

Final report

1.1 Project details

Project title	EnergyLab Nordhavn - Platform
Project identification	ELN#00
Name of the programme which has funded the project	EUDP-13-II (64013-0557)
Project managing company/institution (name and address)	DTU - Technical University of Denmark Anker Engelundsvej 1 2800 Lyngby
Project partners	DTU Københavns Kommune ABB Balslev
CVR (central business register)	30060946
Date for submission	Dec 2015

1.2 Short description of project objective and results

The scope of EnergyLab Nordhavn is to establish a long term and strategic organisational and experimental platform for projects, utilising the new Nordhavn area as a full scale laboratory for smart energy solutions in future sustainable urban areas, and specifically to qualify and formulate a first experimental project.

Kort beskrivelse (dansk):

Målet med EnergyLab Nordhavn er at etablere en langsigtet og strategisk organisation og en eksperimentel platform for projekter som benytter det nye byområde Nordhavn som et levende fuld-skala laboratorium for smarte energiløsninger i fremtidens bæredygtige byområder, samt specifikt at kvalificere og formulere det første eksperimentelle projekt.

1.3 Executive summary

An increasing part of our energy consumption is related to energy services in the growing cities. The cities' density in population, activities and energy consumptions provides specific opportunities for multi-string energy networks and for energy efficient and integrated energy solutions, but also challenges in relation to local energy generation and distribution capacities.

Within the next decades, Copenhagen aims at developing the new area Nordhavn with 40 000 new homes and 40 000 new jobs, demonstrating examples of tomorrow's sustainable city, buildings and energy solutions, and contributing to Copenhagen's ambitious aim to become CO₂-neutral by 2025.

The overall aim is that EnergyLab Nordhavn becomes a long term and strategic organisational and experimental platform, utilising the unique opportunity of using the new Nordhavn area as a full scale, live laboratory for smart energy solutions in future sustainable urban areas. A series of supplementing EnergyLab Nordhavn activities and projects will systematically test and demonstrate new smart city energy concepts and solutions; develop decision

support methods and tools for planning and operation; and collect and distribute data, knowledge and experiences.

The specific objectives of this project were to 1) describe a robust and efficient organisational setup; 2) to specify important requirements to the Nordhavn live laboratory platform; and 3) to formulate the first real EnergyLab Nordhavn project.

The options and challenges, and thereby the solutions, for the new area Nordhavn in the large city Copenhagen will be different from the solutions for e.g. an island system as Bornholm, an industry dense area as Kalundborg or a village like Stenderup, even if techniques, technologies and components may be the same.

With the increasing requests for energy infrastructures and buildings adapted to the new energy systems and requests for energy solutions meeting the political demands for sustainability, EnergyLab Nordhavn provides huge business potentials. And Denmark and the Danish companies are as World leading well dressed to benefit from these potentials.

The aims of this first project EnergyLab Nordhavn | Platform for Developing Smart City Energy Solutions are to establish EnergyLab Nordhavn as an organisational platform; to identify the end user's needs for information; to characterise the energy behaviours of future buildings, including their energy flexibilities; to identify and characterise the options for smart city energy integration; to identify and characterise available data and objects, relevant for new knowledge and smart integration; to develop a data acquisition concept suitable for smart city energy systems; and to qualify and formulate a succeeding large-scale data project.

The results of the present project expect e.g. to be that EnergyLab Nordhavn is defined and established as an organisational platform for initiating, coordinating and steering EnergyLab Nordhavn projects; that new and valuable knowledge regarding future building's energy characteristics, options for smart energy integration and data acquisition concept for smart city are generated, disseminated and documented; and that a new EUDP data project proposal has been applied for.

