

# Interim report – WP5

## District Heating Infrastructure

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Reporting months: July 2018 – June 2019



Photo: By & Havn / Ole Malling

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June 2019

## **Work package aims and objectives**

The work package WP5 aims at developing SMART district heating solutions and to demonstrate the potential of the district heating energy system as a vital part of the future flexible and integrated energy system.

## **Overall progress of the work towards WP Objectives**

During the last year, many tasks, demonstrations, tests and analyzes related to the district heating infrastructure have been carried out.

HOFOR has tested and proven that thermal flexibility exists in the entire district heating system; production, distribution and consumption can be utilized in the future renewable and integrated energy system.

The successful demonstration of flexible customers or short-term heat storage in buildings has been expanded to also include an area in Nørrebro. The preliminary results from these tests have proven so interesting that the activities will continue after the EnergyLab Nordhavn project.

The FlexHeat heat pump system has been in operation for almost a year and has already provided some interesting results and knowledge on the possibilities of utilizing heat pumps in a low temperature district heating system in combination with a heat storage to operate mainly in periods with low electricity prices and/or a high degree of renewables. However, HOFOR has had unexpected operational issues with FlexHeat from April 2019 and the heat pump is not yet up and running in a stable mode. This is very unfortunate for our test schedule, but we expect to have FlexHeat in operation again during June 2019.

During the last part of the project, focus will be on the remaining deliverables in WP5, but also on the activities and deliverables in WP8 where HOFOR is lead.

HOFOR is very satisfied with our own results in the EnergyLab Nordhavn project, as they, among others, have proven that our customers are interested in SMART district heating and also that new production technologies like central heat pumps can improve and develop the district heating system into providing more flexibility and integration with the future renewable energy system.

## Status and activities in the WP5 tasks

### 1.1 Task 5.1 – District heating performance

The deliverables are finalized and approved. HOFOR is working on implementing the new heat label internally and have also initiated meeting activities externally to bring the new heat label into play with relevant parties to secure a broader and hopefully future implementation (See figure 1 below).

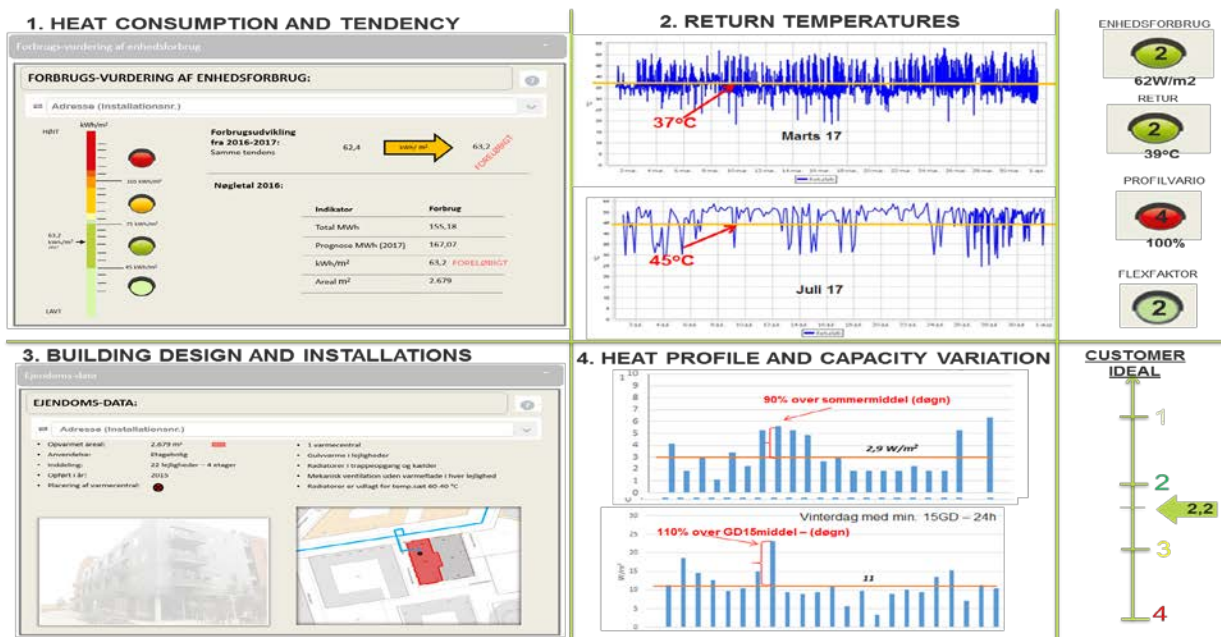


Figure 1: New heat label

### 1.2 Task 5.2 – District heating flexibility

The deliverables on district heating flexibility are all in the finalization phase or have been finalized and provides results on among other:

- Criteria for selecting heat pumps for Nordhavn – taking available heat sources such as air, seawater, ground water etc. and various types of heat pumps like individual, central etc. into account. The work is done by PhD's Wiebke Meesenburg and Henrik Pieper from DTU-Mekanik.
- Heat storage in district heating pipes is a possibility for reducing peaks and utilizing more renewables, but is also very sensitive to the operation of the district heating substations and the technical limitations on the district heating pipes.
- Flexible customers / Short term heat storage in buildings has been successfully demonstrated both in Nordhavn and Nørrebro. A solution for automatic control of many buildings is tested together with Danfoss in a new deliverable. The concept has many positive side-effects apart from reducing peak load, such as customer involvement, optimization of district heating substation providing energy savings. The concept can be compared with battery, where the buildings are batteries of

heat and typically always charged and can thus be discharged and recharged, as can be seen in the below illustration.



Figure 2: Types of buildings and flexibility in time and energy (4t means 4hours)

### 1.3 Task 5.3 – Optimum operation of heat stores

HOFOR has installed a 100 m<sup>3</sup> large heat storage at FlexHeat.

The heat store will be the real live heat storage for demonstrating a protocol on smart operation of a thermal heat storage, allowing the heat pump to be in operation primarily during low cost hours and/or renewable hours will also be able to deliver flexibility to the electricity system.

Tests and demonstrations are ongoing and the reporting is expected to be finalized during summer 2019. Please see figure 3 below for the complete application overview of FlexHeat.

### 1.4 Task 5.4 – Low temperature district heating

The low temperature district heating demonstrations have been carried out, tested and delivered. The results clearly prove that new buildings can cope with the lower supply temperatures, but also that it requires a high degree of attention on the operation and maintenance of the district heating substations in the buildings as well as in the internal heating systems in the apartments. If this operation is not optimized the lower supply temperature can lead to higher return temperatures to the district heating network and thereby reduce the benefits of low temperature district heating.

Two of the demonstrations are focusing on reducing the district heating return temperature in combination with heat pumps. In both the ultra-low temperature demonstration and the domestic hot water circulation demonstration, the heat pumps are utilizing the energy in the return pipe from the building to reduce the district heating return temperatures.

### 1.5 Task 5.5 – Island district heating

The FlexHeat heat pump system supplies the three Cruise Terminal buildings and the UNICEF warehouse in a small low temperature district heating network.



The heat pump is app. 800 kW (heat) and 250 kW (electricity) and also includes a 4 MWh (100 m<sup>3</sup>) thermal heat storage, and 2 instantaneous electric boiler of 100 kW each.

The low temperature district heating network running at a maximum of 70-80°C, provides a high efficiency for the heat pump and in combination with the heat storage, the heat pump is mainly producing during hours with low electricity prices and/or a high degree of renewables.

FlexHeat has unfortunately not been in operation during April and May due to technical issues, but the challenges are expected to be solved during June, and should thereby still be able to deliver the expected demonstrations and results.

Please find an application overview below.

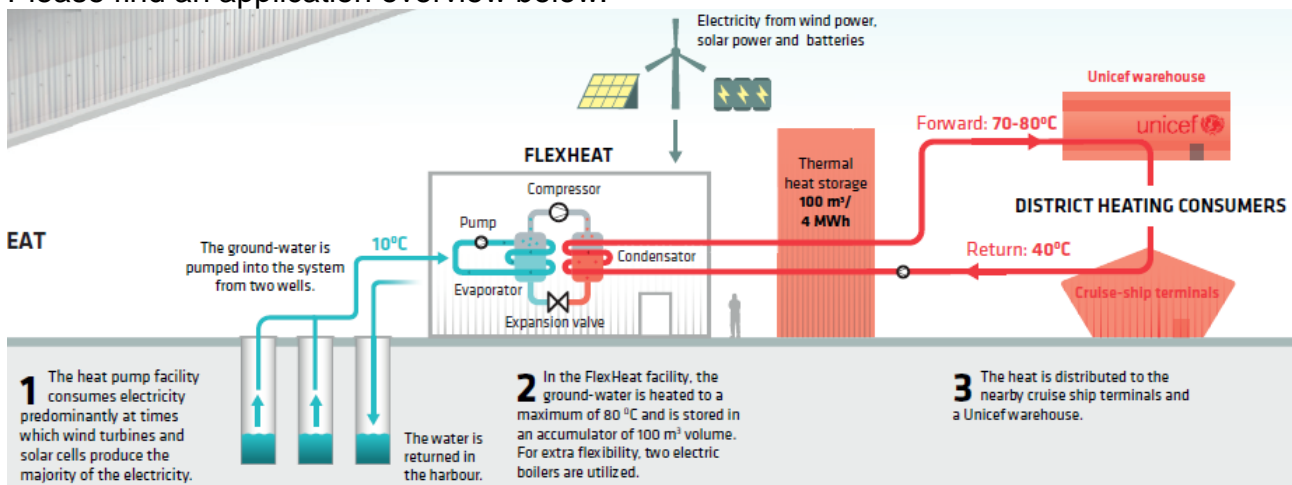


Figure 3: FlexHeat Nordhavn - heat pump system

## 1.6 Task 5.6 – Scenarios and recommendations for Nordhavn

Main results from WP5 and other WP's are now available and will be used to create scenarios for supplying Nordhavn with heat in 2025, 2035 and 2050.

