The Expansion of Renewable Energy Production in Two Swedish Municipalities

Multiple Case Study of Renewable Energy Integration in Planning Documents

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Abstract

With a growing world population, changing climate, and a greater reliance on electricity, global energy consumption is expected to continue to increase. Solar and wind energy are good options as they are renewable, safe and do not contribute to a lot of emissions as other energy sources. As both energy sources are growing in capacity, it is necessary that they are properly integrated in the planning processes, which should be reflected in the planning documents of municipalities.

The aim of this thesis was to examine and compare how the municipalities of Linköping and Örebro integrate wind and solar energy into their planning documents. Additionally, to study the role of external actors and identify possible obstacles for the expansion of renewable energy production in the municipalities.

The documents from both municipalities revealed that both municipalities integrate renewable energy through specific goals and plans for wind and solar energy. Linköping focuses on becoming a leader in solar energy production, while Örebro faces fewer obstacles in expanding both wind and solar energy. Both municipalities also work with energy companies and collaborate with various actors to achieve renewable energy goals, as the companies contribute with knowledge, finances, and innovation. The main challenges identified include prohibited areas designated by the armed forces, possible opposition from local communities, and long application processes.

Although the research questions were responded to, the potential outcome of this thesis is recognised to have been enhanced and produced more substantial results and contributions, if a more comprehensive method approach was taken.

Key words: Renewable Energy, Municipal Planning, Planning Processes
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Göteborg in May 2023

Zein Anani
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1. Introduction

With a growing world population, changing climate, and a greater reliance on electricity, global energy consumption is expected to continue to increase (Kamarulzaman et al., 2020). As global energy demand increases and electricity consumption is mostly concentrated in cities, the integration and growth of solar and wind energy to provide local energy sources becomes important to counteract past energy patterns that have led to increased carbon emissions and to meet climate targets. Solar and wind energy are good options as they are renewable, safe and do not contribute to as much emissions as other energy sources (Birging & Lindberg, 2019, Formolli, Lobaccaro & Kanters, 2021, Kamarulzaman, Hasanuzzaman & Rahim, 2020, Hagen Koch & Matthias Büchner, 2016, Cherp et al., 2021). Although solar energy has the potential to supply the entire planet with electricity, it is difficult to transport and store this energy, which makes it important that it is locally produced and has a short distance to the electrical grid (Kamarulzaman, Hasanuzzaman & Rahim, 2020). While solar energy is on the rise, it accounts for approximately one per cent of the energy produced in Sweden, wind energy accounts for 17%, making it a more established energy source. As both energy sources are growing in capacity (SCB, 2021, Swedish Energy Agency, 2022a), it is integral to their growth that they are properly integrated in the planning processes, which should be reflected in the planning documents of municipalities.

1.1. Problem Statement

As a result of the EU Directive promoting renewable energy sources, the Swedish Parliament has set a goal of achieving 100% renewable energy in the country by the year 2040 (Sveriges miljömål, 2022; Swedish Energy Agency, 2018). The Swedish Energy Agency expects both wind and solar energy to grow, with solar energy accounting for 5-10% of renewable energy produced by the year 2040 (Prop. 2017/18:228). Currently, hydroelectric, nuclear, and wind energy are the primary sources of electricity in Sweden. Solar energy accounts for only 1% of total electricity production, whereas wind energy accounts for 17%, making it the country's third largest source of energy production.

The majority of solar energy is also generated by small-scale or privately owned solar cells, such as those found on house roofs. In recent years, advancements in wind energy technology have enabled more production in colder climates and forests, allowing wind energy to become more established in northern Sweden (Swedish Energy Agency, 2022b). Wind energy and solar energy are both estimated to be the cheapest options for meeting Europe's future energy needs, with solar energy having the lowest production cost (Swedish Energy Agency, 2020; SCB, 2021).

A local source of electricity can also be useful in dealing with various threats to global energy supplies, such as wars, pandemics, and other phenomena. As a result, solar energy becomes important from a societal standpoint, and it will be critical to incorporate it into future city planning processes (Hernesniemi, 2022; Lingfors, Åberg, & Widén, 2019). Solar energy is also expected to grow as more efficient methods for capturing solar energy become available. To meet the environmental objectives, it will be necessary to assess the potential of solar energy in order to better plan for it (Hernesniemi, 2022; Lingfors, Åberg, & Widén, 2019). Some municipalities in Sweden have begun to plan for a more solar-powered future.

Though there are no clear guidelines to follow for how to do it, unlike wind power, which can be viewed as more established because wind farm plans and regulations for wind energy...
expansion are more prevalent, solar power has grown in demand and scale in recent years. This highlights the absence of similar documents and proper planning (Eriksson, 2014).

Municipalities play an important role in renewable energy transition and development. In instances where a municipality owns land or property that can be utilized for wind farms or solar parks, it becomes involved in the administration of these areas. The municipality will also be in charge of responding to potential stakeholders interested in land for renewable energy production. They will also be in charge of informing the public about renewable energy issues in order to reduce emissions, as well as forming partnerships and networking with actors and stakeholders in the energy sector (Westling, 2018). Actors can include different municipal and private energy companies, actors who work in forestry and agriculture, amongst others. Through their strategic documents, the municipality is also responsible for providing advice on energy and climate issues, as well as contributing to the achievement of global, EU, and national environmental goals (Energimyndigheten, 2015, Walston et al., 2022, Malafry, 2021). One way to maximize the potential of solar energy production is to position it on large areas of land such as agricultural, farmland, or arable land (Hernesniemi, 2022). Solar energy on a large scale, also known as utility-scale, produces more energy. Despite the fact that many large land areas, such as agricultural land, have a high national interest value in Sweden. While wind energy is allowed on these types of lands, there are laws and regulations in place to protect amongst other things environmental and cultural values. This creates conflicts between prioritizing solar and wind energy production and meeting future energy consumption needs while also ensuring other national interests (Öhlund et al., 2020).

There are several studies looking into solar energy production and how it can be integrated into urban planning. However, many studies focus on the technical aspects and how to optimise the benefits of renewable energy production and on identifying the best potential locations (Birging & Lindberg, 2019). Similar studies have also been conducted in other parts of the world to investigate the integration of solar energy into urban planning. Because solar energy has only recently gained importance and relevance, it will become increasingly important to study its integration in the same way that wind power has been studied as it continues to be a growing energy source. Furthermore, because renewable energy production can be viewed as a global issue, it will be beneficial to develop an understanding of the various interests that arise (Birging & Lindberg, 2019, Saikku et al., 2017, Batel et al., 2015).

To examine possible conflicts and lessons for the probable expansion of fast-growing energy sources, comparing how municipalities include wind and solar energy in their planning documents, can be beneficial (Nilsen Carman, 2020; Andrew-Speed et al., 2015; Avila, 2018).
1.2. Aim and Objectives

The aim of this thesis is to investigate and compare how the Swedish municipalities Linköping and Örebro integrate wind and solar energy into their planning documents, as well as look into the role of external actors and stakeholders, such as private energy companies, in the expansion of renewable energy production in municipalities. This aims to provide an overview of current planning practices in the municipalities and generate an understanding of what lessons can be learned for the impending future expansion of renewable energy.

1.3. Research Questions

To help achieve this, the following research questions will be addressed:

1) How do the planning documents of the chosen municipalities reflect their objectives for the expansion of wind and solar energy, and do the documents differ in their approach between wind and solar energy?

2) What role do actors outside of the municipalities play in the expansion of renewable energy, and what effects do they have on the development of renewable energy projects?

3) What are the main challenges expressed in the planning documents by the chosen municipalities for expanding in renewable energy, and what are the possible strategies proposed to overcome them?

1.4. Delimitations and Choice of Case Study

In order to study and compare how municipalities include renewable energy in their planning documents, two municipalities have been selected. The selection of a case can be determined by several factors. The personal interest of the author can play a role in the choice for instance. That is why the chosen municipalities are in Sweden, where I am familiar with the political system, as well as the language of the documents, making the research easier.

To determine the choice of municipalities, the decision was made by finding municipalities that have established planning documents that include the relevant topics, mainly discussing renewable energy, specifically solar and wind energy individually. This was relevant as there are more established regulations on wind energy compared to solar energy. It was also important for the municipality to have some kind of plan or study made for the potential of wind power. Although there are plans for it, not a lot of municipalities have finished plans for solar energy yet, which also made it an important factor. The cases chosen for this study ended up being the municipalities of Linköping and Örebro. These were one of the few municipalities which had the resources and priority of creating separate studies and planning documents for wind and solar energy. They are also comparable in size, population size, geographical location, and climate (SCB, n.d.).

1.5. Relevance

This thesis can hopefully contribute to helping guide future planning through insights into municipal approaches for renewable energy. It could also identify potential barriers and opportunities in how renewable energy is currently included in planning documents (Maleki-Dizaji et al., 2020, Farthing, 2016; Gomez & Jones, 2010; Yin, 2009).
2. Literature Review and Context

This section will provide an overview to give context and an understanding of existing literature and relevant background information regarding the topics discussed in this thesis.

2.1. Wind Energy

Wind energy has been one of the fastest growing energy source in Sweden in recent years and produces 17% of the national production of energy. It is produced all over the country as there are good prerequisites for wind (Hartmann & Ros, 2022). It is expected to play an important part in the country’s future transition to a completely renewable energy system by the year 2040. Most common is land-based wind energy production, although offshore is gaining in popularity (Rigole, 2018). Most municipalities have produced wind power planning documents, usually as thematic supplements to the general wind power plan. This occurred around the year 2010, when grants for wind power planning were available from the Swedish National Board of Housing, Building, and Planning (Östergötland län, 2016). It has been established through multiple sources, including Szarka (2007), that it is through policy support on a national level that growth and expansion of renewable energy sources is beneficial.

Since the 1970s, a lot of development has happened in the technology for wind energy production. Wind turbines are much larger and produce a lot more energy than they used to and are much more effective with a longer life span than previously. Due to them becoming larger, this has also caused bigger issues with the wind turbines emitting audible sounds that can be disturbing for humans and wildlife (Marshall et al., 2023; Tegnhammar & Johansson, 2012).

Beside the fact that Swedish municipalities have a monopoly in adopting land use plans according to 1 ch. 2 § in the Planning and Building Act (SFS 2010:900), they also have a municipal right to veto plans for wind energy as a way of preserving the idea of local self-governance. This makes it possible on a municipal level to manage wind energy production (Westander et al., 2022; Ståhl, 2018). Municipalities do not have the same power over other energy sources, which can be questioned considering the transition towards a larger share of renewable energy that includes other resources than wind energy (Motion 2020/21:388). The Swedish Armed Forces also have a right to stop possibly planned wind farms if they are in too close of a vicinity to their training areas (Wizelius, 2016). The armed forces have a very strict control and prioritisation over the areas surrounding their training facilities, which has led to many projects, both for solar and wind energy being denied their applications due to this (Masson et al., 2014).

The Swedish Civil Contingencies Agency, and the Swedish Transport Administration also need to be contacted when planning for new wind power projects, as there are restrictions that the municipality could be unaware of. It is then the municipality that receives applications for permits for wind power projects. Both the Planning and Building Act and the Environmental Code are applicable in those instances (Wizelius, 2016).

2.2. Solar Energy

The sun is an important source of renewable energy. This energy can be harnessed by conserving it in the form of electricity but also as heat. It is harnessed through solar cells, which can be attached through solar panels on different surfaces including rooftops, building facades, integrated into glass and more. The technology used for solar cells is called photovoltaics (PV) (Jäger-Waldau et al., 2020; Mussard, 2017). The Swedish Energy Agency is aiming for 5-10%
of the renewable energy produced in Sweden by the year 2040 to be solar energy (Prop. 2017/18:228). At present, the electricity produced in Sweden comes mainly from hydropower, nuclear power and wind power. Solar energy accounts for only 1% of electricity production. Both wind power and solar energy are estimated to be the cheapest options for powering future energy needs in Europe, with solar PV energy having the lowest production costs (Swedish Energy Agency 2020, SCB, 2021). Solar energy is expected to increase with the development of methods that can capture solar energy more efficiently. The technology and interest is on the rise and even more so for larger installations that can be located on roofs or on land that is connected to the power grid (Swedish Energy Agency, 2020; Swedish Energy Agency, 2016). Therefore, in order to achieve the targets, it will be important to assess the potential of solar energy in order to better plan for it (Hernesniemi, 2022, Lingfors, Åberg & Widén, 2019). Solar PV connected to the grid itself is a small share of the solar energy produced, although it is on the rise (Swedish Energy Agency, 2016). Off-grid solar energy also has a stable market, largely found in summer cottages, caravans, and the like (IEA, 2020).

Solar energy is also an important part of the transition towards a 100% renewable energy system. Although it cannot be the sole source of energy due to weather and other conditions, it could contribute to sustainable energy sources. In part due to the fast-evolving technology of solar cells that can work in colder climates. Similar to wind energy, in the case of solar energy, it is emphasized that political support is necessary for its expansion as a reliable energy source on a larger scale. There is untapped potential that is not being fully utilized due to the lack of political backing. The easiest approach expressed for addressing this, is by integrating solar cells on existing buildings and roofs (Statens energimyndighet, 2016, Motion 2020/21:388). It is estimated that solar energy could be responsible for 5 – 10% of the national energy use in the country by the year 2040. Compared to the current production rate of one per cent, there is a long way to go. Unlike wind energy, there have not been any national plans for solar cells and solar energy production for a long time, which has prevented the expansion and the ambitions to expand (Statens energimyndighet, 2016).

Solar energy has been viewed as a good option to meet future energy needs as it is renewable, safe and does not contribute to much emissions (Birging & Lindberg, 2019, Formolli, Lobaccaro & Kanters, 2021, Kamarulzaman, Hasanuzzaman & Rahim, 2020). Although solar energy has the potential to supply the entire planet with electricity, it is difficult to transport and store this energy, which makes it important that it is locally produced and has a short distance to the power grid (Kamarulzaman, Hasanuzzaman & Rahim, 2020). The longer the distance between the production of solar energy and the consumer, the greater the transmission losses. This means that energy losses will occur along the way, and in turn increases transmission costs (Wideberg, 2019). Moreover, the capacity of the electricity grid to receive solar energy varies depending on the voltage levels of different wires. And the larger the solar energy production facilities are, the more energy will be produced (Birging & Lindberg, 2019).

