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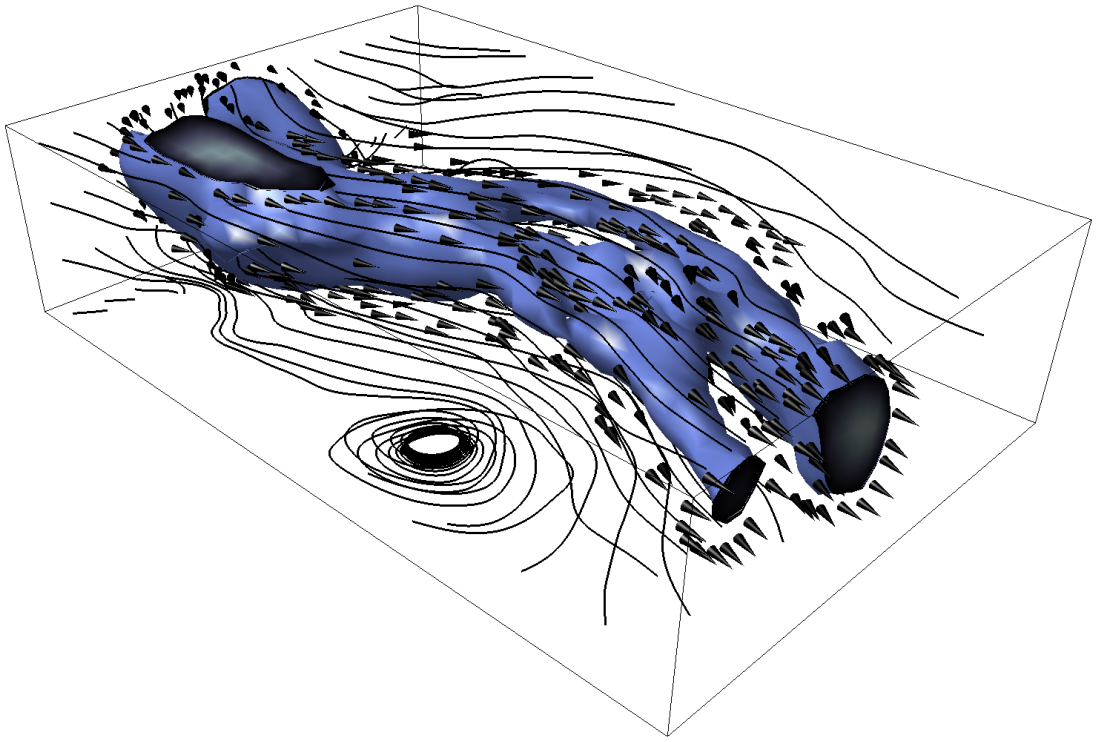

Challenges to achieve fossil-free production

Bachelor thesis within Mechanical Engineering

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Institution for Industrial and Materials science
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2021

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Sammanfattning

Volvos Group Trucks Operations som företag gör sina ansträngningar för att slutföra sin del av Parisavtalet som syftar till hållbarhet genom att göra sin produktion av fordon fossil-fritt. Problemen med detta är svåra, delvis på grund av att företaget är så stort och även på grund av den tillgängliga tekniken, som man ska fokusera på och som man ska undersöka. Vi har fått i uppdrag att skapa en färdplan för Volvo GTO genom forskning och intervjuer med olika experter från olika platser från Volvos Group Trucks Operations här i Sverige. För att senare ta reda på vad i synnerhet varje site behöver för att uppnå dessa mål. Vad som man har kommit fram till är färdplaner för varje enskild site med specifika problem och möjliga lösningar för dem alla och företaget som helhet. Resultaten som visas är mycket intressanta eftersom det finns specifika problem på vissa siter som andra kan ha och de möjliga lösningarna som kan användas och undersökas. Det finns mycket arbete som har gjorts och visats upp i denna rapport som människor kan ta del av och arbeta med själva för att få en hållbar produktion att fungera.

Abstract

Volvos Group Trucks Operations as a company are making their efforts to complete their part of the Paris agreement aiming for sustainability through making their production of vehicles fossil-free. The problems of this are difficult in part because of the company being so large and in part because of the technology available, which to focus on and which to research. We have been assigned to create a roadmap for Volvo Group Trucks Operations through research and interviews with different experts from different sites from Volvo GTO here in Sweden to find out what in particular every site needs to achieve these goals. What has been concluded from all this are roadmaps for each individual site with specific problems and possible solutions for all of them and the company as a whole. The results shown are very interesting as there are specific problems in some sites that others might have and the possible solutions that may be used and researched. There is a lot of work that has been done and showcased in this report which people can take part of and work with for themselves regarding making a sustainable production work.

Acknowledgements

Carrying out this work has been very instructive for us as students. We feel very enriched on a knowledge where it has recently aroused great interest. We want to take the opportunity and thank everyone who in some way contributed to the work being successful. A big thank you to our supervisors Lena Moestam and Ann Sofie Gullbring who gave us the opportunity to carry out our work in the company. We would also like to thank all our interview sources, who helped us gain great knowledge.
We also want thank the university library and other staff who have helped us with literature search and reference writing. Last but not least, we would like to thank our supervisor Mélanie Despeisse for a rewarding discussion and support during the work.

Issa Hermz & Julian Zora, Gothenburg, August 2021

GLOSSARY

LPG Gas - Liquefied Petroleum Gas, another word for gasol as a fuel for vehicles.

LBG gas - Liquid Biogas.

RGB - Biogas.

HVO100 - HVO100 consists of 100% renewable and fossil-free diesel with lubricating additives.

GTO - Group Trucks Operations.

CHP - Combined heat and power

Contents

1
Introduction

This chapter presents the background to answer the question, what challenges we face when it comes to achieving fossil-free production. It also presents the aim of the report, the aim of the project will be divided into several segments that will be answered throughout the thesis. Finally the introduction will end with a short introduction over the boundaries of the project.

1.1 Background

Volvo Group Trucks Operations continuously evaluate the environmental and climate impact that they give rise to. Volvo Group manufacturing operations have an environmental footprint that is relatively small compared to the footprint they get during their use phase. The company strives for a more sustainable production which means a continuous reduction in the amount of waste and emissions. Also an improvement in the handling of solvents, oils and various chemicals. In the future, the company strives to be able to make it possible for customers to drive vehicles that are completely emission-free and also create products with 100 % fossil-free energy. Fossil fuel free means: No investments in any company with proven carbon reserves. No investments in any company that explores for, extracts, processes, refines, or transmits coal, oil, and gas. No investments in any utilities that burn fossil fuels to produce electricity. These challenges can be achieved through extensive collaborations with the right stakeholders.

As early as 2021, Volvo GTO will start manufacturing the first concept vehicles and machines with steel that is produced with hydrogen. “In 2022, series production is planned on a smaller scale, and then a gradual escalation towards mass production begins.” This quote is from one of Volvo GTO’s articles, which describes the plan it has for the future regarding fossil-free production. Volvo Group Trucks Operations will also collaborate in research and development to optimize the use of steel in Volvo’s products in terms of weight and quality, and together develop more fossil-free steel products with the goal of achieving series production within a few years. Fuel cells are an important factor when talking about long transports with trucks. Carbon dioxide neutral transport can be achieved with the help of electrical energy from, for example, batteries or by converting hydrogen on board into electricity.

The Volvo Group’s organization consists of three truck divisions, one for Group Trucks Technology, another for Group Trucks Purchasing and the last one Group

Trucks Operations where they study all production of trucks, engines and gearboxes. Logistics operations and spare parts supply are also the organization's services.

Volvo Group Trucks Operations has made an order of committing to the Paris Agreement. The agreement is about the entire running fleet that is provided by Volvo Group Trucks Operations to run on 100 % fossil-free fuel by 2050. The company strives to contribute to an emissions-free future. Volvo GTO works with an ambition to have a steady shift into electric propulsion, they want the combustion engines to run on bio-fuel. They also have an ambition to make their products run on fossil-free fuels by 2040, the average life-span of their products are 10 years.

