

Multiscale Stochastic Programming

Flexible Neighborhoods in the European Power System

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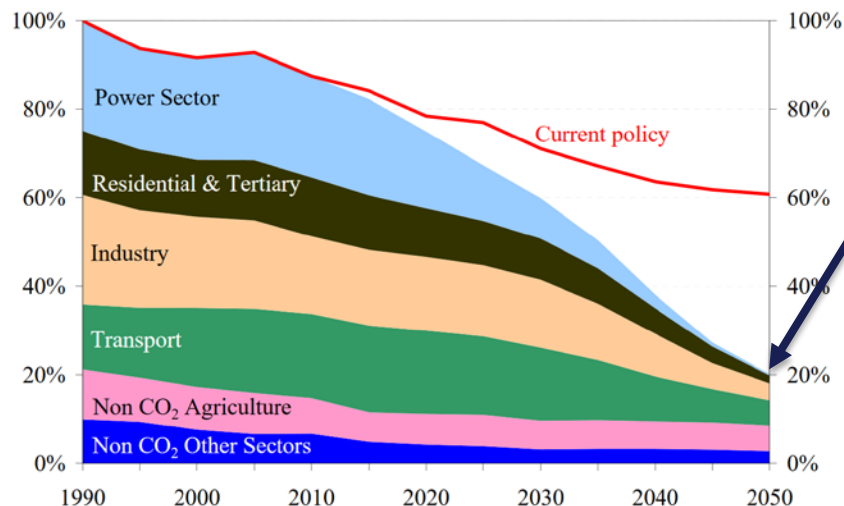
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Content

- Why this model?
- Why neighbourhoods?
- Modeling framework

Decarbonization

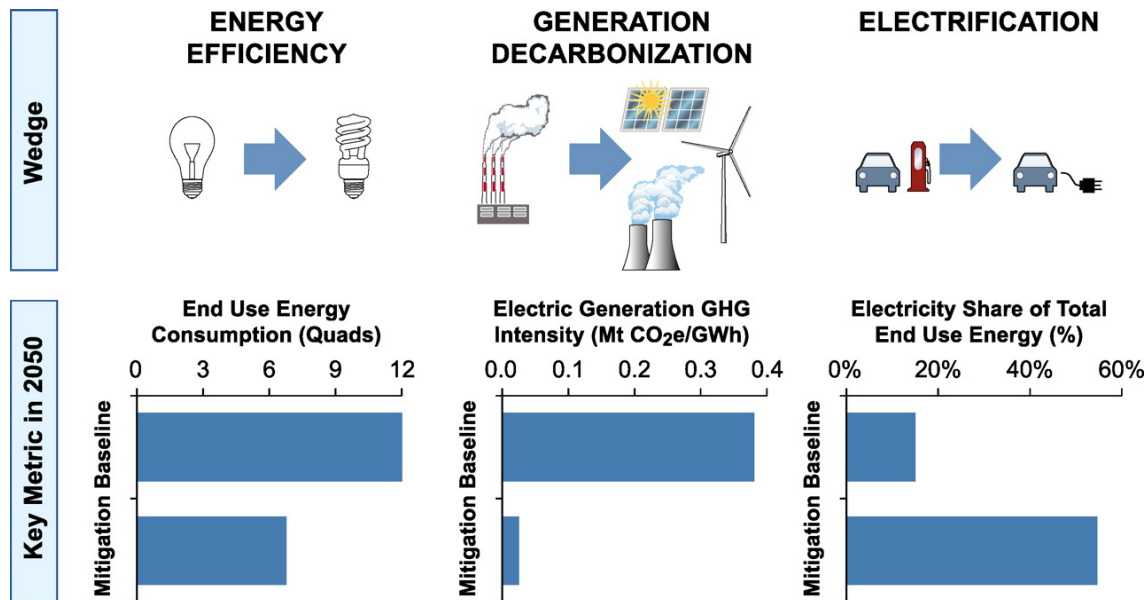
Figure 1: EU GHG emissions towards an 80% domestic reduction (100% =1990)