2.3. Agrivoltaics and Alternative Use

According to Zainol Abidin et al. (2021), Curtis et al. (2020), and Toledo and Scognamiglio (2021), combined solar energy with agriculture, so-called agrivoltaic farming, is an example of a method used where crops are grown under solar panels in a symbiosis without affecting crop yields. This has reportedly been tested in various locations in the US, Europe, and elsewhere. It is viewed as a good option for densely populated cities that need to accommodate population growth with food security from agriculture, while meeting the need for sustainable and renewable energy production. The solar panels also benefit the biodiversity, while the land can still be cultivated (Zainol Abidin et al., 2021; Curtis et al., 2020; Toledo & Scognamiglio, 2021).
It is also possible to introduce a multifunctional use of solar energy with pasture, where grazing animals help to manage the land around the solar panels, according to the Swedish Energy Agency (2019). It is also possible to combine solar and wind energy in so-called hybrid parks. In the Netherlands, for instance, solar and wind energy have been combined with a battery storage system (Vrielmann, 2021). Peatland is also an alternative to using agricultural land, which has been tried in Finland (Hernesniemi, 2022). Other places have utilized surfaces on water by creating floating solar parks. In Portugal, Europe's largest floating solar park is located in Alqueva, on the surface of an artificial pond, with 12,000 solar panels, supplying the region with over 30% of its energy needs (Figure 8). In China, there is also a floating solar park located on a pond over a disused coal mine. The advantage of floating solar farms is that they do not take up land space and can counteract evaporation of water when placed in reservoirs for drinking or irrigation water. If the water is artificial this also eliminates the risks for natural habitats or animals being affected, as presented by Campbell (2022) and McCarthy (2017).

2.4. Environmental Impacts and Other Considerations

Wind turbines have some negative effects on the environment, mainly revolving around the disposal of inoperative or retired wind turbines and their possibility to be recycled. As modern wind turbines can be very large, they may also visually affect the landscape. A small number of wind turbines have caught fire, and some have leaked lubricating fluids, though these occurrences are rare. Wind turbine blades can also produce noise which can be distressing for people who live or work in the vicinity. Birds and bats can also be injured or killed if they are hit by turbine blades (Walston et al, 2022, Peschel et al, 2019 & Chock et al, 2021 in Råberg et al, 2021).

Compared to other renewable energy resources, solar energy does not have the same environmental impact. For example, there is not the same possibility of noise as with wind power, nor the same problems for birds and bats as solar panels do not have the moving parts that wind power has (Hernesniemi, 2022). However, solar energy has the best efficiency on bright and clear days, which can clash with parts of the Nordic region in the winter when solar electricity production is comparatively low (Vattenfall, 2022).

The main environmental impact of solar cells comes from manufacturing them. From using materials such as metals and minerals that can have a negative environmental impact on the local area when extracted. Chemicals used during production, along with air and waterborne emissions, also occur during both production and recycling. There can also be an impact on land use when installing solar cells. Otherwise, solar energy is silent, free of emissions and greenhouse gases and has little impact on animals and nature. Methods are currently being developed to make the extraction of the materials less harmful, and researchers are also encouraging the introduction of stricter regulation for more reuse of materials in the production of solar cells (Håkansson, 2018; Tawalbeh et al., 2021; Naturskyddsföreningen, 2021 et al.). Research shows that a large amount of carbon emissions occurs during the life cycle of solar cells. The carbon footprint is generated from the manufacturing process, transportation and then during installation. It can also occur due to the maintenance and dismantling of the solar cells (Rahman et al. 2022).

As supported by a study conducted in Paris by Guoqing et al. (2021), solar cells offer several environmental benefits, including the potential to mitigate urban heat islands and create cooler areas on the ground surface (cool islands). Additionally, when it comes to roof-based PV
systems, they generally have a minimal impact on biodiversity and can even be advantageous, particularly when combined with green roofs (Gasparatos et al., 2017).

One of the key advantages of solar power is its ability to operate without emitting greenhouse gases. Furthermore, solar energy is a renewable and inexhaustible resource. Another advantage is that solar cells can be conveniently installed on existing surfaces like roofs, eliminating the need for additional space. This makes it possible to generate locally produced electricity on various scales. However, since electricity demand and production fluctuate, it can be challenging to achieve a perfect match. Therefore, solar energy needs to be integrated with other energy sources or the generated electricity must be stored (Vattenfall, 2022; Swedish Energy Agency, 2016; Wargert et al., 2018).

It is not yet common with land-based installations of solar cells, though agricultural land, among with other types of land are suitable for solar cells. That is since they benefit from flat, dry, and unshaded areas that are close to the electricity grid. That is why roofs and buildings can also be suitable. The areas where solar cells are installed can also benefit by enhancing biodiversity and restore vegetations depending on the previous land use. The installation of solar cells or solar energy parks can affect land areas and ecosystems negatively depending on the installation and the site. For instance, solar parks, like wind energy farms, can cause a negative impact on habitats and fragmentation between species. It is therefore discouraged to place solar parks in locations such as Natura 2000 sites (Lammerant et al., 2020, Blaydes et al., 2021).

Solutions that have been put forward to reduce the negative environmental impact of PV installation are to adapt the site for pollinators as it affects biodiversity in a broader perspective. This is especially true for unused agricultural land, which may be overcultivated and lacking in fertility and therefore initially low in biodiversity. Agricultural land that was previously intensively used and where solar parks are installed should benefit the biodiversity of plants such as herbs and grasses, while reducing the need for pesticides. There are a lot of benefits to the health of the soil in land-based solar energy parks, though not a lot of research has been done yet for it to be guaranteed (Blaydes et al., 2021; Montag et al., 2016 in Råberg et al., 2021, Tawalbeh et al., 2021, Hernesniemi, 2022).

An important aspect to consider is to place solar cells and wind turbines at a distance from nature reserves and active airports as it can create obstructive reflections and other deterrents (Hernesniemi, 2022). Another impact that can be caused by PV installations is its effect on defence and aviation equipment. This is because the technical parts of solar cells that optimize their electricity production can cause electromagnetic interference and can affect important radio communications. Wind turbines can affect aviation depending on their height. In addition, an unintended consequence of solar cells may be that the cables connected to the electricity grid can start acting as transmitting antennas. Mobile traffic can also be affected by the components of PV installations and wind turbines (Fors et al., 2020).

2.5. Sustainable Development Goals and Renewable Energy

As a way to achieve sustainable development, energy efficiency and a transition to renewable energy are included in several of the Sustainable development goals (SDGs). Solar and wind energy can be seen to touch upon several of the goals in one way or another. By connecting renewable energy to the SDGs and National environmental goals, this gives a wider context to how renewable energy is connected to a global issue. Renewable energy production such as through wind turbines and solar cells, can contribute to meeting environmental objectives at
various supranational, intergovernmental, and national administrative levels. On a global level, to provide energy to the world’s population, and with the global energy crisis and an increase in prices of natural gas and oil following recent world events, reliance on renewable and locally produced energy sources has become more important (IEA, 2022).

Among the SDGs is one relevant goal number 7, which seeks sustainable energy for all (Globala målen, 2022). By providing access to sustainable energy, this can also contribute to meeting other SDGs. Solar and wind energy also contribute to cheap and clean energy. It also touches on Goal number 11, which deals with sustainable cities and communities. Expanding renewable energy production is one way to reduce the environmental impact of cities (Walston et al, 2022). Goal 13 which deals with combating climate change can also be achieved through renewable energy sources (Globala målen, 2022).

2.5.1. Objectives at an EU level

According to the 2016 national Energy Policy Agreement (Prop. 2017/18:228), Sweden aimed to achieve 100% renewable electricity production by the year 2040. This is also in line with the EU’s Climate Change Act and the European Green Deal, which aims for climate neutrality in the EU by the year 2050. A European climate law was proposed by the Regulation of the European Parliament and of the Council in 2018 for carbon dioxide neutrality by 2050 in the EU which, among other things, expresses the requirement for a transformation of the energy system and the introduction of energy efficiency measures (Malafry, 2021; European Parliament, 2018).

Moreover, at an EU level, one of the priorities through the Green Deal is to meet the targets of the 2030 Agenda. With principles that include shifting to clean energy and ensuring a secure and affordable energy supply in the EU. Also prioritising energy efficiency, improving the energy performance of buildings, and developing a power sector based mainly on renewable energy sources (European Commission, 2022a). According to guidelines developed by the European Commission, these include reducing the EU’s dependence on imported energy by improving the efficiency and diversification of domestic electricity production. According to a directive on renewable energy, the EU also wants to promote national targets on renewable energy sources in different sectors. The EU aims to move energy flows from linear to a more integrated energy system where flows between different sectors and actors will circulate, thus becoming more sustainable and reducing losses in resources and energy (European Commission, 2022b).

2.5.2. Objectives of Swedish Energy Policy

In order to achieve the objectives decided at EU level, the energy policies on a national level reflects this. Swedish energy policy aims to contribute to efficient and sustainable energy use, a cost-effective Swedish energy supply with low negative impacts on health, the environment, and the climate, and to facilitate the transition to an ecologically sustainable society (Government Bill 2017/18:228). In 2009, the Swedish Parliament adopted new energy policy targets that required at least 50% of total energy use to consist of renewable energy by 2020. It also specified how many terawatt hours (TWh) of wind power that should be produced per year (Government Bill 2017/18:228). The Swedish Energy Agency has also proposed, among other things, an increase in solar power production (Swedish Energy Agency, 2016). The goal of the Swedish energy policy is to mirror the policies on EU level. In accordance with the EU Energy Summit, Sweden has set the goal of having 100% renewable electricity production by 2040. By 2030, energy use should be 50% more efficient than the reference year 2005 and energy should reflect GDP (Regeringskansliet, 2022; Government Bill 2017/18:228).
There has been an interest for clearer rules around energy policy by market actors. With this objective, this is estimated to contribute to a higher share of renewable electricity production and to encourage a greater willingness to invest. With rapid developments in solar energy technology, this also results in lower production costs. This, in turn, is expected to lead to an increase in the various types of renewable energy (Government Bill 2017/18:228).

Sweden's environmental goals also reflect those set at the global level in the SDG, of which limited climate impact is relevant, for example, where increasing the share of solar energy produced can help reduce greenhouse gas emissions. The goal of a good built environment may also be relevant as it can be linked to resource-efficient development where it becomes important to take solar energy into account already in the planning process as solar production touches on issues such as land and water use (Swedish Environmental Goals, n.d.).

2.6. Laws in the Environmental Code

The production of solar power differs between countries and even within the same country. For instance, agricultural land has been used for the purpose of solar energy production in some places. Although there are no restrictions on building large-scale solar PV systems on agricultural land in Nordic countries, it is less common (Hernesniemi, 2022). However, according to the Environmental code, renewable energy production is seen as important and can be installed on agricultural land, as long as it does not interfere with the larger social interest and that there are no other alternative lands to install it on (Miljöbalk 1998:808). Worth mentioning is that the Land and Environment Court of Appeal MÖD in 15064-21 and 1026-22 has set precedence in two cases recently where it was ruled against solar parks on arable agricultural land, as it was deemed more valuable and of higher priority to society than renewable energy production.

To install wind or solar energy farms, when it comes to a larger land area, the municipality and sometimes the county administrative board, get the final say. There is a process of different actors that need to be contacted to ensure. Actors can include different municipal and private energy companies, actors who work in forestry and agriculture, amongst others. If a private actor is interested in installing solar energy on an area of land, they need to contact the municipality who in turn look at the area to see if it is possible. For solar energy, most municipalities have created so-called solar maps to help the civic population as well as other actors find potential roofs to put solar cells on and how much energy would be produced on a particular roof. Maps of land-based solar energy are not prevalent, though plans of creating them have begun (Birging & Lindberg, 2019).

There are currently specifically designated areas of national interest for wind energy, but there is no special national interest for solar energy as of yet (Svensk solenergi, 2022). Though, even if there is a national interest, the national interest for the armed forces always outweighs all others (Masson et al., 2014). The construction of a large-scale solar park can affect the environment in various ways. According to the rules of consideration in Chapter 2 of the Environmental code, there is a responsibility to take precautionary measures to protect the environment and human health from damage or harm. The same applies to the site choice of energy production farms (SFS 2022:1272).
2.7. Planning Documents and Ownership

The PV market has until recently consisted of ownership of solar PV installations through traditional business models. In the case of rooftop solar, the owner is the same as the owner of the property. However, other business models have emerged with high requirements of the capacity of PV installations. In the future, it may become increasingly common to be able to purchase solar PV as a service, without having to own or install anything yourself (IEA, 2020).

Energy companies in Sweden have also started offering ready-made solar PV systems, targeting roofs of residential buildings. The energy companies collaborate with companies that in turn install the solar cells. There is also an option to lease solar cells. In addition, energy companies have started to offer the purchase of surplus electricity from micro-scale producers. There are also electricity companies that are actively working to create photovoltaic parks. However, large-scale solar production in the form of photovoltaic parks is not subsidised in Sweden, which has led to different business models being applied. These include co-owned solar parks and contracts for the purchase of electricity from solar cells (IEA, 2020). For businesses that want to use solar power to reduce their electricity consumption and energy costs, there are regulations that require this to be done through an immediate use of the energy produced, i.e. the electricity is used directly when and where it is produced, unless there is an alternative where it is possible to store the energy in batteries on site (Swedish Energy Agency, 2019b). This suggests that there should be more incentives to facilitate businesses wishing to resell their surplus electricity. Government regulations are more favourable for micro-scale producers than larger-scale solar production (Wargert et al., 2018).

Along with having comprehensive plans and other planning documents, municipalities also need to plan their energy use as well as the supply, and distribution of it (Energimyndigheten, 2022). As an effect of that, and a growing interest in renewable energy, some municipalities have also started making specific plans for wind and solar energy. The plan usually starts as part of the comprehensive plan, but can evolve into its own document, depending on the municipality and its resources and priorities. The plan should give guidance on the use of land and water areas in regard to wind or solar energy. It should also include suggested areas that are suitable, as well as unsuitable areas to place renewable energy. As well as inform on applicable laws and considerations for natural and cultural heritage values, amongst other things. It is also pertinent to highlight the importance of proximity of the energy park to the electricity grid, or else explore the possibilities of extending connections to the grid, which can be quite expensive. As solar energy is more novel as an energy source in Sweden, there has not yet been as many inclusions of it in the comprehensive plans. It is becoming more common to install utility-scale solar energy parks, as it is also more effective and economic to produce solar energy on a larger scale (Energimyndigheten et al., 2022). Yet it is not easy to find suitable areas for it and a lot of factors need to be accounted for, which can make it difficult for municipalities to include in their plans.

