Delivery no.:
D7.2 eV Carshare & D7.3 charging Facilities

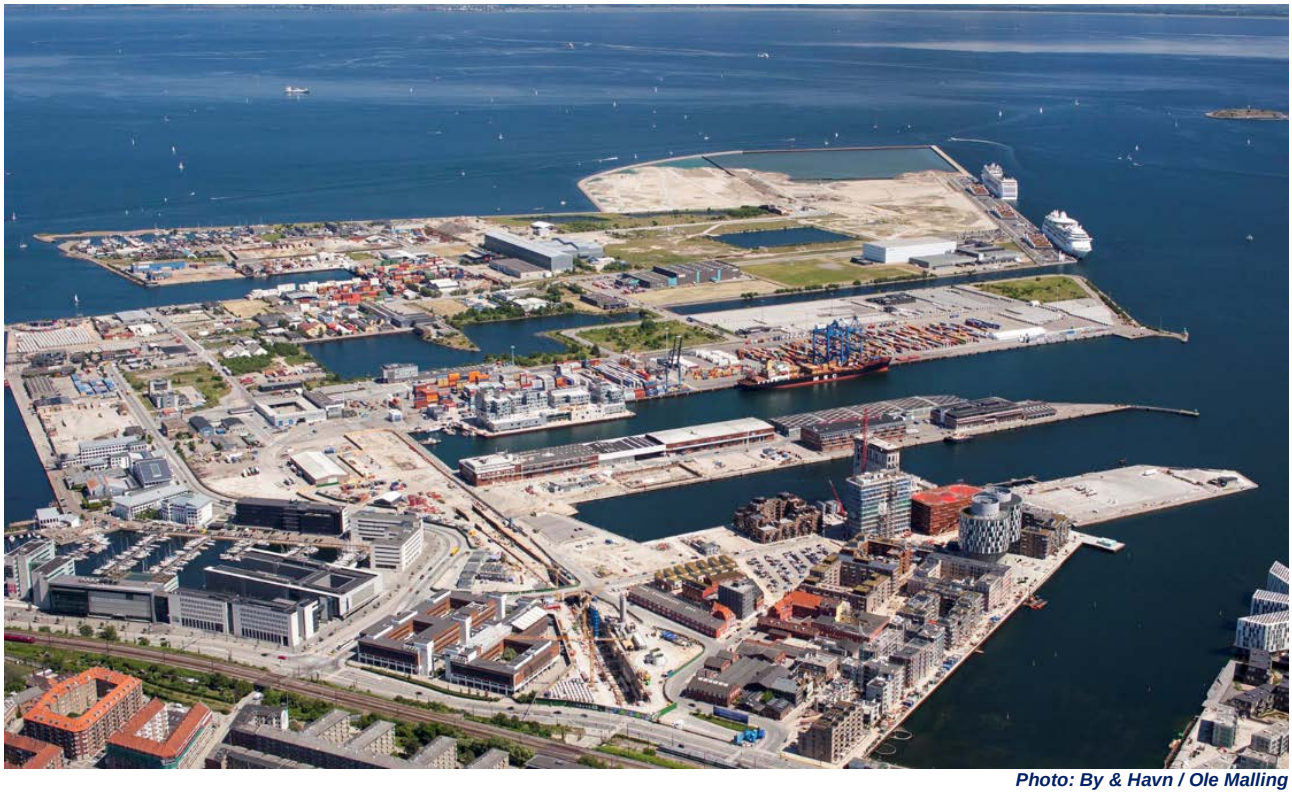

Photo: By & Havn / Ole Malling

Nerve Smart Systems ApS

12. April 2019

Public deliverable ☒

Confidential deliverable ☐

Preface

EnergyLab Nordhavn – New Urban Energy Infrastructures is an exciting project which will continue until the 31st October of 2019. The project will use Copenhagen's Nordhavn as a full-scale smart city energy lab, which main purpose is to do research and to develop and demonstrate future energy solutions of renewable energy.

The goal is to identify the most cost-effective smart energy system, which can contribute to solving the major climate challenges the world is facing.

This report shows the status on the current results and indicates interesting future perspectives for the project. The report also includes a presentation of the upcoming project, in which Nerve Smart Systems implements an Energy Storage Solution as backup for AC and DC charging in the parking house Lüders.

Budget: The project has a total budget of DKK 143 m (€ 19 m), of this DKK84 m (€ 11 m) funded in two rounds by the Danish Energy Technology Development and Demonstration Program (EUDP).

Disclaimer

Nerve Smart Systems wasn't a part of the EnergyLab Nordhavn when the deadlines for D7.2a Business case, D7.2b Establishing eV Carshare & EV Fleet vehicles – each with operators, D7.3a Implementation of AC charging Facilities and D7.3b Fleet system operation implementation was planned. Since the work described by the deliverables D7.2 a and b and D7.3 a and b are up and running, detailed reporting with a focus on how to do things in the future, that has already happened seems redundant. Nerve Smart Systems will instead focus on providing a status on the work, that has been done and provide an insight in future areas, that will be covered in the final report.

Project Information

Deliverable no.: 7.2a, 7.2b, 7.3a and 7.3b
Deliverable title: D7.2 eV Carshare & D7.3 charging facilities
WP title: Electric Transportation Infrastructure
Task Leader: Ulrik Mehr
WP Leader: Ulrik Mehr
Comment Period: January 2018 to December 2018

For further information on this specific deliverable, please contact:

Nerve Smart Systems
Mette Parsner Krogsgaard
Nerve Smart Systems ApS
Langebjergvænget 19A
DK-4000 Roskilde
Denmark

E-mail mpk@nervesmartsystems.com
Phone +45 52 10 50 71

www.nervesmartsystems.com

For other information regarding EnergyLab Nordhavn, please contact:

EnergyLab Nordhavn Secretariat
Center for Electric Power and Energy, DTU Electrical Engineering
Elektrovej
Building 325
DK-2800 Kgs. Lyngby
Denmark

E-mail eln@dtu.dk
Phone +45 45 25 35 54

www.energylabnordhavn.dk

Table of Contents

List of Abbreviations

ELN - EnergyLab Nordhavn
ESS - Energy Storage Solution

Executive Summary

Nerve Smart Systems ApS has as of the 31st of December 2018 taken over the role of CleanCharge Solutions in the ELN-project, and the company mentioned last has been closed by the end of 2018. Considering this transition, the report will clarify the four deliverables due to ELN.

