eTelligence

Das E-Energy-Leuchtturmprojekt
in der Modellregion Cuxhaven

EENERGY

Modelling the effects of integration in the eTelligence project

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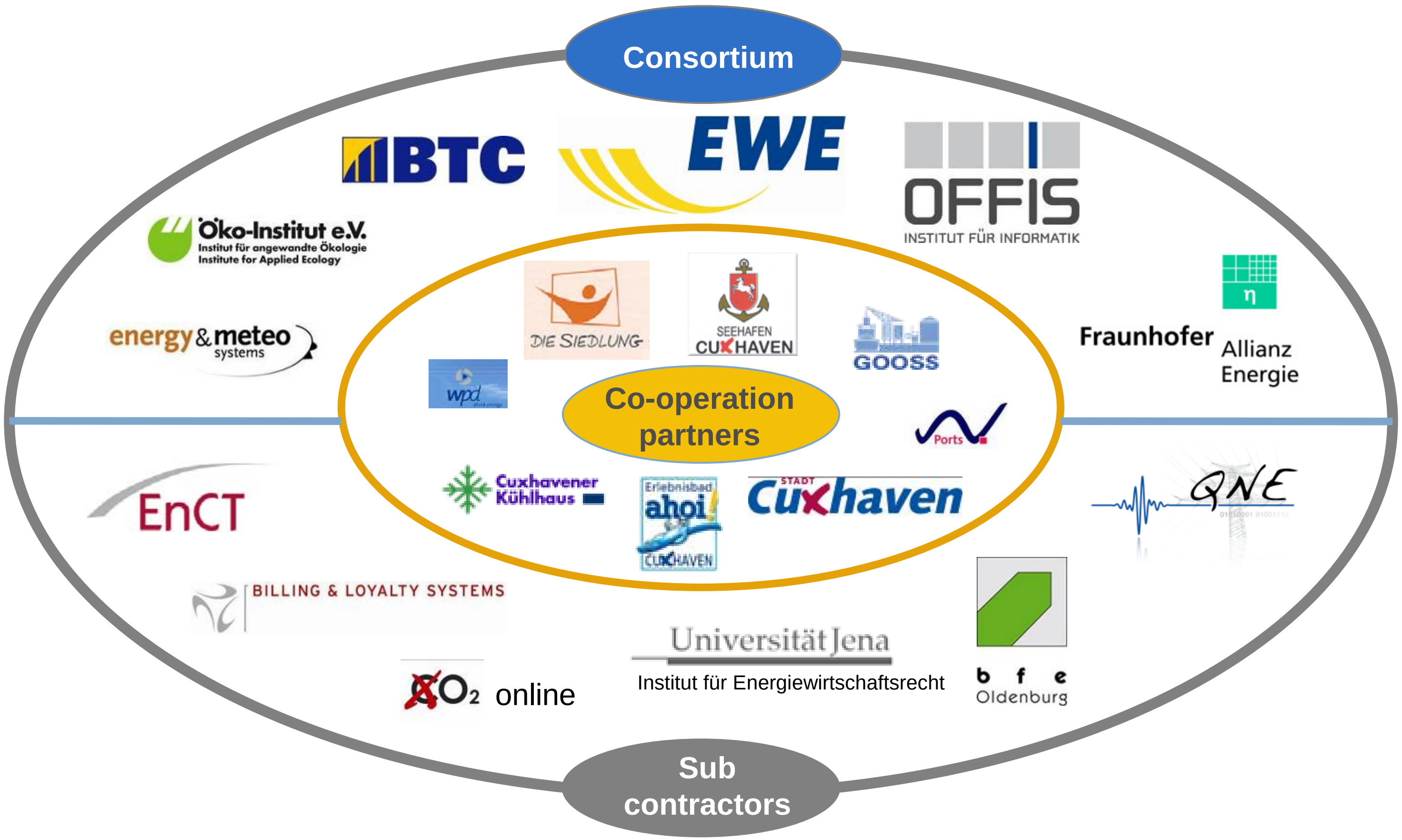
Agenda

I. The eTelligence project
II. Economic and ecological effects of flexibility in the electricity system
III. PowerFlex model for quantitative analysis
IV. Case study: smart flexibility from electrical cooling
V. Conclusions and next steps

II. The eTelligence project

Who is participating in eTelligence?

