EXPLORING THE FACTORS INFLUENCING ORGANIC WASTE SORTING IN DENMARK

An Interactive Qualifying Project

ABSTRACT

Biogasification harvests energy from recycled and treated food waste. Sorting food waste is key to Denmark's goal of recycling 50% of household waste by 2022. This project, sponsored by Dansk Affaldsforening, researched practical and motivational factors influencing Danish sorting of household food waste through interviews with citizens and waste sector experts, waste treatment plant site visits, two surveys and a social media photo survey. Our recommendations for an effective campaign to sort waste include: give clear, simple information; show results to intrinsically motivate people; and focus on children to perpetuate the habit. These results yield valuable insights for Dansk Affaldsforening's members for implementation of future food waste sorting campaigns.

Mei Lee Amend, Ryan Bagge, Andres Leiro, & Jason Ward

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Exploring Factors Influencing Organic Waste Sorting in Denmark

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owm-d14@wpi.edu

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Submitted By:

Mei Lee Amend
Ryan Bagge
Andrés Leiro Fonseca
Jason Ward

Submitted to:

Dansk Affaldsforening
Copenhagen, Denmark

Professor Steven Taylor
Professor Robert Kinicki

Executive Summary

Organic waste is the biodegradable component of the waste stream and can be broken down into simpler components by microorganisms. In 1998, the Danish Government released Waste 21, a waste management plan that announced raised targets for recycling rates, which required the separate collection of bio-waste and increasing the collection of paper and glass. Now 15 years later, the Danish Government has released a new waste management plan, dubbed *Denmark without Waste*. In conjunction with the European Union's waste hierarchy, shown below in Figure 1, Denmark is seeking to incinerate less and recycle more, exploiting the energy in waste even more efficiently than it is now.

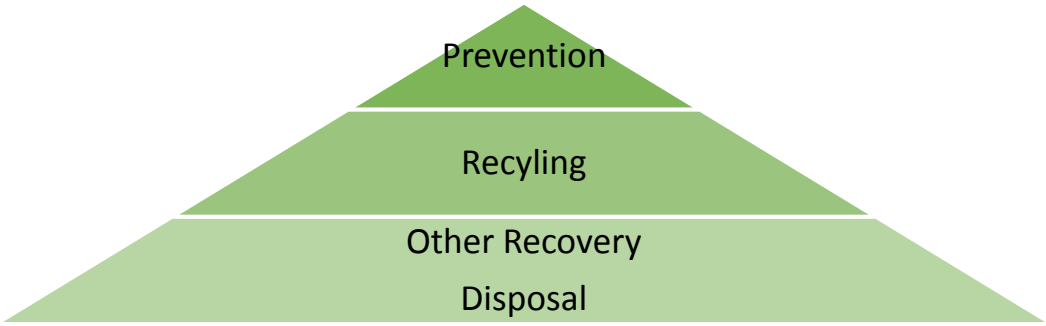

Figure 1: Waste Hierarchy

As a greater demand is placed upon the recovery of material and energy resources, Denmark aims to have waste incineration play less of a role. In 2012, the Danish Parliament passed the Danish Energy Agreement, which aims to produce 35% of Denmark's energy through renewable resources, like biogas and wind. Denmark's current waste management plan emphasizes the view of seeing waste as a resource. In the words of Ida Auken, former Danish Minister of the Environment, "We have become too good at incinerating and too bad at recycling." Thus in order to satisfy Denmark's goal to recycle 50% of household waste by 2022, methods of sorting organic waste for recycling, and motivation must be identified and provided.

Goals, Objectives, and Methods

The goal of this project was to assist Dansk Affaldsforening in understanding the practical and motivational factors that influence sorting household food waste in Denmark. In order to do this, the team focused on assessing organic waste sorting practices already in place, and discerning the public view on sorting organic waste within the household. The team investigated the barriers and motivations that affect how residents participate in a waste sorting system. The Facebook survey submitted to

12,000 followers of Nulskrald asked questions such as, “What challenges do you face?” and “What motivates you to sort?” in an effort to further this investigation. These surveys, and the interviews that supplemented them, resulted in the creation of insights that can be used to create a more successful and sustainable system of sorting.

To attain the project goal, we accomplished four objectives:

1. Understanding organic waste sorting techniques and practices within Denmark
2. Investigating perceptions of householders concerning organic waste
3. Learning from other waste management awareness programs
4. Analyzing the results gathered and reporting our findings.

We used these objectives in the process of our methodology. Each of the first three objectives occurred simultaneously to create insights that are both accurate and useful. By waiting until these objectives were accomplished before conducting an analysis, we ensured the formation of accurate and supported conclusions. This process is shown below in Figure 2.

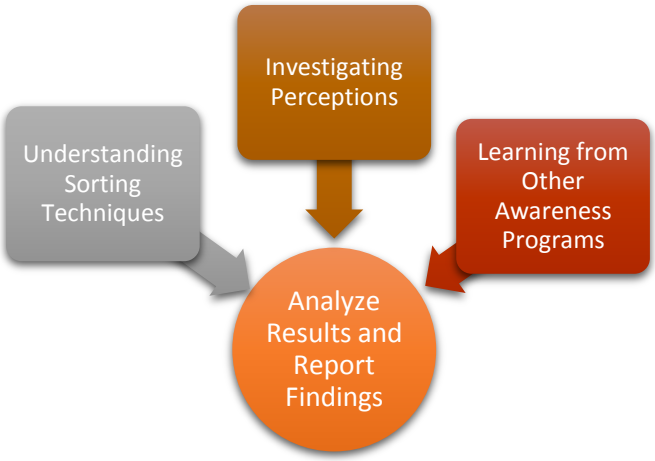

Figure 2: Methodology Implementation of Objectives

Objective 1: Understanding Organic Waste Sorting Techniques and Practices within Denmark

Our first objective was to gain an understanding of the current waste sorting techniques and practices employed in Denmark and Sweden. By investigating the successes and barriers to sorting strategies already implemented, we used history and experience in conjunction with our own findings. Previous research in biogasification, the process by which organic waste becomes usable methane, provided a sufficient understanding to conduct interviews with biogas plants and municipalities alike.

Objective 2: Investigating Perceptions of Householders Concerning Organic Waste

The second objective was to investigate the perceptions of typical householders in the area of sorting organic waste within the home. Although interviews and case studies within the population were performed, the team focused on conducting three surveys within Tversted, Høje-Taastrup, and online, via a Facebook page with 12,000 likes at the time of this project.

Objective 3: Learning from Other Waste Management Awareness Programs

The third objective was to learn from information campaigns and waste management awareness programs conducted. The team traveled to Tversted and Malmö, Sweden to investigate both the Nulskrald movement and Tack för Maten campaign. In both cases residents sorted organic waste separately from the residual waste stream, however the approaches were different. The Swedish campaign employed a 'top-down' method where the government managed all aspects of the system, and participation was mandatory. Tversted utilized a 'bottom up' method, where the campaign provided the population with relevant information, and it was up to the citizens to create their own household organic waste sorting system.

Objective 4: Analyzing the Results Gathered and Reporting our Findings

The team gathered data continuously throughout this study. This data included interviews, surveys, and site visits. Residents of Tversted, followers of Nulskrald's Facebook page, and customers of IKEA were surveyed to investigate their perceptions of household waste. The team analyzed the interviews and site visits through an open coding system, and the surveys were examined through comparing demographic information with the resident's motivations, reluctance, and reasons for sorting waste.

Findings:

Evaluations of the results lead to a series of findings. First, Peter Brønnum told us that, **"Our challenge is not to get a purer fraction. Our challenge is to get a larger mass."** Biogasification plants such as BioVækst use methods of separating plastic impurity from the organic waste. Although reducing the impurities present within organic waste will reduce the cost of the system, it is more important to BioVækst that residents separate a larger percentage of their total organic waste, so that less potential material is incinerated.

Second, **patience must be used in the formation of a sorting system**. When Dansk Affald created a system of organic sorting among 300 random households, there was initial reluctance to take part. People often expressed that they did not have the time or energy to sort. However, by the end of

the study, impurities were below 1%, and residents asked who they should vote for to continue the sorting system.

Third, **people desire a pre-made system for sorting within the kitchen**. From the surveys conducted, 88% of respondents opined that they desired a system provided to them, rather than to create their own system from provided information. People were evenly split (44%) between a system given to them including bags and bins and a system given to them with different options available. Only, 12% chose creating their own system but they want the campaign to provide the relevant information in order to do so.

Fourth, **paper and biodegradable bags have the highest purity of sorted organic waste.** Paper bags have a greater than 99% pure organic waste fraction, meaning that more than 99% of the waste placed within them was organic matter, separated from the garbage. Biodegradable bags were a close second at 98%. When people see the paper or different nature of the biodegradable bag, they realize that plastic and other impurities should not be placed inside them.

Fifth, **clear, understandable information and simple explanations allow people to sort.** Information campaigns should provide distinct and understandable information to residents to allow them know the proper material to sort from their residual waste into the organic fraction. By using simpler phrases like 'food waste' rather than organic, using consistent colors and symbols and passing information to representatives within the household residents will know what is organic and what is not, reducing the amount of impurities within the collected organic waste fraction.

Last, **providing motivation to the population encourages participation.** Although information is key in allowing residents to understand what they should sort, campaigns should provide motivation to encourage this sorting. By using factors like politics, economics, and social pressures residents will be motivated to use the knowledge they have and apply it. Although every person is different, a combination of these factors will likely be successful in motivating them. By using motivation in conjunction with information, residents will know why they should sort their waste, increasing the amount of organic waste separated from the residual waste stream.

Insights:

Based on the findings and researched background information, we created a list of three insights for our sponsor, Dansk Affaldsforening, their members, and future researchers. We believe these insights are the basis upon which household sorting can be implemented.

1. **Sorting is social**. When sorting becomes a part of everyday life, people accept it as an efficient and popular solution. By using peer-to-peer interaction and conformity within a closed population, residents can be motivated to sort their waste through intrinsic rather than external motivating factors. Additionally, these same factors maintain a clean sorting of waste within the population for a period after any extrinsic influence is removed, due to the formation of habit and the peer pressure that is associated with being in a community that sorts.
2. **Children create a closed-loop**. Teaching children what organic waste is and how to properly sort it into a different fraction creates a closed-loop system for organic waste. As these children grow and develop, they transform from children who sort into adults who sort. In turn as they have children themselves, they will instill their children with the same values they learned including a desire to sort waste cleanly and effectively. Although this focuses on a long-term result rather than a short-term one, by influencing the children of today, the adults and children of the future can perpetuate the system.
3. **Information is key in the development of any sorting campaign**. In addition to making the information easy to understand for the residents who received it, the information must contain the reasoning behind why the municipality implemented the sorting system. Although residents will take part in a mandatory sorting campaign, instilling them with a sense of purpose and showing them the results of their sorting leads to the collection of a larger quantity of organic waste as well as a cleaner fraction.

Conclusion:

This project has the potential to be implemented in every municipality in Denmark. Due to the independent and unique nature of these 98 municipalities, the insights, discussion, and results of the surveys and interviews performed can be used to create distinct systems suited to the needs and challenges of each region. With Denmark's focus on recycling and using waste as a resource, a sustainable system of organic waste sorting must be implemented. By using the information, motivation, and factors identified in this report, municipalities in Denmark are one-step closer to becoming a zero waste society.

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1.0 Introduction

In the evolving economies of the world, resources are becoming increasingly limited and communities are producing waste at a rapidly increasing pace, which is predicted to triple within the next hundred years (Hoornweg, Bhada-Tata & Kennedy, 2013). Around the world, cities, farms, and suburbs are producing two billion tons of municipal solid waste (MSW) per year as of the new millennium (Giusti, 2009). In recent years, populations are viewing waste as a potential resource rather than a health or environmental concern. This has motivated initiatives to recover materials present within the waste, or if recycling is not available, to convert the waste into a usable material or energy, using systems such as incineration. Biogasification is a mix of the two, returning nutrients found in organic waste back to the soil as well as producing methane for heating and power. Given that different waste types require separate management systems, the collection of unsorted waste can be a major setback to using waste as a resource.

Denmark without Waste, the country's most recent waste plan, lays down Denmark's plans for future waste management. The plan proposes recycling a larger percentage of its waste, and moving toward becoming fossil fuel independent by 2050. In Denmark, 1.7 million tons of household waste is collected on a yearly basis, of which 700,000 tons is organic (Baky & Eriksson, 2003). Using incineration, Denmark has successfully reduced the waste sent to landfills and recovered energy in the form of electricity and heating, but to move forward with their plan, they need to harness the full potential of waste. In order to use this potential, several areas in Denmark started developing an infrastructure to support the biogasification of organic waste. Biogasification is a system that utilizes the natural decomposition of organic waste by microorganisms to produce phosphorus rich fertilizer and biogas, a methane rich gas commonly used as a fuel (Al Seadi, 2010). Most municipalities across Denmark do not have an organic waste sorting system currently implemented leading them to incinerate the waste instead, removing the opportunity of recycling the nutrients (Ministry of Environment and Energy, 1999).

As of 2011, about 25% of the total waste produced in Denmark was household waste, and 75% of that household waste is incinerated (Danish Government, 2013). With such a large amount of potential recyclable material incinerated, it seems logical to develop ways of maximizing the recovery of waste potential. On the national level, the government has set a goal to separate 300,000 tons of "wet"

organic waste, and double its current percentage of waste recycled by 2022 (Danish Government, 2013). In order to accomplish this goal, our sponsor, Dansk Affaldsforening (Danish Waste Association) is working towards understanding the details involved in motivating a large percentage of the population to cleanly sort organic material from the residual waste, the remaining garbage once all recyclable material has been removed. The goal of this project was to assist Dansk Affaldsforening in understanding the practical and motivational factors that influence sorting household food waste in Denmark. The team assessed organic waste sorting practices already in place as well as psychology concerning organic waste sorting at the household level.

2.0 Literature Review

International and Danish communities are currently facing a rise in waste production and increasing political demands for sustainable and environmentally friendly waste management. A need has arisen for the installment of new and more efficient methods of treating waste and the creation of an infrastructure to support biogasification. Additionally, the Danish Government has implemented a new model for waste management that focuses on treating waste as a resource rather than as an expendable factor.

This chapter gives an overview of the current organic waste management system in Denmark, and focuses on the sustainability goals and new directions in policy that have emerged. First, this chapter discusses the history of organic waste management in Denmark and the goals for the future. Second, the different methods of waste management are explored, comparing landfilling, incineration, and biogasification. Third, the Danish waste model and issues with biogasification are discussed and compared to incineration. Lastly, the chapter provides an understanding of several recognized systems of sorting, and a synopsis of the challenges associated with creating a system of sorting.

2.1 Organic Waste Management in Denmark

Using organic waste to produce biogas has the potential to reduce greenhouse gas emissions and contribute to Danish sustainability goals (Hoogwijk, van den Broek, Berndes, Gielen, & Turkenburg, 2003). In addition to recycling nutrients back into the environment, biogas could potentially become a major global primary energy source over the next century if countries around the world commit to developing the necessary infrastructure to make it a feasible energy source (Berndes, Hoogwijk, & van den Broek, 2003). As environmental awareness increases, a large number of countries are attempting to decrease their reliance on fossil fuels and their overall carbon footprint (Satre-Meloy, n.d.). Denmark is one of the leaders of this movement, however to accomplish its goal of becoming fossil fuel independent by 2050, a large amount of progress remains (Danish Government, 2013).

2.1.1 Sustainability Goals in Denmark

For decades, Denmark has been a leader in developing environmentally conscious policies and practices. The energy crisis of the 1970s significantly hampered the economies of a multitude of countries. As a result, Denmark moved towards becoming fossil fuel independent. In 1973, oil made up 92% of Denmark's energy consumption. After the oil embargo, Denmark vowed to one day become completely independent of fossil fuels, both foreign and domestic. In 2010, oil provided only 40% of the

total energy for the nation (Nordic FolkeCenter, 2010). After the crisis, Danes actively researched and developed renewable energy resources, with a significant focus on wind turbines and biogas. Currently, wind power supplies more than 20% of Denmark's electricity consumption (Lund & Mathiesen, 2009).

In 2012, the Danish Parliament passed the single largest environmental development plan in its history, the Danish Energy Agreement. This set in place ambitious goals to move towards a sustainable society (Gerdes, 2012). The Agreement identifies some short-term goals to achieve by 2020, such as aiming to produce 35% of Denmark's energy consumption using renewable resources such as biogas and wind (Ministry of Climate, Energy and Building, 2012). By 2050, Denmark plans to supply half its electrical consumption with wind power alone. This proposal is unique in that no energy agreement has ever experienced such a large support base within the Danish Parliament or covered such a long period of time (Gerdes, 2012).

Ultimately, Denmark wants to become fossil fuel independent by 2050 (Green Living, n.d.). One of the key aspects to Denmark's success in establishing large-scale sustainable practices is their policy making. Denmark offers compelling incentives to companies and families who adhere to environmentally friendly practices (Gerdes, 2012). A good example of this is Denmark's carbon-negative island Samsø. The Danish Government offered an appealing tax exemption policy to families that produce their own electricity. Thus, residents of Samsø started developing wind energy in the area, creating cooperatives through which they could manage their investment. (Larsen et al, 2005).

Part of Denmark's energy plan depends on the utilization of organic waste, with a focus on manure and food waste, which biogasification converts to fuel and potential energy. Using biomass, or organic waste, as an energy source allows for flexible electricity production, which is necessary to supply the grid when wind production cannot meet electricity demands at a given time. As of 2007, there were 19 centralized large biogas plants and 56 farm-scale plants in Denmark, producing around 2.6 Petajoules (PJ) (2.6×10^{15} Joules) of energy. Due to the lack of organic sorting, this clean energy production does not contribute highly to Denmark's gross energy consumption of around 800 PJ in 2012 (Ministry of Climate, Energy and Building, 2012; Birkmose, Foged, & Hinged, 2007). Although the percentage of energy produced is small, the country aims to expand the amount of waste it treats in these plants in the near future. The Energy Agreement of 2012 stresses the importance of ensuring biogasification expansion in Denmark by setting a goal of tripling the amount of biogas currently produced (University of Copenhagen, 2012). Through initiatives such as subsidies for biogas and increasing start-up aid for

biogas projects from 20% to 30%, Denmark has begun the process of expanding its biogas infrastructure (Ministry of Climate, 2012).

2.1.2 History of Organic Waste Management

Waste management in Denmark has slowly developed into the current resource management system. This system has a focus on, and a history of, incineration of waste spanning over 100 years with constant development and improvement (Copenhagen Cleantech Cluster, n.d.). Denmark viewed waste as a health and safety concern; consequently, the Dane's primary focus was removing and depositing their garbage in massive landfills outside their major cities. As time progressed, outdated methods of waste treatment such as landfilling have become less and less popular.

As awareness of the repercussions of dumping waste in landfills grew during the 1970s and 80s, environmental concerns developed as well (see Figure 3). This major shift occurred when people started viewing waste as an environmental issue rather than as a health issue (Kleis, Babcock, Volund & Dalager, 2003). Partly due to this increased awareness on the negative environmental impacts of landfilling, in 1973 Denmark became the first country in the world to pass an environmental protection law (State of Green, 2011). With rising political pressure, landfilling lost popularity and waste incineration and composting became the primary waste treatment solutions. Over the past 35 years, incineration has had numerous improvements in both the mitigation of its environmental impacts as well as its efficiency in the capture of heat and energy. Municipalities have gradually reduced the amount of waste sent to landfills, from around 20% of the gross waste produced in 1995 to less than 5% in 2010 (Danish Government, 2013). With increased international involvement and the gradual development of comprehensive Danish regulations concerning waste handling, Denmark became one of the first countries to achieve high recycling rates and minimized landfilled waste (Copenhagen Cleantech Cluster, n.d).

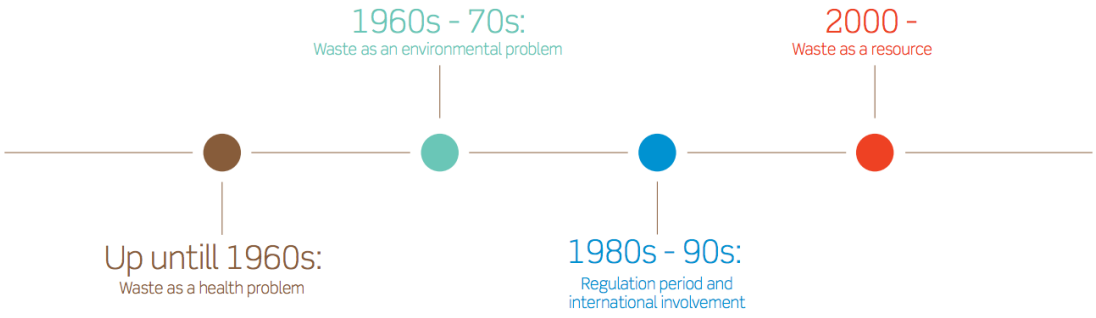

Figure 3: History of Waste Management in Denmark (Copenhagen Cleantech Cluster, inspired by DAKOFA's timeline, n.d.)

Until 2004, the Danish Government's plan for waste policy was termed *Waste 21* and focused on the quantitative aspects of waste management, such as the minimization and prevention of waste, and increased recycling throughout the country (Ministry of Environment and Energy, 1999). One of the key principles of *Waste 21* was to have more types of waste collected and treated separately to develop new methods of treatment. Additionally, new requirements forced local councils responsible for waste management to develop new and more efficient waste solutions across Denmark. Better quality in waste treatment is now necessary to minimize the spreading of environmental contaminants and to optimize the utilization of diminishing resources.

2.1.3 Waste Strategy 2005-2008

In 2004, Denmark published the Waste Strategy for the years 2005 through 2008. This strategy built on *Waste 21*, but started to shift the goals towards minimizing the loss of resources in the current waste management systems. This plan also focused largely on starting to minimize the environmental impact of the country's waste flow. According to the publication, this would be done by implementing new methods of measuring the amount of resources the country is using and the environmental impact this waste has (Danish Government, 2004).

This waste strategy also proposed a large push to eliminate the correlation between economic growth and increase in waste production. By identifying the factors responsible for the production of waste, the plan proposed a long-term reduction in the total waste produced. Furthermore, the strategy emphasized the importance of increasing the cost-effectiveness of sustainable policies and waste management practices and technologies.

2.1.4 *Denmark without Waste* – New Directions in Policy

In 2013, the Danish Ministry of the Environment published *Denmark without Waste - Recycle more, Incinerate less,* seen below in Figure 4, which provided a brief overview of the current system of treating waste and a statement of the Danish Government's goal to increase waste separation and recycle 50% of household waste by 2022. This new focus on waste is not only a result of the environmental and health and safety concerns brought about by the growing production of waste across the globe, but also due to a mounting limitation of resources. A shift must occur from seeing waste as an expense, or a leftover of production, to viewing waste as a resource.

Figure 4: Cover of Denmark's current waste plan

This transition from waste to resource still requires basic principles, such as the harvesting of the energy from the organic waste stream to be efficient and profitable, while simultaneously reintroducing the nutrients that the waste contains back into the agricultural soil for use in food production. Copenhagen Cleantech surveyed waste companies within Denmark about their views on waste and there was a good indication that the companies were in an ongoing transition from waste to resource management. The negative perspective that waste typically receives is increasingly changing towards seeing waste as a potential source of profit. As part of this research paper, Copenhagen Cleantech asked companies to state their financial expectations for 2012-2017 compared to their performance as of 2006-2011. Their responses showed that two-thirds of the companies had an increase in turnover, despite the global recession that they were experiencing at the time (Copenhagen Cleantech Cluster, n.d.).

Long before the implementation of the goals set forth in *Denmark without Waste*, the government had been looking for methods of moving the country towards reducing waste. An important component of this shift in strategy is facilitating industrial symbiosis between businesses. Industrial symbiosis is the sharing of resources between two companies in which the waste of one becomes the raw materials used by the other (Kalundborg Symbiosis, 2014). Kalundborg is one example of a municipality within Denmark that practices industrial symbiosis. This symbiosis not only helps each

company involved generate profit, but also ensures that all waste is re-entered into the industrial cycle as energy, nutrients, or materials for the next generation of production. By closing the loops of different waste streams, companies like Inbicon, a biogas producer, receive waste from the municipality, and convert it into energy and bioethanol. Inbicon sells this ethanol to Statoil, a Norwegian multinational oil and gas company, which exports its waste cooling water to DONG Energy Asnæsværket, which produces heat and energy through incineration of coal and sends its residual fly ash to Gyproc, an interior construction company, as input in the production of gypsum, a component of plasterboard (Statoil, 2010. Kalendborg Symbiosis, 2014). By combining the products of one company with the waste of another, Denmark has been able to create a system where energy efficient practices and economics work in harmony.

2.2 Waste Management Methods

Historically, studies have regarded the production of waste as an effect of industrial and economic development in societies. As populations grow and develop, waste management methods grow with them. Some methods are simple and involve essentially finding a space where waste is stored. Other methods have developed with more of an environmental focus, in which people try to get the most use out of their waste. This section provides a brief description of the most widely used methods, along with their major benefits and drawbacks.

2.2.1 Landfilling

For many years, landfilling has been the largest waste disposal method in Western Europe, with 57% of solid municipal waste landfilled in 1999 (Giusti, 2009). In 2010, around a dozen European Union countries landfilled more than 60% of their waste (Danish Government, 2013). Landfilling consists of depositing waste in a pre-defined space, usually abandoned quarries, or borrow pits, areas where soil has been removed for use at another location. This method is simple and relatively inexpensive, but it has inherent disadvantages. One of the major issues is if the process becomes mismanaged, the landfill has the capacity to have huge negative repercussions for the surrounding population and environment (Environment Protection Agency, 1996). Given the mixed composition of the waste placed within them, landfills inevitably release greenhouse gases such as methane into the atmosphere. Worldwide methane emissions from landfills have been estimated to range from 15 to 20 Teragrams (Tg) (1Tg=10^{12} grams) per year. Although a significant amount of landfill sites around the world implement a methane collection system, this collection system only amounts to around 5 Tg a year, allowing the remaining 10-15 Tg to contribute to the global warming issue. Methane is the third greenhouse gas in order of

abundance, after water vapor and carbon dioxide, and is responsible for a major amount of the greenhouse effect, being 20 times more impactful on climate change than CO_2 (Spokas et al, 2006).

Another significant drawback to landfilling as a method of waste disposal is water accumulation in landfills. Leachate is accumulated contaminated water, and if not contained, often has detrimental effects in the soil and any nearby water reservoir. This leachate has the capacity to become a major health and safety concern if it begins leaking into a water reservoir used for drinking water (Environment Protection Agency, 1996). Landfilling fails to fulfill the ideal of using waste as a resource because instead of dealing with rising energy costs and demands as the new Danish objective suggests, landfilling takes up valuable space that has the potential for more productive development.

2.2.2 Composting

Composting, a process very similar to biogasification, transforms biodegradable waste into a rich fertilizer. Composting methods vary widely as the process can be carried out in private homes as well as in industrial plants. Composting occurs when organic material is piled together and naturally occurring microbial organisms begin to decompose the material into heat and compost, or material which can be used to supplement the growing of plant material. This typically occurs over a span of three to 18 months, although industrial systems can complete the composting in as quickly as 90 days (Drapalova, 2004).

2.2.3 Incineration

Over decades of practice, Danes have become exceedingly proficient at waste incineration. The purpose of incineration is to reduce the volume and hazard of unsorted waste while capturing recoverable energy through combined heat and power (CHP). There are varieties of different technologies incinerators employ, but gate furnaces are the most common in Europe (Drapalova, 2004).