Summation

- Collaboration with CarShare from two suppliers, DriveNow and GreenMobility, has been established.
- Facilities for AC and DC charging is installed and in service. In total 8 outlets (5 AC and 3 DC)
- 4x22 kW AC outlets are recommended to be included in the ELN project onwards. Historical data from 2018 is available for analysis.
- The operative system for controlling the charging facilities from Innogy GmbH are up and running – Emobility Self Service portal

81% of all charge((s) cycles) are from 22kWh AC type 2 charging stations. 18% of all charge cycles have a duration of less than 1 hour, and this is due to cars that do not require lengthy charging or cars being moved by service staff. Cars charging with 22 kW AC which must be moved by the owner are charged in 9% of the cases for 1-2 hours or 13-14 hours in 7% of the cases, which shows that residents either move their car when they have charged enough or leave them to charge overnight.
The consumption of kWh used for charging is increasing during the year and ends up with an increase of 104% from January 2018 to December 2018. The average consumption per hour has increased by 49% and peak by 12%.

Nerve Smart Systems recommends the implementation of an Energy Storage Solution (ESS) in the parking house Lüders in Nordhavn. The ESS is a battery buffer that will support AC and DC charging in the parking house Lüders, when multiple chargers are activated simultaneously and the need for more charging power arises. It will be possible to minimize the load of the connected radial, after an ESS has been installed, as well as lowering the total CO2 load with intelligent control of when the battery is charged and discharged. Detailed data is collected, such as how much is charged per minute and how long the charge lasts, in order to analyze the optimization of charging in the smart cities of the future.

Version Control

Version	Date	Author	Description of Changes
1	2019-03-01	Mette Parsner Krogsgaard	Report writing
2	2019-03-11	Andreas Thingvad	Review
3	2019-03-26	Naomi Hagelberg	Coordination and replies

Quality Assurance

Author	Reviewer	Approver
Mette Parsner Krogsgaard	Andreas Tingvad	WPL group

Status of deliverable		
Action	**By**	**Date/Initials**
Sent for review	Naomi Hagelberg, Nerve Smart Systems	**2019-03-01 NH**
Reviewed	Andreas Tingvad,	**2019-03-26 AT**
Verified	Ulrik Mehr	**2019-03-26 UM**
Approved	WPL group	**2019-04-12**

1. Introduction

Originally, the company CleanCharge Solutions played a role in EnergyLab Nordhavn. Nerve Smart Systems took over the activities of CleanCharge Solutions during 2018, including its role in EnergyLab Nordhavn. Nerve Smart Systems is represented by Chief Executive Officer Jesper Boie Rasmussen, Personal Assistant Mette Krogsgaard, Technical Support Manager Ulrik Mehr, Project Controller Naomi Hagelberg and Sales & Marketing Manager Mikkel Swane Olsen.

Nerve Smart Systems focus on the development of a Battery Management System (BMS) for controlled and optimized management of battery cells. The unique and intelligent technology can revolutionize the battery industry in the same way that LED changed the lighting industry; same performance, better economy and higher energy efficiency.

The product developed by Nerve Smart Systems – Nerve Switch® - is aimed at controlling and managing battery systems and it can for example be used in battery buffers and energy storage in charging stations for electrical vehicles. This gives Nerve Smart Systems a natural incentive to participate in EnergyLab Nordhavn. Nerve Smart Systems' solutions/products can add value to the neighborhood. Value from their ability to control and manage flexible charging on the existing and possibly the new charging stations. It will also be possible to develop and expand the solutions for the charging stations, by charging the battery from the power grid or solar panels during non-peak periods and then during peak periods, it releases the power to the charging stations, thereby relieving the load on the power grid. The battery will support both AC and DC charging.
Besides Peak shaving, Nerve Smart systems' battery solution also offers savings on the connection to the power grid, since the battery can receive a lower power from the power grid, but still release the power demanded.

Connected to the takeover of CleanCharge Solutions' activities, Nerve Smart Systems has chosen to maintain the operation of the charging stations in Nordhavn. There are a total of 5 AC outlets and 2 DC outlets. Nerve Smart Systems has also chosen to maintain a few other strategic charging stations elsewhere in Denmark. Nerve Smart Systems primary business is the development and sale of Nerve Switch®.

This report covers multiple deliverables in the ELN project. More specifically it gives a status report on the following:

- 7.2a Business case
- 7.2b Establishing EV Carshare & EV Fleet vehicles – each with operators
- 7.3a Implementation of AC charging facilities
- 7.3b Fleet system operation implementation

Every deliverable has been assigned their own chapter in this report.

2. D7.2a Business case

The business case was supposed to describe how to establish a carshare called an EV fleet for private residences and commercial tenants, supporting transportation needs for both. The business case should also show how income from charging could support the upfront charging hardware investments.

At this moment in time, we do not find a retrospective business case all that relevant. However, Nerve Smart Systems acknowledges that it could be interesting and beneficial for future charging installations, that more data be collected and analysed. By doing so, participants will obtain a better understanding of costs and revenues. Therefore, Nerve Smart systems will analyse this when delivering the final report in August 2019. To get a complete picture of the transportation needs in ELN, Nerve Smart Systems will include information from their own chargers, that are not a part of the ELN project.

3. D7.2b Establishing EV Carshare & EV Fleet vehicles – each with operators

EV CarShare has been established in collaboration with the operators DriveNow and GreenMobility. The partnership with DriveNow entered into force December 2017, while the partnership with GreenMobility entered into force June 2018.

DriveNow is a European city car concept renting out city cars in 12 European cities. In Denmark DriveNow is represented with about 300 electrical vehicles and 200 gas cars in Copenhagen. In connection with the project, 2x22 kW AC outlets with type 2 sockets have been set up in the parking house Lüders in Nordhavn, as well as two reserved parking spots connected with the operator's car fleet's charging stations.
DriveNow's charging cables are provided with a RFID chip, linked to a Contract ID. This is used for starting the charge by scanning the cable on the RFID scanner on the charging station.