Near full
decarbonization of
power

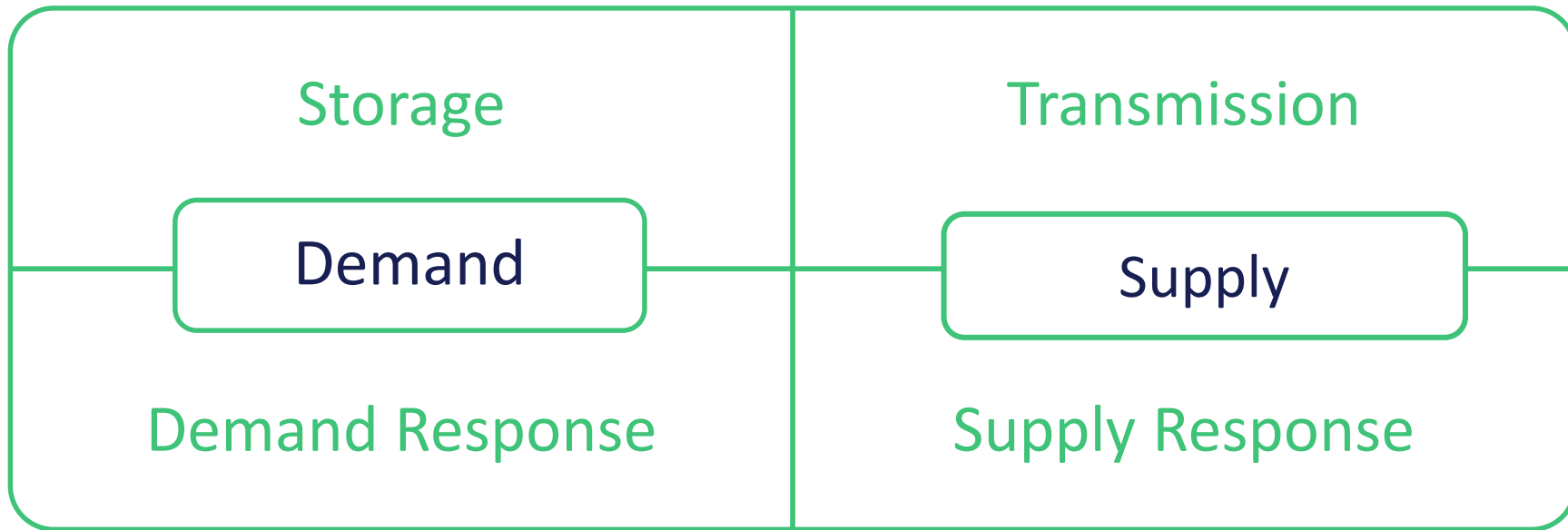
Source: European Commission. (2011). A Roadmap for moving to a competitive low carbon economy in 2050. *Communication from The Commission to The European Parliament, The Council, The European Economic and Social Committee and The Committee of The Regions, COM(2011).*

Decentralization



Williams, James H., et al. "The Technology Path to Deep Greenhouse Gas Emissions Cuts by 2050: The Pivotal Role of Electricity". Science 335.6064 (2012): 53-59.

Democratisation



Digitalisation



**we
power**

Financing



Green labeling



EV charging



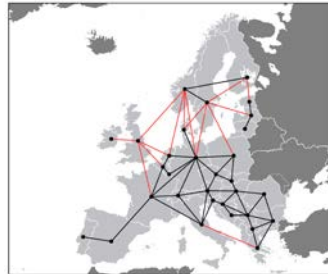
Internet of things (IoT)

Integrated energy system: Multi-scale stochastic capacity expansion



Temporal scale

- Investment
- Operation
- Uncertainty



Spatial scale

- European interconnected power system



Demand scale

- Electric load
- Thermal load

Operational time scale: Representative seasons

- Representative weeks
 - 168 consecutive hours
- Peak day and night
 - 24 consecutive hours