Municipalities are permitted to operate a business if it is non-profit and aims to provide public facilities or services to municipality members, according to the Municipalities Act. Municipalities are prohibited from operating speculative businesses under the rule (Göteborg Stad, 2023). A company that wants to develop a piece of land needs to contact the municipality to get a zoning plan in place. In some cases, the municipality wishes to develop an area that it owns but chooses to delegate development to third parties. In that case, the municipality may offer developers the opportunity to purchase properties in that area. Following that, the parties enter into a land allocation agreement, which gives developers the right to negotiate with the municipality to acquire properties subject to certain conditions (Boverket, 2015). Private actors
can through that become a part of the public sector when for instance wanting to purchase or rent land that is owned by a municipality (Douay, 2018). Stakeholder engagement is an important part of renewable energy expansion. The relationship stakeholders have to potential land, can be dependent on the opinion and engagement of the local citizens to the landscape (Colvin et al., 2016). Stakeholder engagement that is a part of the work of municipalities focus on two stakeholder groups: farmers and recreationalists, as these are two groups that have been voicing their opinions in the support or opposition to renewable energy in the past. systems (Denis, & Paul. (2009).

As there are potential conflicts between the different interests that are competing for land, including agriculture and forestry. In this conflict there can be a dispute in the hierarchy of what benefits society the most (Råberg et al., 2021). Locally produced renewable energy can be beneficial for governments for the decarbonization effects and cost advantages. It also reduces reliance on imported fossil fuel, leading to an increased energy security. It has been demonstrated that governments succeeding in the implementation of renewable energy systems that have also been well-met by the public, have focused on involving local communities and communicating with stakeholders and other relevant actors (Bues, 2022).

### 2.7.1. Renewable Energy in Local Planning Documents

There has been other research which explores how planning documents on a local level affects renewable energy. For instance, Blaszke et al. (2022) studied the characteristics of municipal planning documents in Poland that determine how renewable energy is carried out. The study found a correlation between planning activities in municipalities for renewable energy, and population size and density. Larger considerations in planning documents were found in higher urbanised areas where the population is bigger and denser. It was also determined that policies and municipal plans play an important role in integrating issues regarding land use and renewable energy (Blaszke et al., 2022). According to Blaszke et al. (2022), it is also necessary for further analysis in other countries to identify how best to implement renewable energy in planning documents. Similarly, Bazan-Krzywoszańska et al. (2018) studied how to implement renewable energy into strategic planning documents in a city in Poland. The study found that there was a lack of inclusion and research for renewable energy, particularly in urban areas, in the literature for cities in Eastern Europe. Bazan-Krzywoszańska et al. (2018) also determined that there is a necessity for planning documents to incorporate plans for renewable green energy. This was determined to optimize energy efficiency and power management in the city. This was also established to yield more investment in renewable energy and economically benefit the municipality and energy consumers (Bazan-Krzywoszańska et al., 2018). St. Denis and Parker (2009) also examined the role of renewable energy in municipal planning in Canada, finding that wind and solar energy were only recommended in one of the five large municipalities that were studied. Of the smaller municipalities studied, three of five suggested multiple renewable energy sources, showing that smaller and remote municipalities in Canada were more likely to introduce renewable energy systems in their planning documents (St. Denis & Parker, 2009).

Aligning with the sentiment of municipal planning documents being an important part of implementing municipal renewable energy policies, Petersen (2018) explored implementation challenges for renewable energy policies in 17 Danish municipalities. Establishing that to reach national renewable energy targets, policies are required at a local level. Although there were policies and plans for renewable energy found in the planning documents of the municipalities, there was difficulty in implementing and applying them (Petersen, 2018).
3. Theoretical Framework

This section will introduce the theoretical framework, which aims to connect the subject of the thesis with the different concepts presented.

3.1. Ecological Modernisation

Toke (2011, 2014) describes Ecological Modernisation (EM) as an approach used in the EU that aspires to harmonise economic growth while also protecting and improving the environment. It can according to Toke (2014) provide a framework for understanding renewable energy. It is claimed that EM is a way to protect the environment through utilising technology, and this in turn could lead to both the economy and the environment thriving. This views technological development as a way to solve environmental issues (Toke, 2014). As explained by Næss and Saglie in Davoudi et al. (2020), EM as a concept involves changes in both social and technological transitions in the planning process and this can have both positive and negative aspects when applied to urban planning. It can for instance lead to improved environmental sustainability by integrating renewable energy sources. It can also face challenges in terms of social equality depending on how certain groups may be affected by the changes through having less access to the benefits of renewable energy. They further argue that ecological modernisation has in recent years been integrated into environmental concerns and economic and social development (Davoudi et al., 2020).

Davoudi et al. (2020) claims that EM can through technological innovation help reduce negative effects on natural resources as the concept aims to produce more but with less resources, leading to economic growth separating from negative environmental impacts. By incorporating innovation in technology and new forms of administration with economic incentives, this is indicated to have benefits for the environment as well.

Toke (2011) discusses the concept of ecological modernisation by suggesting that economic growth and protecting the environment can both be accommodated by implementing technological innovation and improving efficiency. Renewable Energy technologies are described as essential for EM as it contributes to reducing carbon emissions and sustainable development. Toke (2011) suggests that through studying policies and planning practices, renewable energy can be analysed in how effectively it is promoted and integrated. The political and social dimensions of renewable energy are also discussed, along with the role of institutional frameworks for implementing renewable energy (Toke, 2011).

To study the subject of renewable energy through a lens of ecological modernisation, it can be relevant to examine how solar power and wind energy are being integrated into the development of the country and how they contribute to the purpose of environmental sustainability and what possible economic, social, and political factors drive it forward and what implications there are of the development of renewable energy sources on society and the environment. It will also be beneficial to consider the role of policy and regulation of the mentioned renewable energy sources in how they promote ecological modernization and how they potentially shape how wind and solar energy is integrated. Through EM it could also be possible explore collaboration between different actors and how EM pertains to renewable energy. By working with various actors it can be possible to create sustainable planning practices (Toke & Stracahan, 2006, Toke, 2014). By implementing this, this study can provide awareness of transitioning to renewable energy in Sweden and inform practice in that area.
As well as what role technological innovation has and how stakeholder engagement can play a role in the development of renewable energy. It is suggested that issues with planning for renewable energy can be managed through having more local ownership, and collaboration between stakeholders (Toke & Strachan, 2006). Stakeholders, as previously mentioned, can include private energy companies looking to, for instance, install a solar energy park.

Although there are positive aspects of EM, as it, according to Toke (2011), emphasizes the potential for environmental improvement while simultaneously benefiting economic growth, there is also criticism presented against the concept by Toke (2006, 2011). He argues, amongst other things, that the possibility of having both economic growth along with environmental benefits provides false hope as it so far has not been possible to have both in a sustainable way. And that often, ecological trade-offs occur for the benefit of the economy, as technological improvements and efficiency can lead to negative environmental impacts. There is also a critique on how EM can be viewed as driven by the market which leads to promoting profit over other concerns, such as the environment (Toke, 2006).

### 3.2. Public-Private Partnerships

Public-private partnership (PPP) describes the relationship between the public and private sector and how they collaborate to provide services and infrastructure to reach a collective objective. The public sector includes governments and administrative entities such as municipalities. The private sector includes businesses and organisations (The World Bank, 2020).

PPPs, as suggested by Uzunkaya & Sarmento (2017), are important to help evaluate how efficient renewable energy is. Fang et al. (2018) and Ma et al. (2022) also explain that by exploring PPPs, it is possible to help reach the objectives of SDGs. PPPs can also become a platform that contributes to economic development by encouraging collaboration between actors, emphasising flaws in conventional approaches to economic and sustainable development (Fang et al., 2018).

PPPs are therefore helpful for achieving renewable energy and sustainable development goals. It also helps attract investments, knowledge, and innovation from the private sector, that is missing from the public sector. It also aids with implementing renewable energy projects. Depending on the governance, it can encourage an environment where PPPs can prosper. PPPs connect with the criticism of EM by Toke (2006) as they can allow private companies to be driven by profit to achieve the goals of renewable energy set by the municipality, even if it affects the environment and can lead to blurring of lines between the municipality being governed by private companies.

PPPs provide possibilities for renewable energy through investments and innovation, as well as allow for collaboration between the private and the public (The World Bank, 2020). Though there are possible drawbacks as well. As presented by PPIAF (2009), PPPs can lead to higher costs as they are complex and involve many actors. Furthermore, with an increase in external actors working for the municipality, the municipality as a public authority will need to commit to partnerships that are long-term. This can allow private actors to influence the municipality as they become dependent on their investments which can have conflicting interests for the municipality. It is also pointed out that PPPs can give private actors power by providing services that could be offered by the public at a lower cost (PPIAF, 2009).
3.3. Connecting the Concepts

To summarise, the concept of EM offers insight into how technology can create efficiency and improve the environment while promoting economic growth. It provides a way to study planning practices and how effectively they promote renewable energy sources. Public-Private Partnerships (PPPs) are relevant to the thesis as they emphasize collaboration between the public and private so all actors can achieve collective goals. In the context of this study, PPPs can be helpful for understanding how the public sector needs the private sector for investment, which is an essential part of renewable energy projects.

The two concepts can together provide a lens to examine how renewable energy is integrated into planning documents. Ecological Modernisation and Public-Private Partnerships act as lenses to examine the integration of renewable energy sources, the effectiveness of planning documents and the collaborative efforts between different actors. Overall, PPPs and EM are connected as they both can be used to achieve the collective goal of achieving sustainable development and incorporating renewable energy in municipal planning. PPPs help bring together the resources and knowledge of the private sector, which aligns with the focus on technology and efficiency in Ecological Modernisation.
4. Methodology

This thesis uses a qualitative research design that follows an inductive approach, meaning that the results were derived from the collected data. This approach is suitable as it aligns with the research questions and aim of uncovering planning processes and its starting point is the data for identifying emerging patterns. According to Creswell (2018), by using this method, a deeper exploration and understanding of these aspects can be achieved.

4.1. Research Design

The approach of this thesis was to gain knowledge on how solar and wind energy is portrayed in the documents of the selected municipalities by comparing and interpreting the selected documents and later analysing and connecting the findings to the research questions, as aligned with Yin (2009). Through induction and beginning the research with skimming through and processing the documents, it became possible to identify categories and themes, as explained by Bryman (2012). As described by (Bryman, 2012), the meaning of the studied material was shaped by the context presented in the documents. Similar research is argued in Krehl and Weck (2020) to be a rewarding strategy as it helps explain and reveal patterns and deliver insights for how processes are connected. With the aim of this study being to examine how solar and wind energy is portrayed in the planning documents of two Swedish municipalities, qualitative research was considered suitable as the documents were analysed and interpreted.

4.1.1. Multiple-Case Study

A case study of multiple cases is suitable for this thesis as the aim is to explore potential differences or similarities and to identify possible best practices (Bryman, 2012). By studying multiple cases, as opposed to a single-case study, it makes the study stronger according to Yin (2009). Multiple-case studies, according to Bryman (2012) are more flexible in terms of case selection, as they do not need to follow a strict selection method. This was applied as the selection method for this thesis was simply to compare municipalities to find the most suitable for the study. Although these types of studies may not be easily generalised, they still offer valuable insights and knowledge (Veselý 2011, Bryman, 2012). To achieve that, a larger and more in-depth study that includes more municipalities and their work would be needed (Esaiasson et al., 2017).

Case studies are suitable for document analyses because it makes it possible to focus on a certain process or issue within a case. On one hand, focusing on a specific issue allows for a deeper understanding of that topic. On the other hand, this narrow focus might also make it difficult to generalise the findings if that is the purpose (David & Sutton, 2011). The purpose of this study however is not to generalise, but to learn on a municipal level about the approaches used. As Sweden has the same political structure in all municipalities, this should help inspire similar sized municipalities that also share the same resources and prerequisites. The intention was to establish an understanding, as well as interpret and explain. Geddes (1990) points out that to avoid any bias it is helpful to follow certain criteria such as choosing cases that are relevant to the research question, choosing cases that are representative of the phenomena, and choosing cases by using a systematic case selection. This was followed in this thesis as the cases chosen were relevant to the aim and topic. They were also representative in a way as they were of the few municipalities that had documents covering solar and wind energy. It is also highlighted by Geddes (1990) that it is important to be transparent in the case selection to increase the credibility of the research findings. This transparency was attempted with Table 1, which shows
the compared documents from different municipalities and their population size. The municipalities with the most comprehensive documents were chosen. For this thesis the chosen cases aim to be representative of municipalities that are actively working to advance in the area of renewable energy. As solar energy is still new, the number of municipalities are few to choose from. Although it is further explained by Geddes (1990) that choosing cases based on their perceived relevance, and availability of data can create bias, the availability of documents is imperative for the aim of studying documents, making it an important attribute to case selection of this study. Geddes (1990) as well as Yin (2009), explain that this types of studies need to state the same purpose and criteria for the selected cases. To achieve that, Table 1 and Table 2 were created to compare municipalities.

