The Role of Forecasting Energy Consumption and Demand in the Iron and Steel Industry

by the Example of an Electric Arc Furnace

DI Vanessa Zawodnik
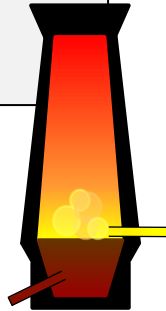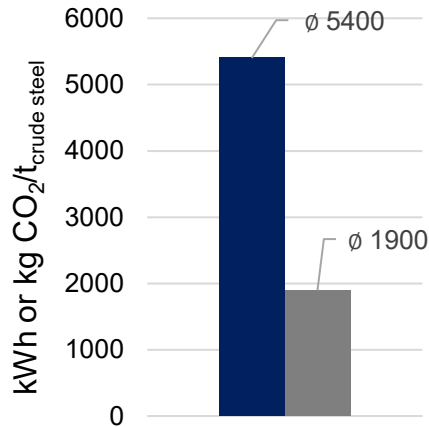
NEFI-Conference

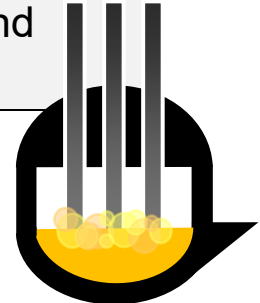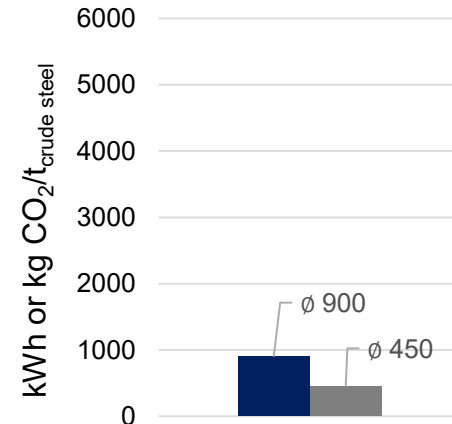13TH of October 2022

KEY NOTES

IRON & STEEL INDUSTRY

PRIMARY PRODUCTION

Input material: Iron ore
Energy carrier: Coke

SECONDARY PRODUCTION

Input material: Steel scrap
Energy carrier: electricity (and natural gas)