- Numerous partners from research and industry are among the project consortium led by EWE.



eTelligence-Scenario

eTelligence-Scenario: Local Generation

eTelligence-Scenario: Shiftable loads

eTelligence-Scenario: household customers

eTelligence-Scenario: Power Grid and Communication Network

eTelligence-Scenario: The market place

II. Economic and ecological effects of flexibility in the electricity system

Flexibility for integrating intermittent RES

- Increasing demand for flexibility due to renwables
  - short-term fluctuations
  - long-term fluctuations
  - forecasting errors
- Flexibility options today
  - ramping of thermal power plants
  - pump storage plants
- New flexibility options
  - storage power plants (CAES, batteries,…)
  - demand side management (“smart flexibility”)
  - flexibility of renewables and DG (“smart flexibility”)

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Economic and ecological effects of (smart) flexibility

- Generation shifts from peak to base load plants
  - Flattened load curve
  - Replacement of conventional balancing capacity

CO_2 ↑↓ EURO ↓

- Efficiency increase of conventional plants
  - Reduction of part-load operation of conventional plants

CO_2 ↓ EURO ↓

- Higher system capacity for integrating RES
  - Demand shifts to times of negative residual load
  - Reduction of electricity generation linked with spinning reserve

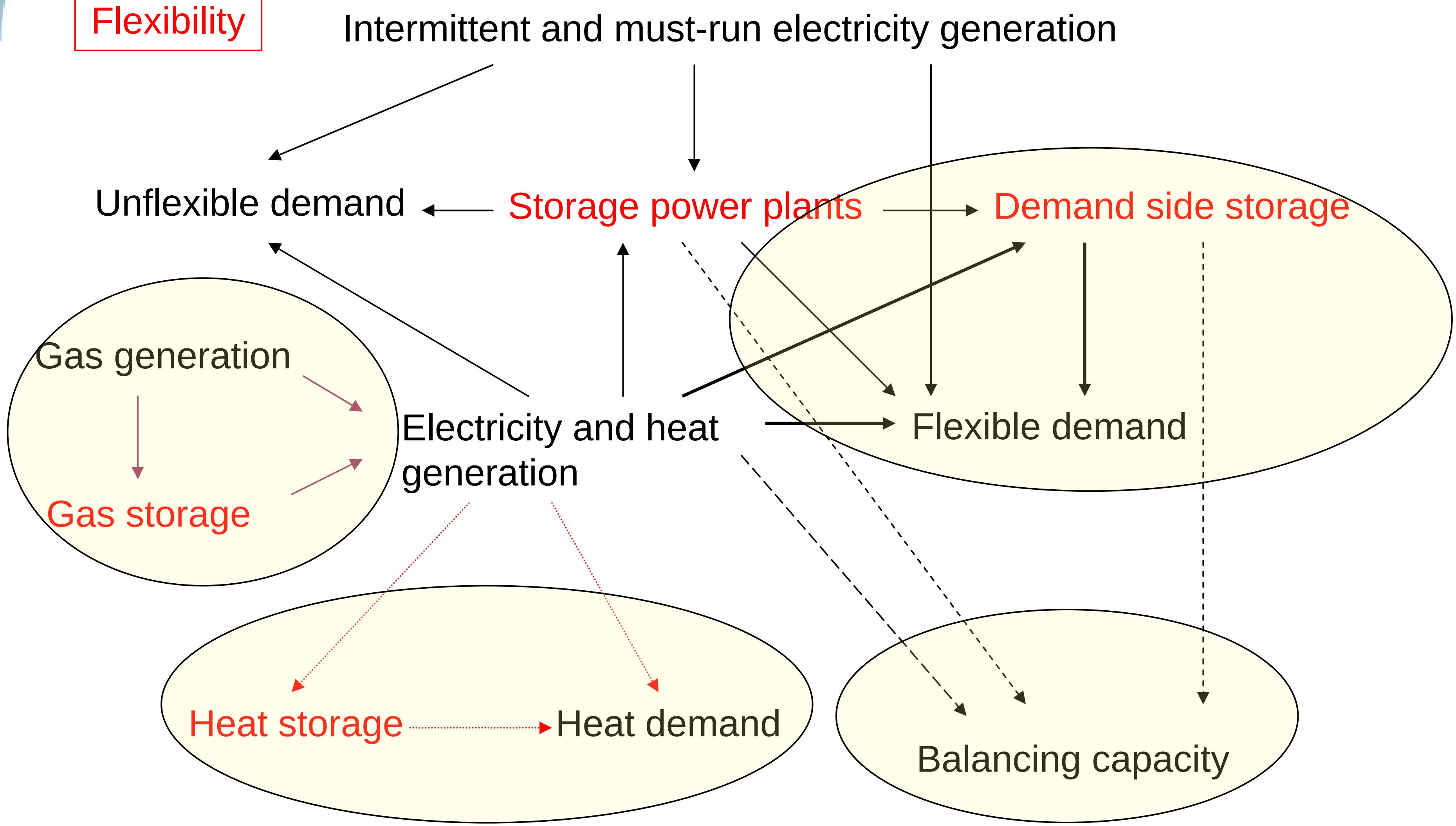
CO_2 ↓ EURO ↓

II. PowerFlex model for quantitative analysis

PowerFlex model for quantitative analysis

