Coding of the Thesis
☐ Access only possible after consultation of the author
☐ Confidential: Access not possible

Bachelor Thesis

The Challenges of Municipalities during the Energy Transition

Lucerne University of Applied Sciences and Arts - School of Engineering and Architecture
Bachelor of Science in Energy Systems Engineering

Horw, Lucerne University of Applied Sciences and Arts – E&A
June 11th, 2021

Submitted by Yves Hauert

Lucerne University of
Applied Sciences and Arts
HOCHSCHULE
LUZERN
Technik & Architektur
FH Zentralschweiz

Bachelor Thesis at the Lucerne School of Engineering and Architecture

The Challenges of Municipalities during the Energy Transition

Author: Yves Hauert
yvesmichel.hauert@stud.hslu.ch

Supervisors: Prof. Dr. Shaun West
shaun.west@hslu.ch
Richard Lüchinger
richard.luechinger@hslu.ch

Expert: Jim Siler
Jis Associates

Industry Partner: Prof. Dr. Christoph Imboden
Competence Centre for Power Economy

Semester: Spring semester 2021

Lucerne University of Applied Science and Arts – School of Engineering and Architecture
Bachelor of Science in Energy Systems Engineering

Horw, Lucerne University of Applied Science and Arts – T&A
June 11th, 2021

Declaration of authorship

Lucerne University of
Applied Sciences and Arts
HOCHSCHULE
LUZERN
Technik & Architektur
FH Zentralschweiz

Bachelor's thesis at the Lucerne School of Engineering and Architecture

Declaration of independently created work and due academic integrity

Title	**The Challenges of Municipalities during the Energy Transition**
First name	**Yves**
Surname	**Hauert**
Date of birth	**19.04.1996**
Study program	**Bachelor of Science in Energy Systems Engineering**
Semester	**Spring semester 2021**

Independently created work
I hereby declare that I have carried out this thesis independently and used only the resources specified.

Academic integrity
- ☐ All text extracts, citations or content from other authors are expressly indicated as such.
- ☐ This version of the bachelor's thesis has not been reworked by a lecturer.
- ☐ The digital version submitted for the portfolio database is identical to the printed version (if a written version had to be submitted), both in terms of content and layout.

Place, date **Bern, 11th June 2021**

Signature of student

Yves Hauert

Executive summary

Due to the consequences of global warming, demographic, economic and technological developments are changing faster than ever before. The availability and quality of vital resources depend on these changes. The importance of climate and environmental issues is not only reflected in the awareness of the population, but also in corresponding laws and regulations. While laws and framework conditions are mostly set at the (inter)national level, implementation is mainly regional and local. This can also be observed for the energy transition, in which municipalities are confronted with complex new tasks. Therefore, this thesis analyses the challenges of the energy transition faced by Swiss municipalities using the municipality of Küsnacht in Zurich as a case study. The methods used include a stakeholder analysis and expert interviews to identify the relevant actors, as well as an ecosystem analysis that identifies drivers, barriers and key success factors of the energy transition at the municipal level. In addition, possible conflict potentials were uncovered by means of systems thinking to derive a recommendation as best practice for the municipalities.

The results of the stakeholder analysis (Figure 2) show that six stakeholders were identified as relevant actors for the energy transition in the municipality of Küsnacht (highlighted in red). Among them are four institutional stakeholders (municipality executive, energy commission, municipality president and community parliament) and two external stakeholders (local residents and building owners) who possess great interest and power in the local energy transition and were thus identified as key players.

Figure 2: Results of the stakeholder analysis for Küsnacht ZH

To better understand the connections and relationships between the identified key players, an ecosystem analysis was carried out. This enabled the identification of relevant drivers, barriers and key success factors for the local energy transition in Küsnacht. Figure 3 below, shows the complex ecosystem map with the respective value flows based on the layers depicted in the legend next to it.

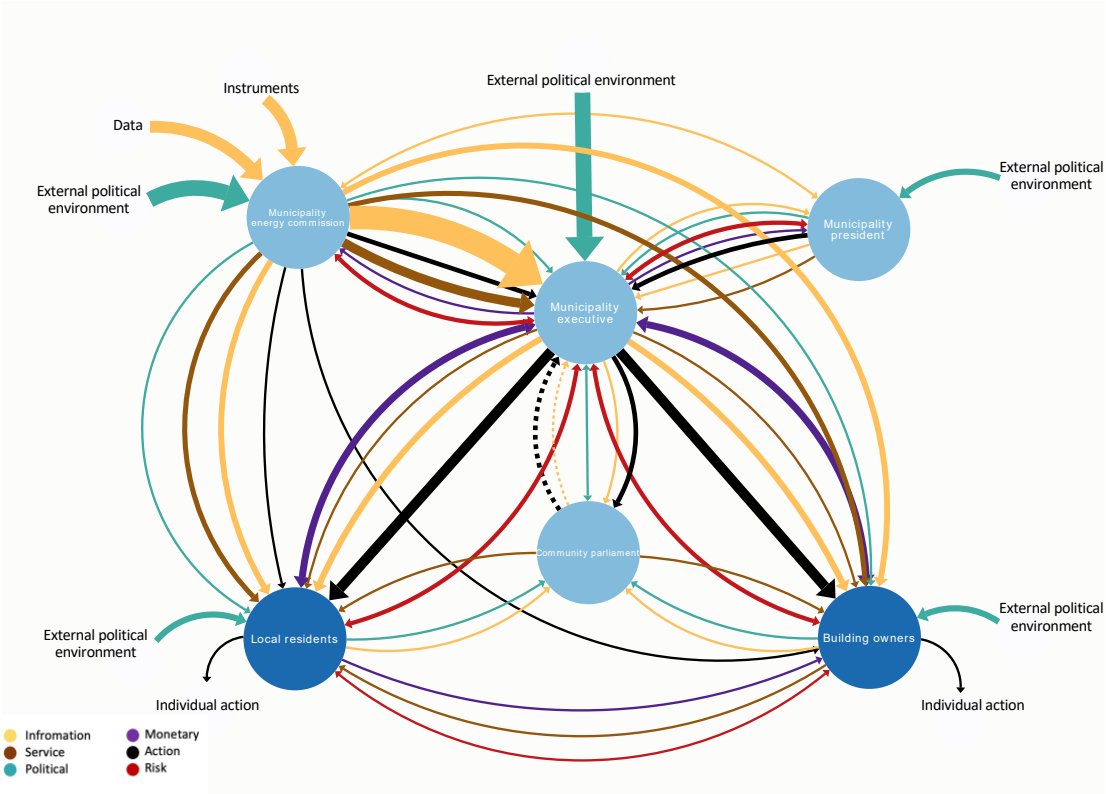


Figure 3: Results of the ecosystem analysis for Küsnacht ZH

The analysis identified the strong financial resources, the will of the municipality to take on a pioneering role and the occupation of key positions within the municipality with ambitious personalities as relevant drivers. Complexity was identified as one main barrier to a successful local energy transition, as the role of municipalities in the energy transition process is perceived as not being defined clearly enough. Therefore, from the municipalities' point of view, clearer cantonal guidelines are desired to facilitate the persuasion of the population. Since local residents and building owners have been identified as key players, the development of an engagement strategy for these actors is essential for the municipalities. However, the results of this thesis show that there is still room for improvement in terms of long-term communication strategies. Only through participatory processes can the behaviour of energy consumers be influenced, which ultimately determines the development of the local energy transition in addition to regulatory guidelines. However, to adequately derive the necessary strategies for this, municipalities are dependent on reliable data quality and planning instruments that show the status of the current situation. Through this, appropriate measures can be developed that can be implemented by local actors.