Primary Production chart (kWh or kg CO_2/t$_{crude\ steel}$):
- ø 5400
- ø 1900

Secondary Production chart (kWh or kg CO_2/t$_{crude\ steel}$):
- ø 900
- ø 450

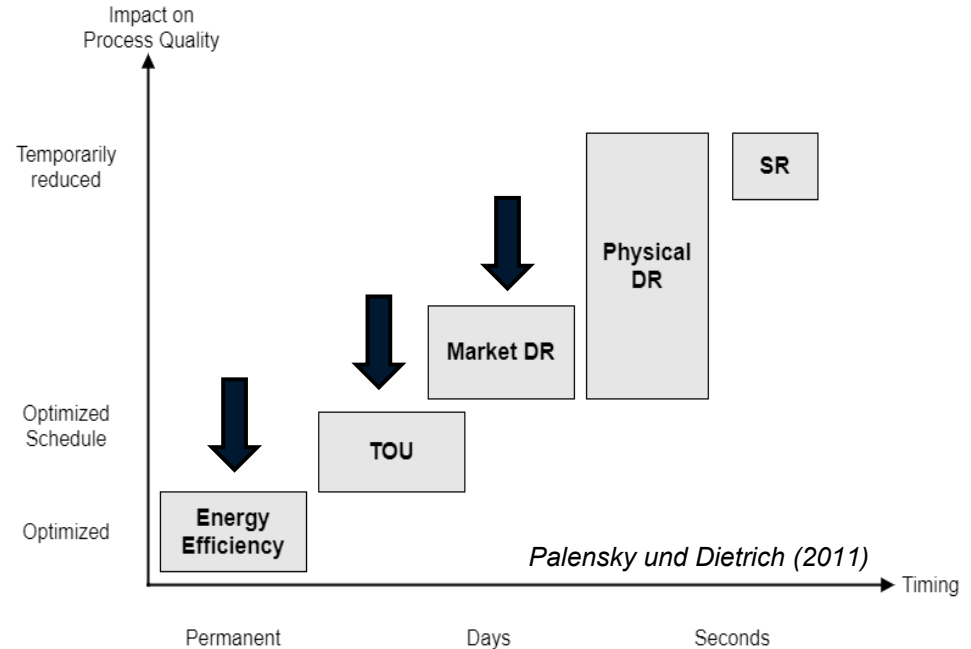■ Specific Energy Consumption   ■ Specific Carbon Dioxide Emissions
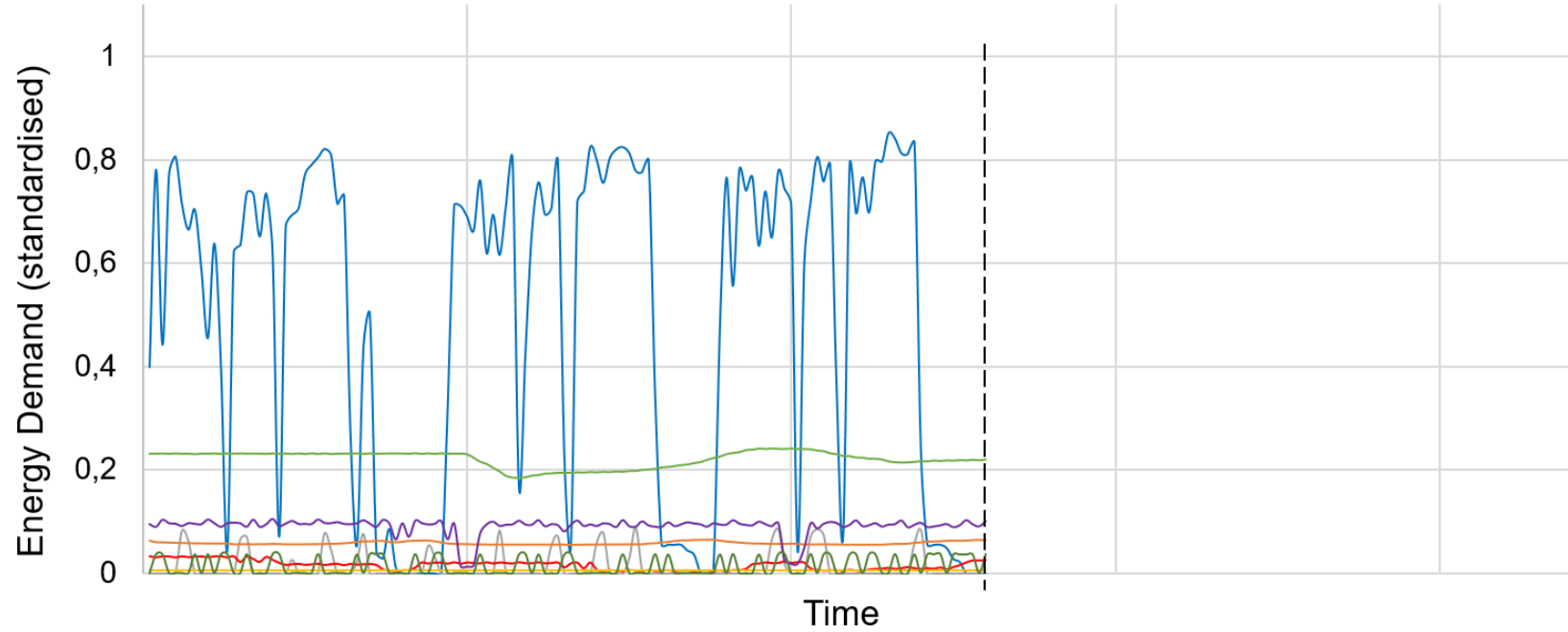
Key Notes
Demand Side Management

What is it about?

