Position paper:
Norway's role as a flexibility provider in a renewable Europe

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FME

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Status

- Cooperation between FMEs CenSES and CEDREN

- Technoport Talk in Trondheim in June 2013
  - Debate: Ola Borten Moe, Connie Hedegaard, Asgeir Tomasgard
  - Summary of the Position Paper prepared for Technoport Forum
- Draft version finished July 2013
- Final version will be finished soon

- Based on results from projects such as LinkS, BM-MPM, EU FP7 TWENTIES, Ramona, and others

Outline

Background and motivation

Research questions / Limitation of scope

Example of results

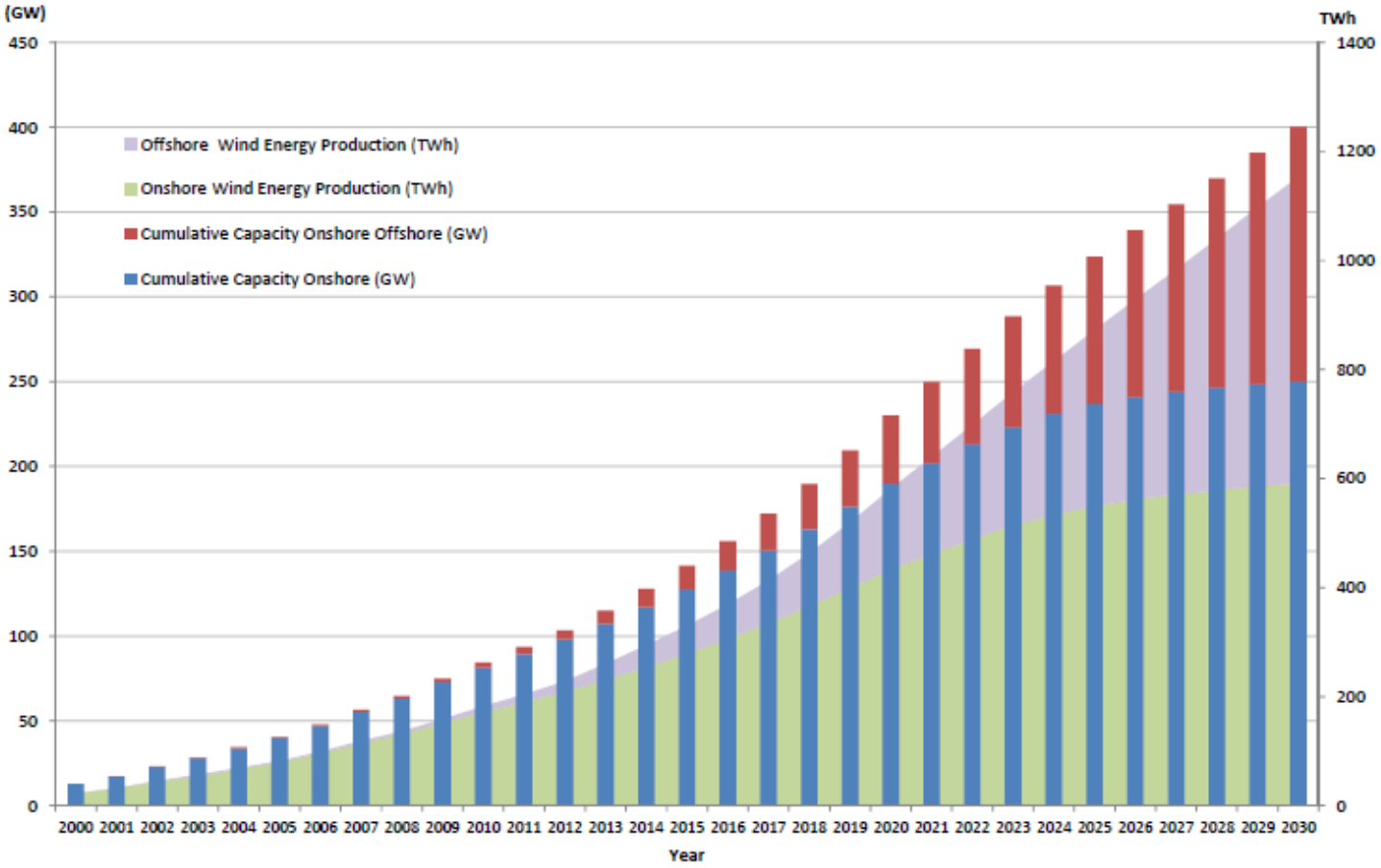
Conclusions

Background / motivation

- Increased power generation from renewable sources in Europe towards 2050
  - Reported in numerous scenario studies
- The non-disptachable nature of many renewable sources leads to an increase in the need for balancing services
  - Multiple time scales
  - Periods with considerable deficit energy, and periods with considerable surplus energy
- What is Norway's potential for providing Europe with flexible services and balancing energy?

Contents

Wind power in Europe (EWEA)



