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ANNEX 57 — Flexibility by implementation of heat pumps in multi-vector energy systems and thermal networks

Demo No.: D-001	**Location/City:** Neusiedl am See	**Country:** Austria
Project name: Energie Burgenland HP Neusiedl am See		
Quotation: "Use excess wind electricity for heat pumps to enable flexible operation of the district heating system"		
Schedule of the demo project (research study):		**Year of realisation:** 2021
Leader organisation (owner, constructor, solution developer, research inst., etc.): Energie Burgenland		
Participating organisations – demonstration project part (involved other organisations): Energie Burgenland, Ochsner Wärmepumpen, Hybrid DH Demo, 4Ward Energy Research, Heat Water Storage Pooling		
Budget of the demo (invest/monitoring etc.): €5m		
Summary of the project: The region Burgenland (where Neusiedl am See is located) is the region with the highest wind energy supply in Austria. Neusiedl am See is a preferred living space with increasing heat demand. The project consisted of installation of a direct electric line from a wind park, a thermal and electric storage, as well as the installation of 4 high performance heat pumps and provides therefore the unique opportunity to source heat from renewable electricity generation.		
Expected results • Gas-savings of around 1,250 GWh/a • Reduction of carbon emissions of around 300 t/a • Reduction of biomass consumption of around 1,200 t/a • Reduced transport of biomass, reducing carbon emissions in transport by 9 t/a		
Published articles (paper, article etc.) • N/A		
Contact information -		
Country: Austria	**Participating Organisation:** Energie Burgenland	**Contact/name:** Matthias Lehner

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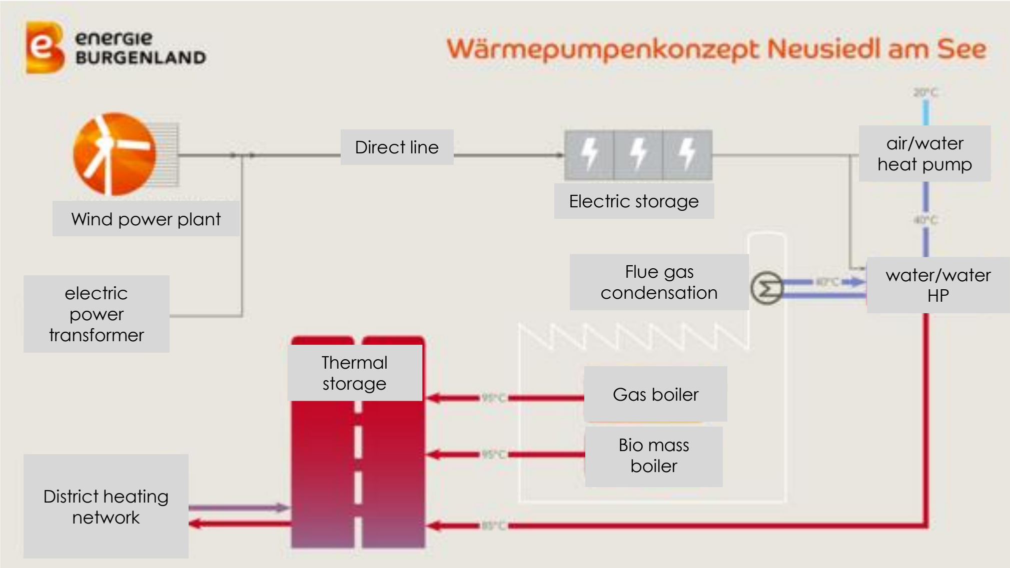

Figure 1 General layout

Project classes:

RD&D status

Large-scale demonstration	Small-scale demonstration	Lab scale (results based on measurements)	Design study (results based on simulation)
☒	☐	☐	☐

Type of heat pump

Decentralized HP (cold district heating)	Centralized HP with a district heating system
☐	☒
Heating	Cooling
☒	☐

Heat source of HP: Air, Flue gas condensation

Power supply for HP (electricity grid, PV, wind turbine etc.): direct line from wind turbine

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Buildings

New buildings	Existing buildings	Mix of new and existing buildings
☐	☐	☒
Residential	Non-residential	Mixed use
☒	☐	☐

Energy storage

Battery storage		Thermal energy storage	
Centralized	Decentralized	Centralized	Decentralized
☒	☐	☒	☐

Control for the flexible heat pump operation

Heat driven control[1]	Predictive control[2]	Rule based control[3]
☒	☐	☐

[1] Operation of heat pumps to the cover heat demand depending on ambient temperatures
[2] Operation of heat pump using a model based heat demand prediction
[3] Heat pumps are controlled by a set of predefined rules (e.g. heat pump operation with blocking time)

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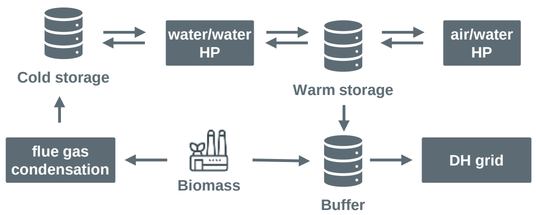
1. General description of the project

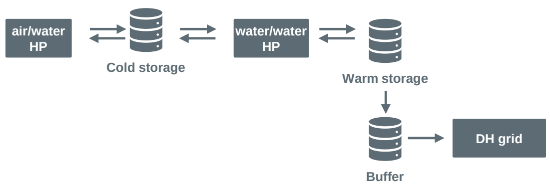
The project is located in Neusiedl am See, a town with increasing population size. Within this project, the existing infrastructure of a district-heating network as well as the biomass-boiler was extended by a direct line to the nearby wind park, a battery storage as well as four heat pumps.

