

EnergyLab Nordhavn

New Urban Energy Infrastructures and Smart Components

EnergyLab Nordhavn is a large-scale integrated research and demonstration project that contributes to the grand challenge of transforming the energy system to efficiently integrate a large share of renewable energy.

The project focuses on a cost-effective future smart energy system that integrates multiple energy infrastructures (electricity, thermal, transportation) and provides an intelligent control of subsystems and components – providing necessary flexibility for efficient utilisation of renewable energy. The demonstration

takes place in Copenhagen's Nordhavn, one of the largest development districts in Europe.

A LIVING LAB FOR INTEGRATED URBAN ENERGY INFRASTRUCTURES

The EnergyLab Nordhavn project will establish itself in Copenhagen's Nordhavn as a living laboratory for future smartenergy technologies, innovative business models and new operational solutions on all scales - component, building, grid infrastructure and system level - and provide basis for design and dimensioning of future energy

infrastructure in sustainable low-energy city districts.

BRINGING STAKEHOLDERS TOGETHER

EnergyLab Nordhavn brings together stakeholders from various sectors such as energy infrastructure, authorities, industries and knowledge institutions. The project interlinks development and research activities creating an environment for strong research-based innovations.



ABOUT THE NORDHAVN DISTRICT:

Copenhagen's Nordhavn is one of Europe's largest metropolitan development districts. It is being developed by the CPH City & Port Development. Over the next 50 years it will be built as a sustainable city district with 40,000 new residents and 40,000 new jobs. Supporting the vision of Copenhagen to be the world's first CO2 neutral capital, sustainable urban development is integrated into all aspects of the city district - green traffic, energy solutions and social diversity.

THE PROJECT ADDRESSES KEY CHALLENGES OF FUTURE SMART ENERGY SYSTEMS:

► **DEVELOPMENT OF A COHERENT FLEXIBLE ENERGY SYSTEM**

with novel technical solutions like energy storage by variable district heating temperatures, buildings providing flexibility and more integrated markets where infrastructures are closely interconnected and operationally co-optimized.

► **RE-THINKING ENERGY INFRASTRUCTURE DESIGN AND DIMENSIONING METHODS**

to accommodate e.g. new low heat demanding buildings, new dynamic patterns from responsive prosumers and technologies to shift between use of electricity and district heating.

► **DEVELOPMENT OF ENERGY TECHNOLOGIES**

providing grid services by smart cost-effective controllers and associated new business models and user interactions.

IMPACT

EnergyLab Nordhavn will significantly contribute to national and international goals for a reliable, sustainable and affordable energy system.

With current global urbanization trends, the development of sustainable city energy systems becomes crucial. Today more than 50 % of the world and 75 % of the European population live in cities. More than 30 cities have more than 10 million citizens. The UN expects the share of the world's urban population to increase at a pace of approx. 1.5 % per year. As Greater Copenhagen accounts for 40 % of Denmark's population, solutions in Copenhagen will substantially contribute to national targets.

Experimental activities and research-based technology development in the project will have substantial societal, scientific and commercial impact. Societal impact by developing a future energy system and efficient future market designs, rules and regulations, scientific impact by new knowledge breakthroughs and expansion of the global knowledge-base and commercial impact by leading the way for new patentable products and attracting new energy enterprises to Denmark.

Being a 'first mover' and being part of the internationally recognised green and sustainable development of Copenhagen we expect, growth, jobs and export opportunities will be generated.

NORDHAVN EXHIBITION EMBRACES ENERGYLAB NORDHAVN

The Nordhavn development area is already highly visible, also in an international context. EnergyLab Nordhavn will benefit from this visibility and will establish a showroom to demonstrate the progress and results of the project. The showroom will be open for all interested parties and will be created alongside the existing Nordhavn exhibition. The EnergyLab showroom demonstrations will be developed continuously and the involvement of the general public is enabled from the start of the project by the exhibition in the Nordhavn Silo.

CUTTING-EDGE RESEARCH

The research element of the EnergyLab Nordhavn project ensures research-based technology development, while generating new methods, tools and theories for future smart energy systems integrating multiple energy infrastructures. The research activities are key elements to successfully meet project objectives and include 9 PhD and 4 post-doctoral projects.

The research component is highly integrated with the innovation and experimental activities of the project. The research benefits from unique data provided by measurements and experiments in the Nordhavn city area - research hypotheses and objectives are developed in dialogue with industrial partners, and the research provides the necessary scientific base for the innovation of the project.

The project includes the following experimental activities (number of units in brackets) embedded in the ten work packages:

1. User behaviour and demand response with home management systems (50)
2. Technology for adaptive use of low temperature district heating and electricity (27)
3. Grid services by electric water heaters in private homes (20)
4. Smart energy-flexible building management system in commercial buildings (2)
5. Controller for optimal operation of large heat pump (1)
6. Smart charging EV infrastructure (20)
7. Electric battery storage in the power grid (1)
8. Low-temperature district heating supply solutions (3)
9. Islanding heating system supply (1)
10. Integrated heat and electricity market and control centres (1)
11. Ultra low temperature substations installed in multifamily or commercial buildings (2)
12. Flats equipped with remote controlled thermostats (10)
13. Supermarket heat recovery system (1)

ENERGYLAB NORDHAVN ENACTS POLITICAL AMBITIONS AND STRATEGIES

On a national basis the project addresses explicitly national strategies for the development of intelligent energy systems. The 'Danish energy policy 2012-20' (2012) states a number of initiatives to transform the energy system into a smart system. EnergyLab Nordhavn is aligned with these.