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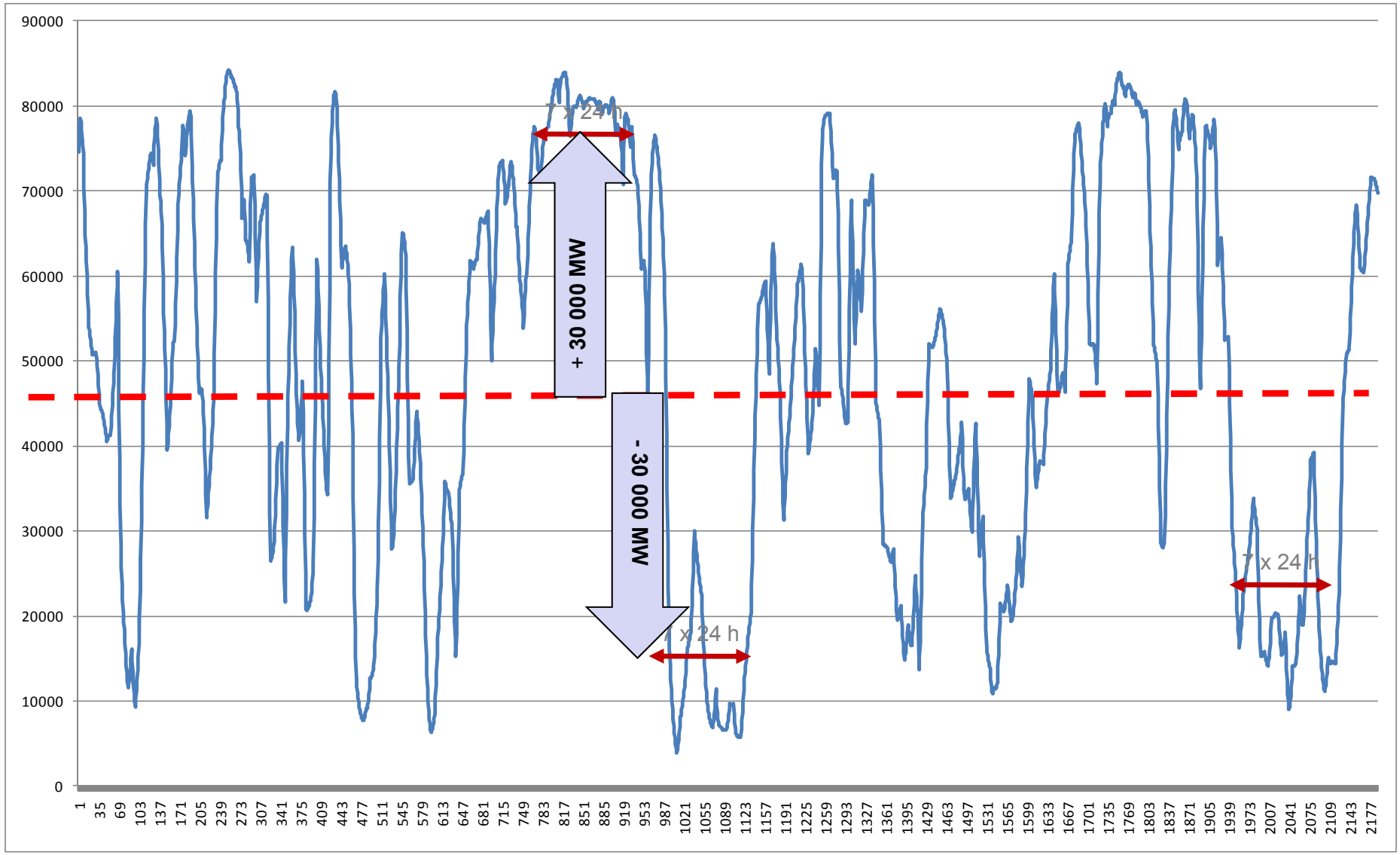
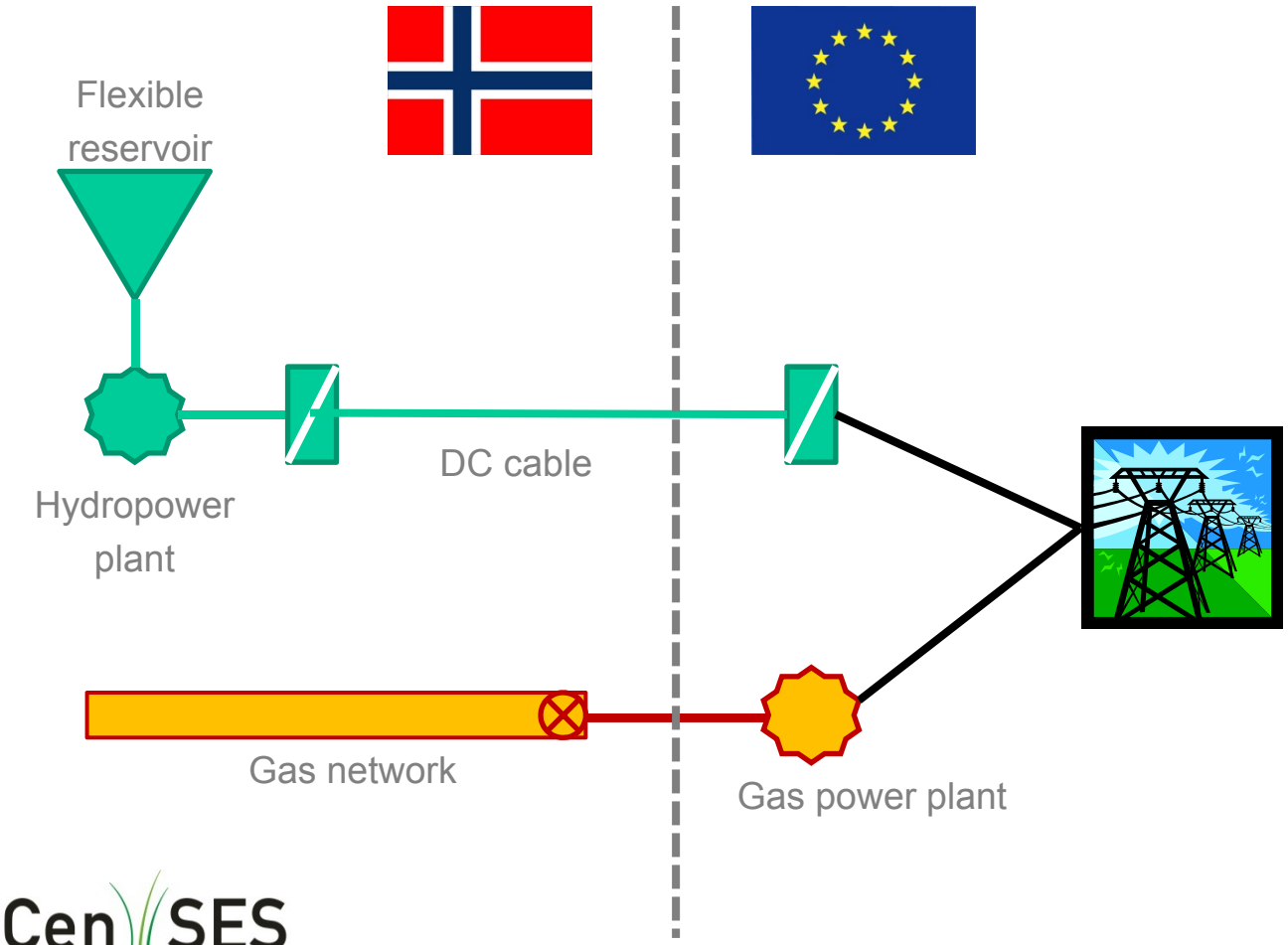
Wind Power North-Sea Region - Jan – March 2001



Hydro and gas for balancing power



<u>Timesteps</u>

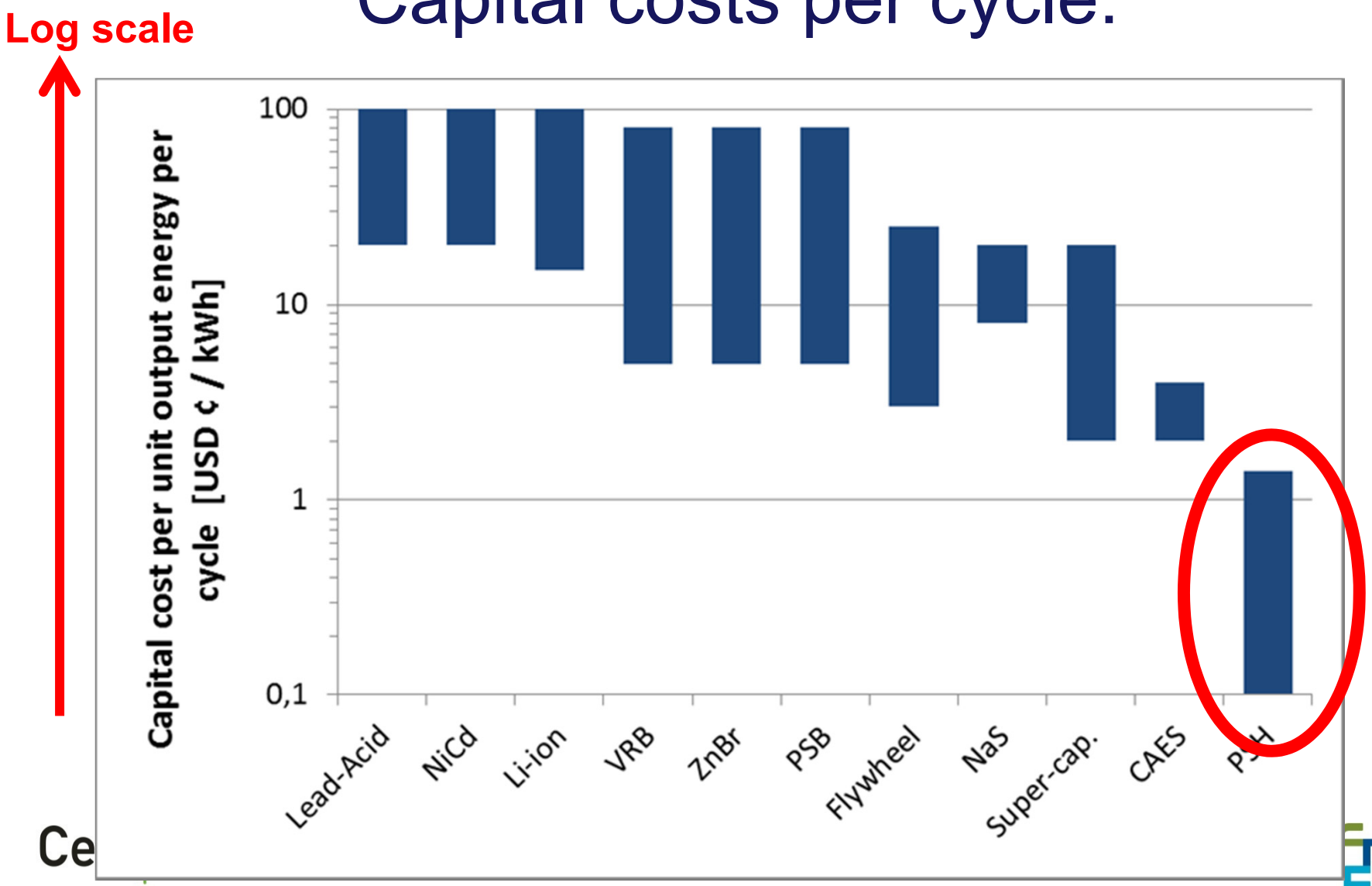
Days and weeks (relate to wind power)

