HOW LARGE A ROLE SHOULD INDUSTRIAL ENERGY SAVINGS AND ELECTRIFICATION PLAY IN THE DANISH ENERGY POLICY MIX?

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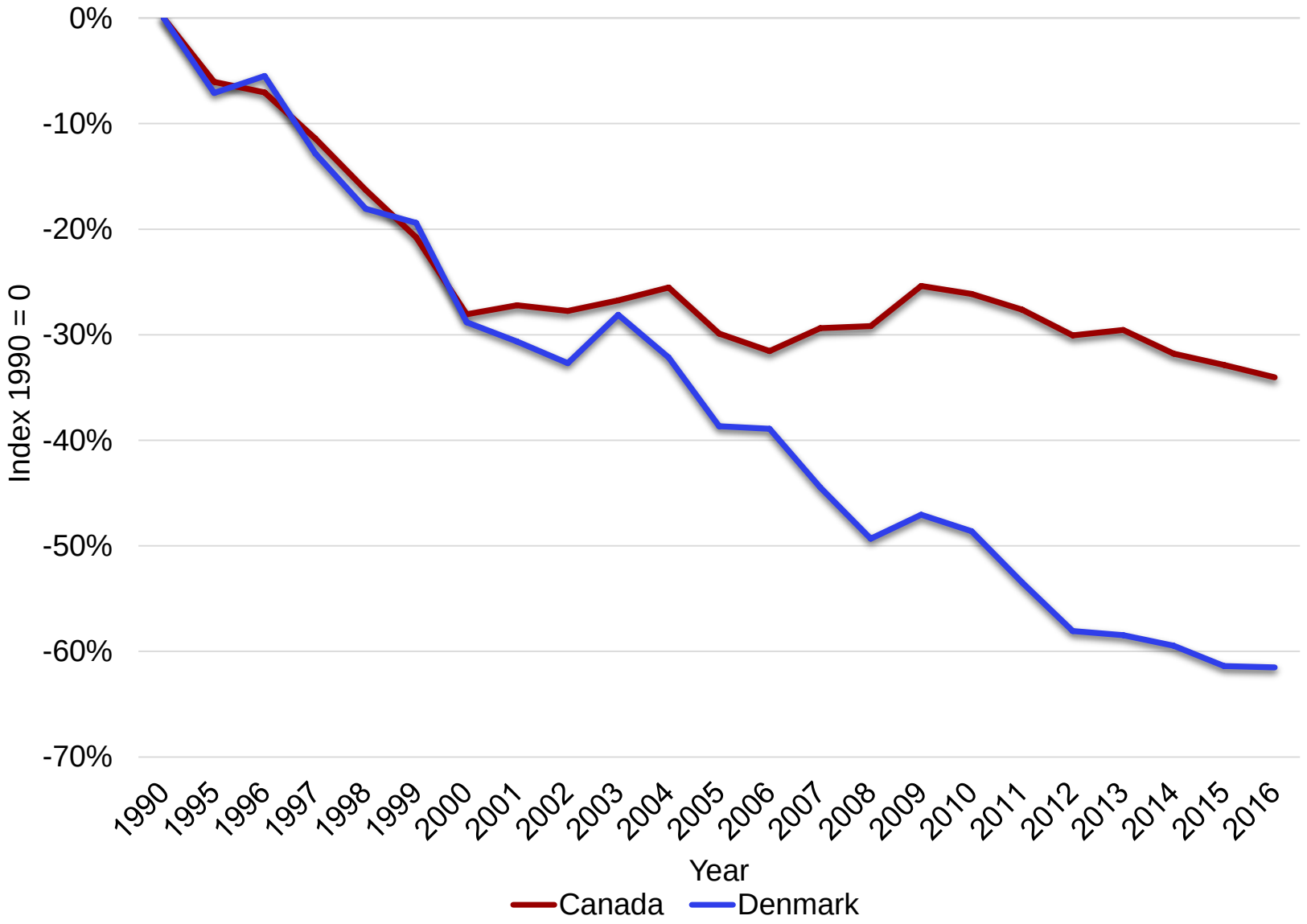
Industrial energy consumption in Denmark

- Relatively low energy intensity
- Diverse composition of resources
- Low taxation
- Ambitions to reduce fossil fuel consumption
- Fossil fuel reduction options in use of natural gas

Energy intensity in manufacturing [ENERGY/GDP]