Incinerators operate on the basic chemical principle of oxidation with a combustible material. Although waste is a mix of water, organic, plastic, mineral, and metallic waste, the substances burn when they have reached the necessary ignition temperature and come in contact with oxygen, with a self-sustaining chain reaction occurring. This process requires no additional fuel once the waste begins to ignite. Flue gas released by the ignition process contains the majority of the heat used in CHP (Drapalova, 2004). CHP uses the heat released in the furnace to boil water for a power cycle. Steam generated in a boiler passes through a turbine to power a generator that produces electricity. The steam then goes to a heat exchanger, where it heats up water that provides heating to the city (*Copenhagen: Waste-to-Energy-Plants,* 2014).

Incineration can be controlled to maximize its energy output, and a large amount of research and effort has gone into maximizing the process's efficiency. However, a significant amount of effort is required to remove the hazardous byproducts of the incinerated waste. When not filtered, these gases are extremely harmful both to the environment and nearby populations. Additionally, the leftover ash, which is typically 20-30% of the weight of the municipal solid waste (MSW), is virtually useless being only useful as a construction aggregate (Renosyd, 2013). However, even this use has drawbacks, polluting the area it is used in due to its hazardous nature.

One of the major drawbacks to using incineration as a method of waste disposal is that a significant amount of municipal solid waste is organic and naturally contains large amounts of water. This kind of waste, which is mostly food waste, will not burn easily due to its high moisture content. This means that incinerators have to spend increased amounts of energy to dry the material before it begins to release energy. Studies have shown that treating a large amount of organic waste through incineration is less efficient than treating it through biogasification (Bolin, 2014). Biogasification maximizes the recovery of the potential in organic waste.

2.2.4 Biogasification

The biogasification process harvests methane from decomposing organic material. The organic waste sits in sealed containers with heat applied to it for two weeks. Bacteria gradually decompose the waste, producing a methane-rich gas mix. Purifying the biogas brings it from its natural 50-70% methane concentration to a 95% concentration (Al Seadi, 2010). At this point, the gas is exceedingly versatile, as it can be stored, transported, or pumped into the gas grid. This gas, called biomethane due to its nature as a man-made natural gas, produces electricity and heat when burned with CHP, and has the capacity to power gas cars.

It is important to understand that biogasification does not eliminate the need for other waste management methods due to its limitations to strictly using organic and food waste. The argument still exists that biogasification returns nutrients back to the soil where incineration destroys it, and produces usable energy where composting and landfilling do not. Using this method, all the methane produced is contained and made available for use. The solid remainder after the biogasification process completes is rich in phosphorus, which makes it very usable as fertilizer. Biogasification companies can sell this fertilizer, increasing the profit from the system even further.

Currently, Denmark lacks an infrastructure to supply enough material to support the planned expansion of biogasification facilities (Danish Government, 2011). Still, there is a significant potential in

the amount of organic waste in households that can help biogas to become one of Denmark's main sources of heat and electricity.

2.3 Methods of Organic Waste Sorting

In the words of Ida Auken, the former Danish Minister of the Environment,

> *"Today we incinerate food scraps that could become biogas. We incinerate sludge from wastewater that could be used as fertilizer... We have become too good at incinerating and too bad at recycling... It is bad for the environment and makes no sense in a world where demand for resources increases every day." (Lauritsen, 2013)*

This section delves into the current Danish Waste Model, as well as the barriers to the future improvement of the organic waste sector in Denmark.

2.3.1 The Danish Waste Model

The "Danish Waste Model" developed in 1980, placed the responsibility for the treatment of all waste, with the exception of recyclable business waste, on the municipalities rather than the government. This in turn encouraged private companies to use the facilities allotted by the municipalities. This mutual dependence has not only created a system of efficient collaboration but has the potential to create a local collaboration between different companies where the waste of one company is the valuable resource for another.

The transition from waste to resource management not only requires the development of new techniques and methods of sorting waste, but also requires strong political backing and leadership. As part of the *Danish Energy Agreement,* the Danish Government is encouraging biomass initiatives by increasing the startup aid for new projects from 20% to 30% (Ministry of Climate, 2012). Even though the Danish biomass market is relatively small in comparison to other European countries, the presence of the world's biggest biogasification test facility in the University of Aarhus and the largest biomass production facility, Maabjerg Bioenergy, have kept Denmark as the fifth highest biogas energy producer per inhabitant in Europe (Andersen & Mortensen, 2014).

As of 2011, Denmark produced approximately 13 million tons of waste, of which 60% was recycled (State of Green, 2011). Of the total waste, Denmark incinerated 1.3 million tons of organic household waste (Danish Government, 2013). The government aims to shift the use of biomass into either a biogasification or compositing process, returning the nutrients back to the environment

(Copenhagen Cleantech Cluster, n.d.). The Danish Resource Strategy, implemented by the Minister of the Environment, plans to recycle more than twice as much household waste as today (Lauritsen, 2011).

One of the major challenges facing the creation of biogasification plants is the separation of the organic and biodegradable waste streams from the rest of the ordinary waste supply, shown below in Figure 5. In most European countries, biodegradable, kitchen, and garden wastes make up the greatest fraction of the municipal solid waste stream (DONGenergy, 2011). "When we mix potato peels, paper, shampoo bottles, and empty beer cans in the trash bin, it is incinerated and valuable resources end up in smoke. Denmark can reuse twice as much household trash in 2022 through better means of sorting trash" (Lauristen, 2013).

Figure 5: An example system for sorting different household wastes (morgueFile, 2000)

2.3.2 Overcoming Costs Associated with Biogasification

In Denmark, there is a general state tax on waste, managed so that it is most expensive to landfill, less expensive to incinerate, and tax exempt to recycle waste. Municipal councils also charge fees to finance their waste management, but they optimize these charges to suit their municipality's specific needs.

Prior to 2003, capital, operation, and maintenance costs associated with the normal operation of biogasification systems did not compare well to other alternatives. This was because biogasification systems were typically several times smaller than their incineration counterparts. Smaller-sized plants had higher capital cost per kilowatt-hour and higher operating costs because they produced fewer kilowatt-hours per employee. These factors, combined with the inexperience of the technicians

operating the biogasification systems, made the process completely inefficient. However, as with any system, the economies of scale will eventually begin to take over as the system becomes increasingly popular and prices will eventually decrease (Sieger, 2002).

Comparing three biogasification plants to their incineration counterparts in Singapore showed that the net production of electricity was much greater in the biogasification plants. This is important due to electricity being the main profit of the waste treatment plants, with incineration averaging 2/3 MWh (Megawatt hours) of electricity and 2 MWh of heat produced per ton of waste (Copenhagen Cleantech Cluster, n.d.). This study showed that as biogasification plants increase in size, they increase in the efficiency of net electricity produced as well as heat recaptured through CHP (Bolin, 2009). A large biogasification plant was able to produce nearly 2.5 times the electricity of incineration plants. The net output of electricity from incineration of organic waste is only 40% of that from a large or medium scale biogasification plant. Therefore, a large or medium scale facility seems to be preferable to several small scale facilities scattered throughout the country (Bolin, 2009). Sorting and transporting organic waste to a central large-scale facility creates more clean energy than is currently being produced by the incineration facilities.

2.4 Recognized Systems of Sorting

In the past 20 years, legislation has created significant changes to the treatment of organic waste, which spread throughout the municipalities of Denmark. This section details the program and subsequent failure of sorting organic waste in Aarhus, a municipality located in eastern Jutland, the peninsula of Denmark. It also investigates the successes experienced by municipalities and companies located on Zealand such as BioVækst and REnescience. Although there have been failures in the sorting of organic waste, lessons can be learned from both situations that would allow future attempts a much greater ability and probability to succeed.

2.4.1 Aarhus

In Denmark, practical organization of waste often varies from town to town. This is because the Danish EPA is the authority responsible for the overall management of waste, while municipalities decide on the practical implementation. A unique system however, is the situation that occurred in Aarhus, where the municipality began sorting organic waste in 2001 and ceased sorting in 2004 (Aarhus-Utilities, 2003c). Aarhus utilized a 1-stream system where residents sorted their organic and residual waste into green and black bags. The municipality collected these bags together and used an optic sorting system to separate them at a facility. By identifying the different colors of the bags, the system

sorted the bags for incineration or biogasification (Drapalova, L., Fisker, L., Neszi, N. Z., & VanBrabant, W., 2004).

However, several issues with the efficiency of the system soon developed. The municipality was quickly forced to use dewaster technology to separate the plastic bags from the organic waste. However, this resulted in the loss of a large amount of the organic waste. By using the dewaster, an unexpected 9 million DKK per year was added to the maintenance cost of the sorting system, a burden that the residents were forced to shoulder (Aarhus-Utilities, 2004b; Kirkeby & Christensen, 2003).

In addition to the cost of the dewaster, another issue arose with the optical sorting system. When the bags arrived at the sorting plant, many of them had split open and spilled their contents, defeating the purpose of sorting them. The first solution to this issue was to use less compression within the trucks, but this proved to be unsuccessful. The investigation into this issue found that 60% of Aarhus citizens lived in high-rise apartment buildings, and dropped their bags through waste chutes. The height of these chutes and the weight of their contents often resulted in the bags splitting open and spilling their contents. In order to remedy this, the municipality increased the percentage of plastic, causing the system to cost an additional 9.5 million DKK per year (Kirkeby & Christensen, 2003).

Due to the rising costs of the sorting system, the municipality conducted an investigation into the costs and benefits of switching to an incineration only system.

- Switching to an incineration only system saves 18.3 million DKK per year.
- A savings of 6.8 million DKK per year occurs when the facilities associated with waste sorting are no longer operating
- Switching to incineration only reduced 15,900 GJ/year of net consumed energy
- 1,550 tonnes/year of CO_2, 9.3 tonnes/year of SO_2, and 1.8 tonnes/ year of NO_x were reduced by converting to an incineration only system.

Although the biogasification system produced more gross energy than an incineration plant, due to the issues that arose with the reinforced bags, optic system, and dewaster, the net energy produced ended up being lower. Even with these three limiting factors, the difference in energy and emissions between biogasification and incineration was still less than 200 households compared to the 6,000 each supplied. One of the reasons that this difference was so small is that citizens of Aarhus only sorted 10% of the total potential organic waste (Drapalova, 2004). It is important to take into account that the

maximum amount of organic waste collected from households is around 70% of the total organic waste produced. Although a new information campaign could increase the sorted waste by 10-20%, it can cost up to an additional 2 million DKK (Aarhus-Utilities, 2004b). The losses contributing to this lack in efficiency are:

- Lower than expected sorting efficiency in households (63% instead of 70%)
- Loss in trucks (5%)
- Loss in optical sorting system (4%)
- Loss in dewaster (49%)

Based on reports from Aarhus Utilities and DTU, a public hearing determined there were three possible options:

- Continue with the system of green and black bags as usual.
- Use incineration only and reduce fees by 150 DKK/year per household.
- Use incineration only and use money for continued research in waste treatment.

In March 2004, the citizens of Aarhus voted to stop the sorting of organic waste and caused the municipality to pay 10 million DKK back to the people. The municipality no longer provided the citizens with the heavy-duty green bags, the municipality sold all sorting facilities it owned, discontinued the use of optic sorting, and the citizens of Aarhus were no longer required to sort their organic waste fraction separately (Thyssen, 2004).

2.4.2 Solum: Noveren System

Nine municipalities in Northwestern Zealand sort their organic waste into a separate fraction. BioVækst, a biogasification facility, treats the collected organic waste from eight of these municipalities, while the remaining municipality composts their own organic waste (Drapalova, 2004). Unlike the method of treating waste in Aarhus, BioVækst uses a much simpler technology to produce compost and biogas, which in turn creates heat, electricity, and synthetic natural gas.

Specifically, these municipalities use a two-stream collection system with sorting taking place in the household and the waste remains separated until arrival at the treatment plant. Trucks and bins with dual compartments allow this system to work with maximum convenience and energy efficiency.

This system is much less sensitive to incorrectly sorted items due to the simpler system of sorting and makes the costly pre-sorting unnecessary.

2.4.3 REnescience

One method of treating sorted organic waste is through REnescience technology. With over 10,000 hours in service, DONG Energy's REnescience demonstration plant has become a nearby and reliable technology ready for implementation (*Inauguration of REnescience Demonstration Plant on Amager*, n.d.). Together with the municipalities of Fredericia, Kolding, and Middelfart, DONG Energy investigated the possibility of constructing a full-scale plant to sort up to 170,000 households' municipal waste.

This system treats unsorted municipal solid waste with water and warms it to 37^{o}C. Adding enzymes and bacteria liquefies and separates the biodegradable materials from the non-organic solids. After separating the bio liquid from the rest of the waste and transporting it from the plant, a variety of purposes exist that could use the bio liquid, including biogas production (DONGenergy, 2011).

2.4.4 Clark University

Recently, Clark University, a college located in Massachusetts within the United States, began to implement a "If it was ever alive, you can compost it!" campaign. By placing small waste receptacles in three freshman-housing dorms, Clark University sought to collect and divert all compostable items in these halls. Students compost their previously landfilled items such as food and paper towels with a system that motivates them to participate through the ease of use.

Figure 6: Small bin found next to the sink

Figure 7: The larger bin found outside the dormitories

Due to how easy food waste disposal has become, small composting bins placed atop the kitchen counters of these dorms (See Figure 6) encourage students to participate in this system. Moving these small bins to a larger bin (See Figure 7) that is further away from the rest of the housing helps overcome concerns about smell and bugs infesting the dorms. The collected waste in the larger barrel accumulates for two to three days before a university worker moves it to an offsite location where it sits until a bi-weekly collection company picks up the waste and brings it to an industrial composter. By

working in this manner, Clark University has kept the compost sorting area clean, and removed any bugs or other issues typically associated with food waste (Clark University, 2014).

2.5 Challenges Associated with Expanded Sorting

Addressing public psychologies and influences is part of the proposal of any societal change. As indicated earlier, one of the Danish Government's goals is to be fossil fuel neutral by 2050 (Andersen & Mortensen, 2014). This section discusses the science behind implementing change in behaviors and the stages required for acceptance of an organic waste sorting system. It then describes how this relates to Denmark specifically and concludes with key factors to increasing participation rates.

2.5.1 Stages of Change

Numerous studies exist which determine the factors contributing to successful behavioral change. In the case of this project, a challenge that municipalities often face is getting people to participate in a recycling program. When people are deciding to make a change, they go through a process known as the spiral model of change, shown below in Figure 8 (Bourge, 2012).

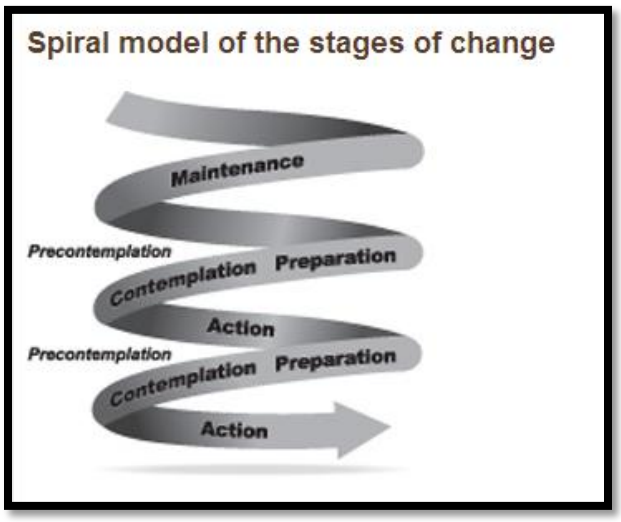

Figure 8: Spiral Model of Change. (Prochaska, 1993)

There are five stages of this process: pre-contemplation, contemplation, preparation, action, and maintenance. Pre-contemplation is the beginning stage where a person is not aware of wanting to make a behavioral change. When the person becomes aware that he or she needs to make a change, but has no commitment to act upon that desire, the individual enters the contemplation stage. Some people remain in the contemplation stage indefinitely and do not make a change, but those who decide to make a change go through the preparation stage, during which the person begins to create plans to

enact the desired change. After the preparation stage is complete, the action plan is the next stage to be completed, and this is where the theoretical plan transforms into an action plan. After 6 months of this change, there is a maintenance phase where the new behavior ideally becomes a habit. However, relapse into old habits can occur throughout this process of change (Berens, 2010; Bourge, 2012). The maintenance stage is critical in creating a long-term recycling behavior and if sustained will soon become a habit; a behavior that is no longer thought about.

To increase recycling participation, the ultimate goal would be to make recycling a personal habit for people. A habit is a learned action that soon becomes an automatic response during trigger situations (Bourge, 2012). Instilling good habits is often difficult because it takes a couple of steps to accomplish. For example, to recycle a bottle one needs to wash it, store it, and then put it out to be collected later. Some people find that process to be too much effort. Knussen and Yule's study consisted of surveying Scottish residents in an effort to determine why residents failed to recycle. The top reasons were lack of recycling habit, facilities were not readily available, and no local curbside collections were in place (Knussen & Yule, 2008). The study also showed that the lack of recycling habit was due to the lack of recycling in the past. This corroborates with the idea that the frequency of past behavior is a good indicator for future behavior (Oullete & Wendy, 1988). The frequency of past behavior creates a favorable attitude towards that behavior (Eagly & Chaiken, 1993).

2.5.2 Recycling Behaviors in Denmark

In order to increase recycling behavior, it is important to study the psychological factors of behavior and learn the motivations of Danish citizens. RenoSyd I/S is a waste management company that conducted a past study on the typical recycling behavior of its consumers within the municipalities that it operates. The results of this study are a compilation of data from focus groups, interviews at home, and observations of large groups at recycling centers. The parameters RenoSyd I/S judged on were: proactivity, experience, knowledge, interest in learning more, focus on the environment, focus on self, aesthetics, convenience, waste is a problem, and willingness to sort waste. Through these parameters, seven typical consumers emerged from the study. These consumers ranged from Anders Ansvar (Anders Responsibility), who is the ideal recycling citizen who sorts almost all his waste, to Lief Ligelglad (Leif Indifferent), who just wants his waste to go away and does not care about the method used. In between these extremes were consumers who were motivated by aspects like convenience and willingness to sort. (Biener, et al., 2013)

Dansk Affaldsforening recently published a similar study, Kend din Kunde, and identified the motivations of the Danish people when they sort their waste. The consumers that emerged with respective percentages were Ida and Ivan Idealist: 30%, Cristina and Claus Convenience: 23%, Paul and Pamilla Pragmatiker (Pragmatist): 36%, and finally Lasse and Linda Ligeglad (Indifferent): 12% (Dansk Affaldsforening, 2013). These identified personas are similar to the ones identified earlier by RenoSyd I/S. The analysis factors used were: idealism, price focus, convenience, aesthetics, other motivators, and satisfaction. As with the RenoSyd I/S study, there were idealists whose goal is to make a difference in the environment. In contrast to that, Christina and Claus Convenience believe that sorting should be as easy as possible and they want to make a difference, but sorting itself is a barrier. Paul and Pamilla Pragmatiker will sort if they must because there are rules, but they do not have any extra motivation beyond that. Lastly, Lasse and Linda Ligeglad represent the small population who do not care about sorting (Dansk Affaldsforening, 2013). These studies provided insight into the motivations of the Danish population to sort their waste.

2.6 Outreach Campaigns Promoting Sorting

This section details the outreach campaigns that have successfully dealt with increasing recycling participation in the past. In particular, these sections explore specific studies conducted on the habits of local household recycling practices as well as potential methods of implementing change. Lastly, this section studies organic waste sorting campaigns that have enjoyed success in Sweden, such as the Tack för Maten campaign, as well as the local systems of Stop Spild af Mad and Mission Mulig 2.

2.6.1 Elements of Successful Campaigns: Learning from the Recycling Change

Successful information campaigns have effective education components that inform and engage the consumer. Traditionally, information campaigns have dealt with recycling by listing off statistics and facts in order to convince the consumer to recycle using logical persuasions. However, limiting the persuasive arguments to this one aspect eliminates a wide range of potential arguments. In 1988, de Young, a researcher investigating the motivations behind participation in household recycling practices, conducted a pilot study with 200 households and identified the homes as either recyclers or non-recyclers. After the conclusion of the pilot study, de Young contacted the households and asked them to answer a series of questions that 91 of 200 the households responded to. De Young's study concluded that people were aware of the environmental benefits behind recycling, but they lacked the knowledge or motivation to begin. Information campaigns traditionally attempt to convince the consumer to sort through negative reinforcement concerning the pitfalls of not participating in the recycling system, but do not cover the details on how to start. From de Young's study, the non-recycler scored highly on the

perceived difficulty scaling of recycling, indicating that the reason the process seemed difficult was due to a lack of knowledge concerning how the local recycling system functioned (de Young, 2008). Several studies share these findings suggesting that this is a universal psychological phenomenon.

In the Metropolitan Area of Lisbon (MAL), Vicente, another psychological researcher, conducted a study with a goal of gaining insight into local household recycling practices. The study showed that households were more likely to recycle if information on recycling was present within the household and if the recycling area was clean and nearby. Another important consideration is the presence of children within the home, because children tend to be more open towards the creation and maintenance of a recycling system (Vicente, 2008). In Denmark, this could be used to bring a new mindset into a home which otherwise would not be willing to participate.

Another study proposed the idea of viewing children as "a powerful agent of change at home" to encourage adults to change their otherwise close-minded views (Chen, 2009, p. 826). If teachers teach children to recycle, then they will become adults who know how to properly sort and recycle when they grow older. This generation then teaches their children the methods that they learned, closing the looped cycle. Although these studies focus on recycling rather than the sorting methods needed for organic waste, these ideas are transferable to organic waste. Creating a perpetual system of sorting organic waste in the household requires educating adults and children about the proper methods of sorting a clean fraction of organic waste from the residual waste.

Creating the right form of information distribution and advertisement is just as important as the actual information itself. Research has proven a few avenues, such as television, radio, and social media, work in the general passing of information. However, direct media campaigns would likely be much more successful than campaigns marketed to the masses (Vicente, 2008). By creating a more personal, communal feel that encourages people to participate, these campaigns create sustainable and efficient systems of sorting.

2.6.2 Successful Organic Waste Sorting Campaigns

Throwing away food costs Danish households an average of 16 billion dollars or 86 billion DKK, per year (Stop Spild Af Mad, 2014). The majority of younger Danes agree that they would participate in an organic waste sorting system if they could see personal financial savings from reducing their daily food waste, while older generations were among those who indicate that they were unable to reduce their food waste any further. These findings agree with the studies discussed in the previous section that

the creation of any new sorting system should focus on changing the habits of the younger generations to perpetuate a cycle of recycling and sorting (Stop Spild af Mad, 2014).

In Sweden, the company Va Syd has implemented a campaign called “Tack för Maten”, or “Thanks for the Food”. This campaign aims to sort 40% of the food waste in Burlöv and Malmö from the municipal waste stream for use in biogasification plants. The average Swedish household throws out 5.6 kg of food waste every week resulting in 33,000 tons of food waste ending up in the municipal waste stream annually. When Va Syd started a system of organic waste sorting within the municipality of Husie, they saw participation from the majority of individuals before moving on to the next municipality in a systematic manner. The project began in May of 2012, and concludes in September of 2014 after visiting 11 different municipalities. Va Syd provided enough infrastructure to make the entire project feasible and easy to participate in by delivering 9-liter paper bags within brown waste receptacles free of charge (Täck for Mäten, 2011).

Lastly, there is a sorting campaign created by RenoSyd I/S referred to as “Mission Mulig 2” or Mission Possible 2 within Denmark. This is the follow up to their highly successful Mission Mulig campaign, which educated adults on good sorting practices. Students and children are the focus of this campaign, and they are encouraged to support the changing perception of waste to value. Additionally, it works to develop both games and teaching materials to facilitate these new perceptions towards waste. The creators of Mission Mulig 2 linked several different websites where these teaching materials are available to aid in the classroom (Renosyd, 2014). By focusing their projects on changing the perceptions of children rather than adults, this mission hopes to revitalize and invigorate significant change in the sorting practices of households. Although this is a new movement in Denmark, there is great potential behind campaigns like these.

2.7 Conclusion

This background chapter reviewed the history of organic waste sorting in Denmark, exploring the goals and past strategies that have led to the current desire for the recycling of household waste to be doubled by 2022. Biogasification was shown to be advantageous when compared to landfilling, composting, and incineration because not only does it return valuable nutrients to the soil, but provides energy and methane that can be used to power and heat homes. Different case studies were explored where sorting waste had encountered both successes and failures, however implementing organic waste sorting was found to require not only a proper information campaign, but also accurate and well thought out motivation aspects.

Organic waste sorting has been attempted many times in the past, and although there have been successes and failures in equal moderation, it is clear that it is here to stay. While there are challenges to expanding the current sorting practice in Denmark to include organic waste, there have been enough successful sorting campaigns that creating a lasting behavioral change is not only a possibility but could soon become a reality.

3.0 Methodology

This chapter describes the methods used to identify the requirements for the creation of an organic waste sorting system within households in Denmark. The goal of this project was to assist Dansk Affaldsforening in its goal of understanding the practical and motivational factors that influence sorting household food waste in Denmark. The team worked on this project from March 17, 2014 until May 6, 2014.

In this section, the team first describes the objectives for the project, where in each subsequent section, the team examined the objectives in depth and the methods used to collect data. Due to the comparative newness of separating organic waste from residual waste, almost every municipality in Denmark is at a different stage in their recycling program. To accommodate for this, the objectives are further broken down into smaller sections focused on each site where the team collected information.

To achieve our project goal, we created the following objectives to both identify the views householders have of organic waste and to compare and contrast different information and motivation campaigns. The four objectives the team created were:

- Understanding organic waste sorting techniques and practices within Denmark
- Investigating perceptions of householders concerning organic waste
- Learning from other waste management awareness programs
- Analyzing results gathered and reporting findings

Figure 9 below shows a Gantt chart showing the dates that the team accomplished each objective. An outline and overview of the objectives and the methodology behind accomplishing these appears in Figure 10.