GreenMobility offers city cars in Copenhagen and their fleet of cars counts 400 electrical cars. GreenMobility has 2x22 kW AC with type 2 socket outlets in the parking house Lüders in Nordhavn, as well as two parking spots reserved with connection to the charging stations. GreenMobility did not wish to use a Contract ID, and their station is set to "plug and play" and will begin the charge when a cable is connected with a car.

The contracts concerning the use of the charging stations and billing for charging with DriveNow and GreenMobility have been transferred to Nerve Smart Systems pr. 01.01.2019.

Since no EV fleets, for example home care or similar, operating in the near vicinity are in need of charging electrical vehicles, no partnerships have been established.

4. D7.3a Implementation of AC charging facilities

Nerve Smart Systems has set up the following five charging stations totaling 8 outlets at the parking house Lüders

One 2 x 22 kW AC for DriveNow
One 2 x 22 kW AC for GreenMobility
One 1 x 43 kW AC for residents and public use
One 2 x 50kW DC (CCS & CHAdeMO, can't charge simultaneously) for residents and public use
One 1 x 150kW DC (CCS) for residents and public use

All three AC chargers have type 2 sockets, and the two DC chargers offer together both CCS and CHAdeMO.
There are a total of eight outlets in the ELN project, five AC chargers and three DC chargers. It is only possible to activate one DC outlet at a time at the 50kWh charger. Therefore only seven outlets may be activated for charging at the same time.
The charging stations are financed by Nerve Smart Systems, in collaboration with By & Havn. By & Havn is now part of the financing, as they see an advantage in collecting data, to create a foundation for how the future parking house should be designed.

Apart from the chargers in the ELN project, there is an additional 2 x 22 kW AC charger with type 2 outlets in the Lüders parking house for the residents, which Nerve Smart Systems now have taken control over the operation and ownership of.
Nerve Smart Systems has assessed that it would be relevant for the project to add data from these four outlets, as we will then be gathering data from all the charging stations available in the parking house Lüders. Any analyses based on data from only eight of the available outlets will not give an accurate picture of the pattern of consumption and needs in Nordhavn, as a significant part of the residents can use these outlets. Nerve Smart Systems therefore recommends that these four outlets are added to the ELN project for collection of data in the future. In this report Nerve Smart Systems will provide access to the historical data from 2018, to form the foundation for a more complete analysis.

The charging structure in the parking house Lüders is therefore in reality, seven charging stations with a total of 12 outlets.

One 2 x 22 kW AC for DriveNow
One 2 x 22 kW AC for GreenMobility
Two 2 x 22 kW AC for residents and public use
One 1 x 43 kW AC for residents and public use
One 2 x 50kW DC (CCS & CHAdeMO, cannot charge simultaneously) for residents and public use
One 1 x 150kW DC charger (CCS) for residents and public use

All five AC chargers have type 2 sockets and the two DC chargers offer together both CCS and CHAdeMO.

The parking spots are under parking control to ensure that the DC charging stations are not occupied for longer periods and to ensure that shared cars only park in the assigned places. There are 12 outlets in total, nine AC outlets and three DC outlets. It is only possible to activate one DC outlet from the 50kW charger at a time. 11 outlets are therefore able to be activated for charging at the same time.

Nerve Smart Systems incorporates data from their own 4 x 22 kW AC with type 2 outlets in this report, in order to create a more accurate picture of the charging pattern.

5. D7.3b Fleet system operation implementation

The operating system for the charging stations, the access control and load management is offered by the company Innogy GmbH. The backend is called Emobility Self Service Portal and the AC chargers operate with the protocol LG2WAN while the DC chargers operate with the protocol OCPP 1.5.

Early 2019 will bring an update to the backend. It is an update for Innogys new backend eOperate 2.0. This will not impact the operation of the charging stations and the update will optimize the underlying system as well as make the user interface more suitable for the operators of the charging stations. It will be possible to gather more detailed consumer data with help from the Emobility Self Service Portal.

Table 1: Number of charges and usage of kWh during the week days and weekends for 2018 and average per day. Nordhavn 2018

	Number of charges	per day	kWh	per day
Week days	1036	3,98	20477,92	78,76
Weekends	391	3,76	7947,13	76,41

Since table 1 shows how there is no big difference in the average charged power and the number of initiated charges per day during the week days and weekends, the data in the rest of this report will not discern between week days and weekends.

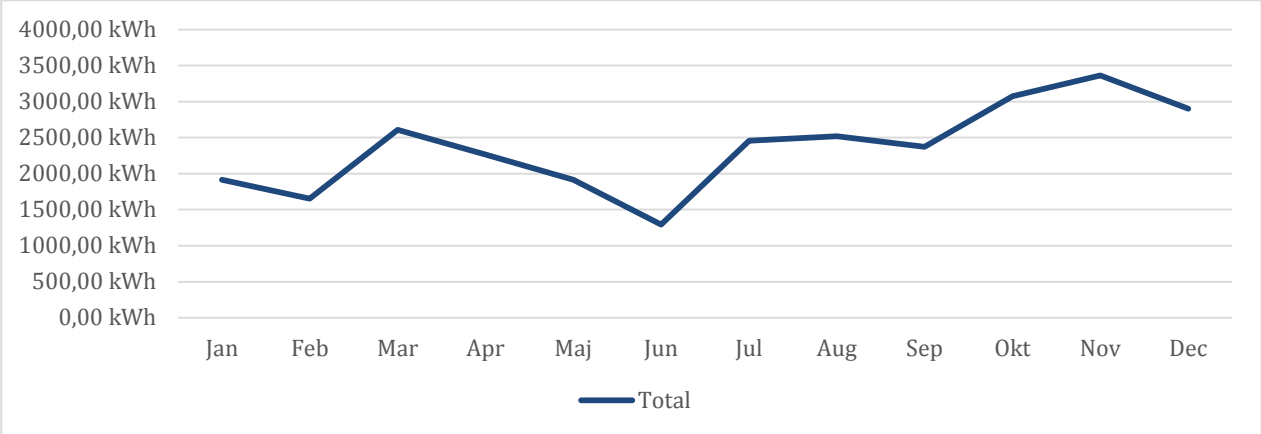

Figure 1: Charging consumption in kWh on the power grid from the chargers in Nordhavn 2018 per month

Figure 1 shows charging consumption in Nordhavn in 2018. The consumption rises throughout the year. In January the consumption was 1481,40 kWh and in December the consumption was 2902,78 kWh. An increase of 104%. Part of the explanation is that the charger GreenMobility uses is activated in July 2018, when the deal is put into motion with GreenMobility. It can also be a sign of more people acquiring electrical vehicles, supporting the importance of ensuring that there are opportunities for everyone to charge. There's a drop around the month of June, which could be caused by the summer holiday which brought with it a lower need for charging.

