3RD INTERNATIONAL CONFERENCE ON

SMART ENERGY SYSTEMS AND 4TH GENERATION DISTRICT HEATING

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Simulation based analysis of demand side management as enabler for the integration of heat pumps in district heating networks

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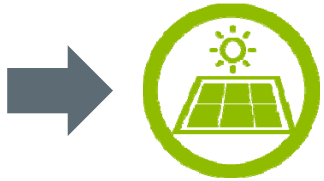
BACKGROUND

- Austrian electricity demand targets: **71% from renewable energy by 2020**

  →**intermittent generation sources**

  → increased research towards grid-stabilizing strategies



- Austrian district heating (DH) networks setting:
  - ~1GW of biomass heat plants > 20 years old

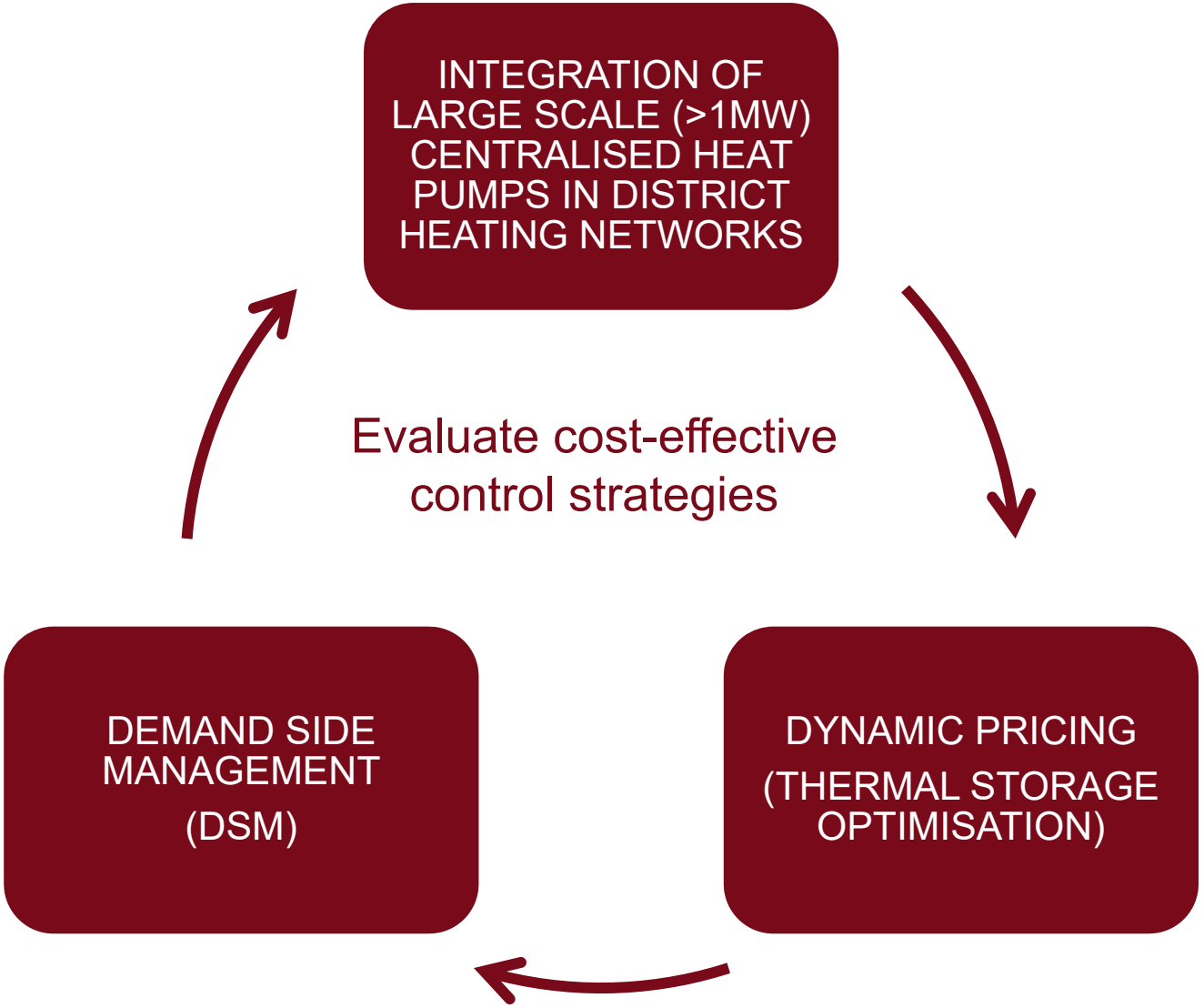
    → **Low efficiency** for the old plants