1.4 Project objectives

The overall objective was to utilise the unique new low energy city development area Nordhavn in Copenhagen for live demonstrations of tomorrow's smart energy solutions, with the specific objectives

- 1) to establish EnergyLab Nordhavn as an organisational platform for identification, initiation and coordination of a series of supplementing smart energy live demonstration projects in Nordhavn under real conditions;
- 2) to define EnergyLab Nordhavn as a physical platform for live demonstrations of smart energy solutions in the new city area Nordhavn;
- 3) to qualify central issues for the implementation of smart energy solutions;
- 4) to formulate the first EnergyLab Nordhavn demonstration project.

1.5 Project results and dissemination of results

The main outcomes of the project are:

- 1) EnergyLab Nordhavn has been established as a network between the core partners for the development of EnergyLab Nordhavn as a platform for initiation and coordination of smart energy live demonstration projects.
- 2) EnergyLab Nordhavn LiveDemoLab: The first steps have been taken to establish EnergyLab Nordhavn as a physical platform for live demonstrations of smart energy solutions under real operation conditions.
- 3) Selected topics have been qualified.
- 4) A proposal for the first EnergyLab Nordhavn project was formulated and submitted.

EnergyLab Nordhavn Partnership platform

The Steering Committee for the present project functioned as a network between core partners for realising EnergyLab Nordhavn as an organisational platform, with representatives from:

- Copenhagen Municipality – links to the local political system
- By&Havn – responsible for the urban development of the new Nordhavn area
- DONG Energy Distribution – responsible for the power distribution in Nordhavn
- HOFOR – responsible for the district heat distribution in Nordhavn
- DTU – with focus on generation and collection of new knowledge
- Balslev – representing the consulting industry
- ABB – representing the component industry

EnergyLab Nordhavn LiveDemoLab

The first steps were taken to establish a physical platform for live demonstrations of smart energy solutions in Nordhavn, as part of the first EnergyLab Nordhavn project proposal:

- A dedicated smart energy data management system has been proposed.
- Specific smart energy solutions have been proposed to be demonstrated in Nordhavn.

Selected topics

The project focused on three important topics for the future energy system:

- the smart energy approach,
- the role of the buildings, and
- the necessary data management system.

For each topic an open workshop was organised and a public report was prepared by the partners.

Smart energy

Fluctuating energy generation from wind and solar, distributed generation and control, and free market competitions form new challenges for the energy systems, in terms of both reliability and optimisation. Smart energy is part of solution for optimising design and operation of the energy system of the future. Energy flexibility, energy system integration, data communication and intelligent operation are crucial issues for realising the smart energy approach.

Some of the key findings:

- Large-scale energy flexibilities will be required in both the electrical grid and the thermal grids and solutions due to the increasing fluctuating generation from wind and solar. The energy flexibilities should be provided at all levels and by all parts of the energy system – energy generation, energy services, energy components, energy conversions, energy storage and energy exchange.
- Flexibility should be provided by integration of the energy sectors at all scales – from large-scale conversions between energy carriers (e.g. from power to heat and / or gas) to fuel-flexible energy services (e.g. heating services provided from a mix of district heat and power).
- With proper design and operation, the thermal and gas infrastructures can provide large-scale energy storage capabilities.

The role of the buildings

Cities, buildings and their citizens are responsible for a substantial part of the total energy consumption, but the buildings also represent potentials for substantial energy flexibilities. The project Task 3 and the project Workshop #01 focused on building's interactions with the energy systems.

Some of the key findings:

- Building's external energy requirements for maintaining the indoor climate are regulated by the national building regulations. The requirements are specified as the building's annual energy consumption relative to the building's living area. This is too simple for energy sys-

tem optimisations. There are needs for describing the building's energy dynamics and energy flexibilities.

- In reality, most new buildings does not meet the requirements in practice – mainly due to unskilled craftsman work and unexpected use of the buildings.
- New buildings will only require external energy for space heating 15-20% of the year.
- In new buildings, half of the external energy is for the production of hot tap water (or hot domestic water).

Data management system

Real-time access to relevant data is crucial for realising the smart control and optimising the operation of the entire, integrated energy system.