The charging consumption divided into the individual charging station types can be seen in figure 2 and 3.

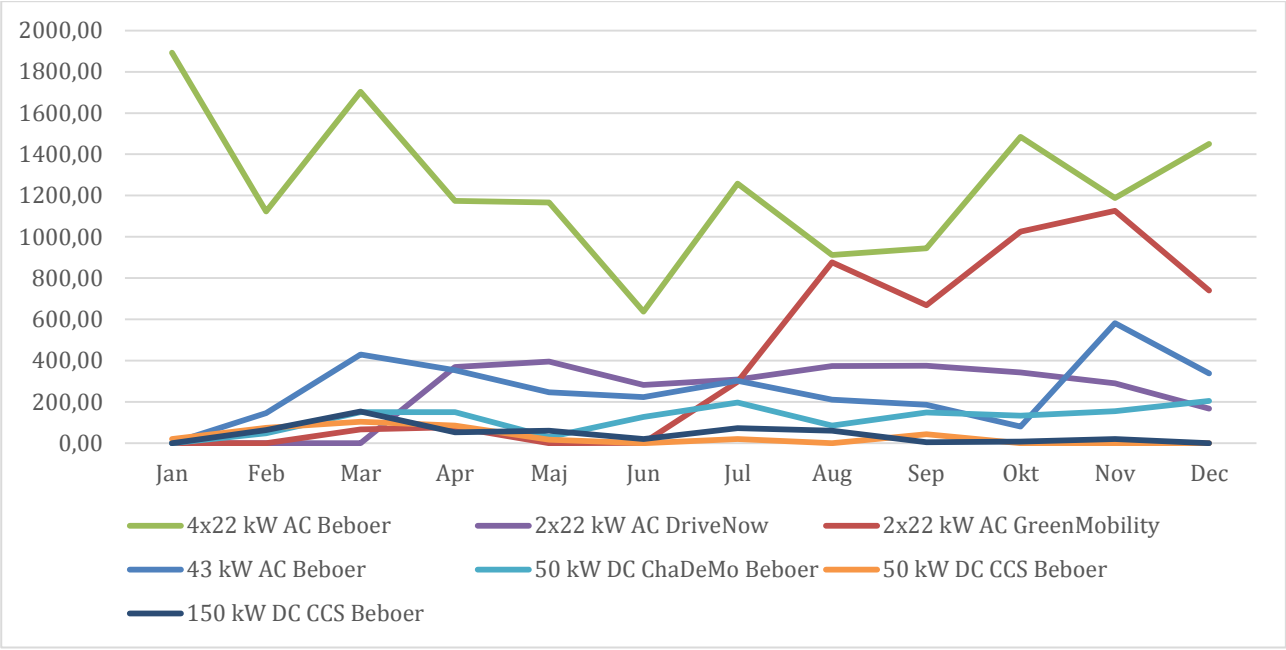

Figure 2: Charging consumption in kWh per charging station type in Nordhavn 2018

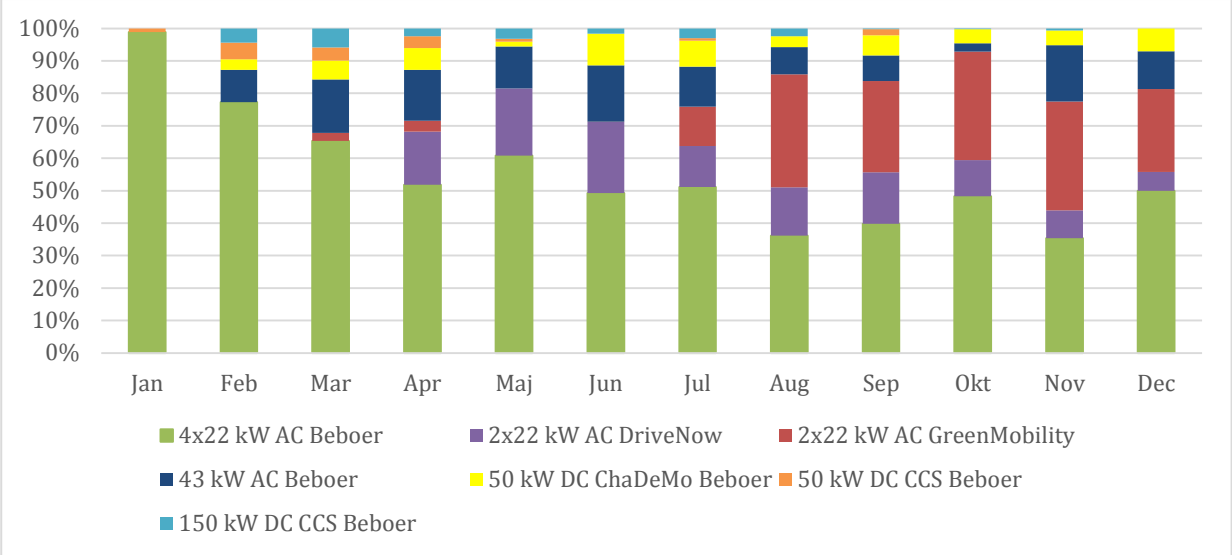

Figure 3: Charging consumption percentagewise in kWh from the different charging station types in Nordhavn in 2018

Figure 2 and 3 show that in 2018, the highest charging consumption was from the 4x22 kW AC charging stations available for everyone. The last 5 months show a significant higher consumption from the 2x22 kW AC GreenMobility. This could be because GreenMobility does not have access control on their chargers, making it possible for other users to use their chargers, even if they are not allowed. Users from GreenMobility have to use the reserved charging stations, since they are unable to activate the other charging stations. This indicates that it is important to ensure that there are enough 22 kW outlets available for both GreenMobility's customers and the other residents. We can see that the percentage consumption from the charging station 22kW AC at DriveNow decreases in July and continues until December, and that the consumption peaks in August and September and only thereafter begins to decrease until December. The percentage change is caused by the activation of GreenMobility's charger and the decrease in use can be because of the new system established by By & Havn around July, which banned parking and charging at the parking spots reserved for DriveNow and GreenMobility, and violating the terms will trigger a fine. This new reality can take a couple of months for other users to become accustomed to and to stop using the charging stations for DriveNow and GreenMobility.