Composition of industrial energy demand: Savings and electrification

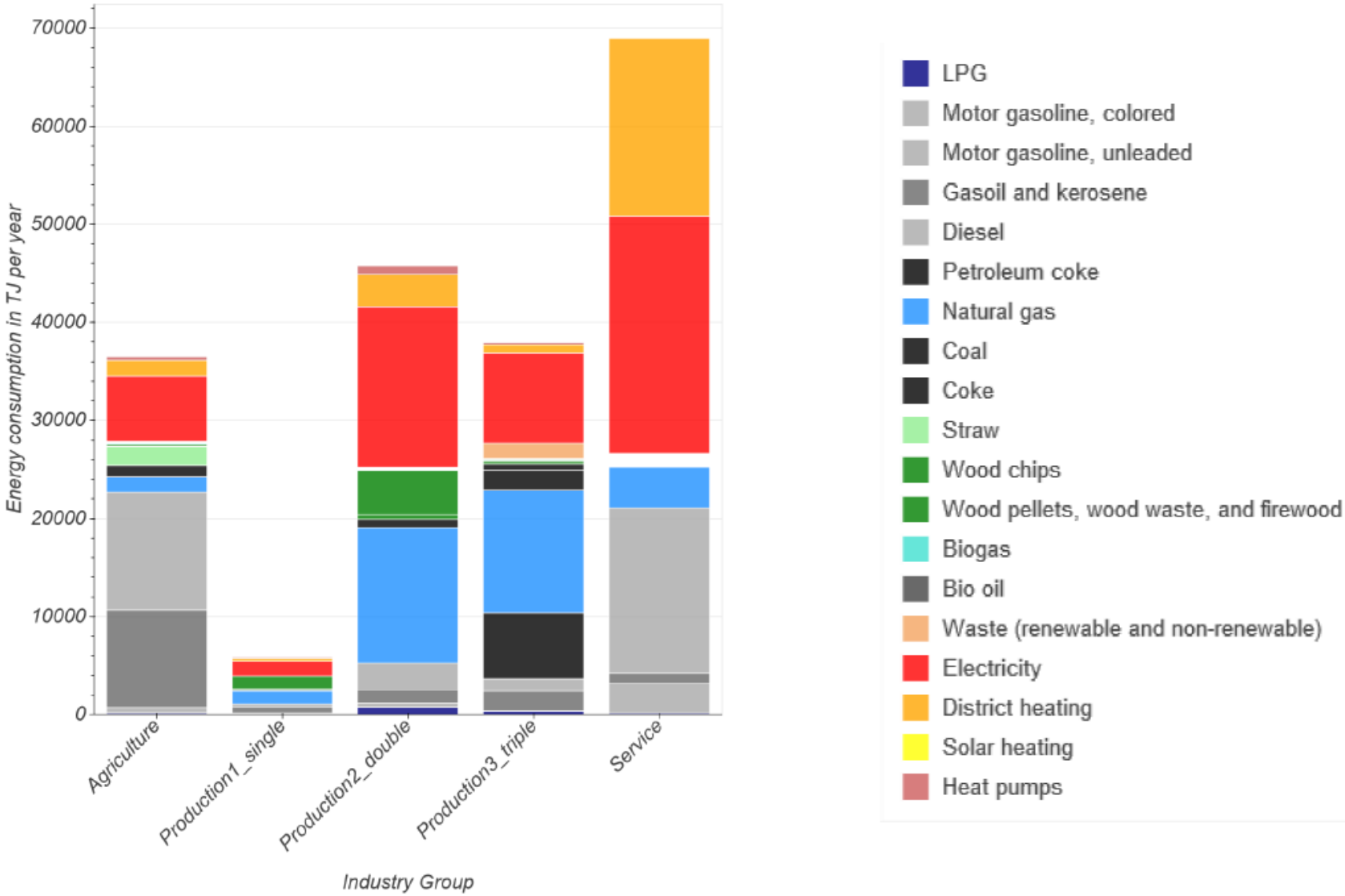
- Composition of final demand (2012)
  - Electricity 29%
  - Fossil fuels 55%

- End use savings and electrification – hourly profiles
  - Electricity savings follow electricity demand profile
  - Electrification of natural gas follow gas demand profiles

- Construction of profiles depending on variability of demand:1-2-3 shift consumption mode
  - 3 shift mode is probably stable and 2 shift less stable
  - Savings of electricity more valuable if unstable – 1 and 2 shift industries
  - Electrification of gas (fossil) demand most attractive if stable – 3 shift

