



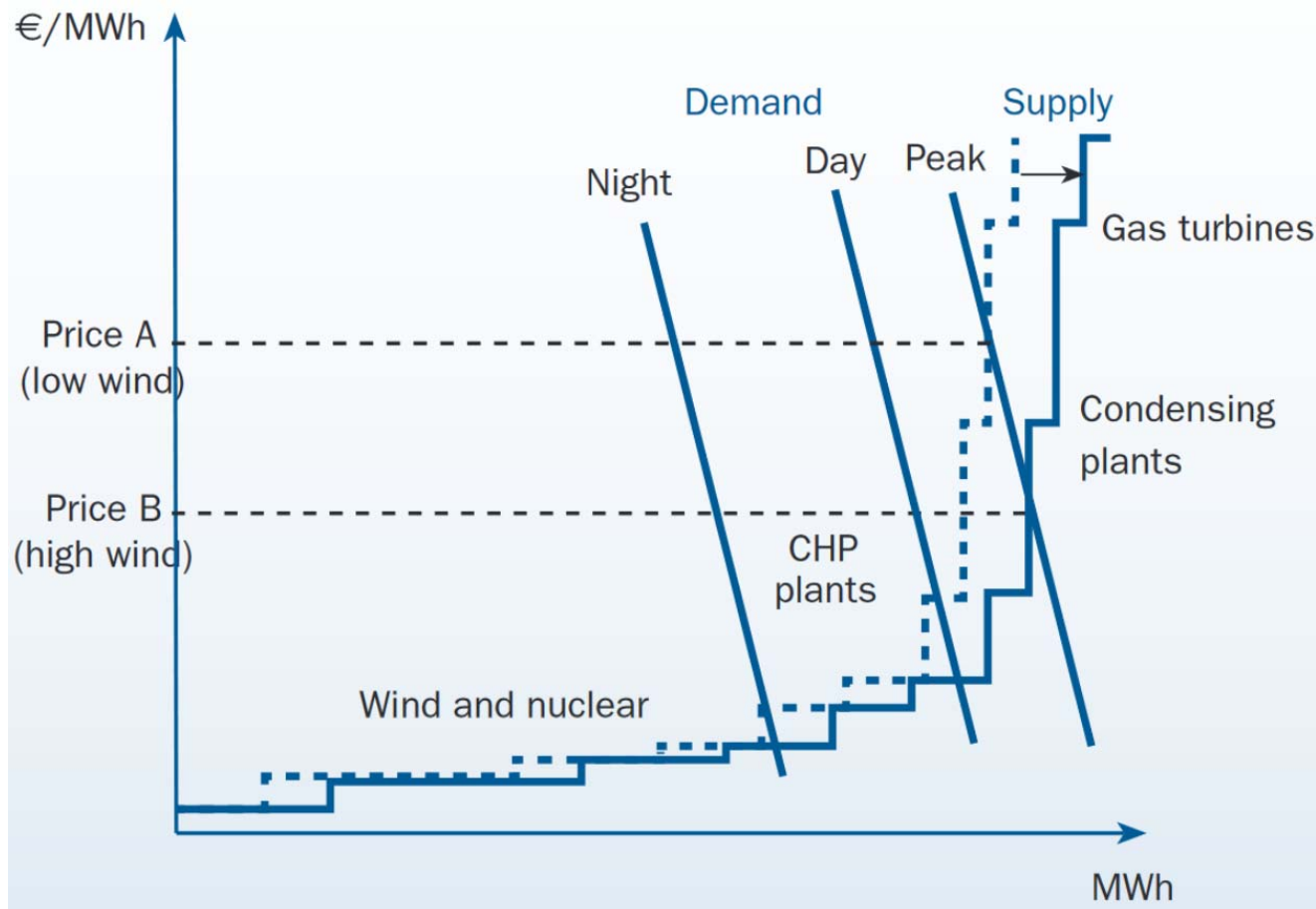
Operational analysis of future renewable energy systems