Table 1: Overview of planning documents in various municipalities

<table>
<thead>
<tr>
<th>Overview of Municipalities</th>
<th>Geographic Location</th>
<th>Available planning documents on wind energy</th>
<th>Available planning documents on solar power</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falkenberg</td>
<td>West Coast – Halland County</td>
<td>Wind energy study (2011)</td>
<td>- Guideline for solar electricity production - Unpublished solar document plan</td>
<td>47 017</td>
</tr>
<tr>
<td>Herrljunga</td>
<td>West Coast - Västergötland</td>
<td>Part of comprehensive plan 2017-2035</td>
<td>Development of Solar energy plan – thesis (in collab with Herrljunga energy)</td>
<td>9 517</td>
</tr>
<tr>
<td>Örebro</td>
<td>South central Sweden</td>
<td>Landscape analysis &amp; sensitivity assessment and areas for wind power establishment</td>
<td>Documents for the promotion of solar electricity production</td>
<td>158 057</td>
</tr>
<tr>
<td>Finspång</td>
<td>East-south central Sweden - Östergötland</td>
<td>Part of comprehensive plan</td>
<td>Solar electricity programme (2022)</td>
<td>21 903</td>
</tr>
<tr>
<td>Perstorp</td>
<td>South - Skåne</td>
<td>Supporting documents for the Masterplan 2030 with theme for wind power and solar energy</td>
<td>Supporting documents for the Masterplan 2030 with theme for wind power and solar energy</td>
<td>7 442</td>
</tr>
<tr>
<td>Malmö</td>
<td>South - Skåne</td>
<td>Part of comprehensive plan</td>
<td>Opportunities and obstacles for increased urban solar energy in Malmö’s energy system</td>
<td>357 377</td>
</tr>
<tr>
<td>Uppsala</td>
<td>East Central Sweden – Uppsala</td>
<td>Wind farm plan - supplement for comprehensive plan</td>
<td>Part of comprehensive plan</td>
<td>242 140</td>
</tr>
<tr>
<td>Gotland</td>
<td>East of Sweden - Gotland</td>
<td>Part in Manual for renewable energy</td>
<td>Part in Manual for renewable energy</td>
<td>61 173</td>
</tr>
</tbody>
</table>
The table was based on the following compiled criteria based on a similar study by Yin (2009): (1) Availability of and access to data. As the material for this thesis is based on documents, this will be the most prioritised criteria. Although this can be viewed as a bias, it is also something that is relevant to this study and reflects how far the municipality has come in the planning process for wind and solar energy. (2) Geographic location. The municipalities that are located in similar geographical regions ensure similar weather patterns and other climatic conditions. This will make it easier to compare their prerequisites for solar energy and wind energy production. (3) Population size. Municipalities with a similar sized population should have similar resources and prerequisites to work with. (4) Political climate. Municipalities with similar levels of support or interest in renewable energy. In Sweden the political climate should be similar, though difference in leading political parties and how resources are distributed in different municipalities and how they choose to prioritise renewable energy can differ. By considering these factors, it was intended to choose municipalities that share enough similarities to make meaningful comparisons, while still allowing for an exploration of differences. It was found that many municipalities had only short parts about solar or wind energy in their comprehensive plans or other documents. The topic of renewable energy might have been brought up in several documents, but many of the municipalities had only one specific document for wind or solar energy.

4.2. Data

4.2.1. Document Analysis

To answer the research questions, a document analysis was conducted of available and published planning and policy documents from the different municipalities. Document analysis, according to Bowen (2009), as part of a qualitative content analysis is a way to obtain knowledge and develop empirical evidence from secondary sources in the form of documents. Document analysis is also a relevant method for conducting studies of official documents and reports (Bowen, 2009). Studying the available documents helped adapt the research questions to the findings in the documents available and create a better understanding of the approaches of the different municipalities, as aligning with Farthing (2016). The document analysis also helped provide a clearer view when comparing the work of integrating solar and wind power as it compares documents and identifies possible themes (Gomez & Jones, 2010).

<table>
<thead>
<tr>
<th>Borås</th>
<th>West Coast – Västergötland</th>
<th>Part of comprehensive plan and Conditions for wind power</th>
<th>Solar cells in Borås - project with Borås Energy</th>
<th>114 445</th>
</tr>
</thead>
<tbody>
<tr>
<td>Västerås</td>
<td>Central Sweden</td>
<td>Part of comprehensive plan</td>
<td>Part of comprehensive plan</td>
<td>158 653</td>
</tr>
<tr>
<td>Helsingborg</td>
<td>South - Skåne</td>
<td>Part of climate and energy plan</td>
<td>Part of climate and energy plan</td>
<td>150 975</td>
</tr>
<tr>
<td>Varberg</td>
<td>West Coast – Västergötland</td>
<td>Solar and wind energy study (2022)</td>
<td>Solar and wind energy study (2022)</td>
<td>67 800</td>
</tr>
<tr>
<td>Sundsvall</td>
<td>North-east Sweden</td>
<td>Part of climate and energy plan</td>
<td>Part of climate and energy plan</td>
<td>150 975</td>
</tr>
</tbody>
</table>

Sources: SCB (n.d.), Respective Municipality
Key literature that was utilised, included the official planning documents from the municipalities of Linköping and Örebro, as found in Table 2. Although there are more documents available, these were the documents found which mainly featured the topics of this study. The documents were studied through a thematic analysis as per Braun and Clarke (2006). This analysis, according to Braun and Clarke (2006) comprises six key steps. The first step is to (1) familiarise with the data by reading the content. The next step is to (2) create initial codes while reading for the purpose of labelling parts of the documents. The next step (3) is for themes to be identified by searching for patterns and connections between the codes from the previous step. These themes are reviewed and refined during the progress with the intent to review and refine the themes to give them context and relate them to each other. Later, the themes are (5) organized into a coherent structure before finally (6) writing an analysis. This method of analysing text documents can according to Braun and Clarke (2006) help make the process of managing a big amount of text easier and more effective. Other sources used were previous course literature for the methods section as well as for providing background information in the literature review.

Why policy and planning documents are relevant to this research is because these documents are a significant part of the planning process, and these documents are usually developed over long periods of time and with great effort and resources. Planning documents can influence the choices for development and outcomes of the coming period of time in the municipality. It is also interesting to study these types of documents to pay attention to what is omitted or selected to be included. And in that way that can also say something about different issues. The text in planning documents can also show how different concepts are promoted. As the content of the text should reflect the values of the municipality (Farthing, 2016).

Table 2: Key Documents from Linköping and Örebro

<table>
<thead>
<tr>
<th>Municipalities</th>
<th>Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linköping</td>
<td>Master Plan (2009)</td>
</tr>
<tr>
<td></td>
<td>Wind Power Feasibility Study for the County of Östergötland (2016)</td>
</tr>
<tr>
<td></td>
<td>Climate and Energy Programme for Linköping Municipality (2022)</td>
</tr>
<tr>
<td></td>
<td>Sustainability Report Linköping Municipality (2022)</td>
</tr>
<tr>
<td>Örebro</td>
<td>Master Plan (2018)</td>
</tr>
<tr>
<td></td>
<td>Landscape Analysis and Sensitivity Assessment for Wind Power (2011)</td>
</tr>
<tr>
<td></td>
<td>Promotion of Solar Electricity Production in Örebro Municipality (2014)</td>
</tr>
<tr>
<td></td>
<td>Climate Strategy for Örebro Municipality (2016)</td>
</tr>
<tr>
<td></td>
<td>Follow-up of the climate strategy for Örebro municipality (2018)</td>
</tr>
<tr>
<td></td>
<td>Energy and technology – part of the Master Plan (2023)</td>
</tr>
</tbody>
</table>
4.2.2. Method Analysis

This study was intended to include more cases, as well as other methods, such as identifying attitudes in the local media and between different actors and stakeholder, as well as public perception on renewable energy. However, due to time limitations this was not possible to achieve while also analysing the two chosen cases in a sufficient way, which is why the literature review and part of the results had to be omitted, and the aim and research questions adapted to reflect the current version of the thesis. The results and analysis could have been more comprehensive if there were more municipalities compared. Parallel documents released in the same years would also make the municipalities more comparable. The inclusion of the public perception and more focus on the relationship between the municipality and other actors could also have enriched the study.

The chosen municipalities were based on the available documents that have been published for both solar and wind energy. As master plans and other documents are not produced at the same time, and newer information might be included in the newest and unpublished versions of the documents, the results might not include the most recent work from the municipalities. This means that the results could reflect a less progressive approach to the issues studied. It was also hard to compare how far the municipalities have come based off of only the documents, as looking at their official websites made it possible to find newer and more up-to-date views and projects. A more comprehensive approach with possible interviews with experts could have benefited the study with more nuanced material.

The thematic analysis was beneficial to the understanding of the documents and contributed to giving an overview of the data as well as helped with quickly seeing patterns and relating the different parts of the documents to each other. The cases chosen for this study ended up being the municipalities of Linköping and Örebro. These were one of the few municipalities which had the resources and priority of creating separate studies and planning documents for wind and solar energy.

4.2.3. Analysis of Data

To analyse the data, the process begun by searching for documents on the official web pages of the chosen municipalities, to make sure the documents are reliable. I searched for official and published planning documents. That includes anything that could be found regarding solar and wind energy as well as the municipal master plans and climate and energy documents.

To analyse the data, the steps provided by Braun and Clarke (2006) were followed. I started by skimming through all the documents and doing an initial search for key words from the aim and research questions such as wind, solar, and energy. The codes that were identified from the documents through this process and created for this study included: Planning goals for solar/wind, External actors, Collaborations, Challenges, and Strategies. Later, those codes were grouped into categories or themes, which included: Planning objectives for renewable energy expansion, Differences between wind and solar energy, Roles and involvement/influence of external actors, Collaboration with municipalities, and Limitations in infrastructure. The themes were reviewed and refined and the texts were divided into the different categories with the themes in mind. I often went back to the documents during the writing process to make sure that the identified themes were relevant.
4.3. Quality Assurance

To ensure the reliability of the research design, the data collected was data from reliable and official sources. Several documents from each municipality were included to ensure that they share the same or more information regarding the same topic. This also helped to produce the results and aided in creating a more comprehensive picture from the different documents (Yin, 2009). To achieve reliability for a case study, one of the mentioned prerequisites by Yin (2012) is to properly document the methods and process and conduct the research in an honest and trustworthy manner, which has been attempted in this study through explaining how the steps by Braun and Clarke (2006) were applied. As well as present the tables of municipalities.

It was decided to focus on specific cases with the intent to provide insight and understanding through the context of the chosen cases. To ensure consistency and accuracy of the data used, it was chosen by reviewing, amongst other things, when, where and by whom the documents were published. This should lend credibility to the material according to Bryman (2016) and David & Sutton (2011). Though this research method can, according to Creswell (2018), be limited by the availability of data, it can also potentially become time-consuming while going through the documents. The data in this study was available though manageable and the thematic analysis made it possible to effectively study the documents. Additionally, there can be limitations in the author’s own personal biases and abilities to interpret and understand the documents (Creswell, 2018). By providing information on where the documents are from, as well as describing the methods used, and being knowledgeable in the original language of the documents, this shows transparency to attempt to avoid limitations and biases. Using a thematic analysis could also have prevented this as the study focuses on the results of the codes and themes found, making little room available for personal biases. Since the documents were published by municipal authorities, or in collaboration with the municipalities, they are also considered authentic (Bryman, 2016, David & Sutton, 2011). David and Sutton (2011) also discuss the justification of using secondary data as it is easily attainable and available while also often being efficient compared to other approaches. It also makes it easier to work without the concern of processing sensitive information as can be needed in other methods (Bryman, 2016, David & Sutton, 2011).

4.4. Ethical Considerations

From the perspective of ethical considerations, the use of official municipal documents is justifiable as they do not include any sensitive or private information. They are also free and publicly available. As the purpose of these documents is for legislation and regulation, among other things, it is permitted to use the information they provide in a study like this (Merriam, 2009). The texts in local plan documents also represent the interpretations and visions of municipalities in regard to solar energy and wind power, making it a reliable source for the purpose of the study (Farthing, 2016).
5. Results and Analysis

In this section, the research questions will be responded to, and the results will be analysed

5.1. Objectives for the expansion of wind and solar energy

5.1.1. Linköping Municipality

Linköping municipality, as part of the county of Östergötland, has adopted the county goals, which include an energy and climate strategy for the years 2019 to 2023. The overarching goal for the municipality of Linköping is as defined in their climate and energy program, to achieve net-zero Greenhouse gas (GHG) emissions by the year 2045. To achieve this, there are complementary measures suggested to aid the goal alongside the measure of reducing emissions. The measures include an aim to encourage more production of renewable energy both inside and outside of the municipality’s borders. The municipality has, as described in its Climate and Energy Programme (Linköping kommun, 2022a) for a long time worked to achieve a healthier environment and air quality, including minimising the GHG in accordance with the Paris Agreement and the national climate goals (Linköping kommun, 2022a). The aim is to create a better place for coming generations, in agreement with sustainable development goals. This is also stated in the Climate and Energy Programme for Linköping Municipality (Linköping kommun, 2022a) as including work outside of the municipality as part of taking responsibility on a larger scale. It is stated that renewable energy is one way in which this is possible, with non-renewable energy sources being considered as a last resort. The goal is to follow a four-step plan in which the strategies ascend from most prioritised to last. It starts with reducing need for energy, and then properly harnessing any residual energy. The next step is to use renewable energy, and finally use non-renewable energy sources. Renewable energy is therefore favoured over non-renewable and fossil energy resources. This is also stated as being able to contribute to the municipal goal of achieving net-zero emissions of GHG by the year 2045. Linköping municipality describes itself as wanting to be an actor that takes part in removing carbon dioxide through negative emissions. These targets also apply to construction by private developers on municipal land, who are expected to adhere to the goals (Linköping kommun, 2022a). Another objective stated in the Action Plan for Solar Energy (2020) is to integrate solar cells into city planning by applying them onto roofs, facades, and surfaces such as noise barrier panels on roads. As well as prioritise new building projects and areas that allow and encourage the installation of solar cells (Linköping kommun, 2020).

Linköping municipality has also set local goals to achieve carbon neutrality by the year 2025. To reach this goal, renewable energy is included as a strategy, including investing in wind and solar energy. These objectives refer to both inside and outside of the municipality borders (Linköping kommun, 2022b). Due to Linköping Municipality being situated in a valuable area for the armed forces, large areas of the municipality, as well as parts of the county of Östergötland, have been designated for defence purposes and prohibited for wind and solar energy production. This is described in the Wind Power Feasibility Study (2016) as something that has directed the Municipality and its objectives in how they approach renewable energy. (Östergötland län, 2016). The municipality planned, as per the study from 2016, to invest in wind energy production outside of its own borders due to the existing prohibitions (Östergötland län, 2016).
Back in 2016, the municipality of Linköping also planned to invest in a municipal wind energy company with the intention to eventually invest in other renewable energy sources, such as solar power. As the Wind Power Feasibility Study (2016) is the most recent document for wind energy in the municipality of Linköping, it is not clear what kind of development this project has had. The armed forces are also against the modernisation of old wind turbines to modern ones once the old ones need to be replaced, this makes it difficult to establish wind energy production in the area. There were in 2016 six wind turbines in the municipality with no further plans of expanding and no possibility of modernising or restoring older wind turbines once defective, due to the prohibited areas by the armed forces (Östergötland län, 2016).

In 2016, the region also mapped and identified what can prevent and encourage wind energy to make it easier for regional actors to establish wind energy production. As part of the national interest in wind power, the Swedish Energy Agency was tasked to identify areas on land that are suitable for wind energy production. Though these areas were reduced due to opposition from the armed forces (Östergötland län, 2016).