Task	Week								
	Prep	1	2	3	4	5	Easter	6	7
Orientation and Background									
Understanding organic waste sorting techniques									
Investigate perceptions concerning organic waste									
Learning from other waste management awareness programs									
Analyze data and report findings									
Presentations to Dansk Affaldsforening									

Figure 9: Gantt chart

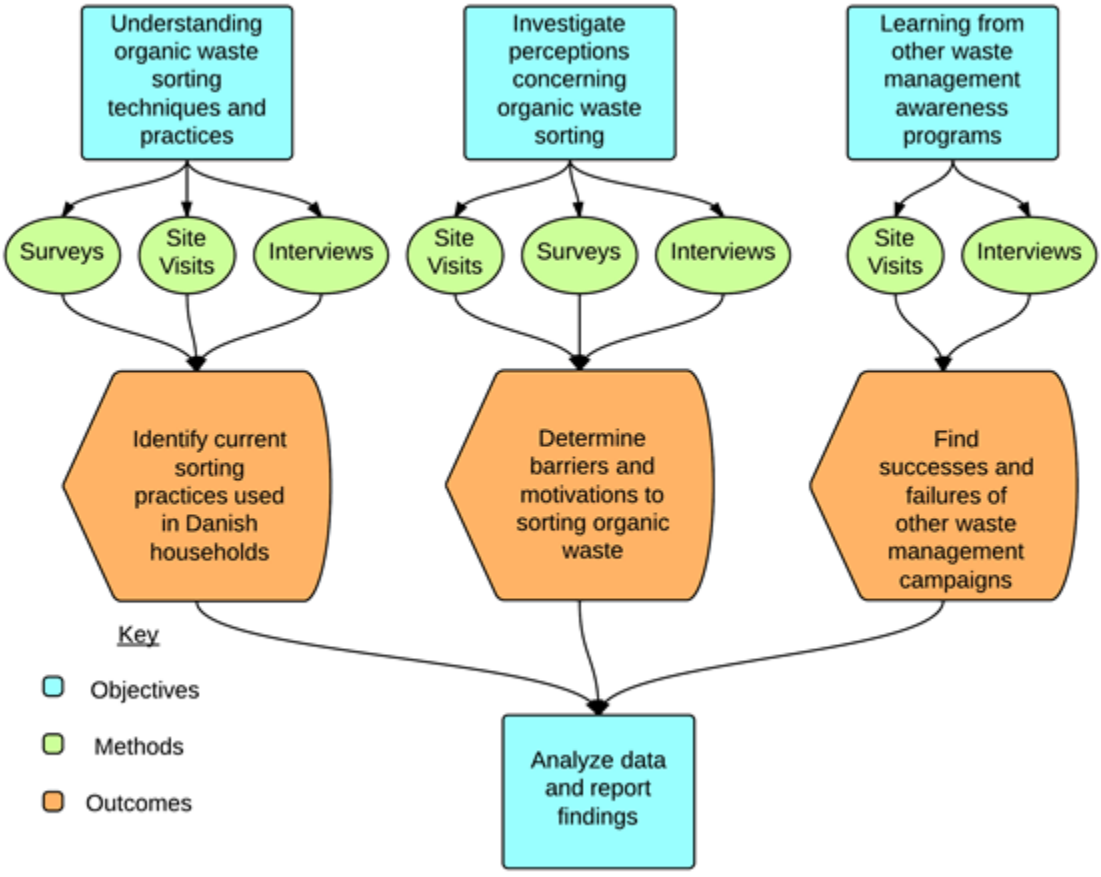

Figure 10: Project Flow Chart

3.1 Understanding Organic Waste Management Techniques and Practices

To understand how to implement organic waste sorting in Denmark most effectively, an in depth knowledge of the current organic waste management systems must be formulated, with a focus on the specific sorting practices implemented in households. Currently, 98 distinct municipalities exist within Denmark and each uses a unique waste management system, which greatly complicates an overall understanding of the sorting practices. Therefore, the team's first objective was to gain an understanding of the current organic waste management techniques and practices. We accomplished this through site visits and interviews with Holbæk, BioVækst, and Sysav. Key factors that the team considered in acquiring this knowledge were:

- Requirements for the purity of the sorted organic waste
- Frequency that organic waste receptacles are changed
- Methods for collection of organic waste from households

3.1.1 Interview with Klaus Jacobsen

On Wednesday, March 19, 2014, the team visited the municipality of Holbæk, one of 14 municipalities whose citizens already sort organic waste at the household level. The team arranged a meeting with Mr. Klaus Jacobsen at Holbæk Forsyning, a public limited company that oversees aspects of waste collection, water, sewage, and heating for the municipality of Holbæk. A summary of the interview with Mr. Jacobsen is available in Appendix B. Some of the questions and topics that the interview covered are below:

- What is the current system for sorting of organic waste within Holbæk?
- What are the influences concerning why people would change their sorting habits?
- What factors limit the implementation of new systems and how can they be overcome?

The purpose of these questions was to identify the waste sorting techniques that Holbæk residents are currently using and to determine potential obstacles to successful sorting. By inquiring into the current system, we were able to draw upon the experience that Holbæk offered and analyze successful means of encouraging citizens to participate in the system.

Before the interview began, the team followed the interview protocol listed in Appendix A. Upon the conclusion of the interview, Mr. Jacobsen kindly offered the team permission to examine the

sorting system he implemented within his household as an example of the system of sorting household waste that individuals already implemented in Holbæk.

3.1.2 BioVækst Plant Site Visit

After interviewing Mr. Jacobsen and visiting Holbæk Forsyning, the team traveled to BioVækst on the same day, Wednesday, March 19, 2014. BioVækst is a biogasification company located near Holbæk; unique in that it is the only one in Denmark that relies solely upon household organic waste to produce biogas for heating and electricity. The purpose of this visit was to view key concepts that were not available in the background research, as well as to discover if any concerns existed over the current organic waste brought to the company. A detailed summary of the interview conducted with Peter Brønnum and Morten Brøgger Kristensen from BioVækst is available in Appendix C, with example questions shown below:

- Which municipalities provide the cleanest fractions of organic waste & what methods do they implement?
- How often is the sorted organic waste transported from the household to BioVækst?
- What was involved in creating a system of securing a constant input of organic waste?
- How are you ensuring the continued viability of BioVækst?

Before the interview began, the team followed the proper interview protocol and recorded notes. Upon the conclusion of the interview, Peter Brønnum, Ph.D., a project manager at BioVækst, gave a tour of the day-to-day operations of the facility and listed areas of improvement with the intake of the organic waste.

3.1.3 Sysav Pretreatment Plant

On March 27, 2014, the team visited Sysav, a pretreatment plant that receives residual and organic waste separately, incinerating the residual, and turning the organic waste into slurry for biogas production. The team conducted an interview with Rustan Nilsson and Appendix D contains a detailed synopsis and outline of the discussion. Some of the questions were:

- How does the pretreatment process increase biogasification efficiency?
- How much expense does this incur on the treatment as a whole?

Before the interview began, the team followed the interview protocol located in Appendix A. Upon the conclusion of the interview, we received a short tour of the operational facility. From this

interview, the team was able to ascertain the viability and need for pretreatment of waste before biogasification occurs. Additionally, we developed insights into the clean percentage of the organic waste along with considerations for cultural differences between Swedes and Danes.

3.1.4 Interview with Dansk Affald

On April 26, 2014, the team conducted an interview with Jesper Heinzl, Sales and marketing manager at Dansk Affald, a company owned by the municipalities of Haderslev, Tønder, Vejen, and Kolding. The purpose of this interview was to investigate the project conducted in Holsted involving 273 households. By performing the interview, the team formed a greater understanding of a successful project. We conducted the interview following the interview protocol shown in Appendix A and listed complete notes in Appendix N.

3.2 Investigating the Perceptions Concerning Organic Waste Sorting

In addition to understanding successful organic waste management techniques, the team also had to investigate people's views on organic waste. After gaining an understanding of these views, it is possible to create a system that minimizes the barriers to sorting waste and maximizes the motivations. Therefore, the team's second objective was to explore the perceptions of the common householder concerning participation in an organic waste sorting system. The team accomplished this through surveys, site visits, and interviews with Claus Petersen, Jonas Engberg, IKEA, Tversted, and Nulskrald. Key factors the team considered during these interviews and surveys were:

- The motivations to participate in recycling and organic waste sorting
- The negative factors, barriers, and challenges keeping householders from recycling and sorting
- The perceptions that homeowners already had concerning organic waste (i.e. smell, hygiene)

3.2.1 Claus Petersen

On March 26, 2014, the team conducted an interview with Mr. Claus Petersen, co-owner of Eco-net. Due to Mr. Petersen's familiarity with surveying and experience with the public's perception of organic waste, the team believed that he offered valuable insight into the motivations and reasons why homeowners do not participate in sorting campaigns. The team followed proper interview protocol outlined in Appendix A and listed complete notes in Appendix E. A few of the key questions posed to Mr. Petersen during the interview were:

- How can people be encouraged to sort their waste cleanly & purely?
- How can the organic percentage in the residual waste be reduced?

3.2.2 Jonas Engberg

Another avenue of gaining insight into the motivations concerning organic waste sorting was an interview conducted on March 21, 2014, with Jonas Engberg, a sustainability manager from IKEA. As an international store producing one-third of the new kitchens bought throughout Denmark, an interview with questions concerning the sorting of waste within a kitchen provided valuable insight into the practical considerations of sorting organic waste within a Danish kitchen. Additionally, this offered the chance to see the sorting options that are commercially available to consumers. Appendix F contains a full synopsis of the interview, while some of the key concepts covered were:

- What options do you provide to kitchen customers for sorting waste?
- How important is organic waste to your company?
- How will the recent shift in focus to utilizing waste as a resource effect the options you offer to customers in the future?

The purpose of this interview was to identify the corporate considerations and understandings of the incentives concerning the future development of organic waste sorting within a major company such as IKEA. Although the interviews with BioVækst and Holbæk covered this topic, Mr. Engberg brought valuable considerations and practical views about how to best motivate householders to sort organic waste. The team considered IKEA to contain a measure of expertise in the area of efficient bin placement and consumer motivation because they are such a large kitchen manufacturing company.

During the interview with Mr. Engberg the team followed the interview protocol located in Appendix A. Upon the conclusion of the interview, the team once again thanked Mr. Engberg and gained permission to survey a nearby IKEA in order to expand upon the interview conducted.

3.2.3 IKEA Survey

Although the team utilized experts within the field of organic waste sorting effectively at this stage, we decided to acquire primary rather than secondary data and survey the public on our own. The purpose of this IKEA survey was to gain the opinions of the more general Danish populace. The team conducted the survey at the Høje-Taastrup branch due to the high volume of customers. The survey questions, focused on the barriers associated with sorting waste and were constrained by a two-minute time limit given to us by IKEA. The team chose to focus on general sorting behavior as opposed to just organic waste sorting due to the fact the people surveyed did not necessarily sort organic waste. The 40

surveys that were administered over a three-hour period on April 12, 2014 were written in both English and Danish, but due to the Danes general comfort with speaking English, the surveys were facilitated by team members wearing identifying badges belonging to Dansk Affaldsforening.

We began the survey by asking customers if they had time to answer a two-minute survey concerning waste in the kitchen. The team then gave a brief description of the project and asked each of the 10 questions if the responder was fluent in English, or let the responder fill out the survey if not. Before beginning the survey, we informed the customers that their responses would be completely confidential and that all questions were optional. The team aimed to ensure that all responders filled out the survey questions completely and found that most customers, while busy, were willing to stop and answer the survey. The complete survey is in Appendix G.

3.2.4 Survey Strategy for Tversted

To explore the motivations concerning participation in the household sorting of organic waste, the team visited the town of Tversted, which became the first "Nulskrald Village" or "Zero Waste Village" in 2014. On Monday, March 31, 2014, the team arrived in Tversted and surveyed residents outside of two different grocery stores. These locations have high foot traffic with people who are generally not in a hurry and therefore have time to fill out our survey. The team administered the surveys verbally in English and Danish, with the help of the company liaison at Dansk Affaldsforening, Nana Winkler, from 17:00 to 18:00. The team split into two groups at each location and identified ourselves as affiliates of Dansk Affaldsforening. Each time the team surveyed a citizen of Tversted, the procedure began by asking if the citizen would be willing to complete a quick survey concerning their organic waste sorting habits. The team then gave a brief explanation of the purpose of the survey and the goal of the project. Before beginning the survey, the team informed the residents that all survey responses were completely confidential and that all answers were optional. The team found that the citizens interviewed were willing to stop and once stopped, were happy to talk about their home sorting.

Tversted offered a unique opportunity due to being a working experimental model on how citizens implement different sorting systems into their households. The team passed out surveys to 12 people from the village concerning their opinions on organic waste and their concerns in regards to sorting. The survey used in Tversted is available in Appendix H and an example of the questions posed shown below:

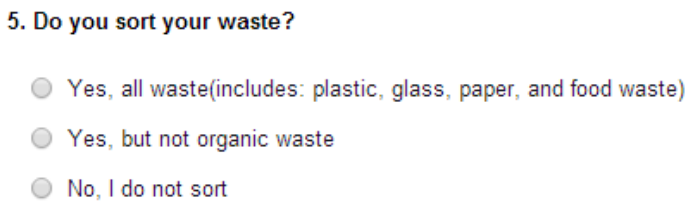

Figure 11: Question 5 from Tversted Survey

Figure 12: Question 7 from Tversted Survey

The purpose of these questions was similar to the ones posed to BioVækst and Holbæk in that they identified householder motivation in the sorting of organic waste. These questions are important in that they show any discrepancy between the motivations that the citizens have and those that the municipalities and biogasification companies believe the citizens to have. Additionally, due to Tversted having only recently initiated the zero waste initiative, the team had the opportunity to ask people who had recently converted to waste sorting about their thoughts.

3.2.5 Nulskrald Facebook Survey

Nulskrald has a highly followed Facebook page with over 12,000 likes that the team used to distribute a survey asking citizens the methods they used in the household sorting of organic waste. By contacting the facilitators of this Facebook page, we gained permission to perform a “Vis os Hvordan du Sorterer” or “Show us How You Sort” survey. In this survey, the team asked people to take a photograph of their organic waste sorting set up and to give a brief explanation. Along with the picture request, the survey (see Appendix I) included a demographic component in order to better organize the results gained from this survey and assess which municipalities correlate good sorting habits with good sorting systems. Using social media, the team expected to reach a wider range of households than would be possible through physically traveling to these sites.

For the photo survey, the team used online software called SurveyGizmo. This website allows survey respondents to upload their sorting photos along with responses to survey questions. The survey was live from April 11 until April 25, a two week span that was limited by the seven week period available for the project. The team chose the online tool as opposed to asking for photos emailed to the team alias because the anonymity of submission would be lost with email.

The team received 39 complete responses and 10 omitted partial responses to the survey, with a large resurgence in responses after Tue Jepsen, Nulskrald's Facebook page moderator reposted the survey. Although people were willing to fill out the questions, the photo upload had much less success with only eight uploaded photos. By closing the survey at the end of week 6, the team ensured that sufficient time was available to effectively review and analyze the data collected.

When respondents opened the webpage, it informed them of the purpose of the survey and reminded that their answers were completely confidential and optional. From there, the survey asked several demographic questions and then asked if their municipality required organic waste sorting. Depending on their answer, the survey directed them to different pages, as shown in Figure 13 below.

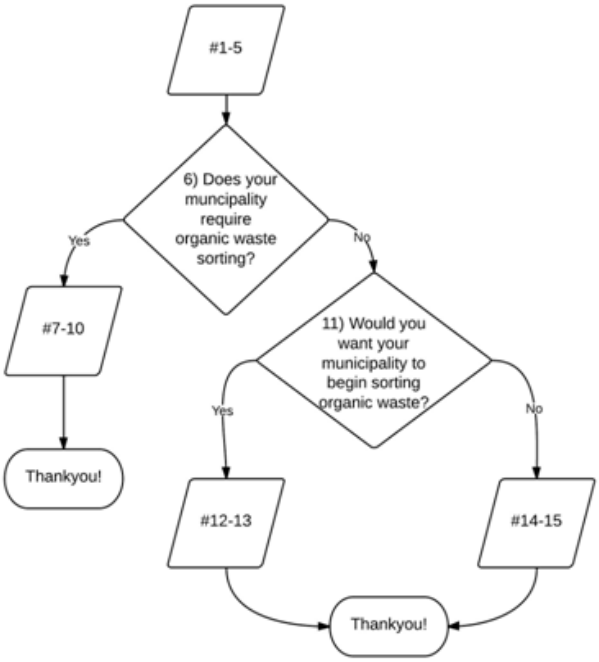

Figure 13: Logic Chart

3.2.6 Interview with Nikolaj Hänselt

Due to the team's previous focus on interviewing experts in the fields of organic waste sorting, we acquired a large amount of secondary information. By interviewing Nikolaj, the team found a primary source who it could directly ask a resident about his experiences and perceptions of organic waste and sorting as a whole. The team followed proper interview procedures outlined in Appendix A and listed Mr. Hänselt's interview within the results section of this paper.

3.3 Information Campaigns

By exploring the successes of information campaigns, the team discovered key aspects to improve the utilization of organic waste as a resource in Denmark. Countries such as Sweden have implemented programs for the sorting of organic waste and these provide valuable insight into participation in sorting programs not available in Denmark. The team's third objective was to explore successful information campaigns to investigate how information relates to clean sorting of organic waste and high participation. Interviews and site visits to Va Syd, AVV, and Vestforbrænding accomplished this objective. Key areas of interest in the investigation were:

- How was the system implemented and what was required to gain participation from the citizens?
- What aspects of this campaign need improvement?
- Are information campaigns an efficient means of relaying information?

3.3.1 Tack för Maten

On March 27, 2014 the team traveled to Malmö, Sweden to visit Va Syd, the municipal joint authority responsible for the creation of "Tack för Maten", or "Thanks for the Food", an organic waste sorting campaign in place since 2007. The team followed the proper interview protocol found in Appendix A, and listed the notes and a synopsis of the interview in Appendix J. Following a presentation on the creation and maintenance of the system, a question and answer session allowed the team to investigate key points of interest outlined in Appendix J. Some of the issues covered are:

- How is the continued support and participation of the program ensured?
- When did the Tack för Maten campaign start?
- Did the implementation of this campaign result in an increase in sorting?
- What methods do you use to reach out to the citizens of Malmö effectively?

3.3.2 AVV

On March 31, 2014, the team traveled to Tversted, and before conducting the Tversted survey, interviewed key members of the Nulskrald, or "Zero Waste" movement, Thomas Dyrmann and Lene Høg. The team followed the interview protocol located in Appendix A and listed the complete notes from the interview in Appendix K, with key parts of the interview listed below.

- What makes Nulskrald a unique program?
- How are you motivating the populace without mandatory sorting?
- Is this an effective and sustainable method of encouraging waste sorting?

The purpose of this interview was to investigate the bottom up approach that Nulskrald utilized to motivate the citizens of Tversted to sort organic waste. While there, Thomas and Lene referred the team to two residents of Tversted to interview, Mads Ejlersen and Jens Guldsmed-Thomsen. Their interview allowed the team to further develop its understanding of the perceptions that common residents had concerning the sorting of waste. The team conducted the interview in accordance with the interview protocol listed in Appendix A, and created a summary of the interview found in Appendix M.

3.3.3 Vestforbrænding

On April 3, 2014, the team conducted an interview with Camilla Petersen, Isabelle Skaanning, and Per Brix at Vestforbrænding. The interview followed the protocol laid out in Appendix A, and complete notes of the interview are in Appendix L. A few of the key questions covered in the interview were:

- What are the challenges in setting up a sorting system in a municipality?
- How do you educate citizens to sort their fractions properly?
- What is your preferred method of setting up organic sorting within a municipality?

The purpose of this site visit and interview was to gain an understanding of the methodology used by municipal authorities in the creation and maintenance of an organic waste sorting system and to learn about information campaigns that worked in various municipalities.

3.4 Analyses of Findings

Upon the completion of the research objectives, the task of analyzing all collected information began. The team used an inductive open coding method of analysis to organize themes from the interview into an understandable form. After putting the data into this more readable form, we used open coding again in a second round of analysis to further sort the information into five categories. In

order to analyze this data most efficiently the team decided to use Survey Gizmo's data interface tools to organize all the survey responses.

3.4.1 Survey Assessment

After collecting all data and closing the online Facebook survey, the team analyzed all three surveys in a similar manner. Although conducted in person and on paper, we entered the IKEA survey and Tversted survey responses into Survey Gizmo for convenience. Survey Gizmo imported the responses into Excel to represent the data graphically in order to best show the information. The team first examined the demographics to recognize any skew in the data since time of day and location can influence those surveyed. Once we represented the results with graphs that best correlated their specific information, insights were drawn. The team drew these insights by referencing the open coding used to identify key elements in the interviews and cross-reference them with the data available in the graphs. We summarized the insights derived in the concluding section of this paper.

3.4.2 Interview and Site Visits

Interviews and site visits provided the majority of the data in the project. Originally, we planned to record the audio of every interview and then replay it later when a member of the team could transcribe the dialogue and extract key details from the interview. We eventually discontinued this practice due to the amount of time and effort required. Instead, one team member put the notes taken during the interview into an online database where the team could access them later.

The team used an inductive open coding analysis method for analyzing the qualitative data. After reviewing the notes and transcriptions, the team used open coding to note themes and label them with short "codes". We used these concepts again later as we began to explore the data more in depth as subsequent rounds of data analysis occurred. Lastly, the team created sub-categories based on what arose in the interview, such as money being an incentive as a motivating factor to sort. Specific colors and highlights assigned codes within the interview summary document to label sections as important pieces of information. The team used these colored concepts for all interviews so we could easily identify what topics were most prevalent throughout all the conducted interviews. This aided in determining the overarching themes throughout the collective interviews and in the goal of creating a list of factors that motivated citizens to sort organic waste.

3.5 Methods Summary

The team implemented this methodology to determine the factors that prevent citizens and householders of Denmark from participating in the sorting of organic waste, while researching the best

campaign methods to implement sorting in other municipalities. The team accomplished this through investigating the systems currently implemented in municipalities such as Holbæk and Vestforbrænding, information campaigns like Tack för Maten, and motivational campaigns such as Nulskrald.

4.0 Results and Discussion

This chapter describes the results and discusses the implications of the data that can facilitate the creation of an organic waste sorting system. The goal of this project was to assist Dansk Affaldsforening in understanding the practical and motivational factors that influence sorting household food waste in Denmark. Recent political interest in biogasification in Denmark, shown in strategies such as *Denmark without Waste*, indicates our project is of high interest.

Over the course of seven weeks, from March 17, until May 6, 2014, the team conducted 11 interviews (listed in Table 1). Next, we conducted three surveys within Tversted, IKEA, and online via Facebook. The purpose of this data collection was to accomplish the first three of our main objectives, reiterated below:

- Understanding organic waste sorting techniques and practices within Denmark
- Investigating perceptions of householders concerning organic waste
- Learning from other waste management awareness programs
- Analyzing results gathered and report findings

The last section of this chapter analyzes the collected data and reports it along with several insights, which can potentially ease the creation of organic sorting systems within municipalities seeking to implement them.

Table 1: Table of Interviews Conducted

Organization	Type	Contact Person	Position	Date of Interview
Holbæk Forsyning	Public Limited Company (PLC)	Klaus Jakobsen	Project Manager	March 19, 2014
BioVækst	Public/Private shared company	Peter Brønnum Morten Brøgger Kristensen	Project Manager Chief Technology Officer	March 21, 2014
IKEA	Private Company	Jonas Engberg	Sustainability Manager	March 21, 2014
Econet	Private Company	Claus Petersen	Co-Owner	March 26, 2014

Va Syd	PLC	Ingela Morfeldt	Communications Officer	March 27, 2014
SySav	PLC	Rustan Nilsson	Communications Officer	March 27, 2014
AVV	PLC	Lene Høg Thomas Dyrmann Winkel	Communications Officer	March 31, 2014
Unaffiliated		Mads Ejlersen & Jens Guldsmed-Thomsen	Tversted citizens	March 31, 2014
Vestforbrænding	PLC	Camilla Petersen Isabelle Skaanning Per Brix	Functions Manager & Communication Consultant	April 3, 2014
Dansk Affald	Private Company	Jesper Heinzl	Marketing Manager	April 23, 2014
Unaffiliated		Nikolaj Hänselt Anna Kristiansen	Amagerbro citizens	April 23, 2014

4.1 Findings

This section creates a summary of the interviews, surveys, and site visits conducted by the team over the seven-week period. While varied, questions focused on gaining an understanding of the current systems implemented and the issues associated with them. Due to the differences between each interview and the qualitative content, summaries of each interview divide this section for clarification.

4.1.1 Understanding Organic Waste Management

In order to accomplish the team's first objective of gaining an understanding of the current organic waste management techniques and practices, we conducted site visits and interviews with Holbæk Forsyning, BioVækst and Sysav.

4.1.1.1 Holbæk Forsyning

On March 19, 2014, the team traveled to the municipality of Holbæk located in northeastern Zealand. In the municipality, the team visited Holbæk Forsyning, a public limited company (PLC) that handles the municipality's water supply, wastewater, solid waste, and district heating. Klaus Jakobsen, a project manager in the waste department, met with the team to discuss the company's role in the solid waste sector and their implemented organic waste initiatives. Holbæk Forsyning treats waste producers as customers, not citizens. By placing customers at the center of their decision-making, they are able to focus on making waste management as convenient and inexpensive for the customer as possible.

Holbæk citizens have been sorting food waste for over a decade, but before the company brought the food waste to a biogasification plant, the residents were already accustomed to sorting due to a previous composting campaign. In Mr. Jacobsen's opinion, the transition for the residents of Holbæk to sorting food waste was easier due to their composting experience. Inside the kitchen, residents place food waste in a separate container in a plastic bag. Although most residents use these plastic bags, Holbæk Forsyning recently created an experiment seeking to reduce the levels of impurity in the collected organic waste. Starting with 200 families, the participants had a median age over 50, these households received a letter stating their selection to participate in the new sorting system. Along with a green bin, the municipality provided biodegradable bags to the families to use as a replacement to the inorganic plastic bags currently in use as seen in Figure 14. Although two households elected not to participate, Holbæk plans to gather feedback from this experiment in the near future.

Figure 14: Bin and Biodegradable bag used in Holbæk's Study

Outside the house, Holbæk residents have large trash bins with separate chambers for residual and organic waste (See Figure 15).

Figure 15: Holbæk's divided trash bins. Left for organic waste and right for residual waste

These trash bins have bar codes and GPS devices that associate them to the family that owns the house. The waste truck driver checks inside of the bin to ensure that the organic waste and residual waste are separated before loading into the back of the garbage truck. If not, then the contents of the whole bin will be placed into residual. At the time of removal, waste trucks read the chips as they weigh the bins, and the more the bin weighs, the more the family pays. These trucks also have two chambers, for residual and organic waste, shown in Figure 16. As the trucks lift the bins, the operator positions the bins so that both types of waste fall into their respective chambers in the truck. The trucks then transport the organic waste to BioVækst, and the residual to a nearby incinerator.

Figure 16: Holbæk divided garbage truck.

Holbæk residents recycle waste into more than a dozen streams. Typically, homes have recycling bins for paper, glass, food, and residual waste. While trucks collect residual and food waste on a weekly basis, five communal recycling stations around the municipality receive 30,000 tons of recyclable waste each year. These stations have sorting containers for waste such as tires, foam, medical waste, hazardous waste, garden waste, and furniture, as well as a secondhand store for clothes and electronics. Although the municipality requires citizens to take recyclable waste to the stations themselves, they are encouraged to do so because of the fees placed on collected residual waste as opposed to no fee for using the recycling stations.

According to Klaus, Holbæk Forsyning's customers do not believe that enough space for more sorting exists in their kitchens, but Klaus firmly believes that this is not true. Klaus's own sorting system, seen in Figure 15, utilizes a ventilated green bin for his organic waste with two open bins for plastic and residual waste. Although he is not a typical citizen, Klaus's system shows that with some creativity a solution is possible to fit their unique kitchens.

4.1.1.2 BioVækst

BioVækst is a biogasification plant that specializes in the treatment of household organic waste. Currently, BioVækst handles 22,000 tons of waste, and they expect that number to rise to 35,000 tons within the next few years. The plant produces 300 kg of compost and 80m^3 of biogas (56m^3 methane) per 1,000 kg of organic waste, which equates to 290 kWh electricity and 1,400 MJ heat. BioVækst has

the ability to treat waste with up to 50% impurities, filtering most contaminants with the rotating drum in Figure 17. However, when residents do not cleanly sort their waste, the process becomes more expensive due to the removal and incineration of the impurity.

Figure 17: BioVækst's system for filtering plastic impurities

Peter Brønnum, project manager at BioVækst, discussed "Our challenge is not to get a purer fraction. Our challenge is to get a larger mass." He explained how when impurities are removed, potential organic matter is lost as well, reducing the amount of biogas produced by the plant. The removal and incineration of the plastic bags adds an expense to the process. Before the interview concluded Dr. Brønnum mentioned that the issue at the moment was some areas use biodegradable bags, while others use regular plastic bags. These types are all collected together in the same garbage truck. When the mixed biodegradable plastic and regular plastic arrive at BioVækst the bags need to be removed from the food, which results in the loss of the benefits of the biodegradable bags. He said this process would be improved if all areas used biodegradable plastic.