Peter Sorknæs, AAU

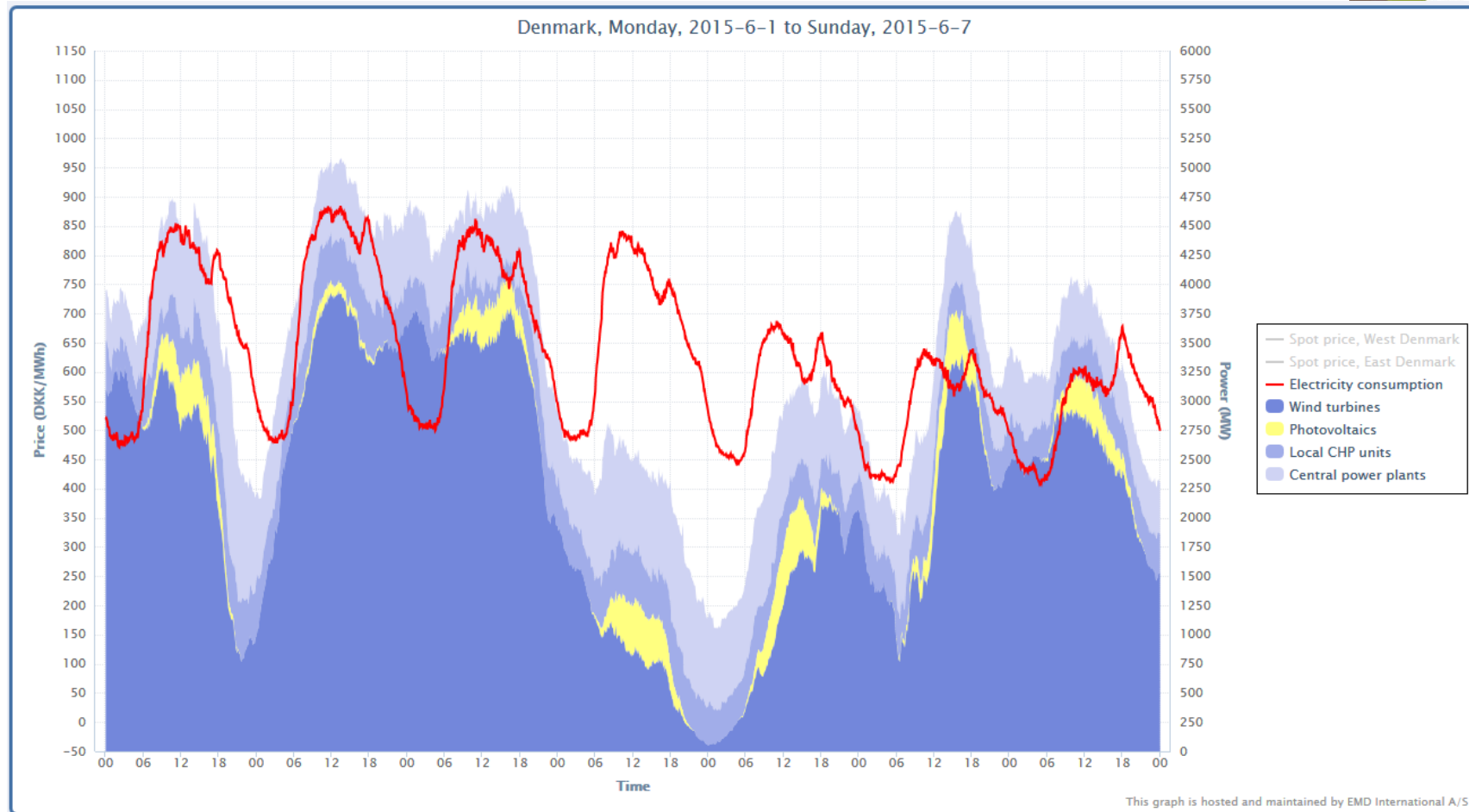


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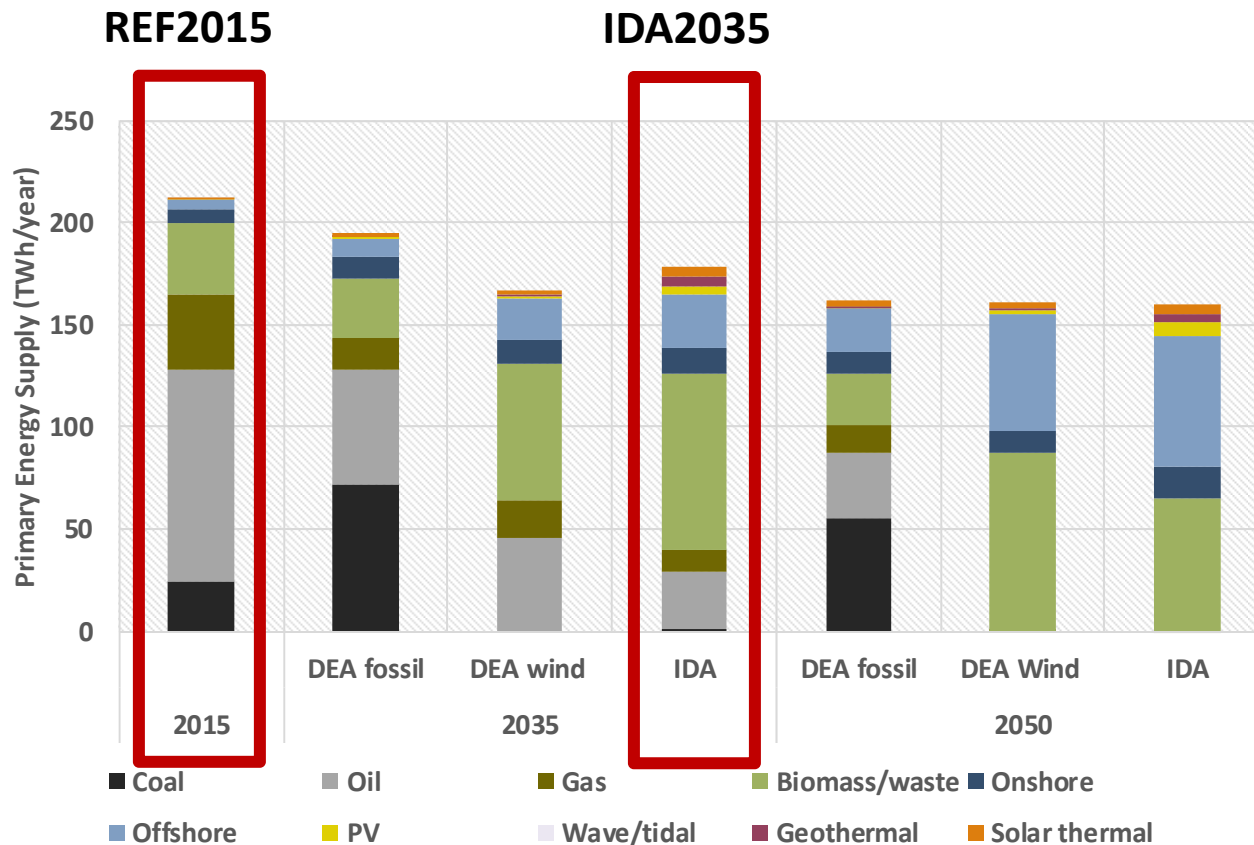
The merit order effect



