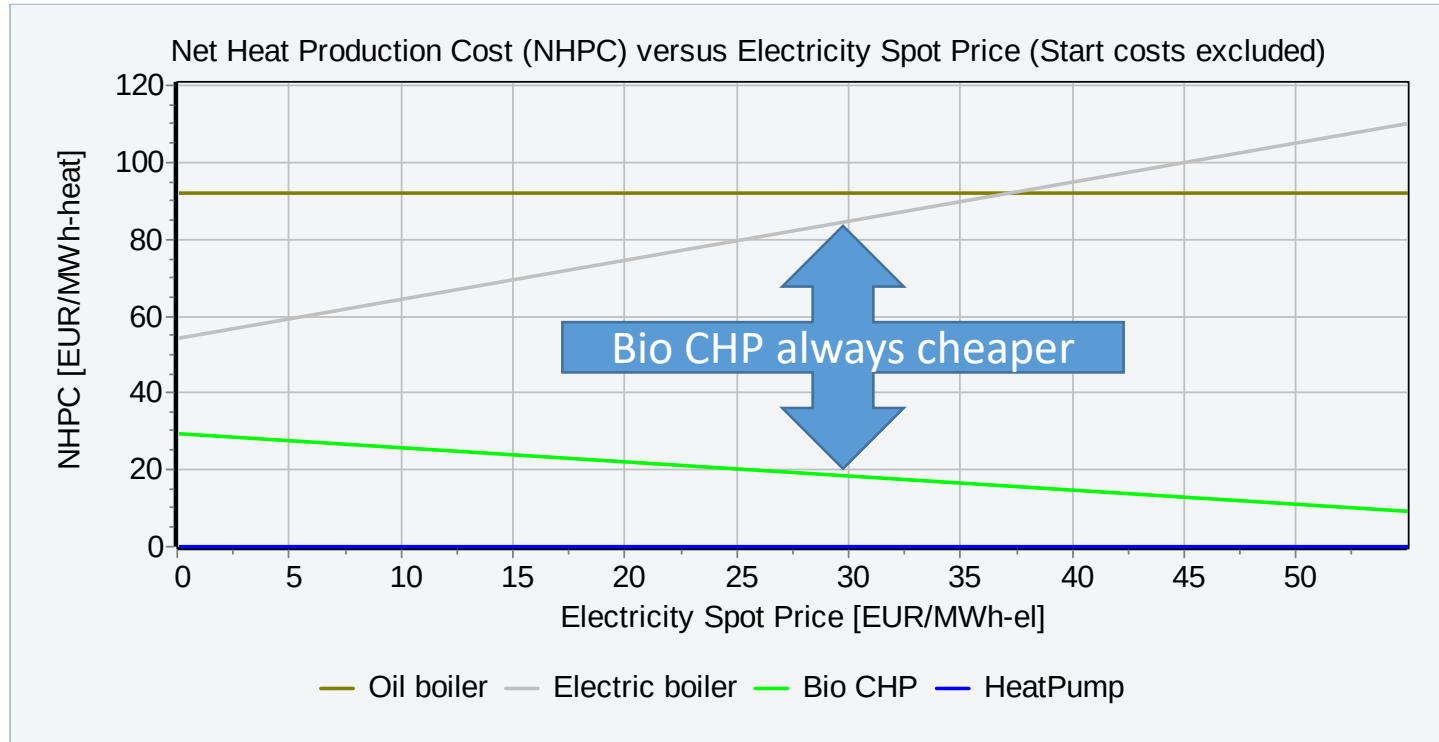
Breakdown of subsidies, taxes, tariffs and other elements