4.1.1.3 Sysav Pretreatment Plant

Sysav is a pretreatment facility that receives and treats biowaste from households in southern Skåne, Sweden, before exporting the slurry to biogasification companies elsewhere. In 2013, SySav handled 984,000 tons of source separated food waste and pretreated the food waste through a process

of screw pressing and adding water to create a slurry mix. The press screws the slurry mix past 12mm screw holes from which the impurities fall into a container for incineration The impurities make up 30% of the total waste taken in by the company and although this method is successful at removing nearly all impurities, a large portion of the impurities contains bio-content when it is removed.

During his interview, Rustan Nilsson, communications officer within Sysav, stressed having an infrastructure of source separated organic waste in place before building a biogasification plant. In his opinion, source separation was a more effective option due to an emotional bond forming between the homeowner and the quality of the waste sorted. In Sweden, sorting waste became the clear responsibility of the household in 1969. Although Swedes remove 70% of all food waste from the residual waste, in order to accomplish an even more efficient waste separation, people must be motivated to sort better rather than simply being required to sort. In order to remove a higher percentage of waste from the residual waste, Mr. Nilsson believes that people, especially Danes, would have more success if given reasons about why they should sort.

4.1.1.4 Interview with Dansk Affald

Dansk Affald, or Danish Waste, is a company created and funded by four municipalities: Haderslev, Tønder, Vejen, and Kolding. The purpose of the interview was to investigate a project conducted in Holsted (located in Vejen Kommune), involving 273 households sorting organic waste. Before the creation of the project, the citizens already had 2 large bins outside their home, one "duo-flex" bin that had a divider to separate wet and dry waste and a residual waste bin. Wet waste includes fractions sensitive to water such as cardboard and paper. Dry waste includes fractions such as glass, plastic, and metals. Citizens also had a separate bin for residual waste. Every two weeks the municipality collected the sorted waste, with little complaints from the residents. In an effort to reduce any bias and create a more precise picture of what households do when they have a new system implemented, 300 random households were chosen to participate in the study. In the end, 273 chose to participate and 27 chose to not participate. At the end of the study the participants were surveyed and 78 chose to respond.

Before the municipality gave new bins and paper bags to the 273 households, they invited residents to attend a meeting to inform them about the new sorting system and to answer any questions that the residents might have. Mr. Heinzl said that for the study they used "paper bags, not plastic to avoid confusion of people thinking they can put plastic in them, and then contaminating the food waste." In addition to the meeting, a brochure was provided explaining helpful tips for sorting and also what is involved in the treatment of the food waste.

Although the purity level was not spectacular the first time the waste was collected, quality quickly improved, and by the conclusion impurities were below 1%. In Mr. Heinzl's opinion, the project was a great success. He said, "We didn't have to teach them that you have to sort at home; they already had that." In the informational meetings and pamphlets the idea of sending less waste to the incineration plant, but instead sending more to a biogasification plant was emphasized. They explained that the biogasification plant created energy and the end product could be used as fertilizer. This idea helped them understand the reasoning behind the importance of sorting organic waste. Jesper attributes the success of the SAGA I study to the participant's knowledge of why their efforts were important. He shared that, "It's important to give all the information, make sure that it makes sense, and for the people to know they are making a difference."

4.1.2 Investigating the Perceptions Concerning Organic Waste Sorting

The team's second objective was to explore the perceptions of the common householder concerning participation in an organic waste sorting system. To accomplish this, the team handed out surveys at IKEA, Tversted, and online via Facebook. Additionally, the team gained secondary sources of information when the team interviewed Claus Petersen and Jonas Engberg, individuals with great experience in working with householders. Also, the team interviewed primary sources, Jens Guldsmed-Thomsen, Mads Ejlersen, and Nikolaj Hänselt; everyday citizens who gave the team their unique perspectives on sorting.

4.1.2.1 Survey Results and Analyses

This section discusses the results of the three surveys conducted. The surveys focused mainly on demographics, challenges associated with waste sorting, motivations for waste sorting, and population targeted questions depending on the survey. In the analyses of the surveys, some questions were excluded in order to focus on important questions.

Tversted Survey

This section analyzes the results of the survey conducted on March 31, 2014, outside two grocery stores in the town of Tversted. There were 12 people surveyed between 17:00-18:00. However, due to time constraints the surveying could not be continued further. The team split into pairs standing outside of different entrances, spending 30 minutes at each grocery store. Tversted has an ongoing study on sorting called Nulskrald. This gave the team the opportunity to speak with people who recently increased their sorting participation.

Q1.) Are you male or female?

Figure 18 shows the majority of people surveyed were female. This could be due to the time of day. The team surveyed at 17:00 which is generally when people get out of work and shop for dinner ingredients.

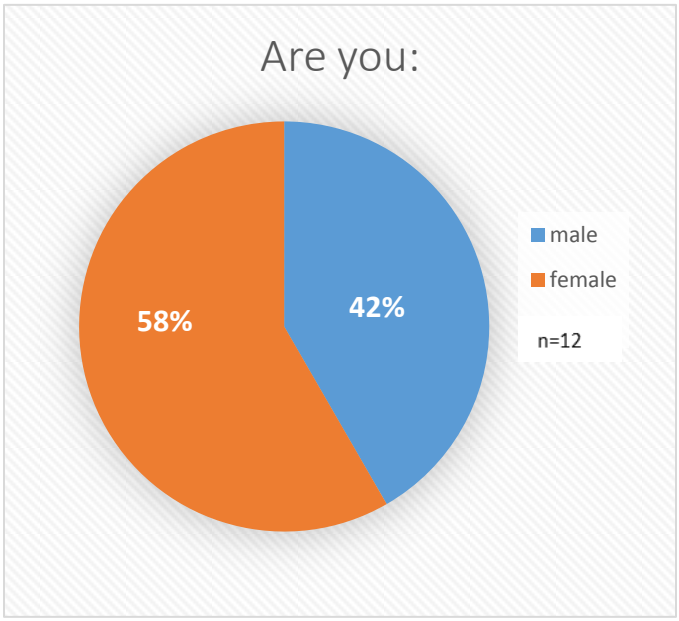

Figure 18: Tversted Survey Gender Distribution

Q2.) How old are you?

Figure 19 shows the people surveyed were mostly an older demographic and the second largest age group represented was between 30-39 years old. This specific age group could occur due to the time and location of the survey which was 17:00 at the grocery store.

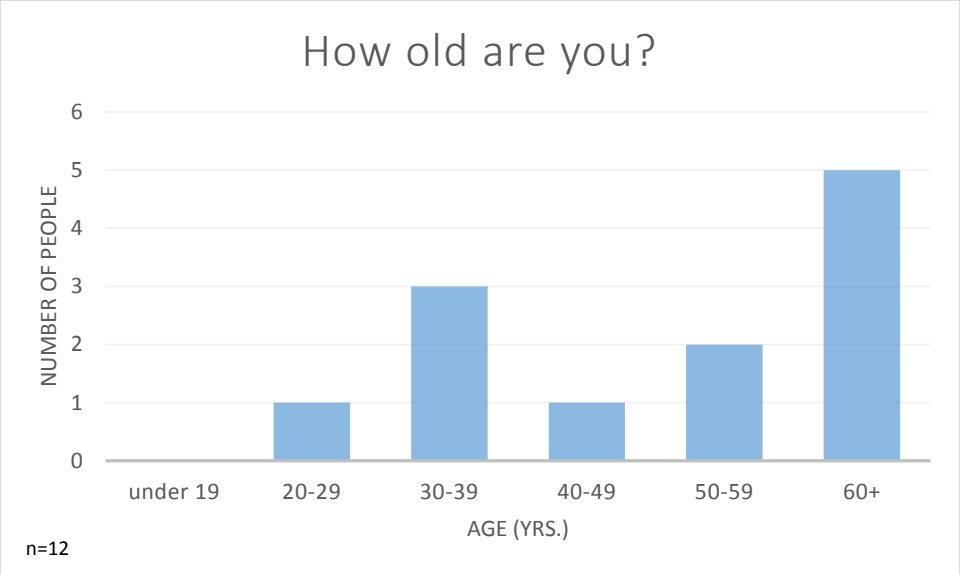

Figure 19: Tversted Survey Age Distribution

Q5.) Do you sort your waste?

This question was multiple-choice with the options shown in Figure 20. A large majority of respondents did sort their organic waste, which was unexpected since only a few people in Tversted asked for an organic waste bin. There was an ongoing information campaign in Tversted called Nulskrald, which encouraged the idea of sorting as much as possible so the least amount of waste goes to residual. What was surprising were the extra comments by a few individuals. Three people said they did not sort organic waste. This was due to the fact they fed the food scraps to the chickens or composted it in the fields. These were not responses the team expected because past interviews took place in more urban municipalities.

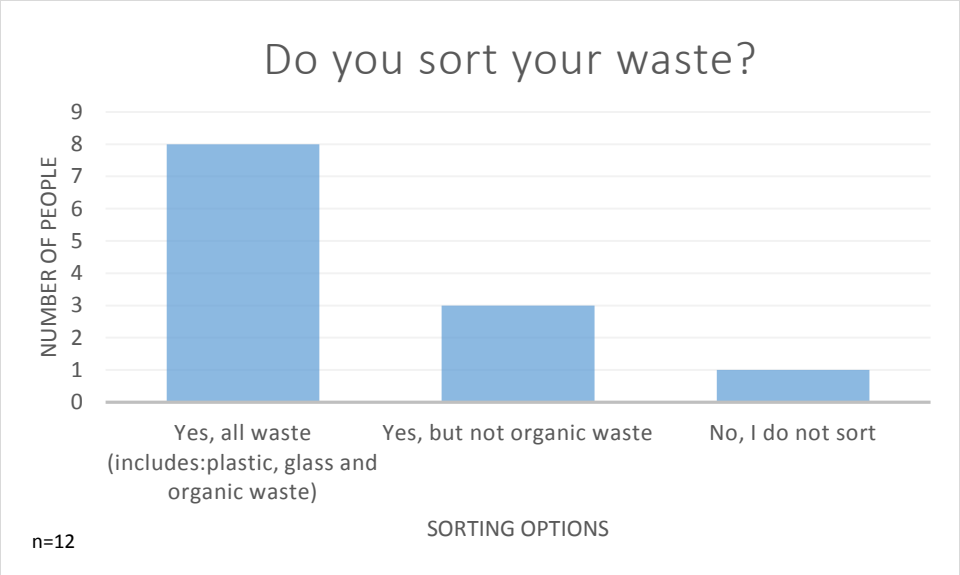

Figure 20: Do you sort your waste?

Q6.) How important is it for people to sort kitchen waste? Rate on a scale from 1-5, 1 as least important to 5 being very important.

The citizens of Tversted that we surveyed considered food waste sorting to be an average of 3.75 of importance on a scale from 1-5, with 5 being the most important. Figure 21, suggests that kitchen waste was important, but not the top priority. This average importance level also suggests that citizens need more information on the benefits of food sorting in order to increase their motivation to sort.

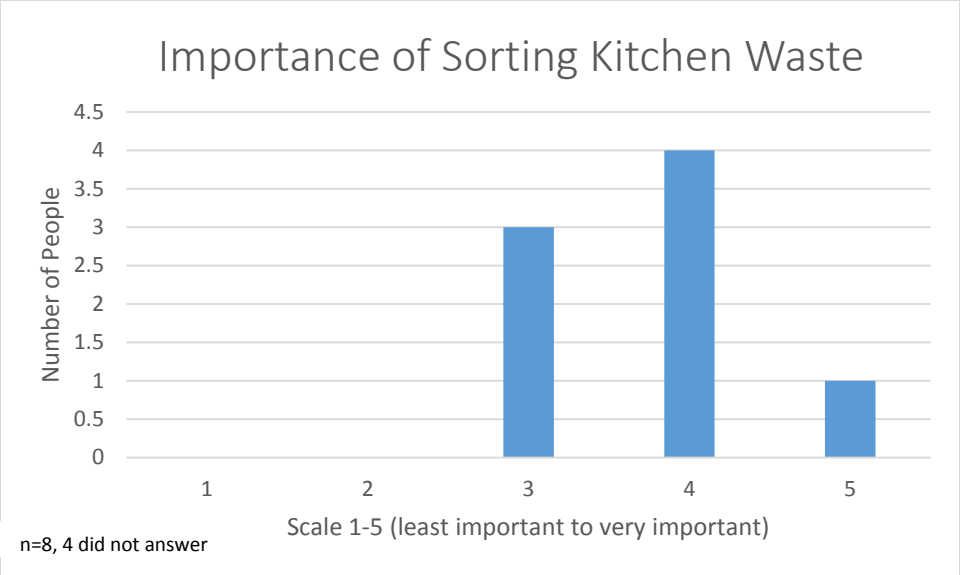

Figure 21: Importance of sorting household kitchen waste

Q8. What is your biggest obstacle to sorting waste?

This question was multiple choice with an "other" option. Figure 22 shows the five options the team provided (insects, convenience, lack of space, smell, none), and the answers people filled in the "other" category. The majority of respondents did not consider sorting to be challenging, but of the small pool that did, there were a few insightful responses that showed a unique reason. One person shared that setting up the sorting system was difficult in terms of where things should go and what bins they should use. Another respondent shared that the actual thinking associated with sorting was challenging. When one begins to sort there is uncertainty as to what fraction the trash belongs, but as residents become used to sorting, this quickly fades.

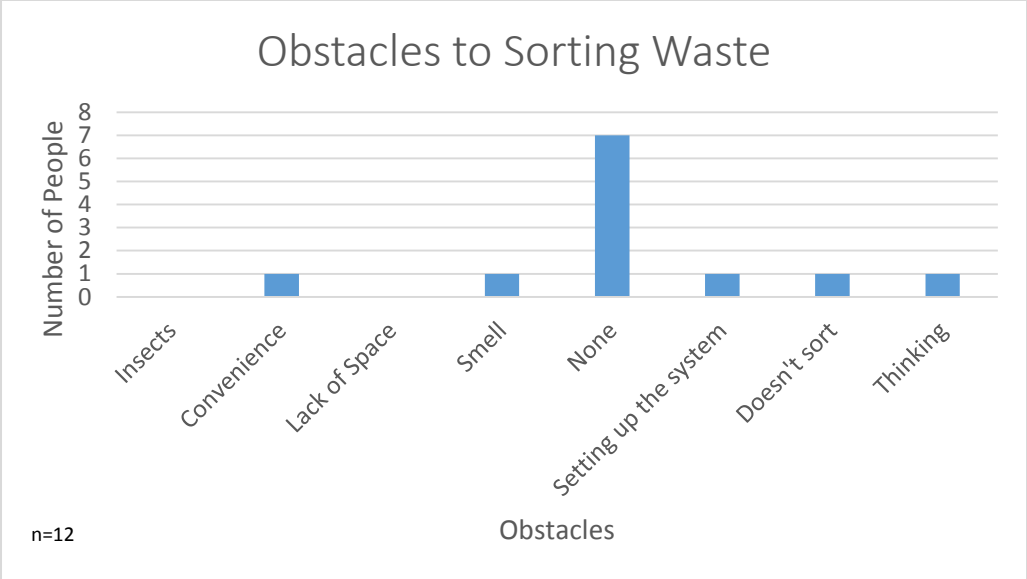

Figure 22: Obstacles to Sorting Waste

4.1.2.2 IKEA Survey

This section analyzes the results of the IKEA survey conducted on April 12, 2014, which yielded 40 responses after three hours of surveying. In the Høje-Taastrup IKEA, the team stationed all four members in various parts of the kitchen section. Each team member sought out people who were looking at kitchen appliances asking for two minutes of their time. At the end of the survey, the participants were thanked and offered candy for their participation.

Figure 23 shows the age distribution of all the survey respondents. The majority of people who completed the survey were between the ages of 40-59. This was due to their likelihood of being more financially stable and having the means to afford new kitchen appliances in comparison to younger age groups. Figure 24 shows the ratio of males to females surveyed. A majority of people surveyed were women, similar to the Tversted survey results in gender.

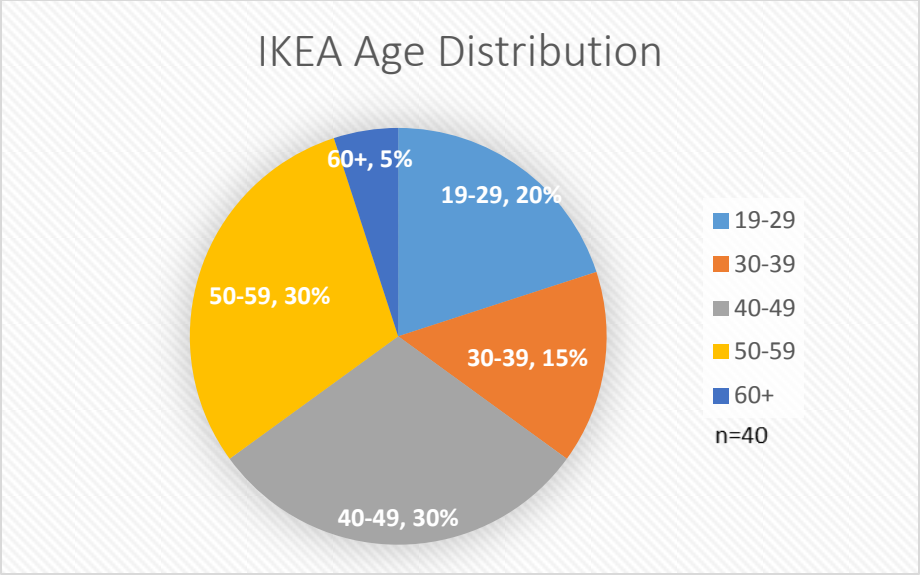

Figure 23: IKEA Age Distribution

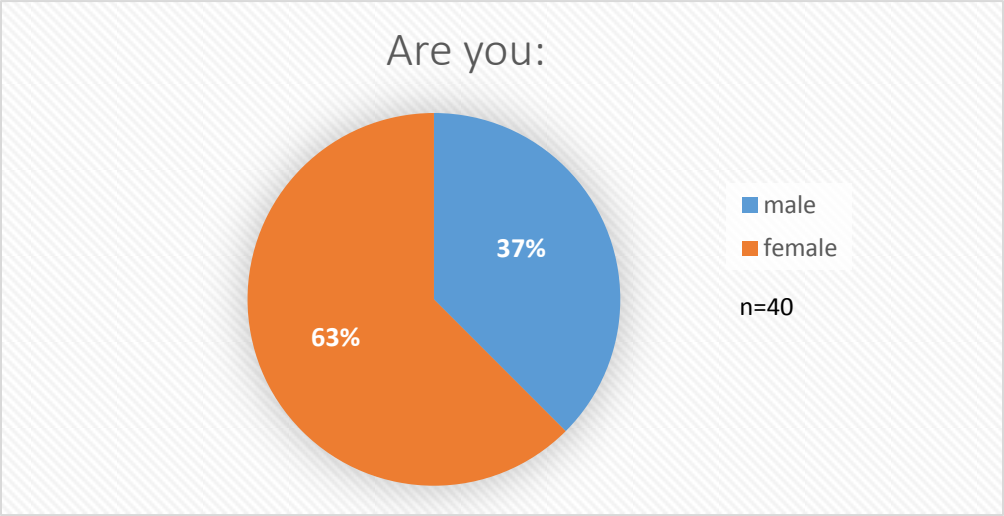

Figure 24: IKEA Gender Distribution

Q1. What waste do you sort at home?

For this question, the team considered any place of residence to be a home. This question gave waste fraction options seen in Figure 25 so respondents could check as many all that applied to them. The majority of people sorted glass and paper. Plastic and metal came in second with around 16 people out of the 40 who responded. The lowest quantity of sorting occurred with organic waste.

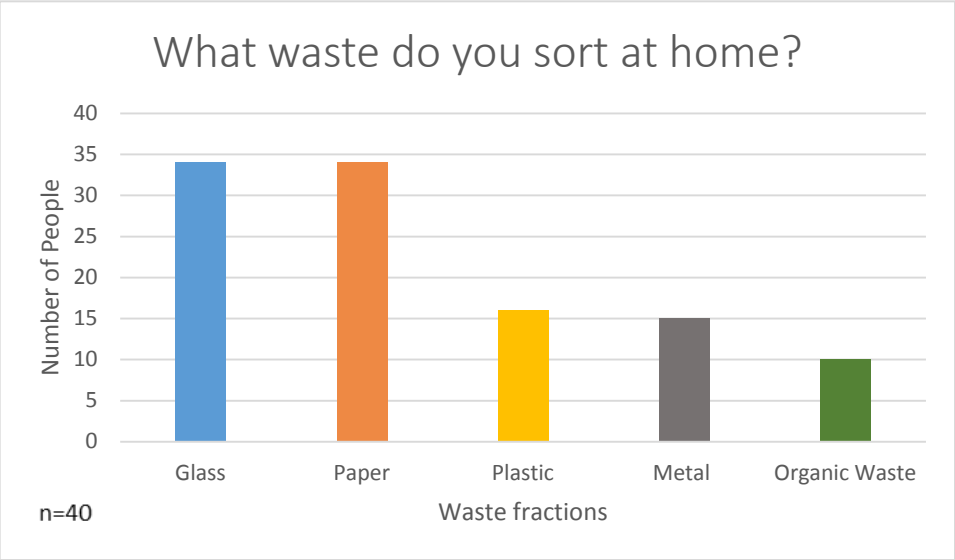

Figure 25: Types of waste sorted at home

Q3. To sort in the kitchen, do you use a system of your own design, one supplied by your municipality, or a store bought system?

Municipality supplied sorting systems made up the majority of systems used by citizens. However, 30% of people indicated they use of a combination of a municipal system and a system of their own design. The data shows that very few people buy a pre-made store bought system. Many people during the survey indicated that they just buy various bins that fit into the space they have.

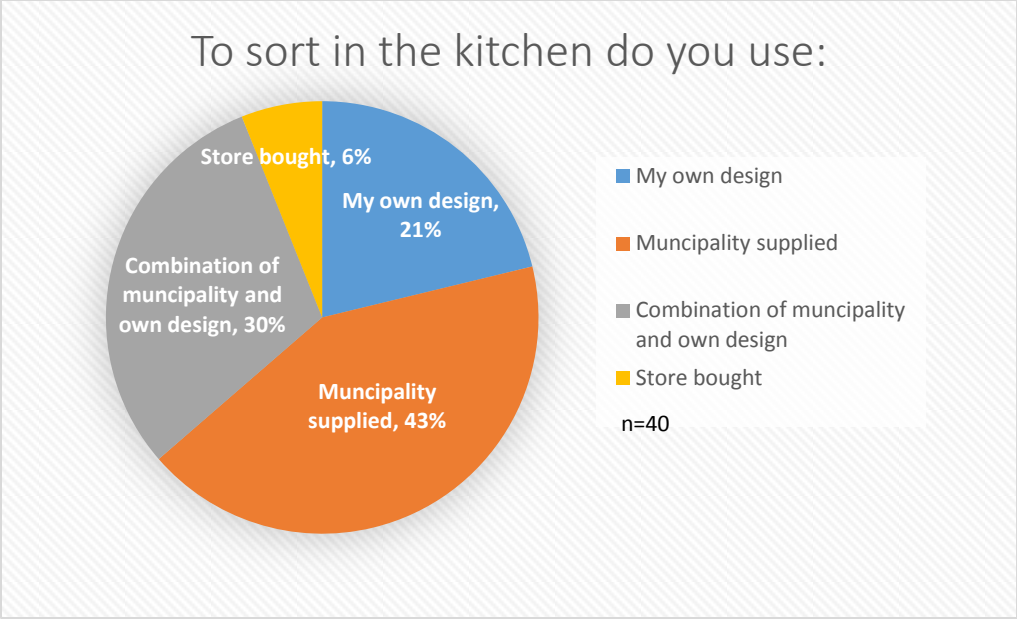

Figure 26: To sort in the kitchen, do you use:

Q5. What do you find difficult about sorting?

This question was an open-ended question and it provided various difficulties, but the main issues that emerged amongst the survey respondents are shown in Figure 27. The majority of people stated that nothing was hard about sorting, which was encouraging to hear. However, the more interesting responses were in regards to issues with the amount of space needed to sort and not knowing where to put fractions of waste. These difficulties came in second and third in number of answers after the "nothing" response. The concern for space is understandable; considering that Danish homes, such as apartments or single-family homes, have small living quarters. Comparing this concern for lack of space in the home with the 6% of people who bought store bought systems shown previously (Figure 26) suggests a need for more compact sorting options in the home that are not currently available. People mentioned that they were sometimes uncertain with where to throw fractions of waste. This hints that information distribution may need to be improved either in content or in frequency.

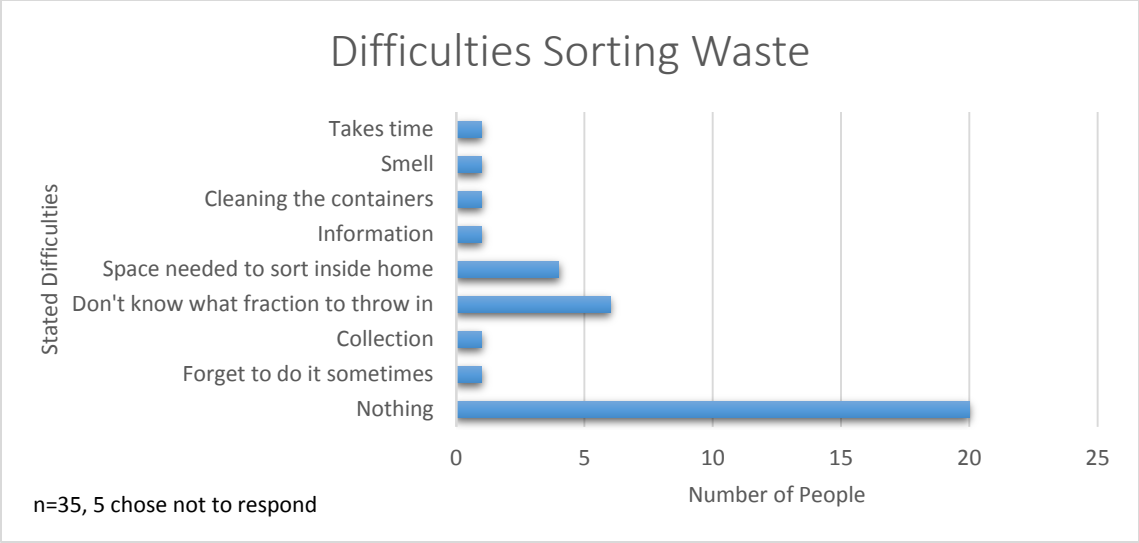

Figure 27: Difficulties with sorting waste

Q6. Do you consider waste sorting when looking for a new kitchen?

The pie chart indicates that the results from this question are inconclusive. The answers indicated an equal split between yes and no, while the other 23% admitted that they did not really considering organic waste sorting when buying a new kitchen. No strong opinion emerged and this may be due the fact that some people were not completely honest because they wanted to please us with their response. This result could imply sorting was important, but not necessarily a priority when customers look for kitchens.