Day-night regulation (~12 hours)

Spot marked (1 hour)

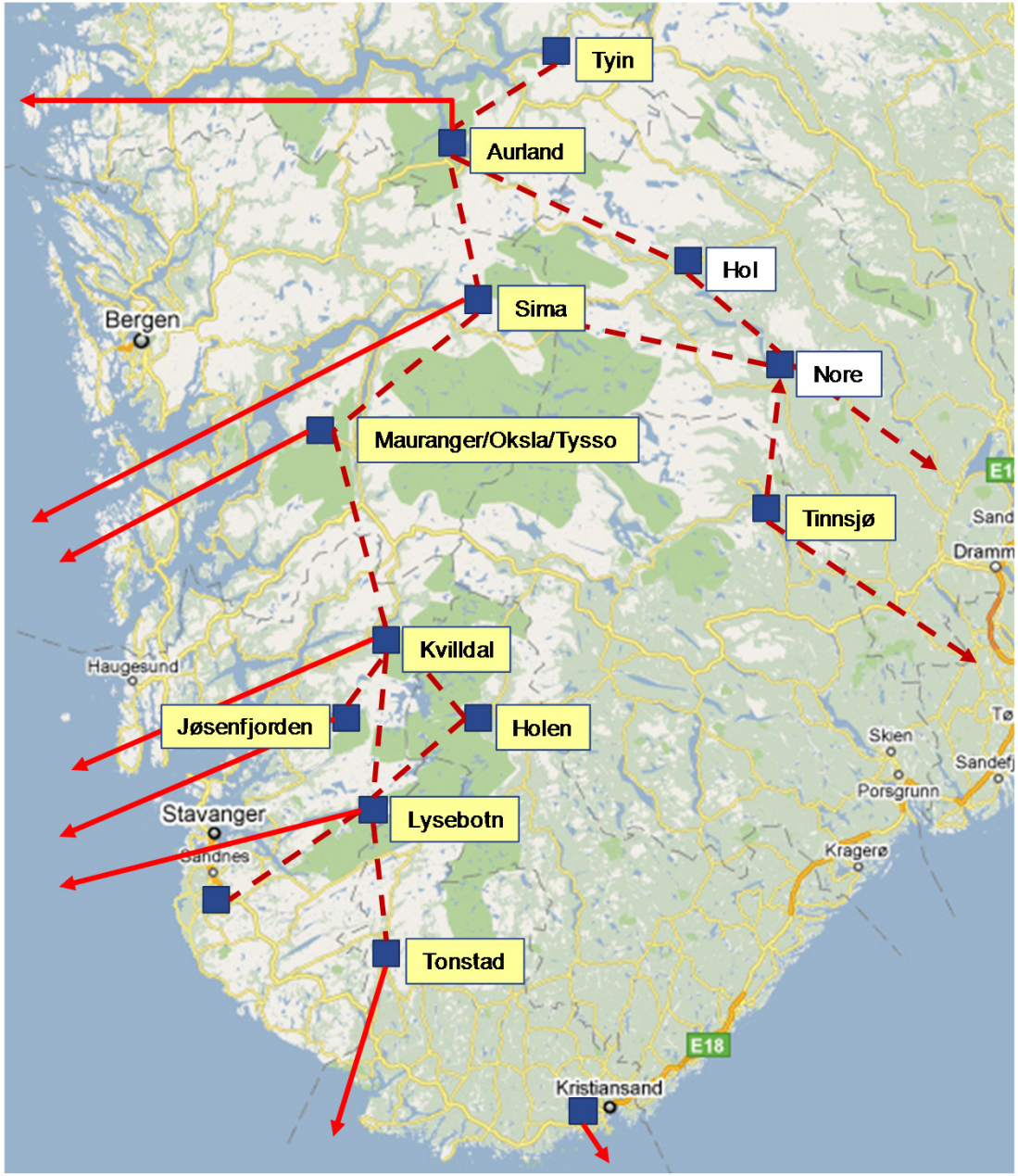
Balancing marked (msec - 15 min)

Capital costs per cycle:




Statkraft
Blåsjø
7.8TWh RESERVOIR

CEDREN Case study 2030 A



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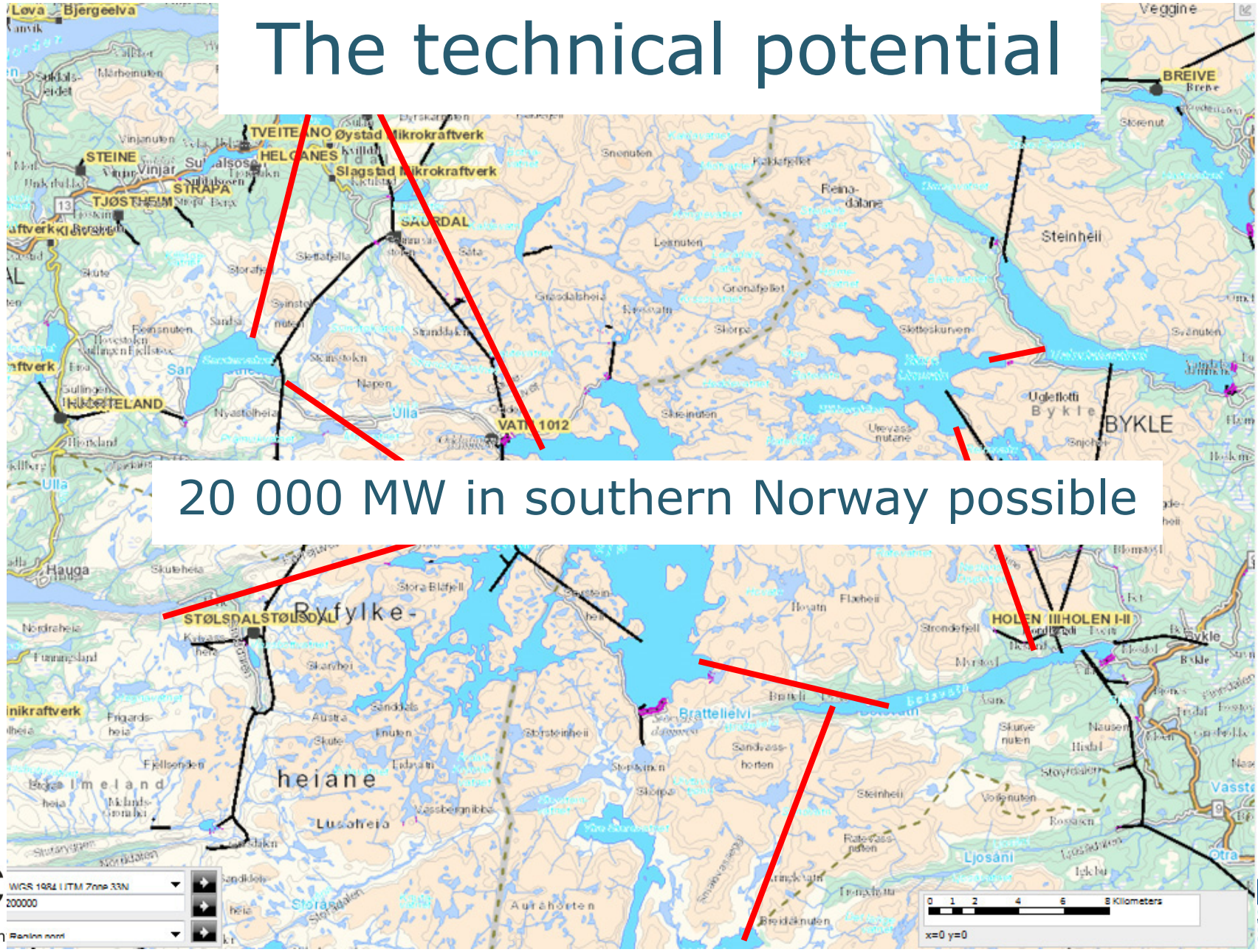
Slide 12