Some of the key findings:

- Access to data requires data and accessibility. Data should be generated by and made remote accessible from all parts of the energy system.
- Efficient and attractive smart energy data provision business models should be developed. The access to energy data could e.g. be combined with other smart services.
- Efficient solutions should be developed to exchange data – including communication standards, data management (where to find the data, who should have access to the data, the quality of the data etc), and data security.
- Operational robustness to missing or bad data must be secured through proper design and / or complementary data.

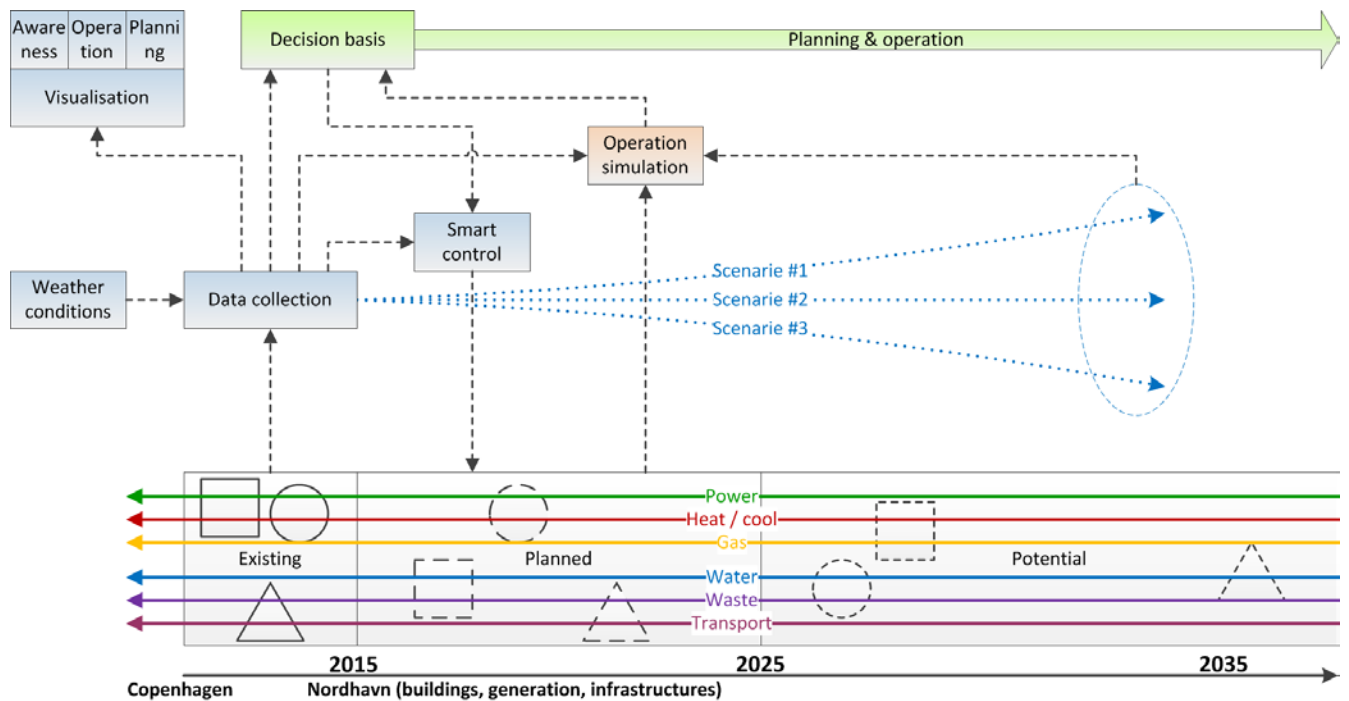
EnergyLab Nordhavn #1

A proposal for the first EnergyLab Nordhavn project has been formulated and submitted: 'EnergyLab Nordhavn – New Urban Energy Infrastructures', with the specific objective: 'To develop new methods and solutions for design and dimensioning of the future cost-effective multi-carrier energy system (electricity/thermal/transport) based on Nordhavn as a globally visible real-life laboratory. It includes development and experiments with novel business models, smart energy technologies and intelligent operational solutions.'