Concerning solar energy production, Linköping municipality has set a goal to become one of the municipalities with the most solar energy produced in the country, producing five per cent of the municipal energy usage by the year 2025 and 20% by the year 2040. This is according to their Action Plan for Solar Energy (Linköping kommun, 2020). There are also connections made to the municipal climate and energy program. The municipality of Linköping has been working with expanding solar energy for a long time. One of the ways has been to install solar cells on municipal owned roofs, as well as through spreading information and knowledge. The solar map, which several municipalities have adopted, is also counted as a method to expand solar energy in the municipality, along with allowing building permits for solar energy to be free of charge. This approach, according to the Action Plan for Solar Energy (Linköping kommun, 2020) has successfully put them among the top contenders of municipalities with the most solar energy production. The target the municipality aims to achieve is five per cent of the total energy production being produced from solar energy by the year 2025 and growing to 20% by the year 2040 (Linköping kommun, 2018, Linköping kommun, 2020, Linköping kommun, 2022a).

Solar energy production is stated in the Action Plan for Solar Energy (2020) to have become more common. This has primarily been accomplished through micro production by private homeowners and through the installation of solar cells on property roofs. In 2020, the total municipal solar energy production was 33 MW, including 10 MW from a local solar energy park (Linköping kommun, 2022a). By the end of 2017, the municipality of Linköping had installed solar energy which approximately corresponded to about 1.22% of the electricity consumption of that year. As per the Action Plan for Solar Energy, published in 2020, the municipality had more than 900 solar energy installations in 2019 (Linköping kommun, 2020).

5.1.2. Örebro Municipality

According to the Energy and Technology section of the Master Plan (2023), Örebro municipality aims for efficient energy use with a reduced impact on the environment as a basis of their physical planning. The municipality wants to work to achieve this in buildings as well as new productions and restoration work. In a case where municipal land is sold for housing development, the aim is stated to be achieving energy efficiency and building materials that are environmentally friendly (Örebro kommun, 2023).
In the master plan for the municipality of Örebro (Örebro kommun, 2023), a responsibility is expressed for expanding wind energy production. There is a need identified to for instance create a map of suitable areas for wind turbines in the municipality. They have also pointed out areas that are of national interest for wind energy production. This map should make it easier for the municipality to handle inquiries from different actors who are interested in installing wind turbines (Örebro kommun, 2023).

One of the municipal objectives mentioned in the Örebro follow-up report for climate strategy (Örebro kommun, 2018), was through promoting renewable energy production with the help of companies and organisations. The purpose of that was to allow purchases of shares in wind and solar power plants. Kumbro Utveckling was one of the companies mentioned to be working with other energy companies in the county of Örebro, but as of 2018, there were no opportunities for companies and organisations to buy shares in wind farms or solar parks (Örebro kommun, 2018).

Despite a positive trend up until 2018, the assessment in the follow-up report for the climate strategy (Örebro kommun, 2018) was that it will not be possible to reach the target for 2020. Although there were wind energy farms planned, the target would not be achieved in time. This was described as being due to high construction prices in combination with previous low energy prices. For solar energy, an investigation was made, but it was explained that legislation in that time made it difficult for companies, organisations, and individuals to invest in solar energy parks as it was standing in the way of profitability. (Örebro kommun, 2018, Örebro kommun, 2016b). It was too expensive to invest as the energy was cheaper back then, compared to today.

Another target was to achieve collaboration between the municipality and companies and organisations to reduce the climate impact. The framework produced to achieve this is to invest in solar energy. To do this there was an apparent effort in reaching out to businesses. There had been an increase in recent years in the investment in solar energy along with the municipality witnessing a higher interest among individuals as well as companies (Örebro kommun, 2018; Örebro kommun, 2014).

In relation to solar energy, Örebro had according to the Promotion of Solar Electricity Production (2014) identified an increase in interest by the year 2014 in inquiries for the production of solar energy. This created a need to have an inventory of suitable solutions for solar cells. Several private companies, including the municipal group, as a result, started installing solar energy in response. This initiative resulted in solar cells being installed by several administrative bodies, such as buildings belonging to the Transport Agency, the University, the County Council’s office, a preschool, and a local football stadium, as well as privately owned houses and small industrial properties (Örebro kommun, 2014). The goal for the region of Örebro, according to their energy and climate strategy (2016a), was to produce 5 GWh of solar energy by the year 2020. To reach this goal, the municipality wanted to research to promote energy-efficient construction and the production of solar energy.

The document for the promotion of solar energy production (Örebro kommun, 2014) acknowledged in 2014 that solar energy had potential in the municipality, aspiring to generate 5 GWh of solar power in the region by the year 2020. The project created to accomplish that was an initiative to produce local solar energy and was financed by the Swedish Energy Agency, the Swedish farmer federation, the Örebro County Administrative Board, and the Örebro Regional Council (Örebro kommun, 2014).
In the document for the promotion of solar energy production, Örebro municipality aspires to be at the forefront of solar energy production, aiming for all municipal real estate companies to have at least one solar energy installation by the end of 2015 (Örebro kommun, 2014). To help achieve their goals, the municipality used solar maps of existing buildings and roofs, the inventory tool which Linköping is also a part of, SEES (Solar Energy from Existing Structures). Accompanied by a GIS map, which was expressed as helpful for finding potential areas in the municipality for solar energy production. Especially for placing solar panels on roofs and buildings. All the roofs on buildings owned by the municipality have been studied for this purpose. Including the municipal companies as well. The analysis was then done of different data for each individual building, including amongst other things the amount of solar radiation, potential electricity production and investment costs, as well as the amount of shading and the sloping of the roofs. Other aspects that have been considered include nearness to the electricity grid and the size of the installation of solar energy production. The size of the solar panels, how much they will produce and how possible residual energy outputs will be dealt with to minimise electricity output to the grid are also mentioned as important aspects. The analysis showed that several of the roofs suitable according to the criteria used and a price estimate has been set. The most suitable and profitable is when facilities can utilise their solar energy produced directly. It is not very easy to currently be granted a subsidy though (Örebro kommun, 2014).

For municipalities in general to grant planning permissions for solar panels or solar cells there are criteria put in place to fulfil the requirements such as placement on the roof in contrast to the edge of the roof, as well as needing to be installed in a way which provides proper opportunities for restoration. Especially if it is a historically important building and the appearance needs to be adapted to fit the building as it is not supposed to change the character of the building or area (Örebro kommun, 2014).

The municipality was, according to its master plan, in favour of property-based solar energy installations that are sustainable and aesthetically pleasing. It is expected that there is a need in spatial planning to consider the need and utilisation of land for increased production of solar energy (Örebro kommun, 2023). There have also been proposals for the location of land-based solar power plants in 2014. For a successful solar power plant the municipality stated the importance of finding land areas of low value. In the first instance, areas that are already in use can be subject to solar energy production as long as they are not of high value and are not in the plans for becoming potential new buildings, used for agriculture or other conflicting interest (Örebro kommun, 2014).

A reason stated for why the goal for renewable energy has yet to be achieved is the work on energy efficiency that has been accomplished. But also restrictions in contracts between the municipality and Kumbro. The municipality of Örebro, similarly to Linköping, applies renewable energy as one of the ways to achieve carbon neutrality (Örebro kommun, 2022). The electricity system in Örebro Municipality is interconnected with neighbouring countries, meaning that the import and export of electricity are reliant on national and international developments in renewable energy. This connects the local development to a larger energy landscape and puts the municipality’s renewable energy goals into perspective. Furthermore, the cost of energy storage is also stated as an obstacle as it affects the efficiency of renewable energy (Örebro kommun, 2022).

However, several possibilities have been identified in the document, to address these challenges. This includes having clear objectives and following up on the progress. As
suggested by the document, there should also be clearer agreements and communication regarding energy production across the actors involved (Örebro kommun, 2022). Cooperation and collaboration between the municipal group and various stakeholders could also enhance the efficiency of initiatives surrounding sustainable energy, such as energy companies and representatives from forestry and agriculture.

5.1.3. Comparison and Analysis

Overall, the documents from both municipalities show that renewable energy has been prioritized, with specific goals for wind and solar energy, following both the SDGs, the EU objectives, and the national goals for renewable energy (Globala målen, 2022, European Parliament, 2018, Swedish Environmental Goals, n.d.). The planning documents from Linköping Municipality seem to focus on becoming a leader in solar energy production (Linköping kommun, 2020), while Örebro seems to have fewer obstacles to expand in both wind and solar energy, which also reflects in their planning documents. The two municipalities also seem to share similar goals and actively encourage renewable energy installations, yet due to different circumstances, their objectives reflect that. For instance, while Linköping seems to encounter limits in expanding wind energy within its borders, Örebro has instead described challenges related to construction costs and legislation affecting solar energy profitability. Although Linköping might have had similar problems, it is not stated in the documents used for the study. Since the documents are not all published in the same year, this could also look different today.

The obstacles expressed in the documents reflect the sentiment of policy support being needed on a national level for renewable energy to expand successfully (Szarka, 2007). The fact that there has been a growing interest shown towards renewable energy in both municipalities can also reflect the global trend of renewable energy growing in relevance as mentioned by Nilsen Carman (2020), Andrew-Speed et al. (2015) and Avila (2018). This could also be related to a dependence which has existed on other countries, such as Russia, to provide energy to Europe. Due to different world events, including the Russian invasion of Ukraine, this might have led to individual countries in Europe and over the world becoming aware of the importance of renewable energy as a local energy source.

Örebro municipality had set the goal in their energy and climate plan to add 115 GWh of energy from renewable sources annually by the year 2020. The aim was to make the municipal group independent by producing their own renewable energy. For wind power, the aim was to produce 110 GWh per year in 2020, with 5GWh coming from solar cells (Örebro kommun, 2016a; Örebro kommun 2014). This goal shows a good way for the two energy sources being used to complement each other. This also would achieve the targets for solar energy production set by the Örebro region. As Örebro is the largest municipality in the county, their role of contribution to achieve the targets becomes more significant. The approaches of Linköping Municipality and Örebro Municipality towards wind and solar energy reflect the concepts of public and private partnerships and ecological modernization.

In Linköping Municipality, the set goals for renewable energy were set for the entire county of Östergötland with 2000 GWh by the year 2020 (Östergötland län, 2016). For solar energy, there are set goals in Linköping with 62 GWh by the year 2025 and 248 GWh by the year 2040 (Linköping kommun, 2020). The lack of presented goals for wind energy is likely related to the municipality not having the opportunity to expand its wind energy production.
There is also an emphasis on sustainable development and taking responsibility on a larger scale. The municipality aims to achieve net-zero greenhouse gas emissions and encourages the production of renewable energy both within and outside its own borders. This indicates a willingness to work to achieve the goal by putting the municipality in a larger context as part of the entire region and collaborating to promote renewable energy production. For example, private developers on municipal land are expected to follow the goals of the municipality, suggesting a partnership between the public and private sectors, which reflects the ideas of PPPs. Additionally, Linköping Municipality planned to create a municipal wind energy company, which shows a willingness to create partnerships between the municipality and private actors.

Newer documents, such as the ones published in 2020 and forward, also reflect the sentiment of technology having developed and using it to help reach the shared objectives, mirroring the ideas of ecological modernisation. As EM sees technology as a way to help protect the environment and the economy (Toke, 2014), the incentives from both municipalities seem to reflect that as well. This can also be found in how renewable energy is prioritised over non-renewable and fossil fuel sources by Linköping Municipality (2022a). By including information and targets for solar energy in the planning documents, this encourages more installations. In that way, Linköping Municipality shows a willingness to update its energy infrastructure in an environmentally sustainable manner. This reflects the ideas of EM which brings up renewable energy as a way to achieve sustainable development.

Similarly, Örebro Municipality also acknowledges the need to expand wind energy production by creating a map of suitable areas for wind turbines. As well as promote solar energy through working with different actors and allowing for the opportunity to purchase shares (Örebro kommun, 2023). By involving various actors, Örebro shows that the municipality values partnerships and collaboration as an approach to developing more renewable energy. This also aligns with the concept of PPPs and the idea of having different stakeholders work together to achieve common goals, as explained by The World Bank (2020).

The documents published for the municipality of Örebro show an emphasis on energy efficiency, using materials that are environmentally friendly as well as planning for more solar energy production. This also indicates a kind of sustainable modernisation of the energy infrastructure. The municipality shows this by encouraging solar energy installations on municipal buildings, private houses, and small industrial properties. This also fits into the concept of EM. In Linköping there are also goals presented for expansion of solar energy, showing that there is potential for collaboration between actors, as with PPPs. As well as aligning with EM as solar energy uses technological innovations and promotes economic benefits for the municipality, with the aim of also benefiting the environment.

One thing to note is that land-based solar energy was not widely featured for its benefits on agricultural and arable land as described by Zainol Abidin et al. (2021), Curtis et al. (2020) and Hernesniemi (2022) amongst others. Instead, solar energy was more featured as something mainly installed on roofs, with land-based facilities briefly mentioned as an option in Örebro (Örebro kommun, 2014). This is likely due to regulations and potential conflicts arising between actors when attempting to create a solar energy park. There was also no mention of the possibility to combine land use for both wind power and solar energy. Though it seems too early
in the process of transition to a heavier focus on renewable energy to be considering these factors.

To summarise, the documents from both municipalities highlight the prioritisation of renewable energy. Linköping focuses on becoming a leader in solar energy production, while Örebro faces fewer obstacles and aims to expand in both wind and solar energy. Although their goals align, they differ due to different circumstances. For instance, Linköping encounters limits in expanding wind energy within its borders, while Örebro presents challenges related to construction costs and legislation affecting solar energy profitability. The sentiment expressed in the documents reflects the need for national policy support to successfully expand renewable energy. The growing interest in renewable energy aligns with the global trend and could be attributed to a shift in awareness driven by world events. Both municipalities embrace public-private partnerships and ecological modernization, with Örebro setting ambitious goals for renewable energy production and Linköping emphasizing sustainable development, collaboration, and technological advancements.

5.2. The role of actors for the expansion of renewable energy in municipalities

5.2.1. Linköping Municipality

As disclosed in the municipal documents of Linköping municipality, there is a collaboration with various actors to help achieve the renewable energy goals in the municipality. Linköping municipality owns companies that need to adhere to certain rules as well as initiate work to install for instance solar cells of roof buildings. Parts of the renewable energy goals that were reached were also thanks to the collaboration between the municipal group and the four largest companies owned by the municipality; AB Stångåstaden, Lejonfastigheter AB, Sankt Kors Fastighets AB and Tekniska Verken. As presented in the Action Plan for Solar Energy (Linköping kommun, 2020), The Swedish Energy Agency and Statistics Sweden, followed by the municipality of Linköping, have accounted for the largest contributions to the expansion of solar energy between the years 2018 and 2019. Not all solar energy is produced by the municipal group as the municipality also collaborates with businesses as part of an initiative of public and private corporations working in a network to manage climate challenges, including energy (Linköping kommun, 2020).