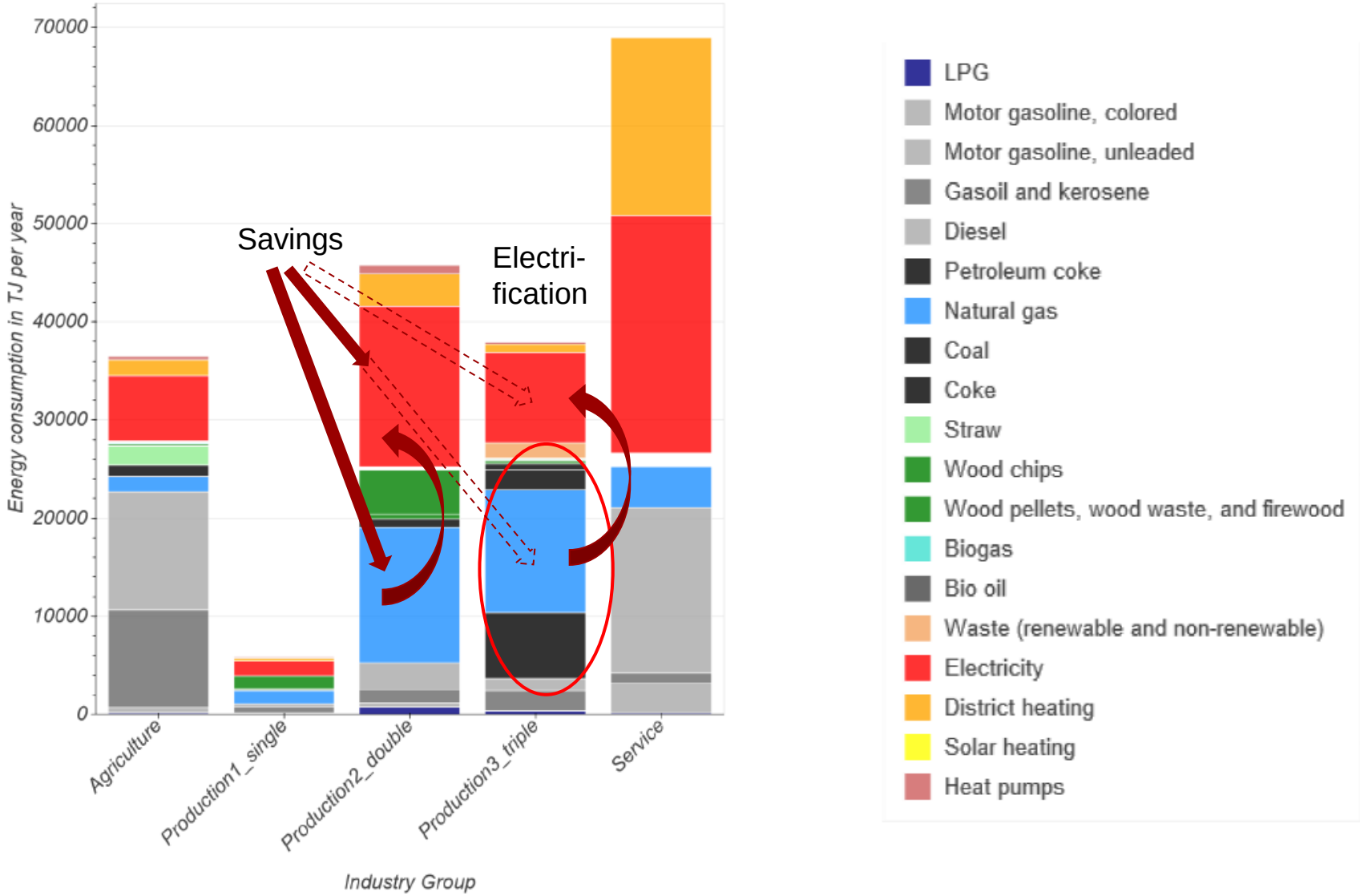
Savings and electrification targets

Based on 57 sub-sectors, 22 end-uses and 20 fuels (Source: Wiese F, Baldini M Pathways to Carbon Neutral Industrial Sectors: Integrated Modelling Approach with High Level of Detail for End-use Processes 12th SDEWES Conference, Dubrovnik 2017)



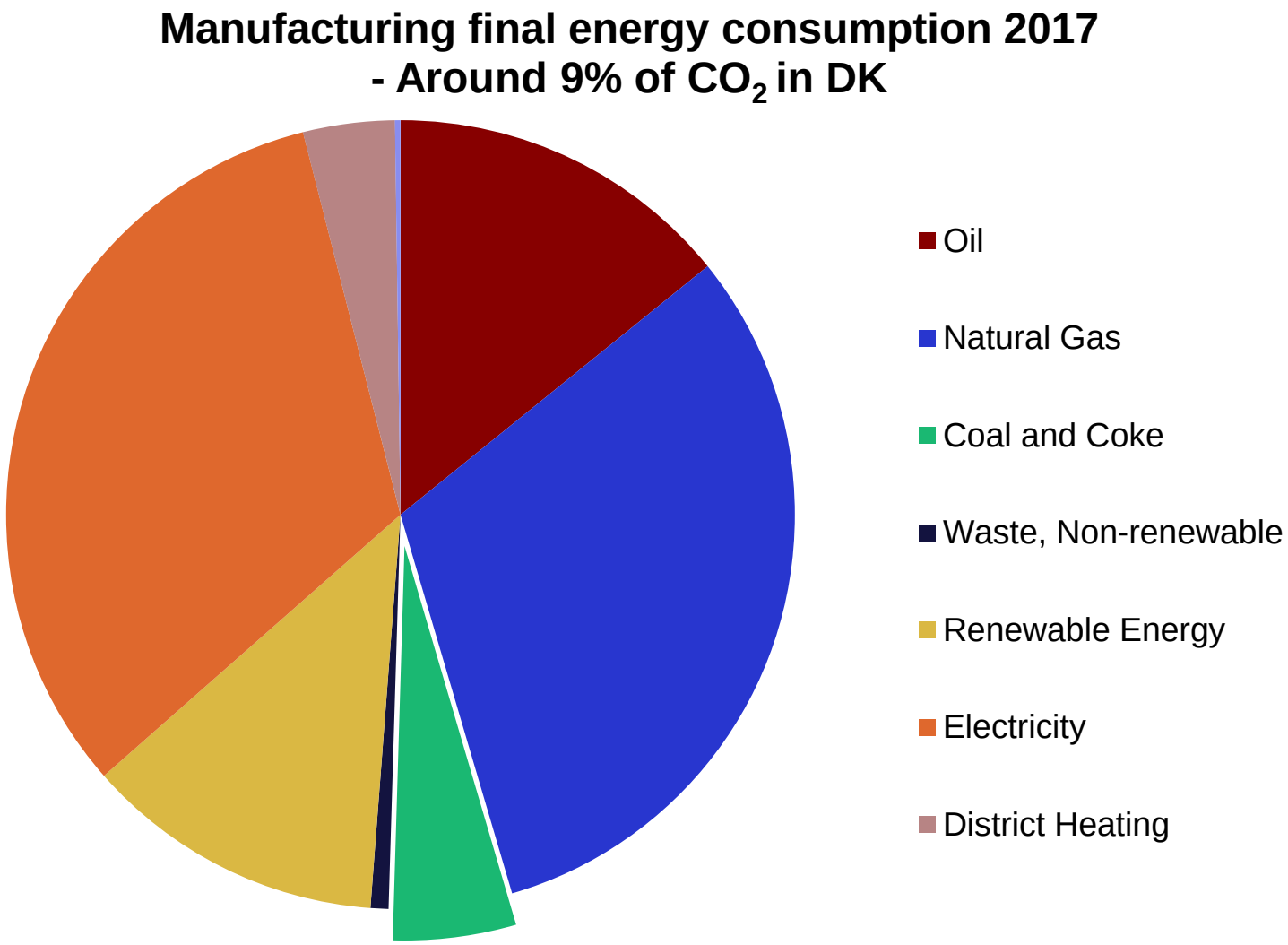
Final energy use in different Danish industry groups by fuel based on data for 2012