Results: 6-7000 FLH baseload on CHP in all cases with heat storage



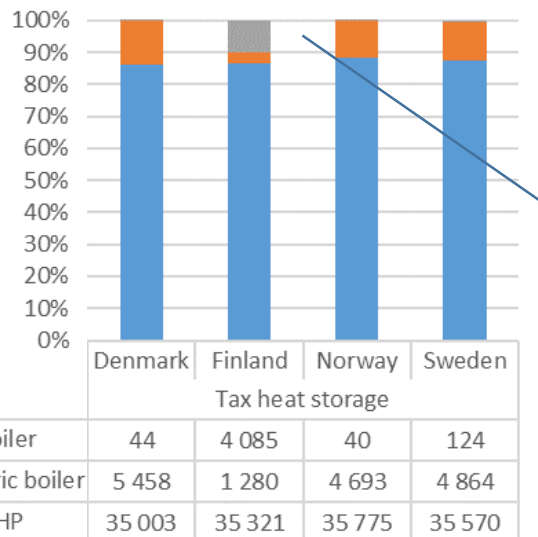
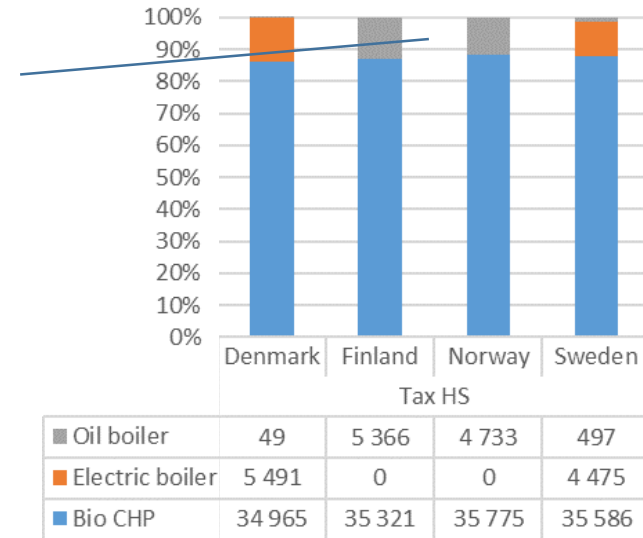
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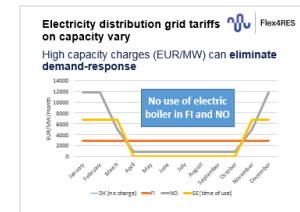
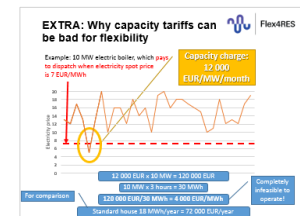


Results: High capacity charges can eliminate demand-response

Capacity charge tariff
(EUR/MW/month)
eliminates demand-response



Energy charge tariff
(EUR/MWh)
allows demand-response



Further details



Conclusion: Will new plants be flexible?

Taxes

- Only **marginal impact on operation** from CHP and electric boilers in this configuration

Subsidies

- **Crucial for investment** in flexible district heating

Electricity distribution grid tariffs

- High capacity charges (EUR/MW) can **eliminate demand-response**

What role do heat storages play?