A2 Author; 15.01.2012

The technical potential



20 000 MW in southern Norway possible

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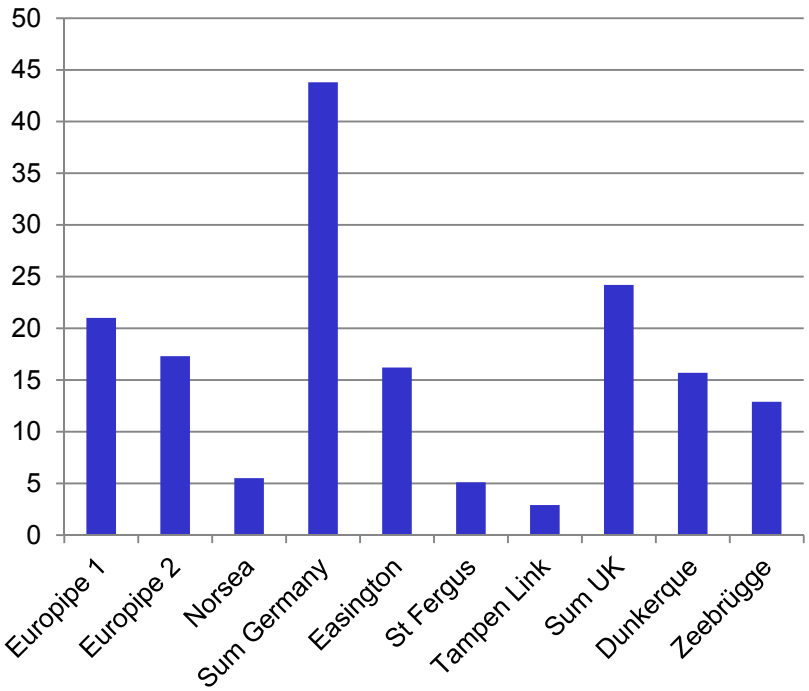
Flexibility – natural gas

Natural gas is easily storable

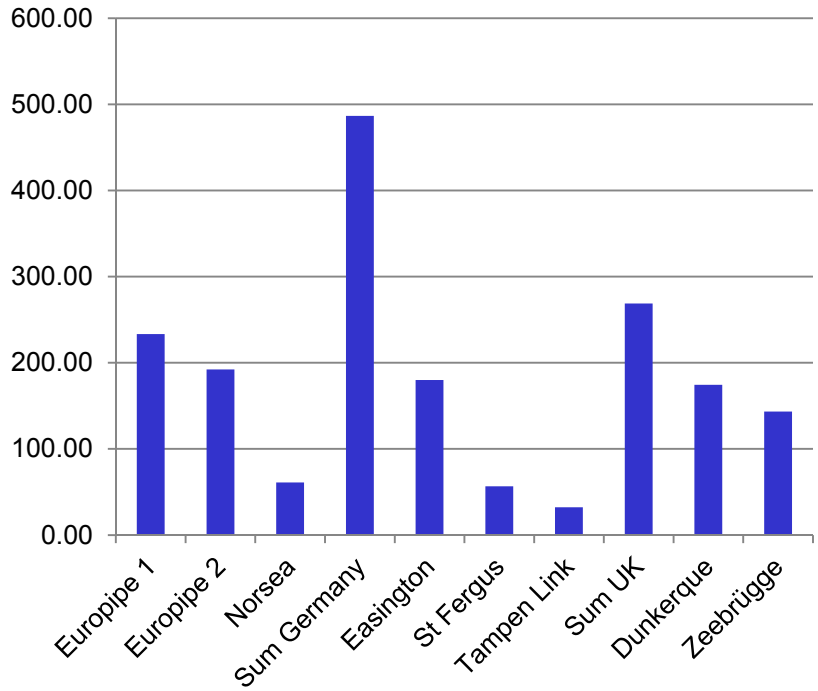
- Reservoirs
  - Seasonal variations, weekly variations
- Linepack
  - Day to hours balancing
- Conventional storages
- LNG storages / the value chain for LNG

Yearly deliveries from Norway

Billion sm^3 gas

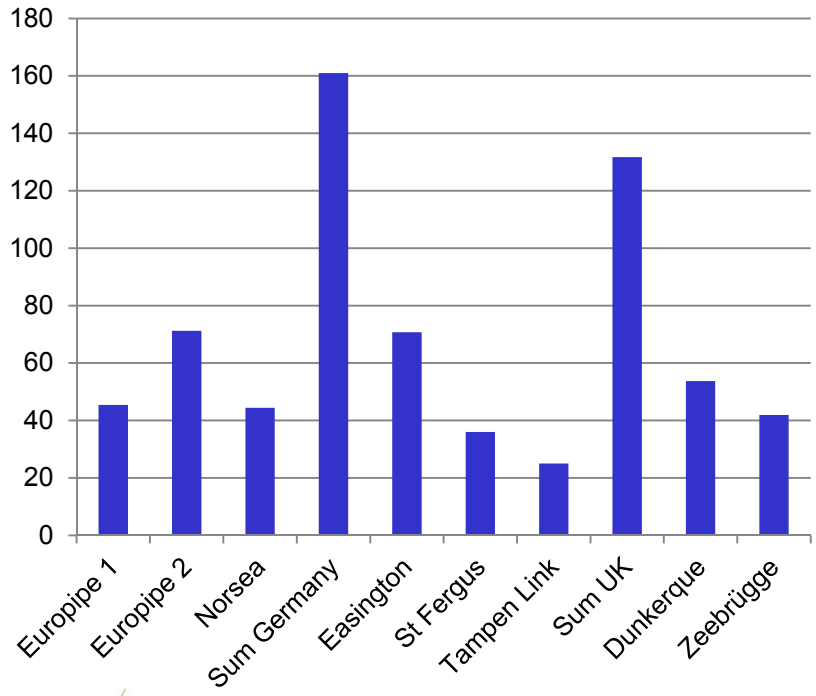


Energy content (TWh)

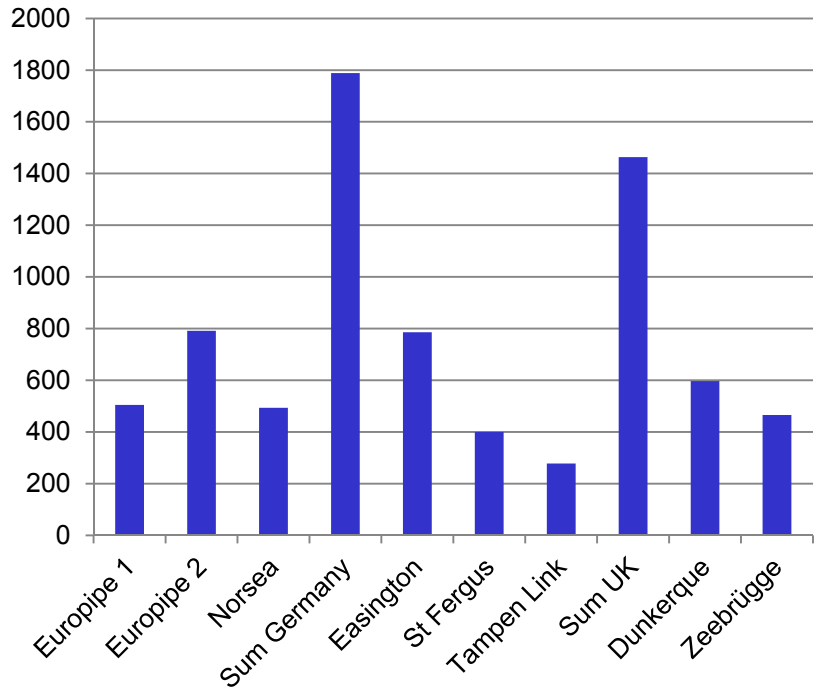


Daily capacity

Pipeline capacity (Msm^3)



Capacity in GWh



Research questions

- How will different policy scenarios influence Europe's need for flexibility services?
- What are the Norwegian capabilities to be part of the solution by providing flexibility to the European energy market, both from the natural gas system and from the hydropower system?
- Which uncertainty faces potential investors in energy infrastructure and generation capacity providing flexibility to Europe?
- How may this uncertainty be reduced and by whom?