    → **Highly replicable** business cases

➢ **POWER TO HEAT**

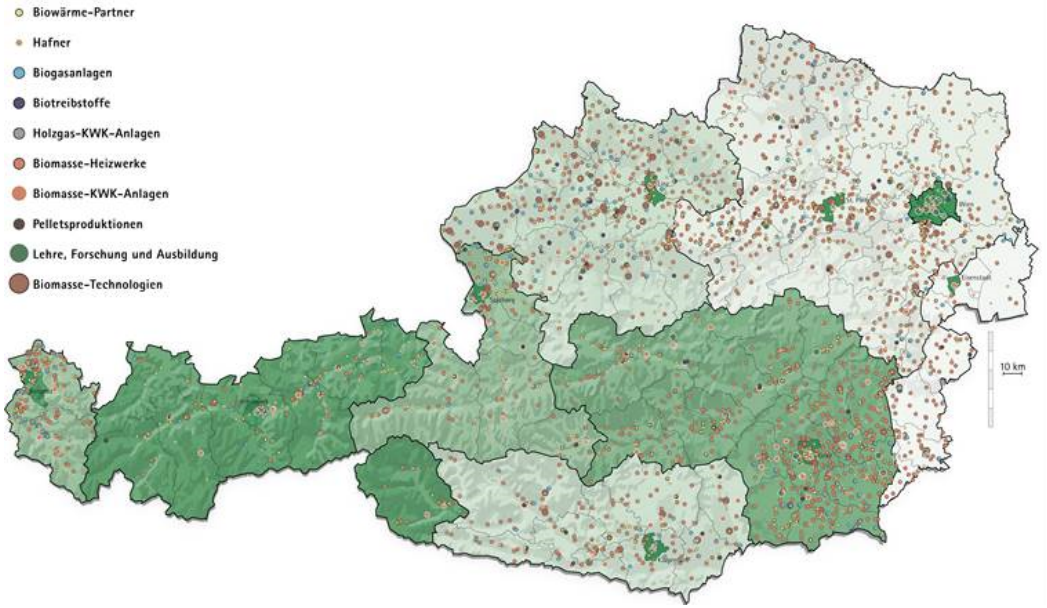
- Heat Pumps (HP) is a potential technology in-between **fluctuating generation** sources and stable heat demand of **DH network systems**

OBJECTIVES

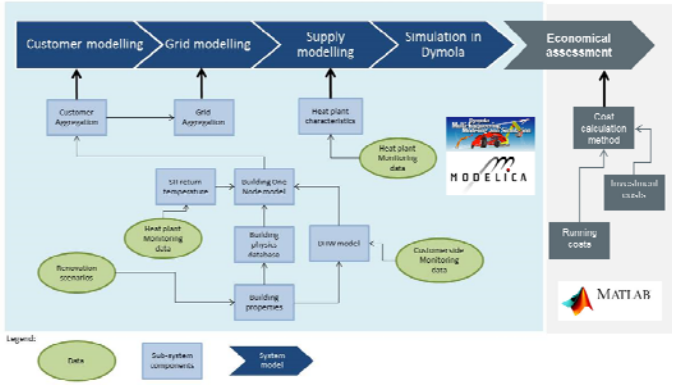

INTEGRATION OF LARGE SCALE (>1MW) CENTRALISED HEAT PUMPS IN DISTRICT HEATING NETWORKS
Evaluate cost-effective control strategies
DYNAMIC PRICING (THERMAL STORAGE OPTIMISATION)
DEMAND SIDE MANAGEMENT (DSM)

CASE STUDY

- Typical **rural** network with ~160 residential customers
- Heat density (relatively dense network): **1.3 kW/m**, **2.9 MWh/m**
- Design temperatures:
  - **Supply temp.** → [90° C, 75° C] @ [-12° C,+12° C]
  - **Return temp.** → ~55° C



System simulation: methodology



Basciotti, D.; Markus Köfinger, Charlotte Marguerite, Olatz Terreros, Giorgio Agugiaro, Ralf-Roman Schmidt: Methodology for the Assessment of Temperature Reduction Potentials in District Heating Networks by Demand Side Measures and Cascading Solutions, 12th REHVA World Congress Clima2016, 22-25 May - Aalborg, Denmark