- Model developed by Öko-Institut
- Mixed-integer, linear optimisation model
  - Minimisation of overall costs
  - Technical and energy economic constraints
  - No network constraints yet
- Dispatch of power plants and flexibility options
- Covering the predefined demand of electricity and balancing capacity
- Optimisation on hourly base for 24 h

Flexibility



Legend: Electricity: Control energy: Heat: Gas:

Flexibility mapping in the PowerFlex model

- Thermal power plants > 100 MW
  - Operational status: start-up, part-load, full load
  - Load specific electrical efficiency
  - Load change ratio, start-up and shut-down time
- Thermal power plants < 100 MW
  - Technology specific groups
  - No flexibility restrictions
- Storage power plants
  - Capacity of pumping, storage and generation
- Flexible consumers
  - Electrical capacity, storage capacity, demand profile

III. Case study: flexibility from electrical cooling

Flexibility potential from electrical cooling – Preliminary case study

- **Cold storage warehouses, refrigeration in households and food retailing (no industrial cooling)**
- Represents approx. 5% of German electricity demand
- Flexibility determined by
  - Installed electrical capacity of refrigeration machines
  - Storage volume
    - technology specific temperature interval (1°C to 6°C)
    - COP (Coefficient of performance)
    - Mass and mixture of cooling goods (specific heat capacity)
  - Demand profile: technology specific or standard load profiles
  - Efficiency of storage (assumption 76% like pump storage)