- | Season split
- Regular sample
- Peak sample



Modeling neighbourhood components

Thermal demand



Buildings
in Norway (SSB):

Approx. 33 %
of electricity
consumption

Approx. 60 %
thermal electric
consumption

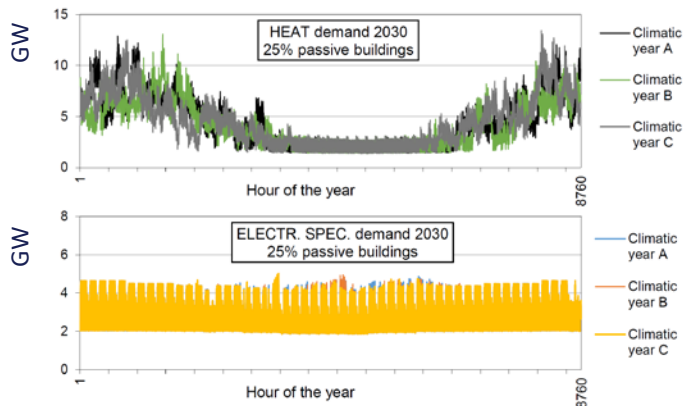
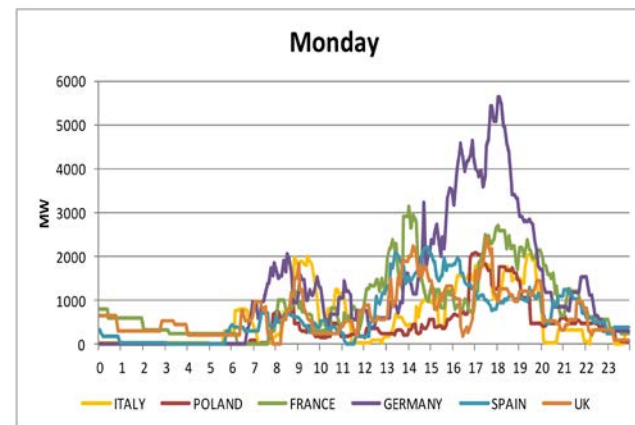


Figure C-4 Hourly load profiles for heat demand (upper) and electric specific demand (lower) of region NO1 in 2030, with a passive share of 25 %. (Predictions are made for three different climatic years).

Lindberg, Karen Byskov. "Impact of Zero Energy Buildings on the Power System: A study of load profiles, flexibility and system investments." (2017).

EV demand



10 % EV share

15 % of
remaining capacity

Pasaoglu, G., et al. "Projections for electric vehicle load profiles in Europe based on travel survey data." *Joint Research Centre of the European Commission: Petten, The Netherlands* (2013).