- **No regrets** for investment and operation

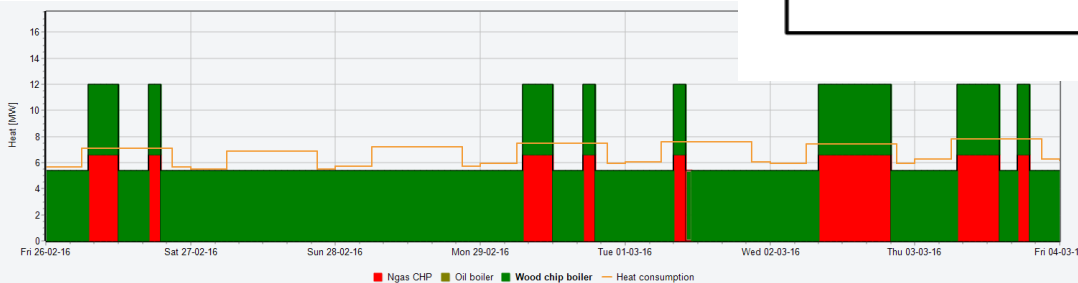
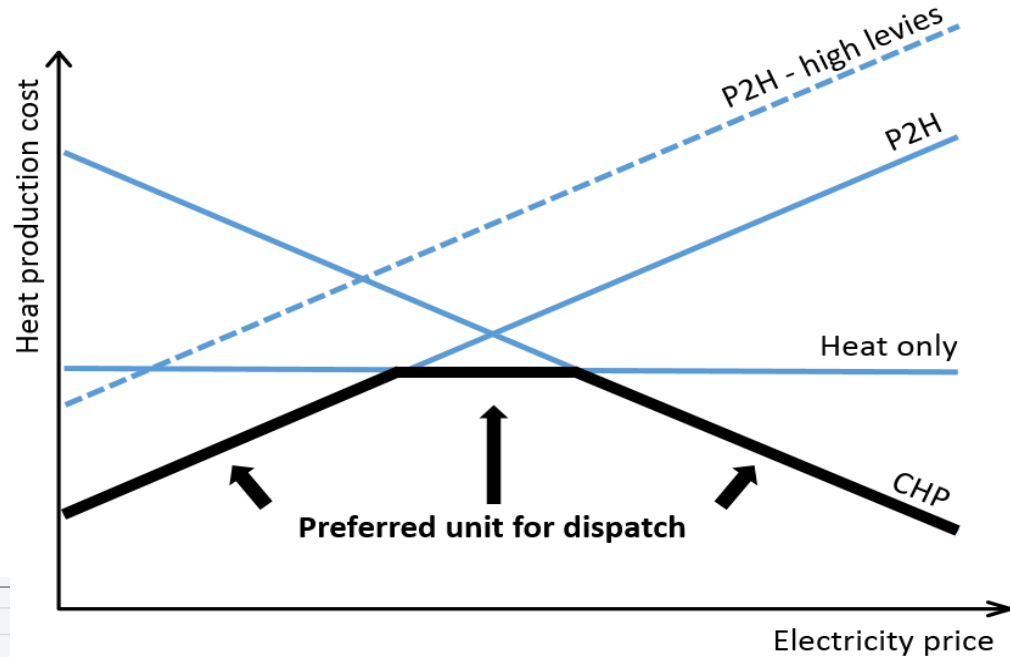


www.Flex4RES.org



EXTRA: Operation optimised in energyPRO software

Minimising heat production costs by dispatch of least-cost heat source



Hourly resolution

Utilisation of heat storage



EXTRA: Why capacity tariffs can be bad for flexibility

Example: 10 MW electric boiler, which **pays to dispatch** when electricity spot price is 7 EUR/MWh