Example of variable renewable energy production



Using scenarios to investigate the issue - IDA's Energy Vision 2050



The Danish Society of Engineers, IDA
a modern professional association for
technical and science professionals

IDA's Energy Vision 2050

A Smart Energy System strategy for 100% renewable Denmark



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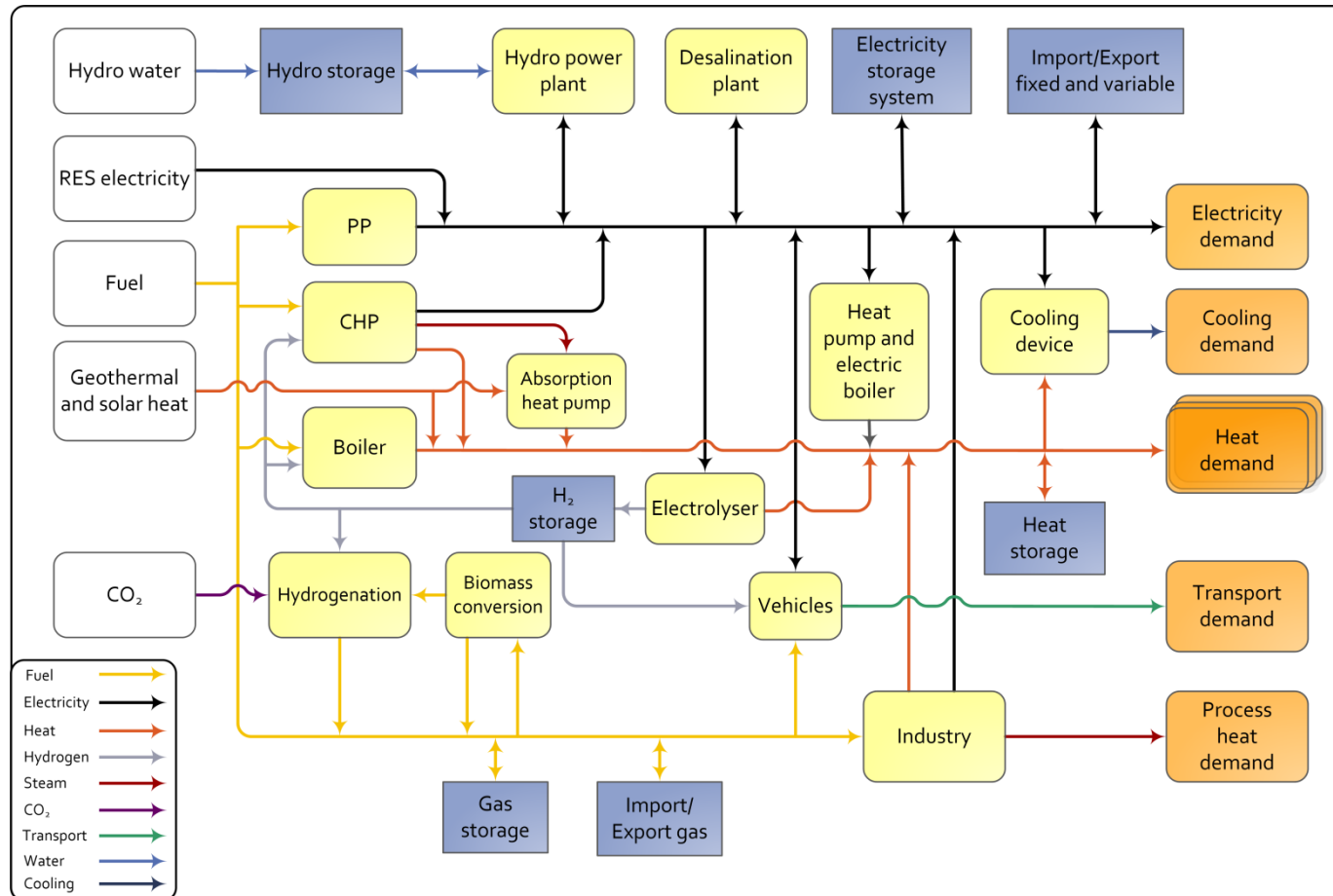
3rd international conference on
SMART ENERGY SYSTEMS AND 4TH GENERATION DISTRICT HEATING
Copenhagen, 12-13 September 2017

