Aalborg University

Masters thesis

Techno-Anthropology 10th semester

Living Lab in Practice

How can a valid experiment be conducted in an open living environment with co-producers?

Authors:
Jens Nygaard Rasmussen
Michael Riis Allesøe
Theis Hæstrup

Supervisors:
Lars Bo Henriksen

7th of June 2019

AALBORG UNIVERSITY
DENMARK

School of Architecture, Design and Planning
MSc Master of Science in Techno-Anthropology

Title:	**[Living Lab in Practice]**
Semester:	**[10th semester]**
Semester theme:	**[Master Thesis]**
Project Period:	**[1st of February – 7th of June]**
ECTS:	**[30 ECTS]**
Supervisor:	**[Lars Bo Henriksen]**
Project Group:	**[tan10aal2019-4]**

Jens Nygaard Rasmussen - 20125255

Michael Riis Allesøe - 20144636

Theis Hæstrup - 20143385

Abstract: This master thesis will focus on the living lab terminology already used in the general public in a number of different ways and will try to redefine the terminology into an easy to understand, well-defined terminology, that every one can understand.

This redefinition will be made through an empirical analysis of the actors involved in the Living Lab Nordjylland-project and their understanding of the term “Living Lab”.

By redefining the term, we hope to underline, what a living lab is in practice and not only on paper.

Number of copies :	[2]
Number of pages:	[101]
Appendix:	[10]
Enclosure:	[n/a]

By signing this document each gourp member confirm that all members equally have participated in the project work and that all are equally responsible for the content of the project report. Further, all group members are personally liable for no plagiarism in the report.

Contents

List of Figures

1 Introduction

This project is an analysis of the project "Living Lab Nordjylland" and an analysis of how the actors involved in the project perceive a living lab and how these perceptions may differ from actor to actor.

One of the main goals with this thesis is to condense and underline exactly, what a living lab is in an easy to understand manner.

The group has been working with a number of different actors that can seem very overwhelming to people not involved in the project. But first the group's previous project as interns with its different actors will be described one by one to get a better understanding of their roles and involvement within the project getting citizens and companies to invest in green solutions to heat up their homes and businesses.

First off, we have (Horizon 2019b).
Horizon 2020 is a research and innovation programme created by the European Union in 2014. The programme consists of €80 billion of funding available over seven years (2014-2020). In addition to the EU agents, private investments are welcome and expected in the different projects. The end goal of the Horizon 2020-programme is to promise breakthrough discoveries and world-firsts by turning ideas from the lab into real, relevant products on the global market (Horizon 2019b).

The products relevant for the programme are products that drive growth and create jobs in and around Europe. By removing the possible economical barriers by providing grants from the programme, Horizon provides a base for new and interesting possibilities in a vast amount of different sectors from the health sector to the school sector and all the way to sustainable engineering.

Horizon 2020 is not a direct actor in this project, but has provided the funds for the Innovate project to come to life.

Innovate is an abbreviation of "**IN**tegrated solutio**N**s for ambiti**O**us energy refurbishment of pri**VATE** housing" (Energibyen Frederikshavn 2019). Innovate aims to integrate sustainable solutions within private homes in Europe. The project consists of a consortium of 13 cities in 11 different EU member states (France, Netherlands, Denmark, Belgium, Latvia, Czech Republic, Cyprus, Sweden, Italy, Spain as well as the UK). Within these countries different cities

ranging from Paris to Frederikshavn are exchanging experiences, ideas and suggestions to provide for better ways to integrate green solutions in the private housing sector (Innovate 2019).

The issue at hand that Innovate is actively trying to solve, is that an energy refurbishment is difficult to grasp and unclear for the average home owner. The incentives are unclear as well as the advantages of doing so. For some people it is not obvious why saving energy is important leading to them ignoring the benefits of doing so (Innovate 2019). Some of the possible positives in energy refurbishment is both the economical aspect - in both property value rising in case of a sale and the savings on heat, power and water - as well as increased quality of life; this could include proper floor heating or the possibility to turn off the water heater, if the person is not at home thus saving energy and money.

Taking on such a project as to refurbish a home can be a very complicated and confusing assignment to take upon yourself, leading to people neglecting doing energy refurbishments on their homes because of not knowing where to begin (Innovate 2019).

Another issue at hand is the possible prioritisation of home improvements. Energy refurbishments fall in the same categories such as buying a new car and remodelling the bathroom, where these are more interesting to a lot of people leaving the energy refurbishment to never get further than the planning stage (Innovate 2019).

Innovate seeks to reach the citizen through a *One-Stop-Shop-concept* (OSSC from now on). The idea behind the concept is to make the process of an energy refurbishment less cumbersome. When a citizen wants to begin a refurbishment, the person at hand will meet a project manager within the OSSC, who then has the necessary contacts needed to complete the refurbishments, which ranges from the different craftsmen, along with an architect. The main contact person would be an energy consultant, possibly in a close collaboration with the architect. The concept's main goal is to make it less cumbersome for the citizens to begin an energy refurbishment by having only one point of entry to communicate with. This could help making sure that nothing is misunderstood and that the project keeps to the schedule. The project manager is available throughout the process of the project, if the citizen wishes to make changes or make further improvements.

Throughout a collaboration between the participating cities in Innovate, a network called the Energy Cities Network (ECN) has been created. The goal of ECN is to collect and share experiences gained from each city's assignment concerning the OSSC throughout the project. The collaborators of ECN meet four times a year to evaluate their progress

The Energy Cities Network can be regarded as the Innovate-project on a European basis (Energy Cities 2017). Frederikshavn Municipality is the Danish part of the Innovate project, which will be delved into below.

1.1 Frederikshavns Municipality

Frederikshavn Municipality is situated in Northern Jutland in Denmark and had a population of around 61.576 in 2011. The six biggest cities within the region are Frederikshavn, Skagen, Strandby, Ålbæk, Sæby and Dybvad. The cities have all been mapped below.

Figure 1.1: Frederikshavn Municipality

The municipality was the first in Denmark to sign the climate contract with The Danish Society for Nature Conservation (DSNC) to become a "klimakommune" or a "climate municipality" (Energibyen Frederikshavn 2019). A climate municipality aims to reduce its footprint on the global climate by reducing the amount of carbon dioxide released into the atmosphere by at least two percent every year for a minimum amount of five years. There are no limitation to what a municipality can do to uphold these demands set by DSNC. It can be everything from workshops involving the citizens to actively limiting the amount of fossil fuelled vehicles within the city (The Danish society for Nature Conservation 2018).

On top of the national climate deal, Frederikshavn Municipality was the first within Denmark to sign the EU Covenant of Mayors. The Covenant of Mayors is an EU initiative created in 2011 aiming to gather like-minded regions within Europe wanting to implement the EU climate and Energy goals in their own area. The initiative consists of over 7000 local and regional authorities across 57 cities in Europe (Europa-Kommissionen 2019).

In order to get the ideas and possible solutions from ideas on paper and into reality, the participants of the covenant have committed to submitting a Sustainable Energy and Climate Action Plan (SECAP) within two years to outline what initiatives they have taken to reduce the carbon footprint within their own region (European Commission 2019).

1.2 Energibyen Frederikshavn

The municipalitan effort of Frederikshavn having signed the Covenant of Mayors as well as participating in the SECAP has resulted in Energibyen Frederikshavn (Energibyen 2018).

Energibyen is an extension of Frederikshavn Municipality actively collaborating with businesses and craftsmen within the municipality to eventually get Frederikshavn Municipality to use 100% renewable sources of energy come 2050 (Energibyen 2018).

Energibyen Frederikshavn actively tries to combine different businesses, where they see an opportunity to build upon their collective yearly goals of lowering the total CO2 emission of Frederikshavn Municipality and thus they are acting as a mediator between the public and businesses from the citizen-perspective *and* from the business-perspective.

To get a better understanding of how this mediation can work, the group has been collaborating with Energibyen working as third parties as well as interns from September 2018 to December 2018.

During the internship, the group was presented with different focus points between them working with businesses, communications as well as end-users and possible users of Energibyen's one-stop-shop. When the internship was finished in December of 2018, the group concluded, that albeit Energibyen's efforts having definitely made an impact on a regional and a national level, most of the work had been spread too thin. This meant that most of their work would be delegated to the respective partners such as house owners or craftsmen. Energibyen would come up with initiatives, that they would not be able to follow through on, because of a lot of limitations being a municipalitan institution.

Energibyen being an institution directly under Frederikshavn Municipality presents itself with some limitations as it is a public institution meaning, that Energibyen can not try to push the market or actively help citizens choose one craftsman instead of another. They can only provide the system for the citizen to choose. This is especially difficult as Energibyen is an inter-institutional organisation

trying to mediate between citizens and craftsmen. This awkward role has been described in Konvergens på Tværs af Velfærdsstaten (Salamon, Lex, and Friberg 1990, p.119).

Energibyen has to cater to both the average citizen, the businesses within the municipality as well as Frederikshavn Municipality. Being a politically administered institution within Scandinavia can conflict with the above mentioned goals of Energibyen, as most politically administered institutions are to create wealth within a municipality by being innovative as well as create growth (Salamon, Lex, and Friberg 1990, p.115).

The limitations of being a municipalitan institution, when it comes to being a mediator or an innovative actor will be elaborated upon in the problem analysis (2).

Growth can be a lot of different things such as knowledge about sustainability, smart homes and green solutions that can create growth in the form of more work to private businesses within the municipality. Saving money on power and heat would be able to create an economical perspective as well.

The previous project lead to the group's continuing work with Energibyen on their master thesis, the project's content, and actors will now be described.

1.3 Living Lab Nordjylland

The Living Lab Nordjylland (LLN) project has the objective of delivering and placing a hybrid energy system at Knivholt Hovedgaard in Frederikshavn. The basis of the project is to use conventional technologies to establish a mini smart grid and will work as a research project, wherein local actors will collaborate. The premise of the project case in present time is to test and provide data for a thorough actor co-operation, which will end in a desired demonstration site of the energy system.

The Living Lab Nordjylland is on the state of applying for fundings at "Det Energiteknologiske Udviklings- og Demonstrationsprogram" (EUDP) which is a public subsidy scheme, which provides funding for green technological projects.

2 | Problem analysis

The starting point for this project is the general interest in climate change, that has become an even greater discussion, and an issue that has sparked political initiatives as well as personal initiatives. We have already established this in the prior semester project, having the opportunity to work in a political driven organisation, as well as having conversations with different citizens in the context of sustainable solutions towards energy refurbishment, that has its roots in the climate change debate.

Climate change is not a new underlying construct, and to grasp upon the Danish entry to the issue at hand, we will dig into the Danish government's climate proposal of 2018. We focus on this take to understand the underlying political initiatives towards the issue and also to get political information that are fully up to date.

In 2018 the Danish government released a new climate proposal with different suggestions on how to lower the collective of the Danish CO2 emission through different initiatives on transport, science, changes in agriculture and increased focus on a green transition for private and business accommodations. The main objective is to get a "climate natural" Denmark by 2050.

This new approach has come in the wake of the UN's new reports and the Paris agreement which can only be fulfilled by an intensified reduction in carbon emissions (Regeringen 2018, p. 8).

One of the main initiatives in the proposal is an extensive scale of replacement of conventional petrol and diesel fuelled cars. Therefore, a part of this proposal is to stop the sale of new petrol and diesel cars by 2030, and stop the sale of hybrid-cars by the year of 2035. To reach this point, the government has allocated 80 mil. DKK., which will be distributed towards the infrastructure and the technological development in general to be able to follow the increasing demand on power stations and so forth (Regeringen 2018, p. 17). To be capable of going through with the proposal, the government tends to make an effort on the progress through The European Union, for the union to demand times for the auto industry and the conditions they work under (Regeringen 2018, p. 17).

In proportion to the green transition of private and business accommodations, the government's proposal is set, firstly, around private housing that are primarily heated by oil burners and gas. This is to be reduced together with the

emission from the industry (Regeringen 2018, p. 31) and will be elaborated on later.

The government will allocate 100 mil. kr. to scientific research to the field of know-how on absorption and storage of carbon dioxide particles. The effort will embrace both technological development and initiatives towards biological absorption in earth and forests (Regeringen 2018, p. 37).
This will supposedly be controlled in compliance with strengthening Danish agriculture, towards a more sustainable future.

Over the last years a new focus point has entered the discussion regarding climate change and what needs to be done. The new focal point has been about sustainable housing and what efforts could be done to make older houses more sustainable, within the occupants economic latitude. The increase in distance for the district heating was one effort, which tried to make the houses more sustainable, in an effort to change peoples source of heating.

As of right now 64% of the Danish households are heated by district heating (Dansk Fjernvarme 2017). This effort focused especially on oil-burners. Furthermore, the government made a legislation in 2012 on oil-burners, and made it legal to use oil burners if no other heat sources were available. Oil burners that are already installed in houses, are allowed to continue being used, but if they have to be replaced after January 1st, 2016, the resident would need to connect to district heating, or, if not possible, to invest in other more sustainable heating options (Energi -og Olieforum 2015). As reported by Tue Patursson, who is an energy consultant at Energitjenesten, changing the heating system within a household can be a confusing endeavour for the house owners, and one of the most common barriers is the age of the house and under which relegation the home was constructed. If the household's primary heating source is an oil burner, the odds for the house's insulation to be sufficient are not very high. This makes for another hurdle to overcome, because district heating is only economically viable if the house is insulated properly. This is another factor, which can make it more cumbersome to navigate in the jungle of knowledge that is heating systems.

The issue of knowledge is something that can be improved upon. Regarding the knowledge of heating systems, and the issue concerning oil burners, Energibyen Frederikshavn collaborated with the group to make an event shedding a light on this issue. Every household in the municipality with an oil burner as their main source of heating was invited. 130 people of the 3000 citizens, who were invited through E-boks(governmental electronic mail service), showed up to receive information about oil burners and new technology from Energibyen and Energistyrelsen. Energibyen had also invited different craftsmen, who worked with refurbishments, district heating, heat pumps, or as an energy advisor. After the presentations, the citizens were invited to have open dialogues with the craftsmen about their house's situation, and what the next steps could be. The craftsmen collected various orders during the event, and the citizen went home enlightened and maybe even with an agreement to receive an offer, or a free energy inspection. This event is a great example of how different instances of a political institution, in this case a municipality, meet the citizens on their

playing field, and try to help them navigate towards a more sustainable living (Jens Fieldnotes 2019).

Energibyen is a municipal authority, which means that they have to be unbiased in their way of working. This was for instance apparent during the first phase of the OSS-project. During this phase, Energibyen reached out to every individual craft business, looked into the scale and work profile of the business, and asked whether or not they would like to be a part of an updated business register within the municipality, and furthermore, if they would like to be a part of the OSS-project to be (Theis Fieldnotes 2019). During our internship it was also evident, what limitations Energibyen had as a municipal authority in regards to the Innovate project and the OSSC. Energibyen would be able to find private investments to the concept, while also being co-coordinators of the process. However, since they are not allowed to invest money, or earn money from the project, Energibyen would have to find a business willing to take the reins, and the majority of the responsibility. This proved to be one of the major issues, to find a business with the needed capacity and know-how in a contextual field of practising the OSSC.

Energibyen wanted to use living lab in practise as a methodology to establish the OSSC, through a collaboration between; the municipality, the businesses and the citizens. However, during the Innovate project, it was evident, that there was different understandings of what a living lab is, which led to misunderstandings throughout the project period, and resulted in even further complicating the matter. What a living lab is, will be elaborated further upon throughout this master thesis.

The results we gathered from the internship, and the project based hereupon, alluded towards a still point with the citizens on one side, and the businesses on the other side, waiting for one another to make the first move.

From the perspective of the citizens the OSSC was difficult to grasp and comprehend, and therefore they were not keen to invest their money in the solution. The citizens contemplating taking use of the OSSC, would benefit from seeing a showcase in practise, or a more visible representation of how the concept would unfold from their point of view. They did however, agree upon the fact that the businesses that are a part of the OSSC would have to be unbiased, when it came to the potential offers, and solutions to the refurbishments, so that the citizens would be able to have some say during the matter, as to which supplier and the like that are to be used throughout the process (Hæstrup, Rasmussen, and Allesøe 2018).

When it came to the point of the businesses, other aspects came into play. These were mostly focused towards the economical and market aspect of the OSSC. As of right now the craftsmen were busy, and had plenty of orders in the future. What staggered them the most, was the need for them to chime in with their own money, into a rather complex and unknown concept, but most importantly a concept which no potential customers had requested before. The businesses had to put in their own resources in form of economical capital towards payments and materials without a beneficial established business plan of

the OSSC. This meant that the businesses would have to be first movers and create their own market for the concept. The capital they would contribute to the concept would therefore be earned back during a longer period, which the businesses were uneasy about. The businesses leaned towards waiting for the citizens to request the market, if need be, and then expand into it.

2.1 Techno-Anthropological insight

On the basis of what we have accounted for in the introduction and the climate challenges surrounding the government's climate proposal, we argue that the Innovate project is relevant in the context of connecting anthropological empirical data and analysis surrounding energy refurbishment in the municipality of Frederikshavn. Through the explanation of INNOVATE and Energibyen, this is clearly stated as a European/world wide issue which validates the relevance of accomplishing this project.

This master thesis seeks to expand on the development of Living Lab as a concept in practise, through an anthropological approach to gathering data material, which can be analysed to innovate upon the Living Lab concept. The aim is to allow the data material collected in this project to be perceived as an understanding of developing a Living Lab in practice and not just in theory.

The project's aim is to grasp and reflect upon the foundation of a living lab, in the context of practising a Living Lab at Knivholt Hovedgaard, where Energibyen is situated, through a redefinition based on existing and additional data collected in the autumn of 2018 from the project surrounding Innovate and energy refurbishments and theoretical and empirical findings throughout this master thesis. This will then be used to gather new data on the basis of an upcoming living lab project "Living Lab Nordjylland" which is in the phase of being approved.

Through this work we seek to aid Energibyen Frederikshavn in overcoming the first possible obstacles in setting up a living lab, and to understand the various involved actors in what is to become "Living Lab Nordjylland". To do this we will try to mediate between the various actors involved in LLN, and gather their perspectives on the basics of living labs. By doing this we intend to evaluate on the premise of LLN based on a techno-anthropological approach, to advise Energibyen and the project in its entirety to set the framework for the facilitation and implementation of the living lab.

This master thesis' techno-anthropological insights has been cemented, it is relevant to look into the roles we as researchers has had within the field.

2.2 Our roles within the field

A returning problem throughout the start of the thesis work has been to distance ourselves from the roles as interns. During the 9th semester (September 2018 - December 2018) the group worked as interns at Energibyen with differ-

ent focus points in mind. This was a good thing, as Energibyen were keen to continue the co-operation the next semester, but meant that the group had to take a firm step back establishing themselves as co-operative partners and not employees at Energibyen. This will be elaborated upon later in the report in the fieldwork section (4.2).

Collaborating with Energibyen after the internship has meant, that the employees of Energibyen have an idea of what we are able to do on an individual basis as well as our interests. When the thesis work started, we were asked as to what focus points we would have during the spring of 2019. During our internship in the autumn of 2018 we had three different focus points, them being communications, user perspective and business perspective. When we returned to Energibyen for the thesis work, they expected us to take on the same roles albeit it never being considered by the group.

Because of the aforementioned issues we invited two of the employees at Energibyen to a talk of what to do going forwards. We had to make it very clear, that we would be focusing on our thesis first and foremost thus bringing our time spent at Energibyen down and cementing ourselves as researchers first, collaborators with Energibyen second.

Distancing ourselves from our previous roles at Energibyen has proven to be quite difficult for one of the group members. The member was offered a job as a student employee at Energibyen thus forcing the two other members to take the reins on meetings with Energibyen, so there would be no conflict of interests (Michael Fieldnotes 2019).

The now employee at Energibyen will also be getting information about projects and actors, that may or may not have been possible to acquire by using Energibyen as a gatekeeper to the other actors involved in Living Lab Nordjylland. This is an issue we have to actively consider moving on with the project (4.2.1).

It is also a unique opportunity to get a deeper insight into how they work, communicate and collaborate at Energibyen, and it can possibly shed some light on some of the problems Energibyen as an actor possesses, seen from a Techno-anthropological point of view.

The aspects which has been described in the introduction, combined with the factors presented in this chapter, leads down to this master thesis' problem statement.

2.2.1 Problem statement

> *How can we as techno-anthropologists mediate the Living Lab into a condensed, easy to understand terminology regardless of actors involved in the Living Lab Nordjylland-project?*

Now the problem which this master thesis seeks to research has been established, it is relevant to look into existing research to create further insights on relevant established knowledge through a state of the art chapter.

3 State of the art

To get a better understanding of the environment we are working in as well as the actors we are interacting with, we are looking into different theories and methods concerning public organisations as well as how Living Lab has come to be a blurred method surrounded by dissimilar theories.

The goal of this state of the art-chapter is to get a better understanding of existing research within the fields, we would like to dive into and explore.

As was presented in the introduction within this master thesis, Energibyen is a public institution and is thus limited in some structural ways compared to a private institution. Being a direct product of Frederikshavn Municipality means that Energibyen has to be a non-biased actor within the municipality and are not able to predispose one actor or another. They have to be inter-institutional, but are still limited in their possible market impact as a public institution (Salamon, Lex, and Friberg 1990, p.113).

Energibyen as a municipalitan actor is not bound to change, so the goal with most of their projects are to hand it over to the private sector, so they can continue without the restraints of a public project lead (Energibyen 2018).

Energibyen being restricted as an institution in some of their work is only part of the problem, which has been described in the problem analysis (2). The other part is creating knowledge and changing people's understandings of sustainable energy and the energy used within their own home.

To get a better understanding of the possible issues presented when having to change a fundamental understanding of energy, we looked into literature concerning paradigm shifts or the like, where end-users had to change their mindset concerning fundamentals.

In Changing Interpretive Schemes and Organisational Restructuring: The Example of a Religious Order by Jean Bartunek. Jean Bartunek is a reseacher at Boston College in the field of management and organisation. Bartunek argues, that most changes to a system happen because of a leader or other high ranked person pushing for it. It is rarely because of the end-user (J. Bartunek and Bartunek 1984, p.357). Changing an initiative is therefore entirely reliant on upper-management or the like. If they don't actively try and enable an initiative or push the people below them towards a given direction, it most likely will not

happen (J. Bartunek and Bartunek 1984, p.358).

In relation to Bartunek's organisation terminology, Energibyen is not an actor in a direct position of power, but rather a department working as the authority of Frederikshavn Municipality to reach their common goal of an emission free municipality by 2030 (Energibyen 2012). The municipality itself is in a position of limited power as they are not able to enforce relegation of green initiatives on the citizens within the municipality, but only inform them and make the green alternatives as attractive as can be, but as they are a public actor, they cannot turn the citizens towards one specific craftsman, as that would have an influence on the free market (Salamon, Lex, and Friberg 1990, p. 114).

3.1 Individual climate perspectives and morality

Contextualising climate change in the debate, it is given that the political aspect is by far the most mentioned, in actively trying to make changes. This is clearly seen through for example the Paris Agreement of 2015, where the 196 member states of the UN's climate convention (UNFCCC) agreed upon a legal binding agreement on climate change (United Nations 2019).