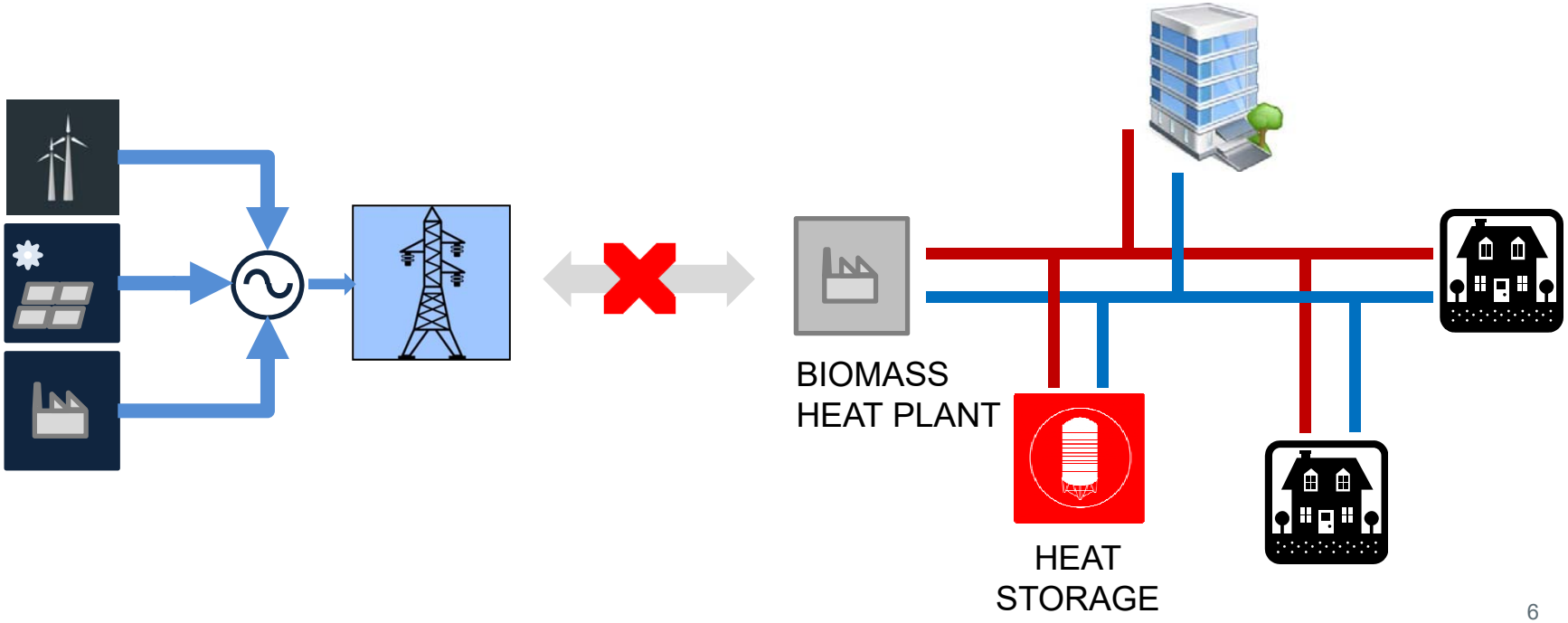
HEAT SUPPLY SCENARIOS

Heat supply scenarios:

i. **BIOMASS HEAT PLANT (reference)**
ii. HP + STORAGE (standard control)
iii. HP + STORAGE (dynamic pricing DP)
iv. HP + STORAGE (DP) + DSM