www.4dh.eu

www.reinvestproject.eu

www.heatroadmap.eu

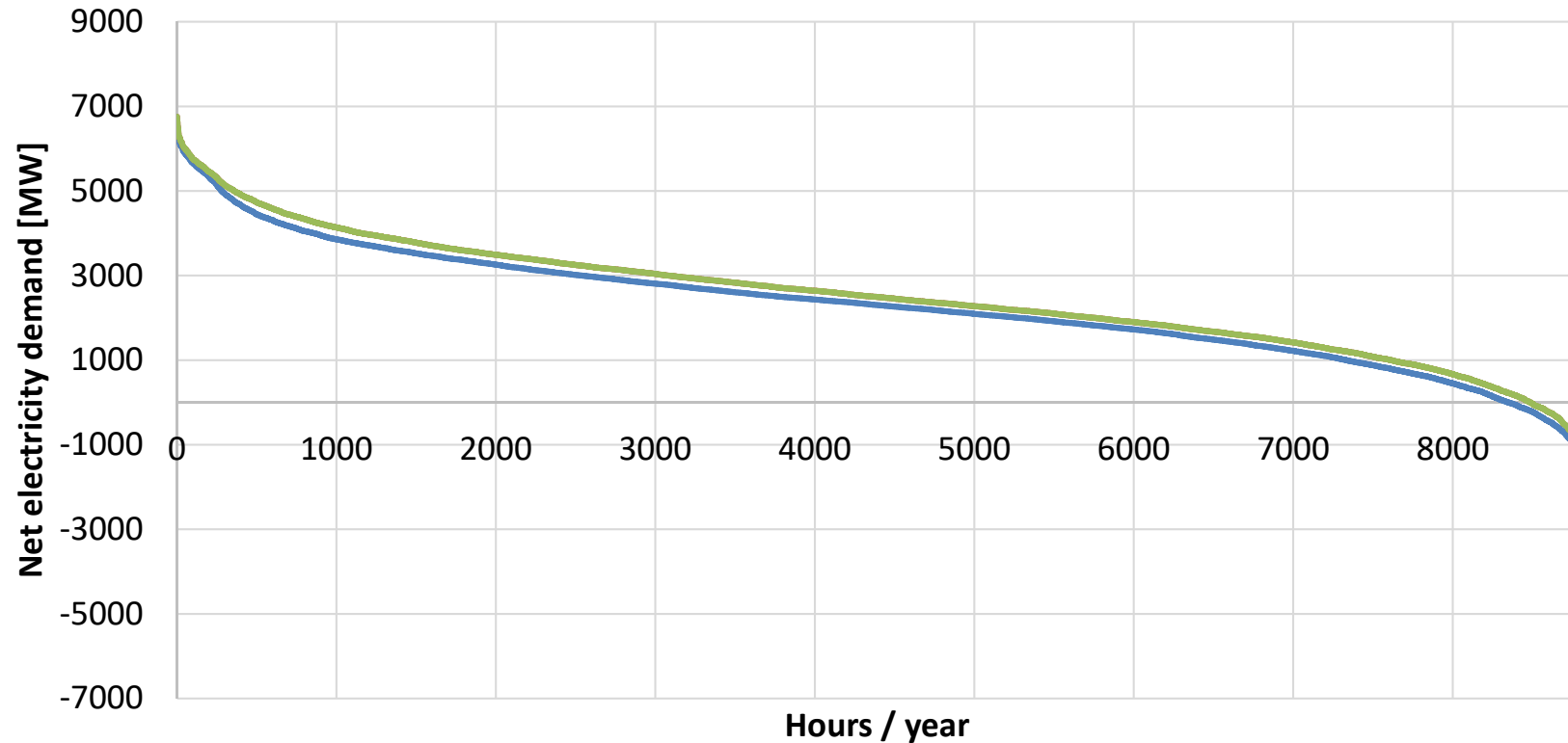
EnergyPLAN – hourly based tool for simulation of energy systems