The aim of the project is to use excess electricity of a wind park consisting of 17 wind turbines (32MW) for heat generation. Therefore, a direct electricity line connects the wind park with a battery storage. During winter months, a biomass-boiler is in operation. A water-water heat pump uses heat from flue gas condensation from the biomass boiler. During summer months, the flue gas condensation is substituted by the air-source heat pump.

Scheme winter



Scheme summer



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2. Building and system description of the project

The innovative concept lies in the coupling of heat and power sectors through the intelligent use of heat pumps and the existing district-heating infrastructure.

The concept ensures the use of excess electricity from the nearby wind park for heating purposes and provides therefore a unique flexibility option.

3. Energy supply – scheme of the heat supply system:

In winter, the majority of the heat load is covered by biomass. When biomass is on, flue gas condensation delivers water of around 30/35°C. From there, 2 water-water heat pumps lift the heat level of the warm-buffer of around 60/65°C to around 65/70°C. Additionally, 2 air-water heat pumps are supplied by the warm buffer with 74°C/78°C which they lift by 4°C. Heat load in winter is between 1-4MW.

In summer, the biomass plant is not operational and the heat from flue gas condensation is replaced by air-water heat pumps which deliver heat at level of 30/35°C that was done by the flue gas condensation before. From there on, same procedure as in winter. Heat load in summer is around 0.5-1MW.

Around 10% of heat is produced from gas, 40% from biomass and 30% from wind.

2 water/water heat pumps, 600kW each
2 air/water heat pumps, 600kW each

Cold-water storage 17m³
Hot water storage 17m³
Buffer storage 2x150m³

4. Flexibility – scheme and control strategy of the system:

The gas boiler is used as backup capacity in case of a wind slack. The battery storage ensures, in case of a wind slack, that the heat pumps can be ramped down in a controlled manner and deliver 1 MW for a couple of minutes. The thermal storage of 300 m³ enables further supply of the DH system for 10 hours during summertime.

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5. Description of the business model with a flexible HP-operation

The trigger for this innovative concept was the dropping-out of wind capacities from the support system around 2015/2016. This provided the case to look for the most profitable use case for wind energy. Depending on the COP and the heat price, using wind electricity for heat production provides a good upside potential.

In a first step, the wind profile was compared to the heat profile and resulted in a good fit, 80% of time, wind was available. To cover the heat load, only a small fraction of the 32MW wind park 'Neusiedl' needs to be used. A direct electricity line of 1.5MW was built for around 2km from the transformer station to the existing biomass/gas heating plant.

6. Results of the project

This leads to significant reductions in

- the consumption of biomass (1,200 t/a)
- natural gas (1,250 MWh/a)
- reducing the CO2 emissions by around 300 t/a
- less transport of biomass (9t CO_2/a)

7. Challenges / socio economical barriers and opportunities

Large challenge lies in the produced noise of heat pumps. There is some housing in the direct neighbourhood of the heating plant, which feels the noise as a destruction. This is especially the case in times of weak-wind periods, where noise of wind does not compensate the noise of the heat pumps. In periods of strong wind, noise of wind typically compensates the noise of the heat pumps.

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8. Additional information: Flexibility options

Contents: district heat pump

Share of heat sources (in %)	1. Heat source: biomass 2. Heat source: wind/HP 3. Heat source: gas	1. 40% 2. 30% 3. 10%
Share of power supply (power grid, PV-units at site, wind turbine at site etc.)	1. Power supply: wind	1. 100 %
System boundary by calculation of the SPF	4	
Seasonal performance factor in design and measured (SPF)		
COP of HeatPump at the design condition (point in °C or traverse as function in °C), independent of site boundaries		
COP incl. all peripheral devices at source and sink side		
Location of heat pump (e.g. heating centre (centralized heating installation), using existing infrastructure etc.)		

Contents: district heating network

Land area for buildings served by heat distribution network	57	km²
Total heated floor area in buildings connected		
Trench length for heat distribution network	~10	km
Heating capacity		
Heat annually supplied into the heat distribution network	12	GWh
Heat annually delivered from the heat distribution network		
Annual average supply temperature in the heat distribution network		
Annual average return temperature in the heat distribution network		
Heat generation based on renewable sources	90	%

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Contents: description of energy storage system

Energy storage type:	
Storage size (capacity):	2 x 17m³ + 300 m³ buffer
Term of flexibility:	
Storage temperature (thermal energy storage)	Buffer 85°C, cold storage 25-35°C, warm storage 60-80°C

Contents: indicators for flexible heat pump operations

Cost (potential cost saving)		
Thermal level (losses of thermal comfort)		
Load matching factors (load supply & load cover factors)		