Limitation of scope

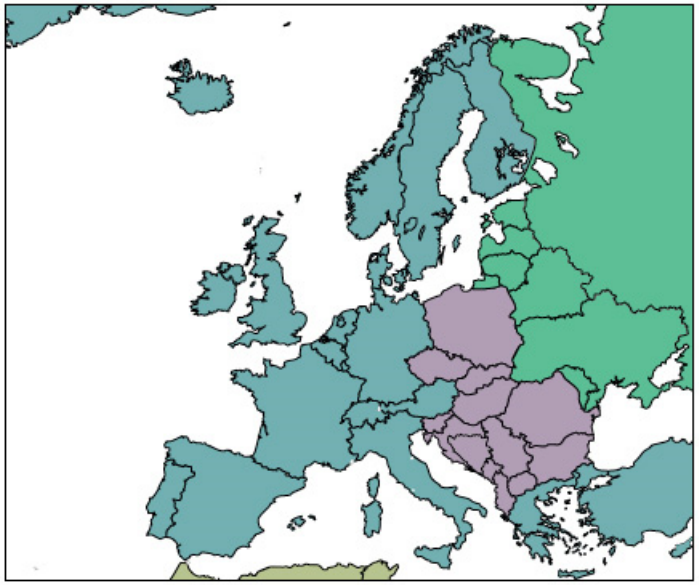
- Analyze the added value from the flexibility of the Norwegian energy resources as a service, not the export of energy in itself
  - net energy export may be zero
- We do not consider prioritization between power production and energy savings/efficiency or energy export versus alternative use of energy (for instance, electrification)
- We only study the power market

Energy scenarios

- Global 20-20-20
  - The rest of the world adopts the three policy targets in the European 20-20-20 program but at different points in time. Renewable portfolio standards, energy efficiency improvements and share of bio fuel in the transportation sector are set for different regions across the world
- 450 ppm stabilization
  - A policy scenario where the atmospheric concentration of greenhouse gases is limited to 450 ppm CO_2-eq by the end of the century. Emission reduction is achieved by implementing a carbon price
- 650 ppm stabilization scenario
  - A policy scenario where the atmospheric concentration of greenhouse gases is limited to 650 ppm CO2-eq by the end of the century. Emission reduction is achieved by implementing a carbon price (but at a slower rate than in the 450 scenario)

Analysis method

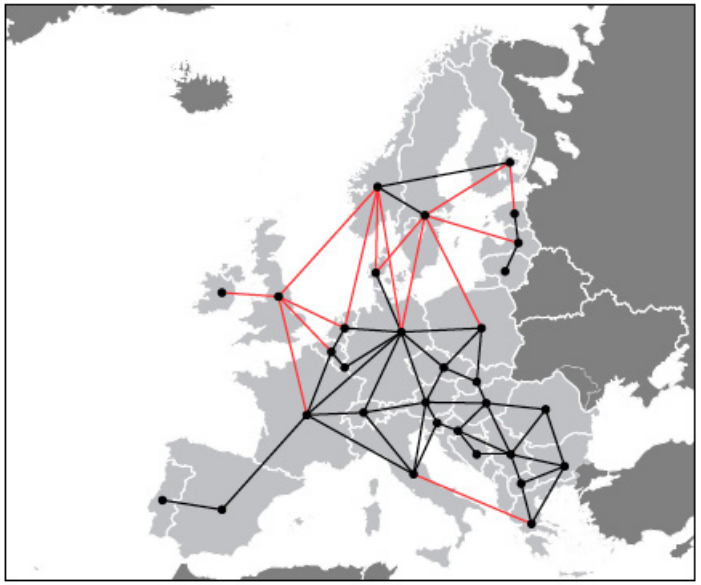
Global IAM



break down

Demand,
fuel prices,
CO_2 prices

The EMPIRE
power system model



UNIVERSITY OF MARYLAND

Pacific Northwest National Laboratory

Joint Global Change Research Institute
JGCRI

SINTEF

NTNU – Trondheim
Norwegian University of Science and Technology

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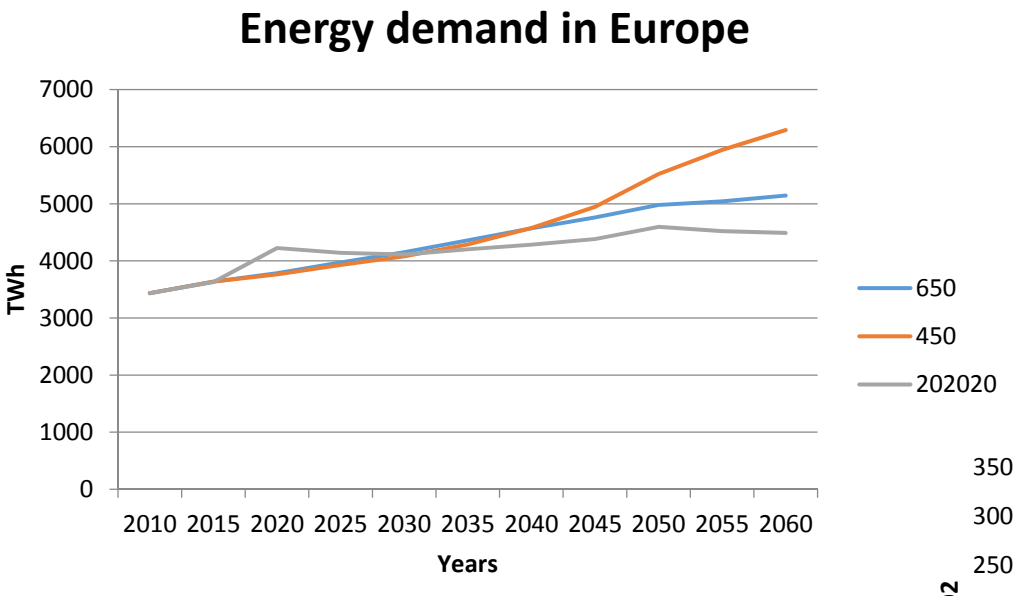
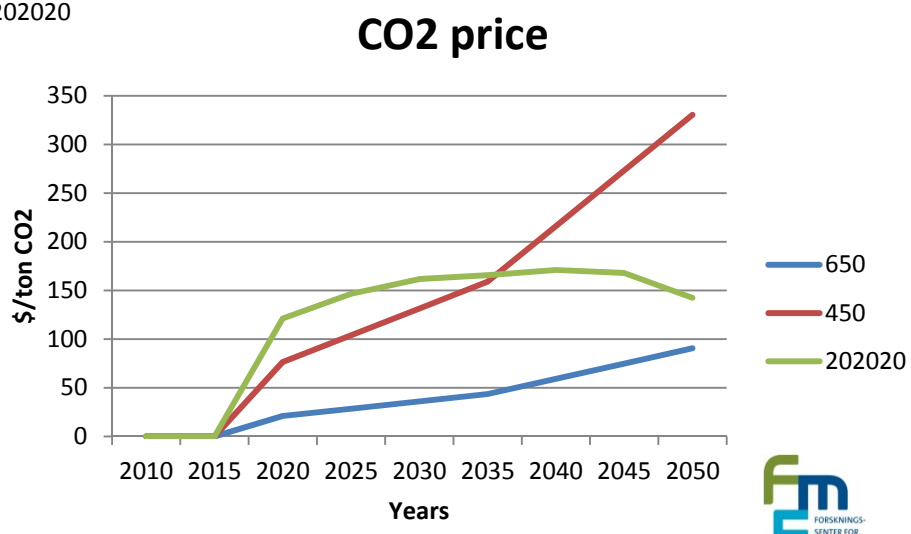
Results from GCAM





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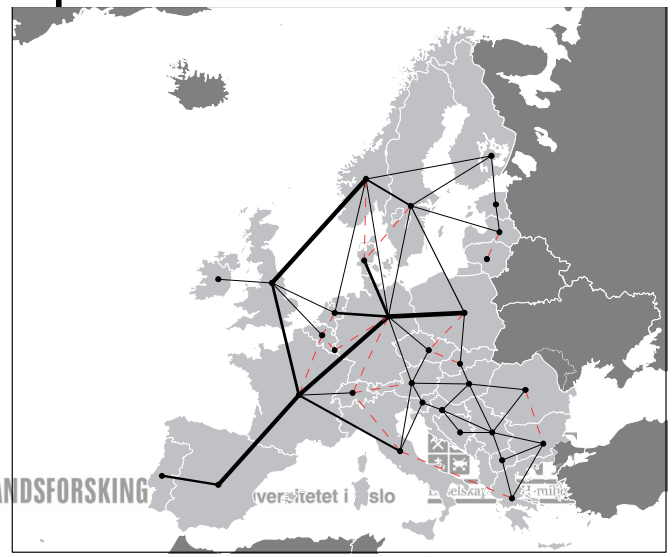
EMPIRE

- Power system design and operation
  - Models each European country´s generation capacity and import/export channels, not physical lines
  - Time horizon until 2050 – investments in 5 year steps
  - Model operational time periods: demand, supply (stochastic wind and solar PV) and optimal dispatch.