- Today's interest is more focused on the demand side

- Includes all measures that influence type and level of energy demand

- Categorized by timing and impact

- Goal: Intelligently influence loads

Palensky und Dietrich (2011)
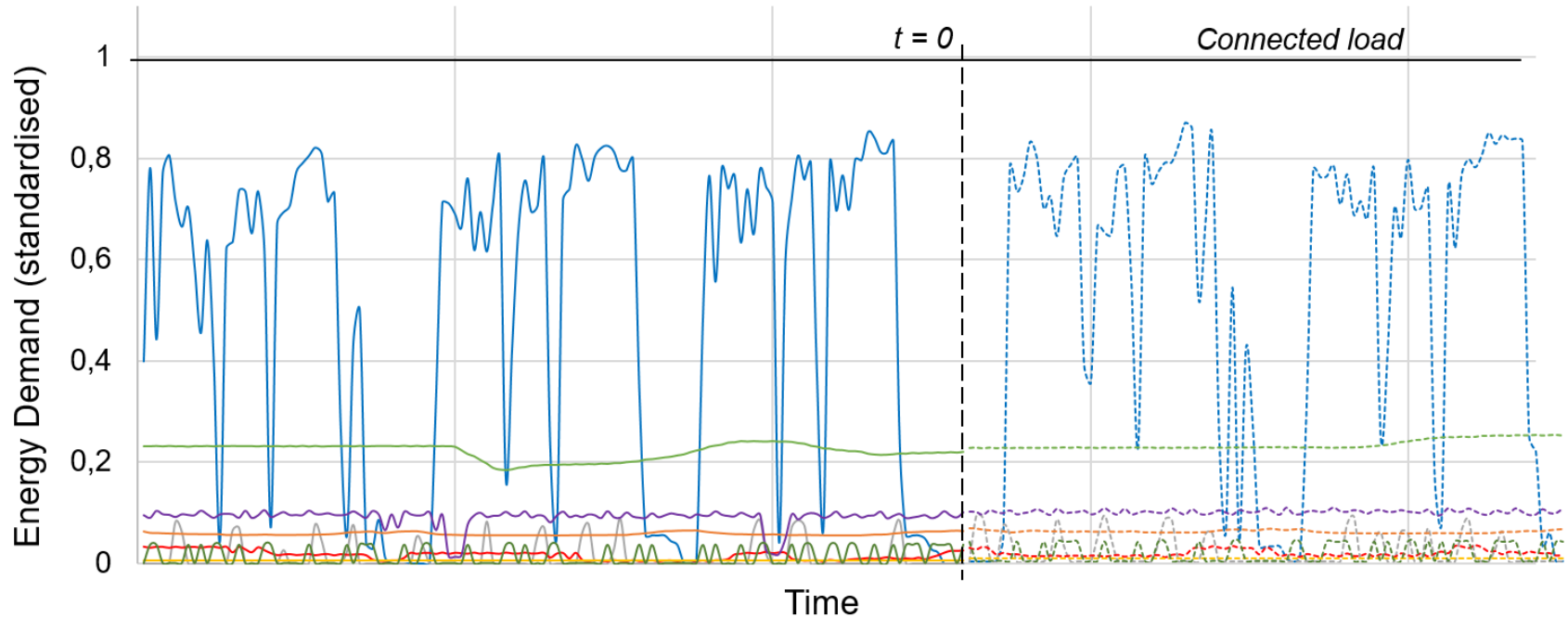
THE NEED OF FORECASTING …

… FOR OPERATION OPTIMISATION

Legend:
- Electric arc furnace
- Ladle furnace
- Ladle heaters
- Continuous caster
- Dedusting
- Pusher furnace
- Rolling lanes
- Recoil plant

Axes: Energy Demand (standardised) vs Time

THE NEED OF FORECASTING …

… FOR OPERATION OPTIMISATION
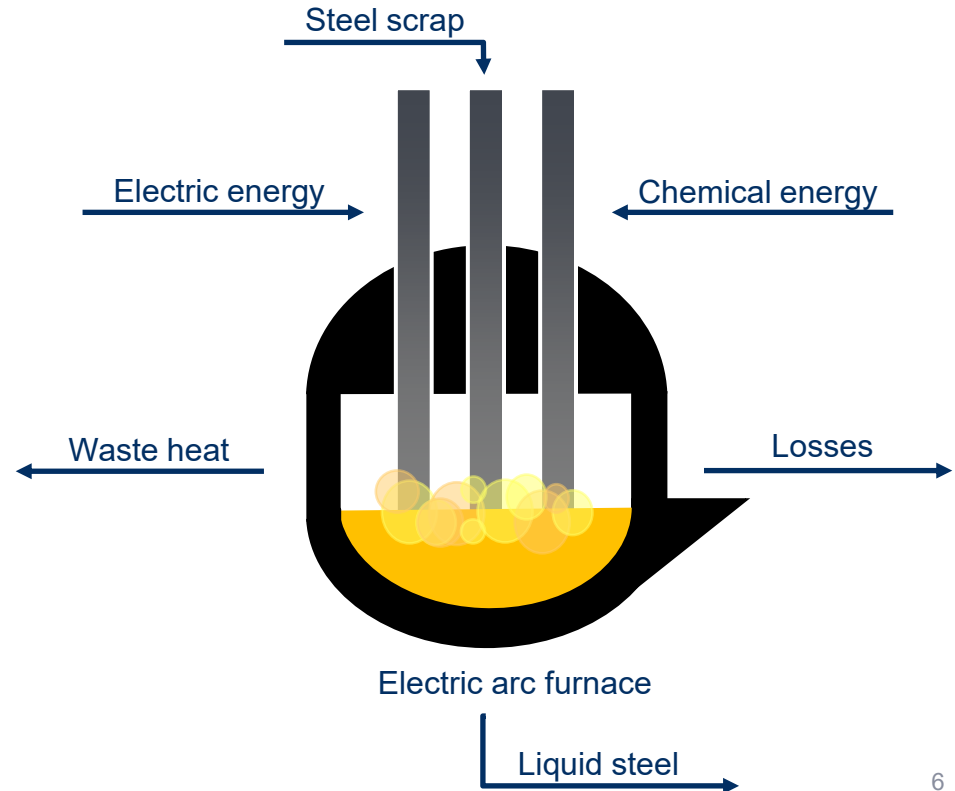
Forecast Modelling
By the Example of an Electric Arc Furnace