## Deliverable status

D #	Deliverable title	Planned completion month	Status 1 = on schedule 2 = completed 3 = delayed
D5.2a	Criteria for selecting between large heat pumps for districts and small heat pumps for individual buildings.	May 2019	<b>3 - is in external review and planned for approval in June 2019</b>
D5.2b	Analysis of the potential for storing heat in district heating pipelines.	November 2018	<b>2</b>
D5.2e	Analysis of the potential for storing heat at interruptible consumers - phase 2 of D5.2c	June 2019	<b>1</b>
D5.4a	Minimum 3 demonstrations of low-temperature (55°C or lower) heat supply to a building.	April 2019	<b>2</b>
D5.4b	Installation and demonstration of domestic hot water circulation heat pump for reducing district heating return temperature	July 2019	<b>1</b>
D5.4c(i)	Installation and demonstration of capacity limitation functionality for domestic hot water tank in a new building, to reduce peak load, lower return temperatures and utilize flexibility in domestic hot water tanks	May 2019	<b>2</b>
D5.4c(ii)	Installation and demonstration of capacity limitation functionality for domestic hot water tank in an old building, to reduce peak load, lower return temperatures and utilize flexibility in domestic hot water tanks	May 2019	<b>2</b>
D5.5a	Minimum one small district (minimum 3 buildings) supplied by a neighborhood heating system separated from the central district heating system.	May 2019	<b>3 – is in WPL-approval process and is expected approved June, 10<sup>th</sup>, 2019</b>
D5.6	A summary report comparing all instruments investigated in this work package.	September 2019	<b>1</b>

## Dissemination

PhD's and PD's engaged in and connected to WP5 are continuously publishing articles on their work and research and this is to found on the ELN webpage:

<http://www.energylabnordhavn.com/>

HOFOR has on the 11<sup>th</sup> of May published a press release on flexible customers, which has been brought in seven news media, among other, as an example in the HVAC Magazine:

<http://www.hvacfokus.dk/7-000-koebenhavnere-hjaelper-hofor-med-at-goere-fjernvarmen-groennere/>

HOFOR is actively promoting the EnergyLab Nordhavn project as a lighthouse project and is regularly hosting guests in EnergyLab Nordhavn Showroom (E-HUB) or at HOFOR.

Some examples are:

- Board of Data Supply and Efficiency, 9<sup>th</sup> of April
- Danish Concrete, General Assembly, 26<sup>th</sup> of April
- HOFOR Management Conference 29<sup>th</sup> of April
- Ukrainian Television – Froljak TV 1<sup>st</sup> of May

## Next steps

- Carry out remaining tests on the FlexHeat heat pump system and prepare reports.
- Develop scenarios for summarizing the future district heating supply to Nordhavn.
- Secure and follow up on time, money and quality in the realization of the remaining deliverables and milestones.

### Quality Assurance

Status of deliverable		
Action	By	Date
Sent for review	Kristian Honoré	2019-06-06
Reviewed	Kasper Korsholm Østergaard	2019-06-07
Approved	WPL-group	2019-06-21

Author	Reviewer	Approver
Kristian Honoré	Kasper Korsholm Østergaard	WPL-group

*The project "EnergyLab Nordhavn – new urban energy infrastructures" will develop and demonstrate future energy solutions. The project utilizes Copenhagen's Nordhavn as a full-scale smart city energy lab and demonstrates how electricity and heating, energy-efficient buildings and electric transport can be integrated into an intelligent, flexible and optimized energy system. The project participants are: DTU, City of Copenhagen, CPH City & Port Development, HOFOR, Radius, ABB, Balslev, Danfoss, CleanCharge, METRO THERM, Glen Dimplex and the PowerLab facilities. The project is supported by EUDP (Energy Technology Development and Demonstration Programme), grant 64014-0555 and runs from 2015-2019.*





## Version Control

Version	Date	Author	Description of Changes
1	2019-06-06	Kristian Honoré	Draft
2	2019-06-07	Kasper K. Østergaard	Review and comments
3	2019-06-10	Kristian Honoré	Final, send for approval
4	2019-06-21	WPL	No comments, Approved