- Taking fuel prices, expected load and costs as input
- Provides a cost minimization capacity expansion plan for Europe, detailed for each country



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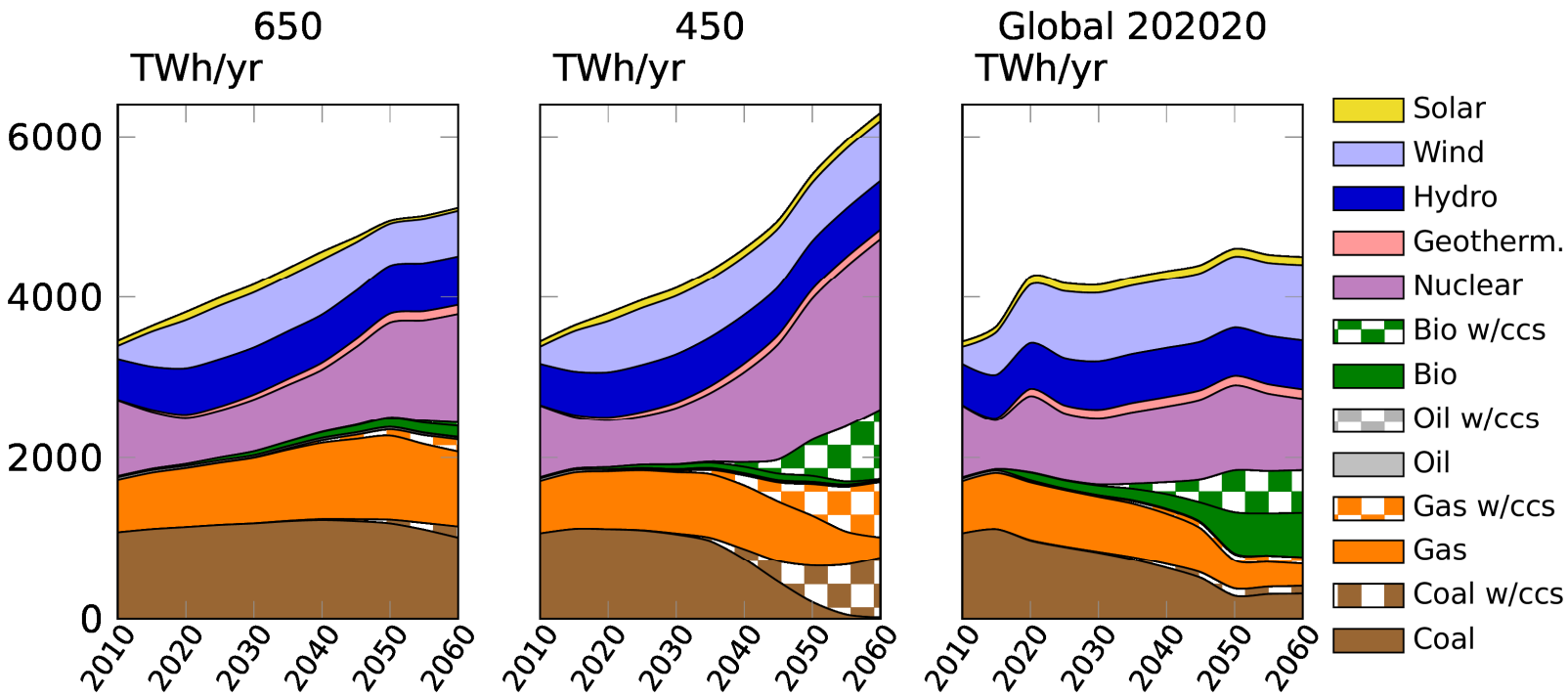
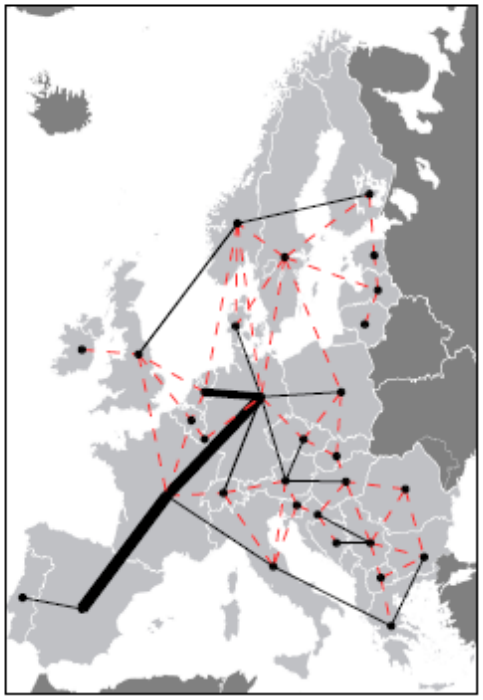
Energy mix in Europe