Therefore, municipalities are recommended to improve data quality through partner projects with neighbouring municipalities, external consultants and local universities. Through resource synergy, more efficient and faster action can be taken. In addition, the shared know-how can be used to test innovations in a real, low-risk environment, fostering innovation cycles that lead to an advancement of the local energy transition.

The report also addresses the fact that the analysis carried out has its limitations. Since the results were obtained using Küsnacht as a reference, they are not automatically transferable to all other Swiss municipalities. This is due to the great heterogeneity that exists between the municipalities in terms of size and governance style. Nevertheless, many of the identified barriers and success factors could also be found in other municipalities, even across national borders.

Abstract

When it comes to climate and environmental change, municipalities are important actors. While laws and framework conditions are mostly set at (inter)national level, implementation is largely regional and local. Municipalities are thus confronted with complex new tasks. This thesis therefore evaluates the challenges faced by Swiss municipalities during the energy transition, using the municipality of Küsnacht in Zurich as a case study.

By means of a stakeholder analysis and expert interviews, the relevant actors in the energy transition at the community level were investigated. The results of the analyses show that above all internal community stakeholders (energy commission, municipality executive, municipality president and community parliament) have great influence and interest in the local energy transition. In addition, external actors such as local residents and building owners were also classified as key players who influence the local energy transition due to their direct involvement as energy consumers.

To identify drivers, barriers and success factors that show which aspects promote or hinder the energy transition, an ecosystem analysis was conducted. Strong financial resources and the ambition to take the lead as a municipality were identified as important drivers of Küsnacht. However, to address the local energy transition, the municipality requires access to qualitative data and planning tools to develop appropriate strategies. This could be promoted through partner projects with neighbouring municipalities, external consultants and local universities. Furthermore, a lack of concretisation of the cantonal guidelines for municipalities was identified to better define the role of municipalities in the energy transition. The municipality of Küsnacht therefore has only limited influence on its population and is dependent on the cantonal framework conditions. Potential for improvement was also identified in the involvement of energy consumers, such as the local population. To realise an effective implementation of the energy transition, municipalities need to involve energy consumers in the local decision-making process in a participatory manner. For this, it was found that a long-term communication strategy is of great importance.

Potential conflicts were illustrated through systems thinking by analysing how changes in barriers and drivers affect the local energy transition. The results confirm the majority of the findings from the ecosystem analysis in that a large part of the impact remains with the end consumer, in this case the local resident, and their lifestyle.

Although there is a great heterogeneity in terms of size and governance style among Swiss municipalities, many of the results obtained could also be identified in other municipalities even across national borders.

Kurzdarstellung

Wenn es um Klima- und Umweltveränderungen geht, sind Kommunen wichtige Akteure. Während Gesetze und Rahmenbedingungen meist auf (inter)nationaler Ebene gesetzt werden, erfolgt die Umsetzung weitgehend regional und lokal. Die Gemeinden sind somit mit komplexen neuen Aufgaben konfrontiert. Die vorliegende Arbeit evaluiert daher die Herausforderungen, die sich den Schweizer Gemeinden im Zuge der Energiewende stellen, am Beispiel der Gemeinde Küsnacht in Zürich.

Mittels einer Stakeholder Analyse und Experteninterviews wurden die relevanten Akteure der Energiewende auf Gemeindeebene untersucht. Die Ergebnisse der Analysen zeigen, dass vor allem gemeindeinterne Akteure (Energiekommission, Gemeindevorstand, Gemeindepräsident und Gemeindeparlament) großen Einfluss und Interesse an der lokalen Energiewende haben. Darüber hinaus wurden auch externe Akteure wie Anwohner und Gebäudeeigentümer als Schlüsselakteure eingestuft, die aufgrund ihrer direkten Beteiligung als Energieverbraucher die lokale Energiewende beeinflussen.

Um Treiber, Barrieren und Erfolgsfaktoren zu identifizieren, die zeigen, welche Aspekte die Energiewende fördern oder behindern, wurde eine Ökosystemanalyse durchgeführt. Starke finanzielle Ressourcen und der Wille, als Gemeinde die Führung zu übernehmen, wurden als wichtige Treiber von Küsnacht identifiziert. Um die lokale Energiewende anzugehen, benötigt die Gemeinde jedoch Zugang zu qualitativen Daten und Planungsinstrumenten, um geeignete Strategien zu entwickeln. Dies könnte durch Partnerprojekte mit Nachbargemeinden, externen Beratern und lokalen Universitäten gefördert werden. Darüber hinaus wurde ein Mangel an Konkretisierung der kantonalen Richtlinien für Gemeinden festgestellt, um die Rolle der Gemeinden in der Energiewende besser zu definieren. Die Gemeinde Küsnacht hat daher nur begrenzten Einfluss auf ihre Bevölkerung und ist abhängig von den kantonalen Rahmenbedingungen. Verbesserungspotenziale wurden auch bei der Einbindung der Energieverbraucher, wie z.B. der lokalen Bevölkerung, identifiziert. Um eine effektive Umsetzung der Energiewende zu realisieren, müssen die Kommunen die Energieverbraucher partizipativ in den lokalen Entscheidungsprozess einbeziehen. Hierfür wurde festgestellt, dass eine langfristige Kommunikationsstrategie von großer Bedeutung ist.

Potenzielle Konflikte wurden durch Systemdenken veranschaulicht, indem analysiert wurde, wie sich Veränderungen der Hemmnisse und Treiber auf die lokale Energiewende auswirken. Die Ergebnisse bestätigen den Großteil der Erkenntnisse aus der Ökosystemanalyse insofern, als dass ein großer Teil der Auswirkungen beim Endverbraucher, in diesem Fall dem Anwohner, und seinem Lebensstil verbleibt.

Obwohl eine große Heterogenität in Bezug auf Größe und Führungsstil unter Schweizer Gemeinden herrscht, konnten viele der erzielten Ergebnisse auch in anderen Kommunen sogar über die Landesgrenzen hinaus identifiziert werden.

Table of contents

List of figures

List of tables

Abbreviations and acronyms

CLD	Causal Loop Diagram
CO_2	Carbon dioxide
EnDK	Kantonale Energiedirektion
ES 2050	Energy Strategy 2050
GHG	Greenhouse gas
IBR	Business and Regional Economics
IEA	International Energy Agency
MuKEn	Mustervorschriften der Kantone im Energiebereich
PV	Photovoltaics
RES	Renewable energy systems
SA	Stakeholder Analysis
TES	Total Energy Supply

1 Introduction

Climate and environmental change as well as demographic, economic and technical developments are changing living conditions on earth in the 21st century as never before. The availability and quality of the essential resources water, air and food depend on these changes. The importance of climate and environmental issues is not only reflected in the awareness of the population, but also in corresponding laws and regulations. On 21 May 2017, Swiss voters approved the revised energy law on the Energy Strategy 2050, which aims to promote renewable energies, reduce energy consumption and increase energy efficiency. This is intended to strengthen domestic renewable energies and reduce dependence on imported fossil energies (UVEK, 2021). In addition to the Paris Agreement (2016), the Federal Council aims to reduce greenhouse gas emissions in Switzerland by 70-85% by 2050 compared to 1990 (FOEN, 2018). To achieve these goals, the three main sectors of households, transport and industry must drastically reduce their energy consumption as well as their greenhouse gas emissions by transforming the energy system. The transformation of the energy system or energy transition is a continuous, complex, incremental process that is guided by the guiding principle of sustainable development (Dewald, et al., 2019).