The ideas in the proposal are illustrated in the figure: The Nordhavn area will be developed over the coming decades. The project wants to collect detailed, real time data from available buildings and energy infrastructures, supporting optimised, smart and integrated planning, design and operation of the energy systems and there components. The detailed data can be utilised for providing customer's awareness, for smart operation and for smart planning. The planning and design must be robust for various possible future scenarios.

The partners in the proposal:

- DTU (coordinator)
- Københavns Kommune
- HOFOR
- DONG Energy EI Distribution
- By&Havn
- ABB Denmark
- Glen Dimplex Denmark
- Balslev
- Clean Charge
- Metro Therm
- (+ Danfoss from 2015)



The proposal included the following work packages:

- WP1: Project management
- WP2: Smart energy data management system for EnergyLab Nordhavn, with the objectives to specify and establish a dedicated data management system for the EnergyLab Nordhavn project.
- WP3: Development and utilisation of low energy building's potential energy flexibility.
- WP4: Provision of network services by smart energy solutions.
- WP5: Thermal infrastructures optimised for the coming low energy buildings in the dense Nordhavn.
- WP6: Optimised electricity infrastructures in the coming Nordhavn with new, unknown load profiles from new components.
- WP7: Infrastructures for smart charging of electric vehicles in Nordhavn.
- WP8: Smart, coordinated operation of the integrated energy system(s) and energy components in Nordhavn.
- WP9: Stakeholder involvement, visibility of the results and establishing of a showroom for new solutions.
- WP10 (from 2015): Smart integration of thermal solutions for space heating, district heating and food cooling in the energy systems.

The proposal included the formulation of 9 PhD studies + 4 PostDoc's for the development and collection of specific knowledge:

- PhD #1: Predicting flexibility in thermal mass in buildings for low energy districts
- PhD #2: Adaptive control solutions for enabling smart network services
- PhD #3: Heat pump solutions for integration with district heating in energy system
- PhD #4: Optimal integration of district heating, district cooling, heat sources and heat sinks
- PhD #5: Control of return temperature in low-temperature district heating network
- PhD #6: Smart end user data analysis and pattern recognition
- PhD #7: Advanced design methods for active distribution networks
- PhD #8: EV smartgrid integration in urban city areas
- PhD #9: Multi-carrier energy market design and analysis
- PD #1: Development of flexibility models of buildings
- PD #2: Scenarios for Nordhavn 2025, 2035, 2050
- PD #3: Cost-effective electrical storage in LV grids
- PD #4: Verification of flexibility models of buildings

The proposal, including the following WP10 extension, with a total budget of DKK 143 mio has following been granted by EUDP with a total support of DKK 84 mio.

Three public reports have been prepared in the project:

- EnergyLab Nordhavn rapport: Smart energiintegration
- EnergyLab Nordhavn rapport: Fremtidens bygninger
- EnergyLab Nordhavn rapport: Datahåndtering

1.6 Utilization of project results

In addition to the successfully granting of the new project proposal, partly formulated as part of the present assignment, the project has contributed to the clarifications of the future energy system, the smart energy options, the needs for new knowledge and demonstrations, and the potential values of a live demonstration laboratory in a large-scale urban area solely including low energy solutions, like the Nordhavn area.

The outcomes of the project have formed input to several further work, including the ongoing work in the 'Partnership Smart Energy Networks – RD&D', formulating recommendations to the conditions for and the prioritisation of smart energy research, development and demonstrations needed to meet the long-term aims for sustainability and robustness of the future energy solutions (the work is supported by EUDP).

1.7 Project conclusion and perspective

Relative to the short duration and the limited budget of the project, the work in the project have had huge impact on the clarification of smart energy perspectives and needs for research, development and demonstrations.