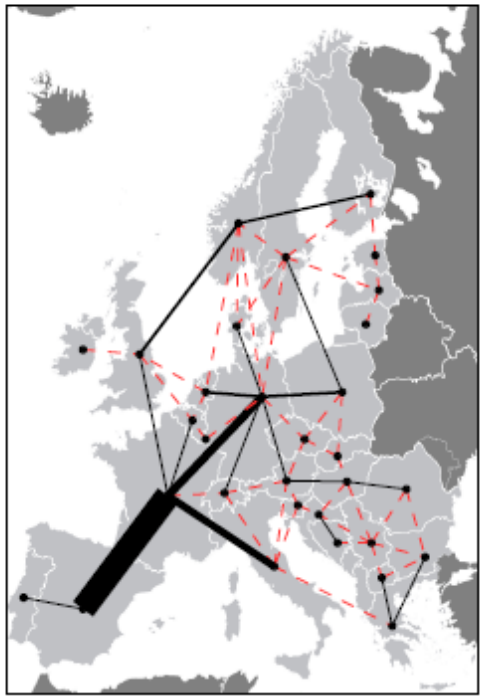


New infrastructure

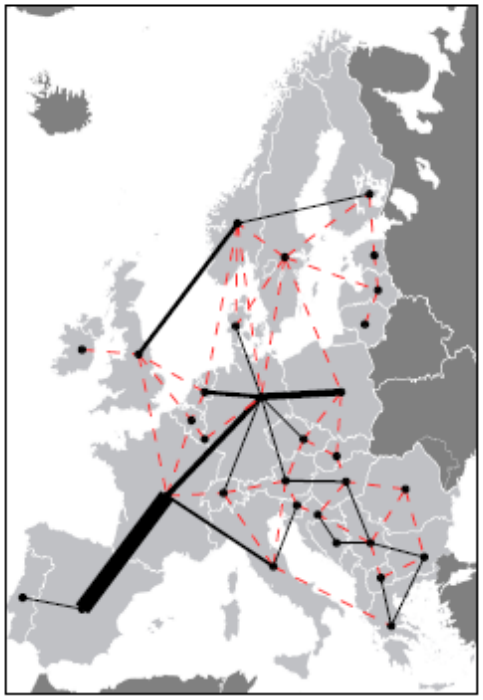
650 ppm



450 ppm

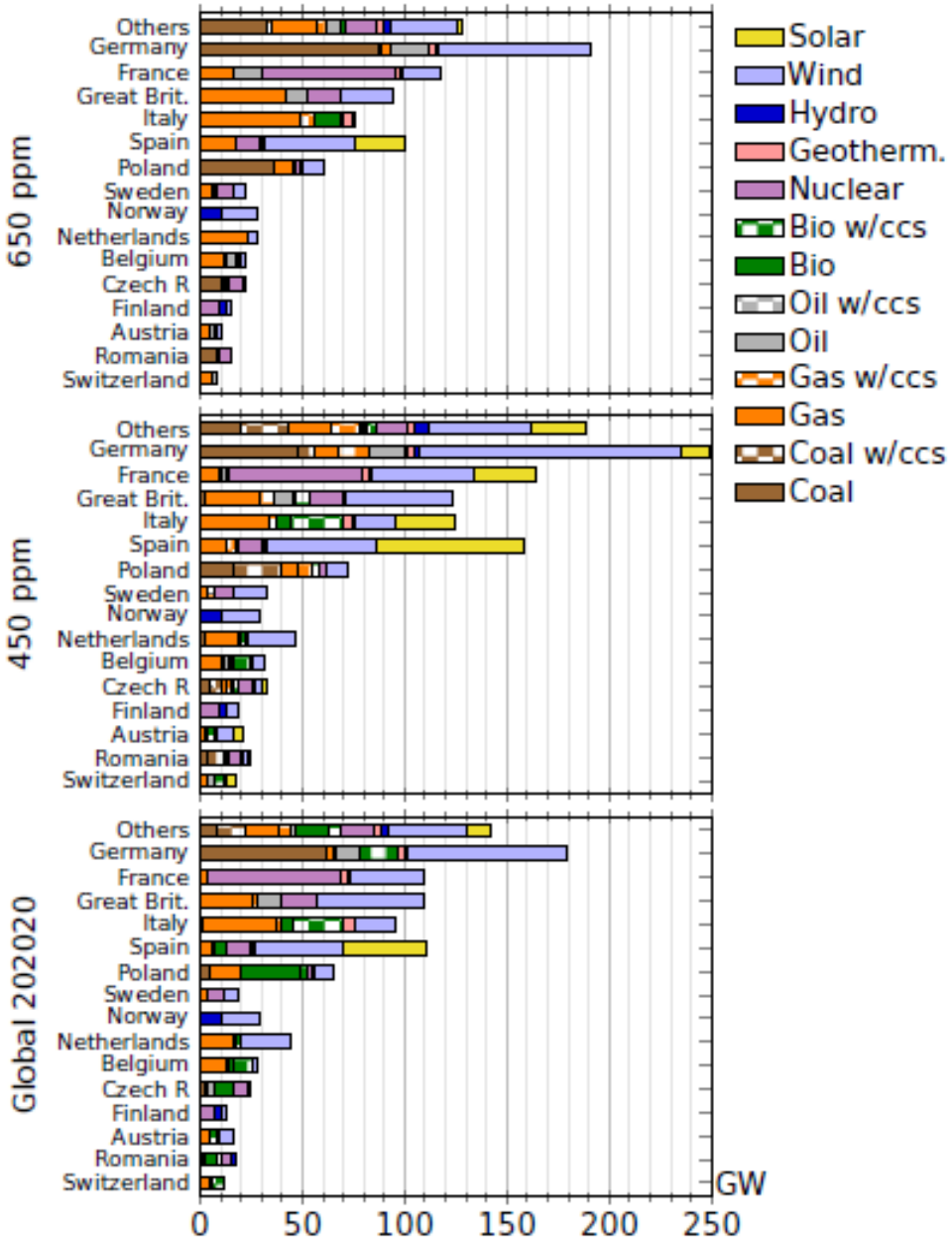


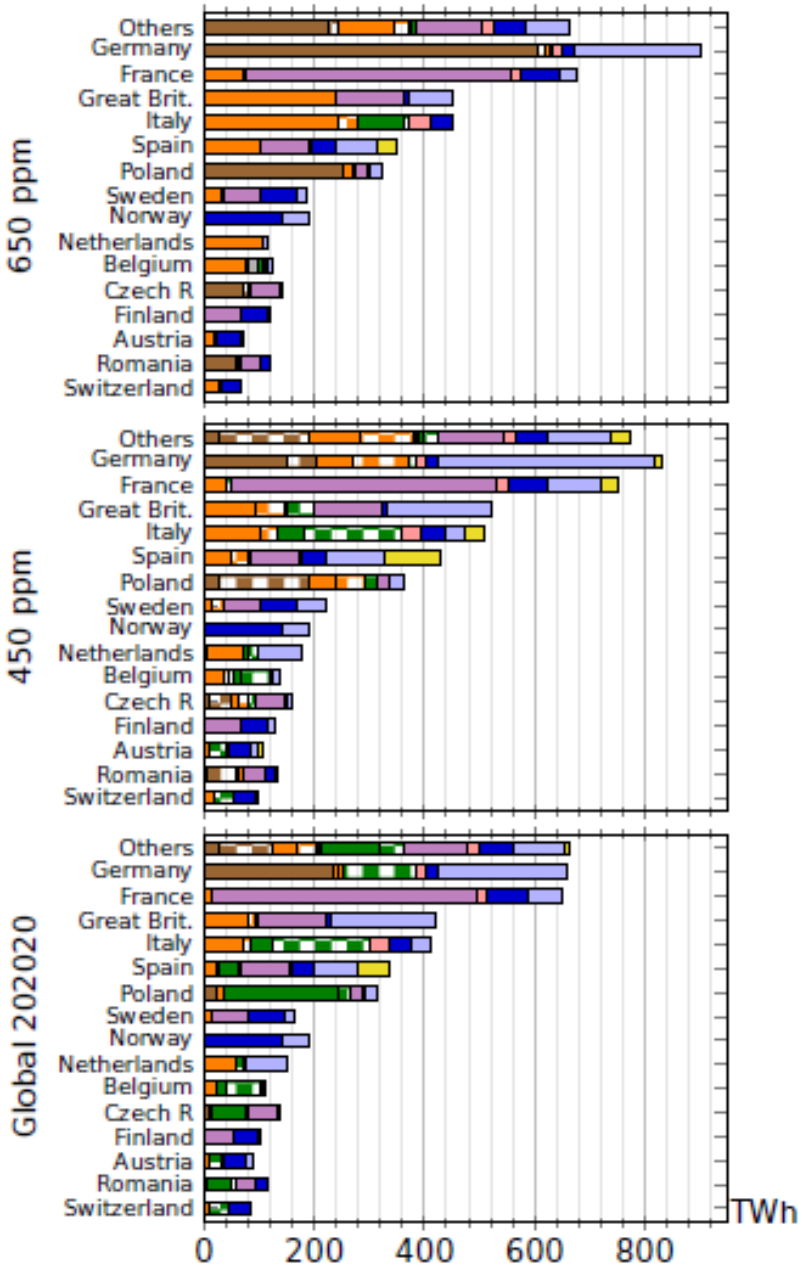
Global 202020



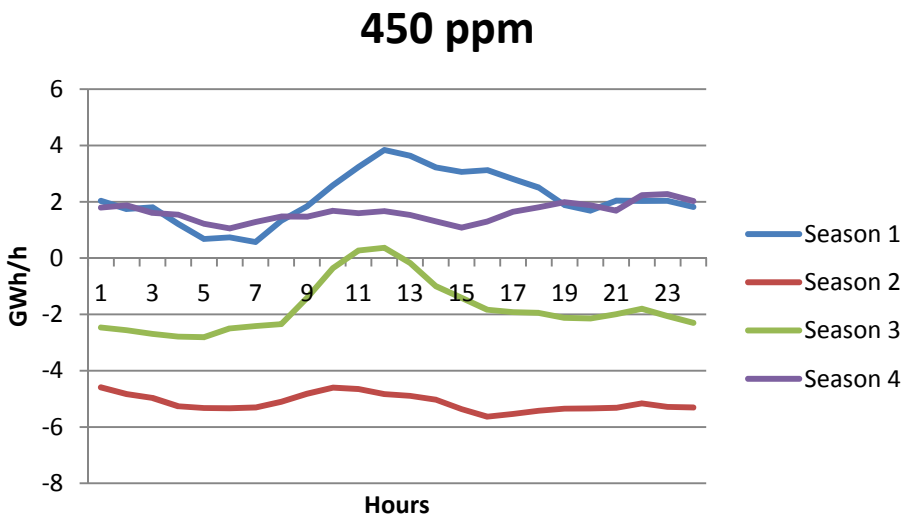
Ce Centre

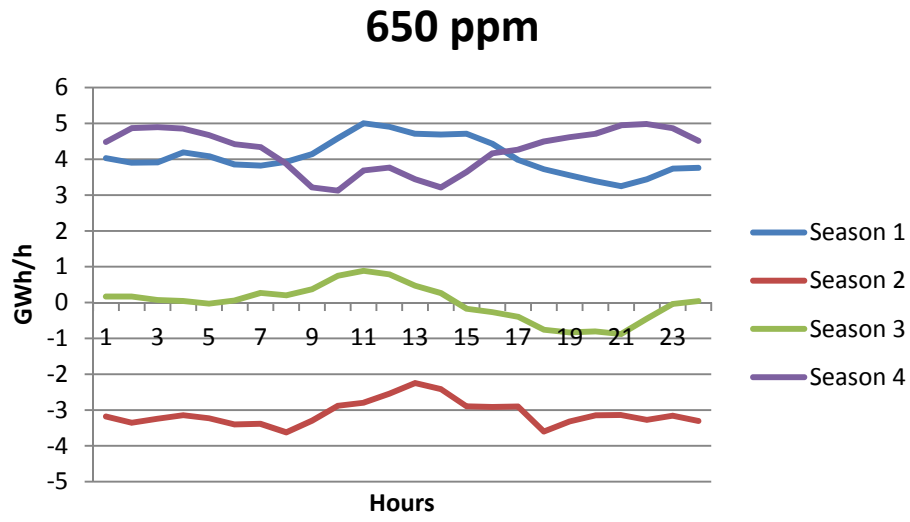
No invest — 0.5 GW — 1 GW — 2 GW
3 GW — 4 GW — 5 GW — 10 GW

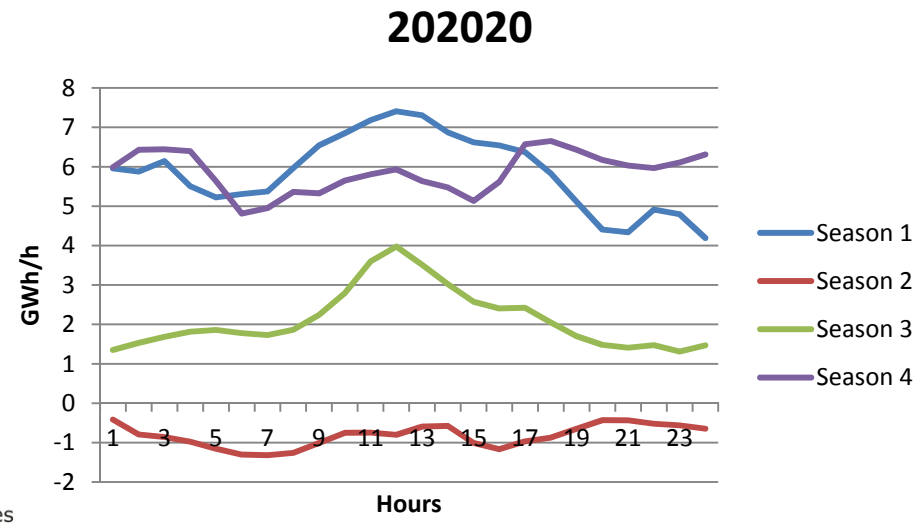




Result example: Power exchange







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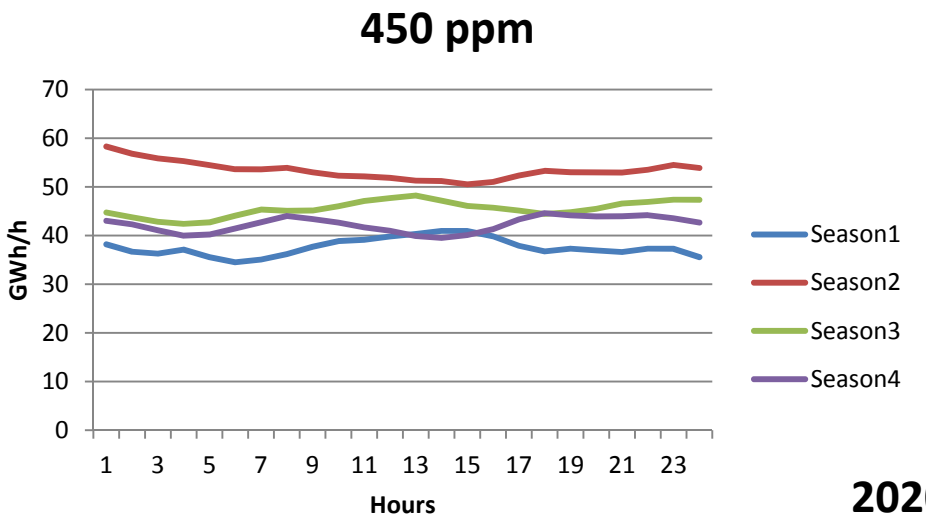