Model decisions



Generator

Electric+Thermal
Dispatchable
Non-dispatchable



Storage

Electric+Thermal
Power+Energy



Converter

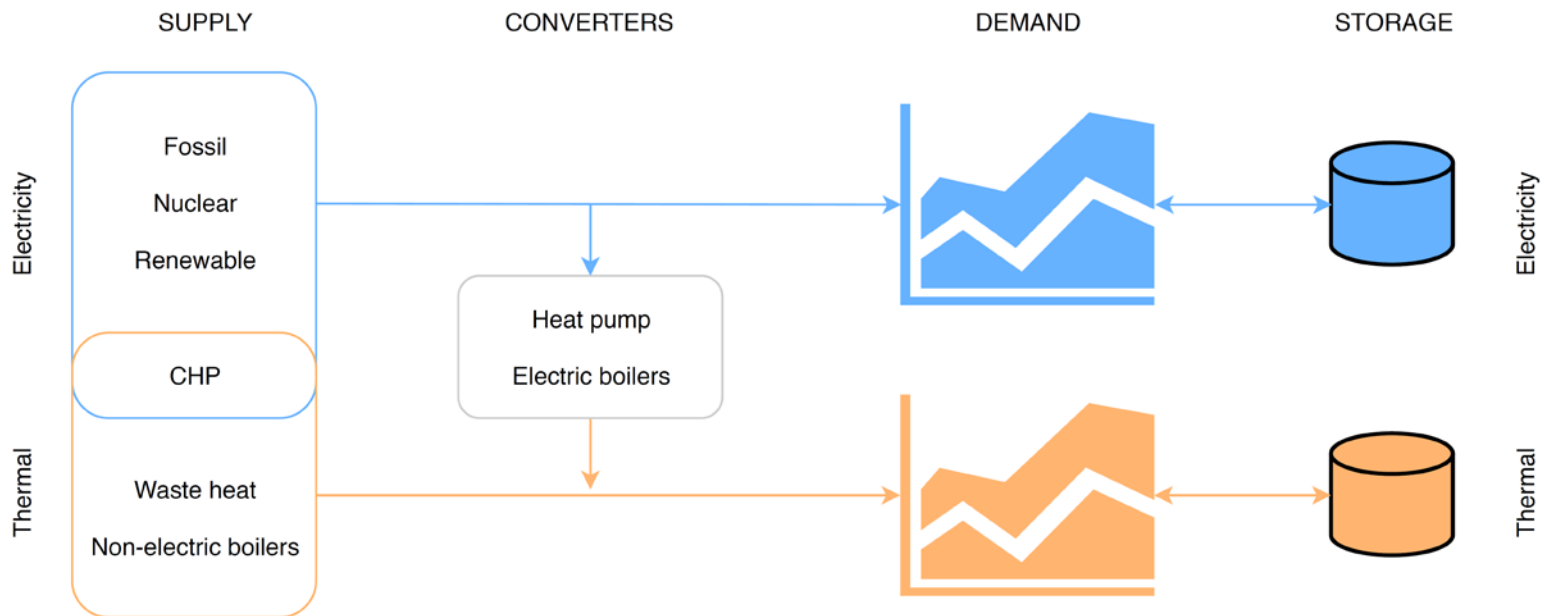
Electric → Thermal



Transmission

Power lines
Net Transfer Capacity (NTC)

Model decisions



Thank you!



<https://fmezen.no>



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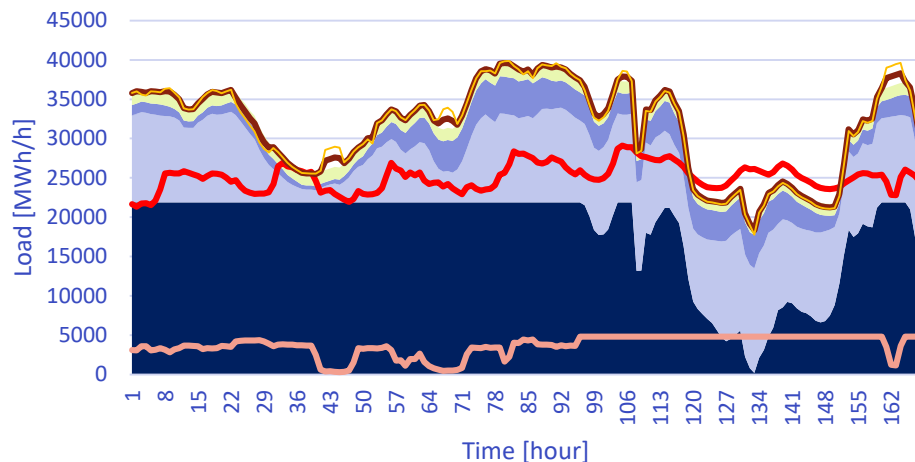


FME ZEN (page)