1.1 Current starting situation

When it comes to climate and environmental change, municipalities are important actors. While laws and framework conditions are usually set at (inter-)national level, implementation is largely regional and local. The municipalities are thus faced with complex new tasks. They are responsible for the energy supply, which must be adapted in accordance with the Energy Strategy 2050, as well as for spatial and mobility planning. As an interface to the population, they have a key function in the implementation of the Energy Strategy 2050. Municipalities take on a special role in the creation of a permanently liveable environment, which takes place in particular at regional and local level. The creation of a more liveable environment must be pursued in parallel with the adaptation to the Energy Strategy 2050. The development and creation of a more liveable environment is an essential part of the energy transition of municipalities. Since adapting to the Energy Strategy 2050 while creating a more liveable environment is a complex undertaking, supporting and accompanying municipalities along this process is indicated and necessary. In order to find solutions to problems that arise, the analysis of the energy transition of municipalities is central.

1.2 Project aim

The aim of this thesis is to identify the relevant actors and their influence on the energy transition at community level in Switzerland to highlight possible obstacles and success factors for municipalities in the implementation of the local energy transition. The solution approaches to overcome these obstacles and thus facilitate the energy transition for municipalities will be developed. Therefore, this thesis addresses the following research questions:

I. Who are the relevant actors in the energy transition at the municipal level?

II. What are the barriers and drivers of the energy transition at the municipal level?

III. What are the most important success factors of the energy transition at the municipal level?

1.3 Project objectives

Based on the project aim, the following project objectives are to be achieved:

- Development of a stakeholder analysis to identify relevant actors and their influence on the implementation of the energy strategy in municipalities
- Identification of barriers, drivers and key success factors in the energy transition at municipal level
- Creation of a visual system dynamic model of the energy transition at the municipal level to identify potential conflicts of interest
- Recommendation for best practices

1.4 Report overview

Figure 4 below provides an overview of the thesis by showing the chapters and the topics covered therein, as well as the correlation between the individual sections.

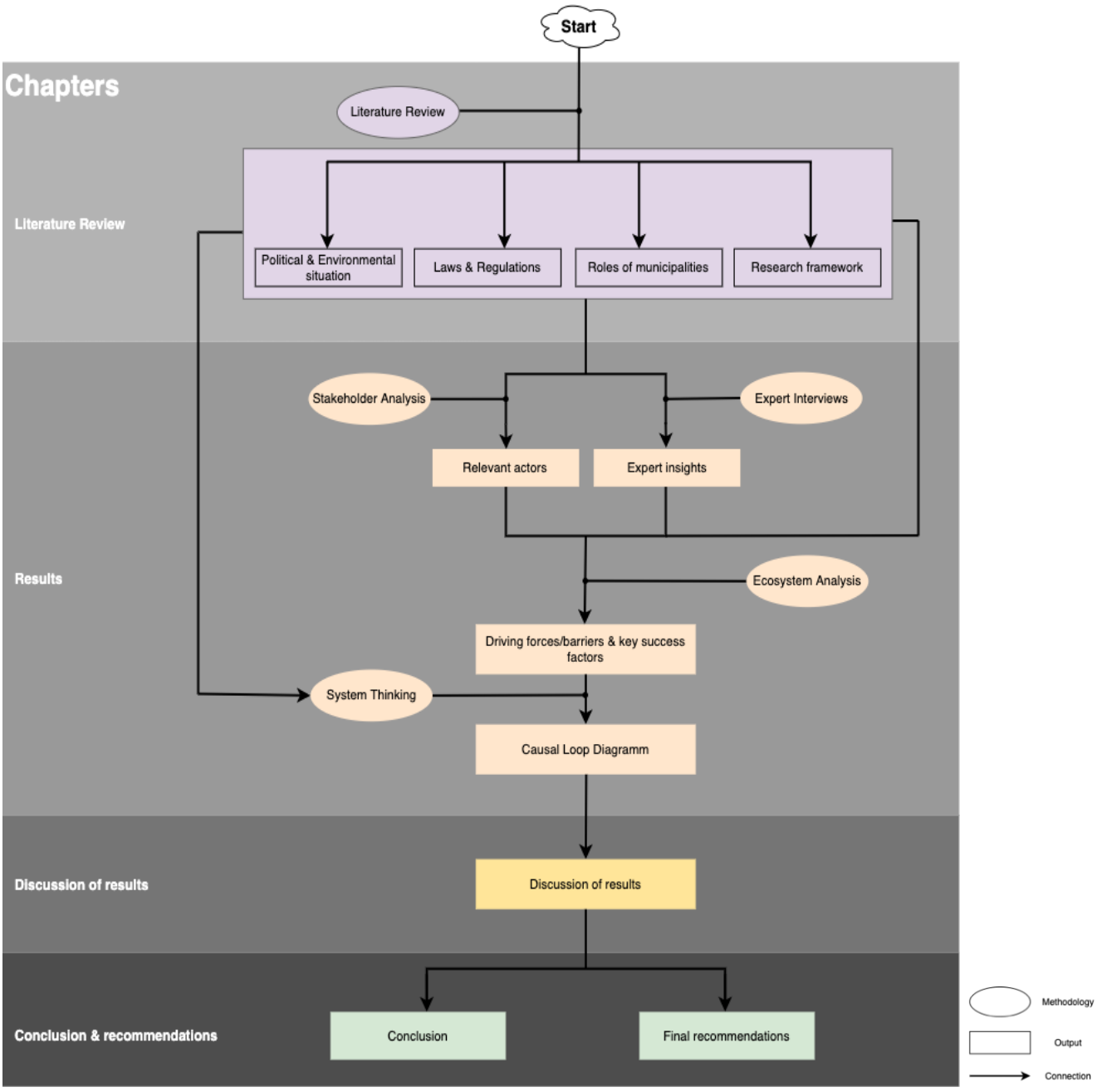


Figure 4: Report overview flowchart

2 Literature review

The literature review serves to provide the proper context for this thesis. The first part of this chapter provides necessary background information on the current political and environmental situation as well as the legal framework applicable in Switzerland. Furthermore, the general role and responsibilities of municipalities in the energy transition as well as relevant studies in similar research areas will be highlighted to have the appropriate know-how achieving the set project objectives. The second part of the literature review prepares the structure of the research methodology by describing the research framework to be applied. The literature presented will serve as a reference to assess the quality of the results and to classify the relevance and practicability of this work.

2.1 Political and environmental situation

On the 12th of December 2015, 196 countries signed the Paris Climate Agreement (UN Climate Change, 2021), which provides the new global framework for climate policy. For the first time, 196 countries accounted to the emitted global greenhouse gas emissions, including Switzerland. The agreement sets a limit for global warming compared to the pre-industrial era of well below 2 degrees, if possible, below 1.5 degrees (UN Climate Change, 2021). Another target is to achieve net zero emissions by 2050, i.e. to emit exactly the amount of greenhouse gases that can be removed from the atmosphere by so-called sinks. To achieve these goals, each country develops a greenhouse gas reduction plan based on interim targets. The intermediate targets are reviewed every five years and, if not sufficient, increased.