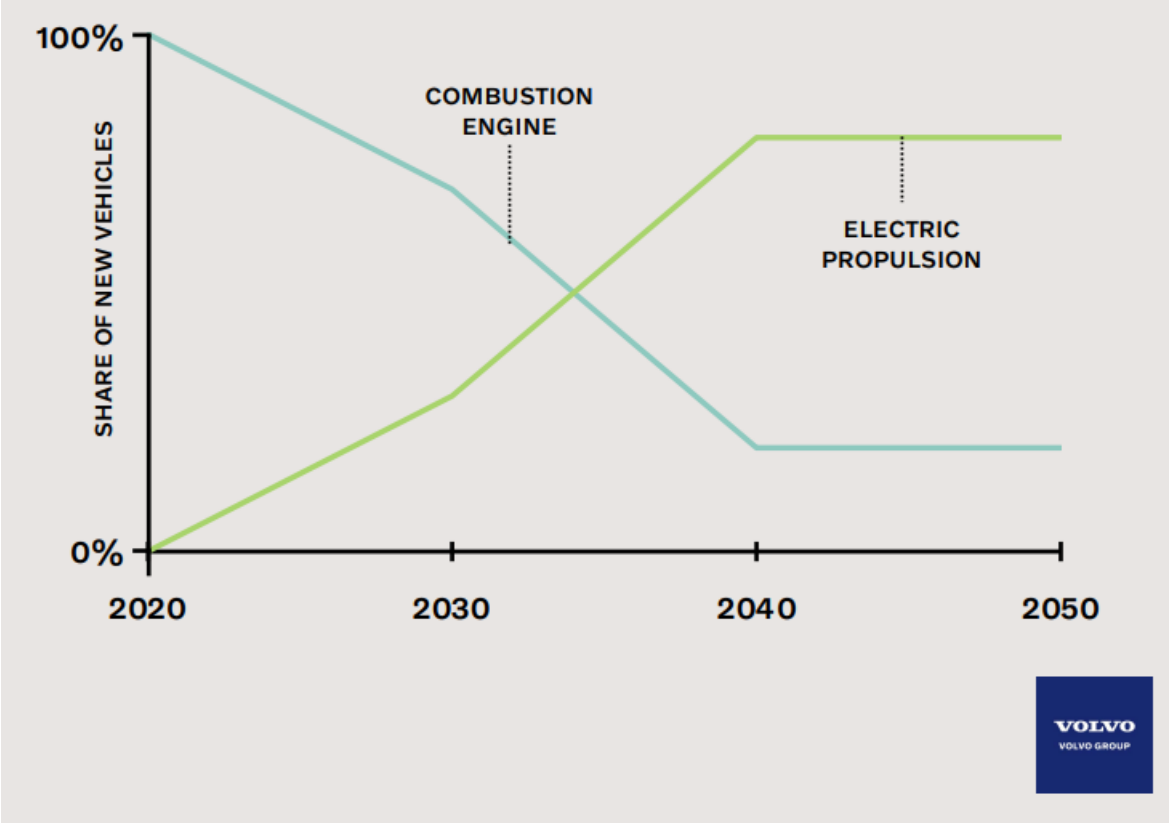

Figure 1.1: The graph of future ambitions [Volvo 2021]

1.2 Aim

The aim of this bachelor thesis is to make a couples of roadmaps with information acquired through various interviews with experts in different factories within Group Trucks Operations. We worked with Skövde, Tuve, Köping and Umeå to identify the challenges that exist in achieving fossil-free production. We have interviewed both environmental managers from the various sites and also engineers that work in these areas. We have also been interviewing the environmental managers at EBM, powertrain and GTO. The interviews are from the sites as well as the global and

regional sources that were interviewed.

The purpose of this project is to make roadmaps for Volvo Group Trucks Operations, about the challenges to achieve fossil free production. It will be easier for future researchers that will be challenging fossil free production, to get answers to what it would mean to become fossil free for the company. Future people working on this can get a better understanding about the challenges they will face and what outcomes they can expect. The roadmaps are going to provide good information about the manufacturing processes and the production it self.

1.3 Questions

This study as a whole aims to provide answers to the following questions:

1. -What would it mean for Volvo Group Trucks Operations to be fossil-free?
2. -How can Volvo Group Trucks Operations achieve fossil free production? (roadmap)
3. -Where should Volvo Group Trucks Operations focus be?

1.4 Boundaries

The purpose of the report is to present the possibilities of how companies can achieve fossil-free production. The subject as a whole is quite large. Therefore, we have chosen to focus on making a roadmap for future researchers who will take on the challenges that lie ahead. Our perspective lies within research into what it would mean for the company to allow all their products to be powered by biofuels.
On one hand, describing the potential for sustainable electricity, heat and biofuel production; and on the other hand a durable demand within each area of use, the picture of a new, renewable energy system emerges and an emission free future. As the report focuses on energy use, those emissions are not addressed as greenhouse gases arising from industrial or agricultural processes, except from fossil energy use within these sectors.

2

Methodology

This report is based on a literature study, case study and a number of research interviews. All papers have been analyzed and documented. The keywords have been taken apart and also grouped by their similarity. In this part of the project, different methods are used in different phases as illustrated in the text.

2.1 Literature Study

To get enough information to start the work and to get a background knowledge within the subject, a literature study must be carried out. The literature study must be ongoing throughout the work and also form the basis for conducted interviews. It is good to have and to use as many new sources as possible to be sure that what is written is correct and current. Literature search is done on available databases, libraries and on the internet.

The keywords that have been used are: “Green production”, “fossil free”, “low carbon”, “carbon neutral”, “carbon technologies”, “recycling”, “sustainable transport” and “Fossil free production”.

The literature study will be giving us knowledge about the various terms that are used as a description for different actions, effects and strategies. Many terms in sustainable development are being used in scientific papers, textbooks and are being used falsely. According to Peter Glavic and Rebeka Lukman in their journal about cleaner production 2007 are the various definitions of terms divided into categories [4]. This is causing a problem with the spread of sustainability terms and their definitions as authors and organizations.

Literature study is important to be able to understand the terms of sustainability and their definition. This provides better communication in processes between people, which ultimately leads to a better development of sustainability. These studies will help the report to avoid the misunderstanding of sustainable development issues and to avoid imprecise usage of the terms. The bibliographic search was performed in several databases like Scopus and ScienceDirect.

2.2 Case Study

Case study is a research strategy that aims to provide in-depth knowledge of what is being investigated. What characterizes the case study is that it focuses on a phenomenon that is often difficult to distinguish from the context of the phenomenon. The goal of a case study is to generalize for theory development.

There are four factors to consider in determining whether a case study as a research strategy is the most suitable for the research work. According to Merriam (1994) , the four questions to be answered are: What type of questions you ask, what degree of control you have and how you think the end result will be. The fourth and perhaps the most decisive factor that Merriam (1994) claims can be if one can identify a limited system as the focus of the study. Based on Merriam (1994) four factors that define a case study, this study should use case study as a research strategy.

2.2.1 Interview Design

Majority of the information obtained for the project will be gathered through research interviews. Research interviews according to "The good research guide" written by Martin Denscombe (2017) are a way to collect data through the people's answers to the researchers questions. The answers are focused on thoughts that the people have and not what people do right now, it is more of what they think should be done and what they believe to help us progress further.

The method we are going to use is semi-structured interviews which also comes from the book "The good research guide" which is simply us having prepared a set of questions but then also allowing the person getting interviewed to elaborate with more open ended answers. This is good because we want to extract as much information that we get from specifically that person and everyone can be good on different things so having the same questions and demanding just straight answers will not be the most optimal way. Also what this allows us is to tweak the interview after each person we have interviewed because if we get some key information and that now suddenly sparks our interest we change or maybe add on more questions related to that.

Number	Questions
1	How would you define Fossil free production?
2	What do you see as the major keys we can focus upon?
3	How can we entice more people to work towards Fossil free production?
4	What type of resources are good to use for achieving fossil free production?
5	What environmentally friendly fuels are there?
6	What does green production mean to you?
7	What are the biggest challenges we seek when it comes to achieving fossil free production in Volvo Trucks?
8	What is a simple definition for sustainability?
9	What energy resources are you using today?
10	How do the materials you are using today and the ones you want to use in the future compare in sustainability?
11	How do you think your factories are located right now are they good locations for future expansions or renewable sources?
12	In the national geographic Before The Flood Elon Musk talks about how these “Gigafactories” can help accelerate us to a future with sustainable energy.This is an extremely complex process and would require tons of different processes but it is more affordable and better for sustainability according to his calculations and predictions. What do you think about "Gigafactories"?
13	Which terms do you feel can be improved, added or removed to be able to optimize the workflow when communicating about sustainability?
14	Do you have information of another country, company or project wanting to achieve this goal that we can extract some ideas from?
15	If we link finances and waste management in recycling how does this help fossil free production and if so how can this be accomplished?
16	Can economic development also be sustainable in the event of going fossil free, if so how?
17	In which areas do you think we as a people should focus our time on and prioritize to get the most valuable information working towards fossil-free production?
18	What Environmental Gains do we get from recycling and how does that transfer to getting closer to carbon neutral production?
19	Are there any ending statements you might want to add on to begin to end this interview?
20	Do you feel like there is anything else you would have liked us to ask about?
21	Is there any data you are measuring which you can share with us?

Table 2.1: Questions for the interviews

Table 2.1 below presents five different themes for our interview, below you will have a table with the interview format and themes explained:

Fossil Free: Here we aim to gather as much information as possible regarding the use of different resources and the general thoughts regarding the subject. How do different people feel about it, what do they think are important and valuable?

Sustainability: Here we aim for a full circular life so to speak, renewable sources how can we work our way towards that. Materials, locations and so on.

Optimization: Here we aim to gather information surrounding questions that maybe people are not asking or putting much value in.

Investments: Here we aim to gather information regarding the financial situation surrounding the project.

Ending Questions: Here we aim to squeeze every last bit of information left after the interview with maybe questions that were missed or different things the people value that we haven't thought of so we cover all ends.

2.2.2 Experts Interviewed

The experts interviewed in this project were identified by our supervisors on Volvo Trucks. All interviews were conducted on Microsoft Teams online in Swedish and were recorded. The questions were categorized according to our themes to conduct semi-structured interviews.

We are only doing one-to-one interviews because as described earlier we want to have a personal conversation with the person and find out what exactly it is that he/she knows and has burning thoughts about so that we can get the most amount of information that we can from these specific persons. The recordings were analysed to capture the experts' background, experiences, knowledge and ideas regarding fossil-free production.

We started by mapping out all the different interviews by checking the calendar in the Volvo system and preparing questions that need to be asked to everyone. Additional questions were asked to draw from the expertise of the interviewees and complement information received from other interviews. Certainly information given to us, could make us rethink and maybe contact other people so there always be a continuous process of following up loose ends and such after an interview with a person. A concluding question have been prepared to ask everyone if there is anything they think we should be asking for the next interview.

Table 2.2 presents the people interviewed, the department's name and site location, their position in the organisation, and the description of their area of responsibility.