STANDARD CONTROL

- Two-points **storage temperatures**
- **NO** electricity market signal



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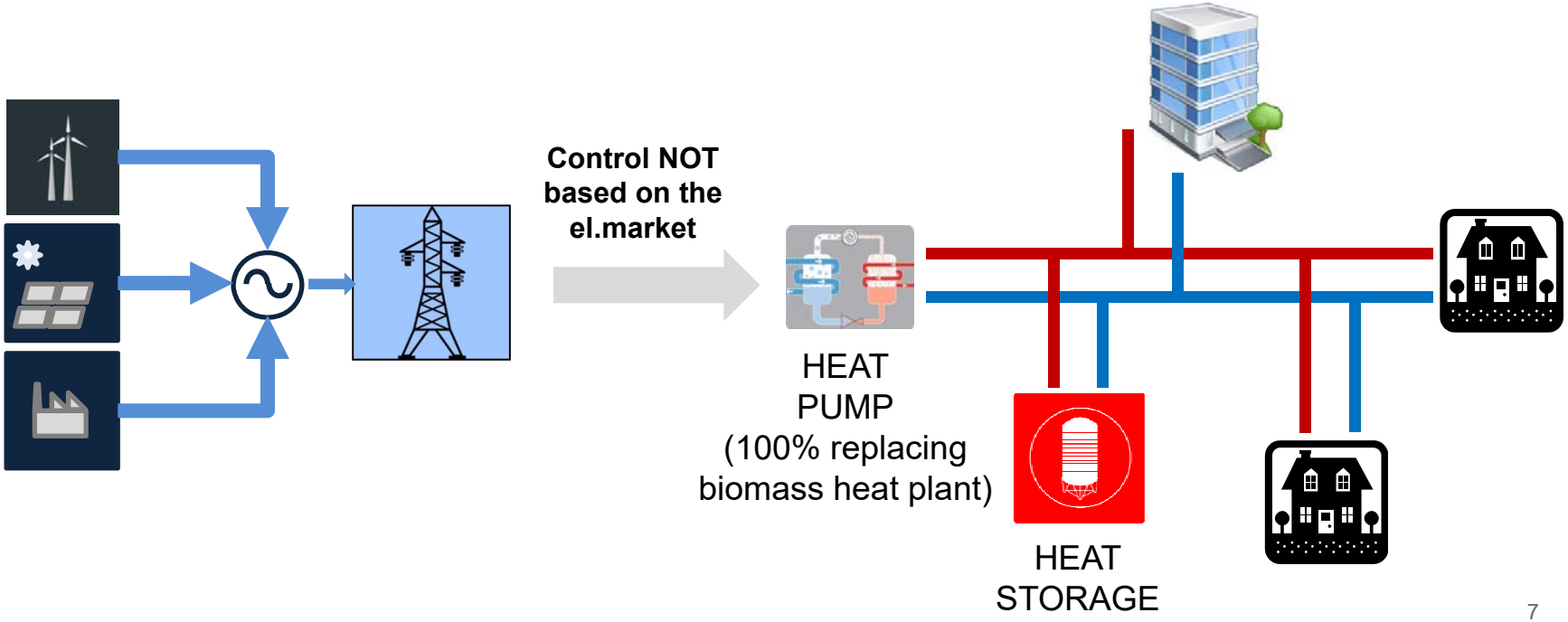

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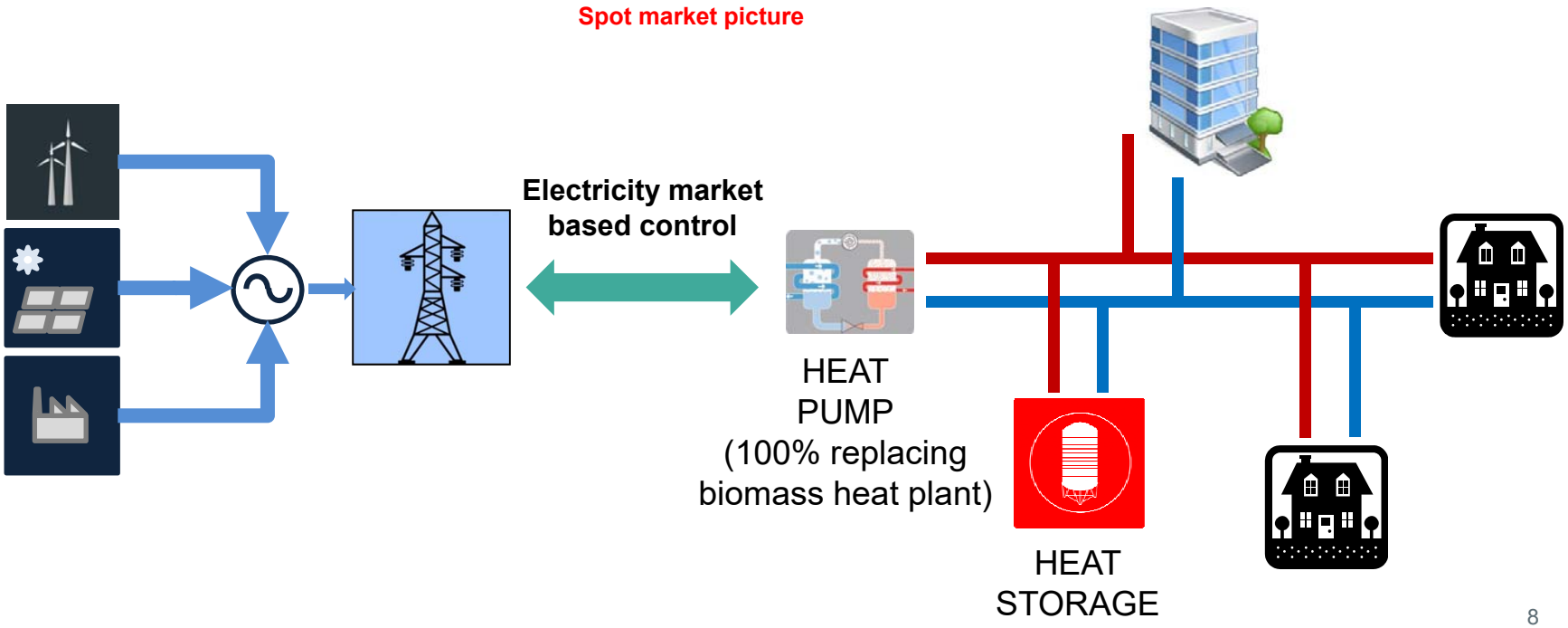
DYNAMIC PRICING