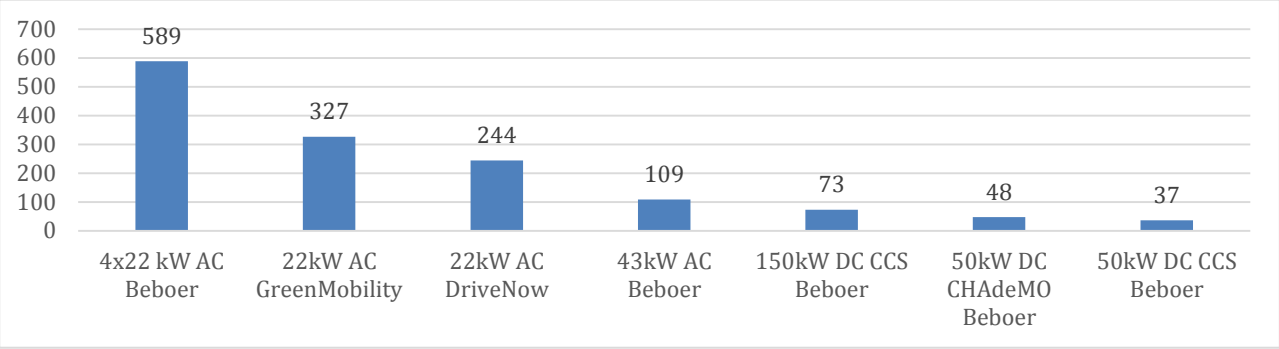

Figure 4: Number of charges on the different charging station types in Nordhavn 2018

41% of all charge cycles are from the 22kW charging station for residents. If all the 22kW AC chargers are added together, then they account for (41%+23%+17%) 81% of all charges. AC charging is therefore used most frequently in the parking house Lüders in Nordhavn.

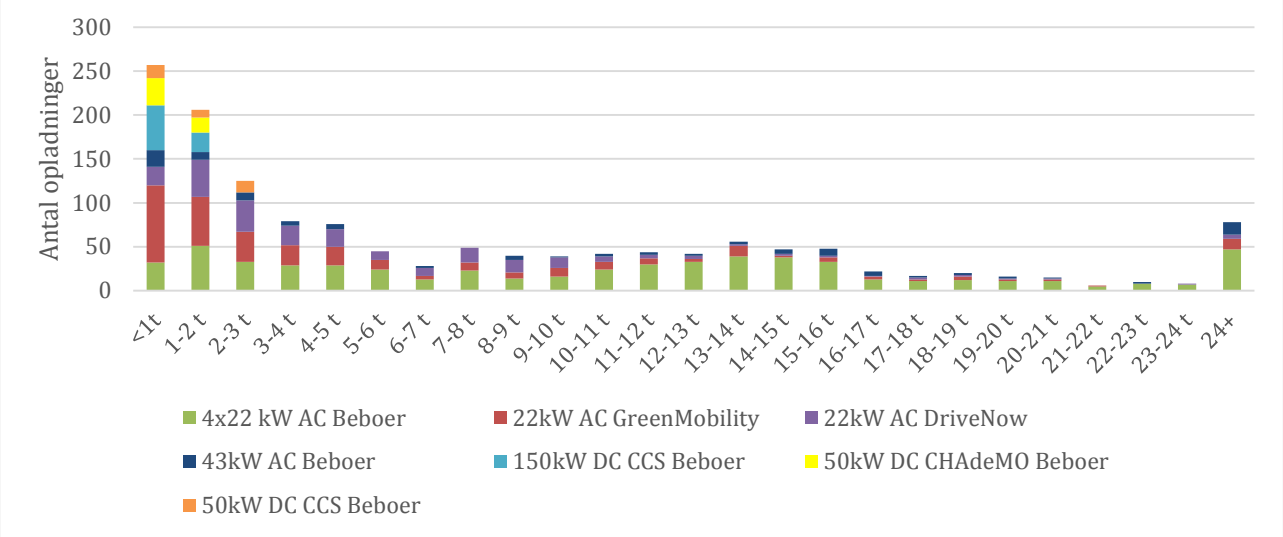

Figure 5: Number of cars connected to the different types of charging stations in different duration in terms of hours. From under 1 hour to over 24 hours. In Nordhavn 2018

Table 2: Distribution of the number of charges in duration of x hours within the individual charger type in percent. Nordhavn 2018

Charger type	<1t	1-2 t	2-3 t	3-4 t	4-5 t	5-6 t	6-7 t
4x22 kW AC Resident	5%	9%	6%	5%	5%	4%	2%
22kW AC GreenMobility	27%	17%	10%	7%	6%	3%	1%
22kW AC DriveNow	9%	17%	15%	9%	8%	4%	4%
43kW AC Resident	17%	8%	8%	5%	6%	0%	2%
150kW DC CCS Resident	70%	30%	0%	0%	0%	0%	0%
50kW DC CHAdeMO Resident	65%	35%	0%	0%	0%	0%	0%
50kW DC CCS Resident	41%	24%	35%	0%	0%	0%	0%
All chargers	18%	14%	9%	6%	5%	3%	2%

Charger type	7-8 t	8-9 t	9-10 t	10-11 t	11-12 t	12-13 t	13-14 t
4x22 kW AC Resident	4%	2%	3%	4%	5%	6%	7%
22kW AC GreenMobility	3%	2%	3%	3%	2%	1%	4%
22kW AC DriveNow	7%	6%	5%	2%	2%	2%	1%
43kW AC Resident	0%	5%	1%	3%	3%	2%	3%
150kW DC CCS Resident	0%	0%	0%	0%	0%	0%	0%
50kW DC CHAdeMO Resident	0%	0%	0%	0%	0%	0%	0%
50kW DC CCS Resident	0%	0%	0%	0%	0%	0%	0%
All chargers	3%	3%	3%	3%	3%	3%	4%