Capacity charge:
12 000
EUR/MW/month



$12\,000 \text{ EUR} \times 10 \text{ MW} = 120\,000 \text{ EUR}$

$10 \text{ MW} \times 3 \text{ hours} = 30 \text{ MWh}$

$120\,000 \text{ EUR} / 30 \text{ MWh} = 4\,000 \text{ EUR/MWh}$

For comparison

Standard house 18 MWh/year = 72 000 EUR/year

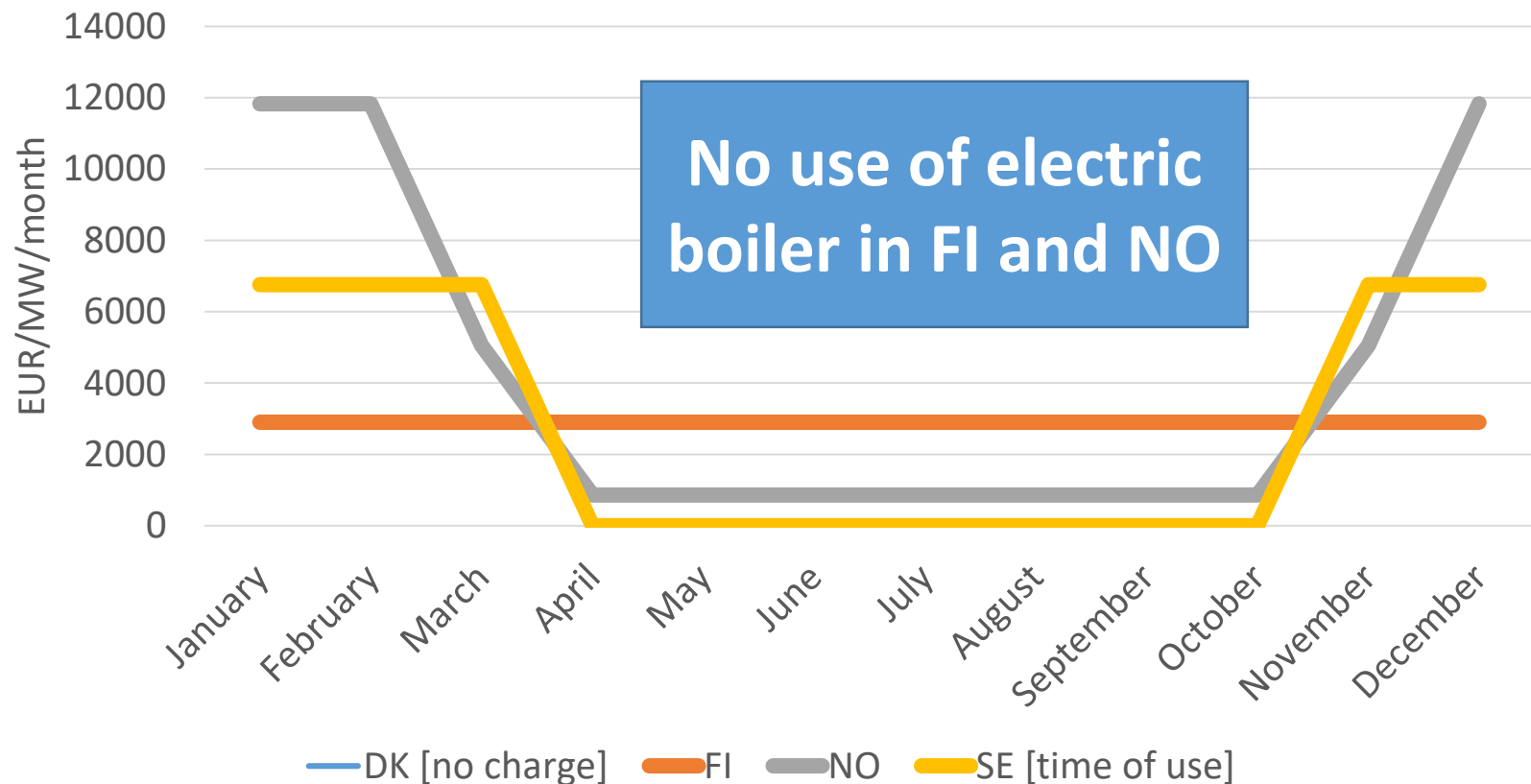
Completely
infeasible to
operate!