What stands to question is how the individual citizens are co-operated into these political resolutions, if their position is even taken into consideration, or if the separate citizens are responsible for these changes. No individual can arguably be excluded from being a factor in the climate pollution to some extent, if the individual is an actor who does not have a fully climate-friendly lifestyle. This leads to the individual perspective, which Theresa Scavenius points out.

Theresa Scavenius, who is a researcher in climate politic- and democracy from Aalborg University, takes the individual perspectives of climate changes and the individual moral consideration into perspective. The first perspective Scavenius argues is the "knowledge deficit", which surrounds the general knowledge that each individual has a personal imprint on climate from their daily actions, and that "we" are incapable of telling in a broader picture, just how much a person is expected to know of general information (Scavenius 2018, p. 2). Scavenuis also argues, that the general individual has a lack of motivation towards changing the way of climate changes, due to the fact that human beings as a whole, are not capable of coping with moral dilemmas due to the absence of moral psychology (Scavenius 2018, p. 2). These arguments can be boiled down to, that for once the individual does not know the scale of their own impact to the environment, and therefore does not know what to do in order to "make green choices" (Scavenius 2018, p. 2). Secondly, as Scavenius puts it:

> *"Even if the first argument is false, people lack an incentive to make green choices because of the cost and availability of environmentally friendly products"* (Scavenius 2018, p. 2).

What we want to argue by looking into this article, is the demands that climate politics have on the individual in the society. What can be demanded from an individual to live up to the standards set by politicians and the debate on climate changes in general?

Scavenius sets up a dilemma whether to excuse people's moral deficit, through an example on public transport. As she writes

> "*If Peter is living in an area without public transportation, it is impossible not to have a car. If Peter wants to reduce his ecological footprint, he needs to move to another city or country with a more climate-friendly public infrastructure.*" (Scavenius 2018, p. 5).

We can use this quote by reflecting on the vision of living standards, and the importance of sustainable developing on already known technologies, for example in the public transport sector, or house refurbishments. Through our existing living standard, it can be argued that the common individual has created for themselves a way of living that is (due to technology in ex. transport or in general convenience) unbreakable because it has become a standard living. It also relates to the issue we have established in the problem analysis, about how people are not willing to invest in for example energy refurbishments, because the lack of for example the financial incitement, whereto individuals in a democratic society without voluntarily committing themselves cannot be forced to change, therefore avoiding climate impairment (Scavenius 2018, p. 6).

We will use this argumentation towards the relevance in establishing the Living Lab at Knivholt, where technologies can be implemented and, for business purposes, displayed and promoted, and for scientific purposes be monitored whereto it can be further developed on.

3.1.1 Understanding innovation

As has been elaborated upon in this State of the Art-section, Scavenius and Bartunek whole heartily disagree on the basics of applying innovation or getting users to understand or adapt to a new system. Bartunek argues, that innovation and the incitement to innovate is based from the top down. Alas, having a boss or other entity of power forcing or otherwise enabling the users below the person to use a new system or technology. It is illustrated here:

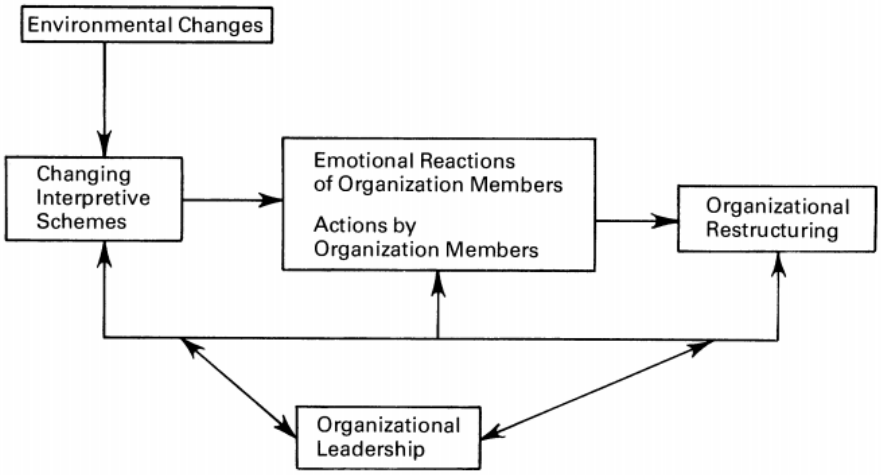

Figure 3.1: *"Relationship between second-order change in interpretive schemes, organizational members' actions and emotional reactions, and organizational restructuring"* (J. Bartunek and Bartunek 1984, p. 357)

As can be seen in the figure, each possible change to a part of the system will have a direct or an indirect influence on other parts of the system. To better understand Bartunek's illustration, we are breaking down the model into their respective parts.

Environmental changes can be a vast amount of different variables outside of the system or organisation's control having an influence on the organisational structure or otherwise changing the system.

This leads directly to **Changing Interpretive Schemes**. Dealing with the change may manifest itself in the members of the organisation.

Emotional Reactions of Organization Members are the users understanding of the change which, if extreme enough, might lead to them actively trying to change or adapt to the outside variable and thus leading to **Actions by Organization Members**.

An action created by the users of a system might in turn lead to an **Organizational Restructuring** if the problems faced are big enough to warrant such a change.

All of the above mentioned situations will have a direct influence on the **Organizational Leadership** within the system or organisation. If the members of the organisation call for a change by the leaders, the leaders or higher ups will have to react accordingly. If the leaders try to implement a change in the organisation, it will affect users within the system one way or another (J. Bartunek and Bartunek 1984, p. 358).

Bartunek argues, that while a new technology may have a direct influence throughout a whole system, it will both modify and affect the rest of a given system in one way or another. The decision to change a system or technology, however, is entirely reliant on the action takers - such as an organisational leadership (J. Bartunek and Bartunek 1984, p. 356).

One thing to have in mind discussing where the responsibility may lay as well as where, this master thesis would focus, is, that Bartunek wrote the article in 1984, where technology as well as the understanding of such is entirely different from what it is today, whereas Scavenius wrote her article in 2018 having a more direct comparison to newer technology as well as individuals having a different understanding of technology.

Therefore it will make more sense to actively use Scavenius when it comes to the direct comparison between technology and the end-user as it will be more relevant than Bartunek in that sense. It is, however, important to keep in mind what a decorated figure can do to implement new technologies or systems in a working environment.

3.2 Existing Labs

Going into this project, wanting to advice on facilitating the Living Lab at Knivholt Hovedgaard, we want to take a close look at other similar test sites, where sustainable and green technology platforms are showcased. It will be structured as a presentation of the different "Labs" that we find interesting in the perspectives of creating the Living Lab at Knivholt, and where certain similar possibilities can be drawn.

Green Tech Center (GTC) is located in Vejle, Denmark, and contains a large area of assembled accommodations; Green Tech House, Resilience House, Green Tech Lab, Green Tech Park. The site displays a large range of different green technology solutions such as wind, electrical vehicles, solar power etc.

GTC consists of various green innovation businesses who have their daily work in the facilities presented by GTC and through this, GTC are able to showcase products. The site can be seen as a test facility for upcoming green technology solutions or products, developed by smaller entrepreneurs, as a stepping stone before going into the market (Green Tech Center 2018). By working closely with GTC, the projects are able to get investors from their "Investment Days" events, where possible investors gather to see what projects may be worth funding in the future. This correlates very well with GTC's "Smart Energy 2 Market" a project that aims to push the ideas to market.

GreenLab Skive is a park in Skive Municipality focusing on renewable and clean energy solutions as well as resource efficiency. Skive is a center point of Denmark's electricity network as well as the gas infrastructure and thus presents a lot of collaborative possibilities within the project.

The very location is organised as its own smart grid, where the partners are

encouraged to exploit and develop the grid. The supply and demand of the grid is equally balanced between project partners, so they are able to focus on optimising their efforts.

GreenLab Skive is more of an "energy playground" (GreenLab Skive 2019). Unlike GTC, it is less focused on pushing the ideas to market, but is more research focused in getting it right. Their aim is "*to become the leading centre for integrated green energy, intelligent grid and sustainable production*" (GreenLab Skive 2019).

H2020 SMILE project is a Horizon2020 funded project consisting of nineteen different partners from different European countries. The goal of the project is to demonstrate different smart grid technologies, based on three different islands, whereas the Danish island Samsø, together with Madeira (Portugal) and Orkney Islands (UK) are the foundations of the project.

Besides developing the technologies, the aim of the project is to establish mutual learning processes for development teams around the European Union to practise the same language in future replication and development (Horizon 2019a).

These existing labs are presented to show that similar projects have been facilitated. There are some clear similarities in relation to the LLN project, which seeks to implement an integrated energy system. The existing labs does not use the living lab terminology, whereas LLN uses this as a main factor in their project. Therefore it will be relevant to into research concerning the living lab terminology, to obtain knowledge on the subject.

3.3 Urban Living Lab

Grasping upon the general understanding of Living Lab, we as researchers have acquired through our 9th semester internship project, we will look into the understanding of Urban Living Labs, due to its close comparison to how we have previously worked with living labs. Simultaneously the Urban Living lab (ULL) will be accounted for in the context of experimenting with smart grid technology, to pick up the understanding of living lab as a process towards experimenting with various socio- and technical aspects of designing and facilitating technologies.

In the book *Urban Living Labs - Experimenting with city futures*, Anthony M. Levenda, who is a Postdoctoral research fellow in Future of Innovation in Society, at Arizona State University, accounts for the fact that new interventions towards lowering carbon emissions is a process from governmental grounds. To do so there has been an upscale in the focus of consumer engagement to test, and through these tests, understand how cities can implement new *smart-technologies* in a smooth transition (Levenda 2018, p. 52).

The idea of ULL is the experimentation of technological implementation in the real world, through social arrangements, in which various actors interfere in the same focus point, and reaches from citizens, government, researchers to

industry, all connected (Levenda 2018, p. 52).

Levanda states that the experimentation in which living lab offers indicates a new way of establishing relations between all the phases in the line of actors. The relation has to grasp from producers to consumers, to the infrastructure and practices (Levenda 2018, p. 54). It is important to state that Levanda identifies ULL, not as a specific model for living labs, but as a transparent box of methods all connected to the premise of a living lab.

As we worked throughout our internship, conducting data from various sources and through different methods, we were introduced to the methodology of living labs. This method was seen as a combination of ethnographic methods applied onto the municipality of Frederikshavn, which was the basis of the case. Therefore, when using the understanding of Levanda's ULL we as researchers now identify it as a living lab applied on the urbanisation (city if you will), and even further as applied onto parts of a city, where demographic changes have an influence on the unified product at that time.

Levanda does not distance his thoughts of ULL, from the mentioned perspective above. He identifies ULL as a simple test-site only established for technological testing, which is called *urban test beds* (Levenda 2018, p. 59).

The mentioned Innovate project was set to be devised in the living lab method, where various actors were to meet on different specifications within the project (2). The Innovate project's idea of the living lab, was to establish a lab where the main actor was Frederikshavn Municipality. This included the municipality itself, the different businesses (craftsmen, energy advisors, architects and such) and the citizens. This understanding of a living lab differs from Levenda's understanding of an urban living lab, in the sense of how a living lab is perceived. From Levenda's point of view, a living lab would consist of a small test bed, or segments of the municipality, where the understanding of living lab from the perspective of the Innovate project, were to include the municipality as a whole, and then develop it from the ground up. The Innovate project along with this master thesis is based on perspectives of the same understanding of the living lab, meaning that for the living lab to be beneficial in a municipal view, The living lab must be comprised of all the potential actors. By law the municipality are not permitted to pick and choose whoever they see fit, everyone has to be heard and asked, to be a part of the living lab (1.2).

Summarized, Lavenda's understanding of a ULL can not be established in a Danish municipality, and therefore another understanding and definition of the living lab would be needed to begin the process of practising a living lab in Frederikshavn municipality.

The existing "labs" and research regarding living labs will be used moving forward as a frame of reference, while a further investigation of the theory surrounding the living lab methodology will be conducted in the theory chapter (5).

4 | Fieldwork

In this chapter a presentation of the conducted fieldwork involving the Living Lab Nordjylland project, the actors involved in the project and the field of research will be elaborated on.

4.1 Living Lab Nordjylland

Throughout the process of conducting data within this project, we are working towards the understandings of Living Lab, and therefore we find the project of "Living Lab Nordjylland (LLN)" interesting. We are using the LLN project as a case surrounding the outlook of using the term "Living Lab", as the understanding of "Living Lab" as a term is vastly different from actor to actor and to us as researchers.

4.2 Fieldwork in practice

Most of the fieldwork conducted throughout this thesis has been done from September 2018 through June 2019, and to some extent, even before that.

We started an internship at Energibyen in September of 2018 together with a Living Lab consultant, who was researching how to get more people to invest into sustainable housing and housing renovations. As has been described earlier on in the project, this was very much in line with Energibyen's goal of spreading knowledge about the sustainable possibilities. We, as students, were then given different roles within the organisation while having our own interests in mind.

The group was divided into the end-user perspective, the business perspective as well as communication by Energibyen. The group was able to share experiences throughout the internship as we were sharing an office we could use freely. We were even provided with a key for Energibyen thus cementing our role at Energibyen as "natives" (Spradley 2003, p. 8).

By being natives of Energibyen, we were seen as employees in the same way as any other job, providing us with the ability to introduce ourselves as interns at Energibyen to informants and not as students from Aalborg University and thus possibly providing us with different information than if we were to introduce ourselves as students. This could both be a good and a bad thing, however, as we were more reliant on the informant's perception of Energibyen

and Frederikshavn Municipality. This goes both ways, however, as some people might not have anything good to say about Aalborg University, but are fond of Frederikshavn Municipality and vice versa (Spradley 2003, p. 47).

The group member focusing on the end-user perspective worked closely together with the Living Lab-consultant in both interviewing the end-users about their habits and their view on sustainability. The main focus of the task was to investigate, if they would be willing to invest into their own homes to make it greener or more sustainable. This work was then illustrated in an article written in collaboration with the consultant and the rest of the group.

4.2.1 Employment in the field

As mentioned in the problem analysis, one of the group members is working as an employee at Energibyen. This was something that we made sure to take into account during this master thesis. He was able to receive a more in depth view of how their daily work schedule, and what their role as an actor was. Furthermore, during the data collecting, when Energibyen had to be interviewed, it was decided that the two other members conducted this interview, while the third member, who was employed at Energibyen, were to not be a part of the interview, to make sure this would not have any influence on the data collected.

4.2.2 Actors

Choosing the informants for the data collection for this project, we looked into the EUDP application for the Living Lab Nordjylland-project, to get an overview of the existing actors chosen for the collaboration in creating the "mini smart-grid" and the living lab at Knivholt. It is important to note, that the informants were representing the institutions collaborating on LLN, therefore, the actors are to be seen as institutions rather than individual actors within the project.

In this section the different actors we have encountered in our data gathering will be shortly presented.

Aalborg University

At the 15th of April, we had an informal meeting with the project lead of Living Lab Nordjylland, who is an associate professor at the Department of Energy Technology, at Aalborg University.

The meeting was to gather a consensus around our intentions working with the LLN, and the actors motivations trying to get the funding for the project. We were also keen to hear how the application process was going.

Nord Energi Net A/S

As Living Lab Nordjylland has to use power to function as intended, Nord Energi Net A/S was approached to participate in the project, since they deliver power and provide the infrastructure concerning everything from fiber optical-cable in

the ground providing internet and to the electrical grid, powering everything north of Aalborg.

Nord Energi Net A/S is a public institution providing both the infrastructure as well as the end-product of electricity in Northern Jutland. On top of that, they own the electricity meters setup in every home across the region (Nord Energi Net A/S 2019). As of right now, they are not included in any practical way in Living Lab Nordjylland, as the project itself is still in the starting phases. They have signed on to provide 75 hours of labour, however.

The representative from Nord Energi saw the living lab as an opportunity to try out a system in practice rather than on paper. According to him, there were no economical incentives to speak of, but the project provided them with the possibility to try some systems, that had not been tested at the time. It was a test of possible future scenarios Nord Energi might encounter in a real situation.

Energibyen

Energibyen has been described earlier on in the report concerning the group's relationship with the entity as previous interns and now as informants regarding Living Lab Nordjylland.

On Thursday 9th of May the group went to Frederikshavn to interview Energibyen concerning their role in Living Lab Nordjylland. To get a proper comparison between the different actors, their understanding of the project as well as their role, the same interview guide was used in all of the interviews. The interview guide can be seen in the methods section of the report (7.1).

Unlike Nord Energi Net, Energibyen focused heavily on the direct collaboration between the actors within the project and on Energibyen providing the Energy path for free use by the other participants. Energibyen's main objective with Living Lab Nordjylland is to provide a platform, that can go from small scale to full roll out. It is supposed to be a proof of concept.

Energibyen's task within the project is to act as a mediator between the partners in the project to make sure the project is going as expected and to assemble the co-operative businesses who are a part of delivering the integrated technologies to the system.

Kamstrup

On the 23rd of May, we had a Skype-interview with a representative from Kamstrup concerning their involvement in Living Lab Nordjylland. Kamstrup are the producers of the electrical meters measuring the power going into the system within the smart grid. Not only are the meters able to measure the amount of electricity being used, but also the quality of the provided electricity. As Kamstrup has never participated in a project, where different forms of energy (solar, wind and other) are to collaborate in a smart way, they would need to make sure, that the quality of the electricity provided meets their standards.

According to the informant from Kamstrup, the new electricity meters are perfect for such a use case as the smart grid, as they can measure the electricity used on an hourly basis, whereas the older models were measured bi-yearly (13).

Lithium Balance

Lithium Balance is also a business who is to be a part of LLN. They work with batteries, and through this storing of additional energy, which can then be used when there is no wind to power the wind mill, or such. Their batteries are to be implemented as a part of the mini smart-grid to store additional energy and supply it to the smart-grid in times of low energy supply. This is some of the newer aspects of a mini smart-grid which have not been tested immensely. It was however not possible to get in contact with Lithium Balance, and interview them for this master thesis. This means that Lithium Balance will not be directly part of this master thesis, but they will be mentioned peripherally throughout the thesis.

4.3 Energy Trail

In this section a description of the Energy Trail located at Knivholt Hovedgaard in Frederikshavn, will be presented from the point of businesses and home owners and illustrated to get a hold on the various parts of the trail.

The energy trail is created as a showcase of different sustainable energy solutions. From larger scale operations such as wind-turbines, heat pumps, lake heating and solar panels, onto smaller scale energy sources such as a body bike, transforming exercise into electricity (Energibyen 2019). It is presented virtually on Energibyen's website, which gives an overview over the different installations and also possibilities for homeowners to borrow thermal cameras, and try out the electrical bicycle.

The Energy city as mentioned, wants to be the spokesman for the citizens while trying to connect local businesses into transferring some of their product portfolio into becoming somewhat sustainable. Therefore, the energy trail is set up to cater both the citizens of Frederikshavn municipality, and the businesses in the municipality.

For the business development point of view, the trail is for businesses who produce or have expertise in sustainable products, to display their products at events at Knivholt (Energibyen 2019). It is a part of the business network which Energibyen has established, where local businesses e.g. craftsmen businesses are able to connect with each other.

For the citizens, with homeowners in mind, the energy trail is created as a walk through. It is possible to get a guided tour to visually see energy installations in full scale, as a guide to "feel" the installations as fitting or not for their homes (Energibyen 2019).

4.3.1 Walk through

To get a proper understanding of the potential the energy trail possesses, the different parts contained within will be elaborated below.

First off, we have the lake heating. According to Energibyen, it is one of the lesser known potential forms of energy. It does require a lake to work, which severely limits the potential amount of users. It works by having a closed system connected to a heat pump, that draws heat from the water in the lake. When the heat has been used, a circulation pump sends the water back into the lake. Energibyen concludes, that the average heating bill can be cut in half using lake heating, if the house is well-isolated and without draft. The initial cost is rather high, but so are the savings in the long run (Energibyen 2019).

Figure 4.1: The lake used for heating at Knivholt Hovedgaard.

The next part of the Energy Trail are the solar panels mounted on top of the west building at Knivholt Hovedgaard. The panels provide both power and heat (through a heat pump) to the kindergarten at Knivholt as well as the nature museum.

Solar panels are one of the more well-known green forms of energy in Denmark and have already been installed in many homes in the country. The average solar panel has a production of around 4600kw pr. year, whereas the common household consumes about 4100kw pr. year (Energibyen 2019). Technically a household can produce 100% green energy from solar panels, but as the power is not able to be stored, a lot of the generated power goes to waste.

The solar panels installed at Knivholt are pictured below.

Figure 4.2: The panels on top of the west wing building at Knivholt Hovedgaard.

Following the solar panels, the next stop on the energy trail is the heat pump, that is powered by the solar panels on the roof. The heat pump works by extracting the heat out of the outside air and then pulling the heat inside to heat up the buildings. It resembles a refrigerator, but opposite.

The heat pump is very efficient as Mariendal Electrics claims, that it can save up to 50% on the heating bill compared to an electrical radiator or an oil burner (Energibyen 2019). The heat pump can be controlled from a smart phone app, so the user can make sure the house is already heated, when they arrive at home. The remote nature of the controls make it a clear possibility in a holiday home as well. The heat pump is pictured below.

Figure 4.3: The heat pump at Knivholt Hovedgaard

The last relevant step on the energy trail is outside the eastern wing at Knivholt Hovedgaard. The workshop and lunch area is entirely heated by earth heating. Underneath the field, where the horses are, there have been dug a long coil in a depth of one meter below the field. Inside the coil is a fluid that collects the heat from the earth and transports it to a heat pump, that delivers it into the building. The system works in much of the same way as a solar panel, as the coils transport the heat the earth has gotten from the sun shining on the ground.

Energibyen claims a possible savings of 50% on the heating bill, if the buyer's house is well insulated. The system does require a large yard or the like to function as expected. The system is pictured below, although not a lot can be seen, as it is dug under ground.

Figure 4.4: The earth heating outside of Knivholt Hovedgaard

4.4 Fieldwork summarised

In conclusion, the fieldwork during this project has revolved around interviewing the actors involved in Living Lab Nordjylland, what their position in the project are as well as their initial thoughts of the project. After the actors and their intentions were introduced, we dived into the energy trail at Knivholt Hovedgaard. The energy trail is to function as the physical execution for Living Lab Nordjylland. The energy trail already presents different forms of green initiatives, but not in a connected matter, as is the main goal with Living Lab Nordjylland and the presented "smart grid".

5 | Theory

In this chapter we will account for the theoretical practise of living labs, together with a clarification of the Technology Acceptance Model. Lastly a clarification upon innovation theory by looking into the term of participatory design will be presented.

Throughout the problem analysis, we have established which factors come into play, when citizens are to consider new energy solutions within their homes. One of the main problems were centred around people not willing to change, because they deem it unnecessary as they may not be as invested in their homes or the possible economical benefits may not be enough to sway them towards refurbishing their home.