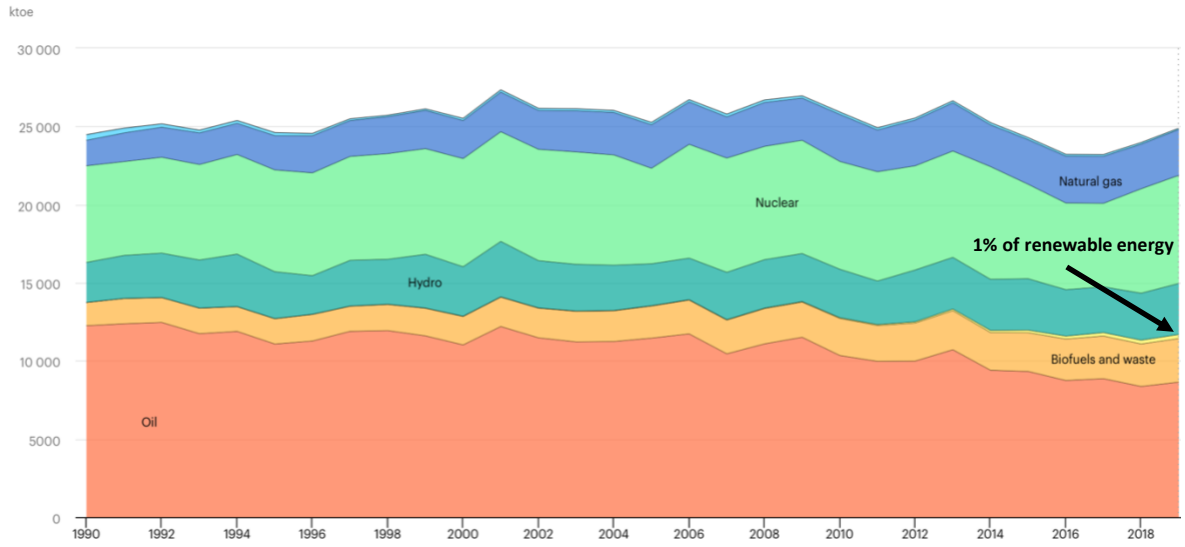


Figure 5: Total energy supply (TES) by source, Switzerland 1990-2019 (adapted from IEA, 2020)

Figure 5 above shows Switzerland's total energy supply (TES) from 1990 to 2019 based on the different energy sources. It can be seen that the primary energy supply in 2019 consisted mainly of oil (red, 34.8%), nuclear energy (green, 27.8%), hydropower (turquoise, 13.2%) and natural gas (blue, 11.8%), with renewables (excluding hydropower) accounting for only 1% (yellow area) of total primary energy supply (see arrow) (IEA, 2018).

Although Switzerland has the lowest carbon intensity and the second lowest energy intensity among the International Energy Agency (IEA) countries, mainly due to its small size and large service sector, the country has set itself ambitious goals for 2050. By reducing greenhouse gases by 50% until 2030, the goal of net zero emissions by 2050 is to be achieved. To meet these targets certain laws and regulations were introduced (IEA, 2018).

2.2 Laws & regulations

This subchapter deals with the legal and regulatory guidelines that apply at national, cantonal and municipal level. This should serve as an overview of the state of the art to provide the right context for this thesis.

2.2.1 National level

One of the most important energy legislations at national level is the so-called Energy Strategy 2050 (ES 2050), which came into force on 1 January 2018. The ES 2050 is intended to help realign Switzerland's energy policy to achieve the goals signed in the Paris Climate Agreement and is based on three main pillars (see Figure 6). Firstly, it is intended to enable the gradual phase-out of nuclear energy without compromising the high level of supply security and the cost-effective energy supply. The gradual phase-out is to be achieved by no longer granting building permits for new nuclear power plants and by only keeping the nuclear power plants currently still in operation until they have reached the end of their service life and full safety can no longer be guaranteed. Secondly, the ES 2050 aims to significantly increase energy efficiency, and the third pillar aims to increase the share of renewables to reduce energy-related CO_2 emissions (SFOE, 2020).

Figure 6: The three main pillars of the Swiss Energy Strategy 2050 (SFOE, 2020)

In terms of energy efficiency, the following objectives were defined:

- Reduction of average per capita energy consumption of 16 % by 2020 and 43 % by 2035 compared to the year 2000.

- Reduction of average per capita electricity consumption of 3% by 2020 and 13% by 2035 compared to the year 2000. Due to the increasing electrification in the Swiss energy system, electricity consumption has lower reduction targets compared to per capita energy consumption (SFOE, 2020).

In terms of renewable energy increase:

- Average domestic production of renewable energy excluding hydropower of 4,400 GWh by 2020 and 11,400 GWh by 2035

- 37,400 GWh of hydropower by 2035 (SFOE, 2020).

A further legislation to be enforced at the national level is the CO_2 Act. The CO_2 Act, which will be submitted to a popular vote on 13 June 2021, aims to reduce greenhouse gases, in particular CO_2 emissions from the use of fossil fuels, along the ES 2050 and thus contribute to the Paris Climate Agreement. To this end, greenhouse gases in Switzerland are to be reduced by 50% until 2030 compared to 1990. In the long term, the transformation away from fossil energies is to be achieved (Schweizer Wirtschaft für CO2 Gesetz, 2021). Among other things, the law contains the following most important measures:

CO_2 compensation: The CO_2 emissions from the remaining consumption of diesel and petrol are to be compensated by fuel importers by up to 90% with climate protection projects at home and abroad. Today, fuel importers are allowed to cover the resulting costs with surcharges on petrol and diesel of up to 5 Rp. per litre. In future, this cap is to rise to 10, and from 2025 to 12 Rp/l.

Air ticket levy: A newly introduced air ticket levy for public and private air transport (30-120 CHF per air ticket from Swiss airports) is intended to make climate-friendly alternatives such as trains or buses more competitive. Half of the levy will go into climate funds and half back to the population and the economy.

Increasing CO_2 tax: The upper limit of the current CO_2 incentive tax on heating oil, gas and coal is to be increased from 120 CHF/t CO_2 to a maximum of 210 CHF/t. The effect of an increased incentive tax is that the consequential costs of climate change are increasingly paid by the polluters and that more climate-friendly alternatives become more attractive. However, the levy will only increase if Switzerland fails to meet its interim CO_2 reduction targets.

Climate-compatible building heating: From 2023 respectively 2026, new fossil-fuel heating systems may only be installed in well-insulated buildings. Subsidy and leasing programmes will relieve homeowners of the often-higher purchase costs and system changeover costs of traditional heating systems. From 2023, new buildings may no longer emit CO_2. For existing buildings, a CO_2 limit of 20 kg per m^2 of heated living space applies. This limit is applied when a heating system is replaced. The installation of an oil or natural gas heating system will then only be possible in very efficient buildings.

Climate funds: New climate funds are to be set up, which are to be fed primarily from the partial earmarking of the CO_2 tax on fuels and half from the revenues of the air ticket levy. These revenues are to be used to promote sustainable projects and technologies (Schweizer Wirtschaft für CO2 Gesetz, 2021).

2.2.2 Cantonal level

At cantonal level, the cantonal model energy regulations (Mustervorschriften der Kantone im Energiebereich, MuKEn) are of particular importance in addition to the cantonal energy laws. These regulations are issued to the cantons by the Cantonal Energy Directorate (Kantonale Energiedirektion, EnDK) as concrete recommendations for implementation in cantonal building and energy law. They represent the overall energy policy package for the cantons and were drawn up in 2014 as implementation of the ES 2050 at cantonal level (AEE Suisse, 2021). Figure 7 provides an overview of the implementation status of the MuKEn based on the respective cantons with red indicating rejected status and green indicating partially or fully implemented status. As can be seen from the figure, the MuKEn have by no means been implemented in all cantons, which indicates a certain reluctance on the part of the cantons.