Electricity distribution grid tariffs on capacity vary



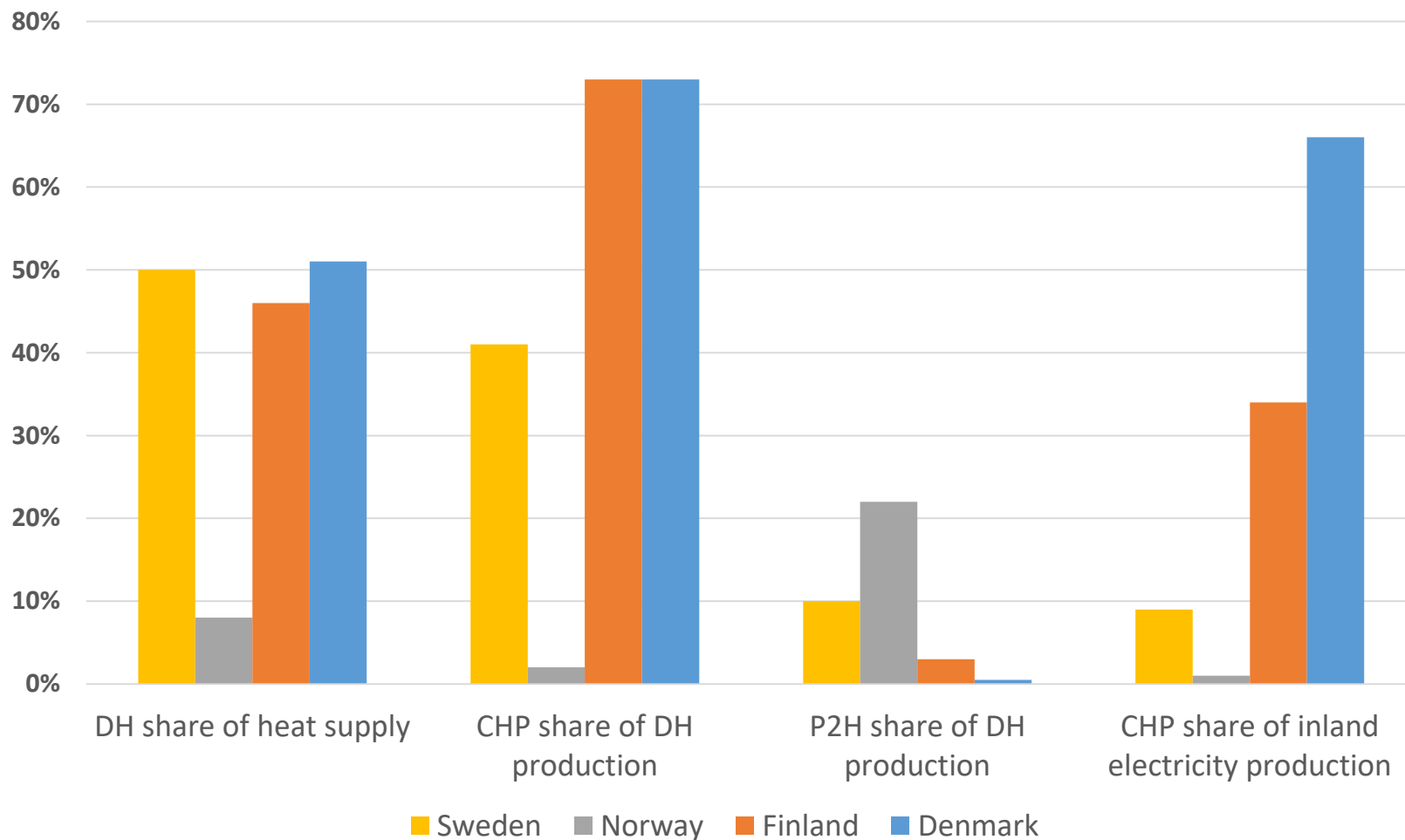
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High capacity charges (EUR/MW) can **eliminate demand-response**





