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]

Index 1990 = 0

Year


Canada Denmark

-70% -60% -50% -40% -30% -20% -10% 0%
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

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

Industry Group

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%

Manufacturing final energy consumption 2017
- Around 9% of CO₂ in DK
Total industry – fuel density per fuel type and end-use (94 PJ)

End Use
- Process Heating: Burning/sintering
- Process Heating: Distillation
- Process Heating: Drying
- Process Heating: Heating/Boiling
- Process Heating: Insulation
- Process Heating: Melting/casting
- Process Heating: Other process heating above 150°C
- Process Heating: Other process heating up to 150°C
- Space heating
- Transport: Moving machinery
- Transport: Transport
- Utilities: Blowers
- Utilities: Comfort cooling
- Utilities: Comfort ventilation
- Utilities: Compressed air
- Utilities: Cooling/freezing
- Utilities: Energy for heat pumps
- Utilities: Hydraulic machinery
- Utilities: IT and electronics
- Utilities: Lightning
- Utilities: Other electric consumption
- Utilities: Other electric motors
- Utilities: Pumping

Fuel
- Bio Oil
- Biogas
- Coal
- Coke
- Diesel
- District heating
- Fuel oil and waste oil
- Gas/Refined liquid
- LPG
- Motor gasoline: Unleaded
- Natural gas
- Petroleum coke
- Solar heating
- Straw
- Waste (renewable and non-renewable)
- Wood pellets, wood waste, and firewood

TJ
- 6000
- 4500
- 3000
- 1500
- 0

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Energy saving options in Danish industry
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

Triple shift show most stable demand
Electricity price profiles – Balmorel model outputs

DK-E average working week

- Increased value of savings
- Increased profile implications

€/MWh

2012  2025
Electricity price profiles 5 working days average over 4 weeks – (actual prices 2018)
Electricity price profiles simulated (Balmorel) and actual prices 2018

Higher due to:
- Quota price
- Fuel price
- Tight capacity
- (increased demand)

DK-E average working day

€/MWh

Hours

2012  2025  2018 observed
Value of savings and cost of electrification (demand)

DK-E average working day

43% higher cost during day (7-23) compared to night

3 shift cost 10% less than double shift (simplified)

- 2025 Balmorel simulation
- 2018 observed
- Distribution of process heat demand triple shift
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)
Thank you

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