As part of becoming carbon neutral, the municipality attempts to compensate for previous carbon emissions. According to the follow-up study of target fulfilment for a carbon-neutral Linköping (Linköping kommun, 2022b), wind energy, along with cogeneration energy, accounted for the fastest-growing compensatory emissions from self-produced electricity in the municipality during the year 2020. This refers to the electricity produced, not for instance the amount of new wind turbines installed. (Linköping kommun, 2022b). Among the initiatives that have been carried out within the municipal group of Linköping, the main activities related to sustainable energy production have been carried out by the largest municipal companies, such as the housing companies Lejonfastigheter and Stångåstaden, and the energy company Tekniska Verken. These initiatives include increased energy efficiency and production of renewable energy. Including the production of renewable electricity through solar and wind power. Among other things, Lejonfastigheter has managed to help reach the municipal solar energy target by an increase in the year 2021 by 25% from the previous year, owning 13 solar energy plants in total. Stångåstaden has contributed by installing solar energy facilities, making it the owner of 14 solar energy plants. In 2021, the company Tekniska Verken, as the largest owner of the
electrical grid, also investigated the possibility of building another solar park outside the city centre in Linköping. Other energy companies that also own the electrical grid include Eon and Vattenfall. Tekniska Verken is described as an important factor for the achievement of the municipal goal of a carbon-neutral Linköping in 2025. The company has had several initiatives for the expansion of renewable energy production with a focus on both solar and wind power (Linköping kommun, 2022c).

Another way actors have been involved in the work of renewable energy in the municipality according to the Master plan för Linköping municipality (Linköping kommun, 2009), is through the Action Programme of Built Environment, which aimed to motivate and encourage a transition to a sustainable built environment. This applied to renewable energy as the actors involved work for sustainable development through the integration of development and energy amongst other things (Linköping kommun, 2009).

In the Wind Power Feasibility Study (Linköping kommun, 2016), it was the municipal company Tekniska Verken, are responsible for most of the ownership of wind farms in the region. The company Bixia ProWin AB is also a shareholder in several different wind companies. Stångåstaden, together with Tekniska Verken are also partners in wind power companies. The purpose presented for having shared ownership was to stimulate the installation new wind turbines.

According to the Wind Power Feasibility Study (Linköping kommun, 2016), the companies that own the electricity grid have worked to avoid increasing the price of electricity within the grid. Yet there are companies that own the grid and also produce electricity. This puts them in a position of power over the network prices, being able to raise them in case electricity prices are low and don’t generate profit. Actors and companies who do not own the grid may in turn find it hard to profit. Ideally, long-term contracts with fixed prices between energy companies and customers are highlighted as being a solution (Östergötland län, 2016).

In the Climate and Energy Programme for Linköping Municipality (Linköping kommun, 2022), it is emphasized that both the municipalities and companies play an important role in the expansion of wind power. Actors outside of the municipality are also included as they support municipalities when purchasing wind and solar power that is produced by the municipality, as well as help promote renewable energy. Collaboration and dialogue are described as important aspects of achieving the municipal climate objectives (Linköping kommun, 2022).

### 5.2.2. Örebro Municipality

The municipality of Örebro has expressed the intentions of installing land-based solar energy facility, as explored in collaboration with the Energy Office of the Regional Council. For this to be successful, marketing was featured as an important aspect so that companies and potential investors looking to invest in solar parks or shares in solar energy would see it as an opportunity for visibility and marketing their brand (Örebro kommun, 2014). As also mentioned in the Promotion of Solar Electricity Production (Örebro kommun, 2014), an example of land-based solar energy parks would be near central shopping centres and their parking spaces, which has been done in other municipalities. Another example mentioned was to place a solar park close to large and busy roads, which also targets companies interested in a strategically placed solar energy facility (Örebro kommun, 2014).

To enhance the profitability of these types of projects, a suggestion featured in the Promotion of Solar Electricity Production (Örebro kommun, 2014), was for the municipal energy
companies to agree with external actors on fixed prices for the energy produced. To promote solar electricity production the municipality of Örebro, one of the objectives was to examine the possibility for different actors to invest in solar cell plants and evaluate the potential of larger solar energy parks. This was to be done in collaboration with the municipal Energy office (Örebro kommun, 2014).

For the ownership of solar panels in the municipality of Örebro, according to the Follow-up of the climate strategy (Örebro kommun, 2018), the strategy described was to offer companies and individuals the opportunity to buy the energy produced and allow companies to use the solar panels for marketing. To make sure that renewable energy projects succeeded, municipal companies also got annual targets to reach for producing solar energy. Investing in solar energy production was also mentioned as part of a framework that aims for collaboration between the municipality and companies to reduce a negative impact on the climate (Örebro kommun, 2018).

The municipality of Örebro and the municipal group, work with companies including Kumbro/Kommunstyrelsen, ÖBO, Futurum, Örebroporten, and Tekniska nämnden. These companies, as stated in the Climate Strategy for Örebro Municipality (2016), shared the responsibility of achieving the municipal objectives of increasing the production of renewable energy between the years 2014 to 2020. This applies to both solar and wind energy, with each company having specific goals to reach (Örebro kommun, 2016a, Örebro kommun, 2018).

As previously mentioned, another target in the municipality is to achieve collaboration between the municipality and companies, and organisations to reduce the climate impact. Within the framework produced to achieve was to invest in solar energy. To do this there was an apparent effort in reaching out to businesses, which has translated into an increase in recent years in the investment in solar energy (Örebro municipality, 2018). In order for the municipality of Örebro to achieve their target by 2030, the follow-up report for the climate strategy (Örebro kommun, 2018) describes that additional efforts are required and that there is a need for change in the policy instruments on a national level as well as on an EU level.

5.2.3. Comparison and Analysis

It is noticeable that in both municipalities, working with energy companies and collaborating with various actors is an important part of renewable energy production. Even if the renewable energy goals can’t be reached in the set time, there has been progress made. Collaborations has contributed to this as the municipalities do not have the resources to do it all themselves. The actors involved are mainly owned by the municipalities or the municipal group and need to follow assigned goals (Linköping kommun, 2020). However, not all solar energy production is carried out by the municipal group. The municipality also collaborates with businesses as part of a network that addresses climate challenges. This is a good way for the municipality to keep control over how renewable energy is expanded, while also retaining some control over how it is done. With the municipal veto for wind energy this might be easier, though with solar energy being relatively new, there might be more challenges faced with external actors expressing interest in for instance wanting to install solar cells on municipal land.

The collaboration and dialogue between the municipality, the local business community, and citizens are emphasized by both municipalities as important for achieving the climate and renewable energy objectives. The Action Programme of Built Environment is an example of an initiative in Linköping Municipality (Linköping kommun, 2009). External actors can also
support the municipality by purchasing wind and solar power generated by the municipality and by promoting renewable energy. They can also invest in solar energy facilities such as solar energy parks. This has also created marketing opportunities, depending on where solar cells have been installed, where companies can purchase shares in solar energy and gain visibility. The municipality of Örebro also shows that efforts have been made in recent years to engage businesses in initiatives to increase investment in solar energy. It is also evident that profitability is an important part of expanding renewable energy production. It seems to influence the plans of municipalities as it for instance helps to attract investors. It is also part of both EM and PPPs. However, one thing to note is that the positive aspects for the environment renewable energy has, is not as prominent. This will hopefully change once the technology develops more and reaches a place that can become competitive with conventional renewable energy sources. The profitability of renewable energy can thus lead for the municipalities to eventually reach their renewable energy goals and secure a more local energy production.

Work from the Swedish Energy Agency and Statistics Sweden (Linköping kommun, 2020) also show the importance of external actors. These two agencies are also owned by the Swedish government, showing that it is meaningful for different administrative levels to collaborate. Örebro Municipality also conveys their aims to reduce negative climate impacts through collaboration with companies (Örebro municipality, 2018). This is in accordance with the ideas of EM and using renewable energy to protect the environment, while also providing a possibility for sustainable economic development. Involving various actors in renewable energy can also create a demand as it grows more popular with investors, which is beneficial for both the renewable energy projects, but also for the investors and the public. The long-term effects of this could be cheaper and greener energy available for the public to use. Another possible benefit of collaboration with various actors is that the more renewable energy facilities there are, it should become cheaper to produce, as well as sell the energy. This could also lead to the extension of the electricity grid, making it more available for more people.

Although it may seem that Linköping and Örebro have different approaches to collaborating with external actors, as the municipality documents used to produce the results are not entirely equal in age and scope, it is difficult to say if there is a clear difference between how they work. For instance the Wind power feasibility study (Östergötland, 2016) for the county of Östergötland contains only parts for Linköping municipality. Meanwhile the municipality of Örebro has its own comparable document with the Landscape analysis and sensistivity assessment for wind power (Örebro kommun, 2011). The two documents discuss wind energy production in the respective municipalities, but in different scopes. Similarly, the Action plan for solar energy (Linköping kommun, 2020), and the Promotion of Solar Electricity Production (Örebro kommun, 2014) also contain different amounts of information as well as being published 6 years apart. Due to their different circumstances and Linköping Municipality possibly having larger areas that are prohibited due to other national interests, it can appear that they have focused on Solar energy more. Different circumstances have caused different outcomes, with Örebro Municipality being able to plan for more wind turbines for instance, while Linköping Municipality is unable to install any new ones. Since the documents do not include much about private actors in the same capacity, it is also difficult to say if there are many private actors involved in the expansion of renewable energy. Though there is mention of the interest by companies to invest in land to install solar cells (Örebro kommun, 2014). PPPs could help the municipalities reduce possible investment risks associated with renewable energy projects and decrease the pressure on the municipality.
Through collaboration with outside actors, such as the Swedish Energy Agency, and its financial support, there is expertise and knowledge shared. As the Swedish Energy Agency is also governmentally owned, they work with all municipalities, making it possible for best practices to be shared. The possible exchange of knowledge allows the municipality to take informed decisions, implement efficient methods, and learn from challenges in the municipalities for the development of renewable energy projects. The collaboration between Örebro Municipality and Municipal companies like Futurum, Örebroporten, and Örebrobostäder (Örebro kommun, 2016a, Örebro kommun, 2018) could help ensure a shared responsibility to achieve common goals. This also helps drive the development of renewable energy projects as there are more actors involved to contribute with knowledge and solutions.

Actors that are outside of the municipalities can also include, for instance, the Swedish government. There is a need recognized for policy changes on both a national and EU level to achieve its renewable energy targets. The municipality can for instance advocate for policy instruments that support renewable energy development. Although they possess some power, they are not able to create as much change as on higher administrative levels. Collaboration with different companies and organisations can also put pressure on the government to change its policies.

Both Linköping and Örebro municipalities engage in collaborations with external actors to achieve their renewable energy goals. This approach aligns with the principles of EM and its emphasis on stakeholder engagement to promote sustainability and environmental improvement (Toke & Strachan, 2006). The collaborations with various actors also create a way for knowledge sharing and innovation in renewable energy systems. This is also an important part of EM (Davoudi et al., 2020). Though, there does not seem to be a clear enough connection between these collaborations and the environmental sustainability of renewable energy. This might emphasise the criticism against EM by Toke (2006) regarding economic and environmental sustainability not being easily achieved simultaneously.

The collaborations between municipalities and external actors in Linköping and Örebro give an example of the partnership approach found in PPPs, where public entities work alongside companies to achieve shared goals in renewable energy development. PPPs often involve the private sector funding and investing in public projects (The World Bank, 2020), while in the case of Örebro and Linköping, it is more municipal companies that are funding these projects. In the context of renewable energy, external actors such as energy agencies, businesses, and investors contribute financially and support the development and expansion of renewable energy infrastructure in the municipalities. Though, with an increase in external actors working for the municipality, this can allow private actors to influence the municipality as they gain more power (PPIAF, 2009). This can become problematic if the objectives of the external actors differ from the municipalities’. The conflicting interests could also affect long-term environmental sustainability if private companies prioritizing short-term economic benefits. With the power of financing renewable energy projects, private actors could in a way influence decisions for the public. It can also not be guaranteed that private actors would act for the benefit of the public and once given the chance might cause environmental damage for their own benefits.

With the expansion of renewable energy and how municipalities work with different actors, it can be important to review how private actors work with the municipalities and possibly encourage that they do. If not, private investors can start to become part of the public sector when for instance wanting to purchase or rent land that is owned by municipalities (Douay,
2018). This could also create conflicts between different actors. It can be useful to also look into how the renewable energy industry can affect agriculture and its relationship to industrialisation.

Why governments benefit from locally produced renewable energy can be, as mentioned by (Bues, 2022), aside from decarbonization effects and cost advantages, the reduction of reliance on imported fossil fuel can lead to increased energy security. As the governments that succeed in renewable energy have implemented an inclusive and transparent process with collaboration with different actors and local communities, this can be reflected in strategies identified by Linköping and Örebro. Though the aspect of including the local population is not as prevalent and might be important to consider.

5.3. Main challenges and strategies presented in the planning documents

5.3.1. Linköping Municipality
Several needs and issues have been identified and highlighted in the document for Wind Power Feasibility in the municipality of Linköping, as well as the county of Östergötland. Several factors are emphasized to have contributed to the challenges faced in expanding renewable energy, such as the prohibited areas that are designated by the armed forces, opposition from local communities, limited profitability, prolonged application and authorization processes, and an insufficient understanding of the technology (Östergötland län, 2016).

There was also a clear impending transformation expressed on a global level for renewable energy and the need to transform and adapt to the coming changes by applying certain measures. For instance, the infrastructure of the electrical grid is mentioned as needing to be adapted to handle a higher electricity consumption and higher demand. It is stated that the municipality needs to create conditions in which proper planning can occur to meet these demands (Linköping kommun, 2022a). Furthermore, electricity certificates are also described as causing a challenge as they are recognised for needing better control and regulations (Östergötland län, 2016).

The Wind Power Feasibility Study (Östergötland län, 2016) described the opposition that was displayed by the public as being another challenge. This manifested itself through protests by the local population against wind power establishments. The reasoning was to protect the environment and nature conservation, as well as the potential negative impact on human health. The possible change of landscape was also opposed (Östergötland län, 2016).