- Two-points **storage temperatures**
- Electricity SPOT **market signals**
  - ➢ storage char./disc. opt



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Heat supply scenarios:

i. BIOMASS HEAT PLANT - reference

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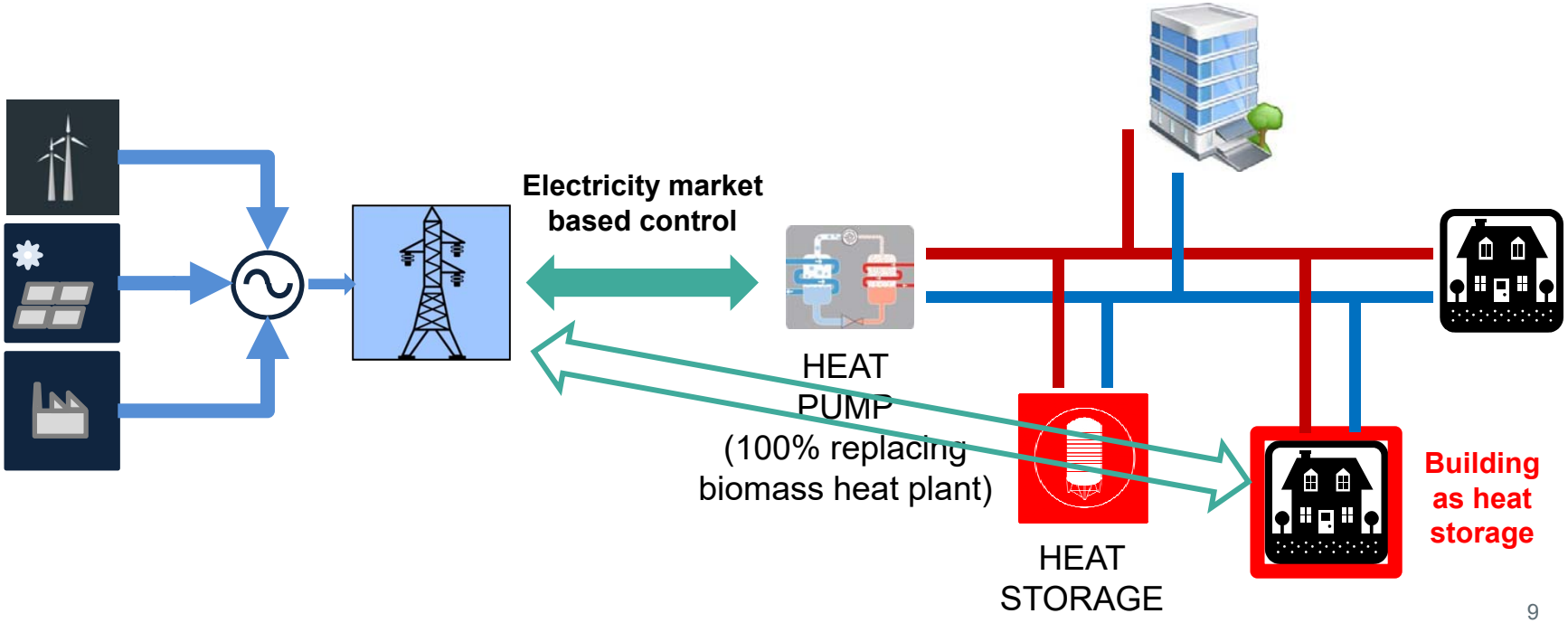
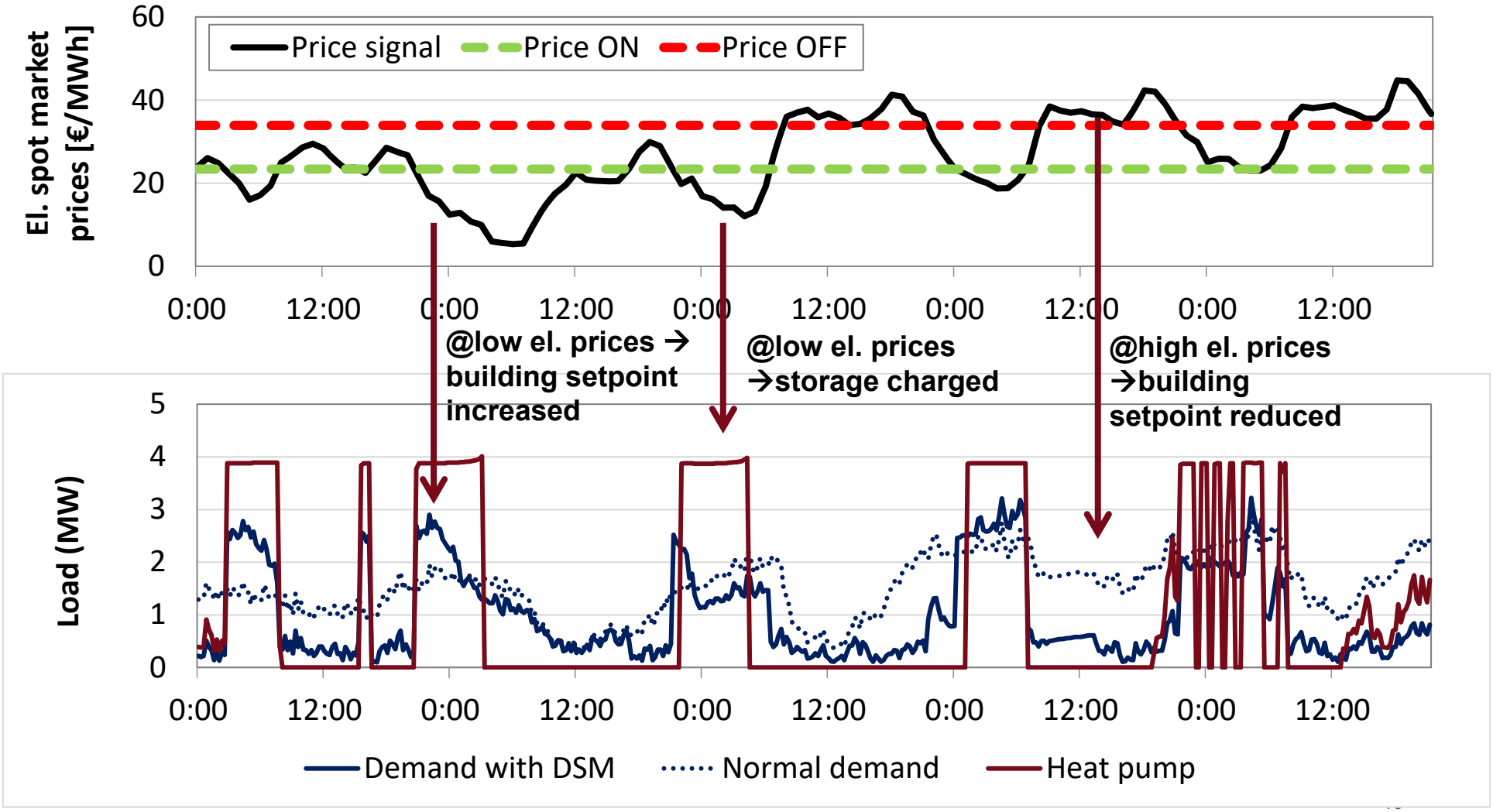
DYNAMIC PRICING + DSM