Charger type	14-15 t	15-16 t	16-17 t	17-18 t	18-19 t	19-20 t	20-21 t
4x22 kW AC Resident	6%	6%	2%	2%	2%	2%	2%
22kW AC GreenMobility	1%	2%	1%	1%	1%	1%	1%
22kW AC DriveNow	1%	1%	0%	1%	1%	0%	0%
43kW AC Resident	5%	7%	5%	2%	2%	2%	1%
150kW DC CCS Resident	0%	0%	0%	0%	0%	0%	0%
50kW DC CHAdeMO Resident	0%	0%	0%	0%	0%	0%	0%
50kW DC CCS Resident	0%	0%	0%	0%	0%	0%	0%
All chargers	3%	3%	2%	1%	1%	1%	1%

Charger type	21-22 t	22-23 t	23-24 t	24+
4x22 kW AC Resident	1%	1%	1%	8%
22kW AC GreenMobility	0%	0%	0%	4%
22kW AC DriveNow	0%	0%	0%	2%
43kW AC Resident	0%	2%	0%	13%
150kW DC CCS Resident	0%	0%	0%	0%
50kW DC CHAdeMO Resident	0%	0%	0%	0%
50kW DC CCS Resident	0%	0%	0%	0%
All chargers	0%	1%	1%	5%

The duration of the connection to charging stations in the parking garage, ranges from a few seconds to several days. Most of them (18%) are under 1 hour. Figure 5 and table 1 show that the users connecting to the 22kW AC, generally charge for about 1-2 hours (9%) or about 13-14 hours (7%). The 13-14 hour charges could indicate that the users connect their car after work, and leave them charging during the night, continuing also after the car is fully charged.
GreenMobility usually connect for less than an hour (27%), which could indicate that service workers from GreenMobility move the cars, when they are fully charges and connect new ones.
The users, who use the 43 kW, charge (17%) in under an hour.
The users charging with the 150 kW DC outlets and the users charging with the 50 kW DC outlets, usually charge in under 1 hour (150 kW: 70%, 50 kW CHAdeMO: 65%, 50 kW CCS: 41%) and a maximum of 3 hours.
It would be interesting to have charging data from outlets that are not placed in a parking house, in order for the customer behavior related to different factors could be analyzed.

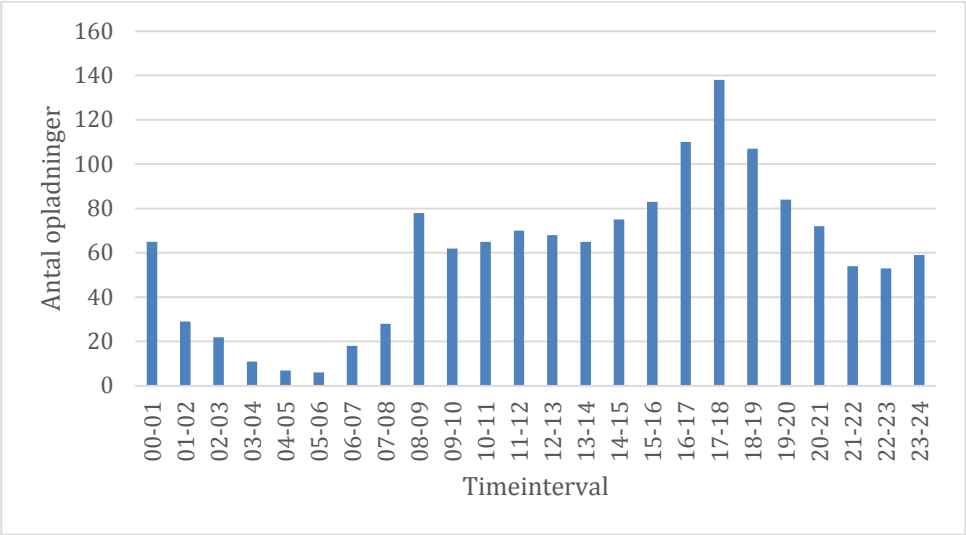

Figure 6: Number of connections to outlets per hour in Nordhavn 2018

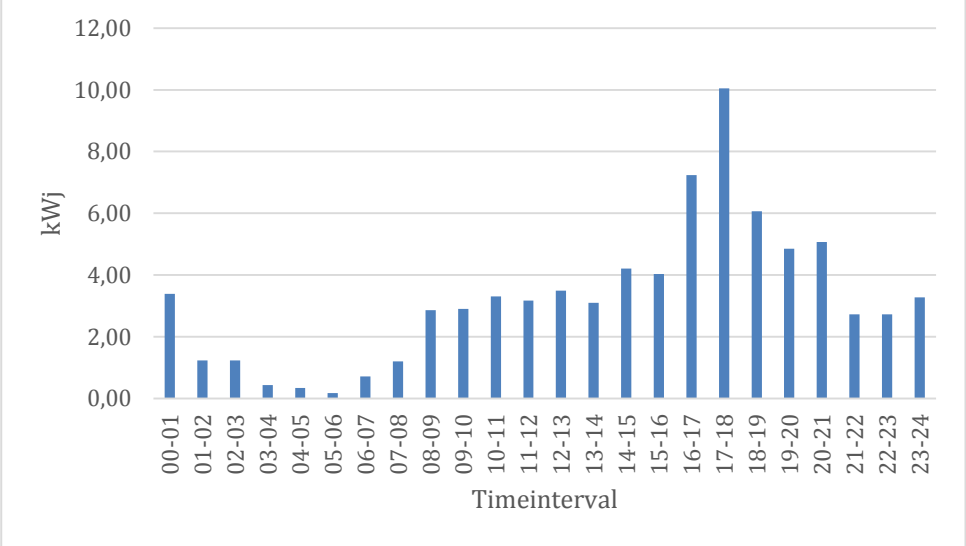

Figure 7: Daily average consumption of kWh per hour, with the assumption that all the power is used within the hour in which it was connected. Nordhavn 2018

Figure 6 shows the number of connections in hourly intervals in 2018 and Figure 7 shows an estimated consumption of power per hour. The off-peak occurs between 01-08 o'clock, with the average consumption per hour at about 0,77 kWh a day, a peak between 16-21 o'clock with average consumption of 6,76 kWh a day and the rest of the time had an average consumption of 3,39 kWh per hour a day. This indicates that if an ESS is to act as a relief for the power grid, this must be done in the period between the hours 16-21 if the demand exceeds the supply. ESS can benefit from charging between the hours 01-08, where demand is low.
The peak-hour in 2018 was an average of 10 kWh. As figure 1 shows an increase in consumption during 2018, figure 7 was divided into quarters, in order to see a more detailed development during the course of the year as well as the different seasons. Q1 is from January to March, Q2 is from April to June, Q3 is from July to September and Q4 is from October to December.