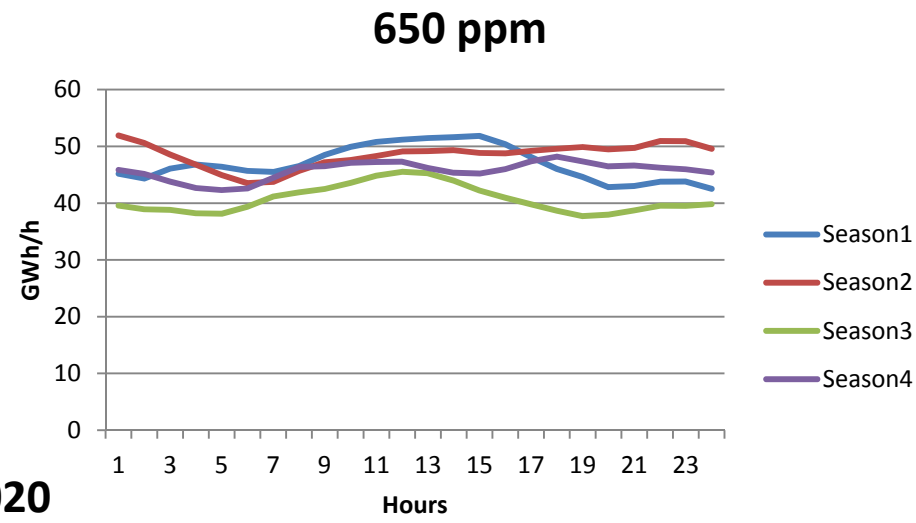
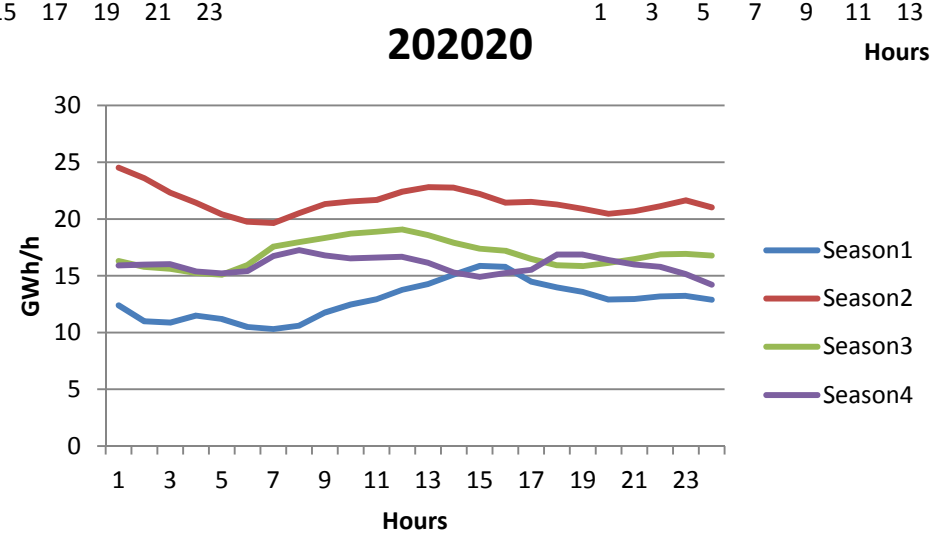
Result example: Electricity from NG







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Conclusions

Uncertain future – many scenarios
Rapid changes may come (…Fukoshima)

Natural gas is easily storable and may provide substantial flexibility
Hydro reservoirs = always an excellent energy storage

We probably need governmental agreements and new markets
Large opportunity for Norway to investigate

We are currently performing quality checks of the results in the paper and plan to publish it soon