The 'Smart Grid strategi – fremtidens intelligente energisystem' (Danish Ministry of Energy, 2013) underlines the need for integration and coordinated operation of energy systems. The document states: 'In the past, the focus of the smart-grid agenda has been on the electricity grid, but in the future it must include gas and district heat in an integrated smart energy system'.

The project contributes to the aim of Copenhagen being CO₂ neutral by 2025. This will happen as the solutions developed are adopted and propagate into the Nordhavn district. The project will show how to obtain sustainable energy flexibilities (from storage and the ability of appliances to shift between the use of electricity and district heating), and energy efficient solutions (e.g. for indoor climate, hot tap water, utilization of surplus heat from supermarket and transport) in Nordhavn, in combination with integrated and coordinated energy infrastructures.

EnergyLab Nordhavn encourages - alongside the core project activities - direct or indirect involvement of small and medium size enterprises (SMEs) to support future deployment of upcoming solutions. In this regard a number of workshops during the project will be held.

BUDGET:

The EnergyLab Nordhavn project has a total budget of DKK 143 mio. (€ 19 mio.), hereof DKK84 mio. (€ 11 mio.) funded in two rounds by the Danish Energy Technology Development and Demonstration Programme (EUDP).

Duration:

2015-2019

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STRUCTURE OF THE ENERGYLAB NORDHAVN PROJECT

The work of the project is organized in ten work packages (WPs). Work package leaders are mentioned in (brackets):

- ▶ **WP1 Project Management (DTU):** The project is headed by a dedicated project manager reporting to a steering committee, comprised of all partners. External stakeholders are to be engaged to secure optimal impact of the project. Project communication is also a part of this work package.
- ▶ **WP2 Data and Measurements (ABB):** The WP will establish and operate a data collection and management system for EnergyLab Nordhavn integrated in PowerLabDK (www.powerlab.dk) providing real-time and historic data from all energy infrastructures (electricity, heating, and transport) and buildings to other WP's and public visualizations.
- ▶ **WP3 Smart Energy Buildings (Balslev):** The WP will provide a new understanding of low-energy buildings as active energy-flexible elements in a smart energy system. It will develop and showcase associated novel control solutions for smarter operation and monitoring of energy in modern buildings transforming challenging fluctuations of the various energy forms into an interconnected system.
- ▶ **WP4 Smart Network Services (DTU):** The WP will develop, experimentally verify and evaluate various control-based enabling technologies and solutions for smart networks services with high cost and energy efficiency and promising business potential, and provide elements for a smart energy infrastructure design and operation.
- ▶ **WP5 Thermal Infrastructure (HOFOR):** The WP will develop district heating designs for dense, low-energy and low-temperature district heating areas. It will also employ measures to create increased flexibility by heat storage in pipelines and buildings, by enhanced communication between buildings' heating systems and the supply network, and by using heat pumps and possibly electric boilers to make the flexibility potential of district heating accessible for the electricity system.
- ▶ **WP6 Electricity infrastructure (Dong Energy Distribution):** The WP investigates flexible and dynamic consumption patterns and new grid designs. A number of innovative add-ons to the current grid layout will be developed and evaluated for grid performance and financial feasibility.
- ▶ **WP7 Electric transportation Infrastructure (CleanCharge Solutions):** The WP will develop and experimentally verify robust and cost-effective smart charging solutions for electric transportation in dense areas, and how these can contribute intelligently to an overall optimized energy system.
- ▶ **WP8 Multi-carrier Energy Systems Operation and Markets (ABB):** The WP will develop, experimentally validate and evaluate the integration of the various energy infrastructures. The developed solutions will cover integrated market design for heat and electricity markets as well as operational control room solutions to function across energy infrastructures.
- ▶ **WP9 Visibility and Stakeholder Engagement (By og Havn):** The WP will ensure stakeholder engagement, support the dissemination of the project results in Nordhavn, and utilize the visibility of Nordhavn and the EnergyLab Nordhavn project to support an associated SME innovation in Nordhavn.
- ▶ **WP10 Smart components in integrated energy systems (Danfoss):** The WP demonstrates and analyses the technical and economic feasibilities of smart control of specific components and systems with main functions to provide heat and cooling services in buildings – including space heating, hot tap water and food cooling. This includes 1: District heating substation based on ultra-low temperature district heating, providing space heating and domestic hot water for multifamily or commercial buildings. 2: Remote controlled valves for regulation of a water based building space heating; 3: Utilization of spare heat pump capacity for a supermarket.

Partners:



ENGINEERING
TOMORROW



KØBENHAVNS KOMMUNE



Sponsor:



Energiteknologisk udvikling og demonstration