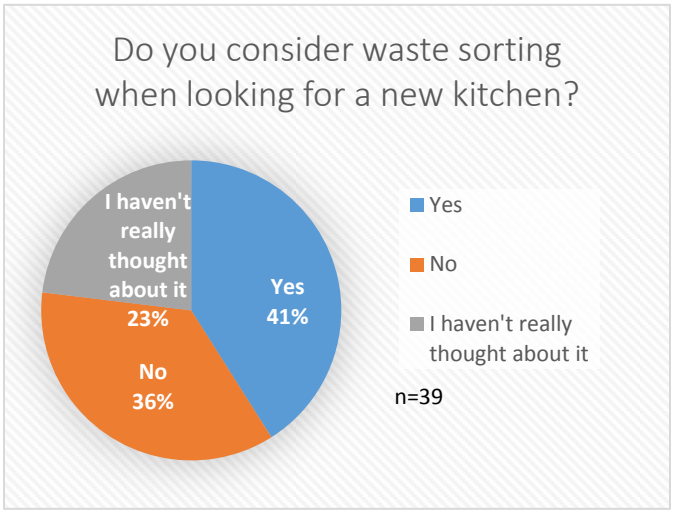

Figure 28: Considerations when looking for a new kitchen

4.1.2.3 Facebook Survey

The Nulskrald Facebook survey was first posted on April 11, 2014 on the Nulskrald Facebook page that has over 12,000 likes. The survey was live for about two weeks, closed at 6pm April 26, 2014, and yielded 39 responses. This survey was different from the IKEA and Tversted survey because the questions branched based on the respondents' answer to specific questions. The online platform of the survey allowed the team to cater questions directly to organic waste sorters and non-organic waste sorters.

Q1. *Upload a picture of your food waste sorting method you use in your home.*

This request had the least responses with eight photo submissions, seen in Figures 29 through 36. The acquisition of these photos served to accomplish one of the main deliverables for this project, and showed how residents have created innovative solutions to the lack of an available sorting system. Some of these photos did not quite relate to organic waste sorting. This implies that the respondents were not clear on the question; however, the photos that are applicable to this project have been included. These are comprised of indoor and outdoor sorting systems, as well as outdoor composting.

Figure 29: Method 1

Figure 30: Method 2

Figure 31: Method 3

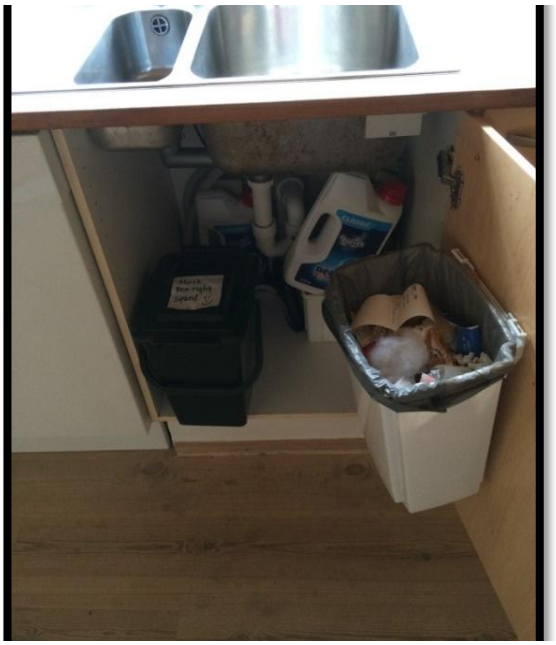

Figure 32: Method 4

Figure 33: Method 5

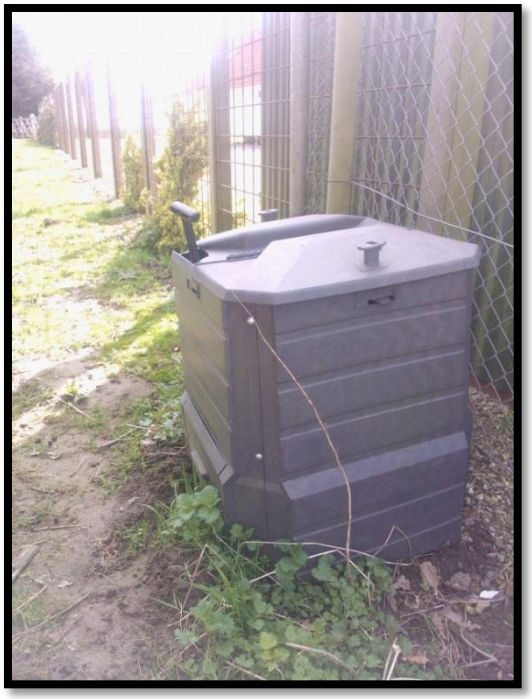

Figure 34: Outdoor Composting 1

Figure 35: Outdoor Sorting System

Figure 36: Outdoor Composting 2

Q2. What is your gender? & Q3. What is your age?

This question revealed that a large majority of the respondents were female between the ages of 19-29. Although surprising, the team could not discover if this correlation was due to women sorting within the household, or liking Nulskrald's page on Facebook, and thus being exposed to the survey. From previous surveys, the team observed that women were more willing to answer questions than men and this survey specifically reflects that. The younger age group of responders was likely due to the survey being posted on a social media site.

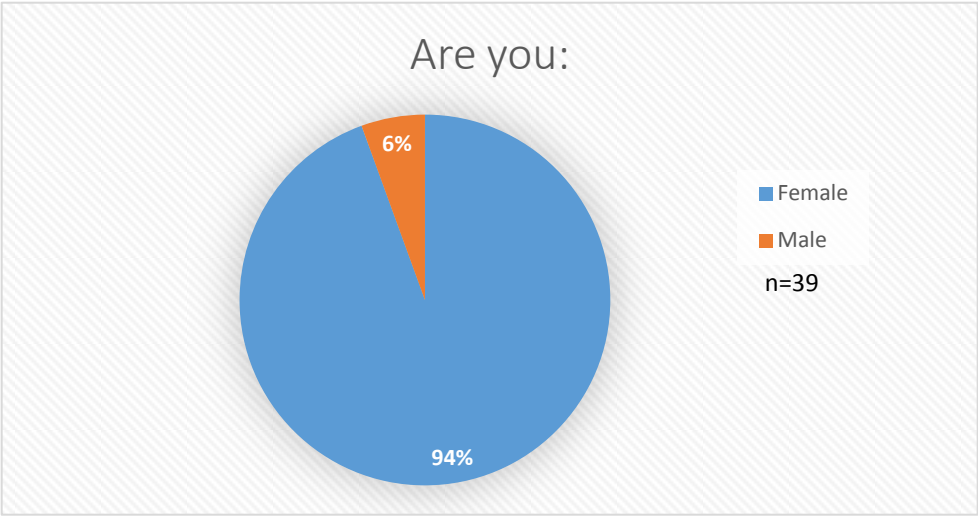

Figure 37: Facebook Gender Distribution

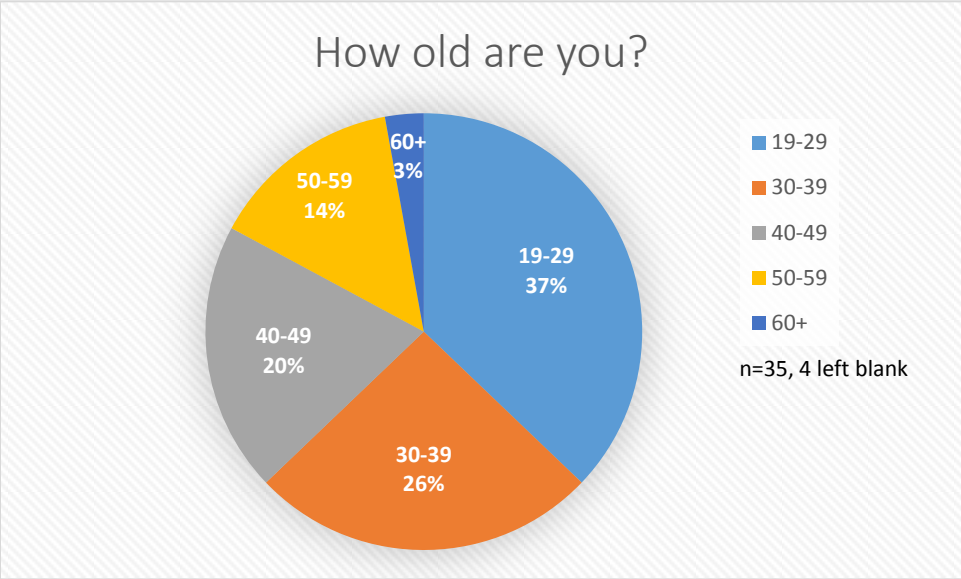

Figure 38: Facebook Survey Age Distribution

Q5. Which municipality do you live in?

This question validated that the survey would reach more than one municipality due to the fact it was online. The team wanted this survey to be more widespread and have less location bias, which is an issue with in person surveys. Of the 98 Danish municipalities, 22 were represented. It is interesting to see Herning had seven people, Aalborg had four people, and the rest had around one or two people.

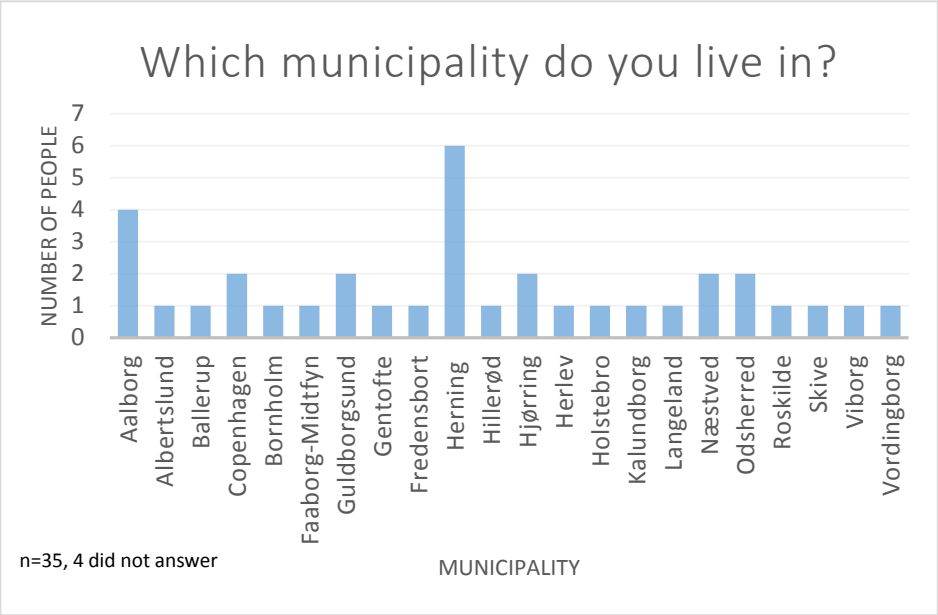

Figure 39: Municipality Distribution

Q6. Does your municipality require organic waste sorting?

For this question, responders could choose between four options: yes, there is a collection system, yes, there is a scheme for home composting, no, but I home compost, and just no. This was where the survey began to branch and become customized to the respondents sorting experience.

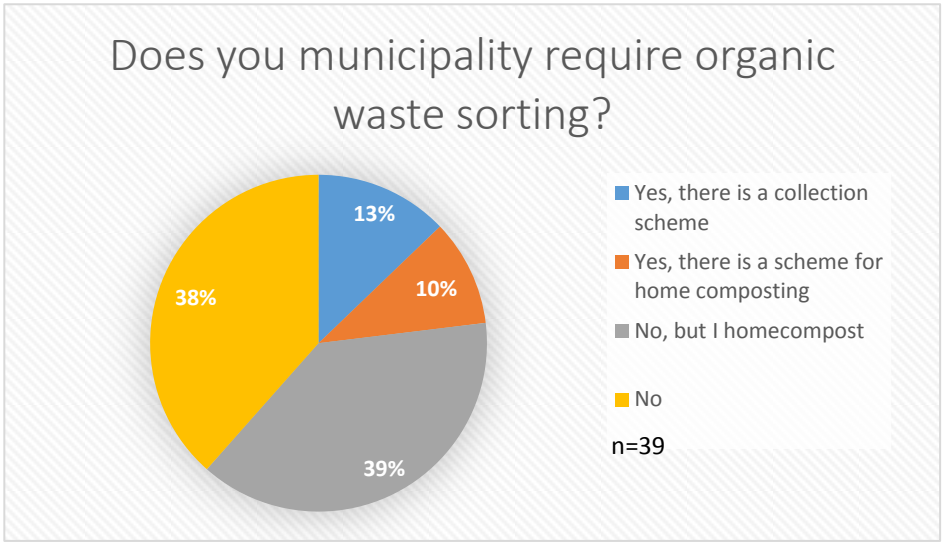

Figure 40: Requirement for Organic Sorting

Q7. Who is the main person who sorts waste in the kitchen?

Those who had previously answered yes to question six *(Does your municipality require organic waste sorting?)* answered this question, and provided 9 responses. These results showed that the responders to the survey, mainly women, were the main sorters within the household.

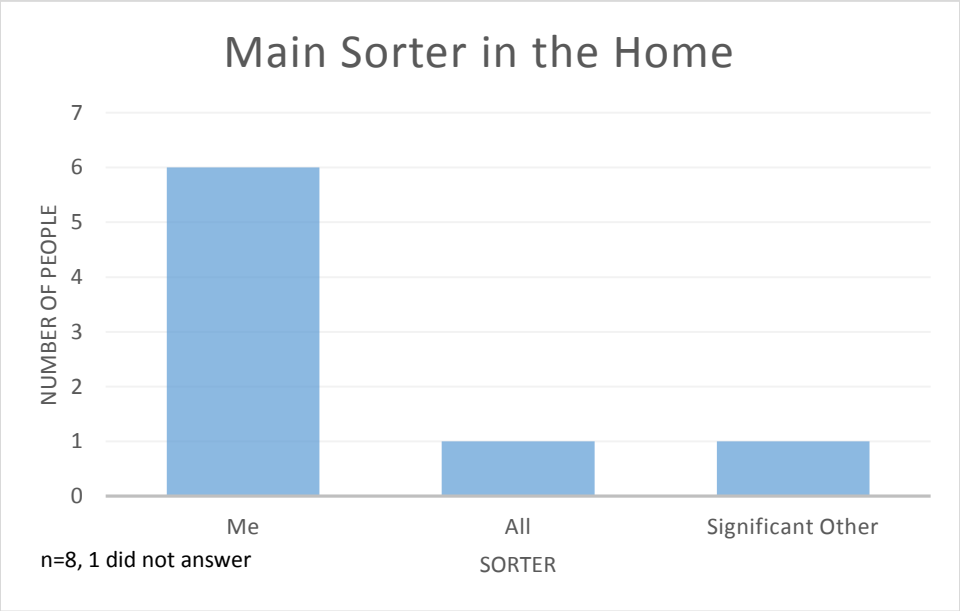

Figure 41: Who is the main sorter in the home?

Q8. What are the main reasons for you to sort food waste?

In this multiple-choice question, a respondent could check all reasons that applied to them with an "other" option. Overall, people were conscious of the environmental benefits of organic waste sorting. The municipality making sorting mandatory and feeling the influence of civic duty equally motivated people. One person used the other option and expressed their motivation came from the fact when food waste was reduced, it also reduced the total amount of waste that was created. That idea kept that person motivated.

Figure 42: Primary reasons to sort

Q9. What challenges do you face when sorting organic waste?

Respondents were able to check all that applied to them for this question. Overall, people's concerns were the lack of space in their home, convenience, and the smell associated with organic waste. Although this sample size was small, these concerns correlate with question eight of the Tversted survey and topics we discussed throughout our interviews.

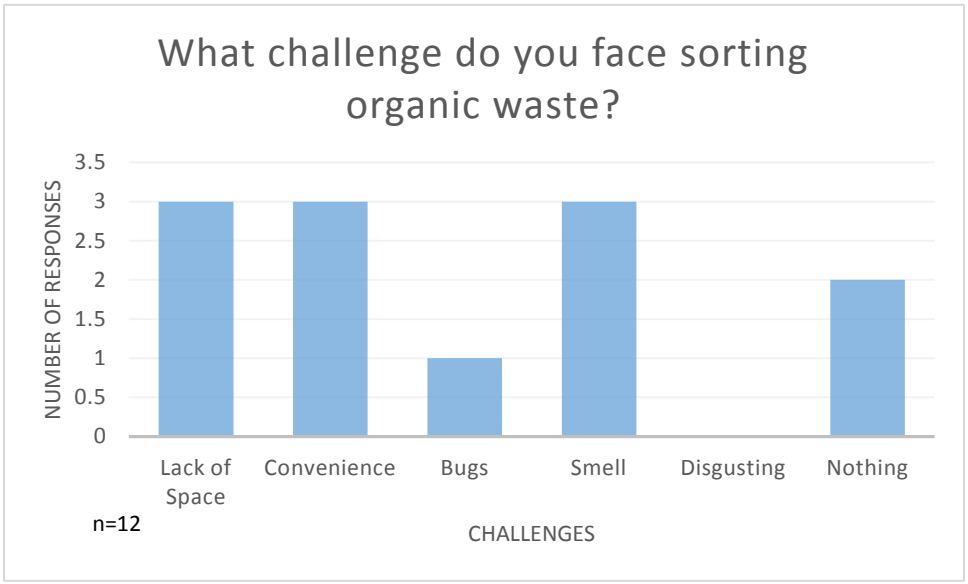

Figure 43: Challenges related to organic waste sorting

Q10. Where would you prefer to get waste information?

This question allowed respondents to choose all the choices that applied to them and add in their own suggestions. A point of interest for the group was if people chose traditional methods of communication versus more modern methods. All methods of communication were chosen about equally, averaging about three people per method. The results suggest people like having informational posters at recycling stations, on the collection bin, and articles in the newspaper. From our interviews with companies like Va Syd, there was agreement that these more traditional methods were still effective at conveying information. This graph illustrated that the poster and social media have the same level of preference, suggesting this could be a new avenue to spread information. One person added there should be some information on television. These responses suggest that there should be traditional print information available, but online resources should also be utilized.

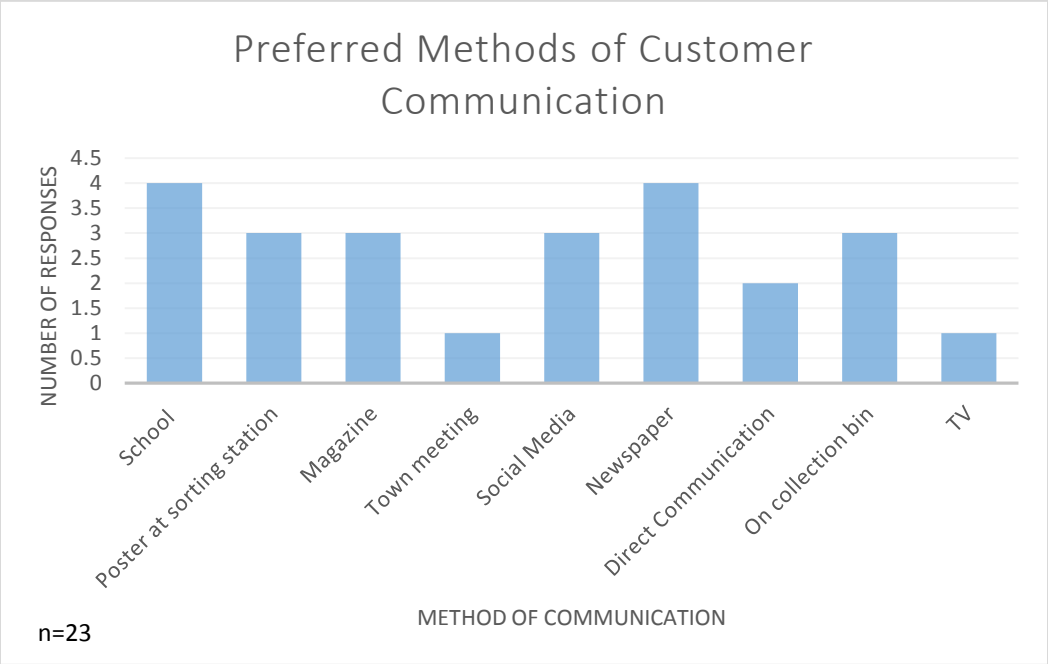

Figure 44: Preferred methods of customer communication

Q11. Would you want your municipality to start sorting food waste in the kitchen?

If the respondents answered question 6, “Does your municipality require organic waste sorting?” with a no, the survey then showed this question: “Do you want your municipality to start sorting”. Figure 45 showed a very high interest in municipalities beginning organic waste sorting systems. However, one needs to take into account where this survey was posted in order to analyze this result. It was posted on the Nulskrald Facebook page, which has dedicated followers who are especially motivated in waste sorting in general, not just organic waste.

Figure 45: Do you want the municipality to start sorting food waste?

Q12. What are the main reasons for you to want to sort food waste?

This question had a respondent pool of 30 people. The question allowed the respondent to check all the options that applied in addition to providing an “other” option for write-in responses. This data shows that a main motivating factor was that sorting benefited the environment. The more interesting results were people’s “other” responses they shared. These responses included:

1. “I assume organic waste does best when composted, rather than being burned with the rest of the waste, but I am not sure. I just do it to be safe “

2. “Wet waste is bad for incinerators. It would have more benefits in biogas plants”
3. “I did it when I lived in London and it worked very well”
4. “We have chickens in the garden which we feed the most”
5. “It will close the nutrient circle”
6. “I use it as manure for growing vegetables”
7. “I use compost in the vegetable garden and share the residue with our hens”
8. “I grow free food from waste”
9. “We own chickens so they will benefit”

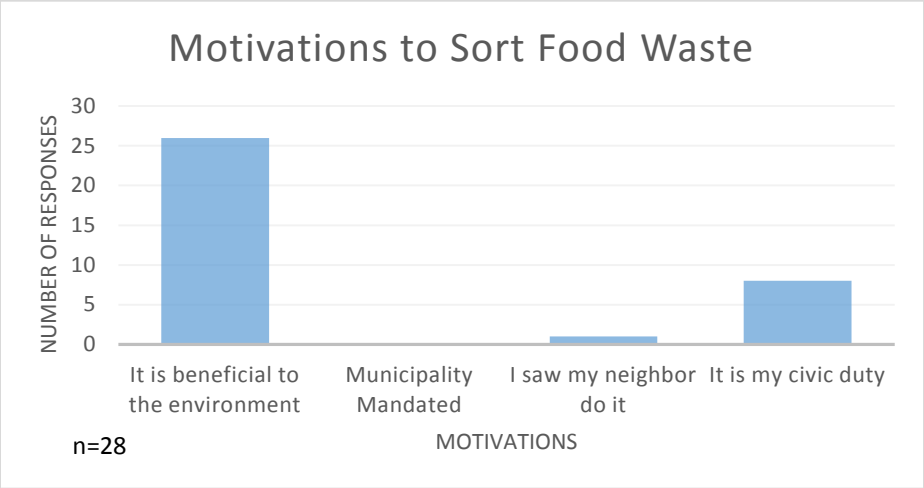

Figure 46: Why do people sort organic waste?

Q13. If your municipality began a food waste sorting system would you want…

From the responses received, the majority of people desire a system of sorting that the municipality has already created, either with bags provided or with different options available. If true, these findings could be useful for municipalities to consider in the future that people want a system given to them. Only 12% of people wanted to have to figure out their own sorting system. This was an interesting opinion because in Tversted that was exactly what they did. They gave relevant information to the citizens, but it was the responsibility of the citizens to create their own sorting system to fit in their home.

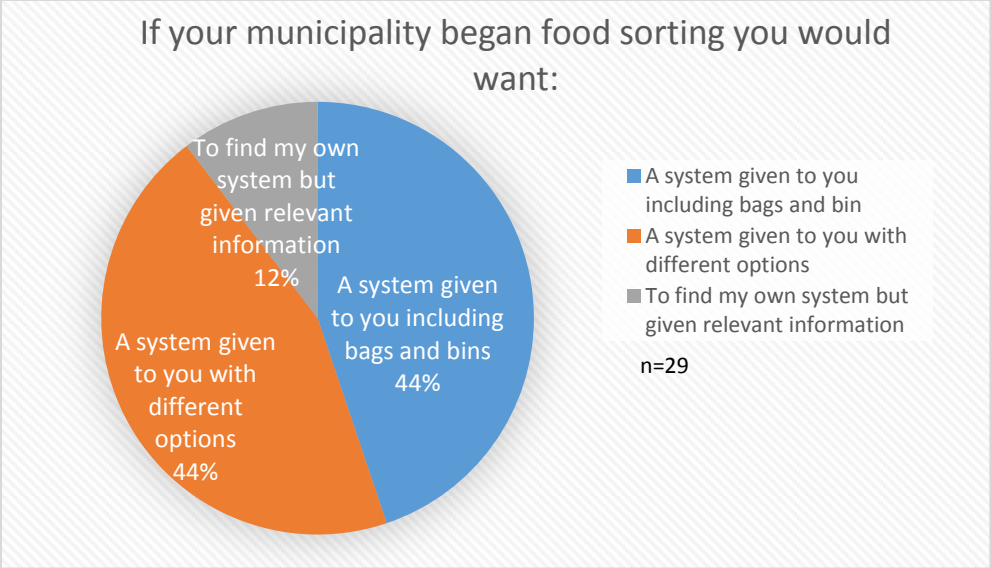

Figure 47: System wanted for food waste sorting

Q14. What are the reasons you would not want your municipality to start food waste sorting?

This question asked people who answered question 11, "Would you want your municipality to start sorting food waste in the kitchen," with a no. In this case, only two of 30 had that sentiment. One respondent chose disgusting and the other respondent chose incineration works well. The last response surprised the team since this was not an idea that many people have shared. If given more time, this idea of people's impression of incineration could be explored.

Q15. If your municipality began a food waste sorting system you would want...

This question followed question 15, and had only two responses so no graph was created. To this question, one person chose a system given to you including bags and bin and the other chose a system given to the person, but with options available.

4.1.2.4 Interview with Econet

On March 26, 2014, the team traveled to Econet, a private consulting company focused on the waste management of public authorities, organizations, and private companies. The team interviewed Claus Petersen about his experiences with surveying the Danish population concerning its waste sorting practices. Although Mr. Petersen reminded the team that results between different surveys should not be exactly compared between different projects due to differences in conditions and cultures, some of the data he acquired was applicable to this project. A summary of Mr. Petersen's interview can be found in Appendix B, however Table 2 below shows the data gathered from a study Mr. Petersen performed examining the purity of collected organic waste in comparison to the type of bag used.

Table 2: Comparison of Type of Bag and Food Waste Purity (Econet)

Type of Bag	Paper bags	Biodegradable Plastic	Typical waste bags	Other Plastic	Large Black Bags	Loose trash
Purity of Food Waste	>99%	98%	90%	70-80%	0-80%	Any

As shown above, paper bags receive the highest percentage of cleanly sorted organic waste, containing less than 1% of impurities. Biodegradable maize bags come in a close second with a purity of 98%. Using any other type of bag reduces the clean fraction that is collected from citizens. In Mr. Petersen's opinion, this is because people easily recognize that plastic should not be placed into a paper bag. However, issues arise because paper bags that have been weakened by moisture are susceptible to breaking; they also tend to be more expensive than plastic bags. Comparatively, when plastic bags are used, they tend to have a larger percentage of impurities present within them, which worsens as the bags become more industrial in nature. If the data from this interview is true, it is possible that biodegradable plastic bags can lead to a cleaner fraction of food waste than regular plastic bags, while at the same time costing less and providing more reliable bags than paper counterparts.

Although the type of bag can influence how clean the sorted organic waste is, an additional consideration is the percentage of total organic waste that is sorted from the residual waste into the organic waste bin. In Mr. Petersen's experience, when a system of sorting organic waste has been implemented for a long period of time, the maximum amount of organic material that is separated from the residual averages 70-75% of the total amount of organic waste. An information campaign can increase the percentage of organic waste separated from residual by only 5-10%.