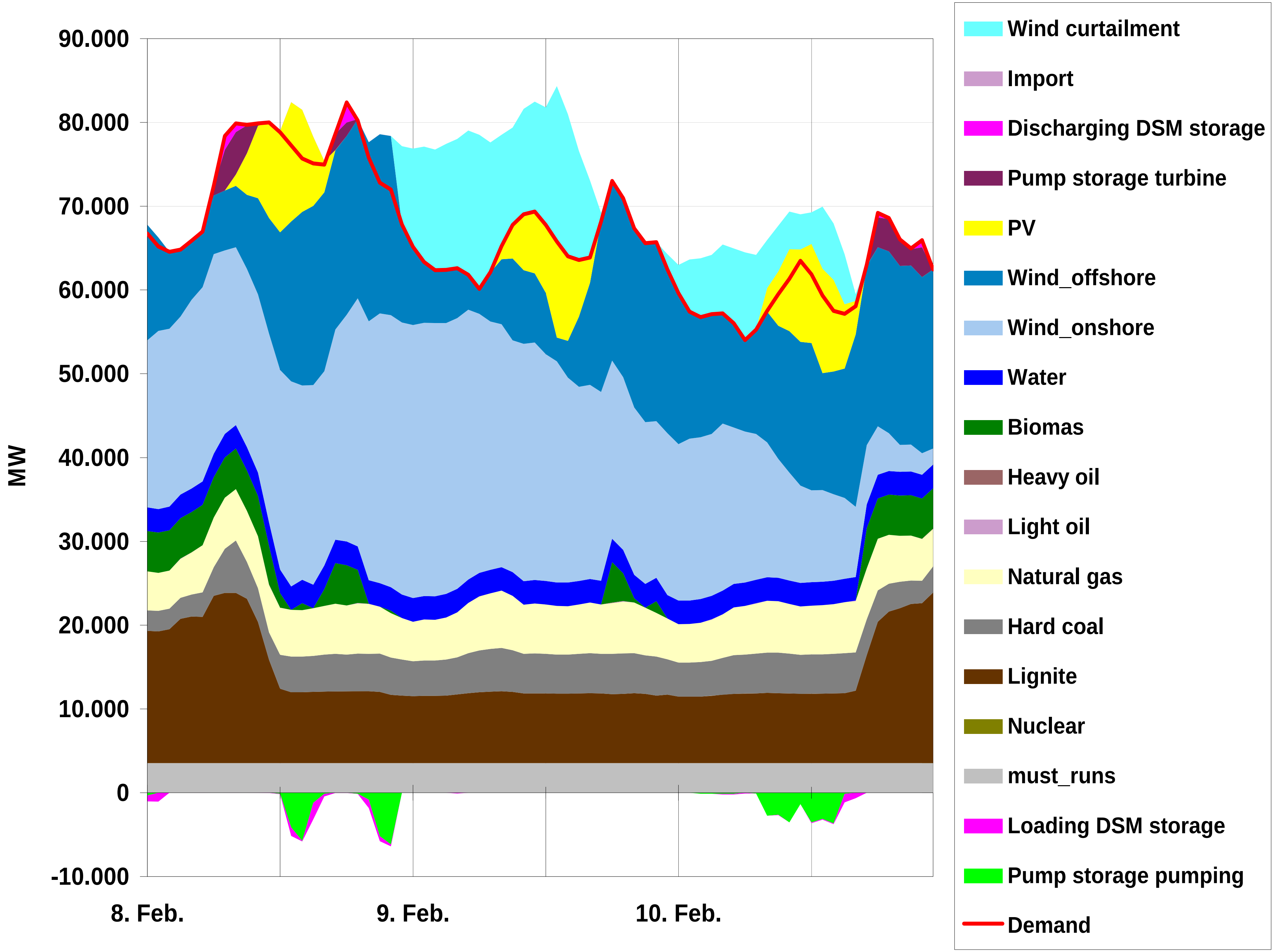
Flexibility potential from electrical cooling – Preliminary case study

	cold storage warehouses	refrigeration equipment	
		households	food retailing
Electrical capacity	**180 MW**	**6.800 MW**	**1.400 MW**
Storage capacity	**1.200 MWh**	**2.500 MWh**	**280 MWh**
Demand	**115 MW**	**2.200 MW**	**900 MW**

Scenario analysis for flexibility from electrical cooling

- Scenario 2008
  - Without additional flexibility:
    - Full integration of electricity from RES
  - With additional flexibility:
    - Fuel mix switch from gas and oil to coal and nuclear
    - + 50 GWh thermal (storage losses)
    - Costs: - 8 Mio €, CO_2-emissions: + 40 kt

- Scenario 2030
  - Without additional flexibility:
    - - 9 TWh wind (5 % of possible supply)
  - With additional flexibility:
    - Fuel switch from gas and oil to coal
    - + 270 GWh wind and biomass
    - + 100 GWh thermal (storage losses)
    - Costs: - 16 Mio €, CO_2-emissions: + 70 kt



90.000
80.000
70.000
60.000
50.000
40.000
30.000
20.000
10.000
0
-10.000
MW
8. Feb.
9. Feb.
10. Feb.
Wind curtailment
Import
Discharging DSM storage
Pump storage turbine
PV
Wind_offshore
Wind_onshore
Water
Biomas
Heavy oil
Light oil
Natural gas
Hard coal
Lignite
Nuclear
must_runs
Loading DSM storage
Pump storage pumping
Demand

- Conclusions
  - Smart flexibility increases integration of RES
  - Additional flexibility and storage options are needed to fully integrate RES in 2030
  - Sensitive input parameter
    - Efficiency of storage / smart flexibility
    - Fuel type switch between base and peak load plants
    - Flexibility and balancing capacity requirements from conventional plants
- Next steps
  - Including further flexible consumers
  - Implementation of heat and gas storage
  - Taking into account results of eTelligence field trial
  - Definition of relevant scenarios
  - Comparing the whole range of flexibility options
  - European perspective

Thank you for your attention!

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