EXTRA: DH widely deployed in Nordics

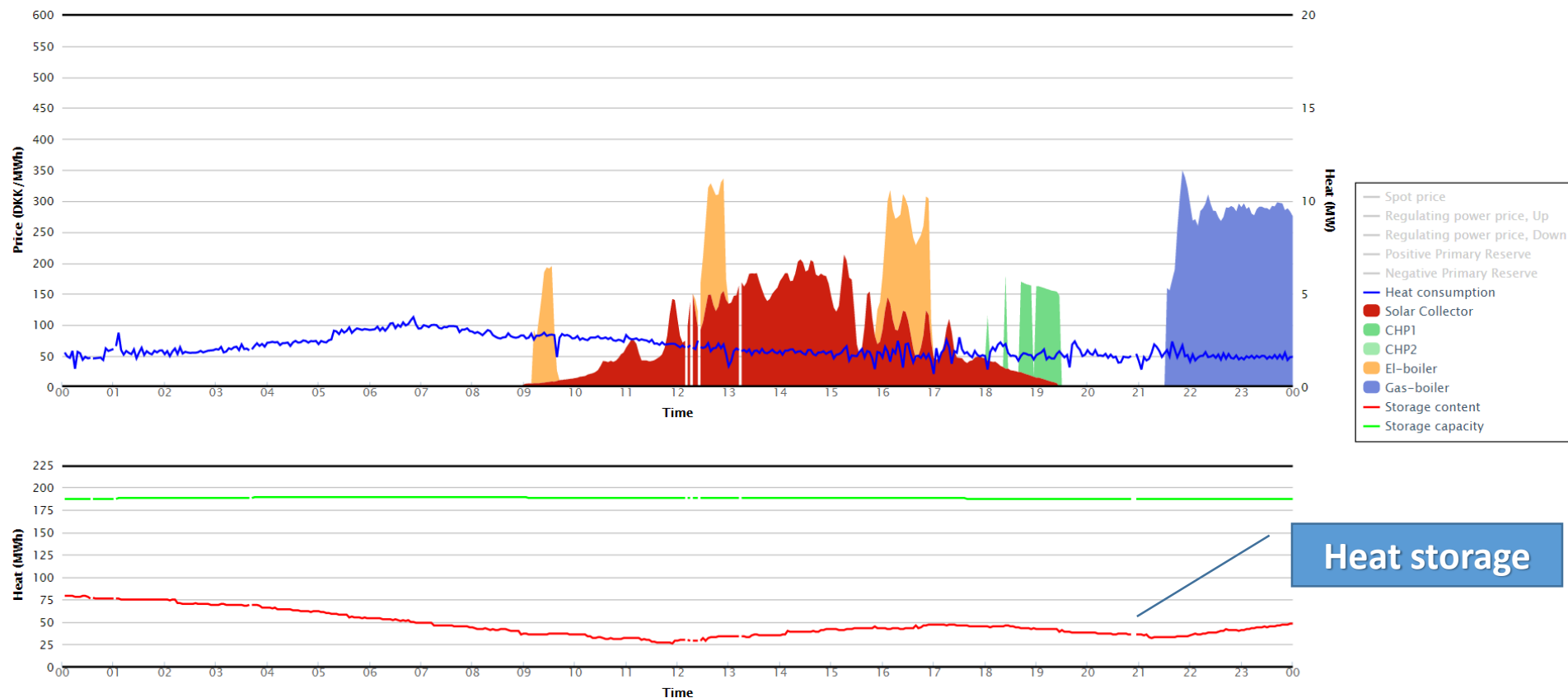


Graph: Sneum DM, Sandberg E, Rosenlund Soysal E, Skytte K, Olsen OJ. Smart regulatory framework conditions for smart energy systems? Incentives for flexible district heating in the Nordic countries 2017. (unpublished primo 2017)