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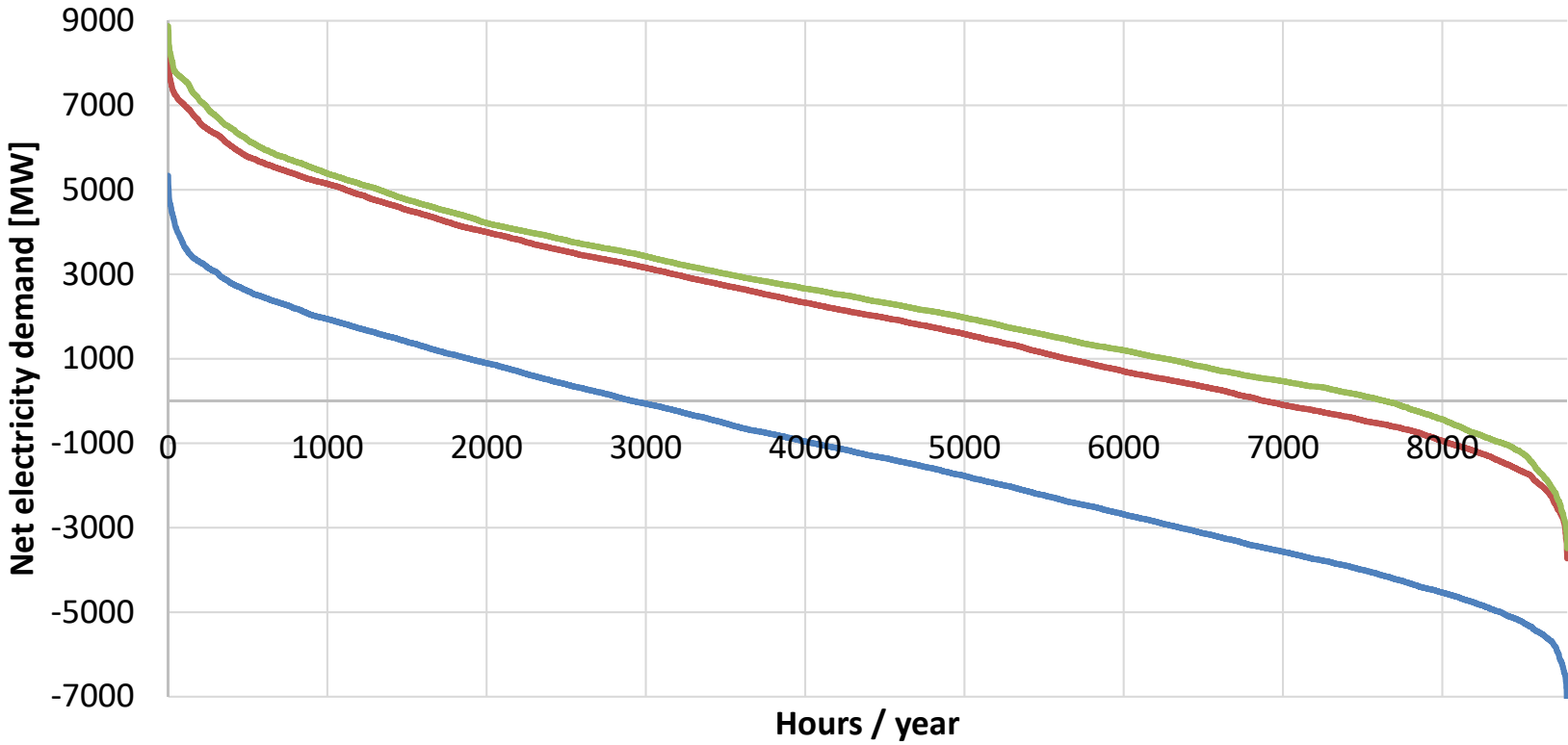
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Duration curves for types of net electricity demands – REF2015