5.1 Technology Acceptance Model

To get a better understanding of why these issues may arise, the group has analysed the Technology Acceptance Model (TAM) developed by Viswanath Venkatesh and Fred D. Davis back in 1989 (Venkatesh and Davis 2000). The model was created to get a better understanding of technology adoption and usage in practice. Even though technology is constantly advancing in both software and hardware making systems faster and more easy to use, it is still mostly impossible to implement a new system - it being hardware or software - without upsetting a number of end-users (Venkatesh and Davis 2000, p. 186).

Davis and Venkatesh started using the first iteration of TAM in different empirical studies, where they categorised the biggest fall groups, that the end-users had problems with, when a new system was implemented. The project started as a way to combat the "productivity paradox" that many new systems were facing. Even though the systems were much quicker, more simple and easier to use, the gains in productivity were not as expected (Venkatesh and Davis 2000, p. 186).

Throughout the empirical studies, Venkatesh and Davis concluded, that two factors were a limiting factor in user behaviour in 40% of the cases; perceived usefulness and perceived ease of use.

Perceived usefulness (U) is how the end-user may see the new system. If they believe, that using the new system is something, that may enhance their

productivity, they have a high sense of perceived usefulness.

Perceived ease of use (E) is how much effort the end-user needs to put into the new system to understand and be able to use the system properly. If both the ease of use and the perceived usefulness is high, the end-user will usually be very welcoming to new systems and will mostly benefit from the new systems, if they work as planned (Venkatesh and Davis 2000, p. 188).

Attitude towards using (A) will be elaborated upon later in the extended model, but can be seen as a product of E and U. If the perceived usefulness and ease of use is considered high, then the attitude towards using the product will be good. The users will be willing to try the new system.

Behavioural Intention to Use (B) is a harder concept to grasp as more outlining variables will come into place.

The behavioural intention to use may not be, what the individual sees as the most optimal way of using the system, but can be something a higher up may have implied the users to do. If they believe a higher up, if it is relevant in the given system, would like the users to use the system in a specific way, they may be more inclined to do so even if their "own" method is better or faster (Venkatesh and Davis 2000, p. 187).

The original Technology Acceptance Model (TAM1) has been used since 1989 and has been a good way of predicting possible user behaviour in new systems and has further underlined, that the end-user needs to see the benefits of new systems to be able to harvest the better productivity. The TAM1 is not without faults, however, as it is hard to try and implement or adjust an existing system within the boundaries of the TAM1. If the system is already implemented, it makes it difficult to research the perceived ease of use and usefulness, as the users will already have used the system and may be hesitant to change their routines (Venkatesh and Davis 2000, p. 189). The Technology Acceptance Model 1 is pictured below.

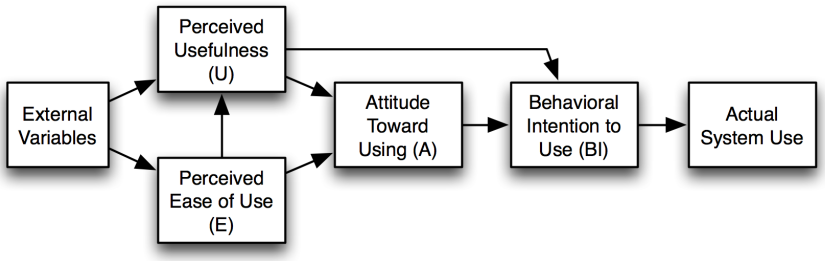

Figure 5.1: Technology Acceptance Model 1

The figure includes more elements than perceived usefulness and ease of use as they play a role in understanding the usage behaviour. External Variables can

be a vast amount of things, but are mostly related to the individual's background. If they are very keen on using for example IT in their daily lives, they may be less reluctant to change to a new system as they may find it interesting to try a new and possibly better system. These variables have a direct influence on both U and E as they determine the user's attitude towards using the system. If this is negatively bound it reflects directly on the behavioural intention to use (B) and thus also on the actual system use leading to a poor end-user experience in practice. On the other hand, if the attitude towards the system is positive, it may reflect on the system usage as well.

The main problem with the Technology Acceptance Model - and also one of the main forces of continuing development - was the fact that it was only to be used before a system was to be implemented and not as a way of gathering experience throughout a project. Therefore Davis and Venkatesh developed a new model, Technology Acceptance Model 2 (TAM2).

TAM2 expands upon the black boxing of external variables to get a better understanding of what goes into the individual's understanding of a new system. These variables are different from person to person and will have a direct influence on how the system is perceived by the user (Venkatesh and Davis 2000, p. 189). On top of trying to provide a better view of usage behaviour, the model is to be seen as an iterative process, that can be used throughout the implementation of a system. Where TAM1 was striving to underline the importance of user involvement, TAM2 aims to consistently improve the system and learn from gathered experience. Below is a picture of the Technology Acceptance Model 2.

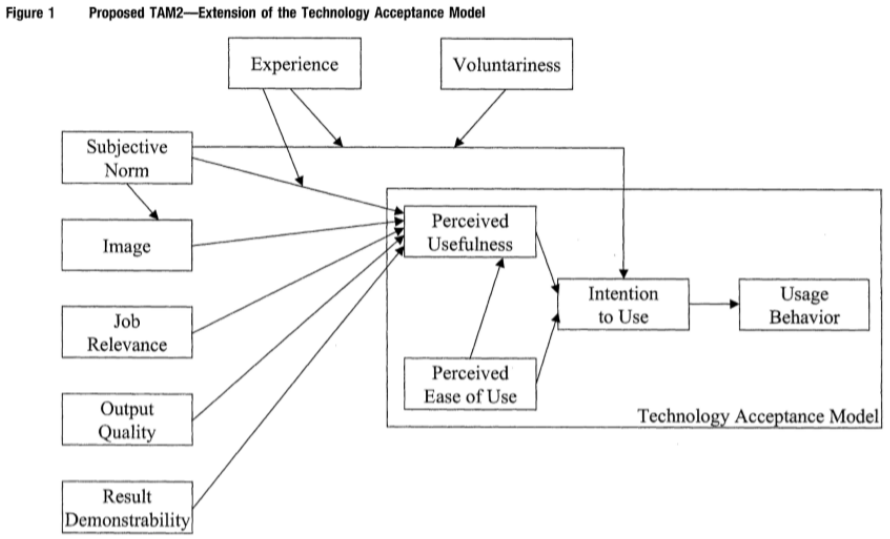

Figure 5.2: Technology Acceptance Model 2

As can be seen in the figure, the external variables column from TAM1 has been removed and seven other points have taken its place instead. These points were all part of the external variables column from the previous iteration of the model, but by dividing it into more groups, it is easier to grasp what the external variables include. All of the variables are very much subjective and will vary from person to person, but by having more categories to divide end-users into, a better product or a better solution may come up (Venkatesh and Davis 2000, p. 190). To understand exactly how the variables play into the perceived usefulness of the end-user, they will be elaborated upon individually below.

Result Demonstrability is how well the system works. If the system has been tested and it is able to clearly present better results than a previous system, the user is more likely to see potential benefits.

Output Quality is very much in line with the above mentioned variable. If the new system is able to produce an end product of higher quality at the same rate or faster, it will be considered a good upgrade.

Job Relevance is a very individual variable as it is how the end-user sees the new system's possible impact on their own work or understanding. If the Job Relevance is not highly regarded by the end-user, it has a large impact on the Perceived Usefulness, as it is very individually based (Venkatesh and Davis 2000, p. 190).

Both the **Subjective Norm** and **Image** are to some extend directly intertwined within one another. Subjective norm is the perceived social pressure of adapting to a new system. If the rest of the users are happy with the system, one user might feel obligated to feel the same way to not stand out from the rest of the people. The image can be seen as the subjective norm's product. If the technology is seen as being worse than the old system, the subjective norm will put pressure towards the users seeing it as being a bad thing.

As can be seen in the figure, the norm not only applies to the Perceived usefulness, but to the Intention to Use as well. It is not only how useful the end users will see the system, but also how they intend to use the system.

Experience is the individual's experience with the system or systems of that nature. This again applies directly to the subjective norm. If it is a group of users with a large amount of experience regarding such systems, the general norm may be to like the new system as well.

Voluntariness is a combination of the subjective norm, image and experience. If the three add up to a positive attitude, the voluntariness to grasp the new system is probably going to be high as well.

Especially the experience, voluntariness and job relevance plays a substantial role in how the user approaches a new system as it directly correlates to the perceived usefulness and intention to use. On top of outlining one of the columns within the model, the TAM2 aims to be an iterative process and thus a model, that can be used throughout the implementation process of a system from the

planning phase and until after full implementation. The iterative model can be seen below.

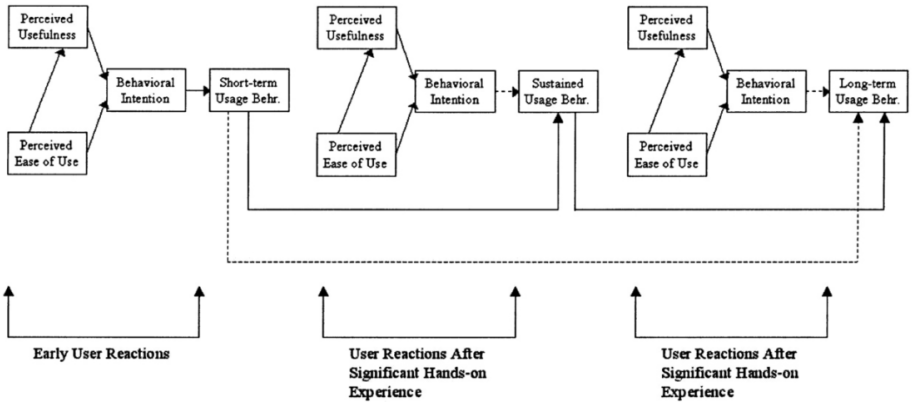

Figure 5.3: The iterative TAM2-model (Davis and Venkatesh 2004, p. 37)

The figure was created in 2004 as a natural evolution to the TAM2-model and is to be seen as an extension of the existing model and not a replacement (Davis and Venkatesh 2004, p. 36). The model focuses on the individual's experiences with a given system as soon as the system or technology is implemented, then again as they have gotten to know the system (this may be three weeks or three months, for example, depending on the system (Davis and Venkatesh 2004, p. 39). And then again after the system has been used for a significant amount of time.

The supposed take-away from the iterative model is the usage behaviour after the different amounts of time. If the usage behaviour was overwhelmingly positive at the start, but not after three months, problems may have arisen that need to be dealt with going forwards, so it doesn't spiral into more negative reactions down the line. This model is especially centred around technology production as it will be more expensive to dramatically change a system later down the line than in the planning phase as can be seen in the figure below.

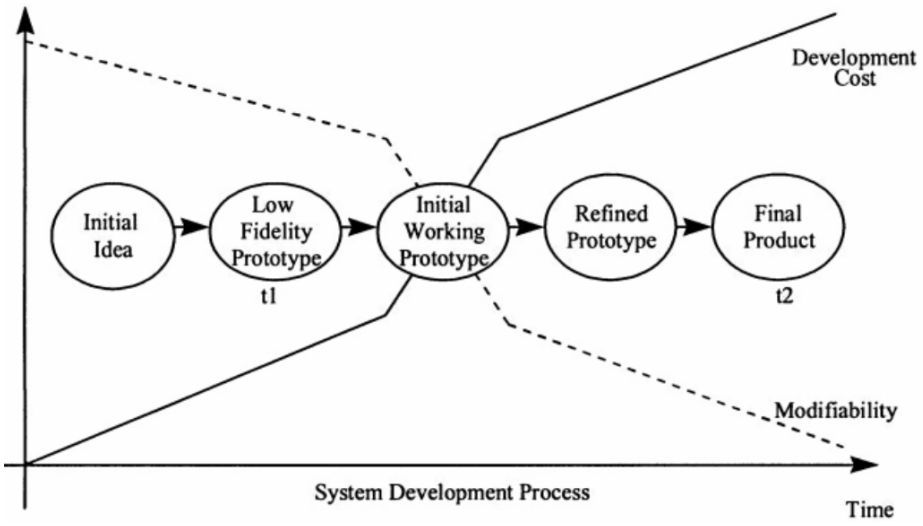

Figure 5.4: System development processes (Davis and Venkatesh 2004, p. 33).

Changing a platform or a product late in development can be both time consuming and very expensive. By actively working with the users, these issues can be eliminated or minimised (Davis and Venkatesh 2004, p. 32). Adding to the cost and development time of a product or a technology, other variables can play a substantial role in accepting or declining a new system. These variables can be classified as *enablers* and *inhibitors* (Cenfetelli 2018, p. 474). The model will be used further in the Living Lab chapter focusing on the advantages and possible drawbacks of a System Development Process within a Living Lab-project (6).

Enablers can be seen as potential benefits from the person using the technology or the system. This can be anything from an economical aspect to an automation of an otherwise tedious process. The enablers can vary from actor to actor and from individual to individual (Cenfetelli 2018, p. 475).

Inhibitors are the exact opposite of enablers, and are variables that can make the user of the product or technology disinterested in it as a whole. As with enablers, this is entirely individual.

Because of the individual nature of both inhibitors and enablers, they would not necessarily be considered throughout the process unless they are being repeated time and time again by different actors. Then it may be a problem, that needs to be taken care of (Cenfetelli 2018, p. 476), but will be seen as a general problem with the product rather than an enabler or an inhibitor (Cenfetelli 2018, p. 477).
Now that the Technology Acceptance Model has been established, and how it has been iterated, to be used throughout the developing process of a technology, we will move on to the theory surrounding the living lab. It is however relevant to look into open innovation before delving into the living lab theories, as this can be seen as a stepping stone to the understanding of the theory behind the living lab methodology.

5.2 Open innovation

The open innovation paradigm can be seen as a way of using focused flows of knowledge coming from outside and inside the business to increase the internal innovation. The innovation paradigm operates according to the businesses ways of advancing their technology through internal ideas as well as external ideas. The paradigm seeks to establish the importance of using and taking into account knowledge or advice received from external and internal partners (Chesbrough, Vanhaverbeke, and West 2006, p. 1).

Internal knowledge and advice has especially been weighted highly through the paradigm from all parts of the business; from the common coworkers, to the higher ranking workers' ideas. Every part of the business can have potential ideas which can help the further development of a technology, as it is important for the business to acknowledge the fact that every internal worker can have a functioning idea which can further the progress, or bring forth new knowledge of a technology, a product or the business itself (Chesbrough, Vanhaverbeke, and West 2006, p. 2). The idea behind businesses being more aware of the potential outcome, which internal and external knowledge sharing can have on the business in general and its technology production, can all be seen as stepping stones towards the living lab theory.

It is however important to note, that the open innovation paradigm is more applicable in some areas compared to others, but the essence of the paradigm can be used as a theoretical basis for unfolding other, more complicated theories. For instance in this master thesis, the basis of the living lab theory.

5.3 Theoretical aspects surrounding living lab

Living lab as a theory, and how to use the methodology in practise can be difficult to grasp upon, both for researchers and end users. This is mainly because there exists various definitions based on how the given researcher perceives the theory, and also how they expect to use the theory in practise. Furthermore, living lab as a practised method has been used as a buzzword, especially in a marketing context, which furthered the misinterpretations of the theory (Westerlund and Leminen 2018).

Throughout this section a presentation of different definitions will be accounted for, most of them being a part of a literature review made by Claudio Dell'era and Paolo Landoni named: "Living Lab: A Methodology between User-Centred Design and Participatory Design". In this article, Dell'era and Landoni are trying to construct a definition of the living lab theory, based on their own knowledge, while taking the other definitions into account (Dell'Era and Landoni 2014, pp. 137-139).

This master thesis seeks to do what Dell'era and Landoni did, once more, but constructing a deeper insight with focus on developing a working living lab definition, which caters to the theory in a contextualising practise to LLN.

However, before investigating the theory further, it is relevant to look into the basis for the methodology of living lab. This is also where the open innovation paradigm comes to light, which was presented before this section (5.2). As mentioned, the open innovation paradigm could be seen as a stepping stone towards the living lab theory and methodology, where acknowledging of external and internal advise should be taken into account, no matter the position of the employee. This is the tentative beginning for the living lab theories, which build further upon this statement. But the idea of acknowledging internal and external advice and knowledge, are the cornerstone of the living lab theory. This is mainly due to design research moving from a user-centred approach, to a participatory approach. Instead of trying to make something *for* the users, the approach is to make something *with* the users, which fits their profile (Dell'Era and Landoni 2014, p. 140).

As for the living lab methodology, and how we operationalise it, can best be explained by first explaining the position of the living lab as a methodology. This will be done the same way, Dell'era and Landoni did, by using the map of design research methodologies made by Liz Sanders. This map will be clarified, and furthermore will lead to a revised map where the living lab methodology will be included. An explanation and reasoning for the position in the map, will be described based upon what Dell'era and Landoni deduced, while taking our own thoughts and knowledge of the term into account to further expand upon the position.
The unedited map of design research methodologies by Liz Sanders can be seen below:

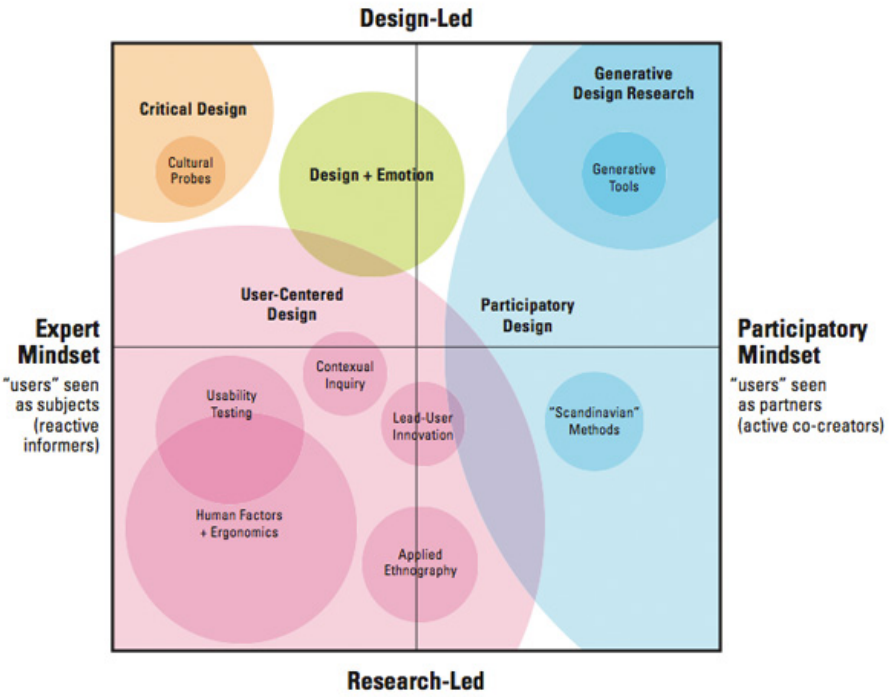

Figure 5.5: Sanders map of design research methodologies
(L. Sanders 2008, p. 14)

The map consists of two intersecting dimensions, the vertical dimension is defined by approach, and the horizontal is defined by mindset. Starting by focusing on the mindset dimension, from the left side, which is from the expert mindset, in which the researchers sees the users as subjects. In other words, they are designing something for the user. Moving further right, on the horizontal dimension, the user will be a larger part of the design process, and the more we move towards the participatory design, the user thoughts will be taken more into account and be seen as partners, where the researchers identifies the users as experts in their rightful domain of experience. Opposed to the Expert Mindset, the researchers are designing something for the users, with the users as partners (L. Sanders 2008, p. 13).
The vertical line in Sanders map of design research methodologies is defined by the researcher's approach underlying the design research.

The map can be linked with the research movement, which the before mentioned open innovation paradigm describes. The paradigm states that the mindset is changing from a user-centered, to a participatory design mindset.

This map showcases the different approaches, design research methodologies, and the researchers mindset behind using the approach. The research-led mindset has been the starting point of the map, and is often used by professions such as; anthropologist, sociologist, engineers among others (L. Sanders 2008, p. 13).

This correlates well with the Living lab, and where Dell'era and Landoni places the living lab in Sanders map of design research methodologies. The edited map with living lab included, can be seen below:

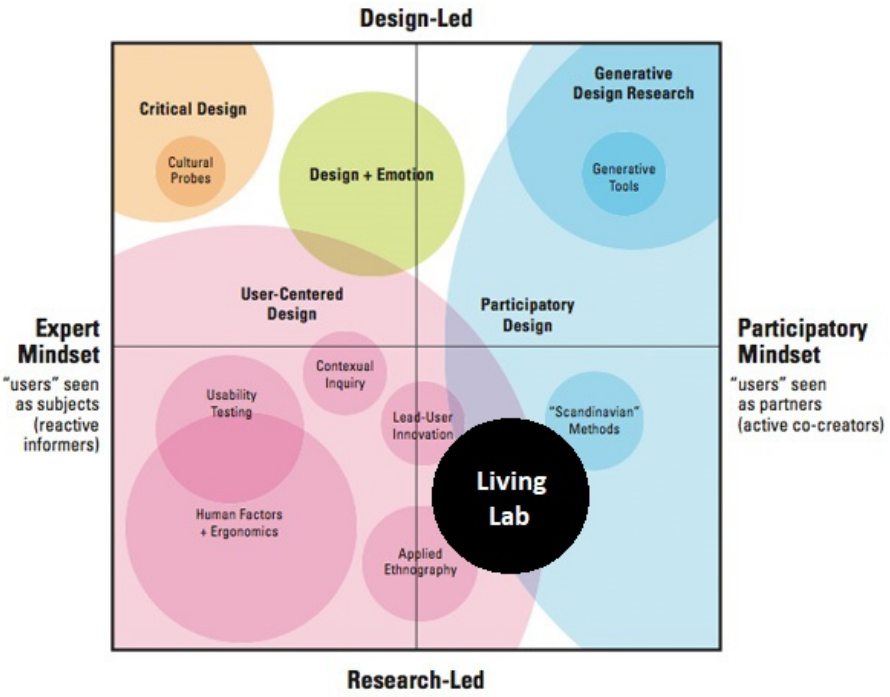

Figure 5.6: Sanders map of design research methodologies, with living lab pinpointed. (Dell'Era and Landoni 2014, p. 148)

The placement of living lab in sanders map of design research methodologies, corresponds with dell'era's definition of the living lab theory, and how we choose to define it in this master thesis. The position of the living lab in the map, is important to note. It is placed in lower right side of the illustration, in the area towards research-led, with a participatory mindset. This means that the chosen *users or informants* are seen as partners of the living lab, but they do not have a say in how the framework of the living lab itself is made. This is something the researchers decide based on their research-led approach. As seen in the revised map, the living lab touches three other methods; "*Lead-user innovation*, *Applied ethnography* and *Scandinavian methods* (Dell'Era and Landoni 2014, p. 148). These methodologies are determined for two reasons, the first being a way to make the living lab more understandable by showing how it has constituent elements from other methods, and secondly because the living lab benefits from embracing multiple methods in itself.