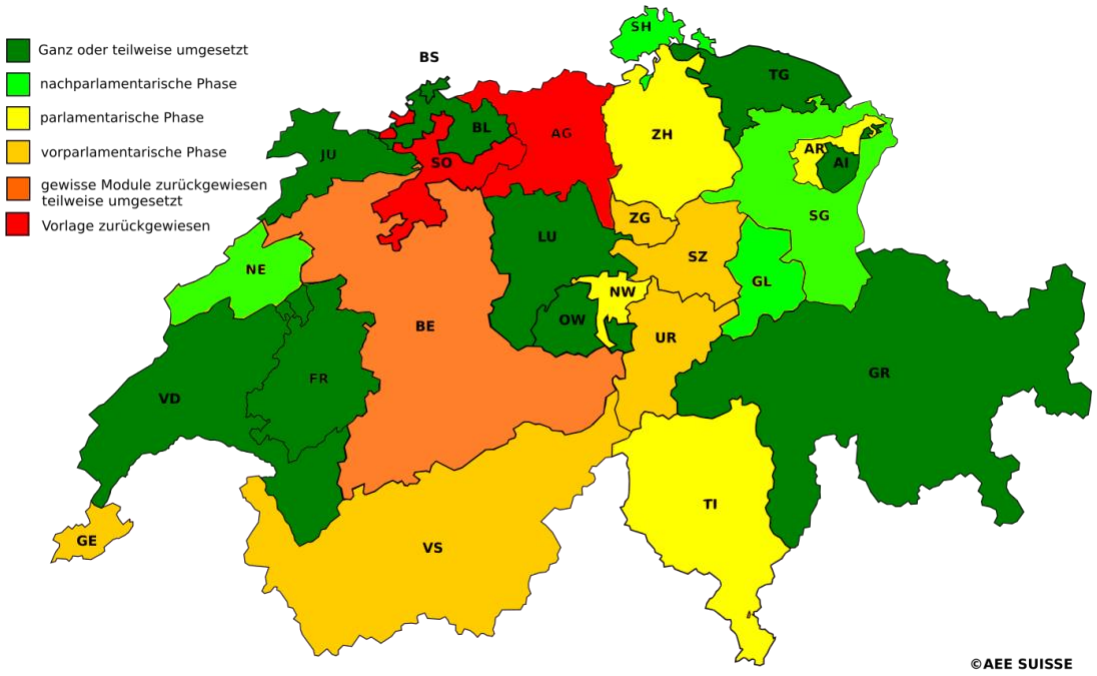


Figure 7: MuKEn implementation overview by the respective Swiss cantons (AEE Suisse, 2021)

The MuKEn are mainly aimed at promoting energy efficiency in the building sector. Other main objectives are:

- To create a high degree of harmonisation in the area of cantonal energy and building regulations in order to simplify building planning and approval procedures across the cantons.

- To issue regulations only where a relevant energy effect can be achieved. In addition, the regulations should be aligned with the state of the art and developments in Europe.

- To promote "near-zero energy buildings" through new standards: new buildings shall be as self-sufficient as possible in thermal energy all year round and in an appropriate share of electricity.

- To allow more freedom for the cantons to provide more tailor-made solutions.

- To make regulations enforceable and legal requirements measurable (AEE Suisse, 2021).

2.2.3 Municipal level

On a municipal level, the energy and climate policy model of the 2000-watt society serves as a unifying orientation aid for the consideration of national and international energy and climate goals, which Swiss cities and municipalities can use as a guide. It addresses two central challenges: the scarcity of sustainably available energy resources and climate change. The 2000-watt society is a vision for a future worth living. 2,500 watts per capita is the global average primary energy consumption today, with enormous country-specific differences. In Switzerland, each person currently consumes about 5,500 watts (Energie Schweiz, 2020). Therefore, with the guiding principle of the 2000-watt society, the following three main goals were defined, which are linked to the ES 2050:

Goal 1: Energy efficiency
Switzerland's primary energy demand is to be reduced to 2000 watts of continuous power per inhabitant by 2050 at the latest, and to 3000 watts by 2030.

Goal 2: Climate neutrality
Switzerland's total energy demand should have net zero greenhouse gas emissions by 2050 at the latest.

Goal 3: Sustainability
Switzerland's entire energy supply - including electricity, heating, cooling, mobility and process energy is to be converted to 100% renewable energies by 2050 at the latest, and to at least 50% by 2030 (Energie Schweiz, 2020).

To achieve the goals of the 2000-watt society, Swiss cities and municipalities have the opportunity to be certified by means of labels. The "2000-Watt-Area" certificate distinguishes cities and municipalities that are committed to climate protection and the sustainable use of resources. The 2000-Watt-Areals are oriented towards the interim goals 2050 of the 2000-Watt-Society (2000-Watt-Areal, 2021). Another certificate is the so-called "Energiestadt" label. Cities and municipalities that bear the label go through a comprehensive process that leads them through various stages to a sustainable energy and climate policy. Through the “Energiestadt”-certification, municipalities gain access to instruments, tools and services for a consistent and goal-oriented local climate policy. In the medium and long term, this can reduce energy costs and strengthen regional value creation (Energiestadt, 2021). An overview of the laws and regulations addressed in this subchapter can be found in Figure 8 below.

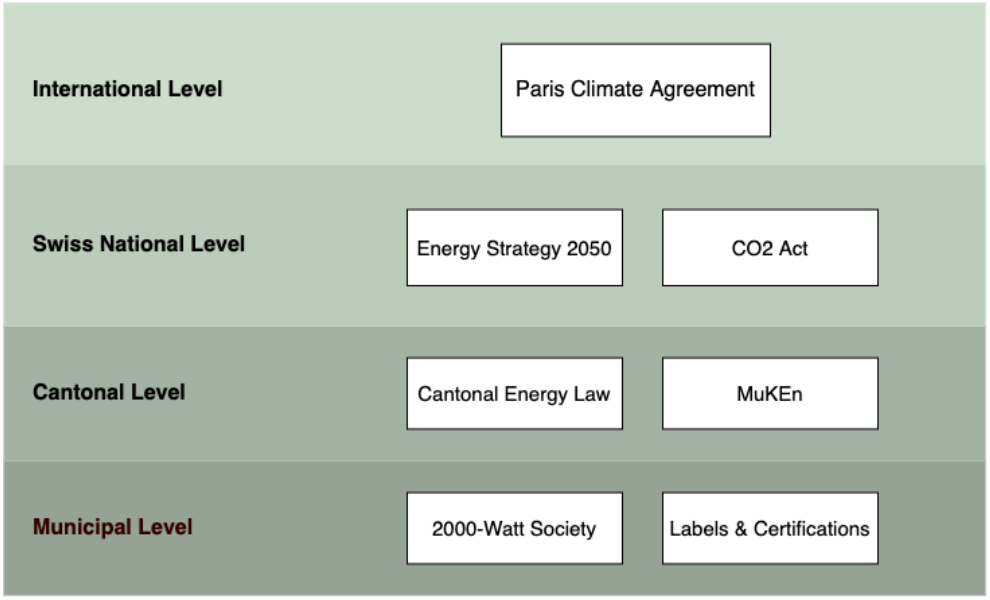


Figure 8: Overview of laws and regulations based on different levels of action

2.3 The role of municipalities

Switzerland's territory is covered by a dense network of municipalities that are relatively small in terms of area and population. The municipalities form the smallest political unit in Switzerland, which are arranged below the federal government and the cantons. In contrast to the confederation and the cantons, the municipalities are not sovereign territorial authorities, but are subordinate to the cantons. They can therefore be restricted or expanded by the cantonal legislature. The tasks of the municipalities can be differentiated according to whether they have been assigned to the municipalities by the canton or the confederation (transferred tasks) or whether the municipalities fulfil them voluntarily and on their own responsibility (self-chosen tasks). A canton can also at any time claim a task chosen by the municipalities for itself by law or definitively transfer it to the municipalities. There are therefore no tasks assigned to the municipalities by definition. The area of responsibility of the municipalities is determined solely by the respective cantonal law (Fiechter, 2010). According to (Fiechter, 2010), the areas of responsibility that can be designated for municipalities as territorial authorities may include those shown in Table 1.