— Net hourly fixed — Net hourly and yearly fixed — Net all

Duration curves for types of net electricity demands – IDA2035



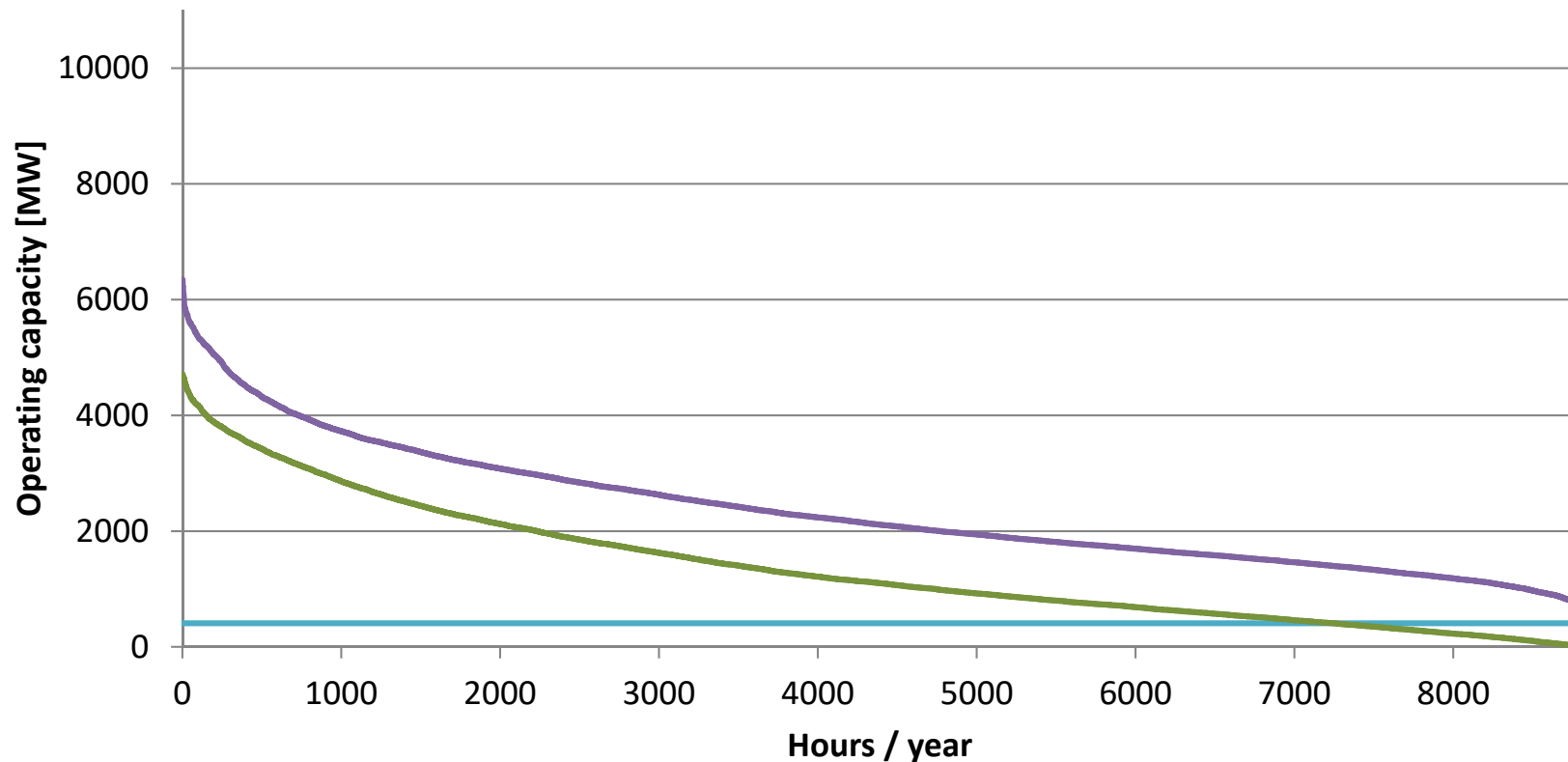
— Net hourly fixed — Net hourly and yearly fixed — Net all