Before we delve further into the living lab theory, the three methods which the living lab is affected by will be unfolded:

Scandinavian Methods is affected by the living lab in the revised map by

Sanders, the reason for this, is mainly due to the inclusion of users, as partners by introducing artefacts, or thinking tools. As sanders put it:

> "*Users in participatory design serve as experts of their experiences, but they must be given appropriate tools for expressing themselves*" (E. Sanders 2006, p. 6)

.
This is an important living lab methodology to state in the context of a theoretical approach as well, in which the users are invited to be a part of the living lab, and giving appropriate tools, or ways of expressing what they feel, and how they picture on the basis of their experience. The tools that the participants would have or be a part of to express themselves could be: Lego Play, workshops, prototyping, presentation or visualisation, to help find solutions to the problem at hand (Dell'Era and Landoni 2014, pp. 147-148). The idea is to give the participants tools to help them express themselves in a common language, to make sure that all the parties of the living lab can understand each other, and express themselves properly, so that all the parties involved are being listened to, and most importantly understood correctly.

This leads towards a specific kind of user, which fits the method **Lead-User Innovation**, that the living lab also has an impact on in the map. Lead-user innovation, could also be seen as expert users. These users, have been a part of, or in the field for a long duration of time, and have hereby developed their own system through their daily use of the product (Dell'Era and Landoni 2014, p. 142), whereas the standard participating user normally have their first encounter with the product during the workshop, or throughout the living lab, and is thus only able to give feedback on the basis of their first impression (Dell'Era and Landoni 2014, p. 142). The lead-user would have been dealing with or meeting the product on a daily basis for a longer period of time. These kinds of users will often have a more practical approach to the product, since they have been dealing with it in their everyday life. This method is a great tool to discover problems with the product before it has been fully developed, and are therefore often used in the early product development (Dell'Era and Landoni 2014, p. 143). Now that the importance of user involvement and innovation has been established, the third point of entry can be clarified.

Applied Ethnography can be interpreted as finding the context, or researching the context. One thing is to learn the ideas and thoughts of the users who use the product, but another important factor is to see the context, how and why the users choose to use the given product as they do, and see under which circumstances it excels and falls short (Dell'Era and Landoni 2014, pp. 139, 147-148).

This is meaningful knowledge that can be used to refine or improve the product, and is also essential in the living lab methodology, where a real life test is required before an actual living lab can be established. Thereby, a factor in this master thesis will be towards a redefinition of the living lab as a theory.

5.4 Participatory Design

To define the use and later on reflect on participatory design in this project, we will elaborate on the text *"Hvad har design med samskabelse at gøre"* written by Thomas Binder and Eva Brandt, published in *"Ledelse og samskabelse i den offentlige sektor"*. The premise for using the text is to define the term of *design*. Binder and Brandt take a step back and elaborate on the general idea of the term *design* as a term of human understanding of a concrete object as "design fashionable". Binder and Brandt reflect on the thoughts of Herbert A. Simon, an American economist, Nobel prize winner and psychologist, who was the first to dig into the general understanding of the term, and make a central thought process of the terminology of design (Fogsgaard and Jongh 2018, p. 334).

Furthermore, their concrete focus is on co-creation between public corporations, institutions and citizens. We have chosen to focus on this text due to Binder and Brandt's casing of the importance of contextualising these issues together with thoughts on private companies influences.

Simon builds his *design thought* through three basic principles, in which every principle supplements the other.

The first principle is the argument that complex human made objectives are obtainable to each by exploring the point where "problem and solution" emerges as one. This is to be comprehended as the work between various mechanisms.

The second principle is about the importance of "trying out". Simon argues that it is important to experiment with different patterns, where this mentioned merger exists, by examining concrete experiments (Fogsgaard and Jongh 2018, p. 335). By researching these experiments in detail, it is possible to determine whether the solutions is acceptable or not.

The third and last principle is whether there is a possibility to determine which solution could be the most beneficial. By Simon's definitions there are no such possibilities. By all means, it is a necessity to state certain criteria in the direction of "at what point are the solutions acceptable" (Fogsgaard and Jongh 2018, p. 335).

Binder and Brandt argues, with emphasis in a sector of public relations, towards citizens and other public instances. By reflecting on Simon's three principles, it is argued how public proposals for design (in any matter) is brought out by dialogue. Through this, finding the perfect design is through a learning basis by *reflecting in action* and afterwards *reflecting over action* (Fogsgaard and Jongh 2018, p. 335). This argumentation and elaboration of the term *design*, is taking into the context of public relations in design, by finding qualified solutions on societal challenges, such as sustainable readjustment in the energy sector.

5.4.1 Who are we designing for?

When Binder and Brandt use the term of co-design it is to be understood in the common understanding of co-operative design, by including the possibility of participants in the design process, who are to be the exact users, which the design process is targeting (Fogsgaard and Jongh 2018, p. 336). Traditionally, designers have been superior in dealing with design, and have designed from their own mindset. Today, more designers are keen to design together with the eventual user, who they are designing for (Fogsgaard and Jongh 2018, p. 336). This is the fundamentals to participatory design, which Binder and Brandt also mentions as the stepping stone for co-creation.

The field of co-creation is by definition interdisciplinary, which ranges from various fields with different agendas towards the design process. In the case of the mini smart grid, and living lab at Knivholt, we acknowledge beforehand, that the different actors who are included in the project, might have different interests to why the smart grid is to be produced.

Various visions on co-designing are presented by Binder and Brandt, starting from American philosopher Donald Cross who in 1971 presented the idea of an ordinary man being able to become a designer of his/hers surroundings, but had to be facilitated by the design professions methods (Fogsgaard and Jongh 2018, p. 337).

In Scandinavia this concept was brought in through the rise of computer technology and automation of the labour market, as also mentioned in Sanders map of design seen here: (5.3). In this case scientists and designers wanted to set a new main focus towards technology development, and bring the user into the centre of designing. Of course the aim of development, in this case was targeting the actual user of new data bases, new technology and the like.

At the same time as Cross presented his idea, an Austrian-American designer Victor Papanek, presented his vision of *design for the real world* (Fogsgaard and Jongh 2018, p. 337). This vision has its basis in anthropological perspectives of research, implicating that creativity was found in the *everyday culture*. The point that Papanek propounds, is further elaborated on by John Thackara, who aims towards the designers, as needed to comprehend the necessity of designing in a modern and diverse world without concrete order (Fogsgaard and Jongh 2018, p. 337). This means that the developer or designer are not needed to invent "the new thing", but through gathering experience and curiousness on already known factors (e.g. technology), it is possible to mould together a more useful "piece" of technology (Fogsgaard and Jongh 2018, p. 337).

These statements are all connected by the shared points of creativity towards a more diverse designing term, that has established the mindset of co-creation and participatory design.

5.4.2 Premise of practising workshop

Elaborating upon the term of participatory design, Binder and Brandt reflects on workshops used in a practical example, for elderly citizens to get a grip in the resolutions towards concepts of socialising elder citizens. The project was called *SeniorInteraktion* (Fogsgaard and Jongh 2018, p. 347).

Starting up the workshop, the premise is to enlist various partners within the preferred area of research, whether its the actual consumer, other research interests or actors on an administration level, everyone who can be connected are interesting (Fogsgaard and Jongh 2018, p. 348). Furthermore, it is important from this going on, that every actor is capable of communicating with each other, despite the actors stake in the research.

Where we see workshops as a fulfilment towards the participatory design, and therefore in the living lab experience, as Brandt and Binder states in their example of workshop in practise:

> *We wanted to take a step further from proposals towards the establishment of new everyday practises, by tentatively establishing some of the platforms, which could support new communities* (Fogsgaard and Jongh 2018, p. 350).

This quote is concerning Brandt and Binders take on workshops in practise, by looking into the premise of living labs. They practise this by inviting some of the senior citizens to test the municipal, physical activity offer, where a mobile app made it easier to be connected, and to get an overview of activity offers everyday, to make meet-ups more straightforward (Fogsgaard and Jongh 2018, p. 350).

The project showed that the senior citizens had other demands for physical activities. For the majority of participating citizens the essential demand was the social aspect of having company in their daily life, but that meeting over physical activities in every aspect was favourable (Fogsgaard and Jongh 2018, p. 350). Therefore, as a sub-conclusion they discovered that, the municipality in their point of focus, did not meet the actual demand from the senior citizens.

These aspects, even though they are stated in a practical view, can be elaborated on later, as being key perspectives towards authorising a workshop with all the included actors in LLN. By stating all the involved actors, every partner's perspectives will be stated in a mutual workshop, where ideas can be adjusted by other perspectives on the same idea.

5.5 Implementation of theory

The Technology Acceptance Model and participatory design, can be seen as a relevant framework for the living lab. During the living lab section in this chapter, it is visible that both the idea of participatory design is a large part of the living lab theory, and the notion of the Technology Acceptance Model can also indirectly be seen as a part of the living lab theory. This is what we use to create the theoretical frame work and clarification of the concepts throughout this

master thesis. TAM focuses on the product/technology and how the technology will be accepted in different aspects by the most desirable user, while also accounting for the enablers and inhibitors of the product and how to anticipate the outcome. The model can be used to support the living lab by clarifying the motives of the actors in the field that the living lab is to be a part of.
The participatory design can be used as a supporting theory of the methodology, and how to implement a living lab in practise, where co-creation and user-centred design is paramount.

Now that the used theories in this thesis have been accounted for, a further investigation of the theory surrounding the living lab, is to come. This chapter will revolve around different theoretical aspects, while also explaining what this thesis seeks to clarify in regards to the living lab theory.

6 | Understanding Living Lab

This chapter is a continuation of theory, and will be constructed towards pointing out various elaborations of different definitions of the term living lab. Therefore, it is related to the living lab theory accounted for in the theory chapter (5.3). The chapter should be understood as a clarification of concepts, which will not conclude upon the concept of living lab, but open up for possible clarifications. The group has researched different theories concerning living lab extending from empirical studies involving end-users to internal workshops being considered as living labs within an organisation.

By researching different concepts of the living lab-theory, it will be easier to underline methods that are being used consecutively throughout each of the theories while also being able to cut away the niche parts of the theories.

The goal is to present an easy to understand model of the living lab, that can be used in practice such as a workshop combined with proper theoretical evidence to back up the practical model.

The first Living Lab-theory the group has analysed is "Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs" by Mika Westerlund and Seppo Leminen (Westerlund and Leminen 2018).

Westerlund and Leminen argues, that a living lab provides a practical setting unlike different open collaborative and open innovation as they are usually a brainstorm or a potential prototype project, whereas the living lab needs participants to function as expected (Westerlund and Leminen 2018, p. 21).

The participants are to have the same *mindset* or goal in mind. A living lab's core activities, according to Westerlund and Leminen, are;

1. **Co-creation:** Co-design between the end-users and the producers of said product or technology
2. **Exploration:** Discovering usage behaviours and potential pitfalls of the system
3. **Experimentation:** Implementing new actions towards helping the end-users achieve better results using the product or to understand it better
4. **Evaluation:** Evaluating the process as a whole and assessing the results to learn from possible mistakes and not repeating them in future projects.

Westerlund and Lenminen's description of "Co-Creation" is

> *"co-design by users and producers; utilizers and* ***enablers*** *are also involved" (Westerlund and Leminen 2018, p. 21)*

Enablers are something the TAM2 takes into consideration when implementing a new system. According to Westerlund and Lenminen these *enablers* are important to facilitate a proper living lab as they are a "*platform that bring together all the relevant parties for innovation and co-creation*" (Westerlund and Leminen 2018, p. 21). The utilizer, which the TAM2 does not take into account, is a non-producer working towards gaining efficiency and making sure, that everything is running as it should (5.1). The utilizer could also be described as being a facilitator between the entities involved in the living lab.

Westerlund and Lenminen has made a model describing the process of a living lab from planning phase to full execution. It is shown here:

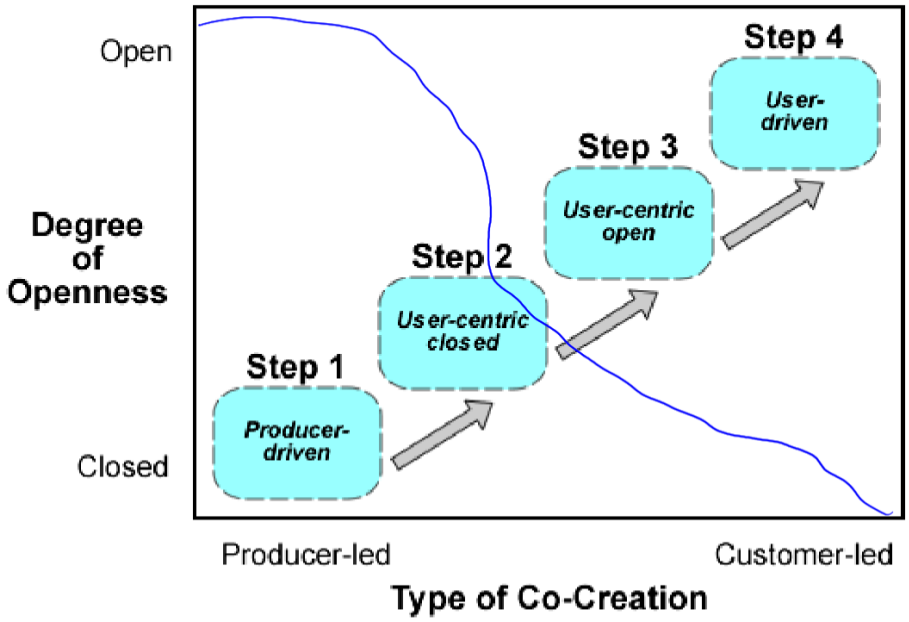

Figure 6.1: "Type of Co-Creation" (Westerlund and Leminen 2018, p. 22)

The Y-axis on the figure ranges from "closed" to "open". The range defines the system's openness to including different third parties. The more closed the system is, the less likely it is for actors to be included in the process after the fact. Whereas a more open system would be open to bringing in more actors, if they show interest in the system.

The X-axis describes the distribution of the responsibility ranging from "producer-led" to "customer-led". The customers are, in most cases, the users to be, whereas the producers are the developers of the project.

The main goal is to produce a working, closed system, that works as intended

and then "give the reins" to the end-users in a more user-centric system, where the users can have an influence on the end product (Westerlund and Leminen 2018, p. 22). When the system reaches step 3, the system itself is mostly done. The goal from then on is to produce results.

Looking at Westerlund and Leminen's co-creation model and comparing it to the Software Development Process, that was elaborated upon earlier in the theory-section (5.4) is very different from the model pictured above, however. The SDP-model is pictured below:

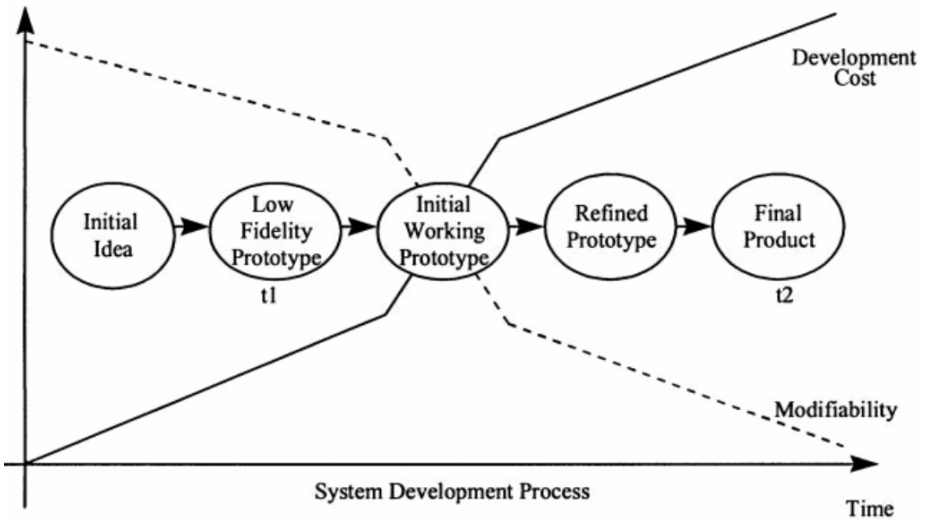

Figure 6.2: The Software Development Process developed by Davis and Venkatesh (Davis and Venkatesh 2004, p. 33).

Unlike the above model model, the X-axis on the SDP-model is based on time rather than responsibility and the Y-axis is focused on cost and modifiability. The SDP-model was to be seen as a point-of-no-return in software development, where the possible changes to a working prototype would be limited due to it being either time consuming, very costly or both. The working prototype is to be as close to a working product as possible (Davis and Venkatesh 2004, p. 34). According to Davis and Venkatesh, the initial working prototype is at the half way point towards a finished working product, whereas Westerlund and Leminen argues, that users will have to be involved in creating a system leading to a more complex system than the SDP if it was to be implemented. Having a working prototype after step 2 in Westerlund and Leminen's model would severely harm the potential of a user-centric and user-driven approach as the product, at least if it is software, is going to be costly to modify if the end-users are not remotely satisfied with the product presented.

The co-creation model could be implemented as a preliminary measure within the SDP-model as a step after the Initial Idea. In collaboration with the producers of the system, the users could provide feedback to the first prototypes concluding into a Low Fidelity Prototype, the producers could work on, leading

to the final prototype and, in turn, the final product.

As seen throughout this chapter, many living lab researchers have made their own definition of the living lab theory based on literature reviews of the existing living lab theories. This seems to be a never-ending cycle. However, Pieter Ballon and Dimitri Schuurman have made a literature review on the living lab theory with another goal in mind. Their aim for this journal is to emphasise the different ways of understanding a living lab, while also focusing on the insufficient research of living labs in practise, and hereby the gap between theoretical and methodological aspects of the living lab that still exists. The journal is called: "Living labs: concepts, tools and cases" the editorial is by Pieter Ballon and Dimitri Schuurman (Ballon and Schuurman 2015, p. 1).

Ballon and Schuurman open up by mentioning the gap between the theoretical and methodological parts of the living lab theory, and touches upon the effects of a literature review in a theoretical perspective. However, they are also mentioning the importance these literature reviews had in the beginning, by rethinking the theoretical aspects of the living lab theory. It was because of these, that some aspects of the living lab theory became cornerstones. This includes the focus on the lead-users by moving towards a user-driven innovation, the experimenting between users and the technology as a way of seeing the technology being used in a daily routine. There is also the spontaneous emergence of innovations, and lastly the literature on open and business model innovation (Ballon and Schuurman 2015, p. 1). Because of where the living lab theory currently is, Ballon and Schuurman argue that a focus on the methodological parts of the living lab should be prioritised and on how a living lab functions in practise (Ballon and Schuurman 2015, p. 1).

However, before Ballon and Schuurman delve into the methodological aspects, they mentions different theoretical approaches, and their definition of the living lab theory to emphasise their opening statement. Ballon and Schuurman review a couple of living lab definitions through time. During these reviews, a pattern is showing. In the beginning there are different definitions focused on the living aspect of the living lab, where a research in an open "lab", eg. gathering data in a shopping center, is defined as a living lab. While in the latest definition the open aspect still has some presence, but not as much. However, it is more seen as the research being performed in the real life context of the researched topic (Ballon and Schuurman 2015, pp. 1-2). If the objective of the living lab is to research, and find better ways to make sure that pupils will not be late for the first class, then the living lab would be conducted in the school's area, and looking into the transport possibilities, the area around the school and many more aspects, but the important factor, being able to conduct the living lab in the area of the research; the element of the research which involves the living.

Another aspect of the definitions of living lab through time, which Ballon and Schuurman also have noted, the involvement of the users. This has become a very important factor of the living lab theory, it has moved from designing *to* the users, to designing *with* the users. Where especially the Scandinavian methods have been a primary influence of the change in definition of user involvement (Ballon and Schuurman 2015, pp. 3-4).

However, as Ballon and Schuurman remarks, even though that the definition of the living lab theory is moving towards a standstill, there is still a long way to go before a common identical understanding of the living lab can be made. This is mainly because of the gap between a theoretical and a methodological definition, or how a living lab actually will be conducted in practise (Ballon and Schuurman 2015, pp. 1-2,5).

There exists some practical examples of the living lab as a method. Ballon and Schuurman have two examples. Furthermore, these two examples are also a way of seeing how the practical interpretation of the living lab has been conducted based on different definitions.

In 2006 MIT created a 1000 square foot "living laboratory", which consisted of facilities of a regular home, where users were observed in while they used products/technologies. These observations were then tracked and recorded. This was a way to research peoples habits, in regards to different devices. Another example of a living lab in practise, is the European Network of Living Labs (ENoLL), in which their practise of living lab involves studying the user in his or her everyday habitat, instead of recreating a home in a laboratory setting, they are bringing the research and testing to the users home turf (Ballon and Schuurman 2015, pp. 5-6).

These arguments and presentation of literature, that Ballon and Schuurman presented through this journal, shed some light on the living lab issues, including the different definitions and practical views of living lab, and also especially the gap between the theoretical and methodological aspects of the living lab.

6.1 Living lab as a method

The above mentioned literature has a very theoretical approach, and a lack of a practical focus when it comes to the living Lab, but as this thesis is based on a practical living lab in Living Lab Nordjylland, it makes sense to research the living lab as a method as well. Therefore we are analysing two different approaches to the living lab as a method. One is a methodological approach to living labs as a general term and the other one is an action research study of an urban living lab in Melbourne, Australia.

By looking at the living lab as both a theory *and* as a method, we will be able to make a better, more condensed approach to a living lab in practice.

Livewell Yarra was a living lab outside of Melbourne, Australia aiming to reduce the of carbon dioxide emissions in common homes owned by the participating actors.

The living lab methods used in the lab was primarily action research, asset-based community development and participatory co-design as well as change research (Sharp and Salter 2017, p. 1).

During the research on the living lab, Schliwa et al. developed a threefold typology concerning the impacts within a living lab;

- **Direct impact** which is the direct impacts the actors face having lived in the living lab. These impacts can be measured in an economical, ecological or user-perspective change.
- **Indirect impacts** are a potential follow up activities such as the exchange of knowledge or other policy reforms made by a regional or governmental actor following the results from the living lab.
- **Diffuse impacts** are changes in normative values, which may only come to light following an evaluation of the project and can be used as a preliminary effort in future projects (Sharp and Salter 2017, p. 2).

These impacts can both be used to further adjust the measures within the living lab to work better as well as a "do's and don'ts" going forward.

To get the actors involved in the project, they used frontrunners to:

> "*Transition management has developed a reflexsive cycle to mobilise actors known as change-agents through transition arenas for experimentation and "learning by doing"*" (Sharp and Salter 2017, p. 3)

This approach correlates well with the Technology Acceptance Model, where the perceived usefulness of a product or technology is directly affected by third parties such as super users or "frontrunners" being able to teach and advocate the system.

According to Sharp and Salter, bringing in end-users to develop a system is a relatively new aspect of user-minded projects in a field, that has primarily been dominated by an analytical approach to the field instead of an action focus including all actors of the project on even grounds (Sharp and Salter 2017, p. 5).

The living lab was conducted in an open manner, where every actor was able to influence the project in their own way by providing feedback all throughout. These actors included everyone from the end-users to the project managers and researchers attached to the project (Sharp and Salter 2017, p. 13).

In conclusion, having both the theoretical framework as well as the practical aspect of a living lab makes for a better understanding of the research design as a whole. The focus is not on the analytical aspect of a living lab and may not be seen as way of evaluating the work, as well as not being focused on the practical aspects of the living lab itself. Looking at both the theoretical framework as well as the practical framework makes for a more complete understanding of the term living lab and will make it easier to alter the term into a more condensed, easy to understand term. This work will be presented in the analysis (8).