Modelling approaches

- Mathematical-statistical
- Machine learning

Challenges

- Stochastic operational behaviour
- Few correlations from data analysis
- The human factor

Steel scrap

Electric energy

Chemical energy

Waste heat

Losses

Electric arc furnace

Liquid steel

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MODELLING OF AN EAF

HYBRID APPROACH

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BENCHMARK

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- Recurrent neural network (LSTM)

- Ideal conditions, perfect knowledge

- Not usable for real world application

Energy Demand Forecast of an EAF (scaled):
LSTM Benchmark with 1 min resolution
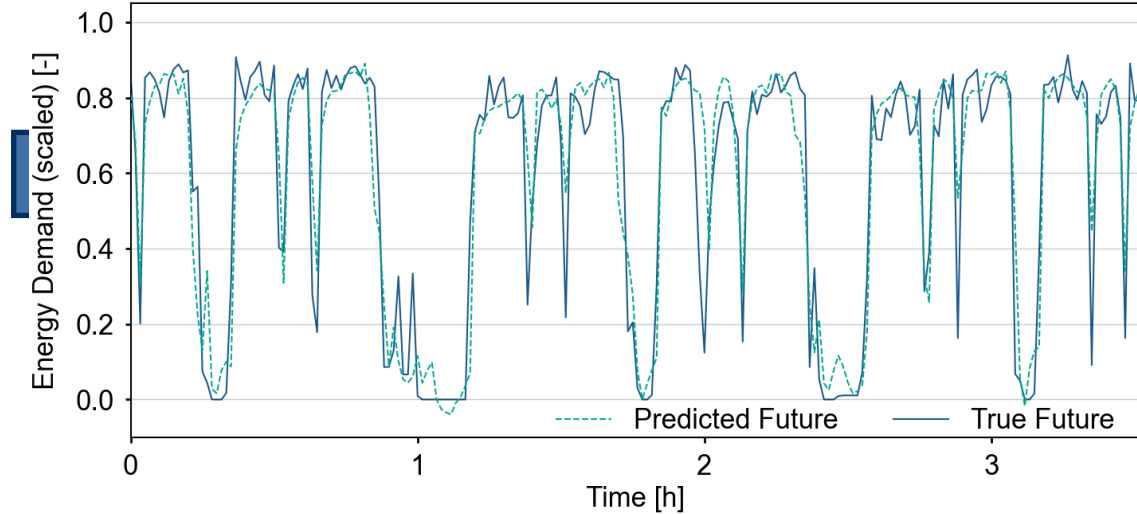
MODELLING OF AN EAF
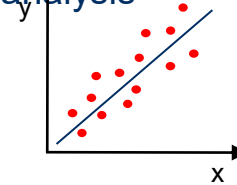
HYBRID APPROACH

BENCHMARK

ENERGY CONSUMPTION

- Recursive neural network (LSTM)
- Predicts energy amount [kWh] for next time step

kWh ± 1,4 %

ADDITIONAL PARAMETERS
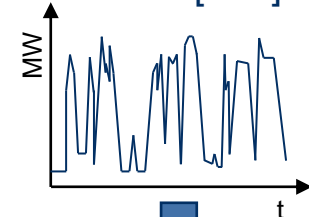
- Regression analysis
- Scrap [t], slag [t], steel [t], exhaust gas [Nm³]

NEXT AGGREGATE MODEL

ENERGY DEMAND

- N-dimensional markov chain
- Detailed energy demand [MW]

OVERALL LOAD PROFILE

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