Savings and electrification

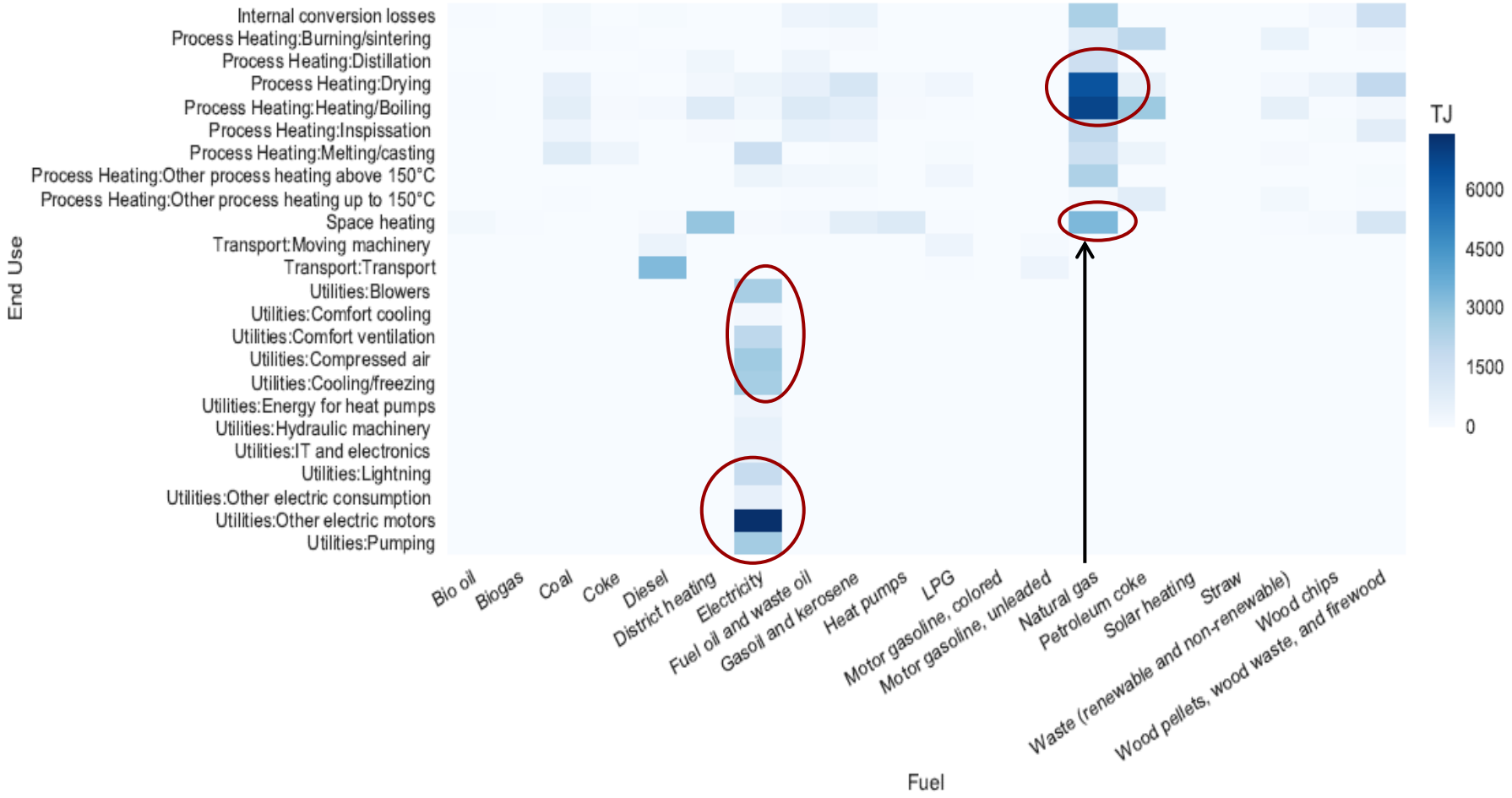


Final energy use in different Danish industry groups by fuel based on data for 2012

Composition of final fuel demand – fossil share still 51%



Total industry – fuel density per fuel type and end-use (94 PJ) (Source: Wiese F, Baldini M Pathways to Carbon Neutral Industrial Sectors: Integrated Modelling Approach with High Level of Detail for End-use Processes 12th SDEWES Conference, Dubrovnik 2017)