Experts	Name of Department	Position of the job	Description
Expert A	Volvo Group trucks Operations, Lundby	Head of Environmental Sustainability	Volvo Trucks' manufacturing unit of all truck brands. Works for environmental issues and strategies
Expert B	Volvo Group trucks Operations, Lundby	Environmental Manager (EBM)	Fossil Free vs Renewable Energy
Expert C	Power train Skövde	Environmental Manager	Iron production in Skövde
Expert D	Power train Skövde	Environmental Manager	Previously worked as an environmental engineer and is currently working with energy technology
Expert E	Power train Köping	Environmental Manager	Environmental manager at köping, worked a lot with chemicals as a chemist
Expert F	Powertrain Köping	Engineering	Materials Engineer, works with materials and heat treatment
Expert G	Umeå Volvo Trucks	Masterplan and Investment Coordinator	Cab manufacturing and painting processes
Expert H	Umeå Volvo Trucks	Environmental Manager	Worked with environmental issues for a long period of time in Volvo Trucks
Expert I	Power train Skövde	Engineering Machining	Worked in Volvo for more than 40 years.Right now working as an industrial engineering manager
Expert J	Tuve Volvo Trucks	Environmental Manager	Lots of different roles in product development, applies a lot of lean theories in environmental work

Table 2.2: List of Experts Interviewed

2.2.3 Interview analysis

We analyzed the interviews using the recordings and interview notes. The data we received from the interviews were analyzed by looking at the recordings and reading the notes that were taken. Using this, we used the roadmap tool[12].

A technology roadmap defines a goal and presents the major steps needed to reach it. It is a strategic plan that also serves as a communication tool. A roadmap explains the "Why?" both behind the goal and the actual plan for getting there. In this case we have used the roadmap tool for better understanding from the results we have gained from the interviews. Most of the headings in pictures are described below more detailed.

2.3 Validity, Reliability and Objectivity

The results we have obtained, we as researchers must prove that this information is reliable. As Björklund and Paulsson (2018) mention, there are 3 aspects that play a role in this situation. Validity, reliability and objectivity. A researcher should always strive to achieve a higher validity question possible in his study.

The measuring tools and all measuring instruments used during the work must be correct, which is what validity means. By presenting and collecting information from the company's own measuring tools and measuring instruments, the validity is strengthened. In our work, information is obtained with the help of interviews, which also increases the validity.

When reliability is to be measured, it is very much about reliability. You must therefore be able to achieve the same result from this work by repeating your research again. When you consider yourself to have high reliability, the information you have received and all references must be from the company itself to the researcher later.

To show that the information you have gathered is true in an objective way is what you want to strive for in a study. One should avoid using one's subjectivity to gather information and instead gather one's information in an objective way. One should try to avoid using one's own knowledge and understanding within the research itself.

Our work limitations gave us more knowledge and information about what it looks like right now for Volvo GTO and how it could be. We have learned a lot about their problems and what kind of solutions they are thinking about using.

To make a production fossil-free for a company is a big project that needs a roadmap that provides all kind of information to make this go froward.

2.4 Roadmaps

The Roadmap tool contributed with a better understanding and better planning of the challenges. It gave us information about the size of the different challenges. With the roadmap tool it's important to understand the structure behind it. The roadmap is divided into 3 rows and 5 columns, the rows stand for the why,what and how while the columns stand for the time perspective during the process except for the last one which is the vision we are working towards.

What we have as a first row is the section called "Why" what are the drivers, why do we need to act? This is what is written here. We have the "What" row, what exactly is it we should do? Lastly we have the "How" row, how can we do this? What are the enablers for the process, what do we need to achieve this. We have the complementary and detailed information about the roadmap below the figures, where we describe the various factors that we used.

3
Literature Study

In this chapter the Literature Study is presented. The theoretical framework sample defines the key concepts of our research and also proposes the relations between them. The chapter also presents discussion about relevant theories based on our literature study. The purpose of this chapter is to get a strong theoretical framework that gives you research direction, allowing you to convincingly interpret, explain and generalize from your findings. All research articles should have a valid theoretical framework and litterature study to justify the importance and significance of the work.

3.1 Environmental Sustainability

Natural resources in the long term are what provides for humanity and future generations. When talking about sustainable development you need to consider the three dimensions; Economic sustainability, social sustainability and ecological sustainability. Pollution creation and nonrenewable resources is the biggest threat against environmental sustainability. If the rates of renewable resource harvest and pollution creation can not be continued indefinitely, then they are not sustainable.

Environmental sustainability can refer to many factors, for example sustainable production. Sustainable production conserves energy from natural resources. The use of production processes and systems that are "Non-polluting" are the ones with the creation of goods and services. Sustainable products have a good impact on environmental sustainability, both financially and also safely and healthily for the workers, customers and communities.

Social sustainability refers to how we as humans need to broaden our way of thinking and how we can live in the future because as we are living now is not sustainable. If we just take the UK for example, according to Seyfang (2010) "Community action for sustainable housing: Building a low-carbon future" half the CO2 emissions come from the heating and running different types of buildings/homes, three hundred million homes were expected to be built by the end of 2020. We need to ensure that new homes are more sustainable both in terms of climate change and adapting to different climates.

This can be done with complex technology solutions such as implementing the latest types of construction for buildings when they are built, consequently monitoring the

energy use in the home and regulating it. This can also be done with not as advanced technology then we have for example recycled consumer waste which can be used to construct a off grid dwelling or a different structures in the local societies were we use and share neighbourhood friendly facilities to ensure optimal resource use and a sustainable future.

3.2 Sustainable Transport

Sustainable transport is a measure of how much effort society puts into maximizing the transport sector's negative impact on the climate and the environment. The big goal of a sustainable transport system is to change its types to a more energy-smart way. The continued growth of motorized transport builds up a threat to the Earth's ecosystem, which can be described as the definition of sustainability and transport according to David L. Greene (1997) [2]. The various threats include too little consumption of non-renewable resources, deterioration of the local and even global environment. Sustainability requires renewable resources, which is also an important factor in transport. The environmental impact of transport is usually a result of its enormous energy use in the form of fossil fuels. The internal combustion engines produce a lot of toxic gases for the environment. The various pollutants include carbon monoxide, nitrogen oxides and fine particles.

Fossil free sources such as hydropower, solar photovoltaic, solar thermal, wind, and geothermal are essential for a sustainable future. People may think that fossil free sources can't convert as much energy as blast furnaces and oxygen furnaces can if we take the steel industry for example according to Zhoua (2019) these furnaces can easily be replaced by electric arc furnaces if there is enough steel scrap. Many fossil fueled processes as drying and such can also be replaced by electric drying systems or electric heating systems or whatever is necessary.

3.3 Energy Systems

We have different types of energy sources. We have solar energy, wind energy, nuclear power, fossil fuels and so on and so forth. Since the founding of the different energy sources the human species has exploited them to the fullest extent for personal gain without much regard to mother nature itself. It has come back to bite us like a whiplash effect where we need to take care of it now and that urgently as well. We have seen that we can do this in a small capacity according to Seyfang (2010) "Community action for sustainable housing: Building a low-carbon future" were much progress was made in regards to renewable energy and spreading the notion around it due to the energy crisis that was happening but once oil supplies came back it all sort of went back to normal. This is what normally happens due to the lack of seriousness we as humans have for situations.

There are new technologies that are gaining acceptance for low carbon solutions for example fuel cells being the primary one. According to Meibom (2013). Wind

power and biomass were expected to be the main sources of energy for the country Denmark, this indicates for us that those two sources may be two really good sources for sustainable energy in the future if optimized and used correctly.

3.3.1 Power System

The power system in the future will be challenged and changed to a much more flexible utilization of the power systems, how they are located geographically combined with a strong infrastructure and markets for electricity internationally. These are all factors for a successful future within renewable energy production.[13]

For example by the end of 2020 Denmark wanted their electricity usage to be 50 % powered by wind energy and with the years even more, in the future the wind power production will be more than what is used, it will be a overflow of energy and there will also be times where the wind can not meet the required power that is expected from it. For today's solutions we have Combined heat and power (CHP) plants that can meet this overlap for when the wind power simply can't deliver the expected amount.

3.3.2 Heating System

A solution that has proven within this area is electric boilers which can function as big immersion heaters that heats the water for district heating, this allows wind power to also be used for heating when the price of power is beginning to dip. They play a big role in the balancing of the consumption and production in the power system. Electric Boilers does not have a lot of hours being operated due to it being expensive and is best used for when needed the most but as said before as we develop wind power more and we know how to take advantage of it to the fullest and we gain more excess wind power we will be able to use these systems for heating instead of fossil fuels according to Meibom (2013) "Energy comes together in Denmark: The Key to a Future Fossil-Free Danish Power System".

We also have central electric heat pumps which are better for longer periods of time, the technology is more expensive but it uses less energy and it produces three to four times more electricity. Then we have the opposite which is cooling, here we can have a closed pipe system exactly in the same way as heating of a district works with the boilers or pumps where we can store cooled down water for when the power price is low or if we have excess in heat. The energy this consumes is only half of what traditional cooling does.

3.3.3 Gas System

The gas system is an essential part of becoming sustainable as this serves as sort of a bridge when the energy from these renewable sources are not enough as the gas can be stored over several seasons. Gas can be converted into electricity, gas in the future can be seen as a renewable energy source and is an important part of fu-

ture energy systems. Gas systems can be produced flexibly from biomass and waste.

Gas storage facilities are used to store large amounts of energy. Gas is later used directly for various transports, to produce electricity in peak load situations and also in industrial processes. Another advantage of gas is that it can be converted into liquid fuel. When there are periods where we have difficulty with the production of renewable energy from wind and hydropower plants, in other words during "Dry years" and so on. Natural and renewable gas be the solution to this problem as a kind of buffer during the difficult period.