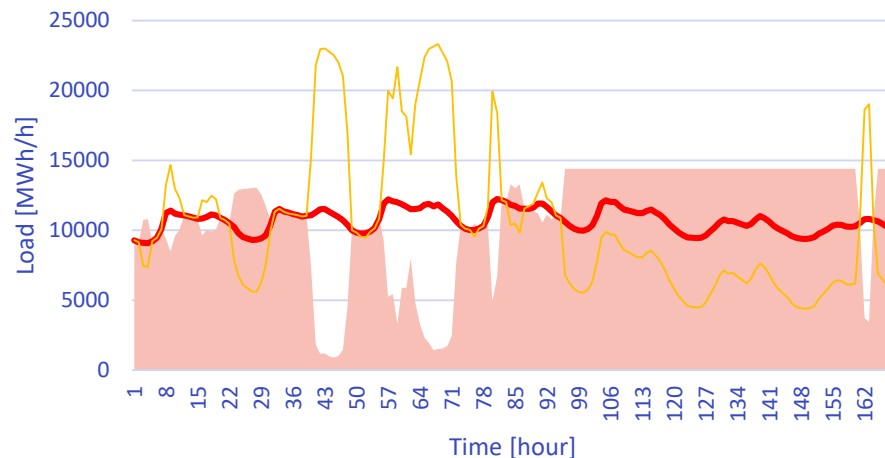
stian.backe@ntnu.no

Model (dummy) output

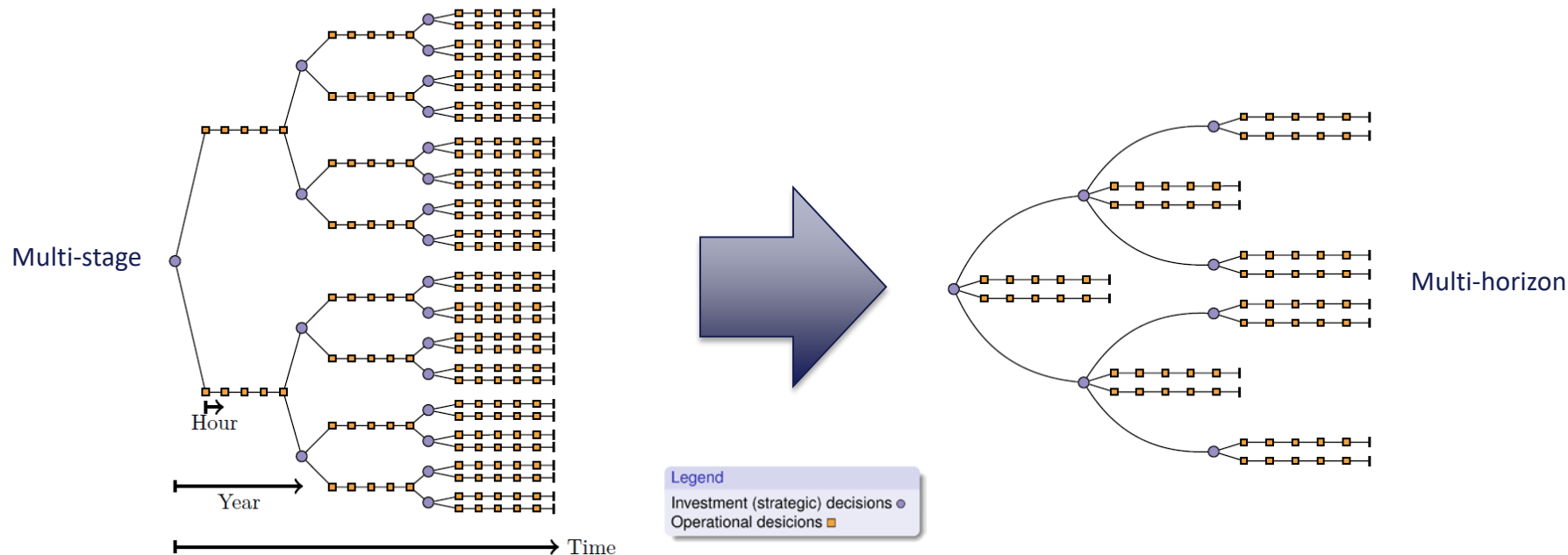
Norway, 2050, Winter week, Electricity market



Norway, 2050, Winter week, Thermal market



Multi-horizon stochastic programming



«The Energy Trilemma»