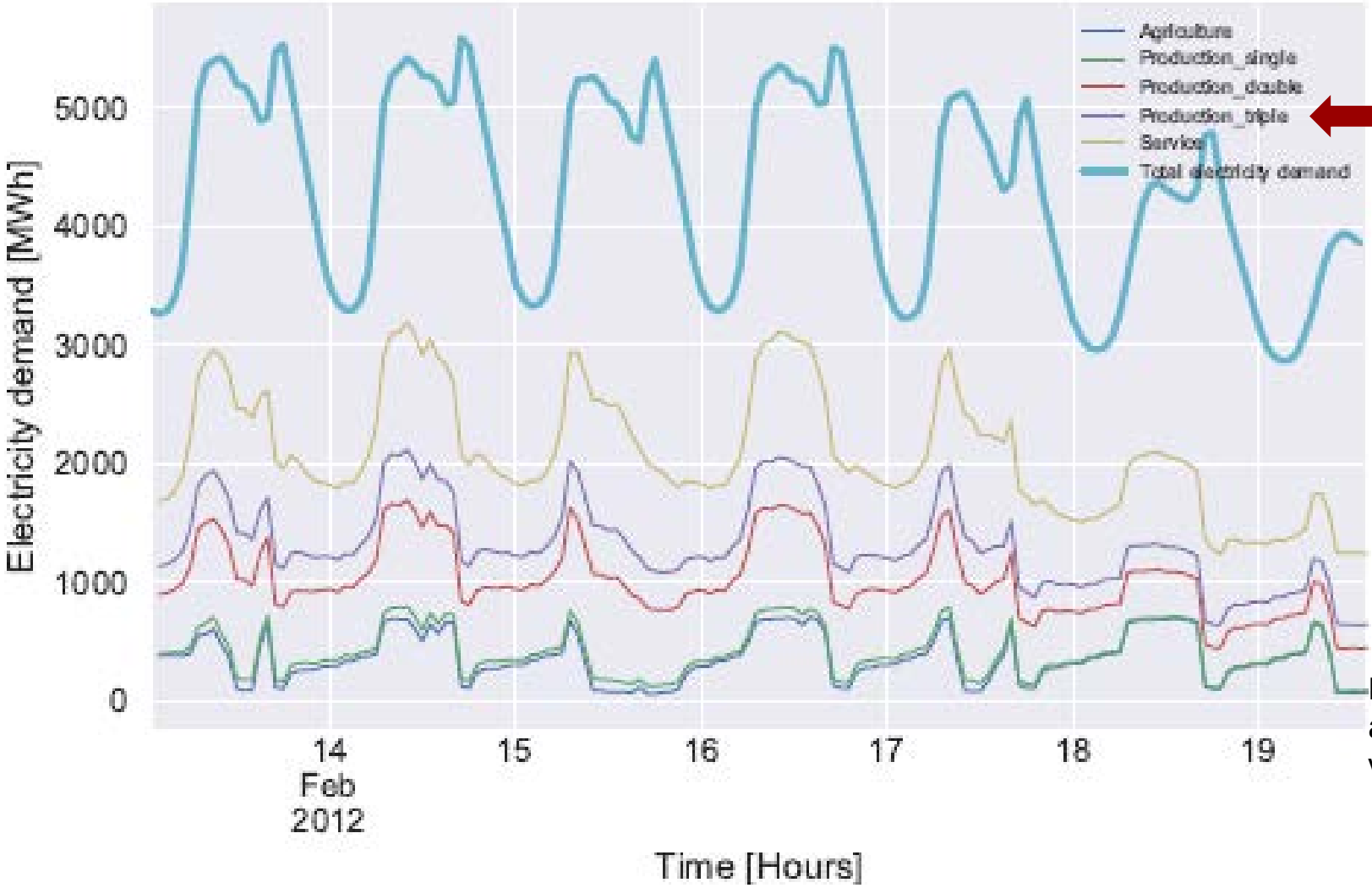


Value of savings and cost of electrification in power system

Time profile of savings (electricity) and profile of natural gas electrification impacts electricity system savings and additional system costs differently

Electricity demand - Sum of profiles compared to the total electricity demand in a sample week (week 07,2012).