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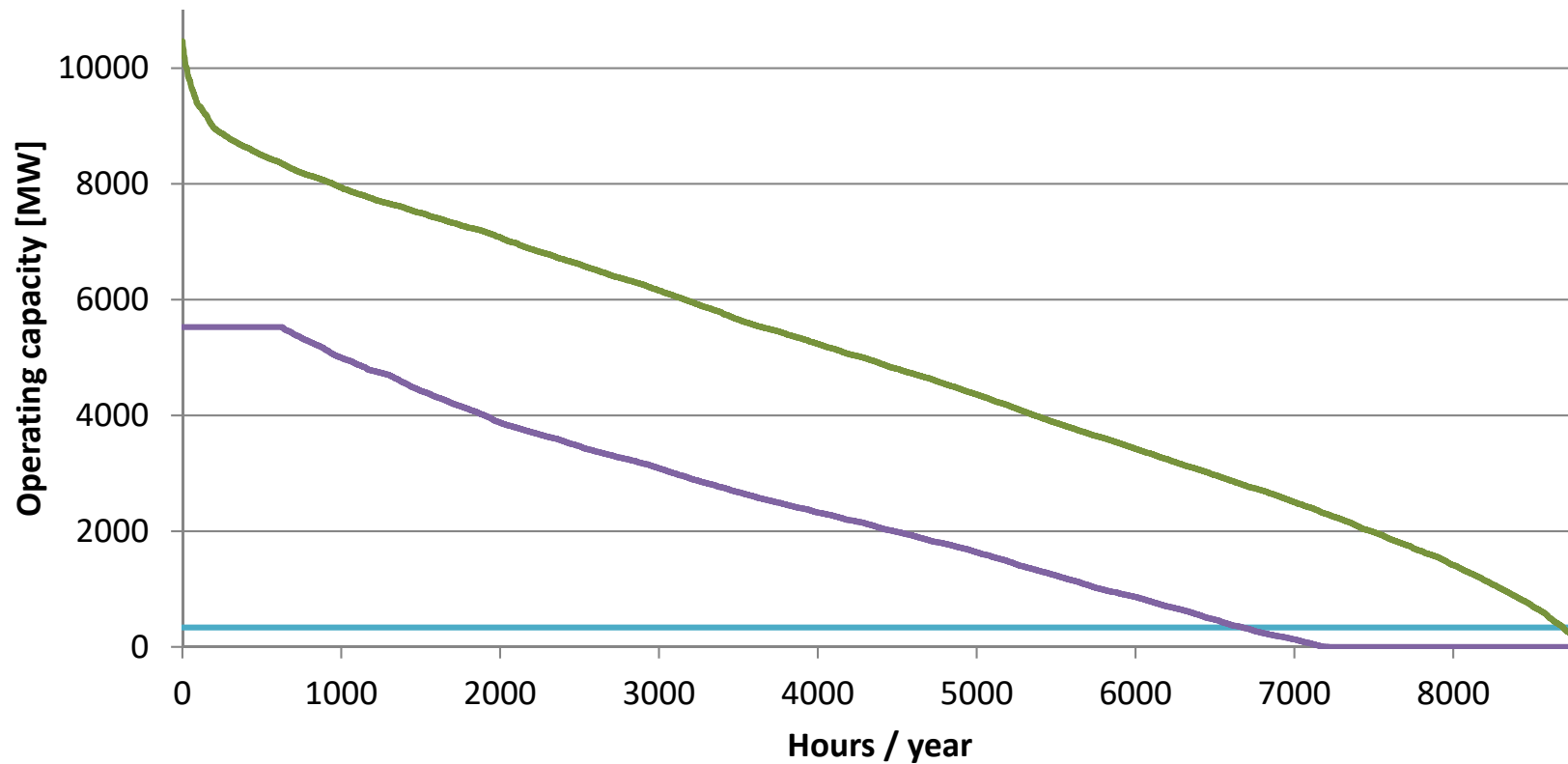
Net demand = Demand - variable RES production