3.3.4 Renewable Energy

According to Abdeen Mustafa Omer (2007) “Focus on low carbon technologies: The positive solution” electricity by renewable energy sources are by definition a environmental green product, therefore solar, wind, biomass and geothermal energy are the most important forms of energy when it comes to renewable energy. For example solar energy has silicon cells which absorb sunlight and transform it into PV which in short stands for electricity-photovoltaics. The potential this has is massive and is gaining more widespread attention per day. This is an example of renewable electricity which is sustainable.

Water, biofuels, wind and solar contribute with renewable sources. Most often, a lot of hydropower and wind power is used to get a good renewable energy production. It will always blow and therefore the wind turbines are very efficient. There is also sun, which contributes a lot of energy. Had we been able to convert all the solar energy that reaches our earth every day. Then we solved many of the planet’s energy problems today.

Wind power contributes a share of Europe’s energy production, it is a renewable source that becomes an important factor when our world is facing major climate challenges. To make it possible to live fossil-free within the generation between 2040-2050, the proportion of renewable energy production must be increased to achieve that goal. Wind power is both cost-effective and overall, wind turbines are the fastest growing form of production in the world right now.

3.4 Raw Materials

In the construction industry we have a lot of scrap that goes to waste when we could use that material for future use as well. According to Liu (2013) “A low-carbon road map for China ” Recycling construction materials for example has the potential to minimise energy intensity by up to 90 %. Scrap material can, if optimized in the way we work with it, replace up to 80 % of the material iron ore as a resource for primary steel production by 2050 also according to this article. What we can see from this small example is that there are real upside and benefits in thinking green and implementing real structural changes in society and how it needs to work is crucial.

3.5 Other Resources

Resources in a factory that is trying to achieve fossil-free production must start thinking about upgrading to renewable resources. Electricity and biogas are what results in a more fossil-free production in a factory. Renewable fuels such as renewable electricity and biogas will be a major sustainability challenge due to the need for large projects. If the factory does not address this, the factory will not reach its goal towards fossil-free production. It is always expensive in the beginning with new resources and new technology that has not yet been tried. The infrastructure itself will be a challenge when it comes to biogas.

The internal combustion engines that run on diesel and Liquefied Petroleum Gas (LPG) use are important resources for Volvo Trucks when it comes to their production. These resources must be replaced by more environmentally friendly and fossil-free resources. Biogas, for example, is cheaper than the LPG used today. They want to replace natural gas with biogas and also replace bio-based coke and find more renewable fuels for transport.

4
Results

In this chapter presents the Roadmaps for the different facilities. The Roadmaps are used to map the challenges identified in the interviews and to describe the solutions proposed towards fossil-free production. The summarized answers from the interview questions are presented in this chapter too.

4.1 Roadmaps

Here is the different roadmaps for the facilities with figures and text down below that describes the figure more detailed and what we have gained from the interview analysis.

4.1.1 GTO Global/Regional Resources View

The information we gathered for this site came through the interviews of experts A,B,D and websites which are referred to in table 2.2. The details written in the roadmap for Volvo GTO are the responses from the interviews with the experts and any information that came from either one of them alone. Also this department are the Volvo GTO and have a global perspective and the experts interviewed are from the central function in the company.

The information written on the roadmap are more of a general approach to how site Lundby can optimize their future work and research towards their sustainability goals. The most important parts being the green energy and resources. More information about these are down below in a road map text format.

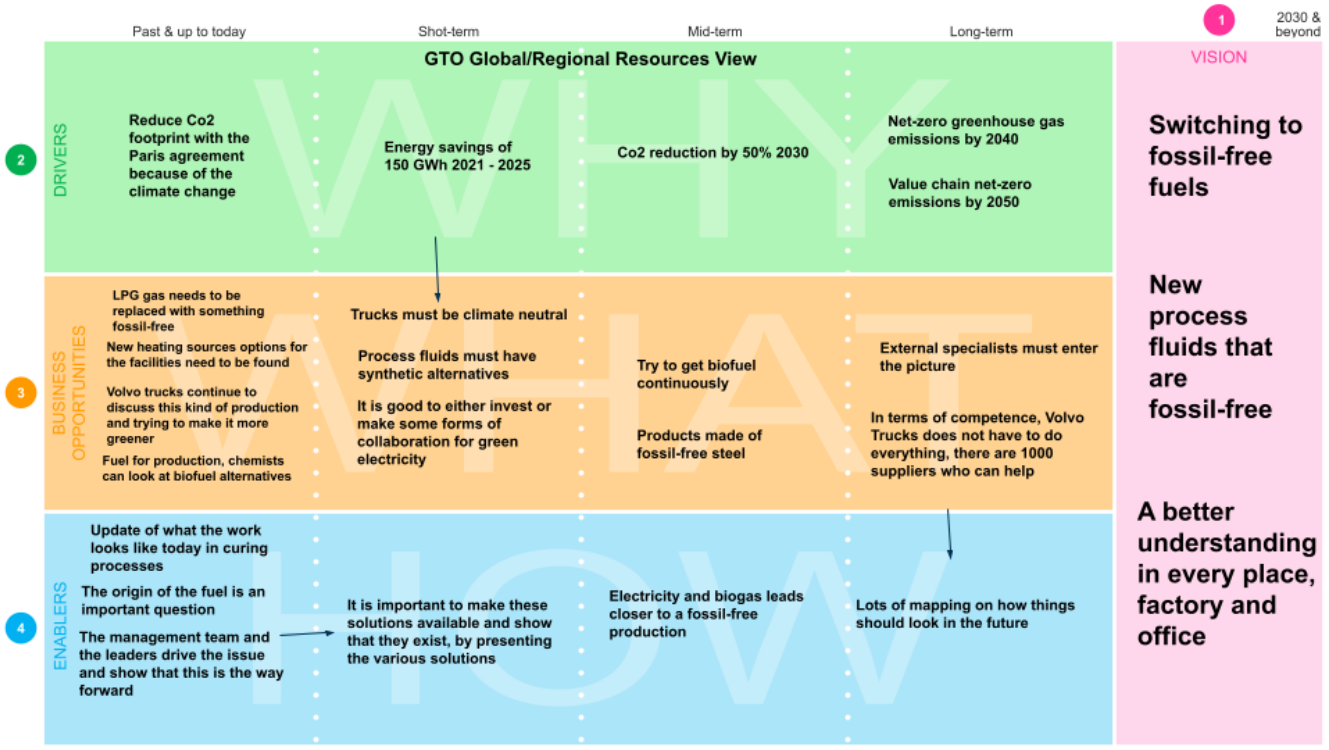

Figure 4.1: Roadmap GTO Global/Regional Resources View

Energy: If you can reduce energy consumption 30-40 % in total, which is very difficult, but the smaller investments in e.g. solar cells, etc. for energy, you can save a lot of money for other things as there are large investments in this area. This applies to all factories as well.

Heating System: District heating 98-99 % work towards 100, diesel trucks are replaced with HVO fuel which is 100 % fossil-free.

Green: Producing products in a green factory 100 % recycling is the goal of green production.

4.1.2 Umeå

Site Umeå is where the cabins for the trucks are produced. The information we gathered for this site came through the interviews of experts G and H and websites which are referred to in the references. The details written in the roadmap for site Umeå are the responses from the interviews with the experts and any information that came from either one of them alone.

The information written on the roadmap are more of a detailed approach to how site Umeå can optimize their future work and research towards their sustainability goals. The most important parts being the resources, ovens and transports. More detailed information about these are down below in a road map text format.

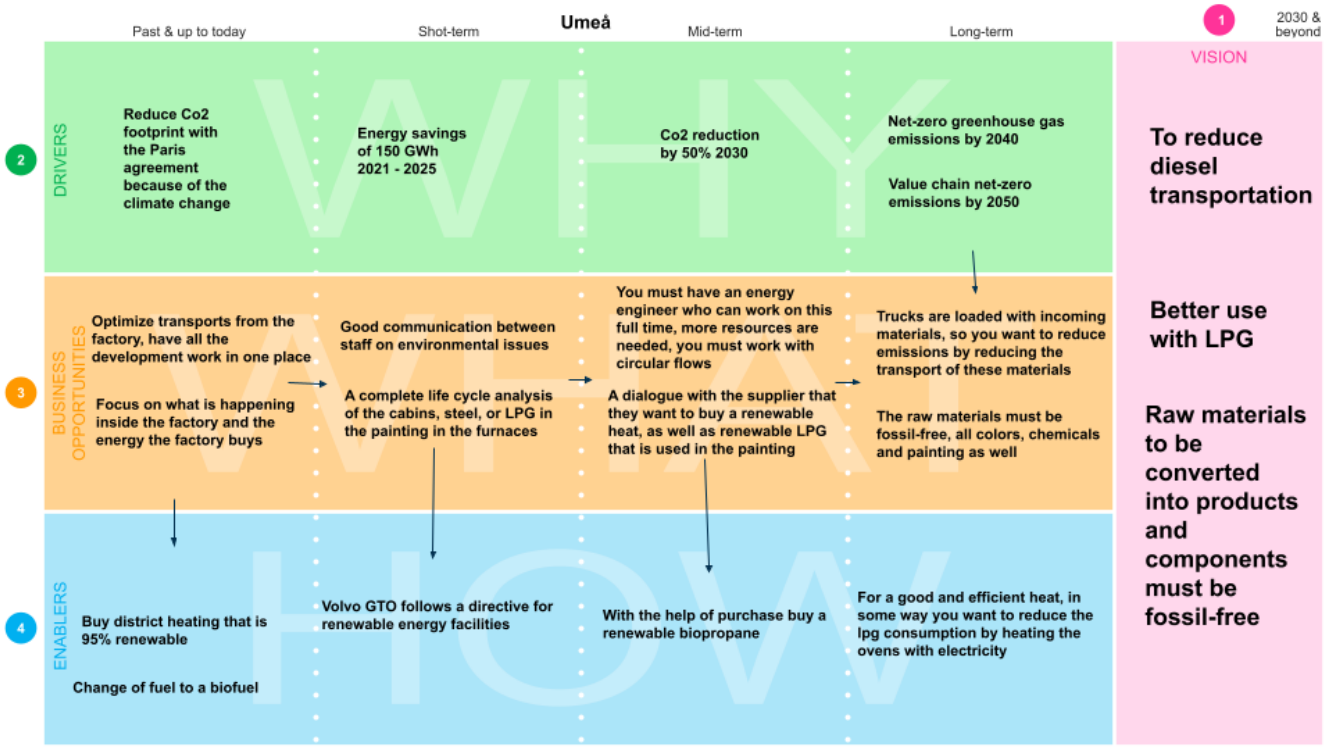

Figure 4.2: Roadmap Umeå

Resources: When cabins are produced, LPG or diesel are not used. It is a little more isolated in the Umeå factory. The Umeå factory strives for fossil-free production by reducing diesel transport. The focus is on delivery to the railway with the cabs, how LPG is used and so on.