Before opening the analysis a presentation of the methodological approach used to gather the empirical data throughout this master thesis, will be elaborated on.

7 | Methods

This chapter will account for the qualitative methods that have been used through the data gathering and processing, surrounding this master thesis, by starting off by accounting for the stand-point of using techno-anthropological competences in the field. Furthermore we will cover the use of semi structured interviews combined with expert interviews.

The foundation for the data gathering is through interviewing the various actors involved in the Living Lab Nordjylland project. As mentioned we want to understand the motivational factors and understandings of the process from all of the actors, going into such a project, by interviewing experts as we see every representative from the respective institutions.

Combined with the interviews, we will also elaborate on our existing knowledge on the facilities surrounding Knivholt Hovedgaard, as being the headquarter for Energibyen, and the place where the living lab will be set up, as mentioned in the fieldwork chapter 4.2.

7.1 Interviews

The data gathering has mainly been consisting of interviews due to the general plan for this thesis, trying to combine perspectives from the various actors involved in Living Lab Nordjylland.

The basis of data collecting through qualitative interviews is the researchers intend of explaining and understanding real life scenarios on the basis of the actors point of view (Kvale 2015, p. 19). This thesis wishes to get a grip on factual answers about the actors history and general work in their respective organisations to understand their work in LLN, and their motivation for agreeing to the project. Together with the factual objective, we are keen to get a clarification of concepts from the interviewees in the understanding of living labs.

As mentioned we are interested in the actors understandings of the lliving lab term, to the extend of how their knowledge of the term has been developed, and whether or not there is a divergence in the different understandings or we can draw similarities between them. To clarify this we ask questions where we try to cover their general description of the term living lab.

The clarification of the term living lab has just been accounted for, but we also want to dig into the actors factual descriptions of their daily affairs in their respective occupations. These understandings will be gathered through interviews with the actors.

7.1.1 Methodological thematization

The premise for the thematizing is a clarification of the purpose of the research, by reasoning the formulation of the interview questions through a theoretical clarification (Kvale 2015, p. 157). Before the researcher is to enter the interview phase, there is a significance in asking *"why, what and how"*.

Starting of by asking *why* is important as researchers, qua the various possible purposes with a study. As it has been stated in the problem analysis (2) we wish to acquire knowledge on the informants/partners experiences and knowledge on living lab, together with their motivation for cooperating in LLN (Kvale 2015, p. 158). The interviews will primarily be from a descriptive perspective, to map out the informants aspects on the case, for us to develop upon the theoretical living lab framework. This leads to the *what* problem in setting up the basis for an interview. The *what* is a predetermined involvement of knowledge, which the researcher obtains to develop a theoretical understanding of the phenomenons that are being studied (Kvale 2015, p. 159).

Throughout this thesis' state of the art chapter (3) we have obtained knowledge on different perspectives of innovation towards an outcome, in who is the main characters to take the steps in innovating for a purpose. Together with that, we have been looking into different "labs" around Denmark, with the purpose of testing new smart solutions in technologies or infrastructure. Lastly the explanation of our predetermined understanding of the living lab term, and a discussion on how there are various definitions with the same premise (3).

In addition to the state of the art, an explanation on our previous work at Energibyen has been presented. This work gave us a view of the location, set for the LLN project to be established. This gives us as researchers, an understanding for the sphere that the project partners, and the project in general is going to interact in.

These thoughts have been the premises of constructing the interview guide which is constant in interviewing all the informants.

7.1.2 Expert interviews

All the interviews have been with key personnel in every institution who has been listed as partners in LLN. This correlates with the premise of expert interviews, which Steinar Kvale and Svend Brinkmann describes as being interviews with individuals who are seen as leaders or experts, who usually holds powerful professional positions (Kvale 2015, p. 201). This subsection will contain formation of opinions towards interviewing key expert within the field of interest, opinions towards what barriers the researcher has the possibility of encountering going through the phase of collecting data.

Stepping into an interview with expert personnel, the researcher has to consider possible complications towards validating the data being collected. There is a possibility of an imbalance of authority between the researcher and the interviewee, therefore getting access to the interview can be difficult (Kvale 2015, p. 201). Having this in mind we see ourselves acting in an exact field of interest where every actor, as mentioned, is an expert within their own field.

As the elite interviewee usually is in a powerful position whether it is business or academia, the interviewee is likely to be an usual person of interest in consulting upon their specialised occupation. Therefore, the expert will usually be a veteran in being interviewed, and stating their thoughts and opinions (Kvale 2015, p. 201).

Expert interviews, have been our primary interview form. They possessed an upper position in their firm, and are experts in their field, which is why they also are a part of the project. During the interviews it was apparent, that they were used to interviews. Every actor started off with explaining what sort of business they were, and what they have been working on, along with why they chose to be a part of the project. They answered some of our questions and wonderings, before we had the chance to ask, which also meant that the interviews did not last much longer than 40 minutes.

7.1.3 Semi structured interview

In this thesis the semi structured interview form has been chosen because we did not want a complete structured interview, to better involve the informants in the process, and gather their elaborated perspectives on the subject, as data material (Kvale 2015, p. 177).

Making a transcript or interview guide of interview questions is still a part of the semi structured interview. Anyway, the interview guide is understood as a guideline to contain a lot of information from the informant, and still keeping it relevant by directing the informant inside the lines of the interview questions. On the other side, through the semi structured methodology of interviewing, we as researchers wanted to examine the informants own dispositions to form their own answers through dialogue.

The basis of semi structured interviews are that various interviews under the same guideline is comparable to each other. This happens because of the standardised interview guide, which in contrast to the last statement, also makes it possible for the informant to reflect around the questions, and talk openly (Riis 2005, p. 104).

Hereby, it becomes relevant to look into how we carried out our semi structured interviews and the aspects of on constructing an interview on the premise of dialogue.

7.1.4 Dialogue

We as techno-anthropologist seek to understand not only the different fields, but also the thought process of the actors, who are a part of LLN. This process of *understanding* can be difficult to reach through a standard interview method using semi structured interviews. This is why we chose to expand on our methodological use, and implement the use of dialogue as a primary part of the interviews to support our semi structured interviews (Nørreklit, Prangsgaard, and Pedersen 1983, p. 16).

A dialogue is a dialectic process between two or more persons of conversation. During an interview as a dialogue the interview is a dynamic process between by both parties, as both the researcher and interviewee asks questions and answers. During an interview, the researcher is asking questions and the actor is a source of information (Nørreklit, Prangsgaard, and Pedersen 1983, p. 16). A dialogue is a process of reflection, and an exchange of reality perceptions are happening during the dialogue, in hope that their own reality perception can further be developed. The purpose of the dialogue is not to choose a winner, or favouring one of the parties (Nørreklit, Prangsgaard, and Pedersen 1983, p. 17).

The purpose is for the two parties to help each other to understand the reality better, and exchange knowledge within the field of interest.

Throughout the dialogue, the researcher will test their understanding of the actor's language with recurring questions, where the observer seeks to correctly understand the actor's way of thinking. By doing this, a bridge is being build between the interviewer and the actor during the interview (Nørreklit, Prangsgaard, and Pedersen 1983, pp. 17-18).

As the researcher it is important to be linguistically open, and quickly identify and use the language, that the actor uses by being an observer. However, the observer must maintain some of his own linguistic identity (Nørreklit, Prangsgaard, and Pedersen 1983, p. 17).

The observer will test his understanding of the actor's language, by asking either directly, or indirectly if he has understood it correctly. During this, he is using the actor's language, but at the same time also upholding it towards his own understanding and use of language, to make sure he has understood it correctly. By doing this the observer is able to use the actor's language, while keeping his own linguistic identity throughout the exchange (Nørreklit, Prangsgaard, and Pedersen 1983, p. 17).

We test these different angles of interviews, from a dialogue perspective by using the semi structured framework to guide the interview in the desired direction. Though, we still want to have an open discussion surrounding the interview guideline, where, as mentioned, the researcher, just like the interviewee, is permitted to ask and answer questions from each other, because we want to share experiences and knowledge.

With this in mind, we as researchers are of course not interested in influencing

the interviewee in their answers, therefore we are aware about having to take a step back in the most important discussions.

The semi structured interview style and dialogue is combined in this project. The aim for the semi structured interview style is to transform the interview into an ongoing dialogue, where both parties of the interview participate equally, and it moves away from the structured interview style. During our interviews, we were aware of the pitfalls, and made sure to avoid the structured issue, by conducting the interview more as an open dialogue, than a concrete interview.

Now that the methodology behind our data gathering has been established, it is relevant to touch upon the ethical considerations during the interviews.

7.1.5 Ethical considerations

In this section a discussion on the ethical considerations that have been reflected upon throughout the data gathering, will be presented. It will contain the aspects of anonymity and what kind of ethical issues, we as researchers faced.

In this thesis we have chosen to anonymise all the informants, due to their detailed statements, on a project that has yet to be begin on the other side of the application process. Starting every interview, we are stating that the informant is going to be anonymised. The intention of anonymising the informants is to get the general impression of their thoughts and intentions towards the LLN, and therefore the informants do not have to consider their statements vulnerability (Kvale 2015, p. 106).

This thesis is not based on sensitive personal data and therefore, we have not been obligated to put substantial resources into not asking private questions. We are starting every interview by asking about the background of the informant, but these answers are not decisive to the analysis. Of course we can interpret the answers of understanding the living lab premise, different or heightened focus according to the informants educational factors or previous occupation.

Now that the ethical considerations of this master thesis have been established, we will explain the terminology of the participants in LLN and conceptualise the actor term which the participants are called throughout in the project.

7.1.6 Actor framework

Humans are called actors, because they create the subjective reality. Humans do not meet a nature created reality, but a human created reality. This is called *The Actor perspective*(Nørreklit, Prangsgaard, and Pedersen 1983, p. 2)

The reality can not be interpreted freely. It is created by other humans, with their interpretations of how a human lives best in the given world. We as humans are designed to acknowledge/interpret and reproduce/develop unlimited diverse realities. We are however, educated to function in the reality which surrounds us. Human beings are a being of society, in other words, its essence is characterised by the society, that surrounds it (Nørreklit, Prangsgaard, and

Pedersen 1983, p. 2).

An actor's actions is based on the actor's motives. These originate from the actor's pre-understanding. The pre-understanding of a given action is that part of an actor's perception of reality, is relevant for the action in question. But the motive, and hereby the understanding, presuppose the actor's perception of the reality, the action relates to. In order for the actor to understand his actions, they must stem from his perception of the context (Nørreklit, Prangsgaard, and Pedersen 1983, pp. 5-6).

When an action has been conducted, an after-understanding takes place, often in the form of a subsequent rationalisation, where the action is evaluated based on the new experienced learned from the action (Nørreklit, Prangsgaard, and Pedersen 1983, p. 6).

Actors and social constructions are created through a creative process, in which the involved actors have thought out new ideas and solutions. However, a researcher can reach a certain level of understanding of the actors based social constructions through general theories. Because of this kind of actor methodology, it is important for us as researchers to understand the actors subjective understandings of reality. This is not something which can be deduced from theories or pre-understandings.The reality must show itself for the observer/researcher (Nørreklit, Prangsgaard, and Pedersen 1983, pp. 12-13). This could for example be done by conducting expert interviews (7.1.2) of the involved actors, before they initiate in the objective together, as a way to understand each actors pre-understanding, and motivation.

Actors are a key part of a living lab, whether it is the municipality, businesses or citizens/end users, every actor is essential for the living lab to be conducted. Which is why this project focuses that much on the term actors, and aim to describe every actor, their role and their motivation of the project.

These thoughts will be used in this master thesis to conceptualise the actor term, and how the term of actors have been used throughout the project which will be evident in the upcoming analysis (8). Now that the reasoning for describing the participants in this projects as actors has been established, a closer look into how the interviews were conducted will be presented.

7.2 Interview guide

Interviewing the participants in The Living Lab was mainly done in person and at their place of work or their other preference. We were to get information from these informants and wanted to intervene the least amount as possible during the empiric analysis.

To make sure we got the answers we wanted from each of the informants, we produced an interview guide to work as an instruction for the interview and to make sure, that we got answers to the same questions from each of our informants. The interview guide can be found below.

Grundlæggende spørgsmål		- Fortæl lidt om dig/jer selv
		  - Uddannelse?
		  - Stilling?
		- Hvad arbejder jeres virksomhed/afdeling med?
		- Hvordan var virksomheden indgangsvinkel til Living Lab Nordjylland?

Teori	Tema	Spørgsmål

Living Lab Theory
Participatory design
	Kendskab til Living lab
	&
	Motivation til projektet
		- Hvordan forstår/fortolker du Living Lab princippet?
		- Hvad har motiveret jer til at deltage/være kommende deltager i LLN?
		- Hvad er jeres interesse i projektet?
		  - Hvad er jeres mål for projektet?
		  - kan i nævne nogle nye aspekter i dette projekt, som i ikke har set/afprøvet før?
		  - Problematikker i kunne se der kunne være på nuværende tidspunkt?

Technology acceptance
Participatory design
	Slutbruger	- Ser i nogle problematikker i forhold til end-user (forbruger)?
		  - Rekruttering
		  - Indsamling af data
		  - Samlede salgsløsninger
		  - Forståelse af produktet
		
		- Indenfor dette felt, hvem synes i der skal tage de første skridt?
		  - Forbrugerne? (Begrund)
		  - Virksomhederne? (begrund)
		  - Offentlige instanser? (begrund)
		  - Eller skal der efterstræbes et sammenspil mellem alle 3 aktører?

State of the art	Erfaringer indenfor andre projekter	- Har i forsøgt jer med andre projekter lignende dette? (måder at inddrage forbrugerne på)
		  - Har living lab været en da af forhenværende projekter?
		  - Hvilke problematikker har i mødt?
		-

We divided the interview guide into three different main aspects; theory (teori), theme (tema) and questions (spørgsmål). On top of the three themes, we asked the informants to present themselves first, to get a better understanding of what they do and what position they are in. We asked this question following our own presentation of Techno-Anthropology, our goal with this thesis and a short introduction to each of us.

The interview was setup as a semi-structured interview, with the possibility of having an open dialogue, which has been elaborated upon here (7.1). We did this to make the interview open to potential subjects of interest, if our informants were to dive into it. We did not intervene, if the informants were diving into something, that was not highlighted in the interview guide, but used the guide as a reminder of what to remember. By having the different actors answering the same questions, we hoped to quantify the answers into possible problems and understandings of a living lab.

7.2.1 Interview in practice

Our first question after the basic presentation of the informants was to ask, why they were participating in the living lab. The next questions focused on the living lab as a practical effort as well as potential goals for the project, but diving into the reasoning for participating in the living lab usually led to the informants answering many of the questions. Informants would elaborate upon their interests in the project as well as potential gains from the project differing from going from theory to practice. For example one of the informants described the LLN as a:

> "*How do you understand/interpret the living lab principle?*" (13)

This question is an example of the interview guide leading to an open discussion on the basis of the informants perception of the living lab term. We sought through dialogue to open up for the possibility of various or a continually interpretation of the answers. It could be considered whether this question was too open, and they interpreted the question differently, which became apparent in their answers.

> *"What is your interest in the project?* (13).

This question is thought as a way to establish, what their interest in the project were, combined with reaching a further understanding of the actors underlying work in their respective institutions, while also getting closer to an understanding of how they interpreted their role in the project.

We chose not to supply the actors with the interview guide even though it might have been beneficial as they would be able to prepare considered answers. This could however also prove to affect their bias. This point has been reflected on in the expert interview section, which is the main reason why we did not choose to supply the actors with an interview guide (7.1.2).

7.2.2 Conspectus of opinions

We have chosen not to directly transcribe the interviews in this project, but have instead opted to create a "meningskondensering". The goal of a meningskondensering is to create a sheet or formula, wherein the actor's answers are highlighted and supplemented with a quote from the recorded interview. This makes the written portion of the work with the interview more of a work of reference rather than a transcription of the whole interview.

The condensation is divided into two main focus points. The first one is a description of the actor, their profile and a quick resumé of their insights into the project as well some field observations looking into the actor's body language, where the interview took place, how they acted throughout the interview and such.

The second focus point of the meningskondensering is to divide specific quotes said by the actor into different themes regarding the living lab and the project.

The themes are pictured below.

Theme 1	**Theme 2**	**Theme 3**
Living Lab Theory & Participatory Design Knowledge of Living Labs & Motivation for the project	State of the art Experience from other projects	Technology Acceptance Model & Participatory Design End users

The given actor's quotes that fit under the categories and act as answers to our questions in the interview guide will then be written beneath the given theme. By doing this, we can use the condensation as a direct work of reference, as has been described previously. All of the condensations will be in the appendix-section, but we will dive into one of the condensations in this section to get a proper understanding of the method.

Living Lab	**State of the Art**	**TAM**
"Jeg spekulerede i, hvorfor det ikke var Frederikshavns Elforsyning, de kontaktede. Men det foregik på Knivholt, som er vores område."	*"Kombinationen af varmepumper og solceller har vi set flere steder, så vi har lignende projekter. Vi har dog ikke batterier."*	*"Vi kan se, at vi bevæger os imod flere varmepumper elbiler osv."*
"...Det er målerdata, vi skal levere. Så man kan se Hvordan dataen hænger sammen"	*"Vi har lavet flere pilotprojekter med Kamstrup."*	*"Planlægning med elbiler er svært at forudse. Vi ved ikke, om man lader hjemme eller ude."*
"Det er interessant for os at se, hvordan det påvirker elnettet med et smart grid."	*"Vi bliver benchmarket op imod hinanden [Kamstrup og Nord Energi red.] men vi ser hinanden som kolleger."*	*"Hvad er det Living Labet kommer til at vise? Kan det bruges på bredere sigt?"*
"På en gennemsnitlig villavej, er der plads til 0,3 elbil mellem 17 og 20."		*"Det ville ikke være netselskabet, der skal tage ansvar for udvikling af et smart grid. Vi udvikler bare."*
"Vi forstår Living Lab som at være et samspil mellem energisystemer, og så ser vi, hvordan det påvirker systemet som helhed."		
"I stedet for at vi bare sidder og kigger på simuleringer, får vi prøvet det i virkeligheden."		
"Der har ikke været problemer eller overraskelser endnu. Projektet er ikke nået langt nok."		

The answers received from the informant were then categorised into the aforementioned categories underlining different problems or experiences regarding the questions from the interview guide (7.2). We will be using the condensations as a starting point for the analysis. It is important to note, while we have used Danish in the interview guide and meningskondensering, the quotes will be translated into English in the analysis.

Now that the theoretical and the methodological framework of this master thesis has been established, we will continue by analysing our empirical findings.

8 | Analysis

In the analysis-chapter we seek to answer our problem statement through an analysis of the empirical data gathered throughout the fieldwork. By implementing both the theories mentioned as well as the methods used, we aim to condense the living lab framework into an easy to understand way of working.

8.1 Strategy of analysis

The analysis will be divided into two parts. The first part aims to dissect living lab as a theory, based on the theoretical basis of this master thesis, concerning the Scandinavian methods as well as Sanders map of design research methodologies. This will, combined with the empirical findings be analysed in an effort to redefine the living lab in practise, by the use of a more versatile definition. Furthermore, a walk through of the Technology Acceptance Model (TAM) will be covered, enabling all the actors statements towards knowledge of living lab and motivation for the project into the model, where TAM will be seen as an analytic method that compliments the living lab methodologies. This definition will be focusing on the practical use of living lab, while aiming to remove the living lab as a buzzword, and becoming a definite terminology, that makes it easier to comprehend and use in the practise of Living Lab Nordjylland.

The second part of the analysis will focus on Living Lab Nordjylland as a case. During this part, the new redefinition of living lab in practise, complimented by the empirical findings will be used to evaluate, and analyse what could be improved, either in practise, or to increase the possibility of a future EUDP application to be approved.

8.2 Condensing the living lab

The first theory presented in the rapport is "Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs by Westerlund and Leminen (Westerlund and Leminen 2018). The main argument presented throughout the literature is, that the living lab presents a more practical way of working on a project. Instead of having the different actors sit down and brainstorm a potential business case, the living lab needs active participants in the project to work as expected. Without participants in the project in practice, there is no living lab.

On top of actively including the relevant participants in the project, the participants are to have the same worldview or *mindset* working on the project to establish a proper living lab. If every actors idea of a potential result of the living lab is different, it fails to meet the core expectations of a living lab. These expectations have been elaborated upon before, but are relevant in the sense of a redefinition of a living lab, as the idea of co-creation in particular has been underlined by each piece of literature. The other core aspects, according to Westerlund and Leminen are;

- Exploration
- Experimentation
- Evaluation

A part from co-creation and co-design, Exploration and continuous updating of the living lab as follow-ups to potential errors or missing focus points of the lab is important, as the living lab is supposed to be an iterative process. The exploration aspect leads well into the evaluation process, which could be in the form of a report highlighting the good and bad things mentioned during the project. By having such a report, there is a higher chance of not running into the same problems as previous projects.

The important aspects to take away from Westerlund and Leminen's living lab theory are primarily revolved around the practicality of a living lab. Unlike other literature analysed throughout this project, Westerlund and Leminen's article is not based on an actual living lab, but is to provide guidance to future projects based on experience gathered from previous projects presented as possible living labs, if they were to be made again.

Therefore, it is very important to not see it as a one size fits all solution, as the project is entirely based on "could be's" and can be seen as a Utopian solution to a practical problem. If everything is to go as the authors prescribe, then the living lab might work out as intended, but it is not necessarily given, as it has not been tested in practice.

It would be relevant to analyse on the mindset behind Westerlund and Leminen's understanding of the living lab theory. It is clear their mindset is leaning towards the participatory mindset, because they are focusing on co-creation and co-design, and hereby seeing the users as partners, rather then subjects. Throughout the analyse, the mindsets of the involved actors will be analysed to establish whether or not they are in line with the participatory mindset required to participate properly in a living lab.

The other literature review analysed in this thesis has been Schuurman and Ballon's literature review of existing living lab theories (Ballon and Schuurman 2015). They delve into the gap between the theoretical framework of a living lab, and living lab in practise, where a large gap between these two are apparent through their literature research. Most of the literature that exists is focusing on the theoretical aspects, and hereby their own definition of what a living lab is. The problem, which this master thesis is focusing on, is the fact

that these definitions and re-definitions only focus on the theoretical aspects, and not how to conduct a living lab in practise. For instance, the term raises confusion and further fuels the different definitions. Some theorists define it as an open environment where the users are considered a part of the production.

> "*(...)Experimentation environment in which technology is given shape in real-life contexts and in which users are considered co-producers*" (Ballon and Schuurman 2015, p. 2).

While others defines it as a closed lab or an arena, where the research can be conducted in a controlled environment

> "*Semi-partitioned spaces in the form of innovation arenas integrated in real-life environments but separated by means of an innovation project structure that cultivate user-led-insights*" (Ballon and Schuurman 2015, p. 2).