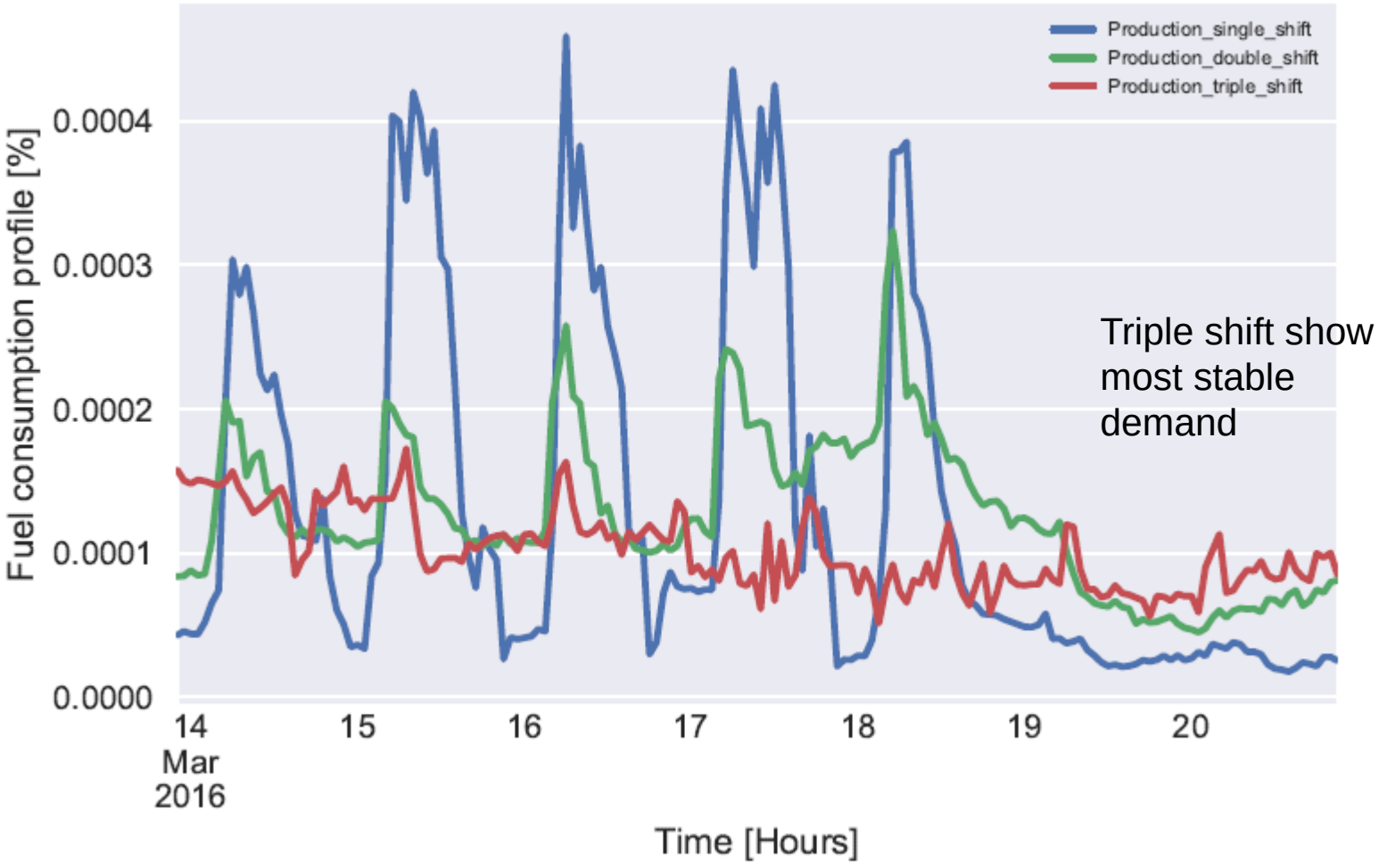
Data for total electricity demand in DK



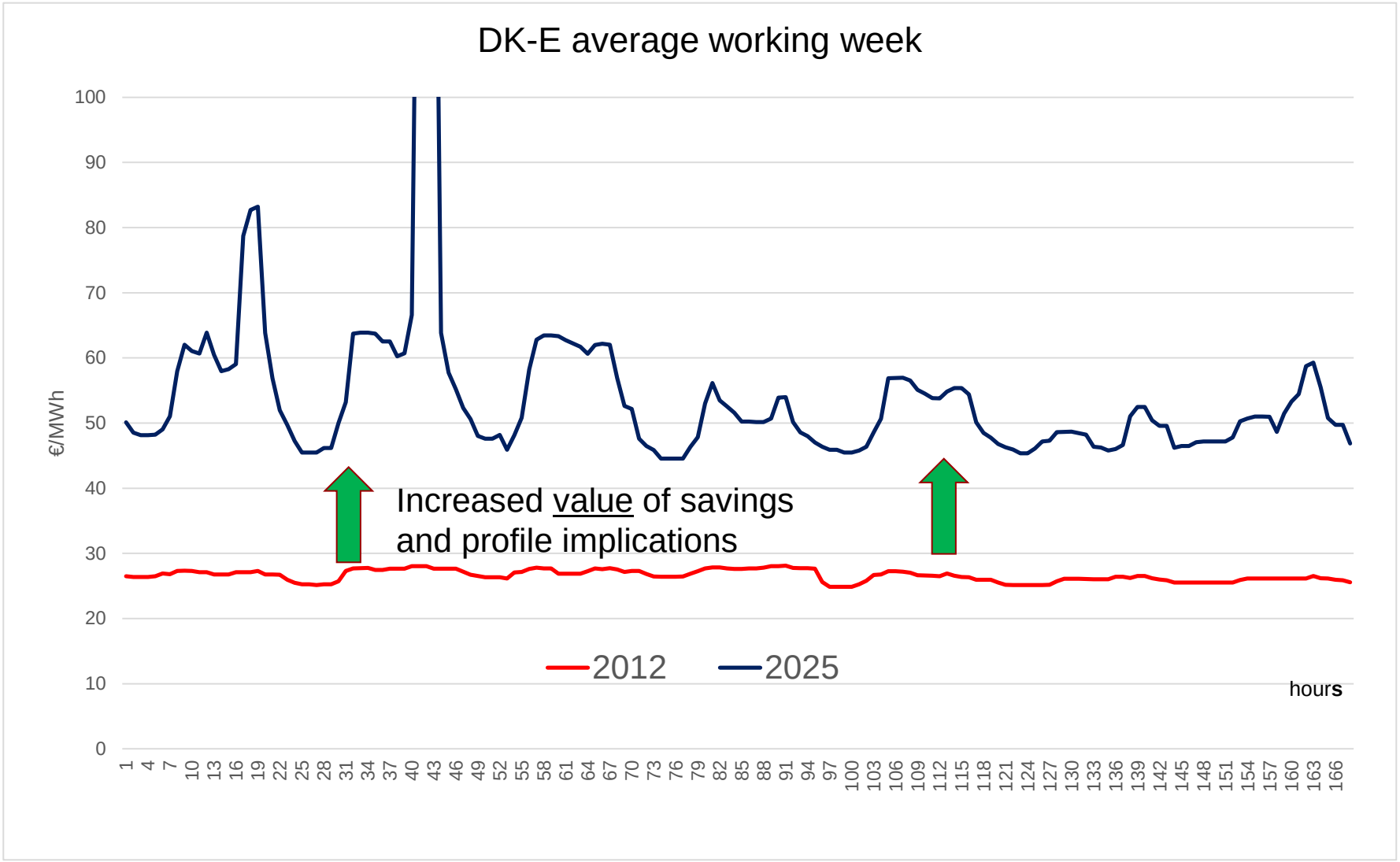
Not much and less variation

Process heating fuel demand (natural gas) for a full week

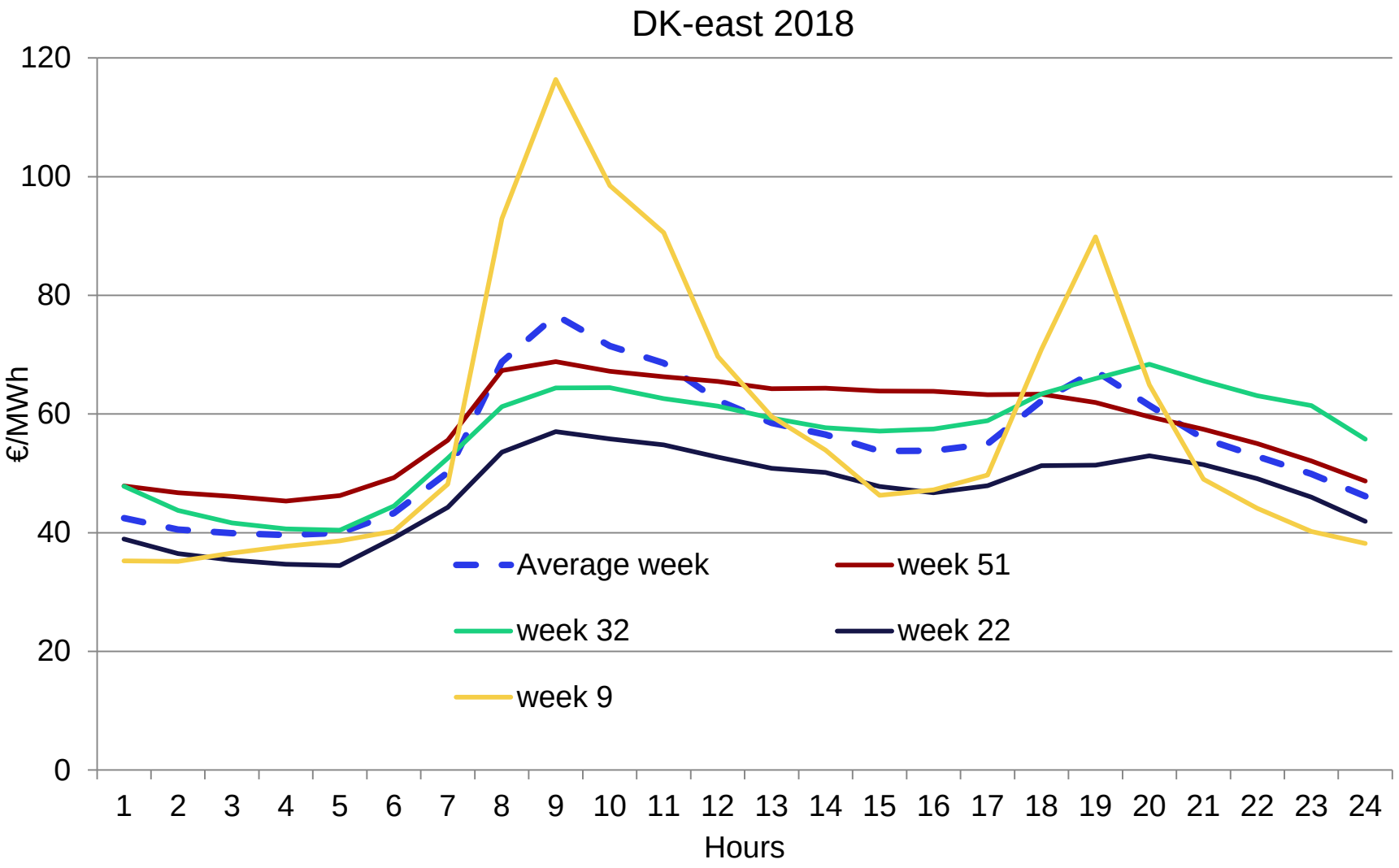