Before the team concluded the interview, Mr. Petersen warned the team to be cautious moving forward. Again, Mr. Petersen shared data from a previous study, where he surveyed householders and asked them how much organic waste they composted in their gardens. Then, the participants' answer was checked by measuring the contents of the residual bin. During surveys, responses may be biased if people feel compelled to respond with the answer they think the surveyor wants to hear. The top row of the table shows how much people think they sort, compared to the second row, which illustrates how much organic waste was actually left in the residual waste bin. The table showed a baseline of 2.3 kg for non-sorters. For people who claimed to sort between 10-90% of their waste, the amount left in residual is 2.2kg. There is no discernable difference between those who did not sort organic waste and those who said they sorted between 10 and 90 percent of their organic waste. When responders indicated they sorted a higher amount of waste, it was likely due to a desire to placate the surveyor rather than provide accurate information. Mr. Petersen recommended to the team that instead of trusting the surveys and opinions of the homeowners that one should only trust concrete data.

Table 3: Comparison between Perceptions and Weighted Measurements of Sorted Waste (Econet)

Percentage of food waste that people believe they sort	0%	10-90%	100%
Kg of food waste in residual waste bin	2.3	2.2	1.2

Our interview with Mr. Petersen concluded that there are several factors that can influence householders to sort their organic waste, listed below:

- Knowledge - what is organic waste and how can one dispose of it
- *Holdning* - (direct translation unavailable) position, attitude, or view on a subject
- Experience - The options available within the individuals scope of perspective

4.1.2.5 Interview with IKEA

On March 21, 2014, the team conducted an interview with Jonas Engberg, a sustainability manager of IKEA, in order to ascertain the current views of one of the largest kitchen companies in Denmark. Complete notes on Mr. Engberg's interview are available in Appendix F. He believes that there are three important elements to instilling sorting behavior within homes: information, available space, and motivating change.

Information

In Mr. Engberg's opinion, the first and most important key factor to instilling sorting behavior within a home is information. He believed that information about the definition of food waste, as well as why sorting is important, should be clear to those sorting the waste. To facilitate the sorting of the waste, Mr. Engberg mentioned how colors and universal symbols can be used to communicate to individuals who cannot read, and express elements that cannot be fit onto a written sticker.

Available space

The second major consideration that Mr. Engberg made is the size available for the proper sorting of the waste. A small Danish household has only a 60-cm^2 area under the sink where residents conduct all kitchen waste sorting. In order to accommodate for homes like these, as well as homes where there might be a larger amount of space available, it is Mr. Engberg's opinion that the municipality or kitchen companies should provide a range of different options to suit the needs of the different types of homes. Currently, IKEA offers their customers a few options, shown below in Figure 49, to facilitate sorting inside their homes. With additional sorting of waste into smaller fractions, kitchens can use smaller size containers, thus helping to alleviate the space issue. Additionally, while many people can be encouraged to create sorting systems of their own within their house, there are others who would prefer to purchase a system that could be easily installed. By marketing to all types of homeowners, it would be possible to broaden the range of participants within an organic waste sorting campaign.

Figure 48: Example of Sorting Bins in IKEA

Figure 49 Example of a drawer sorting setup in IKEA

Motivating change

The last major consideration that Mr. Engberg made about the sorting of organic waste concerns the motivations for behavior change within people. In his opinion, there will always be a small percentage of the population who are intrinsically motivated to sort, and will do so regardless if it is required, and there is a small percentage who will never participate in a program. However, there is a large percentage somewhere in between that can be convinced. In order to gain the maximum amount of organic material, those who have not yet decided one way should be the target of a sorting. However, in order to get this middle population to sort their waste, the sorting campaign must provide applicable motivation. Although these factors of motivation are different for each individual, Mr. Engberg generally categorized them within the following:

- Political - Gaining political support
- Cost - having their bills fall as a result of switching to organic waste sorting
- Closed system - seeing a return on investment for the effort of sorting
- Environmental - Proving that biogasification is a more sustainable and environmental option

4.1.2.6 Interview with Nikolaj Hänselt

On April 23, 2014, the team visited Nikolaj Hänselt and Anna Kristiansen in Amagerbro. The interview began with Nikolaj showing the team around the area surrounding his apartment complex, revealing the round collection containers prevalent throughout Copenhagen. Nikolaj mentioned to the team that these types of recycling containers, particularly glass fractions, had among the highest rates of recycling due to the amount of time this type of sorting system has been in place,

Figure 50: Amagerbro recyling station in backyard of the apartment complex

Figure 51: An example of recycling sign above collection bins

Then Nikolaj brought the team behind the apartment complex to a row of storage units, shown above in Figure 50. Within the building, there were seven recycling containers for fractions of glass, paper, hard plastic, flamingo (Styrofoam), electronics, metal, and batteries. On the wall above all the recycling containers were laminated colored illustrations of the fractions the container should hold (See Figure 51). Not standard within waste sorting areas, Nikolaj acquired these pictures by calling the municipality and asking for better information to be provided than what was currently available.

Next, Nikolaj showed us into his kitchen. As with many apartments, he dealt with the issue of tight space, emphasizing he only had 20 cm next to his refrigerator left for sorting (Figure 52). There was no commercial shelving available to fit that space, so he built his own custom shelving system, and used canvas bags supplied by Vestforbrænding saying that, “Municipalities don’t support apartment sorting.” Nikolaj tried to recycle as much as possible showing tinfoil in his metal bag as well as caps from juice cartons saved to put into his hard plastics bag.

Figure 52: Nikolaj showing his homemade shelving and the 20cm space left for sorting

The team asked Nikolaj which system he believed would work best to motivate residents to sort; making the sorting system mandatory or optional. He responded, saying that all municipalities are independent so it really depends on the situation. The municipality of Gentofte where he works is a richer area where residents perceive waste as just waste, with no added benefit. The politicians are afraid of making any dramatic changes because these citizens have lawyers, and dislike any change to their way of life. Overall, he believed that if you make the solution available, people would begin to use it eventually, as most Danes are environmentally conscientious people. Nevertheless, making new systems mandatory remains mainly a political question.

The team asked about the importance of information to the success of new sorting systems. He considered information very important. Nikolaj explained that in each apartment a resident's council exists that works with the caretaker of the building to manage the waste produced by residents. The caretaker and the leader of the resident's council work together when they received the new bins and they posted the sorting material. That material includes signs, posters, and information pamphlets. However, all the information material needs to be updated; otherwise the sorting signs will soon become part of the background and are easily forgotten. The sorting signs over time will also wear away by weather. Nikolaj said, "Replace it and change the color to pink. Then the next year make it blue" so the signs attract attention and their message is not forgotten.

Finally, Nikolaj told the team that an eventual shift to recycling organic waste would happen. He said, "Other inhabitants will mess up for a year. But give them time and the clean fraction will emerge. For the next 10 years there will be good sorting." By instilling a sorting system now, a cleaner fraction of waste could be achieved and Denmark could be one-step closer to achieving its goal of becoming carbon neutral.

4.1.3 Information Campaigns

The team's third objective was to explore the information campaigns used to successfully investigate how information relates to clean sorting of organic waste and high participation. This was accomplished through interviews and site visits to Va Syd, Affaldsselskabet Vendsyssel Vest (AVV), and Vestforbrænding.

4.1.3.1 Va Syd

On March 27, 2014, the team conducted an interview with Ingela Morfeldt, a communications officer at Va Syd, a municipal authority of Malmö, Sweden. The interview with Ingela began with her stating that Malmö made sorting food waste mandatory in 2012. Va Syd's goal was to have 40% of all food waste properly sorted separately from residual waste by 2015. Nationally, Sweden aims to bio-treat 50% of their food waste, although a timeframe for this was unclear.

Within the municipalities of Malmö and Burlöv, homeowners generally use two large outdoor bins. They have a green bin in which all-residual waste is placed, and a brown bin where all food waste goes. The system they use in the kitchen consists of a brown, lid-less holder, specifically designed to allow for airflow, with a brown paper bag that remains open inside of it. On the sides and bottom are air vents to let airflow dry the bottom of the bag from any excess liquid collection. Printed on the brown paper bag were food waste facts along with a line that marks the maximum fill line. Residents usually place this system underneath the sink attached to the door or on the kitchen countertop. Ms. Morfeldt

went on to explain that the reasoning behind this was to provide a single, clear message to the homeowners, utilizing the brown color of the paper bag in all aspects of the food waste collection.

Figure 53: Indoor sorting system implemented by Va Syd

Six months before implementing the new sorting scheme Va Syd mailed letters to multi-family house owners. They asked if the property owners needed anything and supplied all relevant information to go with the new scheme. The property owners visited their residents and provided a brochure, along with the bin. Families received a large brown bin, which contained the following:

- Paper bags for one year
- A letter from politician explaining the decision to sort and reasoning behind it
- A brown basket frame to hold the paper bag
- A brochure explaining what food waste to put into the bin

Two weeks before receiving the bins and information from their property owner, the residents received a letter in the mail from Va Syd notifying them that the scheme would start soon with the catchphrase: “Soon we will meet every day”. The property owners received informational brochures with the equipment for the system that they forwarded to their residents. The challenge then turned to getting people to start sorting their food waste. Va Syd maintained an ongoing information campaign called Tack för Maten as a reminder to citizens of the new system.

When Va Syd first began this campaign to organize the sorting of organic waste within the household, one of their primary focuses was choosing the name. To accomplish this, Va Syd chose the

name “Tack för Maten”, or literally, “Thanks for the food”. By choosing this, Va Syd implied gratitude and positiveness from the start with their campaign rather than trying to force the public to participate in a sorting system. For the general public, Va Syd ensured that all advertisements had the Tack för Maten logo visible, a symbol of an eaten apple with a brown paper bag background underscored with the phrase Tack för Maten. Their hope was for citizens to recognize the symbol and associate it with sorting food waste. The campaign was large and included advertisements at the movie theaters, bus stops, and newspapers, but focused on informing all parts of the municipality that food waste was not limited to commercial restaurants, but included everyone.

Ingela mentioned Malmö’s population includes a large percentage of internationals and non-Swedish speakers. Given the city’s multicultural nature, part of Va Syd’s campaign included translating the informational brochures to Arabic, Somali, Pashto, and English. One of the biggest goals of the Tack för Maten campaign was to ensure that the information reached as many citizens of Malmö and Burlöv as possible. Va Syd held information sessions for their garbage truck drivers where they learned about the project so that they could answer any questions the customers might have, given that they have the most contact with them. In addition, internal events educated Va Syd employees about the program and each person received material so they could “show and tell” their friends and family.

In addition to written advertising, Va Syd sought out face-to-face interaction with citizens. An example would be Augustenborg 2012, also known as Eco-city day, where Va Syd held a competition for small children in order to teach them about waste. On this day, Va Syd explained the concept of food waste to both children and adults and showed that it can be used as a potential source of energy. After this, Va Syd had children draw their idea of what they though food waste looked like and the best design was printed on the brown food waste bags. By doing this, Va Syd involved the community in the project while educating children about food waste.

As part of Va Syd’s continuing campaign, several buses in Malmö are green, labeled with the message “Biogas för ett grönare Malmö” or “Biogas for a greener Malmö. There are also yellow busses that declare they actually run on biogas, showing the public some of the tangible use of sorting organic waste. By showing people that their sorting is actually fueling the busses that they use every day, Va Syd showed its citizens the fruits of their labor. Although successful thus far, Va Syd plans to reinforce the message of how easy it can be to sort waste. The catchphrase Va Syd plans to use to encourage continued sorting will be that sorting waste is “easier than picking candy” or “enklare an att plocka smågodis”.

Figure 54: "Biogas for a greener Malmö" on a bus in the city

4.1.3.2 AVV

On March 31, 2014, the team visited Tversted in Northern Jutland to speak with Thomas Dyrmann Winkel and Lene Høg, affiliates of Affaldsselskabet Vendsyssel Vest (AVV), another municipal authority. From the interview with Thomas and Lene, a background of the "Nulskrald" or "Zero Waste" project was developed. Using Tversted as a testing ground, Thomas and Lene provided only information without mandatory sorting of waste, to influence families to reduce their waste and create recycling and sorting systems within their home.

Nulskrald began as a 5-week test project one and a half years ago, in January of 2013. At the start, it encouraged people to sort their plastic from their residual waste. With the success in sorting plastic, a composting bin was provided to supplement the sorting of the waste. The purpose of the study was to incorporate how people think in the kitchen with removing all waste from the municipal waste stream. Over the course of the study 100 families volunteered to participate, which was a greater than expected involvement. Individuals quickly began to communicate between each other to pass information concerning proper sorting and answering questions. Although small prizes given out to chosen citizens every week and a grand prize at the end of the experiment supplemented the project, Lene and Thomas hoped that a habit would be formed to continue the sorting into the future.

Currently, Nulskrald has moved from its 5-week test phase to a full year, and implemented a plan to reduce and sort waste throughout the entirety of Tversted. Although the current project does not have the same competition, the project expanded to comprise the entirety of Tversted rather than being limited to 100 families. As of March 2014, the results of the project were to reduce the average waste in the households from 8kg/week to 6.8 kg/week. January 2014 saw the creation of free food waste collection in which 23 of the 300 families present in Tversted participated. Thomas and Lene attributed the small participation to the rural culture present in Tversted, and the disposal of food and organic waste through farm animals and composting.

The Nulskrald project attributed several factors to the reduction of produced waste, listed below:

- Direct attention to the project to make people aware of it
- Personal meetings
- Information
- Conformity (neighbor effect)
- Nudging – having sorting be less effort than not sorting

4.1.3.3 Interview with Jens and Mads

After meeting with the Thomas and Lene from the Nulskrald movement the team met with a couple, Mads and Jens, who had been sorting both organic waste and other recyclables. In Tversted, organic waste is collected on a biweekly basis and requires that the citizens deposit all waste in a paper bag inside of a bin supplied by the municipality at no cost to the homeowner. An overview of the key details from the interview is discussed here.

- Issues that have arisen with sorting waste
- Reasons why they participate in organic waste sorting
- Personal observations and thoughts

Although Mads and Jens sort their organic waste, several issues have arisen, but due to the nature of Nulskrald, providing information and communication to encourage individuals to create their own methods of sorting organic waste, unique solutions were found for the majority of these issues. The first major issue encountered by Mads and Jens in the sorting of organic waste is that liquid foods like soup and pickled herring disintegrate the paper bag placed in the collection bin. In order to counteract

this, Mads and Jens have started collecting all waste in plastic bags, and transferring the contents into the paper bags a few days before the two-week collection. In this manner, the couple sought to increase their own convenience while still maintaining a clean percentage of organic waste. The second issue was with the collection bins themselves, which in their experience is never heavy or full enough to keep from knocking down in the constant wind experienced in northern Jutland. Another major concern they had was the smell, which might begin as the weather warms, and therefore have moved the bin to a location protected from the wind and sun in an effort to keep it sheltered and cool.

When asked what motivates them to sort their organic waste separately, Mads and Jens explained that it first began with the Nulskrald movement encouraging them. However, they dispose of the majority of their food waste by feeding it to the chickens in their backyard. Mads and Jens shared that in the beginning, sorting was difficult due to their unfamiliarity with it, and the need to constantly consult a list. However, over time they began to see how much they reduced their residual waste bin and that motivated them to continue. Mads said, “it became a sport” with themselves to see how much they could reduce their waste.

Their advice on an attempt to encourage others to begin to sort was, “not to demand too much or they won’t do it. But it creeps under your skin in a short amount of time”. They explained since they created their own solution that suited them it made them feel more responsible for their waste as opposed to a system just forced onto them. Nulskrald was “trendy” in Tversted, which led to discussions among neighbors and brought attention to the new movement.

4.1.3.4 Vestforbrænding

On April 3, 2014, the team interviewed Camila Petersen, Isabelle, and Per at Vestforbrænding, a public limited company that offers 19 municipalities solutions for the collection and treatment of waste from households and businesses. This interview focused primarily on learning about information campaigns used in the creation of organic waste sorting systems within the municipalities that own Vestforbrænding. Although Appendix L lists the complete notes gained during the interview, this section provides a brief overview of the upcoming organic waste sorting campaign here.

In order to campaign to the population, Vestforbrænding attempted to simplify the system as much as possible. An example of this was simplifying the term organic waste to just food waste. This was in hopes of keeping the message as simple and understandable as possible for the general population. In addition to this, large quantities of information pertaining to the clean sorting of organic waste were given to the municipalities. In turn, the municipalities gave these to caretakers of buildings to ensure clean sorting as well as to offer information to any residents who had questions. Vestforbrænding

continuously provided information to ensure that people had access to a constant supply of up to date information to utilize in the sorting of waste within their own home. By doing this, Vestforbrænding hoped to overcome any issues that arose with the collection scheme.

4.2 Discussion

After gathering data from interviews and surveys, the team went on to analyze what we learned. The team evaluated the qualitative results from the interviews conducted through two rounds of inductive open coding. Quantitative data from the surveys was entered into Microsoft Excel. This allowed a better representation of the information collected, and provided several key findings that municipalities should be aware of in the formation of an organic waste sorting system.

From the results gathered, the team identified several key elements that can contribute to the successful management of organic waste. By examining systems already implemented, municipalities can draw from the wealth of experience available to create systems that are most effective for their unique situation.

Finding 1:

It is more important to get a greater amount of organic waste sorted, not necessarily a cleaner fraction.

In order to discover how to best sort organic waste in kitchens within Denmark, the team conducted interviews with biogasification and pretreatment plants that investigated what was the ideal material these companies required. Firstly, the team conducted a literature review examining the process of biogasification and the definition of organic waste. This allowed the team to approach the companies of BioVækst and Va Syd with a knowledgeable background and perform interviews that revealed valuable information about the current challenges these companies face concerning the sorted organic waste.

When the team interviewed representatives from BioVækst, they made an interesting observation. Rather than desiring a clean fraction of organic waste, BioVækst prefers having larger quantity of food waste sorted from the residual fraction. In their experience, impurities can be removed from the collected biowaste, but biowaste that is not removed from the residual waste stream cannot be recovered. Increasing the amount of food waste collected for use in BioVækst's biogasification system produces a greater amount of biogas. This compensates and surpasses the increased cost of separating the biowaste from plastic impurities.

The interview with Sysav showed that not all biogasification plants could handle impurities in the same manner as BioVækst, and that a large percentage of biowaste and potential fuel for biogas is lost screening out these impurities. Although the company focuses on treating waste already separated from the residual waste stream, Communications Officer Rustan Nilsson recommended several important considerations concerning the formation of an organic waste separation campaign. In his opinion, it is more important to have a system of organic waste sorting present within the area before construction of a biogasification center starts. He explained that no one can expect a company to create and perform a service when a raw material is not present. In order to both entice and ensure the viability of a biogasification system, a constant and large source of organic waste should be made available for treatment.

Lastly, as the 2022 deadline for recycling 50% of all household waste approaches, it becomes much more important for residents to sort greater quantities of organic waste from its residual counterpart. Although having all organic waste cleanly separated is ideal, focusing on having residents separate a greater amount of organic waste not only allows the biogasification companies to increase their ability to produce biogas and compost, but will also increase the percentage of household waste recycled.

Finding 2:

Patience is important in the formation of a sorting system

As mentioned in the results, Holbæk residents have been sorting organic waste separately from residual waste for over a decade. Their experience composting allowed the residents of Holbæk to easily understand what was defined as food waste when the municipality began to collect it. Within a very short amount of time, a relatively clean fraction of organic waste was being collected from the municipality, and residents were willing to participate in the system. This suggests that as citizens become more familiar with sorting organic waste, participation and ease of sorting become higher as well.

To gain information about how residents react when first exposed to organic waste sorting, the team conducted an interview with Dansk Affald, who published the research project S.A.G.A, or “Sortering Af Genanvendeligt Affald” (Sorting of Recyclable Waste). The project examined how 300 residents reacted to participating in an organic waste sorting system. Although there was a significant effort from those not randomly selected to participate in the project, Dansk Affald elected not to allow these residents to take part, in order to acquire representative data. Marketing manager Jesper Heinzl

said: “We had people that didn’t really care about recycling... It’s important to have such people in the study, otherwise the results get too pretty.” Although there was a large amount of initial concern with creating a system of sorting, once the system was in place people accepted it without hesitation. Mr. Heinzl said: “When we started the Duo-flex system (previously implemented dual-chamber bin for sorting non-organic recyclables) we had people that did not want to participate. However, the municipality mandated that everybody had to participate. In a short time, many of the people that said, ‘No thank you, we don’t want this.’ changed their minds completely and did not want to get rid of the new system. Sometimes people make worries on what they think it is, but when they actually experience it they can change their mind, it’s a very human thing.” This response suggests that while residents may be vocal in their resistance to changing, once they become accustomed to the change their concerns disappear. By the end of the organic waste project, the public opinion of the project was positive, with residents saying, “Who should we vote for to keep this system?”

Finding 3:

People want a pre-made system for sorting within the kitchen

When the team conducted the online Nulskrald Facebook survey, one of the questions asked:

Q11. Would you want your municipality to start sorting food waste in the kitchen?

From Figure 45, 93% of respondents chose yes, they would want their municipality to start sorting food waste in the kitchen. Although a certain bias was expected from followers of the Nulskrald page, such an overwhelming response could indicate that once the population becomes knowledgeable of organic waste and the benefits of recycling it, an overwhelming majority would support those who would implement such a system.

Another response that was notable concerning the collection of food waste was in response to question 13 of the same Nulskrald Facebook survey.

Q13. If your municipality began a food waste sorting system would you want…

From Figure 47, 88% of those surveyed desired a system given to them, either including bags or bin or a system with different options available. The responses showed that the majority of people desire a system of sorting that the municipality has already created, either with bags provided or with

different options available. Only 12% of people wanted to design their own sorting system. This was an interesting opinion because that is exactly what they did in Tversted. The Nulskrald campaign gave relevant information to the citizens, but it was the responsibility of the people to create their own sorting system to fit in their home. If representative, these findings could be useful for municipalities to consider in the future. Most people want a system given to them.

Lastly, during the survey conducted in IKEA, the team surveyed random customers concerning their opinion on sorting organic waste within the household while they shopped for new kitchens. Figure 43 showed that 57% of respondents stated that there would be no difficulty to sorting waste within the kitchen. Interestingly, the second and third responses concerning difficulties encountered were that the respondents either didn't know which fraction to recycle the waste in, or they didn't have the space needed to sort within the home. Although knowledge of which fraction organic waste belongs in can be solved through an information campaign, the second response was much more interesting. The concern for lack of space in the home, with the 6% of people who bought store bought systems shown previously (Figure 26) suggest a need for more compact sorting options.

Finding 4:

Paper and biodegradable bags have the cleanest fraction of sorted organic waste

From the interview with Claus Petersen, it appears that paper and biodegradable bags are more effective than normal plastic trash bags for the clean sorting of organic waste. According to Claus, people associate the organic nature of the bag with their food waste. Although biodegradable and paper bags have unique advantages and disadvantages, statistics show that they each cause about a 10% decrease to the amount of impurities present within them compared to normal plastic bags.

Holbæk Forsyning recently began an experiment in which 198 families received biodegradable plastic bags as containers for sorted organic waste. They were also given a green plastic bin to use with the bags inside their kitchens. Although this study is not completed, at the conclusion of the program, project manager, Klaus Jakobsen hopes that it will reveal significant differences in the percentage of impurities (i.e. metal, plastic) and the amount of organic waste sorted into these bins.

Although it is clear that paper and biodegradable bags attain the cleanest fraction of sorted organic waste, when the team asked Dr. Peter Brønnum from BioVækst for recommendations concerning the creation of new sorting systems, he mentioned that there is no benefit to using a combination of biodegradable and inorganic trash bags. When a mix of the two is brought to the biogasification plant, the bags still have to be removed to eliminate the impurities of the inorganic bags.

Instead, either all biodegradable or all inorganic trash bags should be used to maximize the cost efficiency.

Finding 5:

Clear, understandable information and simple explanations allow people to sort

When a municipality creates an information campaign created to collect a fraction of waste that residents are not familiar with, distinct and understandable information must be provided to the residents that allows them to know what to sort out of the residual waste stream into the organic waste bin.

By utilizing one clear message, Va Syd was able to provide its residents with information that clearly and consistently defined organic waste, and identified the proper methods of sorting and collecting. One of the main ways in which they did this was through reducing the complexity of organic waste as a whole. By referring to it as food waste rather than organic waste, impurities such as garden waste are immediately reduced from consideration by the public. Additionally, the municipal authority passed information to property owners and caretakers who became experts in the area and were able to reduce the amount of questions residents had.

The use of paper bags to collect food waste has been a recurring subject throughout our interview process. In both Jutland and Sweden, Dansk Affald and Va Syd chose to use paper bags in order to keep confusion to a minimum. By having residents sort their food waste into paper bags rather than plastic, these companies mentally encouraged residents to link both the difference in the bags, and in the organic nature of the paper bag itself.

While the most important factor pertaining to the creation of a sorting system is instilling the proper information within a household, an additional consideration is the method of communication. By using universal colors and symbols to communicate the idea, information is spread to individuals who are unfamiliar with the fraction. An example of this is when Va Syd used the color brown to relate to all aspects of sorting organic waste. From brown bins, to brown bags to signs, everything associated with the Tack för Maten campaign contains this feature that allows the individuals to relate each aspect of the campaign to the others.

Figure 55: Tack för Maten advertisement with paper-brown background

By using universal symbols, the message of what should be sorted into the organic waste fraction is quickly and easily shared to the reader. One of the most common symbols used was a half-eaten apple or fruit to separate food waste from other organic fractions such as garden waste. This symbol, shown below in Figure 56 was seen in both Sweden's Tack för Maten campaign and in Vestforbrænding. Additionally, the message of food waste is also shared with people who cannot understand the language the explanation is written in by using symbols such as this.

Figure 56: Vestforbrænding food waste symbol

Figure 57: Va Syd's Tack för Maten logo

Lastly, the team found that nearly all information campaigns conducted could be broken down into two broad categories, listed below:

- Top- down campaigns: Systems of sorting being mandated by a governing body
- Bottom-up campaigns: Self-arising systems of sorting from information provided to the population

The differences between these campaigns is seen both via the short-term and long-term successes of each, although continued research is necessary to explore the full effects of a bottom-up campaign. Municipalities have used the top-down method much more often than its counterpart, and examples can be seen in Va Syd and Vestforbrænding. This campaign system was defined as having the municipal authority mandate sorting within the region. Although residents were required to sort their organic waste, the team often observed that there was complaining upon initiation of the system. Additionally, the quality of the collected waste averaged 70-80% pure. Interviews with representatives from these municipal authorities such as Mr. Nilsson generally attributed to residents not truly being motivated to sort, and instead only doing so because of the requirements set forth by the municipality.

In contrast, AVV has used the bottom-up method to some success in Tversted; however, it focuses much more on the long term effects than the top-down method. The team defined this system as one where the information campaign provided the population with relevant information and it was

up to the citizens to create their own household organic waste sorting system. By working in this way, intrinsic motivation developed within the population, and encouraged them to create their own methods of sorting waste within the kitchen.

Finding 6:

By providing motivation to the population, people are encouraged to participate in the sorting system

Information is key in allowing people to understand what they should sort into organic waste, campaigns must provide motivation to encourage people to participate in the sorting system.

Although Sweden has sorted food waste for over 10 years, transferring ideas across countries may create issues due to differences in culture. In Sweden, Mr. Nilsson explained that one of the reasons Malmö and Burlöv experienced success in the sorting program was that Swedes implicitly trust their government. As a result they are more inclined to do what the government mandates without requiring an extensive explanation. That trust enabled Sweden to enjoy an immediate response to its national intent to sort food waste. However, Mr. Nilsson believed that the collection of waste could be improved if residents were given a motivation for sorting rather than simply being told to participate. Conversely, he mentioned that Danes appear to be more skeptical of their government. However, if they are given the proper information and reasoning about why they should sort, rather than simply being told to sort their waste they would have no issue participating in such a collection system.