Some of the thought processes behind these different definitions are based on how to correctly implement a lab in an open environment, while still taking spontaneous acts from the co-producers into account. In other words, how can a valid experiment be conducted in an open (living) environment with co-producers? Are they to be completely aware of the research, and have influence on the process, or should they be seen as sources of information? Before a further analysis on how to redefine the living lab in practise, it is relevant to include some of the main definitions or understandings of the term to make it clear how broad of a term living lab is considered being. Here are five different understandings, which have been used throughout different research studies

1. An innovation system
2. A real-life social setting
3. An approach for user involvement in innovation
4. An organisation facilitating living lab approaches
5. The European living "movement"

(Ballon and Schuurman 2015, p. 2)
As can be seen throughout these understandings, they are coming from right left and centre, there is however some recurring themes, such as innovation, living environment and user involvement, which will be central for the forth coming analytic navigation of the living lab terminology.

It is worth mentioning that a great deal of these definition have been made primarily from a theoretical standpoint, coupled with the aforementioned attempt to make a one size fits all definition, which simply can not be done when it comes to a living lab in practise.

However, these five research studies, although having five different understandings, still have some similarities with each other from a mindset perspective. It would be relevant to see which of the mindsets these research studies leans

towards. The understandings are precise and a bit cryptic, so the reasoning for the appointed mindset will be explained. Understanding 1 and 2 leans towards an expert mindset, based on the studies seeing the users as subjects, rather then partners. The innovation system will be perceived as a system where the development of a product through innovation is the main focus, rather than developing the product to fit the users. The second understanding touches upon the same principles, the focus is on a real-life social setting, but the users will still be seen as subjects to test the product. They will not be a part of the developing process.

Understanding 3, 4 and 5 commends the participatory mindset, users are to be involved in the innovation process. There will be facilitations of the living lab approaches, in which user participation, co-design and co-creation is the cornerstone of. Last but not least, the 5th understanding refers to the ENoLL, which stands for: European Network of Living Labs, that has been a frontrunner of the participatory mindset, and living lab approach.

Ballon and Schuurman are on the right track when it comes to living lab and their mindset. Their mindset is also of the participatory kind. They are furthermore focusing on the gap between theoretical living lab and living lab in practise, which emphasises their mindset, in regards to implementing living lab in practise and making this partnership with the users during a developing phase.

Before delving into a redefinition of the living lab in practise, based on the theoretical mindset, understanding and definitions, an analysis of this thesis's empirical data will be made, since these gatherings will be a part of the redefinition.

8.3 Actor interpretation

Dissecting not only the theories used in this thesis, but also the different approaches and understandings of a living lab makes it impossible to include every definition provided throughout the literature into one. It will have to be condensed and cut into the relevant information concerning a living lab. By researching what the actors in Living Lab Nordjylland understand when asked "what is a living lab?", we will get a better understanding of potential pitfalls and what understandings might be the same and what might be very different from one another.

When asked "How do you interpret a living lab?" the three actors provided three vastly different answers. The answer from Nord Energi A/S is as follows

> "*We see a living lab as a joined interaction between energy systems, and then we analyse, how it affects the system as a whole*" (7.2.2)

Even though we made sure to underline, that the question was asked in connection with living lab as a general term and not minded on Living Lab Nordjylland, the actor from Nord Energi was quick to respond, albeit it being in the direct context of Living Lab Nordjylland.

The actor sees the living lab as a joined project, where one or more variables are subject to change. These changes will then have an effect on the rest of the project. These effects are then to be evaluated and tweaked accordingly. Elaborating on the answer given, the actor was quick to underline, that the project itself was seen as a possibility to

> "*Take a project from paper to a real life test.*" (7.2.2)

This answer is something the literature underlines again and again. The living labs run with the living lab mentality in mind from the start have usually been a proof of concept or a test to change habits of some sort. This has been elaborated upon in the Livewell Yarra living lab aiming to cut down carbon dioxide emissions in households (6.1).

The actor had never heard the term "living lab" before, and thus his only word of reference was the information provided by Energibyen as the term was *not* used in the EUPD application. This provides another pitfall as no understanding of a commonly used term in a project can lead to misunderstandings as well as having different understandings of common terms can lead to problems.

As mentioned in the participatory theory, we predict that the reasoning for establishing the living lab can differ among the different actors involved in the living lab process. We therefore see this as an opportunity to create the lab in continuous steps, in close co-operation between the main actors and later on the end-users at hand.

The main knowledge aspect we are interested in when developing upon the living lab theory, is how the different actors defined the term. As we went further on and interviewed the representatives from Energibyen Frederikshavn, we expected a direct and complete definition. When asked "how would they define Living Lab?" the first representative from Energibyen stated that

> *"It is called a Living Lab, because it is a laboratory, in mini format but in motion, it is something that has to develop itself"* (13).

This statement did not correlate with the second representatives statement on how to define a living lab. This definition did also occur later in the interview, and was in context of explaining the ambitions towards the LLN project.

> *"There already exist many technologies, but it is not cohesive - That is the idea of living lab, to create a connection between production and consumption in an intelligent way"* (13).

From these two quotes we see, even though the two different representatives bound in the same organisation at Energibyen, are working in the same field, had a different understanding of what a living lab in practise is. This misinterpretation between two colleagues can be seen as an example of the term being fuelled in the whole "buzzword discussion" (5.3).

One of the representatives understands living lab in practise as a way to conduct a research blindly in the field, without knowing how the research should be formed throughout the process.

> *"We get started, and then we meet some challenges, also technologically and then together with our local businesses and academics we need to find solutions to make it work out"* (13)

In other words, Energibyen sees it as taking a long shot, and hoping it pans out. However, there is some precedent in what the representatives mention. A living lab is meant to evolve throughout the process, and include the different actors, aspects and ideas. But for the living lab to be successful, a methodological framework is needed, to make sure that it will yield data which can be used for the research moving forward. Going in head first, without a frame of reference can be catastrophic for the data gathering.

Once again from this statement, it can be deduced that the representatives only understands some parts of what a living lab is, and how to conduct it in practise, which refers back to the buzzword controversy, where the term is being used in a research where it can be a great methodological tool to gather data from the real-life. But only by using half of it, or using it in a misunderstood matter, it can become a source of error. It can be boiled down to understanding the method in practise correctly and using it to its fullest potential, or understanding only segments of the methodology and instead of becoming a relevant and useful tool, it can end up becoming a source of error for the research throughout the process.

The most controversial approach of defining the term living lab on our request, we experienced from talking to the representative from Kamstrup. When asked for a definition of the term he stated

> *"I do not quite believe that I fully understand what living lab implies"*(13).

Having the thought that this would be a first intuition from the informant and through further dialogue, we proceeded asking questions that was in close conjunction with the LLN project, and what information he had been given on the living lab term. Through further talk the actor stated that

> *I will explain it (living lab) as a co-operation we enter ... Actually I do not think I would use the word living lab at all. I will state that it is a co-operation between Frederikshavn Forsyning, Aalborg University and Kamstrup"*(13)

As mentioned from the interview with the two representatives from Energibyen, the living lab term has become a buzzword, that is difficult to navigate around. The actor from Kamstrup uses the word "buzzword" when talking about the living lab term, and said

> *"It has become kind of a buzzword and a synonym to illustrate how to perform inter-disciplinary work"*(13).

By the use of our methodological work of having a dialogue with the actors at hand, we came to a clearer understanding on how they were unable to define living lab in general or in the context of the LLN project. This was clear to us

after more of the actors changed their statement on what they understood as a living lab. Except Energibyen's representatives having different definitions.

To get a proper understanding of the actors' own definitions of the living lab concept as well as their potential influence on an end-product, we are analysing the actors through the use of the Technology Acceptance Model (TAM). The model has been described previously in the theory-chapter (5.1).

8.4 Perceived ease of use and Usefulness

An analysis of our empirical data shows a difference in the understandings of what a living lab is, and how it is to be conducted in practise. Because of this misconception of what a living lab is, it is relevant to look into what enables and inhibits the actor. By analysing each actor, and placing them in the Technology Acceptance Model that has been described in the theory chapter (5.2), the reason for choosing this version of the TAM, will be explained below. But before using the TAM on the actors of LLN, it would be relevant to analyse the model itself in relation to the living lab methodology. As a frame of reference it can also be seen below:

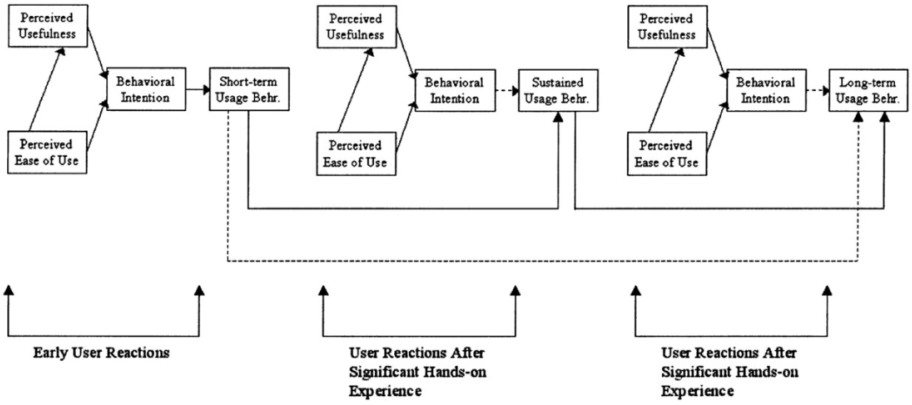

Figure 8.1: The iterative TAM2-model (Davis and Venkatesh 2004, p. 37)

The TAM can be seen as an iterative process with recurring methodologies through its usage, as explained in the theory section about TAM (5.1). The technology will be refined and improved throughout this process by the help of the users feedback and behaviour towards the technology. However, it is important to note that the TAM can not stand alone as a method and needs to be incorporated into another methodology. This is where the living lab methodology becomes relevant, because TAM and the living lab methodology compliments each other throughout the data collection process.

Much like the TAM, the living lab methodology is also based on an iterative process, and is also often used in regards to a new technology, product or implementation of innovations. The TAM can be seen as a more user-oriented methodology, focusing on the users as a source of information, where living lab

is focused on user-centered methodologies, where co-creation is the main focus. However, TAM compliments the living lab methodology by having a model to reflect on, helping to make it easier to comprehend and understand. Living lab is much like the TAM, working in phases, where the involved actors give feedback on the technology, while also helping to refine it throughout the phases. This is a combination of co-creation through Scandinavian methods, lead-user innovation and applied ethnography, as mentioned in Sanders map of design research methodologies (5.3). By combining living lab with TAM, The methodology becomes easier to comprehend, while also making it easier to use/implement in a research, furthermore, TAM can help the living lab by taking into account the surrounding aspects of the research, for instance the perceived usefulness and the perceived ease of use.

Now that the TAM and living lab have been analysed as a collaborative methodology, The TAM will be used on the actors, with the living lab in mind, where the focus will be on what possible enablers and inhibitors may present itself in correlation with each actor's perceived usefulness within the living lab.

It is however important to note, that the TAM is often used on a specific technology or rule set change, for instance cellphones or parking regulations. But in this case it will primarily be used to analyse the actor's pre-understanding and perceived usefulness of the LLN project. Furthermore, since LLN as a project still is in the early stages, it will only be possible to analyse the actors perceived usefulness in the early user reactions part of the TAM. By scoping in on the early user reaction part of the model, the TAM2 extension becomes ideal to use rather than the TAM2 model. The model aims to unbox the perceived usefulness box, as it has been blackboxed in the regular TAM2-model. As a frame of reference, the figure is illustrated below.

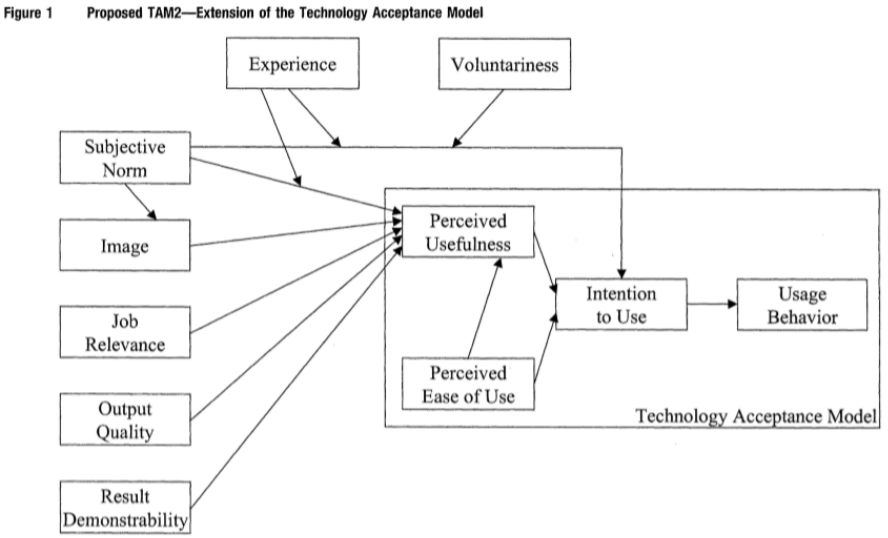

Figure 8.2: Technology Acceptance Model 2 (5.2)

If we start with **Nord Energi** and look into their perceived ease of use of LLN, in other words, what they seek to gain from the project. Nord Energi was invited to be a part of the project, three days before the deadline, because another energy company chose to withdraw in the last minute. This meant that Nord Energi was not informed as much as some of the other involved actors.

Nord Energi aims to receive large amount of data from the systems that are to be implemented into the mini smart-grid, especially when it comes to the co-operation between the devices, such as heating, electricity consumption, and renewable energy. The data which they are able to potentially receive, consists of detailed readings, mainly due to Kamstrup's meters. These data readings from this setting will be new for Nord Energi, and relevant for their further production moving forward, which is their perceived ease of use.

However, during the data gathering it was made clear that Nord Energi was primarily informed regarding the project on a need to know basis. This meant that they were not aware how the project would pan out in practise, furthermore, they were not aware of Knivholt Hovedgaard and what this test site will be able to muster.

Because the project is still in the early stages, only the first part of the TAM will be used and based on the hypothetical nature of the project at this moment, some of the extensions connected with perceived usefulness will not be used, since they are more related to an individual user. The extensions with relevance to this analysis, are:

- Experience
- Job relevance
- Result demonstrability
- Output quality

Nord Energi had some experience with projects concerning co-operation with other actors of the field, especially Kamstrup, who had been a collaborator in other projects, and they see them as colleagues, not competitors. Nord Energi had been working on projects where a combination of solar panels and heat pumps were used, however, not combined with batteries, which LLN aims to implement. They had however, not been working with living labs before.

As the representatives states during the dialogue, the mini smart-grid can have potential to impact the quality of data gathering, along with new ways to test interactions between different technologies in a collaborating system. This can influence the job relevance of the representative. However, only in a positive matter, since the amount of data can be of greater detail.

As mentioned in (5.1), the result demonstrability and output quality goes hand in hand. When used from the mindset of the representative of Nord Energi, the project can yield both better results, and also of a higher quality. First and foremost because Nord Energi has not been a part of a project with this many

actors before, and hereby the potential interaction of the technologies and the quality of data they can receive, through the Kamstrup meters.

To summarise Nord Energi's perceived ease of use and usefulness, the enabler and inhibitor terms will be used.

The main factors which enables Nord Energi are: The potential outcome of higher quality data, based on the combination of technologies which are the source of the data output. Their aim of the project is to receive a higher level of data quality, with the combination of new technologies, in an attempt to improve their own technologies for the future.

The main factors that inhibits Nord Energi are: Nord Energi is a small part of the project, for instance all the data gathering is done by Kamstrup, which means that Nord Energi is not the primary source of the data gathering. This could prove to become something that inhibits Nord Energi, if they were to not receive all the data gathered from the project. However, during the dialogue with the representative from Nord Energi, he explained how they are working together with Kamstrup and are collaborators, having collaborated on other projects, so this would be highly irregular, if it was to happen. The representative from Nord Energi stated that

> *"We have collaborated with Kamstrup in an earlier project, and we see Kamstrup as colleagues and not as competitors* (Theis Fieldnotes 2019).

Another factor, which as of right now can be described as an inhibitor, is the fact that the project is mainly focused around business to business endeavours. The end user/citizen is not a part of the project, which could prove to influence the potential data they can gather, or make it less relevant, because Nord Energi mainly works with end users in their daily work, and this is also the field they hope this data can be used for.

Moving on to **Energibyen** and analysing them as an actor into the TAM model, we will start describing Energibyen's perceived ease of use as rather simple. Their objective in the partnership is mainly to put the facilities at Knivholt at disposal, as the basis of the facilitation of the mini smart-grid concerning LLN. Furthermore, Energibyen are hoping that a project like LLN will make way for more projects of this calibre to come, while also hoping for projects like this to ignite a spark in the citizen's renewable heart.

We will analyse Energibyen's perceived usefulness on the same basis that were used on the previous actor.

Energibyen have been part of different projects where they had the mediating role between businesses. Some of these projects involved various fields, and Energibyen sought to combine them in a way where every partner were able to be a part of a bigger picture, while still being able to see their technology evolve in the process. Energibyen has also been working with the living lab methodology before, although only in a theoretical matter, they have never been able to

execute it in practise, which could be a consequence of the different mindset the two representatives have of what a living lab is. Knivholt Hovedgaard, which is to be the test site of the mini smart-grid, it has not been used as a test site of this magnitude, with this many different technologies before, however.

The test site can prove to be of great job relevance for Energibyen. It can potentially encourage other businesses in Frederikshavn Municipality to use Energibyen as a test site of their technologies, and even further down the line be used to encourage citizens to consider implementing some of these technologies in their every day life. Furthermore, the representatives at Energibyen mentioned that they are working on mapping their own energy consumption

> *"We are having someone working on mapping what our energy consumption of each of our rooms up here (Knivholt)"* (13)

The LLN project could prove to further refine the mapping of energy consumption at Knivholt. It is however, worth mentioning that this mapping should have been done sooner rather than later, especially if they were to encourage the citizens, by translating to a common language, in which the citizen is able to understand how the given technology can help them in their every day life. This will be discussed later (9.1).

The result demonstrability of the test site can prove rather useful for Energibyen, as mentioned above, it can potentially encourage other businesses to use Knivholt as a test site for their technologies. Furthermore, the output quality of the LLN test site can prove to help Energibyen in translating the data and results and making them more comprehensible for the common citizen in the municipality.

Summarised, the factors that enables Energibyen are: The potential to be a test site of multiple technologies integrated into a connected system. The possibility to translate the data to encourage new businesses to reach out to Energibyen, and encourage citizens to endeavour into new technologies and implement them in their everyday life, which could prove to further the renewable energy mindset.

The potential inhibitors of Energibyen can be the fact that they have not been a test site for this such a large amount of different technologies before, and can prove to be too cumbersome. Last but least, Energibyen as of right now, do not have the citizens attention, and can therefore prove to be the largest inhibitor. If the citizens are not aware of the work Energibyen is doing, and do not understand what they are trying to showcase, which can make it more difficult to reach the citizens.

Now that both Nord Energi and Energibyen's perceived ease of use and usefulness and their enablers and inhibitors have been pointed out, we will move on to the last actor of LLN, Kamstrup.

During the dialogue with Kamstrup, the representative mentions that they have another project resembling LLN, which is based in Nordhavn, Copenhagen. However, that project does not have a battery business affiliated with the project, which proves to be a new element that Kamstrup finds interesting

to be collaborating on a project with. This is mainly their perceived ease of use of LLN, furthermore it could also be considered that they are sampling the results for the northern part of Denmark in their portfolio for future use.

The perceived ease of use of Kamstrup, regarding their experience of these kinds of projects have been touched upon a bit. They have been collaborating with other businesses to make test sites before, which is also further supported by the representative from Nord Energi, who mentioned that Nord Energi and Kamstrup have been working together numerous times before, and that he saw Kamstrup not as a competitor, but as a colleague. However, Kamstrup does not have that much experience related to the end users. Through the dialogue with the representative, it was also evident, that the user were not a primary focus of LLN.

LLN can influence the job relevance of Kamstrup, much like it potentially can on Nord Energi, depending on how the test site pans out. It could influence Kamstrup's job relevance when it comes to projects involving technologies collaborating together in an intelligent system. Depending on what LLN yields, their focus on projects to come could be on a deeper level, concerning collaborative technologies and their influence in a business to business matter.

The result demonstrability and output quality for Kamstrup is once again aligned to some extent with Nord Energi, however as their focus primarily is on the business to business aspect, the potential results can prove to become useful and relevant for Kamstrup's work in the future. The possibility of higher quality data, and especially combined with the addition of a battery business in the technology collaboration, has not been a part of any of their previous projects.

Summarised, the factors that enables Kamstrup are: The potential higher quality of data the test site can yield along with the addition of intelligent batteries to compliment the collaborative technology system.

The factors that inhibits Kamstrup are: As we learned through the dialogue with the representative, Kamstrup has an ongoing test site in Nordhavn with an almost similar project, which could prove to be an inhibitor, by them not giving LLN their full attention. However, as mentioned above, LLN consists of a battery business, which Nordhavn does not possess, in other words, the inhibiting aspect could prove to be overshadowed by the enabling part of the project.

Through the TAM, it has been made apparent that the actors are roughly on the same page, when it comes to the end result of the LLN test site. However, as analysed throughout the section, some inhibitors have come to light, which could prove to cause trouble along the project period if not taken into account. The end user perspective seems to cause trouble, because on one hand the actors do not know how to implement/reach them in the LLN, and on the other hand, some of the actors of LLN do not have an interest in the end users.

It is important to note, that the project still is in its very early stage, which can

influence the actors mindset. If they are not sure how the project will pan out in practise, it can be difficult for them to imagine the end game.

8.4.1 Living lab as a buzzword

Based on the findings from the master thesis' empirical data, combined with the results from previous section regarding the TAM, we can legitimise the misunderstandings and misuse of the term living lab in practise, and understanding the term as a buzzword. Looking into where the knowledge of the term has been developed, only Energibyen had previously worked on a project where they could draw some similarities to their understandings of living lab. When asked, if they had any experience within the field of living lab, one of the actors from Energibyen stated that

> *"X has in the case of getting biogas driven busses up here (Frederikshavn municipality) is a good example of the mind-set that lies underneath"* (13).

In this case, it states again that parts of the living lab term are misunderstood, even though parts of it might be useful in different cases. The mind-set of participatory design and interdisciplinary work is, what the actors do not understand as being a living lab.

It is interesting that even though we are familiar with Energibyen's doings and know about the Innovate/One-stop-shop project, which we have described earlier, they did not point out that exact project despite it being on a living lab premise. This further fuels the conceptualising of living lab being used as a buzzword in different projects.

This also tells us the importance of having a same state of mind, when using the term of living lab on a project. We are able to underline some flaws with the interpretation of the project at this state.

When we asked the representative from Kamstrup the same question, we did not receive a specific case of existing knowledge. It is important to note, though, that the informant stated that he had only been at Kamstrup for about a year. Despite that, the informant stated that Kamstrup had been working on a project in Copenhagen called Energylab Nordhavn.

> *"What we have been working on is "Energylab Nordhavn", which is located in Copenhagen"* (13).

Energylab Nordhavn is a full-scale smart city energy lab, wherein both electricity as well as heating and transport will be integrated into the same system to achieve an, according to Kamstrup, intelligent, flexible and optimised energy system (EnergyLab Nordhavn 2018).