Source: Wiese F, Baldini M Pathways to Carbon Neutral Industrial Sectors: Integrated Modelling Approach with High Level of Detail for End-use Processes 12th SDEWES Conference, Dubrovnik 2017



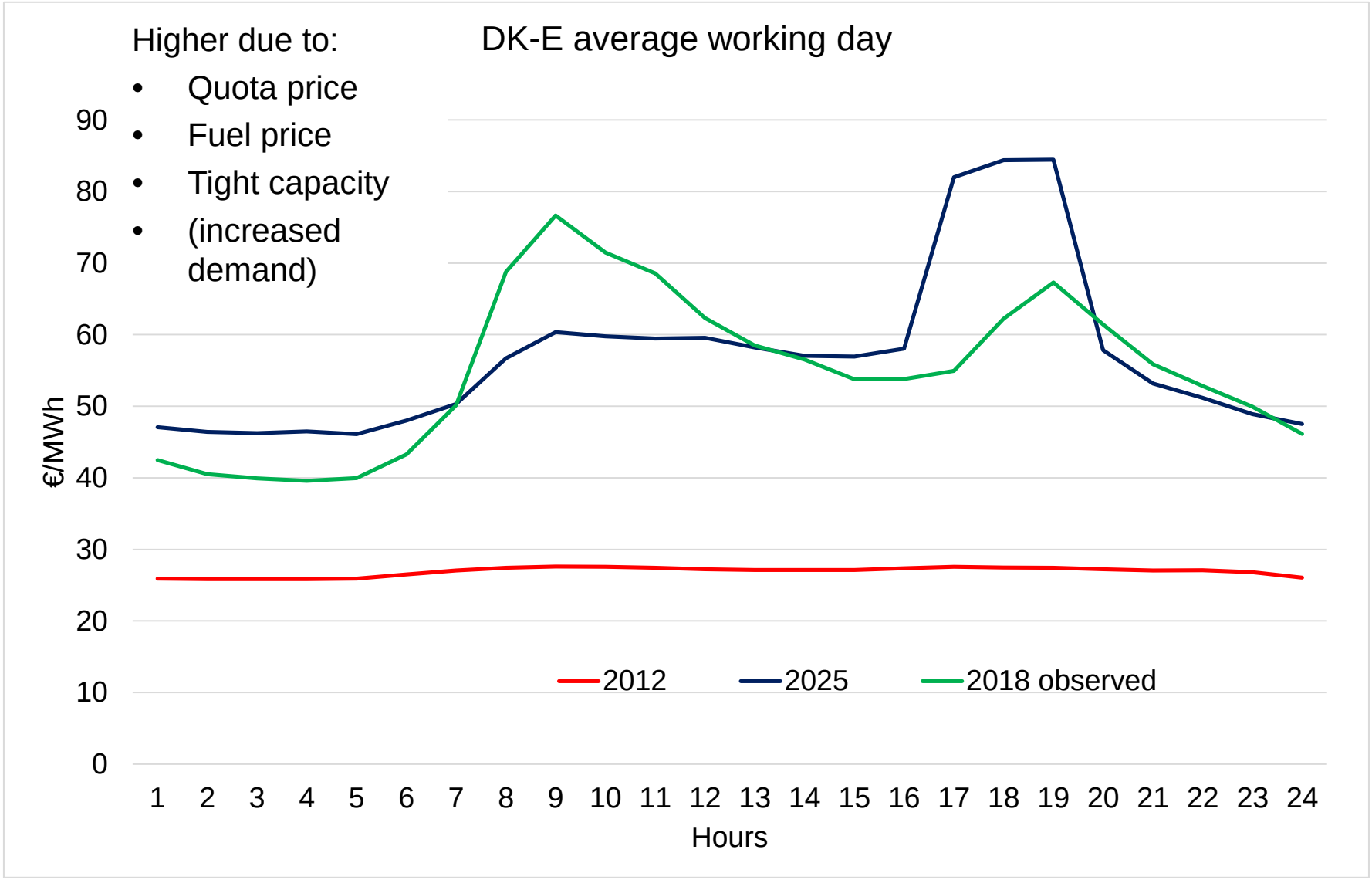
Electricity price profiles – Balmorel model outputs