Although it is not possible to motivate all parts of society, a large majority could potentially be motivated to sort their organic waste. In order to accomplish motivational change, Mr. Engberg from IKEA identified four major factors: politics, economics, direct returns and environmental concerns. Although this study will not completely capture all factors, it is the opinion of Mr. Engberg that these are the most important and influential for motivating change in regards to organic waste sorting. Due to each individual within a municipality being different, a single motivating element will never be sufficient to motivate the entire population. Therefore, a combination of these factors will likely be more successful when attempting to motivate such a diverse population

The municipality of Holbæk requires its citizens to pay an annual fee to have Holbæk Forsyning remove their waste. As part of this fee, Holbæk Forsyning maintains recycling centers throughout the municipality where citizens bring their non-organic recyclable waste for processing without additional cost. On the other hand, residual and food waste are collected by waste trucks at the homes, where the residents are charged an additional fee per kilogram waste collected. Using this system, Holbæk encourages its citizens to sort recyclables by making it less expensive than the residual. This system

could be improved even further by having the food and residual waste collected separately so that only the residual waste is weighed and charged to the householders. By removing the fees associated with food waste, residents would be encouraged to sort more of it due to the monetary incentive.

As part of the Tack för Maten campaign, Va Syd placed campaign posters on busses that run on biogas. By showing citizens the result of the campaign, thus justifying the people's effort. With evidence of their waste sorting producing something that they see in their everyday life, people will likely be encouraged to continue to sort. Additionally, this creates a perpetual awareness within the public, because every time a resident sees the message on the bus, their awareness of food waste sorting is renewed.

Another element encouraging residents to sort their organic waste is summed up by the Danish word, "holdning." Similar to someone's personal beliefs, the word conveys a sense of the attitude and viewpoint an individual has. By phrasing an informational campaign using words that cater to the population's "holdning," the campaign would encourage individuals to sort their waste by catering to their stance on similar issues like environmental or energy concerns for example.

Dubbed the "neighbor effect" by Thomas and Lene during the interview with AVV, peer pressure was utilized as a positive motivating influence to encourage sorting waste. By holding public gatherings and using members of the community who were consistently sorting their waste correctly as ambassadors, AVV encouraged other residents to acknowledge sorting as the norm. Thus, when a resident saw their neighbors sorting waste, they felt motivated to sort their own waste in order to conform to the community around them.

The last psychological tool employed to motivate residents, was the use of "nudging" by AVV to encourage residents to sort. Residents were encouraged to sort their waste by making the process of sorting waste easier and less energy consuming than not sorting. By placing recycling centers close together and within populated areas such as grocery stores, AVV was able to "nudge" residents towards efficient sorting. As people became more and more used to sorting their waste, the creation of this sorting habit even began to transfer over into their homes where before they might not have participated in the sorting system.

5.0 Conclusions

This chapter focuses on creating a summary of the key issues considered in the discussion as well as providing several insights into the main motivating factors fundamental to the creation of a system of organic waste sorting. In the interest of future research within the area, the team created a critique of the methodology implemented and recommendations for future research. Lastly, the chapter includes concluding remarks summarizing the entirety of the project.

5.1 Summary

From the discussion, nearly all interviews touched upon one recurring theme. In order to create a sustainable system of sorting organic waste, the municipality must not only clearly define organic waste, but also motivate the residents to sort through describing the reasoning why it is important to sort the waste separately. This theme can be seen in the interviews with Econet, IKEA, Sysav, Va Syd, AVV and Vestforbrænding. This broad ranging support suggests this is a key factor to installing this system of sorting applicable to a broad range of population.

In order to provide accurate information, the team identified elements within the interviews with IKEA, Va Syd and Vesforbrænding. These considerations included identifying the recipient of the information in order to create methods of communication most efficient for discussion, using colors and symbols to express ideas, clarifying the definition of organic waste to food waste, and utilizing one clear message.

Interviews with Sysav, Econet, Va Syd, AVV, and Vestforbrænding identify influences motivating residents to sort their organic waste through the creation of intrinsic motivating factors. These influences included the residents' understanding of the treatment process, their *holdning*, showing the residents tangible evidence of their sorting, using conformity and nudging, and creating clear lines of communication to resolve issues as they arise.

5.2 Insights

Sorting is social

When sorting becomes a part of everyday life then it will become the most efficient and popular solution. By making sorting a habit maintained by social interaction as well as a part of daily life, waste sorting will be supported by intrinsic motivation rather than relying on external factors. An example of this is in Tversted where sorting centers are located adjacent to grocery stores. There is a large

perception of a lack of time or energy to sort waste, as shown by a woman surveyed in IKEA who said, “Sometimes I go down with the sorted waste and throw it all in the residual bin because I don’t have time, or I don’t want to walk all the way to the other bins.” Using nudging and peer pressure to encourage sorting can result in it becoming a part of everyday life in the same way that it had in Malmö, Sweden.

Children

By teaching children how to sort waste into different fractions at a young age, and teaching them the importance of sorting, Denmark will create a sustainable sorting system within the population. Although focused more on the long-term rather than short-term benefits, education programs for schoolchildren enable the children to bring the information back home, where they expose their parents to it as well. Education systems like these exist in most biogasification and waste treatment facilities, such as Vestforbrænding’s waste lab specifically designed to make learning about waste interactive and fun. As the children grow older, they create a closed loop system where they will instill their beliefs and values within their children. Thus as each new generation arises, a green recycling system arises with it.

Information Campaigns

An important component of successful sorting is the information campaign used on the citizens. From our research, when municipalities give information that not only allows the residents to understand the definition of organic waste, but gives reasoning why sorting is important, the residents become much more motivated. While singularly this is an effective method of motivating residents to sort, by showing the residents consistently that sorting their waste provides a benefit, as seen in Malmö where buses run on biogas, this reaffirms their motivation each time the message is viewed.

A second important component of information campaigns is simplification. Organic waste as a term is highly scientific and can be easily misunderstood by those who are not intimately familiar with it. By simplifying it to food waste or a similar term, residents can more easily understand and remember the definition. In this way, residents sort a cleaner fraction of waste and may even remember to separate their food from their residual due to association with the name of the fraction.

5.3 Critique of Methodology

For future reference and possible research, it is key to assess and understand what aspects of the project worked well and what could be improved upon. Overall, the team felt that the Facebook photo survey was an innovative method to distribute a survey, but the execution could be improved

upon. The team asked people to upload photos of their household sorting techniques. The survey resulted in eight relevant photos and three seemingly random photos, which may have stemmed from the language barrier. In addition, the team asked further questions after the first question. In order to increase photo submissions the survey could be reduced to only one question.

Advice for teams thinking about utilizing social media for distributing a survey is to plan ahead. The team strategically chose the Nulskrald Facebook page because it had 12,000 likes and the administrators made posts at least once a day. The team recommends keeping the survey open as long as possible to collect the maximum amount of responses. Also, remaining in contact with the page administrators that the survey was posted on will ensure that the survey has the opportunity to be re-posted later on. The team encountered the issue of the survey post being pushed down after newer posts were made during the week during the two-week open period.

5.4 Recommendations for Future Work

As the project progressed, we became aware of deeper aspects of the project that we lacked the capacity, time, and ability to understand. We believe that building upon this project, an investigation of the deeper aspects of the social problem may yield additional results beyond what was covered in the course of this study

Most of the answers from the three surveys came from women. In the time we spent interacting with people to complete two of our surveys, we noticed that women of all ages were more prone to engage in a conversation and agree to complete the survey. Most of the time, men did not feel comfortable being approached and did not want to interrupt their current activity (grocery shopping, looking at furniture) to take part in the study. Similarly, almost all the online survey responses came from women. Although this may have skewed the data, it is also possible that this provided representative information of the main sorters within the household. This trend has the potential to be studied to see if this suggests women are the main sorters in Denmark in general.

In various communities we studied, such as Holbæk and Galgebakken, food waste sorting systems were too new to assess their level of success. Therefore, a future study should include an assessment of how people in these communities took to the program. The study should also include an analysis of any issues the communities might have encountered with their specific sorting systems.

Potential Future Research Questions

- What are the motivations/priorities of different people inside the house?

- How do we get the private sector involved in developing the market for indoor sorting systems?
- How have communities received the food waste sorting systems implemented and tested in 2014?

5.5 Concluding Remarks

In conclusion, this purpose of this project was to assist Dansk Affaldsforening in its aim of maximizing the use of organic waste as a resource through assessing the psychology of sorting and behavioral changes necessary to sort organic waste at a household level. Organic waste is the biodegradable component of the waste stream and can be broken down into simpler components by microorganisms. The new Danish waste management plan, *Denmark without Waste* seeks to both recycle, and use this organic waste. By utilizing biogasification, the system by which organic waste is reduced to organic fertilizer and methane, Denmark will be one-step closer to its goal of becoming fossil fuel independent by 2050 and recycling 50% of household waste by 2022.

We performed interviews, site visits and surveys to accomplish the four objectives, laid out below:

1. Understanding organic waste sorting techniques and practices within Denmark
2. Investigating perceptions of householders concerning organic waste
3. Learning from other waste management awareness programs
4. Analyzing the results gathered and reporting our findings.

The final deliverables of this project created insights that Dansk Affaldsforening and its affiliates could use in the implementation of a sorting campaign. Although it is imperative to understand the independent nature of the 98 municipalities making up Denmark, we believe these insights to be universally applicable.

1. **Sorting is social**. When sorting becomes a part of everyday life that is when people accept it as an efficient and popular solution. By using peer-to-peer interaction and conformity within a closed population, residents can be motivated to sort their waste through intrinsic rather than external motivating factors. Additionally, these same factors maintain a clean sorting of waste within the population for a period after any extrinsic influence is removed, due to the formation of habit and the peer pressure that is associated with being in a community which sorts.

2. **Children create a closed-loop**. Teaching children what organic waste is and how to properly sort it into a different fraction creates a closed-loop system for organic waste. As these children grow and develop, they transform from children who sort into adults who sort. In turn as they have children themselves, they will instill their children with the same values they learned including a desire to sort waste cleanly and effectively. Although this focuses on a long-term result rather than a short-term one, by influencing the children of today, the adults and children of the future can perpetuate the system.
3. **Information is key in the development of any sorting campaign**. In addition to making the information easy to understand for the residents who received it, the information must contain the reasoning behind why the municipality implemented the sorting system. Although residents will take part in a mandatory sorting campaign, instilling them with a sense of purpose and showing them the results of their sorting results in the collection of a larger quantity of organic waste as well as a cleaner fraction.

This project has the potential to be implemented in every municipality in Denmark. Due to the independent and unique nature of these 98 municipalities, the insights, discussion and results of the surveys and interviews performed can be used to create distinct systems suited for the needs and challenges of each region. With Denmark's focus on recycling and using waste as a resource to power the world of tomorrow, a sustainable system of organic waste sorting must be implemented. By using the information, motivation and factors identified in this report, municipalities in Denmark are one-step closer to becoming a zero waste society.

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Appendices

Appendix A: Interview protocol

Short Verbal Consent: This prompt was used when the team proctored surveys in Tversted and IKEA.

Hi. Do you have 2 minutes to take a quick survey? This is for a university project interested in sorting behavior of organic waste. Your answers are confidential and all questions are optional.

After completing our survey: Thank you for taking the time for helping our project.

Longer Verbal Consent**:** This was used when the team had more formal interviews.

We are a group of students from Worcester Polytechnic Institute in the US. Our project is exploring the motivations of citizens to sort organic waste and what ways can we encourage citizens to sort more. We thank you for taking the time out of your day to speak with us. Do you mind if we take notes and record this interview to review later? Also do we have your permission to quote and name you in our paper?

Appendix B: Summary of Interview with Klaus Jacobsen from Holbæk Forsyning

Background Presentation

- Holbæk is one of the few municipalities that weighs the waste during collection- organic waste (OW) and residual waste must be paid for.
    - Recyclables (including garden waste) can be deposited in a recycling center for no cost
    - OW has been collected since 2008, although residents have sorted for 15 years
    - Houses are provided a split bin, with residual in one side and organic in the other
    - OW is 96% pure
- Focus on making sorting easy and cheap for the customer to motivate them
- In 2008 Holbæk created a new scheme, before that there was no communication with their customers
    - Currently the focus is on collecting OW. To do this, Holbæk uses green bins and bags to make the customer think of OW while theyre already in "waste mode."
    - Due to a miscommunication, customers thought OW collection began in 2010.
    - From 2011-2013 residual waste amount stayed very much the same, but the amount of organic waste collected dropped slightly
        - Focused on getting customers to sort more organic waste
        - In 2012, equal amounts of OWwas found in the residual waste as in the sorted OW
    - Currently 23-24% of residual waste is organic
- There is a high purity in the collected organic waste
    - Most of the impurity stems from the plastic bag
- Most of the customers say they don't sort because they don't have enough room in the kitchen to do so
- Typically people sort for these reasons:
    - Money
    - The environment
    - Convenience
- The waste is collected via 2-stream waste trucks
    - GPS tags are on the bins of houses and identify the location and owner to charge fees when the waste is picked up
    - Trucks have advertising on both sides advertising the recycling of batteries and OW sorting.
    - Customers pay based on the weight of the divided bin upon collection. Plan to have organic waste collected for free in the future to encourage participation

Question and Answer

What information campaigns have you done in the past?

> Visitors Service Information Campaign. A regional program to teach school classes 8,9,10 year olds what to do and how to sort waste. Last year they spent a week at Holbæk Museum where they taught people what they wanted them to do (what and how to sort) with their waste.

When have you done information campaigns in the past?

One example of a campaign is the trial with the green bins. Maybe green bin and green bags will make people think about their organic waste more. A letter was sent to 200 people telling them about the trial. 2000-2002 there was not much communication to the customers, but now they get a lot more organic waste than they used to. It is not easy to communicate to so many different people in different languages, but they try to find the right way and the best way to do it. Use images instead of text for example. Different municipalities have had these trial bins for 5 or 6 years with mixed results. Overall the goal is to get more quantity of organic waste to get full potential out of it.

How often do you move the little bags within the kitchen into a larger bin outside?

1 or 2 days because of smell

How do you facilitate communication with your customers?

They call Holbæk Forsyning to make complaints. You always want to know your customers. It is very important.

Do you have any recommendations for how to implement an information campaign?

Ask about behavior because that is how to move waste forward.
To get better results you need to change behavior
Patience is very important, results won't come day to day it takes time to change behavior.
Start with kids to change behavior. Kids will pressure parents to sort

Appendix C: Summary of interview with BioVækst

Background Presentation on BioVækst

Peter: I'm project manager for R&D, I try to do my best to develop our process to do it as economically and environmentally as we can.

Morten: We've been here for ten years, we've treated over 70,000 tons, so we have some experience with bio-waste. We have been focusing on, when we started up, making the process feasible, which is difficult because here in Denmark incineration is so big. This has been our challenge, so to speak, to make a robust plant. We are the only plant that is dedicated to [organic household waste]. [Denmark] has a lot of biogas plants for farm and animal manure, but they are not dedicated to this type of waste, where you have to take care of the impurities that come with it.

We were built here because there was a composting facility before, it didn't work well and we asked could we rent this area and build this plant. Our idea was that we should deal only with this type of waste.What we do is recycling and energy recovery. The way our plant works is very simple. We put our waste in concrete boxes, and we percolate water through it. The water is hydrolyzed and easily degradable. By putting the waste in the boxes we don't have to pump it. If you want to take out all of the impurities to make the waste pumpable, you take out potential from the waste, and it ends up with the residual waste.

Question and Answer phase of Interview

Do you make a better market with the Biogas or the compost?

> With the biogas production is in the first place the best market so to speak everybody is interested in it of course. But for the new technology for farmers [not included in the transcription] the compost will get more and more market, especially with farmers that are in need of nutrients. At the moment, the plant is used for electricity and heat, but with the new facility it will be upgraded to methane and it might be used for fueling waste trucks and sold to the grid.

How much impurity can your system handle?

> We can receive waste with 50% of impurities. We can still treat it, but we say you have to pay more for the impurities that are above 8 percent. The municipalities have to have an incentive to make campaigns for cleaner waste. In the beginning, we had waste that was up to 35% impurities, and now on average it's about 18%. It's important to have an incentive to make waste cleaner

Is it more important for your company to receive pure organic material, or a larger amount?

> "In the beginning, it's not so much the purity as it is the mass. The people who use it, it's because they want to, and they do it right. If you force people to sort, the impurity rises, so you have to be patient." In Germany the organic waste is very very clean. They have been doing this for a vey long time. Our challenge is not to get a purer fraction. Our challenge is to get a larger mass. We can handle all the waste with impurities. Even with high percentage of impurities, only 5% of biodegradable waste ends up with the residual waste.

Would using paper or biodegradable bags prove useful to your company?

Using biodegradable bags is useful because the process can run smoothly, without needing to extract the impurities. However, if biodegradable bags are used, it's very important that they get collected separately. BioVækst can handle if some municipalities use bio bags and some use plastic bags. If they receive a single truck with both plastic bags and bio bags, everything will have to be run through the filter system and a lot of organic material will be lost.

Is using sorted organic waste better than using manure?

Pig manure has 3% organic matter, not too good for biogasification. Also very heavy. Waster with less water is better, because it is cheaper to transport. When BioVækst started there were municipalities that already sorted organic waste to be used in a composting plant. So the plant started with some waste already available. What we did then to make this plant feasible is that we treated sewage sludge as well by composting. Hillerød municipalities, started with a small area sorting, and then expanded once they got some experience. It's important that they could deliver the waste to BioVækst, because it would be much more difficult if they had to start building a plant and then begin with the source separation.

How do you get people to choose biogas over incineration?

It's a very political decision. For us it's important to convince the politicians that this is a better environmental solution, because its much harder for us to talk to people.

Appendix D: Sysav Pretreatment Plant Interview Summary

Background

- Household waste is the responsibility of the municipality in Sweden
- Focuses on biofertilizer as a product because many more people are motivated through the nutrient return than they are by the money aspect
    - Biogas produces a much higher profit but not as much consumer good will
- It is more expensive to biotreat, but its greener
    - 1,800 tons of CO_2 saved/year compared to incineration
    - 500kg/year of food waste is created each year in Sweden
- If waste is reduced through decreased consumerism economies could be negatively affected.
    - It's a political problem not an economic one in his opinion
- When you get people to start sorting they become aware of the wasted food and together with campaigns people see the effect
- Reuse is important due to the waste generated during the creation of new products
    - Thus it is more important ton reuse than it is to sort
- 1 message, clear and repeated gets people to sort
    - Have the infrastructure/system in place before you begin communication
    - Never try to be clever, only clear and repeat for 10 years (2 or 3 messages max)
        - Sysav says NO garden waste, even though parts of it can be used to increase understanding
- Mindset of the Swedish people is to trust their government to do the right thing while Danes tend to be more skeptical.
    - In order for people to be motivated to sort better they must understand the reasoning why its important
- Weigh your bin – pay more per kilo.
    - Its cheaper to sort out the food waste – encourage through the use of a recycling station
    - Residual waste still has a high % of organic content

Appendix E: Interview with Econet

- Use paper bags to gain a cleaner fraction of waste. People won't bring plastic impurity into a paper bag
    - There is a problem in that paper bags are expensive, so communities are discouraged from using it
    - Biodegradable bags gather a cleaner fraction of waste than plastic counterparts and can be a viable alternative
- From a study on the waste collected:
    - Paper bags- high degree of sorting efficiency >99%
    - Biodegradable - normally 98%
    - Plastic (bought or delivered) – 90%
    - Other plastic bags – (store bags) – 70-80%
    - Black sacks (trash bags) – 0-80%
    - Loose waste (no bags) – any
- If very good, 70-75% of organic waste will be separated from the residual waste
    - However, fish is typically put in residual waste due to issues with the smell
- From a study conducted on comparing perceptions of how much is sorted vs what is actually sorted
    - Those who said they did not sort – 2.3kg of organic material was found in their trash
    - Those who said they sorted 10-90% of organic waste – 2.2kg of organic waste was found in their trash
    - Those who said they sorted all organic waste – 1.2kg of organic waste in their trash
        - This study showed that people show they sort more than they actually do
- When waste is collected collectively versus individually (multihouse vs single) the purity of the waste decreases
- Don’t put information on a homepage or webpage, people won’t look there. Instead put a sticker on the bin itself.
- There are three motivating factors to the sorting of waste
    - Knowledge
    - Holdning
    - Experience of the possibilities

Appendix F: Interview with IKEA

What type of waste sorting does IKEA provide to its customers?

When IKEA sells kitchens, they sell the waste management solutions as well. “Sometimes the people are not aware of their current waste collection system, and how to get rid of additional waste fractions. We make these solutions available so no matter what your kitchen looks like you are able to put to work a solution that fits you. I think the general perception of the importance of sorting waste is quite high in Denmark. But we can definitely do more to push not only the awareness of its importance for the municipality but also that it’s a benefit for people themselves”

In what way do you think IKEA can help set up a system of sorting?

“Retailers can become really relevant in highlighting the potential and the positive side effects of waste sorting. Its not just something you do for the sake of the environment, its something you do because it will reduce the cost of waste handling. In theory, you are contributing in a positive way to the finance of the municipality. We can’t do all of that, that’s why we work closely with municipalities like Copenhagen.

“We can sell the waste sorting solutions. We can be relevant in the purchasing situations but we can also show what can come out of the waste sorting, so we introduced products, such as garbage bins made from recycled plastic. Showing to the population the circular flow of material can really help people realize that its not just something you do because it says so in the municipality waste sorting folder you get when you move in to a house, its something that contributes to the better of society”

Retailers, namely IKEA, have a lot more contact with customers than the municipalities. So in a way retailers can have a lot of impact. Waste solutions, such as bins are not labeled at the time of purchase. But they do sell stickers for the customers to classify. This is a very conscious decision by IKEA.

Do you think there is a business potential in waste?

“Because there is a huge business potential in waste, there’s a huge potential.” IKEA goal: half of every non renewable that we use must be recycled, and for that we are dependent on people’s ability to supply sorted waste. When it comes to organic waste there’s a huge potential for gas and other things, but the logistics for that is the biggest challenge. I think the financial aspect is something we often forget when it comes to waste sorting, it’s part of the tax we pay to the municipality and we forget about it. What if the financial aspect had an effect on the participation? we could pay for the amount for the amount we don’t sort and get feedback from what we DO sort”

How does IKEA incentivize sorting of waste?

IKEA sorts and recycles almost 90 per of all the waste they generate in their stores. They can do

that by pushing the environmental agenda, but also by pushing the financial agenda. It makes sense for businesses so it should make sense for me as a customer.

Is there a way to incentivize waste sorting in an easier way?

What if you have to weigh all your fractions and pay for the non sorted and get money back for the sorted waste. Or even you pay an amount every year and you got money back if you do it better. Things like these would make it more visible why it's important.

The environmental argument is sometimes a bit difficult for people to grasp. They don't want a more difficult life, they want their life to be easy and beautiful and nice, and not a lot more hassle because they have to do something which is good for the environment, unless they feel the benefits themselves.

We can add the monetary incentive, but if it takes a lot longer and is a lot more hassle we will lose a lot of people in that process. Project in the UK in which they gave 20 coworkers 500 Euros to buy solutions for more sustainable lives at home. A lot of them bought waste sorting solutions, and some of the feedback is that if you do it right you save a lot of time every day. By having several bins but less in each, you can empty the trash every other day or every third day. "A more sustainable life should be an easier life as well, a time-saving life"

Appendix G: IKEA Survey

Hej! Vi er en gruppe universitetsstuderende fra det amerikanske universitet, Worcester Polytechnic Institute, der arbejder på et internationalt projekt sammen med Dansk Affaldsforening. I den forbindelse er vi i gang med at undersøge hvilke faktorer, der har indflydelse på affaldssortering. IKEA har givet os lov til at gennemføre vores undersøgelse hos dem, fordi de også er meget interesserede i at opnå en bedre forståelse for adfærd og traditioner om affaldssortering.

Det vil være yderst værdsat, hvis du vil bruge blot 2 minutter på at fuldføre denne korte spørgeskemaundersøgelse. Hvis du er yderligere interesseret, må du meget gerne give os din e-mailadresse, så vi kan videresende vores rapport til dig.

På forhånd mange tak for hjælpen!

1.) **Hvilket affald sorterer du hjemme? What waste do you sort at home?**
Afkryds venligst alt gældende /Check all that apply.
   a. Glas/Glass
   b. Papir/Paper
   c. Plastik
   d. Metal
   e. Organisk Affald/ Organic Waste

2.) **Hvem står hovedsageligt for at sortere affald hjemme hos dig? Who is the main person who sorts in your house?**

   _____

3.) **Med henblik på sortering i køkkenet benytter du dig så af et system efter eget design, udleveret af kommunen eller købt i en forretning? /To sort in the kitchen, do you use a system of your own design, one supplied by your municipality, or store bought system?**
   a. Eget design/ My own design
   b. Udleverset af kommmunen/ Municipality supplied
   c. Eget design og udleveret af kommunen/ combinations
   d. Købt i en forretning /Store bought
   e. Andre/ Other: _____

4.) **Hvor sorterer du dit affald? /Where do you sort your waste?**
Afkryds venligst alt gældende /Check all that apply.

a. Udendørs/ Outside
b. I køkkenet/ In the kitchen
c. Ved bagdøren (i bryggers)/ Backdoor
d. Andre/ Other _____

5.) **Hvad finder du vanskeligt ved at sortere affald? /What do you find difficult about sorting waste?**

_____

6.) **Har du affaldssortering under overvejelse, når du er på udkig efter et nyt køkken? /Do you consider waste sorting when you look for a new kitchen?**
Afkryds venligst ét felt /Choose one
a. Ja/ Yes
b. Nej/ No
c. Det har jeg slet ikke tænkt på/I haven't really thought about it

7.) **Hvor mange personer bor i din husstand? /How many people live with you?**
Afkryds venligst ét felt /Choose one that applies
a. Enkel person/ Single
b. 2
c. 3
d. 4
e. 5
f. Andre/ Other

8.) **Hvad er din boligsituation? /What is your housing situation?**
Afkryds venligst ét felt /Choose one that applies
a. Enfamiliehus /Single-family building
b. Flerefamiliehus /Multi-family building
c. Lejlighed /Flat – Apartment
d. Lav bebyggelse /Low-rise
e. Andre Boliger/ other: _____

9.) **Hvilken kommune bor du i?/ Which municipality do you live in?**

_____

10.) **Hvad er din alder? /What is your age?**
Afkryds venligst ét felt /Choose one that applies
a. Under 19
b. 19-29
c. 30-39
d. 40-49
e. 50-59
f. 60+

Mange tak for din tid!

Appendix H: Tversted Survey

We are a team of university students from Worcester Polytechnic Institute working with Dansk Affaldsforening. We are interested in learning about what motivates citizens to sort waste and how we can encourage the sorting of organic waste in the household. This survey will ask about your sorting behavior. This survey is voluntary and all responses will be kept confidential. If you are uncertain of an answer please ask one of the team to explain. Also you do not need to answer if you are uncomfortable with the question.