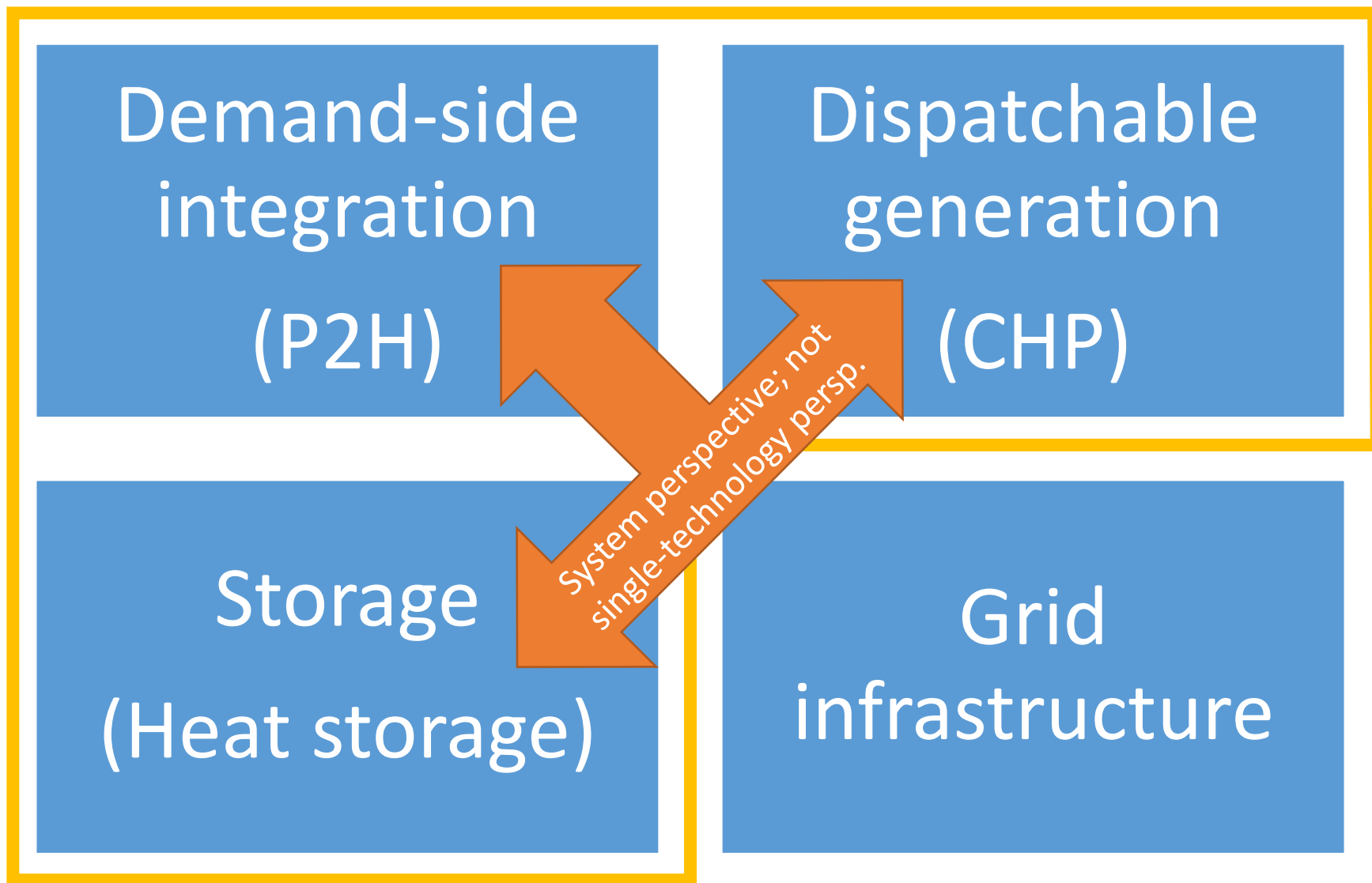


EXTRA: Real-world example: Hvide Sande CHP May 2017

Hvide Sande District Heating, Wednesday, 2017-05-03



EXTRA: Where is DH in traditional flex definition?