Duration curves – REF2015



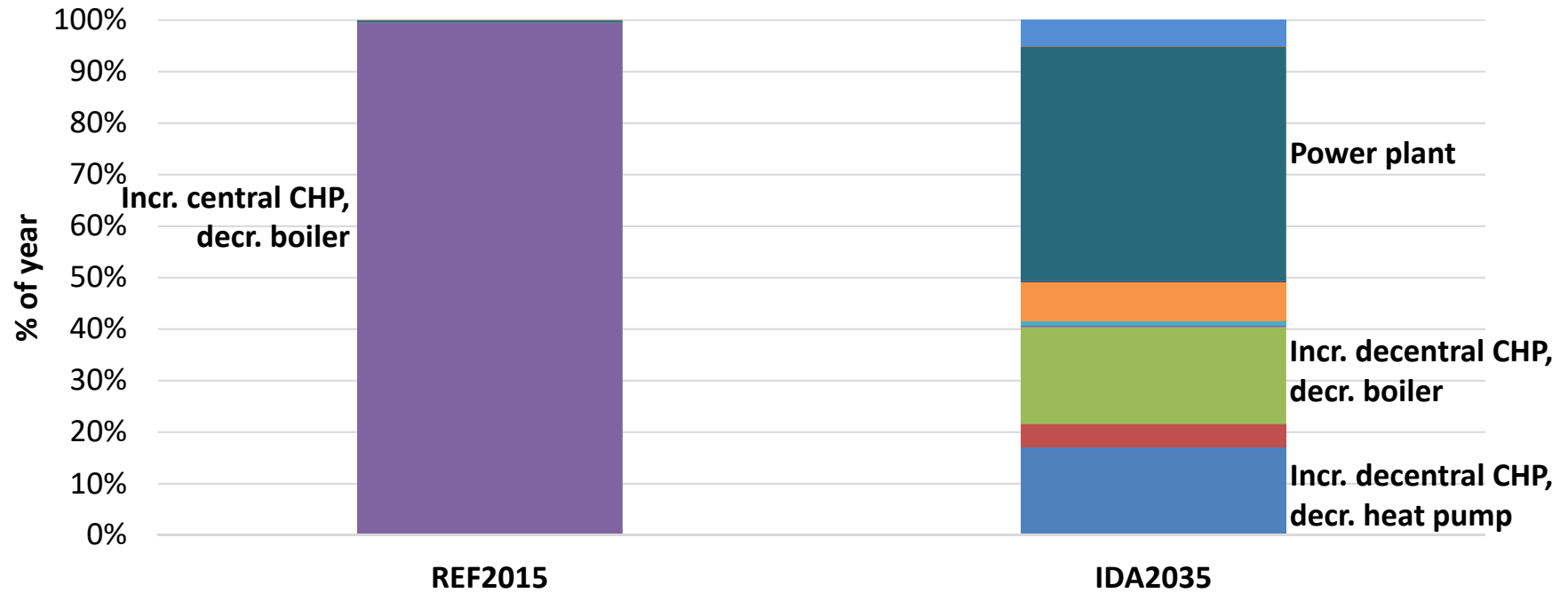
— CSHP — Variable RES — Thermal plants

Duration curves – IDA2035



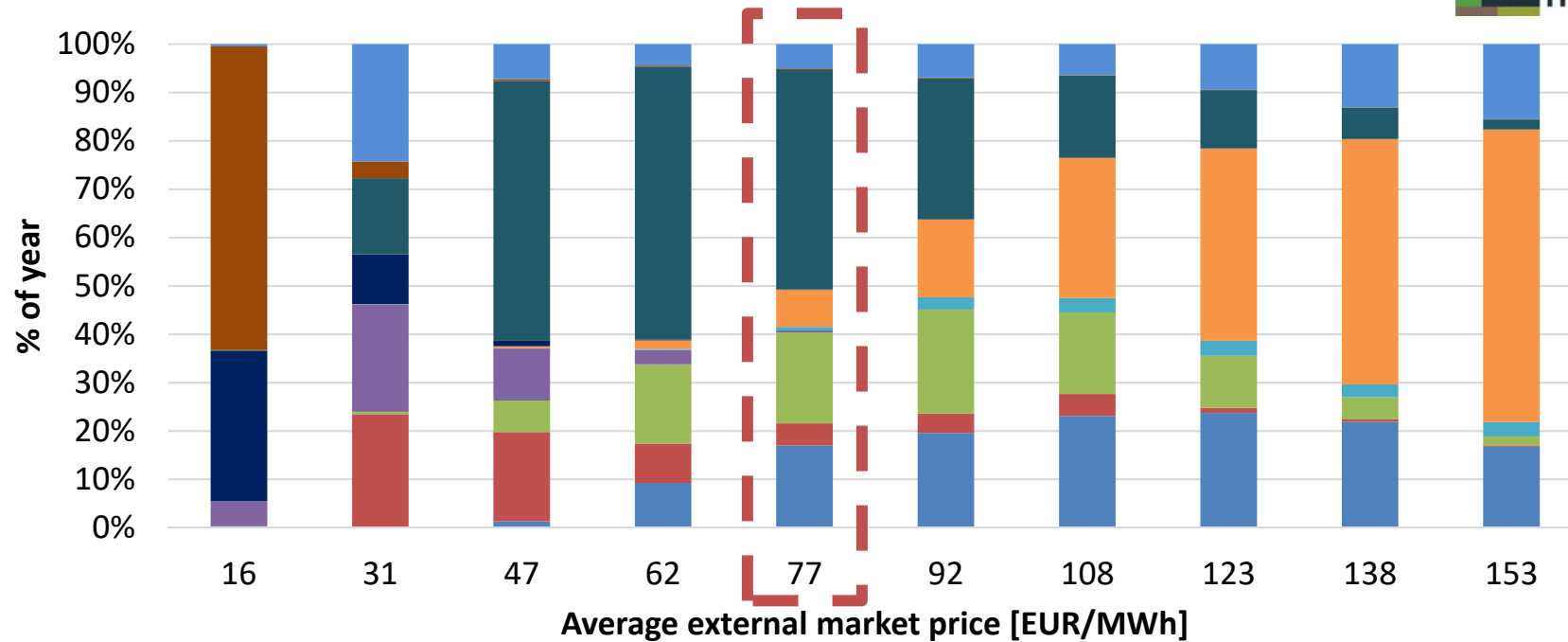
— CSHP — Variable RES — Thermal plants

Marginal activated unit in Denmark



- Incr. CHP2 decr. HP2 ■ Incr. CHP3 decr. HP3 ■ Incr. CHP2 decr. B2 ■ Incr. CHP3 decr. B3
- Incr. B2 decr. HP2 ■ Incr. B3 decr. HP3 ■ Incr. CHP3 decr. ELT3 ■ Incr. B3 decr. ELT3
- Power plants ■ Variable RES ■ Rest

Marginal activated unit in Denmark at different external system price levels – IDA2035



- Incr. CHP2 decr. HP2 ■ Incr. CHP3 decr. HP3 ■ Incr. CHP2 decr. B2 ■ Incr. CHP3 decr. B3
- Incr. B2 decr. HP2 ■ Incr. B3 decr. HP3 ■ Incr. CHP3 decr. ELT3 ■ Incr. B3 decr. ELT3
- Condensing power ■ Variable RES ■ Rest

Yearly profit at 10 different price levels for the external electricity market – IDA2035