In part, Volvo Trucks and Daimler has entered into a collaboration with H2green steel. to produce a fossil-free steel for the products. a good challenge, if the collaboration succeeds, you can put together a good fossil-free production of the steels.

Ovens: LPG farm is located in the factory and is used for the ovens in the painting processes. For a good and efficient heat, in some way you want to reduce the LPG consumption by heating the ovens with electricity or biogas instead.

Transports: The transports of cabins go around half of Umeå to get from the factory and the train station, the fuels that are used is HVO and diesel. In site Umeå there are several wheel loaders that transport materials used for production, the materials transported are received by trucks. They run with HVO100 which is fossil-free.

Optimizations: The painting processes needs to be upgraded. A new infrastructure is being rebuilt in Umeå, which will give them the western link, which can later lead to simpler transports and be more environmentally friendly. The facilities distance them from driving with cabins. A new transport vehicle is needed that

runs on battery and hydrogen. Cabins are run through the painting process. They are driven from the factory 5 km away by tractor and trailer to an incinerator to an external supplier. They use LPG to burn off the dirt layers on the cabins. Move this process instead to site Umeå to optimize work flow and another improvement is to manufacture an electric furnace as it is possible to install electric ovens on the site.

Solar energy is not explored deeply on site Umeå because of the cold climate there. When it comes to cold climates you can still get results if you put solar panels on the facade of the building as the reflection from the snow will give you good amounts of electricity.
The chain: Big investments are required to take steps in the right direction, the more people who help, the bigger the changes we can achieve. There are competent employees who work with production that can provide improvements and proposals that can have an effect. An example in Umeå takes in a sheet metal roll, which turns into narrow rolls. Cut them into sheets and press to articles paint and send on, a lot of sheet metal scrap, manufacturing unnecessarily and transported unnecessarily and later it is scrapped and transported again unnecessarily.

Recycling: Thinner is used to clean the painting processes. The tinner is purchased in a cubic bulk form. A cubic tank are sent out to the processes, and the tin becomes dirty and you want to reuse it, put it back in the cubic tanks and then transported by truck. They invested in a thinner tank in the factory. It is a recycling that is done in the Umeå factory, which means that carbon dioxide emissions are reduced as transport is reduced.

Location: The Umeå factory is far from everyone else, even far from suppliers of materials. This does not necessarily mean it is bad as long as optimization of the right resources are used and taken advantage of as there are no problems with water supply and the energy is fairly cheap such as hydropower at the Umeå factory.

LPG - Gasol: A gas stove has been in the negotiation process. One went on LPG, installed an electric furnace for a large project, a furnace that uses LPG, which should use district heating instead. Energy that is gained is not stored, it just changes the type of fuel. You might be able to run on a biofuel, but you also have to change burners, biofuel requires a different skill, we have to store the fuel. Replace existing LPG with a biopropane that does not require much adaptation in plants, but that you can only change the fuel. A big challenge is the economy, both Volvo trucks and them locally. Locally, time is a difficult factor to have the resources to work with the issues. Things may not move so fast.

Comment: It is important to make sure that demand is in line many questions go through the Volvo networks as the environmental manager has no budget or staff. It is more difficult for the environmental manager to go to the site manager and tell them what to do instead of the site manager getting the information through natural workflow from Volvo networks.

4.1.3 Köping

Less information for this site as a whole as the operations are not quite as extensive and large as the other sites.

The information we gathered for this site came through the interviews of experts E,F and websites which are referred to in the references. The details written in the road map for Köping are the responses from the interviews with the experts and any information that came from either one of them alone.

The information written on the road map are more of a general approach to how site Köping can optimize their future work and research towards their sustainability goals. The most important parts being the resources and metrics. More information about these are down below in a road map text format.

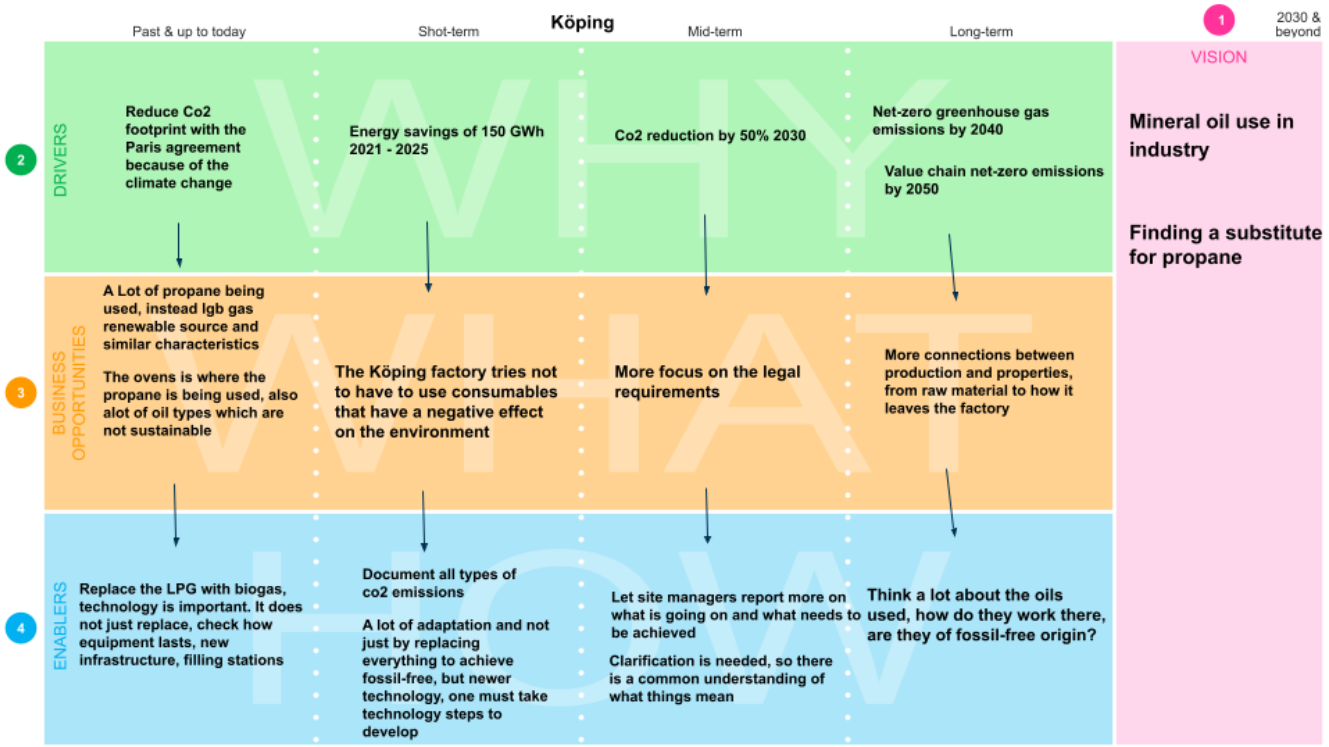

Figure 4.3: Roadmap Köping

Resources: Site Köping consumes a lot of propane. The large energy consumption is the furnaces, which is propane, which must be replaced by something sustainable. Replacing it with bio propane might work. The furnace also uses oils for its maintenance and different types of oil today's are sustainable .

Metrics: Much focus on carbon dioxide levels to get it neutral, so their is 0 carbon dioxide emissions. All types of consumption should be mapped more.

4.1.4 Skövde

The information we gathered for this site came through the interviews of experts C,I and websites which are referred to in the references. The details written in the road map for Skövde are the responses from the interviews with the experts and any information that came from either one of them alone.

The information written on the road map are more of a detailed approach to how site Skövde can optimize their future work and research towards their sustainability goals. The most important parts being the Iron, resources and optimizations. More detailed information about these are down below in a road map text format.