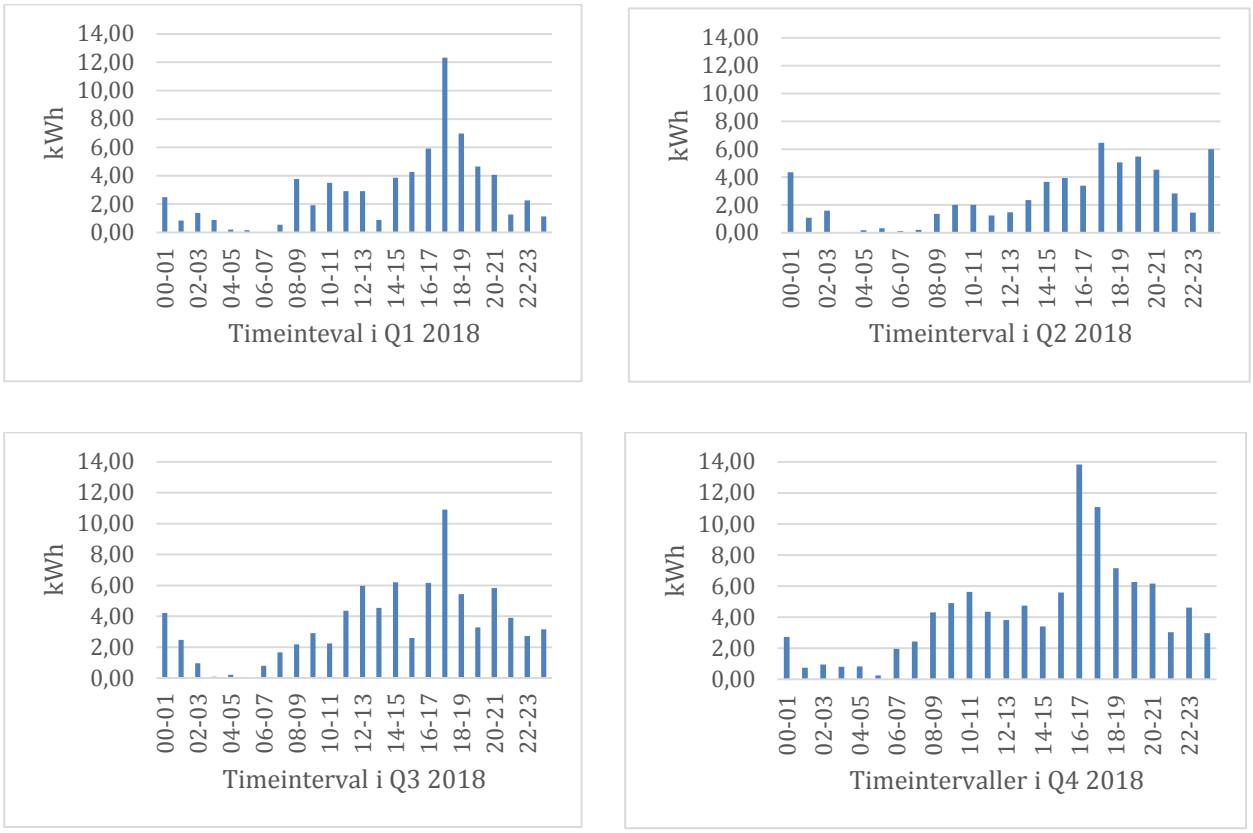

Figure 8: Quarterly average consumption of kWh per hour, with the assumption that all the power is spent within the hour in which the connection was established. Nordhavn 2018

Table 3: Average use of kW per hour and peak value every quarter. Nordhavn 2018

2018	Q1	Q2	Q3	Q4
Average pr hour	2,88	2,54	3,45	4,28
Peak	12,33	6,46	10,90	13,82

The average consumption per hour steadily rises during the course of 2018, with the exception of a 12 % drop in Q2. The year ends with a 49% increase in average consumption per hour when compared to the beginning of the year.
Table 2 shows the peak increased from 12,33 kWh at the beginning of the year to 13,82 kWh by the end of the year. An increase of 12%.
Given that the average consumption per hour and peaks did not increase equally, this might indicate that the consumption pattern has changed and does not just reflect an increase in total consumption of kWh. GreenMobility came to Nordhavn in Q4, and their assigned service workers move their cars when they are fully charged. These service workers are possibly active most during periods outside of the peak time period, and therefore spreading the charge over multiple hours. Since these service workers do not have access to all the cars, i.e. the resident's cars, then it is expected that the peak load will increase gradually as there will be more residents with electric vehicles coming to Nordhavn.
The old back-end from 2018, is unfortunately unable to show what day has the highest peak, instead we look at which days have the highest number of charges per charging station type, with the assumption that there is a correlation between the highest number of charges and a potential peak.

Table 4: Charge from a single connection in 2018 Nordhavn. It shows the charge with the highest kWh for each of the 6 different charging station types.

Highest charge for each outlet type						
Date	9.-10. Mar	16.-17. Feb	22.-23. Jun	6. Jul	22.-24. Mar	17. Feb
Time period	2:34-13:07	19:14-12:07	17:46-12:25	17:55-18:42	19:52-13:04	16:39-17:40
Charged kWh	78,64 kWh	72,84 kWh	62,23 kWh	61,93 kWh	51,22 kWh	47,62 kWh
Outlet	BB-1710-0	BC-7123-8	BB-1193-0	BC-7120-9	BB-3025-6	BC-7122-5
Charger type	22 kW AC Resident	43 kW AC	22 kW DriveNow	150 kW DC CSS	22 kW GreenMobility	50 kW DC

The highest load on the power grid from a charge from a single outlet was on the 6th of July 2018, reaching 61,93 kWh. The Charge was completed in 47 minutes, which equals about 80 kW.