- Two-points **storage temperatures**
- Electricity SPOT **market signals**
  - **Storage** char./disc. opt
  - **Building** as heat storage opt



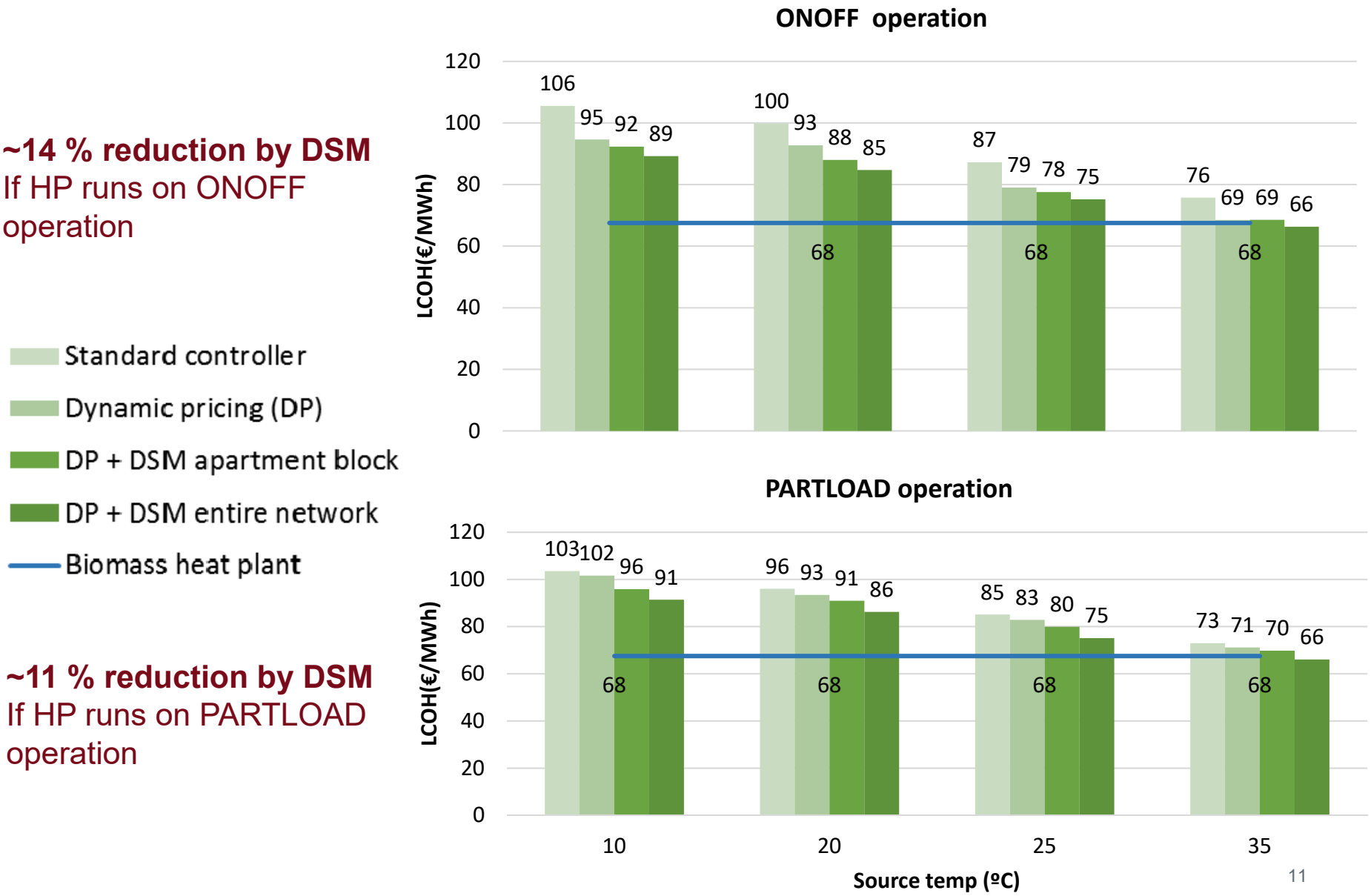
RESULTS: DYNAMIC PRICING AND DSM



RESULTS: LEVELIZED COST OF HEATING

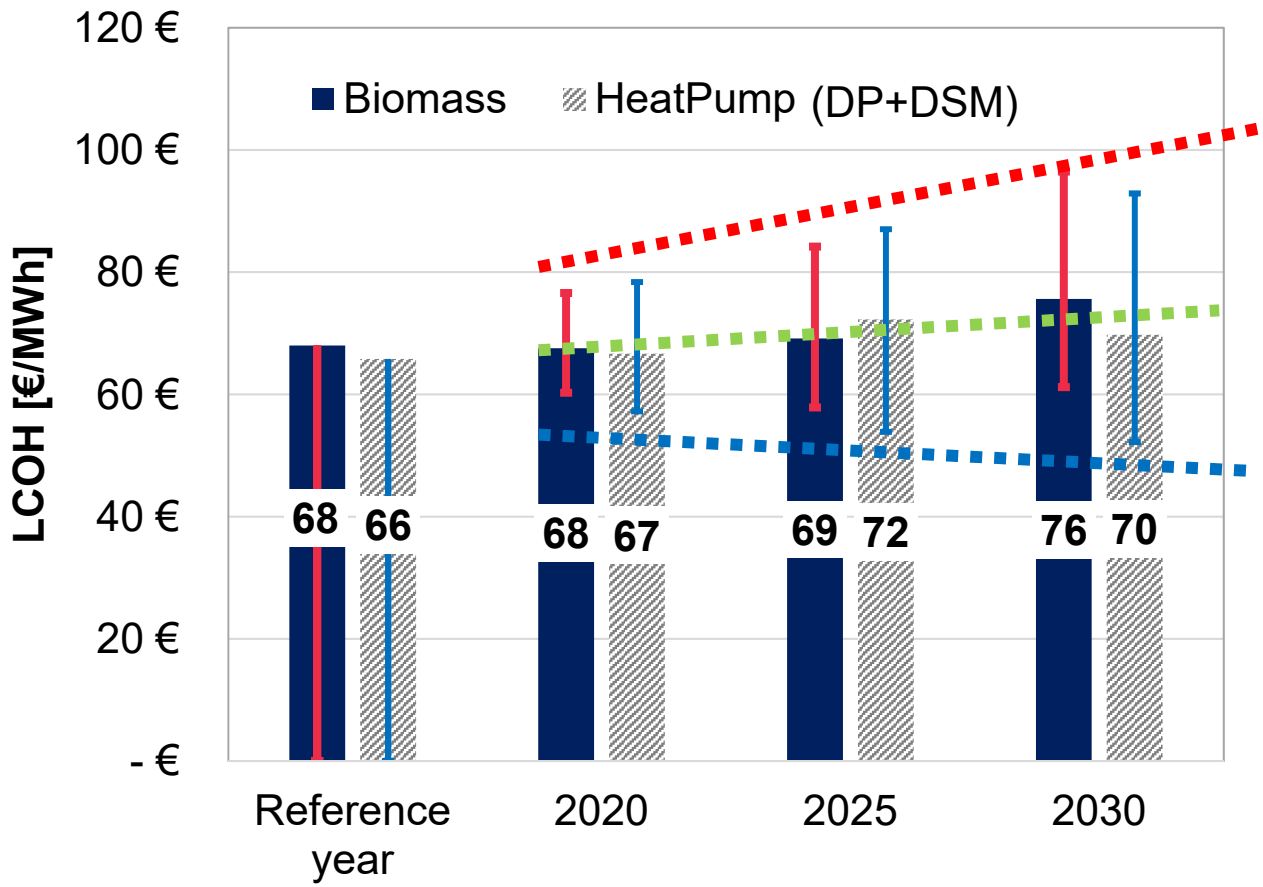
~14 % reduction by DSM
If HP runs on ONOFF operation

~11 % reduction by DSM
If HP runs on PARTLOAD operation



RESULTS: FUTURE FUEL PRICE DEVELOPMENTS

- Impact of the **fuel price development**



Fuel price avg increase
~+4% biomass
~+4% electricity

Stable prices
~+2% biomass
~-1% electricity

Fuel price avg descrease
~-1% biomass
~-7% electricity

TsourceHP = 35°C

Fuel prices scenarios based on Rab, N. (2015), Absicherung von langfrsitigen Preisrisiken der Fernwärmegestehung durch Grosswärmepumpen, Technical report, TU Wien.

KEY DEDUCTIONS- CONTROL SCENARIOS

Results and conclusions:

- **Levelised costs of heating savings** up to:
  - 9% on application of dynamic pricing
  - 11% and 15% reduction with DSM on apartment blocks / entire network
- **Part load Heat Pump** units are recommended:
  - Despite having additional specific investment (+~10%) → part load operation results in 8-10% operating cost reduction and 13-16% energy savings → DSM approach brings lower savings compared to ONOFF operation
- **Integration of heat pumps** at low source temperature (<20°C) can represent a valid when:
  - Dynamic pricing and DSM strategies are considered
  - HP compensates volatility of fuel prices better then other technologies (e.g. biomass plants)

Outlook:

- Development of control strategies and **business models** for integrating pooling of HPs in DH networks as an asset for the operating reserve market
  - Project name **fit4power2heat**
  - Funds **Climate and Energy Funds**
  - Programme **Stadt der Zukunft 4. Ausschreibung**
  - FFG Project N° **861726**

Thank you for your attention.

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4DH
4th Generation District Heating
Technologies and Systems

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- **Project** IEA HPT Annex 47
- **Period** January 2015 – March 2019
- **Funds** Climate and Energy Funds
- **Programme** Forschungskooperation Internationale Energieagentur, Ausschreibung 2015
- **Project N°** 853039

- **Project** IEA EBC Annex 60
- **Period** November 2013 – October 2017
- **Funds** Climate and Energy Funds
- **Programme** Forschungskooperation Internationale Energieagentur, Ausschreibung 2013
- **Project N°** 843149