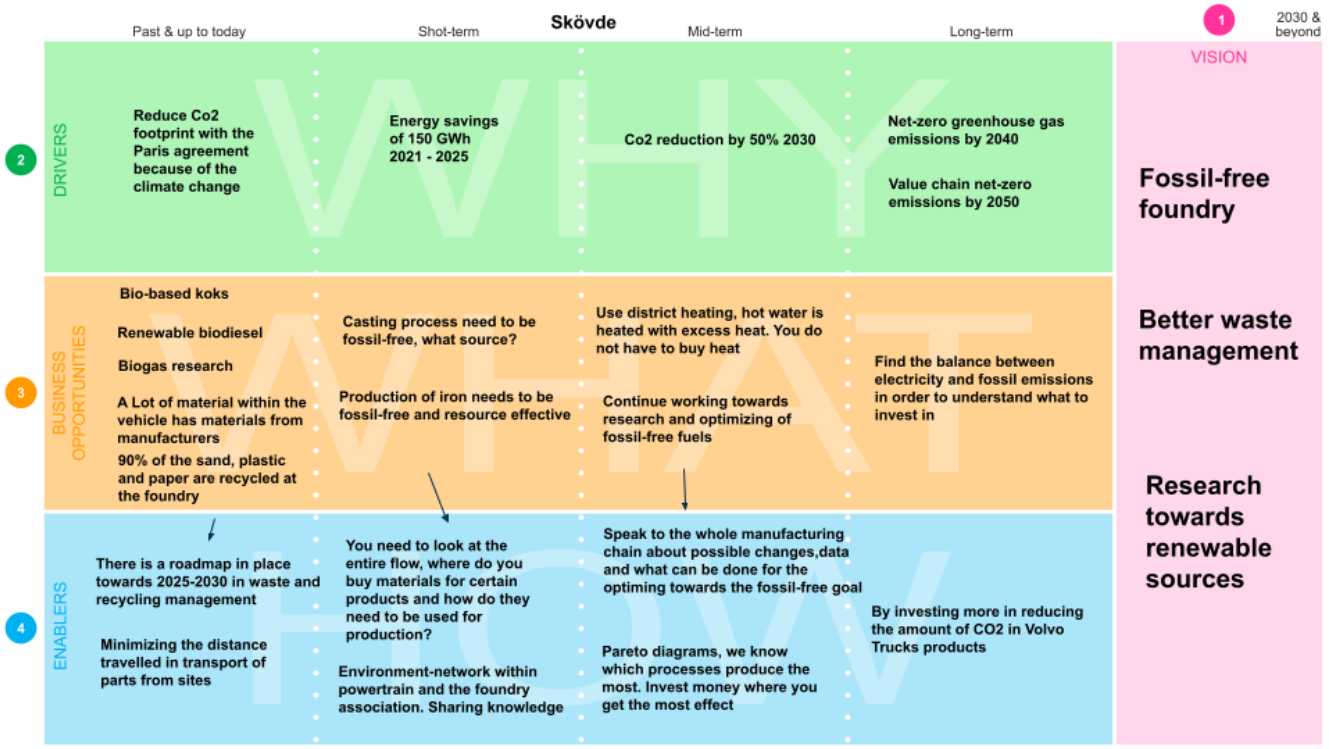

Figure 4.4: Roadmap Skövde

Iron: Fossil-free iron and producing it is priority for site Skövde. The smelting of iron what energy source should be used. There are also Various substances that is mixed with the iron as well they have to be taken care of as well. The casting processes are the biggest challenge for Skövde.

Optimizations: Pareto diagrams, we know which processes produce the most. Invest money where you get the most effect.

Transport: Where is site Skövde located in relation to the other sites where the materials come from. The materials are transported by rail, this is done with fossil fuels to a certain extent. You have to unload the parts from cars, etc.

Minimizes transport between production parts. Again, you need to look at the entire flow. where is the material for certain products transported from and how are they used the most effectively for production, etc.

Resources: Skövde uses a lot of koks which you get from processing charcoal. Before coal goes to the blast furnace, it must be coked in a coking plant, which means that water and other substances are removed from the coal to improve the strength. The coke is heated without access to oxygen and volatile substances, which have a polluting effect on the coke, disappear. So researching bio-based coke, renewable biodiesel, renewable electricity is a good step in the right direction to replace koks. Bio gas, renewable fuels for transport are what you can work towards there.

Iron production in Skövde is the biggest challenge, making it fossil-free and resource-efficient. The koks processes and LPG processes also result in carbon dioxide emissions that needs to be fixed.

Comment: The melting has a great impact, if you remove it, 70% of everything is solved. Volvo's products reduce the amount of CO2 on their products by 90-95%. There is always something to do, at the foundry 90% of the sand is recycled. plastic, paper combustible. Have a roadmap towards 2025 and 2030, where they talk a lot about waste and waste management. District heating gives a profit. Hot water is heated with excess heat. you do not have to buy heat. It is a matter of skipping this or making more money, customers and investors demand this fossil-free, the question is how we solve this to reach the goals.
There are tons o different materials in the vehicles, which Volvo does not manufacture they come from external companies. The whole chain needs to be spoken too and making it clear that Volvo is green and everything needs to be green. Where do these materials come from, who produces them.

4.1.5 Tuve

The information we gathered for this site came through the interview of expert J and websites which are referred to in the references. The details written in the road map for Tuve are the responses from the interview with the expert

The information written on the road map are more of a general approach to how site Tuve can optimize their future work and research towards their sustainability goals. The most important parts being the transport, recycling and materials. More information about these are down below in a road map text format..

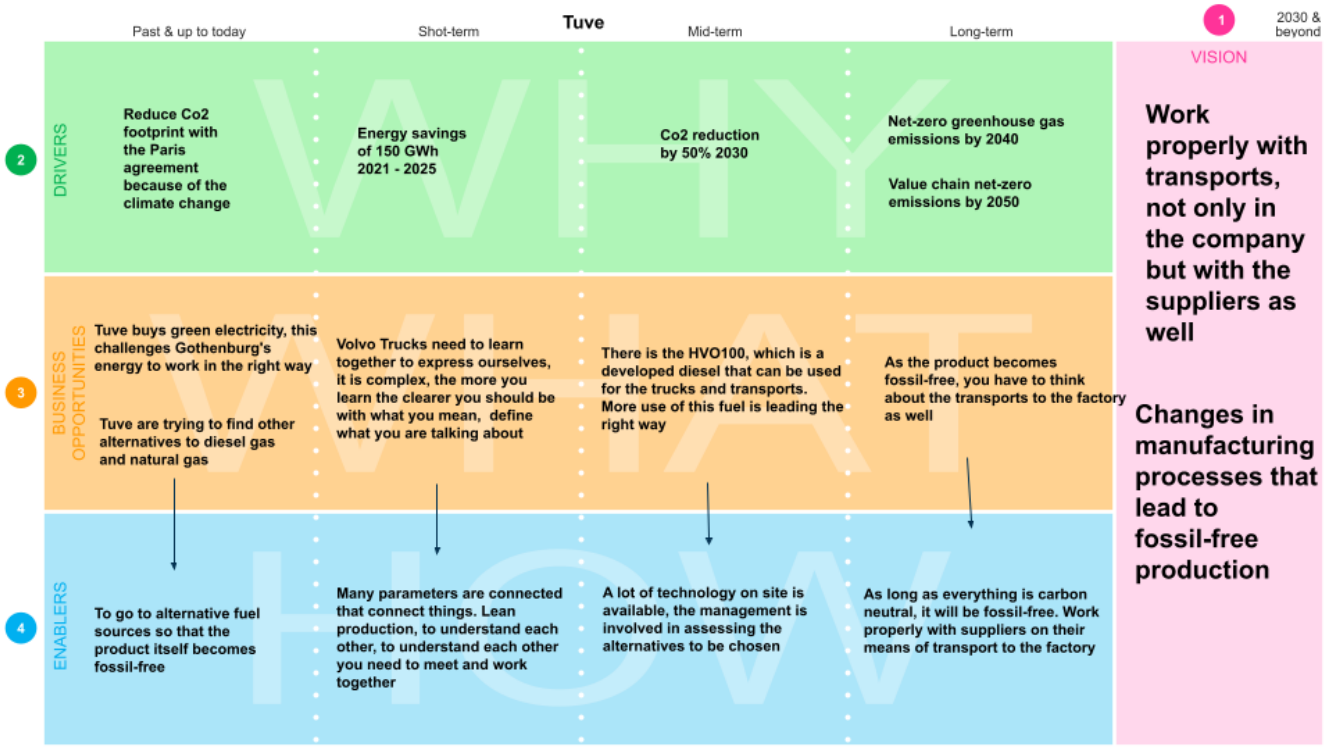

Figure 4.5: Roadmap Tuve

Green Energy: Tuve buys green electricity and as the production becomes fossil - free, you have to think about the transports to the factory as well. As long as everything is carbon neutral, it will be fossil-free.

Materials Today: Tuve today works a lot with packaging, especially optimizing the packaging for sustainability when returning material. The packaging still contains some chemical products that are not good, it is the legislation that governs that part. There is a list with the names of all the chemicals that are highlighted with either gray or black color. Gray color means find a plan to phase out the material and black means immediately get rid of it.

Recycling: Take care of the leftover material you do not profit in the short term to reduce but in the long run when talking about sustainability it is required, you must ensure that source sorting works. Different types of transports will be needed, there will be a whole logistics flow you have to take care of.

4.1.6 Volvo Group Trucks Operations

The information we gathered for this site came through the interviews of experts A-J and websites which are referred to in the references. The details written in the roadmap for the whole Volvo Trucks are the responses from the interviews with the experts. This is a summary of input from the sites as well as the global and regional sources that were interviewed.

The information written on the roadmap are more of a general approach to how Volvo GTO can optimize their future work and research towards their sustainability goals.

As mentioned in the method chapter, all roadmaps consist of Drivers, Opportunities and Enablers. Also a vision on the side, which shows the goals. In the middle for example we have "Future Plans" which later leads to "Transport changes" in the short term and which then leads to other factors. Many of these factors have been described in part below. We can see in Figure 4.1 that this particular roadmap for the company generally contains lots of steps. Also have many challenges in a short period of time.