The main results of the project are:

- The clarification of the perspectives and needs within the selected topics – smart energy, the role of the buildings and data management. The findings are presented in the public reports.
- The 'EnergyLab Nordhavn – New Urban Energy Infrastructures' – a large-scale RD&D-project with several, supplementing demonstration activities in Nordhavn, all contributing with energy flexibilities supporting smart system operation.

Annex

Results from the workshops:

WS#00	2014-02-18	HOFOR	Smart energy
WS#01	2014-05-22	Widex	Buildings in the future
WS#02	2014-06-24	Balslev	Data management system



Workshop

EnergyLab Nordhavn | Data projektet

Tid & sted: Tirsdag den 18/2 2014, kl 9-13, HOFOR, Ørestads Boulevard 35, København.

Formål: På workshoppen vil vi diskutere visionerne for EnergyLab Nordhavn og specifikt mål, ambitionsniveau, struktur, rammer, finansiering og potentielle deltagere i det påtænkte *EnergyLab Nordhavn | Data* projekt.

Baggrund: Under EnergyLab Nordhavn | Platform projektet forbereder vi et storskala udviklings- og demonstrationsprojekt med arbejdstitlen EnergyLab Nordhavn | Data projektet. Projektet vil bl.a. indsamle alle slags energidata fra det nye område Nordhavn i København – produktionsdata, forbrugsdata, konverteringsdata, infrastrukturdata mv.; online data og historiske data; detaljerede data og aggregerede data. I eventuel mangel af tilgængelige data fra Nordhavn, suppleres med data fra andre relevante områder i København.

I kombination med numeriske modeller og simuleringer af energisystemerne i Nordhavn vil de indsamlede energidata blive anvendt til at udvikle og demonstrere beslutningsstøtteværktøjer for byplanlægning, energiplanlægning og drift af energisystemerne. Projektet kan desuden demonstrere forskellige implementeringer af smarte styringer.

Vi planlægger at indsende en ansøgning til EUDP til september 2014 om støtte til projektet.

Indhold: Workshoppen vil indeholde følgende hovedpunkter:

- Præsentation af EnergyLab Nordhavn | Data projektet
- Diskussion af visioner, mål og ambitionsniveau
- Diskussion af projektets delelementer samt struktur
- Diskussion af de nødvendige kompetencer og potentielle projektdeltagere

Deltagere: Inviterede deltagere: EUDP projektkonsulent; Styregruppemedlemmer; projektdeltagere.

Tilmelding: <http://www.doodle.com/acg3v4drismfsftv>

EnergyLab Nordhavn

Workshop: Monitorering og styring af fremtidens intelligente bygninger

V. 2014.05.12

Sted: Widex, Nymøllevej 6, 3540 Lyngø

Dato: 22. maj 2014, kl. 8.30 - 15.00



Emne: Vi skal undersøge tre centrale spørgsmål for datahåndteringskoncept:

- Hvad er den intelligente bygnings rolle i energisystemet?
- Hvilke typer af styringer og målinger er interessante ud fra et energifleksibilitets-synspunkt?
- Hvilke data er nødvendige og tilstrækkelige for at styre og modellere fleksibelt energi i moderne byggeri?

Agenda:

- Introduktion til workshoppen, Per Nørgård/DTU
- Widex film
- Rundvisning hos Widex

Herefter indlæg af ca. 15 minutter, med efterfølgende debat:

- Widex - Erfaringer med at bygge og benytte et energineutralt og -fleksibelt domicil
- Københavns kommune - Byggerier i Nordhavnen nu og i fremtiden
- DTU Byg – indeklimate målinger og fremtidig indretning af bygninger
- TI – Erfaringer med monitorering af bygninger og fjernvarmenet