Table 1: Areas of responsibility for municipalities

Area of responsibility	Examples of the responsibility scope
Municipal organization	Municipal administration and regulatory issue
Municipal police law	Local road police
Communal building law	Building police, local planning, landscape and monument protection
Municipal building law	Local road network, sports facilities and cultural facilities
Communal utilities	Sewerage & water supply, sewage treatment plants, electricity and energy plants, municipal transport services
Communal property administration	Public finances & public land, setting tax rate and collection of taxes, fees & regulations
Municipal citizenship	Granting of municipal citizenship (insofar as cantonal law does not confer a right to naturalisation or provide for the approval of a higher authority)

Since the communal utilities are also under the responsibility of the municipalities, it follows that the municipalities are also in charge of implementing communal energy policy and planning. According to (Energie Schweiz, 2019), several measures are available to the municipalities for this purpose. One measure is the development of a municipal energy concept. The energy concept contains all the necessary elements for planning the achievement of goals: energy and climate targets, a corresponding reduction path, a balance of energy consumption in the municipal or supply area, as well as orientation points for planning measures. An energy concept should be approved by the respective authorities so that it has sufficient binding force for the energy suppliers and the municipality (Energie Schweiz, 2019).

Another instrument is the communal energy report plan, which is issued by the respective cantons and is intended to serve as an instrument for optimising the communal energy supply. The aim is to make optimal use of local waste heat and renewable energy, as this reduces CO_2 emissions and increases local added value. The energy report plan assigns heat supply priorities to the individual areas and formulates supporting implementation measures for the municipality. This creates the conditions for the optimal use of existing waste heat and renewable energies. Unnecessary and inefficient duplication in the supply of grid-based energies can be more easily avoided. The communal structure plan is a binding requirement in larger energy-relevant swiss communes. For smaller municipalities, the structure plan is a voluntary recommendation (AUE & AGR, 2011).

2.3.1 Municipalities in the energy transition

A study on strategic municipal energy planning for municipalities in Denmark states that there is a need for an integrated energy planning system for municipalities that links long-term national targets with all relevant, sector-specific targets such as heating, electricity or transport. In this system, responsibilities and tasks should be clearly distributed between the state, municipalities, utilities and other key stakeholders in an action-oriented way. The necessary instruments and incentives should be developed and provided according to such a clear division of tasks for implementation. The survey of eleven Danish municipalities found that although there is a basic willingness of the municipalities to engage in local energy planning, the role of the municipality in energy planning is not perceived clear enough. Due to the insufficient institutional framework, it is difficult for municipalities to fulfil their role in the national energy strategy. It is suggested that the role of municipalities as energy planning authorities needs to be more clearly framed (Sperling, Hvelpund, & Vad Mathiesen, 2011).

Similar results were also obtained in a study in the German state Lower Saxony. In it, based on fourteen interviews conducted with regional centres, it becomes clear that in the German context an incomplete vertical knowledge exchange has led to a lack of actionable knowledge at local level. Therefore, a local process, parallel to national activities, would be needed to translate measures provided together with higher-level policy into actionable procedures for local authorities. At local level, such a process does not seem to have taken place consistently so far, as local authorities are expected to implement measures, especially of a technical nature, that have only been roughly provided at national level. The interview results of the study indicate that, on the one hand, the knowledge provided by the national level is too abstract and focused on technical-economic areas, while areas for managing change, such as communication, are disproportionately lacking. On the other hand, the knowledge of municipalities about their local impact is limited, as local empirical data for impact assessment is often incomplete (Bickel, et al., 2020).

A lack of a unified approach at the municipal level was also identified in a stakeholder and social network analysis of a municipal waste management system using the city of Maputo as case study. This showed that decision-makers need to develop strategies to improve stakeholder linkages and promote inclusion, adapting these strategies according to the type of stakeholders involved in the project at the municipal level (Sarmento dos Muchangos, Tokai, & Hanashima, 2017). A stakeholder analysis for the energy transition in the Sicilian municipality of Gela also highlights the complexity of the processes underlying the energy transition and makes clear that policy interventions are highly context dependent. Which suggests that policy makers should consider stakeholders' perceptions appropriately when trying to design a well-suited and balanced policy intervention for municipal level (Falcone, 2018).

2.3.2 Governance models of municipalities

The choice of governance model is one of the most important decisions for the administration of the municipality. The management model defines the functions of the municipal council and those of its members, as well as the type of management and the structure of the administration. According to (Canton Aargau, 2016), all municipal governance models in Switzerland have in common being based on the so-called departmental principle. According to this principle, certain groups of tasks are grouped into departments in the sense of a division of labour, which are assigned to an individual member of the municipal council for special supervision. According to (Canton Aargau, 2016), a distinction is made between the following four main municipal governance models:

I. Operational model
II. Delegated model
III. Executive model
IV. Administrative manager model

The organizational charts in Appendix A | Municipality governance models show how these are structured and how they differ from each other.

2.4 Research framework

The following section explains the research framework that serves as the basis for the methodologies used later on in this thesis. Additionally, the reasons for choosing the approach and the critical decision points for translating the theory into the methodology to be applied are described.

2.4.1 Stakeholder analysis theory

The stakeholder analysis (SA) approach proves to be very helpful in identifying relevant actors, as it sheds light on the interests and influence of the actors under consideration in detail. With basic knowledge from literature research, relevant actors can be identified who have a significant influence on a particular project or company (CFI, 2021). According to (Natural Resources Canada, 2014), SA basically involves the main steps, which are shown in Figure 9.

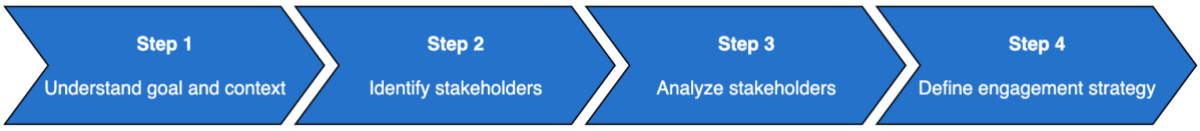


Figure 9: Procedure Stakeholder Analysis (adapted from Natural Resources Canada, 2014)

Understanding the context as well as the goal is fundamental as the first step of the stakeholder analysis. The aim is to get a better understanding of the initial situation and the context in which the analysis is carried out. The second step is to identify the stakeholders, which are defined as all naturally occurring entities that are affected by an organisation's performance (Reed, et al., 2009). Therefore, stakeholders may have a legitimate interest in, or be directly or indirectly affected by, a particular project, company or its actions. Various methods can be used to identify these, from brainstorming to general listing of actors. Once the stakeholders have been identified, the next step is to analyse and classify them. The focus should be on their respective interests, their goals and possible concerns to better understand their general motivation (Natural Resources Canada, 2014).