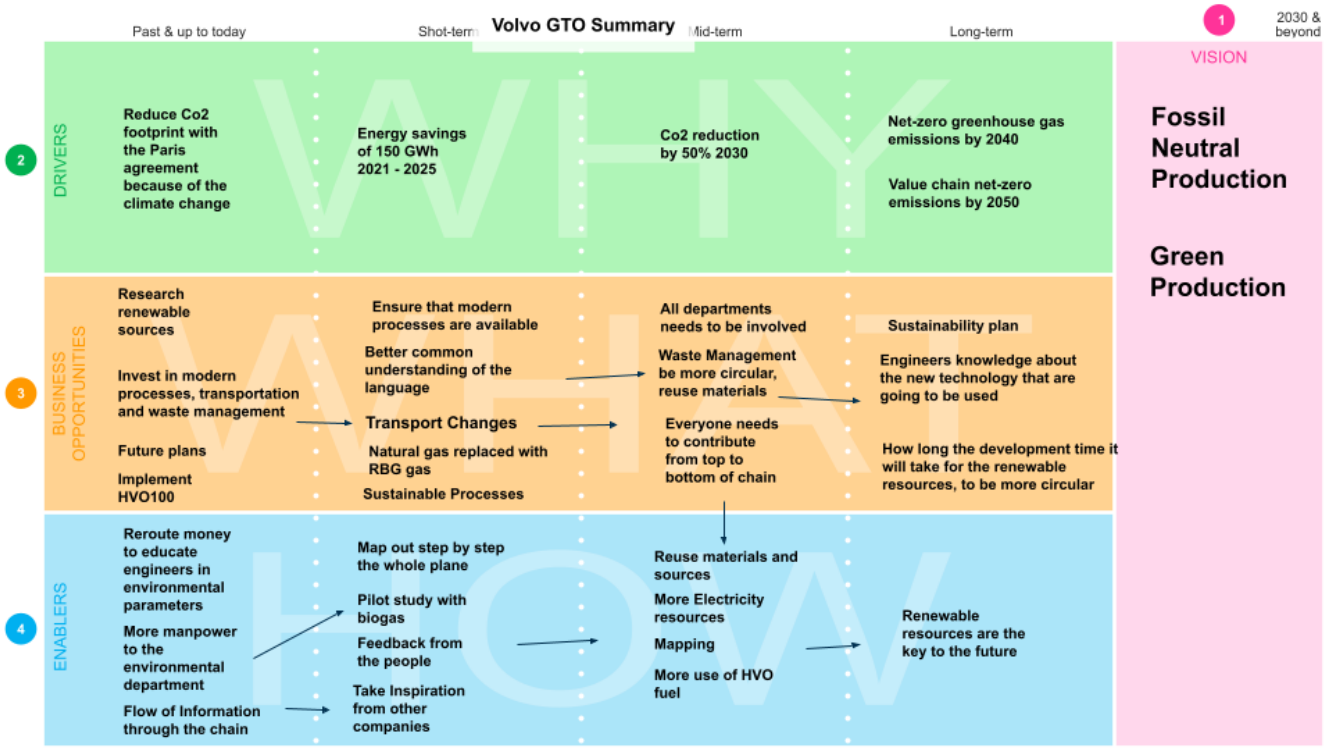

Figure 4.6: Roadmap Volvo Group Trucks Operations

Investments: Ensure that modern processes are available. They require large investments, quite important to look at where to put resources in the form of to get the best effect for customers. Engineers are needed to look at current technology, optimize processes and transportation. They are operators who can see quite clearly

how much waste there is.

Management: Leaders in each team must push the issue of sustainability from top to bottom, everyone must be involved and everyone must be given a chance to pull their weight. If everyone helps with what they can, you will go much further and it will go all the way down to operator level as they can have more nuanced details at the plan level that people higher up in the chain may not see.

Resources: Solar panels, wind power, hydropower, green electricity everything that has renewable energy is prio 1, you want to replace with resources that can be reused, find compensation for biofuel, invest in rbg gas. Natural gas must be replaced for factories that use it. What fuels we use, what we procure, what requirements we have for suppliers.

Renewable Fuel: HV0100 is a renewable diesel, Volvo Trucks can use this renewable diesel to tank the Trucks with. More research about renewable fuels is needed for a better solutions to the fossil-free production.

Processes: Make sure that the liquids you have that run the machines are 100 % fossil-free as you are unsure of where they come from.

Purchasing: Buying materials locally is better instead of buying from other countries, which can lead to much environmental impact. Due to transports of materials and resources into the country and to all factories and offices.

Mapping: Make a really detailed plan step by step that is universal for Volvo and everyone can follow and work together towards each goal, as it can be very messy otherwise a lot of time and money can possibly be wasted.

Language: An official dictionary, so to speak, can be a very good thing to create as it simplifies communication a lot when it comes to internal and external discussions with people. A simple word like “Waste” for example has been shown to have two completely different meanings for the workers and employees in the company.

Take Inspiration from other companies: All large companies work in different ways. All this can result into something good like extracting some good ideas when it comes to working towards fossil-free production and what challenges the other companies struggled thru.

Economic Infrastructure: The energy that is used and overall the transports that have an impact on the environment. The company needs to find a more environmental friendly way of their economic infrastructure.

Green: With green production we talk about a sustainable production, fossil-free, reducing energy consumption as much as possible, be as circular as possible in the company. Mainly with which fuels are used, where the company procures and what

requirements there are for the suppliers for Volvo Trucks.

Recycling: When it comes to recycling, there is always something to do, Expert I. mentions. Volvo trucks in Skövde, for example, recycle the sand used in the foundry, up to 90 % is recycled. Expert i also mentions that road maps are being made towards 2050 for waste management.

Departments: All departments must come into the same mindset as the environmental department, the whole chain needs to help as Expert C mentions in one of the interviews.

Long-term: In the long term we are talking about electricity, we must have a plan that is stable with time, all industries need to know what is coming, they require engineers time and development constantly. There must be a long-term perspective that needs to be applied in the work.

4.2 Summary of the Interviews

Here comes the combined answers and results we have gotten from the interviews for each question written out in a more full capacity.

4.2.1 Fossil-Free

1. How would you define Fossil-free production?
The consensus for how people would define fossil free production was that of course the oblivious answer is the use of fossil free fuels such as bio diesel, electricity, district heating. But also more importantly that they should be renewable sources optimally and that is the vision which people want. What that means is that just because we have found an alternative to fossil fuels such as bio diesel, electricity, district heating we should still be striving more for an alternative that not only can replace it but also be reusable after its use.

2. What do you see as the major keys we can focus upon when it comes to fossil free production?
The consensus here is that people need to invest more time in technical solutions and getting the whole chain to work fossil free that is from the design of the products to the management of the product at the end of the chain. Find out what the biggest losses are in terms of fossil fuels and minimizing them/ cutting them off.

3. How can we entice more people to work towards Fossil free production?
Here the general answer is that more people do not need to be enticed to work towards fossil free production in the matter of the information being out there and people knowing of it especially in the young community. The young public is really into keeping the world a healthy place and in a way demands change or the company will slowly fade out but what they would want more of is more staff power in these

small departments that niche into environmental work also for the whole company in every department to have management drive the issue of the change.

4. What type of resources are good to use for achieving fossil free production?

Here we have solar panels, wind plants, water plants, green electricity, district heating, biodiesel, renewable biodiesel, biobased coks, Bio gas, renewable fuels. But not only is the resources important and what needs to be swapped out but also the infrastructure, equipment and such. Also the companies and the people that work outside the company, how do they think about fossil fuels and how do they strive to achieve a fossil free environment.

5. What environmentally friendly fuels are there?
HVO100 gas and other types of Biogas. For exmaple Liquid Biogas (LBG), where the biogas is first purified from carbon dioxide and later the gas is condensed to a liquid form by cooling down.

6. What does green production mean to you?
Green production is sort of a dilemma. There is no perfect production where everything is green but it is a constant way of thinking, weighing different options and making conscious decisions to protect the planet. It is fossil free, sustainable, minimizing energy consumption and as much a circular process as possible from start to end.

7. What are the biggest challenges we seek when it comes to achieving fossil free production in Volvo Trucks?
Different processes which emit carbon dioxide, creating a good plan for each step that needs to be taken so that people are not all over the place. The sustainability benefit at a cost is a challenge, in volvo you want a short payback period. to switch from gasol to biogas, requires a cost. What should our business model look like? Infrastructure in some countries requires change. Also time is a problem, a lot of time is needed to put in these challenges.

4.2.2 Sustainability

8. What is a simple definition for sustainability?
Environmental, social and economic sustainability, focuses on the environmental parts and the economy automatically enters. Resources and the like must be sustainable for the workers as well. Those who work in the company are a huge resource. Producing a product in a green factory 100 % recycling is also a good expression of good sustainability.

9. What energy resources are you using today?
Under sustainability section Electricity, cocs, gasol, biodiesel, bio gas, green district heating, water plants, natural gas.

For vehicles that run outdoors on the farm in the Umeå factory, they use HVO fuel. The HVO that is purchased has received documentation that it is renewable and also sustainably produced. There is HVO which is made from palm oil. The LPG has started a purchase to find suppliers of biopropane. Hopefully, the Volvo Trucks department in Umeå will replace the LPG with biopropane by the autumn of 2021. A renewable district heating is also being sought, which is an engineer's job. A certain amount of oil is used when it's cold outside which does not count as renewable and this becomes a problem.

10. How do the materials you are using today and the ones you want to use in the future compare in sustainability?

The liquids being used for different processes is not sustainable and this includes many of Volvo Trucks factories in Sweden. The smelting process itself has a great impact, if you remove it, almost 70 % of everything is solved, mentions Expert I from the Skövde factory. A complete life cycle analysis of the cabins. perhaps the steel, or the LPG in the painting in the ovens. We have to work with all the parts of the processes. focuses a lot on what happens inside the factory and the energy we buy. A large part of the materials used today have no qualifications of the grant that it provides mentions Expert I.

The cabins must be 100 % recyclable. If a truck cab is scrapped, it is recycled again. Which leads to a good life cycle on the cab that is good for the durability that Expert H mentions in his interview.