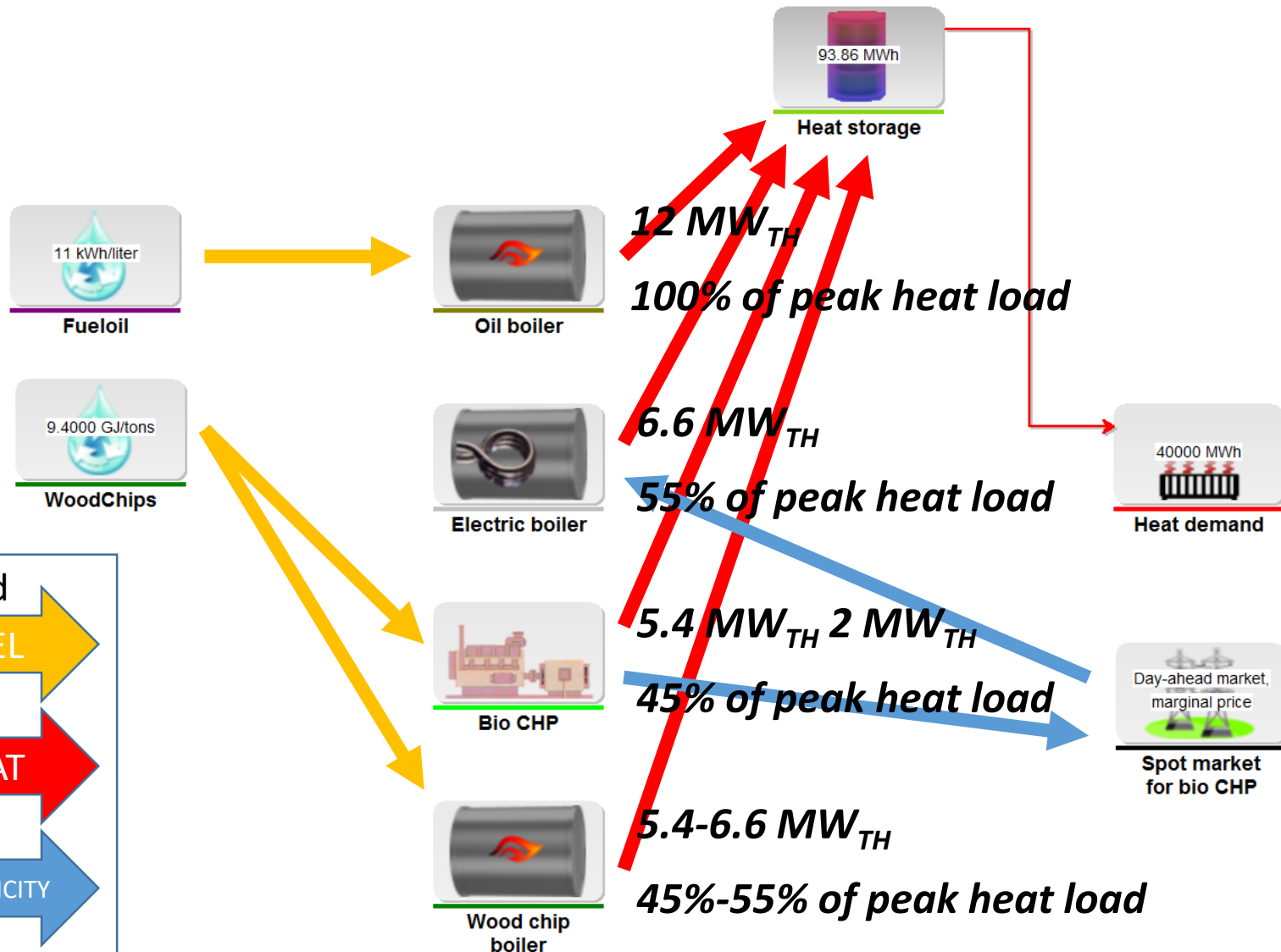




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EXTRA: Plant capacities and flows





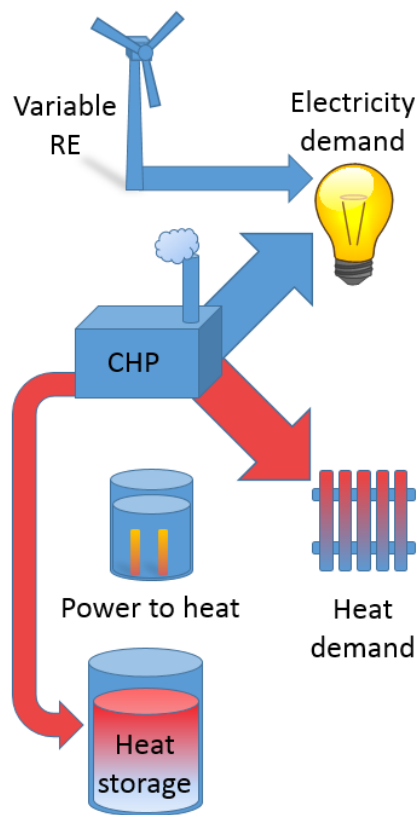
EXTRA: Breakdown of scenarios and their variations

Scenario
Wood chip CHP + electric boiler <i>Flex production + consumption</i>
Wood chip CHP + wood chip boiler <i>Flex production</i>
Wood chip boiler + electric boiler <i>Flex consumption</i>
Wood chip boiler <i>Inflexible</i>

X 4 countries = 72 simulations



EXTRA: Flex in DH can be production AND consumption of electricity



LOW VRE
CHP

Results: CHP + electric boiler depends on subsidies