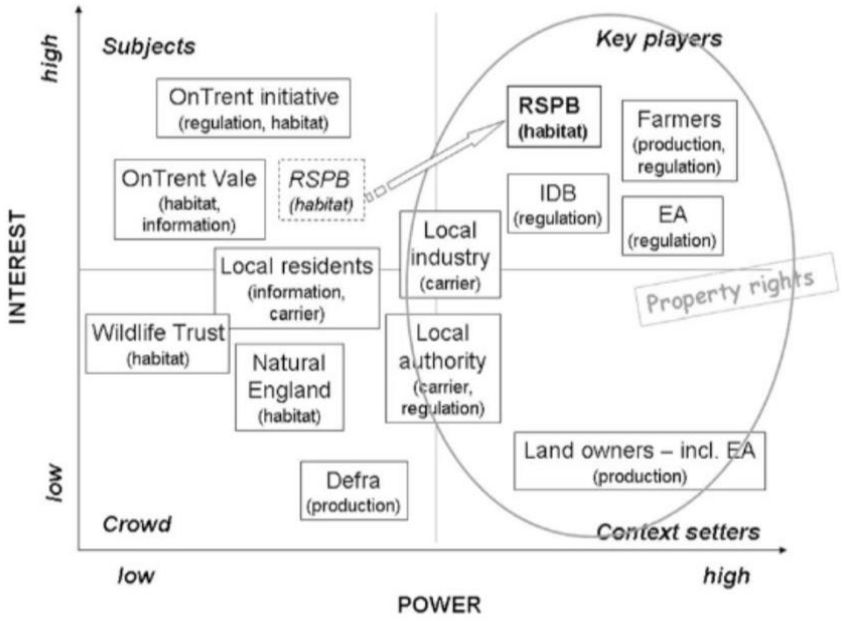


Figure 10: Stakeholder classification example (Reed, et al., 2009)

To support this phase, it is helpful to create an interest-power-matrix according to the level of interest and power of each stakeholder, visually showing which stakeholders are key players, subjects, context setters and the remaining crowd (see Figure 10). The final step is to develop a stakeholder engagement strategy (Reed, et al., 2009). Concrete procedures should be defined to ensure successful cooperation with the respective stakeholder group. It should be clear which of the stakeholders are considered key players and thus have a relevant role in a given project.

2.4.2 Qualitative interviews

Qualitative interviews serve as a method for collecting qualitative data in a specific field. It is assumed that qualitative methods, such as interviews, provide a deeper understanding of social phenomena that would not be possible with purely quantitative methods. Interviews are therefore most suitable when little is already known about the field of study or when detailed insights from individual participants are required. They are also particularly suitable for exploring sensitive topics that participants may not want to talk about in a certain group setting (Gill, Stewart, & Chadwick, 2008). The way an interview is conducted has an impact on the insights gained from it. There are basically three types of interviews: structured, semi-structured and unstructured interviews. While structured interviews have the advantage of being robust enough to easily compare multiple interviews, the unstructured interview method has the advantage of gaining additional insights from the interviewee that are not captured in a questionnaire. The advantage of semi-structured interviews is the flexibility that can be used well during the interview to get additional impressions despite a structured interrogation. This leads to qualitative data that can be used in comparison to literature research. The disadvantage of this interview method is the difficulty to compare several answers from different interviews because the interview guide is not always followed completely. No two questions have the exact same structure, which makes it difficult to compare two results (Gill, Stewart, & Chadwick, 2008).

2.4.3 Ecosystem analysis theory

To identify barriers, drivers and key success factors, the ecosystem analysis method proves to be a suitable approach, which according to (Huonder, Müller-Csernetzky, & West, 2018) is based on a six-level framework. The framework with the respective steps can be found in Figure 11 below. The first step is to better understand the customer by defining its pains, gains and its job to do. As a next step, the actors of the ecosystem are to be identified (step 2) and then analysed in more detail (step 3) to better understand their background. This can be achieved by analysing the environment, behaviour, concerns and desires within the system. Through empathy cards the motivations and values of all relevant actors involved can be better understood (Huonder, Müller-Csernetzky, & West, 2018).

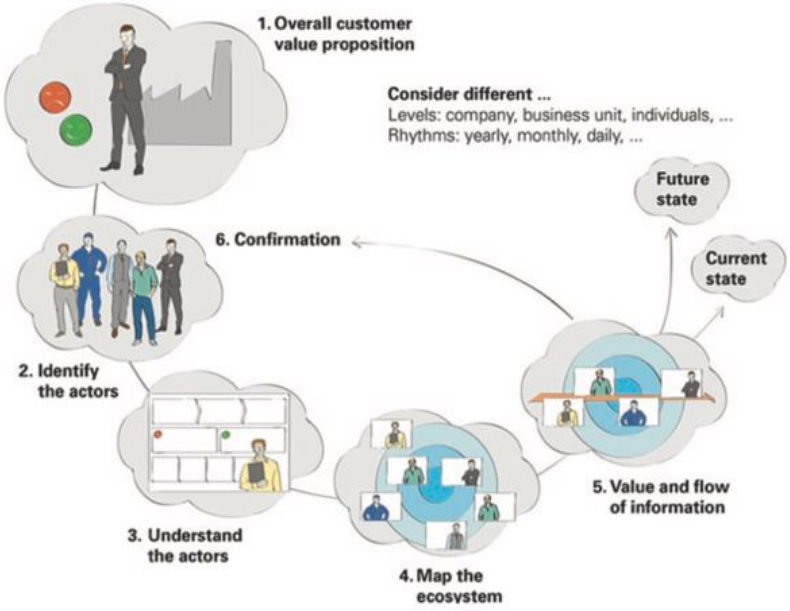


Figure 11: Six-step framework of Ecosystem Analysis (Huonder, Müller-Csernetzky & West, 2018)

In a fourth step, the ecosystem can be visually represented by placing the respective empathy cards on a map. By depicting the value flows between the relevant actors, potential drivers, barriers and key success factors can be recognised (see Figure 12) (Huonder, Müller-Csernetzky, & West, 2018).

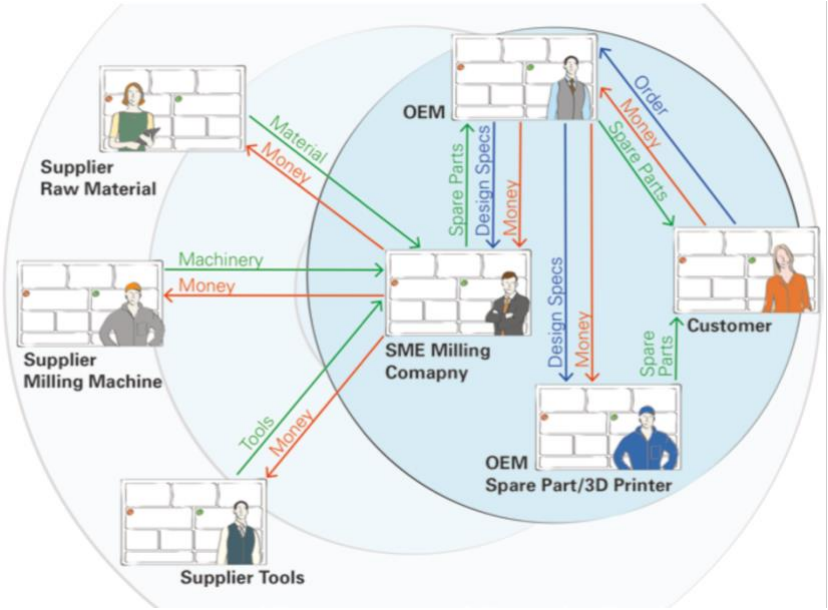


Figure 12: Ecosystem map example showing value flows between actors (Huonder, Müller-Csernetzky & West, 2018)

2.4.4 System thinking theory

A system can be characterised as a group of several components that interact with each other (Dadwal, Lin, & Palopoli, 2020). The system thinking approach helps to understand complex systems and the effects of inputs. Within system dynamics, causal loop diagrams (CLD) are the main analytical tools that help to identify and visualise key variables and the links between them (Ross & Wade, 2015). The creation of a CLD makes it possible to represent the cause-effect relationship between factors or variables and to uncover resulting feedback loops that together form the causal structure of the system. The so-called causal structure can be used to identify the reasons why a particular system behaves in a certain dynamic way (González, Sandoval, Acosta, & Henao, 2016). From this, potential conflicts of interest between actors in a system can be identified and, depending on the conflict, appropriate solutions can be derived. An example of a CLD is illustrated using a predator-prey behaviour in Figure 13.