11. How do you think your factories are located right now and are they good locations for future expansions or renewable sources?

The general consensus here seems that nearly all the plants are in good locations except Umeå which is an environmental load. For example the hut is produced there and then sent to Tuve also the location is not good for future sources. Problem is it is needed there because of the amount of jobs it has for the people in the community. Also a concern is to buy material locally or from nearby countries instead of internationally as it is a big environmental load even though it is cheaper.

12. In the national geographic Before The Flood Elon Musk talks about how these "Gigafactories" can help accelerate us to a future with sustainable energy.This is an extremely complex process and would require tons of different processes but it is more affordable and better for sustainability according to his calculations and predictions. What do you think about "Gigafactories"?
In terms of competence Volvo does not need to be able to do everything. There are alot of distributors that exist which can help but people still tend to agree a little bit in the way of thinking even if not going all the way to extreme like Elon, the interviews could see small plants being next to each other or small villages being built with factories and so on.

4.2.3 Optimization

13. Which terms do you feel can be improved, added or removed to be able to optimize the workflow when communicating about sustainability?
The consensus here is that yes it is considerably easier to work and get closer to the goal if there was more of a broad understanding not only for the world but in the company of what certain terms mean. It is extremely important to conduct such a list.

14. Do you have information of another country, company or project wanting to achieve this goal that we can extract some ideas from?
Ikea, Tesla are just a few of companies that have been doing very well in this regard and companies that Volvo can use to see what they are doing.

15. If we link finances and waste management in recycling how does this help fossil free production and if so how can this be accomplished?
The customers of our consumables take care of it in the right way to create circularity. If you work with the entire value chain, you must have clearer guidelines of what resources you buy in, you do not really have a holistic view all the way, composite packaging that is difficult to sort with easier to buy, a lot of scrap on every ton of steel you buy, efficiency must be increased, money saved, etc. large investment for the whole process must be changed, a different technology must be applied. Must be sure that the technology works, you can not take a chance, you will live with this equipment for 20-30 years for example.

Waste management is important to keep the green life cycle, waste of resources should not be done, therefore Volvo works to minimize this. Nowadays, it is much less plastic due to the fact that the assembly was completed in 2015 in Umeå and moved to the Tuve factory instead, says Expert H.

4.2.4 Investments

16. Can economic development also be sustainable in the event of going fossil free, if so how?
Biogas is cheaper than gasol. The sustainability challenge is that large projects are required. If we do not do it we will not achieve our goals. It is very prioritized, and this may cost a little. It is always more expensive with new technology that is not tested. Infrastructure is very important when it comes to biogas.

Expert G mentions that in recent years it has been realized that one should keep up with the environment as well. It may have to cost a little money to switch. But there is a gap from that level to the factory level, the factory must also manage its finances and keep a stable budget. Customers will fade away slowly if we are not keeping up with the environmental goals so at the end it will not matter anyway.

Environmentally friendly transport solutions are what the people want. There are

requirements within the EU for Volvo Trucks to be much more environmentally efficient. Become as green as you can be, 30 % less emissions by 2025 and 50 % by 2030 less carbon dioxide emissions. It will cost to come up with the solutions. Factory level need to carry a business case. New Laws are coming and it is time to plan.

17. In which areas do you think we as a people should focus our time on and prioritize to get the most valuable information working towards fossil-free production?
Employees should focus on law regulations and making the team leaders responsible and presenting the different information. The whole area must work towards fossil-free production, mentions Expert B from the Lundby factory. One must continue to discuss this kind of production and make it greener. Continuing education and providing information to staff and workers can also be an important factor. External specialists need to be involved.

18. What Environmental Gains do we get from recycling and how does that transfer to getting closer to carbon neutral production?
The end goal is to be fully circular so waste management is something Volvo GTO has to be responsible for. The more you recycle the more money you also get beyond the renewable material and fuel you get.

5

Discussion

Below is a discussion of how Volvo Group Trucks Operations could become fossil-free, what one adjustment in their activities could have an effect on the outside world and finally what shortcomings the work has had and what can be done about it upcoming work and investigations. The goal with the project was to get a knowledge about how it would be if Volvo Group Trucks Operations wanted to become fossil free. During the project, we found solutions, challenges and also examples of what it would be like for the company to achieve fossil-free production. SWOT analysis have been chosen to do and describe our limitations at last in the discussion chapter.

5.1 SWOT analysis

A SWOT model / analysis describes the strengths, weaknesses, opportunities and finally the risks. The analysis is used to be able to answer the question of whether a company is capable of these market opportunities and the challenges it expects in the future. It is a good tool to use to be able to measure internal strengths and weaknesses, as well as external opportunities and threats.

5.1.1 Strengths

One of Volvo Group Trucks Operations strengths is its position as a world-leading manufacturer and its strong presence giving them lots of leverage to change the industry. This role of leadership is a strength and a opportunity. What drives Volvo trucks is their constant improvement work. The company creates an arrangement with the staff that everyone feels that they know what to do. Another of the strengths of the factory in Tuve, for example, is that they get their heat from different types of district heating systems. Volvo Group Trucks Operations is improving there factories around Sweden very well and is constantly researching.

The economy behind Volvo GTO is also a very big strength as capital is always needed for big investments and big investments will surely be needed to confront such a change in manufacturing, everything from research, development, sources and manpower

5.1.2 Weaknesses

Like all companies in the world, you have your strengths and weaknesses in your development. At Volvo GTO, you need a short payback period, which later challenges the sustainability benefits at a cost. For example, switching from gas to bio gas requires a cost. What should Volvo GTO business model look like?

Infrastructure in some countries also differs. The different laws and policy's so Volvo having a lot of places around the world makes it significantly harder also for them as this requires more to tackle than the ordinary business
It is always more expensive with new technology that has not yet been tried. It takes a lot of time and knowledge to drive towards a fossil-free production. It will cost the company, but with good planning and good finances you can tackle the challenges with ambition and commitment.

Above all, communication and communication of the vision is extremely important, from the management's point of view. It should be possible to communicate very clearly what you want for 2030 for Europe's goals for example, as communication will be very important. It must sit in the backbone of everyone who works at Volvo Group Trucks Operations. Given that Volvo Trucks is international, it is important to be able to understand each other and be able to work together in the future.

The transports from the suppliers to the company can have a lot of emissions and a bad impact on the environment. Volvo must constantly improve its transport methods and the choice of fuel for these. Lots of material from vehicles that Volvo GTO receives requires several transports. You have to have the whole perspective.

5.1.3 Opportunities

There are several opportunities for the company to solve their fossil problems. Bio gas, for example, is cheaper than LPG, it is important to always think about the infrastructure when it comes to bio gas. The greatest effect comes from energy types, the amount of energy that is consumed should be kept under control. If the energy does not need to be used, the fossil-free energy can be used elsewhere. If there is a clarification, then this will result in a common perception of what things mean. For example, metrics to get to the key figures.

It is not feasible for Volvo Trucks to immediately stop extracting and using fossil fuels. The global economy, human health and livelihoods currently depend heavily on oil, coal and gas. But over time, the company need to displace fossil fuels with low-carbon renewable energy sources and more changes.

5.1.4 Threats

One threat is the large energy consumption of some factories that comes from the furnaces, which use propane. This must be replaced by something sustainable in

the future. Research and inspiration are needed in this case. The many different types of oil that are not sustainable today are used constantly.

The sustainability challenge is that large projects are required. This costs and is a threat to the economy if the problems are not resolved in time. Much focus should be placed on CO2 levels to make it neutral, so that it results in 0 CO2 emissions. All types of consumption should be mapped more, CO2 emissions are pretty straight forward right now, it is a defined metric that people know, but there are more factors and focus on. Other threats that may exist are global warming, all the rubbish that ends up in the sea, chemical products that do not trade under CO2 and more. It affects so many layers or nature's ability to multiply, due to chemical products.

A big challenge is the economy, both Volvo Group Trucks Operations and them locally. Locally, time is a difficult factor, to have the resources to work with these issues. Another challenge is that things may not move so fast and can lead to a threat to development.

5.2 Limitations

The limitations for this work were working regional within Sweden. Volvo has many operations and sites worldwide but this work had to be limited to certain sites within Sweden to fit within the time frame we had. The sites chosen to work with came from Volvo GTO themselves, the reasoning being they best represent the different manufacturing process that is currently ongoing and more information can be extracted from these and taken advantage of elsewhere.

The work contributed to a better understanding of Volvo GTO's problems regarding how to achieve fossil-free production. With incredibly good information and with the help of research interviews, they got the tools and tools they needed to secure these roadmaps to contribute with a kind of future plan.

To complete this work, help is needed from everything and everyone. The entire production chain, suppliers, the politicians themselves and more must work together and work together to make this possible.

6
Conclusion

This section presents the conclusion that ties the knot around how the study achieves its purpose. Furthermore, proposals are presented that are interesting to carry out for future work.

Based on the research and answers from experts it is very much possible to achieve fossil-free production but it is no easy task. Some of the biggest flaws are not in technology or research in what we know, the bigger flaws are in how the structure and information flows through a corporation. It seems that everybody sits on bits and pieces of information which can sum up to a big picture of what needs to done and this we got confirmed from the interviews as well where experts say that this needs to more in the forefront and all management needs to engage their groups and pull out every last bit of possible help from the employees. The resources to research more about and resources to use and investments to make in technology to go forward in this a lot of them are known. People know in their specific expertise what to do here and here, a way needs to be found to make communication clearer and take action.

What can be done further is expanding this work through Europe or worldwide, to continue this work of interviewing different plants and researching about them to find better and more detailed road maps for all. Also going through the road maps and text to find out the different priorities and what is thought to be the most important to maybe focus on now and start with that.

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