Energylab Nordhavn is a smart-grid much like Living Lab Nordjylland and is even focusing on the same integrated solutions as is the goal with LLN. Even though they are working on a similar project, the representative from Kamstrup was not keen to describe it as a living lab, as it was not clear to the informant

exactly, what a living lab is. To him, he did not want to use a term or definition he did not understand fully. The project itself is in line with the living lab-principles, however, having numerous different actors with different stakes in the project from different business perspectives. These include the likes of DTU, the City of Copenhagen and Danfoss. The project is supported by the EUDP, which LLN, as has been described before, have applied to get funds from (EnergyLab Nordhavn 2018).

This shows us, that albeit Kamstrup is working on a project that resembles the same goals, as LLN in the future, they are reluctant to brand it as a living lab unlike other actors in the Living Lab Nordjylland project.

Energi Nord A/S did not have their own direct definition of a living lab, but told us, how Energibyen had described LLN to them in sparse detail. According to the representative, they did not think of a living lab as a general term or a framework, but only as a description of Living Lab Nordjylland as a project (7.2.2).

Based on the findings of the analytical elements from the theoretical living lab, this master thesis' empirical data, on how the actors understands a living lab, combined with the results from the technology Acceptance Model will be beneficial to make a redefinition of a living lab in practise. This can be used to make sure that the actors are on the same page, and hereby make sure that the project process will be followed through, and every actor receives the best possible outcome.

8.5 Redefining the living lab in practice

Throughout this master thesis, and especially in the findings from these analytical aspects, such as the different theoretical understandings of a living lab, our empirical data surrounding how the actors understand the living lab methodology, and the further analysis through the Technology Acceptance Model. Has been culminating towards a redefinition of a living lab in practise. The redefinition will be based on an amalgam of the common characteristics of the theoretical aspects, the actors of LLN understandings combined with our techno-anthropological insights and expertise.

Throughout the theoretical analysis of the living lab, common characteristics recurs throughout the theorists different understandings of what a living lab is, are: Establishing an open environment, involving users, innovation, ongoing process and that it is based on mutual mindsets. These five understandings of what a living lab is, are the common characteristics which recurs throughout the theoretical aspects of a living lab.

The majority of the theorists mutual understandings of what a living lab is, consist of establishing a living lab in an open environment, where the users are involved in the ongoing process, based on a mutual mindset, where innovation is paramount.

Now that the theoretical common characteristics have been established, the same will be done for the thesis' empirical findings through what the actors mention, and hereby create a common consensus of what they understand as being important parts of what a living lab is. Their recurring terminologies they use to describe living lab are: Co-creation, constant static tests, laboratory setting.

The common terminology used by the actors of LLN, which recurs through the thesis' empirical findings, takes the form as a living lab where, co-creation creates a laboratory setting, where constant static tests are able to be conducted.

Finally our common characteristics of the living lab, based on our techno-anthropological insights and expertise are: Co-creation, ongoing process, user involvement, real-life setting, innovation and participatory design.

The common characteristics of what a living lab is, based on our insights and expertise, as techno-anthropologist, and enlightenment through this master thesis, it takes the form of a living lab where, co-creation and participatory design is used to involve the users in a real-life setting, where innovation is paramount through an ongoing process.

To understand each actors understanding and expertise concerning the living lab, they have been placed into Sanders map of design research, which can be seen in the section below (8.3).

8.5.1 Sanders Map of design research

Having established what each actor believes to be a living lab, it makes sense to take a step back and analyse Sanders map of design research methodologies (5.3) according to LLN and the actors involved in the project. A recurring aspect of a living lab and getting a proper project is to establish a common mindset among the actors involved in the project. If the end-goal is clear from each actors point of view, it makes inter-disciplinary collaboration between them easier. Instead of grouping the actors together into one point called "living lab", defining each actors position in the design map will make for a more definitive understanding of each actors involvement in Living Lab Nordjylland. While the actors are in the same lower right square of the model, they have different fields of expertise, that are vastly different from one another. The map can be seen in the living lab-section of the theory chapter (5.3).

To have a functioning living lab, which has been described in the literature, the actors would have to define themselves within the lower right corner of the model primarily focusing on participatory design, that is either research-led, design-led or a mix of the two. Analysing our empirical data and categorising the answers gotten from the interviews shows a different picture, however.

Energibyen

Energibyen is the lead-partner on the project and functions as a project manager on Living Lab Nordjylland. They are not to actively provide a product or

technology to LLN unlike the other actors, but are to function as a gatekeeper between the actors and a mediator to the public. They are not actively participating in the same sense as other actors. Having this in mind while looking at their definition of a living lab, leads us to place them in the middle of the model.

The lack of active participation and the "work as you go" description of the LLN is not participatory nor design-led.

Aalborg University

Aalborg University has been working closely with Energibyen to produce the EUPD. On top of that, Aalborg University are to gather data from the different actors and create a system, that end-users can use to buy and integrate energy solutions within their homes.

If the end-user is to buy a windmill and solar panels, AAU's goal is to make a software system, where the technologies can be integrated like a mini-mini smart grid. They also function as experts concerning the technologies providing information and sparring with Energibyen if necessary. Because of this positioning towards both Energibyen and their own approach, they have been defined as experts and in the user-centred field. With the data gathered, AAU's goal is to analyse how to sell the living lab to the public.

Nord Energi A/S

Nord Energi are to provide the smart grid with power, as Knivholt is situated within their jurisdiction. They have collaborated with Kamstrup on numerous occasions and have setup electricity meters across the whole region.

Nord Energi underlined, that they were part of the project to try out their products in practice rather than on paper, so they can get valid feedback from end-users and evaluate the product. Therefore they have been placed in the lower right-square, as they are using participatory design to research their existing systems to get a better product in the end.

The above descriptions lead into the revamped map of design research, which is pictured below.

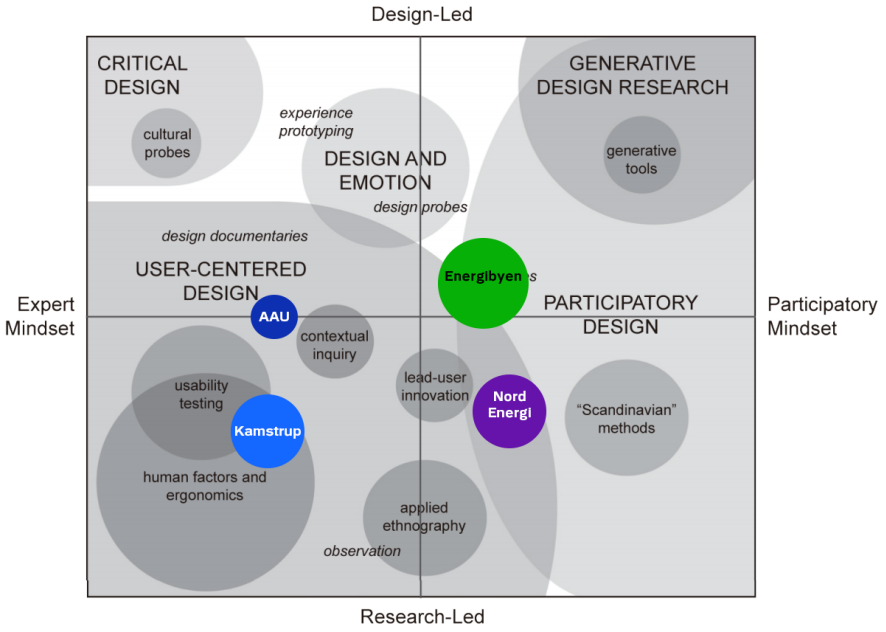

Figure 8.3: The actors positions in the design research map.

As can be seen in the figure, it is only Nord Energi, who is situated within the participatory design-field with Energibyen being in the perimeter between participatory design and user-centred design, as they do not have a well-defined practical role within the project, when it starts up.

The representative from Kamstrup was quick to say, that they were not aware of, what a living lab is and are only providing the capabilities to gather data from the technology provided by Nord Energi. Therefore they have been placed in the left most corner, as they would like to get results from participating in the project, but not necessarily by participating actively in the living lab itself. They want the data for their own business.

Aalborg University sees Living Lab Nordjylland as a prime example of getting relevant data, that can be used in teaching and in future research projects. As they are partners with Energibyen, they do not directly interact with the field itself and would thus function as counsellors to the project.

8.5.2 Living lab definition

Based on these analytical findings, combined with the knowledge we have acquired, a redefinition of the living lab in practise can be made. The redefinition is shown below, with the following argumentation:

A living lab in practise can be defined as:

> *A project, where co-creation consisting of a project manager, producers and integrated users who participate together in a real life setting facing a common problem and therefore collectively striving towards a common goal.*

The definition and the different terms will be elaborated below.

- **Co-creation**
  Co-creation is the joined efforts of the participants.
- **Real life setting**
  The problem needs to be bound and applied in a real life setting.
- **Participation**
  The actors involved in the living lab.
  - **Producers**
    Are partaking by delivering the technologies that set the basis of the living lab.
  - **Project manager**
    Is to make sure that the project works towards the common goal, by ensuring the participants responsibility of co-creating are being accounted for.
  - **Integrated user**
    The users are seen as informants who are being integrated into the living lab process. Their role is two-part as being sources of data, while also being influential in the development and adjustment of the living lab.
- **Common problem**
  There needs to be a problem, the participants can aim to resolve.
- **Common goal**
  The problem the participants aim to resolve, needs to be based on their common goal

It is important to note, that this definition is not to be taken as a one size fits all definition, which has been discussed throughout the thesis. It needs to be adjusted depending on; actors, the field, and what common goal the project aims to reach. However, all the aspects of this definition needs to be a part of it, before a project can be defined as a living lab.

Now that the definition of living lab has been redefined into a practical term for Living Lab Nordjylland, an analysis of Living Lab Nordjylland as a living lab will be made.

8.6 Living lab business model

In this section, the different factors that could potentially influence the process of Living Lab Nordjylland, based on our empirical findings.

When working with various actors from different fields and lines of businesses, we considered that a possible disturbance in goals for the project might be present. All the interviewed actors, as expected, had different motivational factors for investing in the project.

Energibyen, when asked what their motivation for participating in the project one of the representatives stated that

> *(...) "If we can get the LLN up an running, we will hopefully get a network of the actors involved"*
>
> *"In the long run, it is about being able to create some activities, that might be of use to the local businesses within Frederikshavn Municipality"* (13).

It is clear to Energibyen, what their motivation is to participate in Living Lab Nordjylland is. As their primary role within Frederikshavn Municipality is to mediate between businesses and craftsmen in Frederikshavn, wanting to use the Living Lab as a way of generating a network makes sense from their perspective. It is not necessarily compliant with the sense of a living lab being a co-creational effort, but seeing it as a stepping stone for future projects, where Energibyen would be able to draw on an existing network of actors is a genuine win for them as a mediator.

It is important to keep in mind, that Energibyen is an extension of Frederikshavn Municipality and is thus a municipalitan actor. Energibyen cannot earn money from projects such as Living Lab Nordjylland. Therefore they might have a very different motivational aspect towards the project, as a network of actors would help them in future endeavours in the sense, that it might be easier to get a hold of potential interests and not because of an economical incentive.

The other actors involved in the project, Nord Energi A/S, Kamstrup and Aalborg University are in different positions from Energibyen. While Nord Energi is privately owned, they have a technical monopoly on electricity and fiberoptical internet in Northern Jutland meaning, that they are under heavy relegation concerning their business and possible business ventures as well.

Using Living Lab Nordjylland as a real life test, as the actor said, is therefore not directly tied to economical gains from LLN, but a test of new systems. If these systems prove to work as intended, they can be implemented in new or existing systems and thus leading to en economical gain. According to Nord Energi, however, it is only to test their systems in real time instead of on paper or in a simulation.

8.6.1 "Green prosperity does not depend on itself"

Clarifying the importance to look into an additional business plan or model for the LLN project, we are taking a step in the direction of the end-user and analysing through the empirical data, who the actors involved in LLN thinks the so called first movers and possible end-user clientele have to be (Hæstrup, Rasmussen, and Allesøe 2019). This thought on end-user perspectives was developed through our discussion with LLN's project leader, who was not able to, but desired an answer on how the mini-smart grid could be designed in a business case.

This analytical part will primarily consist of the discussion points about ordinary citizens morality shifting towards a climate friendly manner, that has been elaborated on in the state of the art section (3). This will be linked together with the different statements concerning end-user perspectives from the empirical work.

As mentioned, having a sit-down with the project leader, one of the key tasks as of right now, is to grasp upon who the LLN smart grid system is able to promote itself to. For the project to be funded through EUDP, the project has an issue of having to show a financial yield (Hæstrup, Rasmussen, and Allesøe 2019). The project leader stated a desire of having a definite target group of a clientele whether it will be organisations, utility companies or private consumers, to strengthen the application (Hæstrup, Rasmussen, and Allesøe 2019). Handling the question of who or what the LLN smart grid system would be targeting, the actors gave us an insight in their ideas in which we found similarities but the answers also differed.

In the interview with Kamstrup, the informant stated that there is a need for intelligent systems for ordinary households to install these technologies. The informant said

> *"We have to make intelligent operational systems, so that people do not have to think about it"*(13).

This statement correlates well with the discussion, brought up in the state of the art chapter, where we looked into Theresa Scavenius' interpretation on ordinary citizens morality towards changing into a climate friendly lifestyle (3), and whether they are to blame for the lack of proactive decisions on the matter. In general the knowledge spread on technologies and cases like the LLN project, might not be widely spread, and as we have seen and researched about the citizens in the municipality of Frederikshavn wanting to make energy refurbishment for the sake of a green initiative and becoming climate friendly, there is a lack of such (Hæstrup, Rasmussen, and Allesøe 2018).

One of our findings was that, there is a small percentage of people wanting to refurbish their households due to energy efficiency, there were simply not any direct gain from doing it, and also too much til handle doing such a process. This leads up to the next statement the informant from Kamstrup said

> *"It is only extremely enthusiastic people who say that they can save 3 øre DKK per kilo watt hour"* (13).

Here the informant refers to the small percentage of people who have the necessary knowledge and desire of changing habits. These statements correlate with our earlier work, and Scavenius' states that, we can simply not expect citizens to make an immense change in lifestyle without the availability of environmentally friendly products, which could be the insight in sustainable energy solutions. She also states that there have to be political initiatives that makes it "easier" for citizens to make a decision (3). The representative from Kamstrup stated something similar when asked, whether it has to be the consumers, companies or public instances who have to be the initiator

> *"I think it is from the political side it has to be pushed"*(13).

In contrast to the statements given by the representative from Kamstrup, the representatives from Energibyen had clearly been through a phase of reflection. In this phase they have established a mindset on a potential clientele for a unified energy system, which is the mini-smart grid. This point was stated by Energibyen in the interview when one of the representatives said

> *"Only when the mini-smart grid is installed we can upscale and then the first customer will be a utility company, and that will be the primary customer"*(13).

It correlates well with the premise of Energibyen as being a close correspondent to utility suppliers and businesses from all around the municipality of Frederikshavn, and having their interests in mind when taking part in projects (1.2). Having stated this, we were still interested in their view on citizens being a part of a clientele to which Energibyen's representatives said that

> *"The first one is the supplier of energy, then they will have to create incentive so the consumer will bid on the things they want"*(13).

For Energibyen the end-user will consist of utility companies. It is clear they do not see the citizens as direct customers of a system like this. This can be interpreted as an understanding towards the lack of Energibyen's, and in general for the actors, misconception of the participatory design aspect in the living lab term. Even though both Kamstrup and Energibyen have mentioned the consumers, they have not been considered a part of the living lab process, which might also be based on the fact that LLN is in the early stages.

The talk we had with LLN's project leader and the interviews with Kamstrup and Energibyen provided us with the actors understanding of the development issues towards a sustainable transition and one of the representatives from Energibyen stated that

> *"It is going to be in a more evolved manner to be consumer, if we want to keep 100 percent sustainable energy utility alive"*(13).

Every actor we interviewed agreed to the point of developing sustainable solutions do not evolve by just being an active public picture and a flow of thoughts. Anyway, they see the LLN project as a production which can help the course, but despite this, none of them sees the consumer as partaking in the design of the living lab, which we have established as a main factor in the establishing of a living lab.

8.7 "Living Lab" Nordjylland

Through this analysis we have analysed the actors understandings of the living lab principle as well as their focus within Living Lab Nordjylland. Throughout the analyses one of the important aspects of the redefined living lab has been missing entirely; integrated users or the end-users of the project. With users having to use the end-product and giving feedback to the other actors of the project, it makes it impossible to have an iterative approach to the innovation of the technology. If no one is actively using the product, potential pitfalls will not be resolved, and hereby an improvement of the technology will complicate the process

Albeit the actors we talked to having their own goals and reasons to be involved in the project, Living Lab Nordjylland fails to establish a common problem and a common goal for all actors to pursue. By not having a clear goal in mind, it has a direct influence on the actors work as they do not have a common focus point. As of right now, the actors are to deliver software systems, technologies and the like to a project that has a goal of integrating them in a smart grid, but without involving the actors in the project itself and into the other actors projects as well.

Living Lab Nordjylland fails to make the actors participate in the project itself and leaves them to come up with their own solutions within their field of expertise concerning the smart grid instead of working towards a common goal.

LLN transcends towards becoming an "urban living lab", based on the reasoning Levanda uses to describe it, where the focus is on a test site only established for technological testing, which is what he defines as urban test beds (3.3).

As of right now, Living Lab Nordjylland is a collection of systems, and not a system of systems, that a living lab strives to be.

9 Discussion

In the discussion we will discuss different possible approaches to the Living Lab Nordjylland-project as well as previous projects, that Frederikshavn Municipality has worked on concerning green energy and what results, or lack thereof, they had. The lack of end-users actively involved in the Living Lab Nordjylland project will be discussed as well.

Before the project can be established, Energibyen had to send an EUPD-application to get funding for the project. The first application they send got denied, as they were not able to provide enough information about the possible gains of the project. The possible gains could be economical, environmental or the like.

In the new EUPD-application, that Energibyen and Aalborg University made, the representative from AAU underlined, that they had *not* used the term "Living Lab" in the application, as it was found to provide more confusion than concreteness to the project (Hæstrup, Rasmussen, and Allesøe 2019). When the lead partners on a project called "Living Lab Nordjylland" choose not to include the term in the application, it raises question about the terminology itself and whether or not it is easy to understand, and how they choose to use the living premise in the project.

This could be a consequence of them using living lab as a buzzword, where every actor was not sure of the meaning of it, and could prove to further confuse the application. Furthermore, if they were unsure of how a living lab is to be conducted in practise, the wrongful use of the term living lab could also be a reasoning of why the first application was rejected.

9.1 End-user roles

The aspects of integrated users in the LLN project have been overlooked and have therefore not been deemed important to the process. As we have argued throughout this thesis, one of the key aspects to establishing a living lab is the use of participatory design. The issue might be the state which the LLN project is in right now. Though, as the project leader stated, a clientele focusing on actual consumers would help the EUDP application to be accepted. Through the analysis we have stated that the actors involved in the LLN project, do not see the ordinary citizens as an end-user in the smart grid process, but see utility companies as the primary target group and end-user.

These statements differs from the EUDP applications perception of end-users but correlates with the reflected target group. In the EUDP application it is stated that the main target group is the utility companies who can benefit from the project by gathering the knowledge and test the monitoring of a distribution grid. In the EUDP application there is an aspect of consumers being a part of a target group because there is an increase in these users who are willing to implement battery storage to solar installations. It is the basis of the project to make it possible to apply the demonstrated technologies from LLN onto existing technology. The lack of actual end users in LLN could prove to complicate the future end goal of the project, because the end users have not been established and therefore must be found at a later point in the process, where it might be too late.

9.2 Energibyen as a gatekeeper

During the process of the master thesis, a change of direction was made, which meant that we moved from the Innovate project, concerning making a one-stop-shop for house energy refurbishment, to a project concerning establishing a living lab at Knivholt Hovedgaard in Frederikshavn. During our meet ups with Energibyen regarding this new project, Energibyen spoke as they were the project leader of project, and they could supply us with the required contact information of the actors.

However, a month went by, going back and forth with Energibyen regarding receiving the contact information, without success, and Energibyen said that they were not the actual project leader, and we had to contact the representative from AAU, and receive the information through him. This meant that Energibyen was not able to be our gatekeeper for the LLN project, and during our initiating meeting, the representative at AAU, thought that we were a part of Energibyen and collaborated with them, as a part of our master thesis which was not the case. Furthermore, this could potentially have influenced the representative's first impression on the agenda of our master thesis, and be a reason for the trouble we had during our data gathering. We had to make the initiating contact with the actor on our own. It can be discussed, whether this point of entry for our empirical findings could had been of higher quality if we started with the representative from AAU, and he chose to act as our gatekeeper. For instance this could have meant that we were able to reach the battery business that also is a part of the LLN project and include them in our project.

It can be summarised to gatekeeping, and the pros and cons it can imply. If the gatekeeper is not informed correctly, and hereby not qualified to support to the full extent, does not want to have the role of a gatekeeper or misunderstands what is required from them, it have an influence on the initiating fieldwork. Energibyen was either not informed correctly, or did not inform us correctly, and the representative from AAU, might have misunderstood our intentions, and was hereby uncertain how to assist us with our project.

9.2.1 Natives in the field

Working as researchers on this project we were mindful on how we were identified as researchers in the perspective of Energibyen. Having a history in the organisation it was apparent that Energibyen perceived us as natives, which meant that during the project process, we had to make sure to take several steps back from the organisation so that we were able to navigate in the field without prejudice (4.2).

This led to an early reflection on how we could avoid being affected by our previous work at Energibyen, so that we could enter the research field unaffected.

9.3 Lack of participation

During the process of this master thesis, it was evident that the actors objective were to only sustain the living lab with their systems, and have the systems work together in an integrated system, not for the actors to actually work together. It can be discussed whether this was because of the misconception of what a living lab is in practise, and not having the actors be an actual part of the living lab, but only their technologies.

The actors are able to gather data from the same data point, but are not actively discussing the data in between themselves. If Aalborg University analyses the data and concludes a potential pitfall or that the data is not providing correct results, they are not inclined to contact the other participants in the project, as it is not their data to adjust. They are merely collecting the data for their own analysis from the same place as the rest of the actors.

Instead of getting different fields of expertise to work together on the same data set and thus reach a potential higher understanding through the inter disciplinary potential, they may use their expertise for their own good to collect the results each actor would like. This could be a consequence of them working individually on their own goal, instead of working towards a common goal of improving their technologies together and reaching a higher level of understanding. What premises LLN needs to fulfil before they could establish an actual living lab will be delved into, in future prospects 11

9.3.1 Change of status quo

We wonder, whether Energibyen and AAU, have discussed previous project regarding living labs before diving into the LLN. As mentioned in the beginning of this thesis, Energibyen is working on a project where they seek to encourage citizens to refurbish their households with sustainability in mind. They received this project primarily based on, they selling themselves as being in touch with their citizens in the municipality, and understanding their thought process. However, during that project, it was evident that they did not possess the needed knowledge of their citizens, and proved to be one of the key inhibitors of the Innovate project.