The authorisation and application process for wind farms is another challenge as they have been criticised to be time-consuming. There are also a lot of interests that need to be considered, making it time-consuming to involve all stakeholders and interests as well as the public to get a complete overview of all opinions. This is credited to how actors have a more positive attitude towards wind energy if they have been involved in the planning process. The outcome is interpreted to be more successful if all actors are involved (Östergötland län, 2016, Linköping kommun, 2022a). As the County Administrative Board plays an important role in helping determine where wind turbines can be placed it is suggested to have good communication between the Board and those involved in granting permits, to address issues like delays (Östergötland län, 2016).
Another issue brought up in the Wind Power Feasibility Study (Östergötland län, 2016) is that there needs to be a balance between renewable energy production against other declared national interests. The areas specified by the environmental code need special protection as they have valuable natural or cultural values. As different national interests can be in conflict with each other, when it comes to wind power versus other national interests, it is suggested that an assessment must be made on a case-by-case basis. The national interests featured as being in potential conflict with wind energy include the interest in outdoor recreation, cultural environment and conservation of cultural monuments, as well as conservation of nature reserves and Natura 2000 areas amongst others (Östergötland län, 2016).

The electricity certificate system is emphasized as not working as intended, causing it to be another challenge (Östergötland län, 2016). This system is meant to operate as a support system for the market of renewable electricity production. It is meant to help increase renewable electricity production while also making it more cost-effective (Energimyndigheten, 2021). It is described as being intended as a political instrument for the benefit of renewable energy. Though owners of wind energy production facilities express dissatisfaction and a disconnect between the cost of the certificates being high at times when the energy prices are high, and low when the energy prices are low, making it not very profitable for the owners. Though as the country continues producing and expanding renewable energy, the lower the cost is expected to become (Östergötland län, 2016). This issue is expressed by Linköping municipality (Östergötland län, 2016) as being out of the hands of the region and that it is a governmental matter.

The prohibition of areas designated by the armed forces is highlighted as one of the biggest obstacles facing specifically wind energy production in Linköping municipality (Östergötland län, 2016; Linköping kommun, 2022b). The municipality of Linköping is entirely within the restricted area for the armed forces as they carry out exercises in certain areas in the municipality. Another part of the issue mentioned was that the armed forces are against the restoration of old or depleted wind turbines. The issue with this is that newer wind turbines will usually be larger, bigger, and higher. Making it less likely for the armed forces to accept them with their bigger obstruction potential (Östergötland län, 2016). There were as of 2016 six wind turbines in the municipality, with no present plans or possibilities of expanding. One of the first wind turbines installed by Tekniska Verken 20 years ago has been decommissioned and will be resold for re-installation in other countries (Östergötland län, 2016).

One way to drive the progress of climate action and renewable energy, according to the Climate and Energy Programme for Linköping Municipality (Linköping kommun, 2022a), entails the active involvement of various stakeholders, including the local business community, residents, and other relevant actors. This can include actively lobbying and involving organizations like the federation of Swedish farmers (LRF), as they possess a lot of land area. Establishing citizen dialogues, among other approaches, has also been shown to be important for cooperation and collaboration. Transparency and clarity regarding objectives and strategies are also important. It is stated that creating favourable conditions for effective planning becomes imperative to meet the growing electricity demand in municipalities (Linköping kommun, 2022a). The Swedish Wind Power Association and the Association for Renewable Energy & Energy Efficiency have submitted proposals to the Energy Commission to improve the prospects of Swedish wind power. These include measures to facilitate wind power expansion and to assist
companies that invested in the initial surge of wind power despite market high costs (Östergötland län, 2016).

Engaging in open and constructive dialogues with local communities as part of the process has proven valuable in addressing concerns and complaints. Effective communication from the beginning of the planning phase, along with providing opportunities for involvement, such as becoming shareholders or partners in wind installations, has minimized opposition in municipalities within the region. Increased participation is also beneficial as it contributes to cost reduction. However, this works best when electricity costs are not high. If the shareholders find they are not actually benefitting, this is not expected to be successful (Östergötland län, 2016).

The Swedish Energy Agency, according to the Municipality of Linköping, discourages from the installation of wind energy in areas where there is opposition, and especially not by forcing installation through a third party or external actor. Instead, to achieve long-term success in establishing wind energy production, it was stated that there should be a requirement in the planning process and on planners to have a dialogue with local stakeholders, especially with groups that are against wind energy (Östergötland län, 2016).

5.3.2. Örebro Municipality

Similar to Linköping municipality, Örebro Municipality includes challenges for the expansion of renewable energy relating to areas of national interest and protected areas. In the document for Solar Electricity Production in Örebro Municipality (Örebro kommun, 2014), the aspect of natural and cultural values was brought up as affecting permits. This is clear for instance in the requirements by the Housing Agency that the cultural values of buildings should not be altered or affected and that the aesthetic values need to be preserved. This can stand in the way of getting building permits since solar cells can disrupt and affect the cultural value of a building (Örebro kommun, 2014). This is also brought up in the follow-up document for the climate strategy (Örebro kommun, 2018). Where the expansion of solar cells is stated to come into conflict with protected buildings that are of high cultural heritage value. To help manage this, the Urban Development Programme Board worked to collaborate with actors in construction to promote projects that use renewable energy and are more environmentally sustainable (Örebro kommun, 2018). Obstacles mentioned in the analysis for a climate-positive municipality (Örebro kommun, 2022), also include the type of contracts that exist and the distribution of electricity.

A solution could be to simplify the process to get building permits for solar cell installations. The building committee has the task to create guidelines and facilitate the process of applying for building permits for solar energy. Therefore it is suggested that the municipality make clearer guidelines and possibly also exempt fees for building permit applications (Örebro kommun, 2014, Örebro kommun, 2023).

Previous challenges that have been mentioned in Örebro Municipality involve the need for wind turbines to adapt to bird lake areas as they house sensitive wildlife such as breeding and resting areas for birds. Since wind power can have a negative impact on bird life, this means that the appeal of such areas for visitors, such as birdwatchers, can be reduced (Philipson Jancke, Fast, & Ask, 2011).
Other areas affected are older forests. Forests can impact the possibility of expanding wind energy as they are more sensitive to things like fragmentation, which can be an effect of wind energy production. Additionally, wind power can come in conflict with how visitors and locals perceive the landscape (Philipson Jancke, Fast, & Ask, 2011).

Wind power is presented as being something that alters the view of a landscape. It can disturb ancient agricultural landscapes, wetlands, and the archipelago. Wetlands constitute of habitats for a large number of plant and animal species while providing a variety of ecosystem services, can also be negatively affected by wind power. Areas in the archipelago that are important for recreational value are also more visually sensitive to wind turbines as they can be visible at great distances from both land and water. Popular recreational and outdoor areas are also sensitive because wind power can, as presented in the Landscape Analysis and Sensitivity Assessment for Wind Power (Philipson Jancke, Fast, & Ask, 2011), change the conditions for the feeling of wilderness (Philipson Jancke, Fast, & Ask, 2011).

Another topic which was highlighted was the storage of residual energy produced. One of the proposed solutions was to bypass the issue by not having to rely on only one source of energy but to combine multiple sources, such as hydropower with wind power and solar cells. This is proposed since solar cells and wind turbines work the best while hydroelectric plants are idle and vice versa. The combination is stated to make for a more productive renewable energy source (Örebro kommun, 2014).

According to the analysis for a climate-positive municipality (Örebro kommun, 2022), municipalities with fewer resources and limited investment opportunities face obstacles in their pursuit of sustainable renewable energy. Örebro Municipality’s reliance on the energy company E.ON for instance has also complicated matters. As the municipality lacks ownership of its energy company, it has limited influence over the content of the local district heating network.

Another challenge stated in the follow-up report for the climate strategy (Örebro kommun, 2018) was that the energy company Kumbro Vind AB, was part of an electricity agreement with Örebro municipality, Kumla municipality, and Futurum properties which meant they were limited to a certain volume of energy produced. This made it difficult to also reach the renewable energy goals as the energy produced seemingly does not correspond to the goals in the climate strategy.

Reaching the renewable energy goals which were set was described as being challenging as they may require additional efforts due to limitations in energy agreements and the need for policy changes at national and EU levels (Örebro kommun, 2014). However, Örebro municipality explains how expanding solar energy production is possible through having clear municipal goals. For instance, goals for municipal companies and as well as objectives for energy requirements in municipal buildings. Additionally, to get building permits for solar energy facilities, possibly even waive the costs for permits for solar energy. Moreover, producing documents and offering support and counselling to spread knowledge and aid to make decisions regarding solar energy production. Following up on previous projects is also one of the ways to achieve the energy goals according to the municipality (Örebro kommun, 2014, Örebro kommun, 2023).
5.3.3. Comparison and Analysis

Both municipalities express difficulties and challenges in the expansion of renewable energy sources. Though as some of the documents are not recent, the results might look different if studied from more recent documents.

In Linköping, the main challenges identified include prohibited areas designated by the armed forces, possible opposition from local communities, and long application and authorization processes. As well as limited options for producers to profit and an insufficient understanding of the technology. And conflicting national interests. The municipality also highlights the need for the electrical grid to be adapted so it can handle higher electricity consumption and demand. Challenges with the electricity certificate system and conflicting national interests are also emphasized. Strategies proposed to aid with these challenges involve communication and collaboration with stakeholders and citizens. The application process also needs to become more effective. The results show that the political will to expand on renewable energy exist, though the issue with long application processes might be beneficial for something as big as renewable energy. It takes up large areas and can also affect and change the landscape in a significant way. Therefore maybe it can be positive that there are precautions and the progress is slow.

The challenges faced are reflected by the focus of solar energy expansion, as the possibility of expanding wind energy is expressed to be more difficult due to the national interest of the armed forces being prioritised. This is also mentioned by Fors et al. (2020), as they discuss how the defence is one of largest hurdles to allow for the expansion of renewable energy in large areas.

Örebro municipality has a larger focus on challenges for the expansion of solar energy in its document for Promotion of Solar Electricity Production (Örebro kommun, 2014). Challenges mentioned include the cultural values and aesthetic preservation of buildings, as well as requirements by the housing agency. The necessity for a more effective application process is also mentioned. Furthermore, from the documents available, wind energy development in Örebro faces challenges related to its impact on bird lakes and the effect of changed landscapes in different. This could be similar in Linköping Municipality as well, though no document has included it. Strategies to overcome these challenges involve, similarly to Linköping Municipality, a more effective permit application process, and collaborating with different actors in a dialogue. As well as relying on multiple energy sources to create a more sustainable energy production. The municipality of Örebro also highlights the need for the electricity grid to be upgraded.

Something that is not touched upon but seems to be an important aspect of the expansion of renewable energy is to find solutions to store the energy produced (Kamarulzaman, Hasanuzzaman & Rahim, 2020). This should go along with creating better policies and a more national practice for introducing renewable energy. Another thing not brought up in the different documents is how the renewable energy goals have not corresponded to the goals in the climate strategy. This could be assumed should have been acknowledged with newer documents, though it seems that the different planning documents that bring up renewable energy are not streamlined and often repeat similar information. This might show a need for a better collaboration within the municipality. There are also no accountability for not reaching the renewable energy goals, making it easier not to prioritise them.

In the context of renewable energy development, both municipalities Linköping and Örebro have expressed the necessity to transition to renewable energy sources and address various
challenges to achieving that. The difficulty in dealing with concerns from the local population regarding the impacts of renewable energy highlights the importance of having a dialogue with the public and the need for participation in the decision-making process. On the one hand, this participatory approach is aligned with EM and the importance to involve various actors in the planning process (Toke & Stracahan, 2006, Toke, 2014). On the other hand, there are also contradictions between the two concepts. EM emphasizes economic growth and collaborations with the aim of environmental protection and achieving common goals. While PPPs also encourage collaboration, private companies seem driven by their own financial gain with little focus on the environmental aspect. Rather than relying on PPPs, it will be important for municipalities or the public sector to ensure that private actors they collaborate with share the same objectives and values as this can easily become an issue with private companies not being regulated or held accountable in the same way a municipality is.

Furthermore, the challenges related to the permit application process and indicate the need for streamlined and supportive governance structures, as associated with PPPs (The World Bank, 2020; Fang et al., 2018). The municipalities emphasize the importance of effective planning, clearer guidelines, and collaboration between different stakeholders, and local communities as well as moving the responsibility to a governmental level. This shows that an important part of the expansion of renewable energy relies on a smooth administrative process. Though at the same time, the municipal veto for wind power shows that the municipality does have some power (Westander et al., 2022; Ståhl, 2018). The focus should maybe also be on either having a municipal veto for solar energy as well as it becomes possible on a municipal level to influence the energy sources equally.

Energy companies seem to be imperative to help fund renewable energy, yet it seems important to also make sure the municipality and the companies in collaboration with it share power and responsibility, to avoid challenges like the one mentioned for Kumbro Vind AB where the goals were not able to be reached (Örebro kommun, 2018). Both the municipality and the companies working with them benefit from collaboration over one of the parties having more control. As with the dependency on the energy company E.ON for Örebro municipality (Örebro kommun, 2022). The reliance on E.ON for instance has further showed how important it is for control over renewable energy production to be distributed evenly among actors. As the municipality lacks ownership of its energy company, it has limited influence over the content of the local district heating network.

Additionally, the issue of prohibited areas designated by the armed forces and the requirements for preserving cultural heritage buildings, as well as the sensitivity around a changing landscape, highlight the difficulties of balancing renewable energy development with other societal interests. It is reasonable that due to the different conflicting interests, case-by-case considerations are required. This also includes working with different actors and maintaining PPPs. However, due to the many interests that can often overshadow renewable energy, this might indicate a need for a change of priorities.

There is a sentiment presented that local efforts by the municipality are not enough to transform the way renewable energy is currently introduced. Instead, both municipalities express that more engagement at the national level is required. This pertains particularly to the influence needed to change policies and to reconsider restricted areas designated by the armed forces, as well as make changes to the electricity certificate system.
6. Discussion

The expansion of renewable energy, as expressed in the literature review and the results, is clearly something that both municipalities have been moving towards. Providing access to renewable and sustainable energy is something that is likely to become more prevalent in the future, and planning for it will contribute to a more secure future as well as help reach the SDGs. Both municipalities have goals that match the ones on a national level and are working towards achieving them. To answer if there are differences between municipalities and if they have different approaches with solar versus wind energy, the two municipalities work in similar ways, and they have similar published planning documents. Though Linköping inevitably plans for a different landscape of renewable energy with a larger focus on solar energy as the municipality has more difficulties in actually expanding wind energy due to the prohibited areas. From the more recent documents, both municipalities seem to emphasize expanding solar energy production. Though this might merely indicate that the work that can be done to expand wind energy production on land has already been done. This might change if there are areas found on which wind energy can be installed effectively. Since the interest of the armed forces is more prioritised than the national interest of wind energy production, planning should presume from the fact that the armed forces might not allow either wind or solar energy production on their premises. Unless they do, the available land area, as well as areas in the vicinity of them, will have to be excluded from planning. The national interest in food production is also highly prioritised, and even if there has been research that proves benefits for crops from renewable energy, it is still uncommon and might seem to be perceived as too big of a risk to try. Therefore, it is reasonable that the focus has been on solar cells being installed on municipal roofs for instance, rather than finding suitable land areas. It could be discussed if it could be helpful for the expansion of renewable energy if there is a national interest designated for solar energy as well.