1.) **Are you:**
   a. Male
   b. Female

2.) **What is your age:**
   a. Under 19
   b. 20-29
   c. 30-39
   d. 40-49
   e. 50-59
   f. 60+

3.) **What is your housing situation?**
   a. Single-family building
   b. Multi-family building
   c. Flat
   d. Low-rise housing
   e. Other: _____

4.) **How many people live in your house?**

a. 1
b. 2
c. 3
d. 4
e. 5
f. Other: _____

5.) **Do you sort your waste?**

a. Yes, all waste(includes: plastic, glass, paper, and food waste)
b. Yes, but not organic waste
c. No, I do not sort

6.) **How important is it for people to sort kitchen waste?**
Rate importance on a scale from 1-4

Not important ( ) 1 ( ) 2 ( ) 3 ( ) 4 Very important

7.) **What motivates you to sort food waste?**

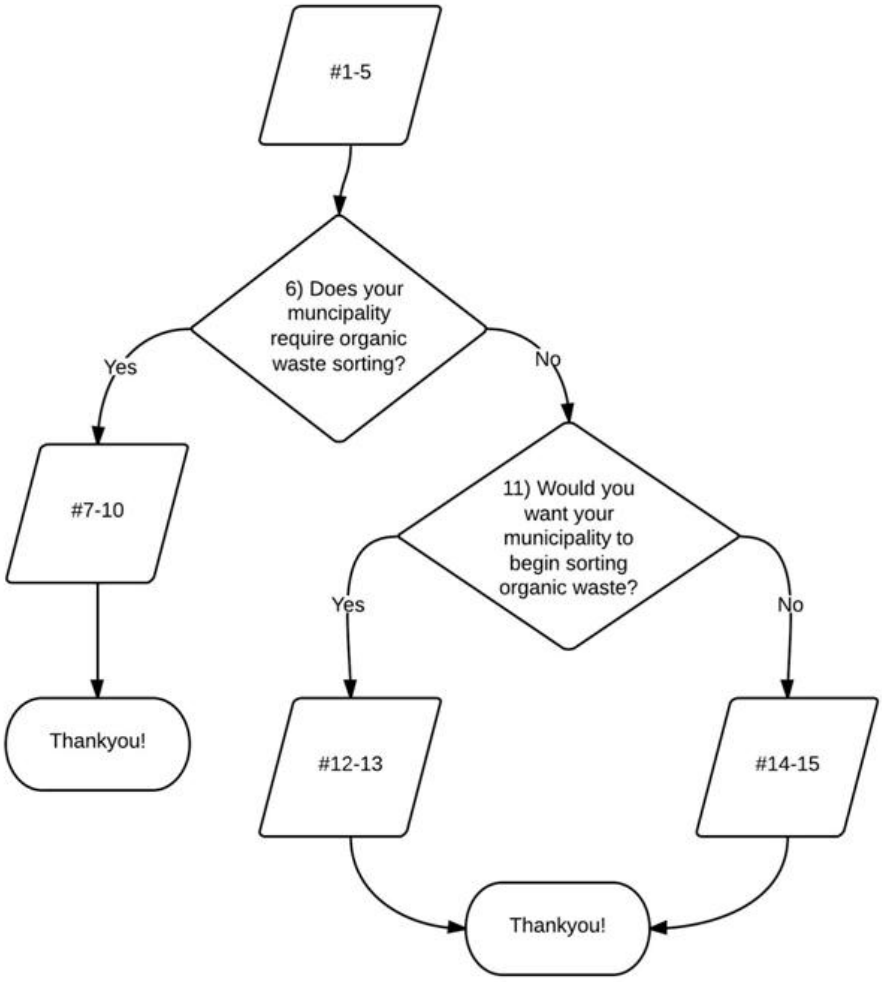
a. Mandated by municipality
b. Environmental concern (It's the right thing to do)
c. Saving money
d. Seeing others sort
e. I don't sort food waste
f. Other: _____

8.) **What is your biggest obstacle to sorting waste?**

a. Insects and/ or hygiene
b. Convenience
c. Lack of space
d. Smell
e. Other _____

Appendix I: Nulskrald Facebook Survey

The Nulskrald Facebook survey used the logic chart shown below to direct responders to questions based on their answers. By using this method, the team was able to gain different answers from those whose municipalities required organic sorting. Below you will see a blank copy of the survey, with all questions included



Vis os hvordan du sorterer!

Page One

Hej! Vi er en gruppe universitetsstuderende fra WPI, et institut i USA, som arbejder på et internationalt projekt sammen med Dansk Affaldsforening. Vi forsøger at kortlægge hvilke faktorer der har indflydelse på sortering af organisk affald. Mange tak fordi du vil deltage i denne undersøgelse og hjælpe os med vores projekt.

1. Vi vil gerne bede dig om at uploade et billede af den sorteringsløsning af madaffald, du benytter i dit hjem.

Husk at trykke på upload knappen!Du kan maksimalt uploade 3 billeder. Vi vil uploade alle billeder på dinsorteing.dk.

Please upload a picture of what food sorting method you use in your house. Remember to hit the upload button! We will be uploading all the pictures to the webpage dinsortering.dk.

Vælg fil | Der er ikke valgt nogen fil | Upload

2. Hvad er dit køn? What is your gender?

- Mand/ Male
- Kvinde/ Female

3. Hvad er din alder? What is your age?

- Under 18
- 18-29
- 30-39
- 40-49
- 50-59
- 60+

4. Hviken type bolig bor du i? What is your current housing situation?

- Enfamliebolig/ Single family house
- Flerfamiliebolig/ Multi-family house
- Lejlighed/ Flat
- Tæt-lavt byggeri/ Low-rise
- Kollegie/Dormitory
- Andet / Other

5. Hvilken kommune bor du i?

Which municipality do you live in?

-- Please Select --

6. Har din kommune en ordning for udsortering af organisk affald? Does your municipality require organic waste sorting?

- Ja, der er en henteordning/ Yes, there is a collection scheme
- Ja, der er en hjemmekomposteringsordning/ Yes, there is a scheme for homecomposting
- Nej, men jeg hjemmekomposterer/No, but I home compost
- Nej/ No

Next

7. Hvem er hovedansvarlig for affaldssorteringen i køkkenet? Who is the main person who sorts waste in the kitchen?

- ○ Jeg/ Me
- ○ Min samlever/ My significant other
- ○ Mine børn/ My children
- ○ Andre/ Other

8. Hvorfor sorterer du madaffald? What are the main reasons for you to sort food waste?

- ☐ Det er godt for miljøet/ It is beneficial to the environment
- ☐ Kommunen kræver det/ The municipality made it mandatory
- ☐ Jeg har set mine naboer sortere/ I saw my neighbor do it
- ☐ Det er min borgerpligt/ It is my civic duty
- ☐ Andre årsager/ Other

9. Hvilke udfordringer oplever du, når du sortere dit organiske madafffald? What challenges do you face when sorting your organic waste?

- ☐ Mangel på plads/ Lack of space
- ☐ Det er besværligt/ Convenience
- ☐ Insekter/ Bugs
- ☐ Lugt/ Smell
- ☐ Ulækkert/ Disgusting
- ☐ Andre udfordringer/Other

10. Hvor vil du gerne modtage information om madaffald? Where would you prefer to get this information from?

Check all that apply.

- [ ] I skolen/ School
- [ ] Plakat på miljø/genbrugsstationer /Poster at sorting station
- [ ] Tidsskrifter/ Magazine
- [ ] Beboermøder/ Town meeting
- [ ] Facebook/andre sociale medier/ Facebook
- [ ] Avisen/ Newspaper
- [ ] via direkte kommunikation – fx email, brev /Direct communication - email, mail etc.
- [ ] På skraldespanden/ On collection bin
- [ ] andre informationskanaler/ Other

11 Ønsker du, at din kommune skal indføre udsortering af madaffald i køkkenet? /Would you want you municipality to start sorting food waste in the kitchen?

- ( ) Ja/Yes
- ( ) Nej/No

12 Hvorfor sorterer du madaffald? What are the main reasons for you to want to sort food waste?

- [ ] Det er godt for miljøet/ It is beneficial to the environment
- [ ] Kommunen kræver det/ The municipality made it mandatory
- [ ] Jeg har set mine naboer sortere/ I saw my neighbor do it
- [ ] Det er min borgerpligt/ It is my civic duty
- [ ] Andre årsager/ Other

13 . I tilfælde af, at din kommune indfører udsortering af madaffald, ønsker du:/ If your municipality began a food waste sorting system, you would want:

- ( ) Ét system stillet til din rådighed (levering af poser og affaldsspande) /A system given to you (bags and bins supplied)
- ( ) Et system med forskellige valgmuligheder stillet til din rådighed (valg af papirs- eller bioposer) /A system with different options given to you (choice of paper or bio bags)
- ( ) Lave mit eget system udfra den fornødne information /To find my own system but given the necessary information.
- ( ) Andet. Skriv venligst anden grund /Other

14 . Hvis tilfældet, hvorfor ønsker du ikke, at din kommune skal indføre udsortering af madaffald? What are the reasons you would not want your municipality to start food waste sorting?

- Forbrænding fungerer godt /Incineration works well
- Jeg mangler plads i mit køkken /I don't have enough space in my kitchen'
- Madaffald lugter /Food waste smells
- Jeg har ikke tid /I don't have enough time
- Ulækkert/ Disgusting
- Andet. Skriv venligst anden grund /Other

15 . I tilfælde af, at din kommune indfører udsortering af madaffald, ønsker du:/ If your municipality began a food waste sorting system, you would want:

- Ét system stillet til din rådighed (levering af poser og affaldsspande) /A system given to you (bags and bins supplied)
- Et system med forskellige valgmuligheder stillet til din rådighed (valg af papirs- eller bioposer) /A system with different options given to you (choice of paper or bio bags)
- Lave mit eget system udfra den fornødne information /To find my own system but given the necessary information.
- Andet. Skriv venligst anden grund /Other

Will all pathways, the survey ended with thanking the participants.

Vis os hvordan du sorterer!

Thank You!

Mange tak fordi du deltog i undersøgelsen. Dine svar er meget vigtige for os.

Appendix J: Interview with Va Syd

- Since 2012, source separation of food waste has been mandatory in Sweden. Malmö has a local goal collecting 40% of the potential of food waste by 2015, (13,440) tons /year. Sweden has the national goal of collecting 50% by 2018 for bio-treatment
- 33,600 tons of food waste was thrown away (5000 Swedish Kroner thrown away each year from a single family)

History of Va Syd's food waste sorting campaign

Started at one municipality and then moved onto the next.

Practical aspects:

2 types of bins are used: 1 brown for food, and 1 green for residual.

- Food waste taken in
    - 75% is from multi-family homes
    - 15% is from single family
    - 10% from corporations

Food waste is collected in a paper bag

- Owner of multi-house knocks on door and gives them a brochure with the bin. Also the bracket to hang on door. Some cases decided for them.
- 98% is food waste, 2% is impurities
- 30% of food waste remains in residual waste
- "If people sort 1 thing they will have the desire and the preconception of sorting more"

Information

- Landlords get a letter ½ a year before start. Takes time because need to set up meeting with them and drop off bins and materials.
- Before wide scale implementation had meeting with multi-family-house landlords and asked what they needed? Gave them a file of information including rules where they could reference.
- Va Syd printed the brochure in different languages including Arabic, Somali, Pashto, and English.
- People received a letter in the mail. The letter had information about the program, and said: "Soon we are going to meet everyday."
- Two weeks later Va Syd delivered to households:
    - 1 year supply of paper bags - single families get a larger bag, multi houses get smaller bags
    - Holder for the bag
    - A letter from politicians- made the decision now you have to sort on this date.
    - Brochure with information
    - All these contained within a large brown bin
- Articles are posted in the local newspaper
- Va Syd sends a newsletter 8 times a year concerning not only food waste.
- **Waste truck drivers get information about what food waste is** - show them what to say to the customers since they'll be the face of the company. The get a tour of Sysav so they understand the system. This way they become ambassadors of the campaign.
- **Cinema** - showed a film of food waste before movies in the cinema. The idea was "people

always have some kind of food waste" (4-5 months)

- **Eaten apple symbol and Brown paper background** - symbol of *Tack* för *Maten*. Every time someone sees the same color background, they immediate recognize the campaign.
- Radio / newspaper/ busses

Community & Events

- **Small children** - memory card game to show them what food waste is and to teach them how and what to throw away (1-5 yrs old)
- **Fairs for Garden**- single household fair, where kitchen, pools and gardens are shown. Va Syd participated and handed out the trolley coin as well as other giveaways.
- Have a website dedicated to discussing food waste. Page for flat owners to reference.
- Eco-city day Augustenborg 2012
    - During the event Va Syd held a competition with 1st-3rd graders. They explained to them what food waste was, and then asked them to draw picture of what they thought it looked like.
    - Va Syd chose the nicest picture and printed it on the brown paper bags they hand out. These bags were put on environmental houses (recycling center for multi-family buildings). There, people could choose between original plain bags and the ones with the printed picture.
- Meet with the citizens in events to discuss food waste. Gave them apples. Then trolley coin and yoyos. Other giveaways with the logo.
- **Dinner party for the company -** gave all employees 1 apple, 1 paper bag and 1 brochure. That way they encouraged them to talk about the campaign during personal social events.

Motivation

- Had biogas vehicles so citizens could see.
- **Information for the company** - allow everyone to understand the basics - give everyone the option to contribute their ideas.
- **The municipalities have a penalty fee for not sorting food waste - but it hasn't been enforced.**
- Complaints of people not wanting to participate transforms into willing participation due to peer pressure and desire to conform to the group.
    - Because of this, it is easier to have a multifamily home sort food waste than a single family home
- People could choose original bags or the ones with the printed picture.
- Community involvement
- **"If people sort 1 thing they will have the desire and the preconception of sorting more"**

Other facts

- Malmö is a segregated city. There are large populations of immigrants living together.
    - 117 communities have brown bag. Main system with air ventilation so wet wate can dry. **Few have plastic bags. Seemed not clean vs. paper bags. Don't offer plastic bags at all.**
- Amount of waste is more important than sorting
- Brown bin 3x cheaper than green bin
- Denmark trend - Informational visuals should not say what not to sort on poster. keep it all

positive.

2012 - 1st campaign

Tack för *maten* – the focus was sorting

Had ads on busses- only for 2 weeks because it is very expensive.

Plans for their new campaign

In the new campaign – Va Syd wants to **remind** people that it's easy to sort. The slogan will be "easier than picking out candy"

- Talk about how easy it is to sort - easier than picking candy
- Families are given 160 bags a year for single family
- The landlord figures out how to actually implement the system. Va Syd gives them the tools and resources.

Appendix K: Interview with AVV

Nulskrald as a project - 5 week test

- Established one and a half years ago
    - Encouraged people to sort more plastic (which was new to sort). Offered the people a composting bin for free.
    - The project aimed to incorporate how people think in the kitchen with removing all waste from municipal waste stream.
- 100 families volunteered - mostly because they were curious.
- Involvement was more than expected, the project's Facebook page exploded (on weekends and evenings)
    - Tried to answer messages quickly to maintain interest levels within the page. Increased participation by responding within a couple of hours.
- A 5 week program was initially created to optimize waste sorting and provide a testing ground
- Managed to reduce waste by 50% for incineration
    - ***note - Competition with small prizes every week and a grand prize at the end of the experiment provided significant extrinsic influences. In order to continue this the people must fall back on intrinsic motivation**
- **The campaign:**
    - Encouraged people to think and create their own methods
    - Increased involvement through surveys posted to the Nulskrald page
    - Reached out to active people to get involved and share personal knowledge. These people became ambassadors (i.e. Mads and Jens).
- Goal was to start a dialogue and create a community around sorting

What are the factors involved in getting people to sort organic waste

- AVV held a community meetings/social event:
    - Kick off with speakers to encourage
    - Gave people recipes with leftover food
    - At end of the 5 weeks gave people a buffet of leftovers cooked by a professional chef.
    - Entertainment provided by children of the community dressed up with recycled clothes
    - Ended on a strong uplifting note. Not just letting experiment die out.
    - Made communities and connections between people
        - Without this competition and encouragement between individuals it would have been a bit more lackluster

Beginning of Project as it stands now (Nulskrald 2014)

- No competition like the 5 weeks test; so weight has not fallen as drastically. So far the decrease has been from 8.0 kg to 6.8 kg per week.
- **Can't tell if everyone is actually particpating since it's hard to tell.**

- Sent out a letter to invite people to a community meeting - ⅓ of the total pop came (100 out of 300 families)
- Tversted was chosen for Nulskrald because of the active social network they have. This is due to all the volunteer work accomplished. Hope the current social network will draw new people in.
- Campaign focus on the behaviors behind sorting waste
- Gave pictures to people from the 5 week experiment as inspiration to Tversted citizens during kick off speech.

Grocery store accepts plastic, cardboard, paper, glass and batteries
a new offer because they have the recycling space but driving time is 10 min rather than 30
established in partial regard to the high tourist population that Tversted enjoys

How do you maintain peoples interest in the project?

- Recycling centers have huge posters (**poster changes every month**) with new offers and information every month.
- Every 4th month people get a free meal and discuss how everything is going
- A large sign showcases the weight decrease in waste produced per family per week. The sign is located near a roundabout that everyone needs to pass to enter and leave Tversted. This way it's seen often.
- The initial 100 people that went to first meeting receive an email once a month.
- The plan for the next upcoming meeting in May is emphasizing the easiness. Maybe have citizens speak about that?

What do you plan to do when the year is over?

- Nulskrald will end in December 2014
- We will work on a new plan for how to deal with waste in the future
- AVV will attempt to have waste picked up in the homes rather than have waste recycling centers all over the place.

How do you get people to be self reflective?

    - Direct information to it
    - There has been a huge media focus on sorting in Tversted so people are constantly aware of it. Also it's a tourist town so this media attention helps.
- Are there people we can encourage to help do this?
    - Cook hired to feed leftovers- gets paid and has volunteers help him.
    - Hired a professional graffiti artist to paint a side of the building with motivating art- This way he gets a job and also involves his friends and family.
- Instead of a municipality handing out a solution it creates a dialogue and not just giving a fine.

- A Top down system just makes people do it. Are they satisfied by how they are being treated? Do they actually care?

What have you gained from this project?

- When people focus on sorting they need to look at it differently.
- Becomes less of an annoying task and more a competition with yourself.
  - Want to reduce your waste just a bit more. People tell themselves “only 1 plastic bag a week”.

Ways they reach out to citizens who don’t use facebook

- Delivered information through mail and email (only original 100)
- Posters at recycling station including bottle returns

Organic waste sorting

- Nulskrald sorting examples: **http://www.Nulskrald.dk/inspiration/Nulskraldernes-sortering-i-hjemmet**
- Food waste sorting has existed for 1 month so far. 23 out of 300 families take part in the organic sorting.
- **This is a rural area so there are a large amount of people who would be composting and feeding to chicken rather than sorting for organic waste and due to the bin smelling too much.**
- Household and organic waste are picked up on alternate weeks
  - Complaints that organic starts to decompose before the 2 week time is up. But no complaints about the household waste filling too quickly - possible extended collection time?
- 5 of the 23 food waste sorters have small sacks within the household and bring them outside every day to a larger bin
- 18 of the 23 use only a large bin with a big paper bag, and bring all their food garbage directly to it
  - Perhaps they made their own solution for inside the kitchen

Why didn’t people sign up for OW bin?

- Lene’s guess is a lot of different factors. Tradition. It’s a new idea that you should pick out food waste from residual. It might be disgusting. There’s a smell. Many people also have animals so they use the food for them.

General Notes and Knowledge

- Some people like to do it themselves but others prefer an established system that works and can be installed and functioning immediately
- People look at waste with different eyes and have competitions with themselves to reduce waste - similar to a game
  - Comes from realizing how much waste they produce.

- **If waste sorting is centralized, people will throw everything into a bin and think that its not their problem since its trucked away. This prevents people from becoming aware of their waste.**
- Energize people to find out themselves, not everyone is interested in sorting
- You have to think of multiple solutions for all the different types of houses and preferences that people have
- People will feel satisfied over the control they have of the waste
    - Replace the ease of putting everything in one bin with the satisfaction gained from reducing the total waste
    - feel a responsibility for sorting after their waste
- **Tversted Bottom up approach- people figure out a solution that works for them. Can't just give 1 solution. Give options.**

Tips for starting our own campaign

- **Information is always the first step**
    - Why should people sort? You have to give motivation by actually showing the outcome of their efforts
- Nudging – give people a path of least resistance to motivate people to choose the choice you want them to pick
    - In Copenhagen, street waste bins were not used much. A campaign used the same trashcans but added footsteps on the sidewalks that lead to them. IT WORKS!
- **Create excitement and community around sorting.**
    - Kick off meeting with the community. Have a key note speaker.
- **Make the recycling center a social place**.
    - AVV has a small stage in the recycling center to have concerts by local citizens.
    - One time they sponsored an event where mechanics checked cars, and people could check their blood pressure.
- Advice for Copenhagen since bigger
    - Create a community around Nulskrald. Since CPH is big have a virtual community. Also have mini groups that are connected.

Reasons why people are sorting waste

- Conformity - extrinsic and intrinsic motivating factor
- The "neighbor effect". If sorting becomes trendy, people feel compelled to participate.
- If you want to make something a habit you have to act on your values, because it's more sustainable.
    - Show people why its sustainable.
    - "To the general populace its a black box what happens to waste after its been sorted." Show people what happens to the waste. Show them where their effort leads.

- People will feel a sense of control of their waste and control of their consumption. They will feel empowerment over their actions.

Thomas

Top down (Tack för Maten)- short term solution

- Does it change habits? People do it because they're told to.
- As long as the campaign is going people will do it. But what happens when it ends? Will it continue?

Bottom up- Tversted

- It takes longer, but when a habit is created it is sustainable.
- It also produces more a community interactive feel.

Appendix L: Vestforbrænding

- Attempted to standardize symbols and colors between 14 different municipalities
- Create education ambassadors within the community
    - Not always there from the beginning but they can be found
    - Depending on the municipality you can always ask them to step forward
- Use the political process
    - Usually need to have a test before the system can be implemented
    - Depending on the election seasons, politicians won't support a new sorting system, even if it is logical.
    - Some municipalities don't try to explain or reason, they just force their residents to do it.
    - Others implement step by step. Feeling out the needs of the system to be successful.
- Brochures can be useful to pass on information but they must be targeted to the municipality's residents

Kalundborg

- 600 small houses
- 10 recycling centers
- chose this town because have "green profile"
- Every wed. Have a community meal- municipal reps. will be there to speak and answer questions.
- not many flats-

Galenbakken

- 600-700 households - close community
- chose bins themselves
- 10 fractions recycled.
- low rise buildings
- Bring all their own trash to recycle islands since trucks can't get to each home. since traffic is separated
    - 10 islands.
- Caretaker- gives information pamphlet and letter.
    - caretakers prefer closed containers
- Don't need an ambassador. People are so motivated already. They are more in the shadows here. Don't take credit.

Ballerup

- citizen meeting
- combined with press release and newspaper
- "coffee and complain"-At the community center where given coffee and critique the new system.
- Take into account the population
    - older population not on internet

- letters or in person contact better

Appendix M: Interview with Mads and Jens

What have been the major problems encountered in the sorting of organic waste?

> Well we used to use paper bags under the sink, but if you make soup or pickled herring, it disintegrates the paper bag in no time at all. It really turned into a problem. But now we just use plastic bags and seal it to keep in the smell. A few days before its collected we'll put it out in the bin, but we always try to keep the bag out of the trash.

What makes you participate in this waste sorting system?

> Mainly its because we don't compost. Most of the organic waste in our kitchen the chickens eat outside, but there's plenty that they can't eat. From meetings we talk to other people, and put leftovers, meat, bones, coffee, tea, snotty paper towels, anything not consumed by the chicken out there. When Nulskrald began we became much more aware about what we were putting in our waste. We're a small community here; you couldn't avoid hearing about it.

What made you choose plastic bags and not use the paper trash bags outside?

> Well plastic bags are the only bags that fit into the bins kept within the house, and it makes more sense to dump your plastic bag into the bin because the paper bag decomposes so quickly. We did not ask if plastic was allowed within the container, we just assumed it wasn't.

What feelings do you have about the 2 week collection system?

> Its still the cold season right now so there's no real issue with smell yet. But it will get more difficult as summer comes. Right now smell is the main issue, not just the water that comes through the bag. It takes a long time to fill the bag because of the chicken eating most of the waste.

Appendix N: Interview with Jesper Heinzl, from Dansk Affald

Background on SAGA project and Dansk Affald

- Project in Billund Kommune. 273 households, 6% of which were "etageboligbebyggelse", apartments or multi-family housing
- From SAGA report: "Erfaringer viser, at jo tættere og nemmere på hjemmeadressen borgerne kan komme af med deres affald, jo bedre er borgerne til at sortere ud til genanvendelse." "Experience shows that the closer and easier on the home address citizens can dispose of their waste, the better people to sort out for recycling."
- Before SAGA, the kommunes already had (for large bins outside the house) a dual chamber bin with one side for cartons, paper (sensitive to water) and the other side for glass, plastics and metals (not sensitive to water and ther are probably wet from food contents). The also had a residual waste bin. Waste would get collected every two weeks.
- To choose the households for the study, Dansk Affald reached out to Billund Kommune, and said "We need about 300 households. We want you to pick 300 households in the same area and say to them 'You are in this study, you are participating.'" "We didn't want people that reached out to us to say 'We wanna participate, we like recycling a lot.' This was in order to get a more precise picture of what households will do when they get a new system that they are not used to."

Question and Answer

Why did you use paper bags to collect the waste?

> "Yeah, we sent letters to the three hundred households inviting them to a meeting to tell them what was going on. The letter told them 'Now we are introducing this project and you are chosen to participate. You can come to this meeting and get information about what the project is and what to expect and to get answers to any questions you may have in order to do the project.' We did this before sending out the bins."
>
> "We use paper bags not plastic to avoid confusion and people thinking they can put plastic in them, and then contaminate the food waste"

Was there a difference in the quality in waste from different types of households?

> "It's hard to say because we had so little multi-family houses. I think there are difficulties in getting different types of households to produce clean fractions, but it is not impossible and we should still work with these different qualities and say there are differences on how we live but that should not keep us from, we could work with different qualities if it is necessary and through communication working on getting better quality by providing better practical solutions."

What were the concerns people expressed about having to sort their waste?

> "People were concerned that the bag would get wet and break at the bottom. Some people threw out their bags every day. There were concerns about smell, but keeping in mind that the project ran through colder months, we didn't have a problem with odor."

How did the collected waste change through the course of the project?

"What was interesting was that from the second time we collected this food waste, that was the quality we saw pretty much for the rest of the project. So the purity level didn't change much throughout the project. The first time we collected the quality was a little lacking. But from the second time on they got it. This product we were sending to Billund Vand before the households in Billund, and we were at the same level, below 1% impurities."

What do you attribute the success of this project to?

"We didn't have to teach them that you have to sort at home; they already had that. Many of them told us that the idea of having less waste go to incineration, and get used for energy and still being able to use the end product for fertilizer, helped them understand the idea behind it. If they did not understand I think maybe we wouldn't have been as successful, because it would not make a difference what they did at all. It's important to give all the information and make sure that it makes sense, and for the people to know they are making a difference."

Do you think you 'converted' people to recycling?

We had people that didn't really care about recycling, who have their own businesses and such. It's important to have such people in the study, otherwise the results get too pretty.

How did you phrase the information campaign?

In the project we chose to call it 'food waste' to narrow it down and make it more understandable, but we also said it was ok if they had an indoor flower or the filters from the coffee. We put guidelines in the bags so people would know exactly what to put in the bins. This way the information was there all the time, people didn't have to go look for the information. It was on the bag so they could get the information very fast

Have you done any similar projects to this?

We have done other projects. When we started the Duoflex system we had people that did not want to participate. But the municipality mandated that everybody had to participate. In a short time, many of the people that said 'No thank you we don't want this.' changed their minds completely and did not want to get rid of the new system. Sometimes people make worries on what they think it is, but when they actually experience it they can change their mind, it a very human thing."