

Interim report – WP6

Reporting months: July 2017 – June 2018



Photo: By & Havn / Ole Malling

Author Poul Brath
Company Radius
June 2018

Overall progress of the work towards WP Objectives

Work in all tasks is aiming on the future load scenario with low energy consumption and stochastic load profiles. Radius has recently reviewed all tasks to secure that they all maintain focus on the overall objective of the Work Package.

The major focus is on the grid connected battery. The battery has been in operation for a while. Minor shortages in the control algorithm were corrected.

The primary purpose of the battery is to peak shave the general load on the 10 kV grid, but the battery is also designed to utilize the spare battery capacity for trading on the reserve market in order to demonstrate a positive business case.

Radius and the other participants in WP6 are continuously expanding the scope of the work according to the learnings obtained in the process, including the research activities on load patterns and new grid design methods. In an innovation process the learning curve may be sharply raising and other or modified investigations than the original planned may suddenly become more relevant or the only way forward. This is also the case for WP6. Therefore, review of tasks and deliveries may once again have to be reviewed.

Status and activities in the WP tasks

Task 6.1 Future load patterns

During the last year (June 2017 - June 2018), the main work has been the development of an online adaptive clustering algorithm for load profiling. The work has led to D 6.1.2a: Application of the online adaptive clustering for load profiling using available hourly data (businesses, industries, large consumers and residential with PV).

In the second half of the year, a master project has been conducted on energy disaggregation and the possible application for DSOs. The master student is continuing the work, which should lead to a journal paper as well as completing Deliverable D 6.1.4: Disaggregation - Demonstration of application of appliances detection and load disaggregation using EcoGrid EU data. It will be applied to electric heat and heat pump.

Task 6.2 New grid design methods

The model of 10 kV Nordhavn distribution grid has been modelled in Matlab, which is currently used for analyzing voltages and power flows through individual components of the system.

Four reports discussing different add-ons to the Nordhavn grid were done. The reports cover the following equipment or services, which could be used to provide flexibility:

- Demand response from customers on the secondary substation level
- Changing the network topology via reconfiguration
- Combination of the demand response and reconfiguration
- Use of the battery energy storage.

Each report states, how the considered element can be used to solve the potential problem of the Nordhavn grid: grid congestion or voltage violation and provides an estimation of the cost for deploying such technology. In addition, an ongoing master project, dealing with creating an algorithm for finding the optimal topology for the group of known load centers, is on the finishing stage. The algorithm takes into account time-varying power demand from different consumer categories, sizes of the cables and N-1 analysis to provide the least cost grid topology.

Task 6.3 Battery storage

Since BESS (Battery Energy Storage System) was put into operation in March 2017, the control algorithm has been adjusted and tested. The 2 basic functions 1) deferral of plant investments and 2) participating in FCR/D market has been tested. Regarding 1) we have developed an IT tool to predict which hours to peak shave the following day and which hours to deliver FCR/D (2) and thereby maximize income from BESS.

Furthermore, the SOC (State of Charge) management has been tested.

Basic timer-functionalities for all 3 services are implemented and tested ok.

All the mentioned tests show correct functionality.

Recently VQ (Voltage and Reactive power) application has been added. We have tested it real time and it seems ok. The setup of logged data does not include VQ values, but we plan to integrate these values as well.

Task 6.4 Grid Tariff and Grid Code

The consumer study regarding reception and acceptance of new tariff structures was initiated in May 2017.

During 2017 Q3 and Q4 a qualitative B2B study has been conducted with participation of four of the seven companies in Nordhavn with a yearly consumption of 400.000+ kWh. The objectives are to gain insights about business customers' readiness and potential interest in new power tariff structures and flexibility product.

In Q1 and Q2 of 2018, fieldwork for the second part of the study was carried out covering 16 in-depth interviews with private customers living in Nordhavn. The objectives are to gain insights about customers' understanding and acceptance of new power tariff structures.

The findings of the studies will be gathered in one report, which will also contain the findings from the third part of the study, which will be conducted in 2018 Q3 and Q4 and covers qualitative interviews with suppliers.