It could be discussed whether or not they had the focus on understanding the citizens, and gathering the correct knowledge of the citizens in the municipality before continuing the process of Innovate and establishing the One-stop-shop. However, the Innovate project could also prove to be a source of potential information of the citizens, they should move away from their authority role with the complete set of knowledge, and instead act out from the perception that they were researching to receive data on the users through projects like these. It became clear that they were required to go from a monologue to a dialogue and incorporate the citizens in the process as a potential solution.

This can be related to the possible pitfalls of establishing the LLN at Knivholt, without having the thoughts of end-users in mind, and primarily focusing on the respective actors involved. Therefore, the discussion will end with the thought process we had throughout this master thesis; is the LLN project living up to the terminology of a living lab?

10 | Conclusion

In the conclusion we aim to answer the question asked in the problem statement (2.2.1).

By collecting empirical data throughout the methodological work involving the actors in Living Lab Nordjylland and researching existing living labs around the world focusing on different aspects of technology and users, we have managed to condense the living lab formula into the focus points, that are relevant and have been used in each of the completed living labs. Combining the condensed living lab formula with the empirical data collected, it has been made clear, that the actors have not been certain as to what the term living lab is.

By applying existing theory to the design map, we have defined exactly, where Living Lab Nordjylland fails to position themselves as an actual living lab as well as defining the terminology of a living lab into a visual and easy to understand model, that can be applied to future projects regardless of actors involved as long as they follow the points regarding setting, actors involved and end-product. The points have been elaborated upon earlier on in the project (8.5.2), but are illustrated below as well.

- Co-creation
- Real life setting
- Participation
- Common problem
- Common goal

Using the illustrated model and defining the above mentioned points will provide proper grounds for creating a living lab regardless of context. The definition was based on the theoretical aspects, empirical findings and our knowledge as techno-anthropologist in this master thesis to define and mediate a living lab in practise, into a condensed and easy to understand terminology regardless of actor. This was then used upon the LLN to analyse on whether or not LLN could be understood as an actual living lab in practise and to further demonstrate how an actual living lab could work in practise, based on our redefinition.

11 | Future prospects

To add to the conclusion, it is interesting to look into, what might happen in the future, when Living Lab Nordjylland begins in a practical sense and not on paper, and what possibilities the LLN project has towards facilitating a living lab.

One of the first things, that come to mind, when talking data collection and the data involved is, as has been described before, the lack of co-creation between the involved actors. The premise as of right now is a collection of systems located at the same location, but not a system of systems, wherein the involved actors can share their experiences and thus create a better product. This is because of the lack of a common goal. If we were to change an aspect of the project, it would be to include meetings within the committee including all actors involved in the project. The meetings could be bi-weekly or bi-monthly depending on how quick the project moves forward (5.4.2). By having these meetings combined with a common goal, the end product - the smart grid at Knivholt Hovedgaard - will be a more complete product, as potential pitfalls within the project will be able to be discussed at the meetings, where potential solutions can be investigated and thus help keeping the focus on the common goal and not the problems.

If they were to include end-users in the project, as is not the case right now, the project would be able to go from small scale at Knivholt Hovedgaard and to a larger scale such as Frederikshavn Municipality or the like. Concluding a project on a larger scale can then be further implemented in other parts of the region and potentially even nationally or globally.

Another future prospect regarding our definition of the living lab terminology is, if it was to be accepted as the defacto definition of a living lab. If this was to be the case, it could help counter the term being used as a buzzword, as it is an easy to comprehend and, hopefully, wide-spread terminology describing the premise of living labs in practice. If this were to be the basis definition of a living lab in practise, it could categorised different use case scenarios, such as technology, usage behaviour, development, innovation and urban design.

12 | Bibliography

Articles

Bartunek, Jean and Bartunek (1984). "Changing Interpretive Schemes and Organizational Restructuring: The Example of a Religious Order". In: *Administrative science quarterly* 29.3, p. 355. ISSN: 0001-8392. URL: https://sfx.aub.aau.dk/sfxaub?ctx_enc=info%3Aofi%2Fenc%3AUTF-8&ctx_tim=2019-02-23T17%3A31%3A55IST&ctx_ver=Z39.88-2004&frbrversion=6&req.language=dan&rfr_id=info%3Asid%2Fprimo.exlibrisgroup.com%3Aprimo3-Article-proquest&rft.artnum=&rft.atitle=Changing+Inte.

Cenfetelli, Ronald (2018). "Inhibitors and Enablers as Dual Factor Concepts in Technology Usage". In: *Journal of the Association for Information Systems* 5.11, pp. 472–492. ISSN: 15369323. DOI: 10.17705/1jais.00059. URL: https://aisel.aisnet.org/jais/vol5/iss11/16/.

Davis, Fred D. and Viswanath Venkatesh (2004). "Toward preprototype user acceptance testing of new information systems: Implications for software project management". In: *IEEE Transactions on Engineering Management* 51.1, pp. 31–46. ISSN: 00189391. DOI: 10.1109/TEM.2003.822468. URL: http://ieeexplore.ieee.org/document/1266852/.

Dell'Era, Claudio and Paolo Landoni (2014). "Living Lab: A Methodology between User-Centred Design and Participatory Design". In: *Creativity and Innovation Management* 23.2, pp. 137–154. ISSN: 09631690. DOI: 10.1111/caim.12061. URL: http://doi.wiley.com/10.1111/caim.12061.

Hæstrup, Theis, Jens Nygaard Rasmussen, and Michael Riis Allesøe (2018). "One Stop Shop". In: *Project in an External Organisation* 1.1, p. 83. ISSN: 0002-2667. DOI: 10.1108/aeat.2006.12778aab.007.

— (2019). "Initiating meeting". In: *Interview*.

Salamon, Halvard, Simon Lex, and Torbjörn Friberg (1990). "Kovergens på tværs af velfærdsstaten". In: *Tidsskriftet Antropologi* 0.72. URL: https://tidsskrift.dk/tidsskriftetantropologi/article/view/105617.

Sanders, Liz (2008). "ON MODELINGAn evolving map of design practice and design research". In: *interactions* 15.6, p. 13. ISSN: 10725520. DOI: 10.1145/1409040.1409043. URL: http://portal.acm.org/citation.cfm?doid=1409040.1409043.

Scavenius, Theresa (2018). "Climate Change and Moral Excuse: The Difficulty of Assigning Responsibility to Individuals". In: *Journal of Agricultural and Environmental Ethics* 31.1, pp. 1–15. ISSN: 1187-7863. DOI: 10.1007/s10806-018-9705-z. URL: http://link.springer.com/10.1007/s10806-018-9705-z.

Sharp, Darren and Robert Salter (2017). "Direct impacts of an urban living lab from the participants' perspective: Livewell Yarra". In: *Sustainability (Switzerland)*. ISSN: 20711050. DOI: 10.3390/su9101699.

Venkatesh, Viswanath and Fred D. Davis (2000). "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies". In: *Management Science* 46.2, pp. 186–204. ISSN: 0025-1909. DOI: 10.1287/mnsc.46.2.186.11926. URL: http://pubsonline.informs.org/doi/abs/10.1287/mnsc.46.2.186.11926.

Westerlund, Mika and Seppo Leminen (2018). "Managing the Challenges of Becoming an Open Innovation Company: Experiences from Living Labs". In: *Technology Innovation Management Review* 1.1, pp. 19–25. ISSN: 1927-0321. DOI: 10.22215/timreview/489. URL: https://timreview.ca/article/928?fbclid=IwAR1MH6niBIq7Yg7nE8_hAq3fecdJ9P1WKkWILlGCyJgycrpvPMVGOTJSTOo.

Books

Ballon, Pieter and Dimitri Schuurman (2015). *Living labs : concepts, tools and cases*. Emerald Insight, p. 93. ISBN: 1785604260.

Chesbrough, Henry, Wim. Vanhaverbeke, and Joel. West (2006). *Open Innovation: Researching a New Paradigm*. Oxford University Press, pp. 1–12. ISBN: 0199290725. DOI: citeulike-article-id:5207447.

Fogsgaard, Morten Kusk and Manon de Jongh (2018). *Ledelse og samskabelse i den offentlige sektor*. Ed. by Morten Kusk Fogsgaard. 1. udgave. Kbh. : Dansk Psykologisk Forlag, pp. 332–361.

Kvale, Steinar (2015). *Interview : det kvalitative forskningsinterview som håndværk / Steinar Kvale, Svend Brinkmann*. 3. udgave. Kbh: Hans Reitzel. ISBN: 9788741263779.

Levenda, Anthony M (2018). *Urban Living Labs : Experimenting with City Futures*. English. Routledge, pp. 1–263. ISBN: 978-0-415-30755-0. DOI: 10.4324/9781315230641. URL: https://sfx.aub.aau.dk/sfxaub?+bulkeley%2C+harriet=&+mai%2C+lindsay=&+mccormick%2C+kes=&+voytenko+palgan%2C+yuliya=&ctx_enc=info%3Aofi%2Fenc%3AUTF-8&ctx_tim=2019-04-

30T16%3A30%3A20IST&ctx_ver=Z39.88-2004&req.language=dan&rfr_id=info%3Asid%2Fprimo.exlibris.
Nørreklit, Lennart, Bo Prangsgaard, and Stig Løkke Pedersen (1983). *Aktørsmetoden : en indføring i erhvervsøkonomisk projektarbejde*. Aalborg Universitetsforlag. ISBN: 8773072508. URL: https://vbn.aau.dk/da/publications/akt%C3%B8rsmetoden-en-indf%C3%B8ring-i-erhvervs%C3%B8konomisk-projektarbejde.
Riis, Ole (2005). *Samfundsvidenskab i praksis : introduktion til anvendt metode / Ole Riis*. 1. udgave. Kbh: Hans Reitzel. ISBN: 8741203631.
Spradley, James P. (2003). *The ethnographic interview*. Holt, Rinehart and Winston, pp. 35–48. ISBN: 0030444969. URL: http://books.google.com/books?hl=en&lr=&id=srmFY4sbkRgC&oi=fnd&pg=PA35&dq=The+Ethnographic+Interview&ots=UMMmoGTelr&sig=fDyoH07pKibCjJ-mFOAyZMtPKZ4%5Cnhttp://books.google.com/books?hl=en&lr=&id=srmFY4sbkRgC&oi=fnd&a.

Websites

Dansk Fjernvarme (2017). *Fakta om fjernvarme*. URL: https://www.danskfjernvarme.dk/presse/fakta-om-fjernvarme%20http://www.danskfjernvarme.dk/presse/fakta-om-fjernvarme.
Energi -og Olieforum (2015). *Oliefyr stadig tilladt - sådan er reglerne - Altinget: energi og klima*. URL: https://www.altinget.dk/energi/rssitem.aspx?id=1170189.
Energibyen (2012). *Handlingsplan for vedvarende energi 2030*. URL: https://frederikshavn.dk/politik/byraad/politikker-og-visioner/handlingsplan-for-vedvarende-energi-2030/.
— (2018). *Energibyen - den grønne døråbner | Energibyen Frederikshavn*. URL: http://energibyen.dk/energibyen-den-gr%C3%B8nne-d%C3%B8r%C3%A5bner.
— (2019). *Energy Trail Knivholt | Energibyen Frederikshavn*. URL: http://energycity.dk/energy-trail-knivholt.
Energibyen Frederikshavn (2019). *Innovate | Energibyen Frederikshavn*. URL: http://energycity.dk/innovate.
Energy Cities (2017). *Energy cities - The European association of local authorities in energy transition*. URL: http://www.energy-cities.eu/.
EnergyLab Nordhavn (2018). *EnergyLab Nordhavn - fremtidens energi system*. URL: http://www.energylabnordhavn.com/%20http://www.energylabnordhavn.com.
Europa-Kommissionen (2019). *Borgmesterpagtinitiativet*. URL: https://www.borgmesterpagten.eu/om/borgmesterpagt-initiativet/oprindelse-og-udvikling.html.

European Commission (2019). *About the Covenant of Mayors*. URL: https://www.covenantofmayors.eu/about/covenant-initiative/objectives-and-scope.html.

Green Tech Center (2018). *GTC Energy Lab*.

GreenLab Skive (2019). *GreenLab Skive - A new approach to green gas and business*. URL: http://www.greenlabskive.dk/#introduction.

Horizon (2019a). *About the project | SMILE*. URL: https://www.h2020smile.eu/about-the-project/.

— (2019b). *What is Horizon 2020? | Horizon 2020*. URL: https://ec.europa.eu/programmes/horizon2020/en/what-horizon-2020.

Innovate (2019). *In a Nutshell - Financing Building Renovation*. URL: http://www.financingbuildingrenovation.eu/.

Jens Fieldnotes (2019). *Fieldnotes*.

Michael Fieldnotes (2019). *Fieldnotes*.

Nord Energi Net A/S (2019). *Nord Energi Net A/S*. URL: http://www.nordenerginet.dk/page958.aspx.

Regeringen (2018). *Sammen om en grønnere fremtid - Regeringen.dk*. URL: https://www.regeringen.dk/nyheder/miljoe-og-klimaudspil/.

The Danish society for Nature Conservation (2018). *Klimakommuner - Danmarks Naturfredningsforening*. URL: https://www.dn.dk/om-os/projekter-og-kampagner/klimakommuner/.

Theis Fieldnotes (2019). *Fieldnotes*.

United Nations (2019). *The Paris Agreement | UNFCCC*. URL: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement.

13 | Appendix

Grundlæggende spørgsmål		- Fortæl lidt om dig/jer selv
		  - Uddannelse?
		  - Stilling?
		- Hvad arbejder jeres virksomhed/afdeling med?
		- Hvordan var virksomheden indgangsvinkel til Living Lab Nordjylland?

Teori	Tema	Spørgsmål

Living Lab Theory
Participatory design
	Kendskab til Living lab
	&
	Motivation til projektet
		- Hvordan forstår/fortolker du Living Lab princippet?
		- Hvad har motiveret jer til at deltage/være kommende deltager i LLN?
		- Hvad er jeres interesse i projektet?
		  - Hvad er jeres mål for projektet?
		  - kan i nævne nogle nye aspekter i dette projekt, som i ikke har set/afprøvet før?
		  - Problematikker i kunne se der kunne være på nuværende tidspunkt?

Technology acceptance
Participatory design
	Slutbruger	- Ser i nogle problematikker i forhold til end-user (forbruger)?
		  - Rekruttering
		  - Indsamling af data
		  - Samlede salgsløsninger
		  - Forståelse af produktet
		
		- Indenfor dette felt, hvem synes i der skal tage de første skridt?
		  - Forbrugerne? (Begrund)
		  - Virksomhederne? (begrund)
		  - Offentlige instanser? (begrund)
		  - Eller skal der efterstræbes et sammenspil mellem alle 3 aktører?

State of the art	Erfaringer indenfor andre projekter	- Har i forsøgt jer med andre projekter lignende dette? (måder at inddrage forbrugerne på)
		  - Har living lab været en da af forhenværende projekter?
		  - Hvilke problematikker har i mødt?
		-

Profile description:
This description will cover both informants at Energibyen, to achieve the highest possible anonymisation. As the informants presented themselves one of the informants spoke about him having main task of connecting the municipality, businesses and citizens in every different aspects. The other informant at Energibyen has the task of obtaining relevant projects, concerning a somewhat sustainable subject parameter.

Resumé of insights:
Energibyen has a know-how on how to deal with projects where different actors are involved. They have shown the outcome of several for example implementing “bio-busses” in the municipality, where different aspects had to be unified for the project to be implemented. That is why they have chosen to agree upon taking in the LLN project, and grant their facilities to the project.

Energibyen had already been in a reflexive position, and saw the harbour of Frederikshavn as a possible taker/end-user for such a product, that is the mini-smartgrid, but were still keen to see the outcome of LLN.

Their ambition for the project is to see a unified system of different sources of sustainable power, which hopefully will drive businesses around Frederikshavn municipality.

Field observations:
The meeting was held at Knivholt manor, the headquarter of Energibyen, located in Frederikshavn. The location is as mentioned in the thesis, where the LLN is

Theme 1	Theme 2	Theme 3
Living Lab Theory, Participatory design Knowledge of the living lab - Motivation for the project	State-of-the-art Experiences from other projects	Technology Acceptance Model & Participatory design End User

"Det er vores indtryk, at det er der en masse teori om, man kan lave nogle simuleringer, men praksis viser, at det her faktisk er svært - Når der skal helt ud på brugerfladen" *"Hvis vi kan få det (LLN) op at stå, så har vi en forhåbning om at vi får et netværk som kan genere - I det lange perspektiv handler det om at vi generere nogle aktiviteter som vores virksomheder kan drage nytte af."* *"Vi kan og skal med dette, fortælle vores historie, om vores bidrag til den grønne omstilling"* *"Vi har en facilitet vi stiller til rådighed"* *"Det vores indtryk er, er at AAU netop ikke har en praktisk facilitet"* *"Smart-Grid og vores virke er - at kunne komme de teknologiske løsninger i møde"* ***LIVING LAB:*** *"Det hedder et living lab, fordi det er et laboratorie, nok i mini-format, men i bevægelse, det er noget der skal udvikle sig"* *"Vi går igang, og så møder vi nogle udfordringer, også teknologisk, og så skal vi sammen med vores lokal virksomhederog akademikerer finde løsninger til at få det til at virke"*	*"Det X gjorde i forhold til at få de biogas drevende busser herop, er et rigtig godt eksempel på det mind-set der ligger bag"* *"Vi har forenet parter, én der vil levere gas, en gas-fylde-station og nogle kommuner, og lige pludselig har man basis for at skabe noget der ikke er eksisterende"* *"Det er vigtigt at de parter der sidder rundt om bordet, kan se fordelene for sig selv når de går ind i det - Det behøves ikke kun at være økonomisk, det kan også være at de vil ind i bæredygtig omstilling"* *"Vi er jo i gang nu med at have en til at kortlægge hvad energiforbruget er i de enkelt rum heroppe (Knivholt)"*	*"Først når mini-smartgrid er på plads, kan vi opskalere og der vil den første kunde være en given forsyningsvirksomhed, og vil være de primære kunder"* *"Den første er den der leverer energien, og så må de leverer nogle gulerødder så forbrugeren vil byde på at ville have (det her, og det her og det her)"* *"Det bliver en mere udviklet måde at være forbruger på, hvis vi skal holde liv i 100% vedvarende energiforsyning"* *"Der eksisterer allerede mange teknologier, men det er ikke sammenhængende - Det er det der er idéen med Living Lab"* *"Bæredygtig udvikling og grøn vækst kommer ikke af sig selv, nogen skal være front-runners"* *"Det er helt oplagt for os som offentlig foretagende, at lægge op til at bringe parter sammen på et projekt, giver og får sparring"* *"Jeg ser for mig en Frederikshavn Havn som kan etablere det her"*

"Det er et arbejdende værksted, uden vi kender svaret på forhånd, det er hvor vi tester og simpelthen prøver nogle ting af i praksis" *"Det er det virkelighedsnære der kommer i spil i forhold til at lave en simulering"* ***Ambition:*** *"Ambitionen er at få skabt et sammenhængende, afbalanceret system for både monitoring men også regulering af et samlet vedvarende energisystem i mini-format"* _____ *"Jeg kender ikke et vedvarende energisystem, som lægger op til det samme som det her, i praksis"* *"Alt er baseret på teori og studier - alt er baseret på computer simulerede programmer"* *"Os bekendt kender vi ikke til noget, hvor elektricitet og varme arbejdes ind i samspil"* *"Der er nogle problematikker i at vedvarende energikilder ikke altid kan levere, når der ikke er sol og der ikke er vind"* - *"Når der er overskud af el, hvordan vi få det lagret"* *"Der eksisterer allerede mange teknologier, men det er ikke sammenhængende - Det er det der er idéen med*		- *"Når vi er færdige med Knivholt, så kører der et projekt nu, om at få sat et afbalanceret vedvarende system på havnen"*

Living Lab - At skabe sammenhæng mellem produktion og forbrug på en intelligent måde”		

]

Profile description
The informant had been working for Kamstrup for little more than a year, as a software developer. He was calm, reflexive and interested in having a running dialogue throughout the interview.

Resumé of insights
The informant had some trouble defining what a living lab is. He was however, more inclined to call the project they were working on, as more of co-creation then living lab, to which he also said that the term was easy to him, more of a buzzword, that people threw around. He did also confess to actually not being sure of the meaning of a living lab. Their objective in the project, will be to receive data from other components such as heat and wind energy parameters, which they have not had the possibility to gather in a complete package, yet.

Field observations
The interview was conducted over Skype. It sounded like he was part of an open office space, which made some noise, but it was possible to hear the informant clearly throughout the interview.

Theme 1	Theme 2	Theme 3
Living Lab Theory, Participatory design Knowledge of the living lab - Motivation for the project	State-of-the-art Experiences from other projects	Technology Acceptance Model & Participatory design End User

"Vores opgave overfor forsyningen, er for at sørge for at der er en ordentlig strøm og spændingskvalitet til forsyningsselskabet" *"Det er en udfordring når der skal reguleres ud fra fluktuerende energikilder"* - *"Vi producerer kun strøm som vinden den blæser"* *"Det er blevet lidt af et buzzword og et synonym for at vise, at man er tværfaglig"* *"Man er nogle gange lidt hurtig til at sætte det mærkat på, det hedder living lab"* *"Jeg vil forklare det (living lab) som et samarbejde vi går ind" (..)* *"Altså jeg tror faktisk slet ikke jeg vil bruge ordet living lab - jeg vil sige at det er samarbejde mellem Frederikshavn Forsyning, Aalborg universitet, og kamstrup"* *"Man kan vel godt kalde det for et living lab - det vil jeg nok helst navigere udenom"* - *"Jeg vil hellere sige at det er samarbejde mellem tre aktørere"* *"Jeg tror egentlig ikke helt jeg forstår hvad living lab egentlig helt indebærer"* *"Der har siddet nogle brandingfolk og fundet på det der term"* *"Med living lab er det første gang jeg støder på begrebet*	*"Der er forskellige Living-Labs rundt omkring i Danmark"* *"Vi har da noget erfaring"* *"Vi vil gerne bruge det her projekt til at sammenligne med tidligere erfaringer"* *"Net 2 dg projektet har vi sammen med Aalborg Universitet"* - *"Det projekt omhandler brugen af eksisterende teknologier til at lave et smart-grid"* *"Det vi har haft lidt at gøre med, er det der hedder Energyhub Nordhavn, som ligger ovre i København"* *"Der kommer også noget tilsvarende nede i Vejle, der hedder Testcenter Danmark, eller sådan noget"*	*"Aalborg Universitet er interesseret i at lave software og lave styringsprocesser"* *"Kamstrup kan leverer eventuelle målere, vi er sådan lidt technology provider"* *"Vi skal lave noget intelligent styring sådan så folk ikke skal tænke over det"* *"Det er kun de ekstremt entusiastiske folk der siger at de kan spare tre øre pr. kilo watt-time"* *"Kan vi måske omdirigere sådan så nogle mennesker kan bruge strømmen på nogle af de billigere tidspunkter"* *"Jeg tror det er fra politisk side der skal skubbe lidt"*

]