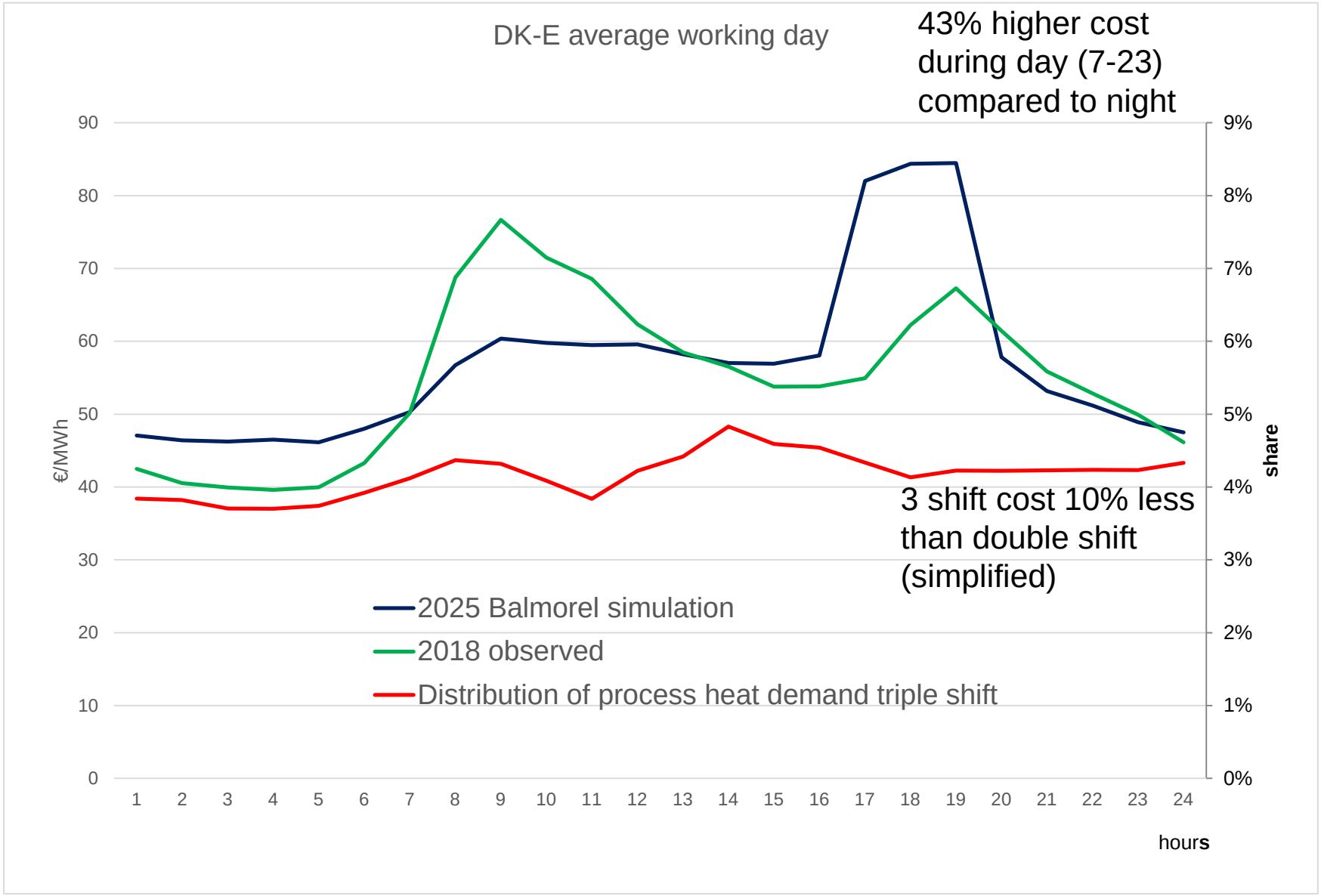
Electricity price profiles 5 working days average over 4 weeks – (actual prices 2018)



Electricity price profiles simulated (Balmorel) and actual prices 2018



Value of savings and cost of electrification (demand)



Conclusions

- Time profile of industrial energy demand and savings varies for sectors
  - Categorising sectors by production/consumption mode in 1-2-3 shift reveals the difference
  - Savings options interact with power system by influencing demand variation – system value of the electricity savings profile is highest for single and double shift industries
  - Power system cost of electrification is highest for single and double shift
- Savings and electrification priority indication
  - Focus on natural gas and electricity savings in single and double shift industries – (highest value)
  - Target electrification to natural gas demand in triple shift industries (lowest cost)

Value of industrial energy savings and cost of electrification

Thank you

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