- Frokost

- SBI - VE og brugeradfærd i fremtiden bygningsreglement
- Arkitema – Arkitektens syn på energifleksibilitet, bygningen som en energikomponent
- Balslev – Hvad kan vi styre og hvad skal vi måle
- Konklusion
- Afslutning

Venlig hilsen
på vegne af EnergyLab Nordhavn teamet
Benny Andersen

Deltagere e-mail

- | | | |
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| • SBi | Ole Michael Jensen | omj@sbi.aau.dk |



EnergyLab Nordhavn Workshop Datahåndtering

Per Nørgård (DTU)

2014-06-24

Balslev



Deltagere

EnergyLab Nordhavn

- Benny Andersen (Balslev)
- Søren Rønsberg (Balslev)
- Morten Christensen (Balslev)
- Per Boesgaard (KK)
- Benny Hansen (ABB)
- Alfred Heller (DTU BYG)
- Brian Hurup-Felby (DTU BYG)
- Per Nørgård (DTU CEE)
- Rasmus Reeh (DTU CEE)

Andre

- Rasmus Pultz (Global Connect)
- Claus Zibrandtsen (Global Connect)
- Ulf Nissen (Cisco)
- Mikkel Haack (Cisco)

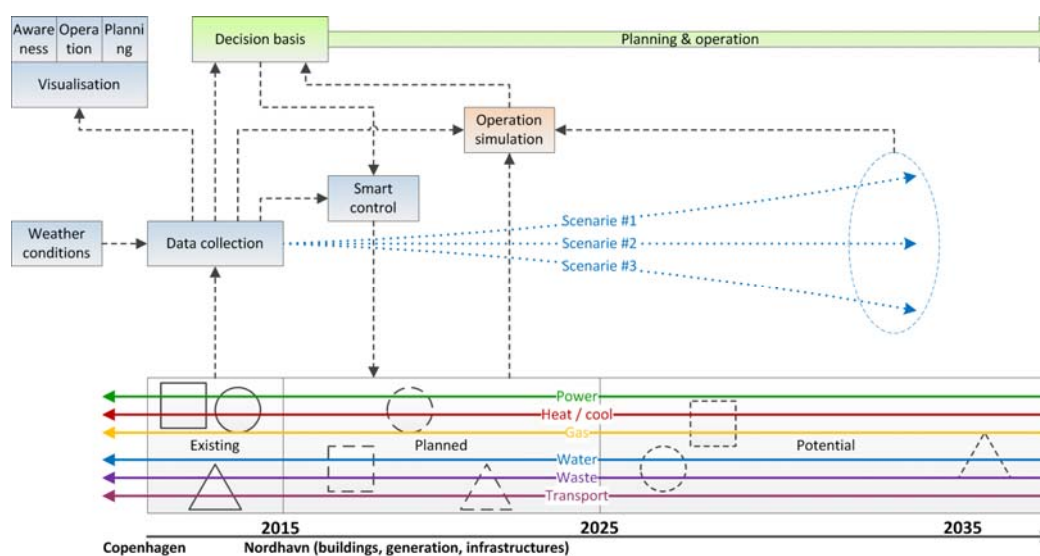


Program

- Velkommen (Benny Andersen)
- Intro (Per Nørgård)
- 8.45: Oplæg / diskussion
- 11.45: Opsummering (Per Nørgård)
- 12.00: Frokost



EnergyLab Nordhavn





Problemstillinger

Hvilke data?

- Formål?
- Historiske / real-time?
- Detaljerede / aggregerede data?
- Rå / bearbejdede data?

Data organisering?

- Centralt / decentralt?
- Koordineret / ukoordineret?
- Struktureret / ustruktureret?
- Metadata?
- Kvalitetssikring?
- Standarder?

Data adgang?

- Beskyttelse af system?
- Beskyttelse af personlige data?
- Kommercielle forhold?



Oplæg

- Benny Hansen (ABB)
- Claus Zibrandtsen (Global Connect)
- Mikkel Haack (Cisco)
- Morten Christensen (Balslev)