We are unable to show a correct indication of charge per hourly interval, since it is not possible to get data on how much is charged in the individual hours in 2018. Instead Figure 9 shows the charging pattern over the five days with peaks within each charging station type, assuming the whole charge occurs within the first hour after its connected.

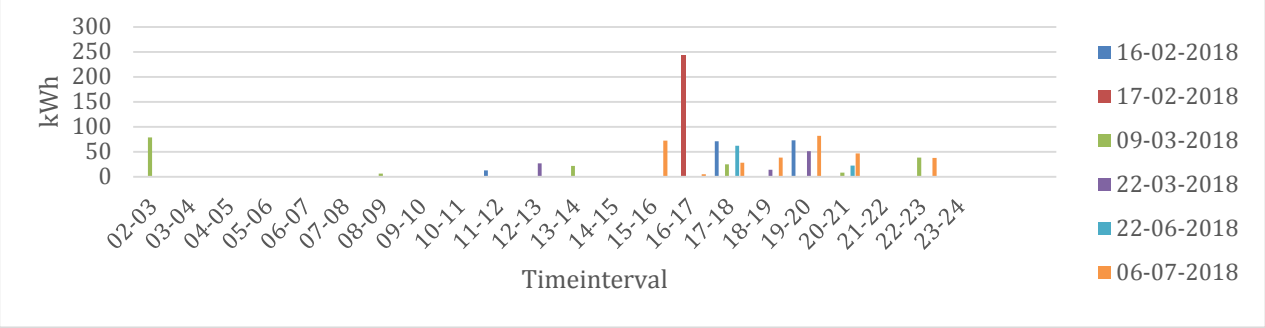

Figure 9: Charged kWh over five different days in Nordhavn 2018, assuming the whole charge occurs within the first hour after connecting to an outlet.

Table 5: Estimated consumption of kWh over five days in Nordhavn 2018. The volume of kWh is recorded in the time frame where the charge was initiated. The specified kWh does not necessarily occur within 1 hour.

Dato	16-02-2018	17-02-2018	09-03-2018	22-03-2018	22-06-2018	06-07-2018
00-01						
01-02						
02-03			78,64			
03-04						
04-05						
05-06						
06-07						
07-08					1,10	
08-09			6,05			
09-10						
10-11						
11-12	12,48					
12-13				26,96		
13-14			21,42			72,29
14-15						4,60
15-16						27,97
16-17		243,49				37,92
17-18	71,03		24,98		62,22	81,58
18-19				13,90		46,52
19-20	72,84			51,22		
20-21			8,33		22,19	37,71
21-22						
22-23			38,32			
23-24						
Sum	156,35	243,49	177,74	92,07	85,51	308,60

Table 5 shows that some days will need to be able to charge 81,58 kWh within a short period of time. It is therefore necessary to have an ESS, able to store needed energy, to prevent peaks from straining the power grid. Additionally, the supply of charging stations may keep the peak level artificially low, if the demand for charging does not match the installation in the parking house Lüders and people then have to drive to other places to charge instead. By expanding the installation with additional AC stations and saturating the demand, an ESS installation will be essential in utilizing the connection to the power grid in the best way possible and not exceeding the supply.

It will be possible to further analyze the collected data in the final report. We are planning more in-depth analyzes of the consumption of the charging stations in the parking house Lüders including, but not limited to, the dispersal of AC and DC charging, consumer behavior, placement, volume needs and load management/peak shaving to ensure that charging needs for electrical vehicles in Nordhavn are supported in the best way possible.

6. Future perspectives

Nerve Smart Systems is researching the possibility of establishing an Energy Storage System (ESS) to store power for the charging stations in the parking house Lüders. In connection with the possible inclusion of the four AC-outlets in the project, an ESS will, together with load management through the backend operative system, give a more accurate setup for use in analysis of the future city, as we get a complete picture of the real strain on the power grid in the parking house Lüders and clarify the need for relieving the power grid.
The connection in the parking house Lüders is 110kW, which means that charges may quickly exceed the capacity in Nordhavn. If the 150kW charging station runs at full power, then the connection will not be able to handle it, and it is therefore necessary to use Load Management in the parking house Lüders, to ensure charging occurs in the best way possible. With the supply of 110 kW, limiting the charging station's ability to run at full power, an ESS solution could help shorten the charging periods for the users. An ESS solution bring savings on the connection while also securing the supply and demands.

The ESS solution will consist of 8 battery modules with a capacity of about 60 kWh and power of 60 kW, with the possibility of later upgrading the power to 120 kW at the same capacity. It will be possible to control and manage the charge most efficiently with the ESS solution, when compared to the peak load the charging stations reach. With additional charging stations, situations where they are all charging might arise, thus generating a great strain on the power grid. The concurrent charges might result in the charging station lowering their power in order to match the connection to the grid. The ESS solution can offset peak loads greater than the connection to the grid and charges can therefore continue, without letting the users lower the power or creating longer charging periods.

The project will make it possible to follow the consumption of power used for charging, as well as collect experience on how to best charge and discharge an ESS, both in the total consumption for the whole installation, but also the individual charging outlets. This will provide valuable experience in understanding how an ESS can help support multiple concurrent charges best, as well as provide a picture of how an ESS solution can relieve the tension on the power grid during peak periods. It will also demonstrate the economic benefit in a smaller and cheaper connection to the power grid. This knowledge can be transferred to future projects in the city.

In other perspectives, Nerve Smart Systems sees opportunities for further data analysis in the coming months, especially when the ESS solution with the battery module is in operation. Analysis of the collected data can map the consumption pattern of AC and DC charging and be used to clarify the best combination and the optimal number of AC and DC installations. The analysis will take into account a rising number of electrical vehicles in the future as well as a greater need for more powerful DC charging, as the car industry is evolving, and offering several different electrical vehicles types with a greater charging capacity, which will put additional pressure on the power grid.

These are points which Nerve Smart Systems expects to address in the final report D7.6 Recommendation for Nordhavn 2035 transportation infrastructure development.