Deliverable status

D6	Deliverable title	Planned completion month	Status 1 = on schedule 2 = completed 3 = delayed
D6.1.2a	Statistics model on new loads scenario and their consumer appliances' simultaneousness. Report of results	Mar. 2018	2
D6.1.2b	Confirmation of model against data obtained	Mar. 2018	3
D6.1.3	Development of an advanced model and a report describing how to give prediction of peak load in a stochastic load scenarios. The report includes practical directions of how to use as basis for grid design. Slide set for presentation of the new method.	Mar. 2018	3
D6.2.2	Report with technical and financial assessment of at least 5 new add-ons to the existing grid in Nordhavn.	Apr. 2018	3
D6.3.4	Report with analysis of battery operation results.	Mar. 2018	3
D6.3.6	Assessment of use of battery capacity on multiple markets; primary combining FDR, FNR and peak shaving	Feb. 2018	2
D6.3.7	Battery incorporation in regulatory economy	Mar. 2018	3
D6.4.1	B2B research on new tariff design	Mar. 2018	3

D6.1.2b: Completion date changed to Oct 2018.

D6.1.3: Completion data changed to Oct 2018.

D6.2.2: Completion data changed to Oct 2018

D6.3.4: Completion data changed to Oct 2018

D6.3.7: Will be merged with D6.3.4 and new completion date is Oct 2018

D6.4.1: Completion data changed to Aug 2018

Almost all the delays in deliveries relate to Ph.d studies and are due to difficult circumstances for accurate planning. None of the deliveries from Ph.d students are critical for the overall progress.

Research

During the last year research in different areas has been made. The research has been in the following areas:

It had been investigated how hourly meter data can be clustered for load profiling

- Application of the online adaptive clustering for load profiling using available hourly data (businesses, industries, large consumers and residential with PV).
- Disaggregation. Demonstration of application of appliances detection and load disaggregation
- Four reports discussing different add-ons to the Nordhavn grid were done. The reports cover the following equipment or services, that could be used to provide flexibility:
 - Demand response from customers on the secondary substation level
 - Changing the network topology via reconfiguration
 - Combination of the demand response and reconfiguration
 - Use of the battery energy storage
- Creating an algorithm for finding the optimal topology for the group of known load centers (green field planning)

Dissemination

Presentation of Battery:

Energistyrelsen

ABB

Energitilsynet

Århus Maskinmesterskole

SEV Bestyrelse fra Færøerne

EKZ fra Schweiz

Power Portfolio Management/DCS

DCS Legal Arrangement

Wind Power Ops Strategy & Business Development

Wind Power, Ørsted

Invitation opening of showroom

Structuring & Valuation Morten Normann Nielsen

Ørsted arrangement; Communication

Energi- Forsynings- og Klimaministeriet

DR P4 Knud interviews

Ørsted, Finance and IT

Articles about the Battery

Energy Supply 19. marts 2018

DR Nyhederne, Web site

Press release in relation to ELN winning of Energy Denmark price, 6 March 2018. No records of the amounts of press obtains.

Magasine Foresights

Research publications

- Data-driven demand response characterization and quantification. 2017
- Online adaptive clustering algorithm for load profiling. 2017
- Optimal Placement of a Heat Pump in an Integrated Power and Heat Energy System. 2017
- Deferral of Grid Reinforcement by Using Dual Flexibility Options Enabled by a Grid-connected Heat Pump. 2018
- Online adaptive clustering algorithm for load profiling has been submitted in April 2018 to the journal 'Sustainable Energy, Grid and Networks'

Lessons

IDA

Danish Ministry of Energy, Utilities and Climate

Energi- Forsynings- og Klimaministeriet

Structuring & Valuation Morten Normann Nielsen

DCS Legal Arrangement

Danish Energy Regulatory Authorities

Next Steps

(Next 6 months)

- Discussions with DTU about using the battery for investigation in battery lifetime.
- Ph.d research as planned

Quality Assurance

Status of deliverable		
Action	By	Date
Sent for review	Poul Brath	04-06-2018
Reviewed	Palle Holdt	12-06-2018
Approved	WPL	02-07-2018

Author	Reviewer	Approver
Poul Brath	Palle Holdt	Christoffer Greisen

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.