By including the Wind Power Feasibility Study (Östergötland län, 2016) without having studied it beforehand, it turned out to be somewhat insignificant for this study. As it was a study that concluded in wind energy not being a reasonable focus for the municipality, it was not comparable to the Landscape Analysis and Sensitivity Assessment for Wind Power (Örebro kommun, 2011). Although it was difficult to find municipalities that did have published documents that were comparable as well as recent, the foundation of the thesis could not rely on this as a way to choose cases to study. It can be presumed that different municipalities have different resources and priorities that have overshadowed the issue of planning for renewable energy. The material available was simply not sufficient for this to be a comprehensive study. A suggestion could be that in the future, to expect parallel documents released in the same years in all or some municipalities. This should include a thorough research and updates on what has been done so far, as well as lessons learned. This should also encompass social, economic and environmental aspects of renewable energy. These kinds of documents, although possibly time consuming and in need of resources, would benefit municipalities by learning from others as well as having an overview of their own work.

Bevir (2011) and Blanco (2013) explain how governance can streamline policy-making processes by avoiding bureaucratic delays. This is also reflected in how the permit application processes take a long time. This can also explain the many planning documents that exist and discuss renewable energy, but not a lot of concrete plans and updated versions exist, as the way municipalities work tends to take a long time. This could lead to technology in the renewable energy industry evolving much faster than the municipalities are able to produce plans to expand renewable energy. Policies need to also change fast enough to allow for the fast-growing
technology. Though renewable energy is part of multi-level governance and is influenced by different levels of government as well as non-governmental actors. It is important to note that with the distribution of power, municipalities can be constrained by policies on a higher administrative level. There is a centralized power hierarchy with national and supranational entities controlling things outside of the jurisdiction of the municipality. It would therefore be beneficial to instigate collaboration between the different levels of authority.

Municipalities work with and answer inquiries from stakeholders who might be interested in building a wind or solar energy farm. By working with the different actors, this helps ensure that all interests and concerns are considered in the planning process. This can make it possible for municipalities to identify and mediate between parties and understand the different perspectives of opposition or approval of the ideas. For instance, owners of agricultural land and farmers, or representatives of the Federation of Swedish Farmers, might be opposed to the ideas of expanding renewable energy on their farmland as it can contend with their interests in maintaining agriculture. Although this shows the importance of involving stakeholders in the planning process for renewable energy, this can also cause hindrance in the process and lead to it taking a longer time.

The idea of Ecological modernisation claims that it is possible to protect the environment while also achieving economic development. Although renewable energy emits little GHG and other pollutants compared to other energy sources, the production of renewable energy should be included in the discussion. Similar to other ideas that benefit already wealthy countries, the production of solar cells and wind turbines, as well as their waste, can also cause stress on the environment and natural resources. Mainly in other countries far away from where they are used. Although technological innovation is important, social sustainability should therefore also be a part of ecological modernisation and the planning for renewable energy expansion.

The use of PPPs as part of the theoretical framework could be argued as it would have been more relevant if the collaboration within the municipalities included more private actors. Though with more actors involved, this could also lead to a longer process for greenlighting renewable energy projects. Conflicts can arise when there are even more interests that are competing for the same land or area. The interests of the armed forces, other cultural and natural values, the security of food production, the profitability for companies, and the opinions of locals seem to be the most repeated interests. The benefits of renewable energy can be recognised only if they don't interfere with all other interests, which can also explain why the process of finding a suitable area can take a long time. It also seems that although companies might be interested in for instance installing solar energy parks as they see it as a good investment, the options to do so are minimised due to the other interests mentioned. It appears as though social sustainability and environmental sustainability in this instance, are prioritised over economic development. What would benefit society the most or what the highest priority should be might be something other than renewable energy. Yet providing a sustainable source of energy is a growing priority that also touches on several other societal aspects and should be aimed to incorporate in the planning of for instance social equality and the distribution of energy. Additionally, it can be valuable to work it into environmental and economic sustainability.

An issue with both EM and PPPs could, at its core, include the conflict between the concepts of economic growth and ecological sustainability, as the two are difficult to achieve simultaneously though both concepts claim that it is possible. There is also a discussion missing regarding social equality and what social groups gain access to renewable energy if it is for
instance driven by private actors. These gaps highlight the need for a comprehensive approach that considers social, economic, and environmental dimensions in municipal planning for renewable energy.

The potential outcome of this thesis could have been enhanced and produced more substantial results and contributions, had the original plan for the method been carried out. As mentioned previously, the study was intended to include more cases, as well as other methods, such as interviews and a discourse analysis by identifying attitudes in the local media and between different actors and stakeholders. As well as public perception on renewable energy. This would have been difficult to accomplish in the time frame of the thesis. Suggested future research derive from that, which is to study more municipalities and include interviews with experts from municipalities and from other actors. It would also be valuable to study public opinions and local news to achieve a more comprehensive overview of the subject. As well as focus on the conflicting interests and how they can be managed.

7. Conclusion

This thesis aimed to examine and compare how the municipalities of Linköping and Örebro integrate wind and solar energy into their planning documents, as well as look into the role of external actors in the expansion of renewable energy production in municipalities. The thesis explored how the municipalities of Linköping and Örebro manage renewable energy through their planning documents. It identified plans by comparing their approaches and highlighted how the municipalities work with different actors. It also identified potential obstacles and opportunities and recognised where there is more need for innovation, collaboration, and resources in the future.

The documents from both municipalities showed that renewable energy has been prioritized, with specific goals for wind and solar energy. The planning documents from Linköping Municipality seem to focus on becoming a leader in solar energy production (Linköping kommun, 2020), while Örebro seems to have fewer obstacles to expanding in both wind and solar energy. The two municipalities also seem to share similar goals and actively encourage renewable energy installations. Since the documents are not all published at the same time, and newer information might be included in the newest and unpublished versions of the documents, the results might not include the most recent work from the municipalities. This means that the results could reflect a less progressive or different approach than the current one.

In Linköping, the municipality has taken a collaborative approach with various actors to achieve its renewable energy goals. The municipality owns several companies that adhere to specific regulations and undertake initiatives such as installing solar cells on rooftops. The Swedish Energy Agency and Statistics Sweden, along with the municipality, have been the major contributors to solar cell expansion. The municipality also collaborates with businesses as part of a network that addresses climate challenges, including energy management.

Linköping Municipality also involves actors outside the municipality through different initiatives. The collaboration and dialogue between the municipality, local business community, and citizens are emphasized as important for achieving the climate and renewable energy objectives. Outside actors can support the municipality by purchasing wind and solar power generated by the municipality and promoting renewable energy.
Örebro Municipality pointed out that marketing plays an important role in attracting companies and potential investors interested in solar parks, as it offers visibility and brand promotion opportunities.

The engagement of actors outside the municipalities in renewable energy projects aligns with the principles of ecological modernization and involves public-private partnerships. These approaches facilitate collaboration, technological innovation, market-driven solutions, and knowledge sharing among other things. By incorporating these concepts, Linköping and Örebro municipalities can enhance their renewable energy initiatives and contribute to a more sustainable future.

The main challenges identified include prohibited areas designated by the armed forces, possible opposition from local communities, and long application and authorization processes. The municipality also highlighted the need for the electrical grid to be adapted so it can handle higher electricity consumption and demand. Challenges with the electricity certificate system and conflicting national interests are also emphasized. Strategies proposed to aid with these challenges involve communication and collaboration with stakeholders and citizens.

In applying the concepts of EM and PPPs in relation to this study, it is possibly to recognise that EM on the one hand focuses on technological innovation and market-based approaches which can lead to sustainable development and environmental protection. Its assumptions on economic growth coexisting with environmental conservation can be possible, however it is indicated that EM prioritises profit and might overlook issues of environmental protection. In municipal planning documents, this may lead to an uneven emphasis on economic development over the benefits of renewable energy on the environment.

PPPs on the other hand, emphasize collaboration and are viewed as a way to for the private sector to provide resources, expertise, and innovation for the implementation of renewable energy projects. However, the private sector may have different objectives than the public sector, specifically related to profitability. This may overlook potential conflicts of interest or the prioritisation of profit over public interest. Moreover, if given the power over the public sector, the private sector might shape the discourse around renewable energy planning and disregard its environmental benefits. Though there exists a paradox as economic profit is needed for the development of cheaper and more available renewable energy projects.

Although the research questions were responded to, the potential outcome of this thesis is recognised to have been enhanced and produced more substantial results and contributions, if a more comprehensive method approach was taken. Still, studies like this can have an impact on understanding how renewable energy is managed on a municipal level and contribute to the existing and growing research that is needed to establish a sustainable and successful expansion of renewable energy.

The themes that were identified through the thematic analysis are the following: Carbon Neutrality Goals: Both municipalities have set targets to achieve carbon neutrality within a specified timeframe. Municipal Leadership and Collaboration: The municipalities both promote sustainable energy in their planning documents and work towards their goals in collaboration with various actors. They also seem to value partnerships for their investments in renewable energy projects. Challenges: The municipalities face challenges in achieving their renewable energy goals. These challenges include restrictions on wind and solar energy production due to prohibited areas amongst other things. Municipal ownership and initiatives:
The municipal groups in both Linköping and Örebro own companies that play a significant role in renewable energy production. These companies are involved in initiatives related to sustainable energy production, including increased energy efficiency and the installation of solar and wind power facilities. Carbon neutrality and emission compensation: Both municipalities have set goals to become carbon neutral. One of the ways they aim to compensate for previous carbon emissions is through renewable energy production. Marketing and strategic placement: The municipalities recognize the importance of marketing and strategic placement for renewable energy projects. In Örebro, the promotion of solar electricity production emphasizes marketing opportunities for companies and investors. Examples include placing solar parks near shopping centres, parking spaces, and busy roads to target companies interested in utilising those spaces. Price regulation and contracts: The municipalities discuss the challenges related to the price of electricity within the grid. Companies that own the grid and produce electricity have the power to raise prices, which can make it challenging for other actors to profit. Long-term contracts with fixed prices are suggested as a solution to ensure profitability and stability. Changes in policy: The documents from both municipalities highlight the need for policy and regulatory changes on national and EU levels to support renewable energy goals. Conflicts with National Interests and Protected Areas: The expansion of renewable energy can conflict with other national interests and protected areas. Balancing renewable energy production with the preservation of natural and cultural values is identified as being one of the biggest challenges. These themes highlight the complicated nature of challenges and considerations involved in expanding wind power and solar energy in the context of Linköping and Örebro.

7.1. Suggested Future Research

Although this thesis has provided some insights into the renewable energy expansion in the municipalities of Linköping and Örebro, there are several avenues for future research that could further enhance the outcomes and contributions of this study. This includes incorporating additional methods and sources of data, and in that way providing a more comprehensive study on the topic. Suggested future research includes studying more municipalities, interviewing experts, studying public opinions in local news, and addressing potential conflicting interests.

Expanding the scope of the study to include more municipalities could allow for a generalisation and understanding of the factors that influence renewable energy. Conducting interviews with experts can provide a deeper insight into the work of municipalities and can benefit the understanding of how different actors work with the municipality through first-hand knowledge. Interviews would provide valuable qualitative data, complementing the quantitative analysis conducted in this thesis. Studying public opinions through local news and media can also add another layer of understanding in regard to possible opposition and the public perception of renewable energy. Conducting surveys, focus groups, or interviews with residents could offer insight into attitudes and concerns and eventually help planners develop strategies and understand how to gain public support for renewable energy projects. Studying local news can also provide a nuanced understanding of the current discourse, initiatives, and highlight important actors that influence renewable energy. By addressing conflicting interests, future research can benefit renewable energy by exploring how to manage any competing agendas and interests as it involves collaboration between several actors to succeed. This can help policymakers and planners to develop more sustainable policies for the future of renewable energy.
References


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Regeringens proposition 2017/18:228 Energipolitikens inriktning. [Retrieved 2023-02-10 from: https://www.regeringen.se/497262/contentassets/5fe7ecdee2b440eb81348fc722324e91/energipolitikens-inriktning-prop.-201718228]


SCB. (n.d.). Kommuner i siffror. [Retrieved 2023-06-05 from: https://kommunsiffror.scb.se/?id1=0580&id2=1880]


SFS 2022:1272. Environmental Code
SMHI. (2022b). Klimatindikator - solinstrålning [Retrieved 2023-04-20 from https://www.smhi.se/klimat/klimatet-da-och-nu/klimatindikatorer/stralning-1.17841#:~:text=Diffus%20str%C3%A5lning%20%C3%A4r%2C%20och%20infaller%20fr%C3%A5n%20hela%20himlavalvet]


Sveriges miljömål. (2018). Andel energi från förnybara energikällor [Retrieved 2023-04-05 from: https://www.sverigesmiljomal.se/miljomalen/generationsmalet/fornybar-energi/#:~:text=f%C3%B6r%20Sverige%20inneb%C3%A4r%20direktivet%20att,3%20procentenheter%20mer%20%C3%A4n%202019]


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Örebro kommun. (2014). Främjande av solelproduktion i Örebro kommun. [Retrieved 2023-04-10 from https://www.orebro.se/download/18.1d8f9a39155628738416904/1467966358123/Fr%C3%A4mjande+av+solelproduktion+i+%C3%96rebro+kommun.pdf]


Örebro kommun. (2018). Temarapport klimat 2017 - Uppföljning av Klimatstrategi för Örebro kommun. [Retrieved 2023-04-10 from https://www.orebro.se/download/18.3f0d8c0917db1f9d43575b/1642767256393/Temarapport%20klimat%202017%20-%20uppf%C3%B6ljin%20av%20Klimatstrategi%20-%20-%20%C3%96rebro%20kommun.pdf]