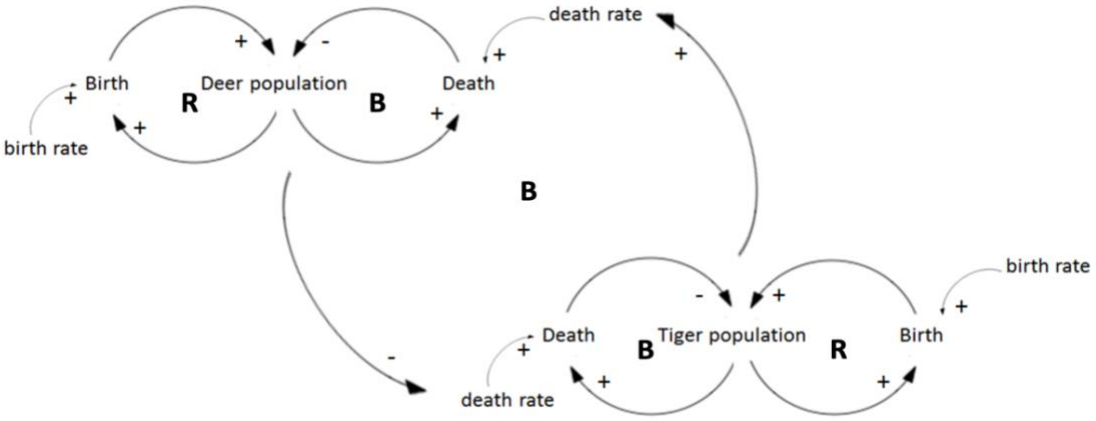


Figure 13: CLD example for predator-prey relationship (Wagner, 2020)

3 Methodology

Once the research framework has been defined, the methodologies used in this thesis were set and limited to the context of the project scope. This chapter therefore aims to give an overview of the qualitative methods that were used to answer the research questions of this thesis and thus achieve the developed project objectives. The following flowchart (Figure 14) visualises the approach of the methods applied as well as their correlations.

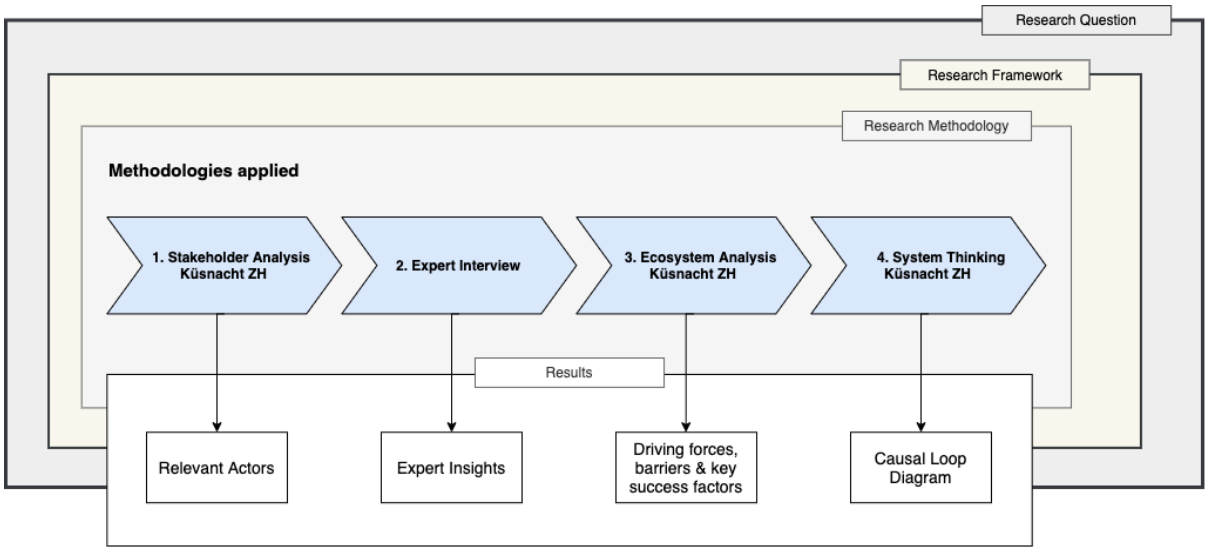


Figure 14: Methodology flow chart

3.1 Stakeholder analysis methodology

Since a stakeholder analysis for several Swiss municipalities would go beyond the scope of this thesis, the municipality of Küsnacht in Zurich was chosen as the reference municipality for conducting the SA, limiting the scope of work. The reason for choosing this reference municipality is the existing network through the project supervisor. The stakeholder analysis was conducted following (Natural Resources Canada, 2014) and (Reed, et al., 2009) to identify the relevant stakeholders (key players according to the interest-power matrix) of the energy transition at municipal level. It is important to note that the analysis was only conducted to identify the relevant actors without elaborating a corresponding engagement strategy for all actors to limit the scope of work. By means of brainstorming and the creation of a general mind map with the visualisation tool kumu, the actors were captured from the perspective of the municipality of Küsnacht, as this method is easy to apply and adapt. Subsequently, based on the findings from the expert interviews and the literature research, the actors were classified into several 2x2 matrices according to interest, power, influence and priority, which enabled a direct comparison of the respective matrices. This led to a more profound analysis and finally to a definitive classification of the actors based on the interest-power matrix. The analysis was developed in an iterative process in which the defined stakeholders were revised and supplemented by the insights gained from the expert interviews. This minimises the risk of overlooking relevant stakeholders and leads to the most accurate results possible.

3.2 Expert interview methodology

Besides the literature review, the primary sources of information were five semi-structured expert interviews, which were conducted according to (Gill, Stewart, & Chadwick, 2008) to gain further insights. The interviews were conducted using Zoom due to the current COVID-19 restrictions and followed a semi-structured method with open questions, which is why the questionnaire was sent to the interviewees in advance. Compared to the structured and unstructured method, the semi-structured interview method proved to be the best option to obtain the most meaningful results, as the structured method may lead to essential knowledge not being uncovered due to its robust implementation and the unstructured method being too informal for the context of this thesis.

3.2.1 Questionnaire

The questionnaire contains semi-structured and open questions that were only slightly adapted to the respective interviews. This way, individual insights can be gained without having to exclude a direct comparison between the interviews. The overall objective of the questionnaire was to identify the perceptions of the different experts regarding the local energy transition and to highlight perceived problem areas and opportunities. As an introductory question, the interviewee was asked to introduce her/himself to learn something about the interviewee's background. Subsequent questions were more specific to the topic to gain deeper insight. The respective questionnaire can be found in Appendix B | Expert interviews.

3.2.2 Sample selection

Selective sampling was used, as the sample selection was based on the existing network of project supervisors. Furthermore, other scientific researchers who are involved in similar projects at the Lucerne University of Applied Sciences and Arts were selected. Two interview partners are active members of the energy commission in the municipality of Küsnacht, which is analysed in this thesis as a reference municipality. Another interview was conducted with the Werke am Zürichsee, the local energy supplier of the municipality of Küsnacht. To have a comparison between different municipalities, one additional interview was conducted with the nature and environmental protection officer of Horw in Lucerne. The reason for selecting this municipality is its similar size to the reference municipality of Küsnacht in terms of population. Finally, an interview was conducted with a researcher from the Institute of Business and Regional Economics (IBR) at the Lucerne University of Applied Sciences and Arts, who is currently working on research projects in similar subject areas. An overview and more detailed information on the selected experts can be found in Table 2.

Table 2: Overview selected expert interview partner

Expert	Position	Field of expertise
Alexander Lüchinger	Resident of the municipality Küsnacht Member in the energy commission	Mechanical engineering Energy consultancy & planning Energy renovation district heating systems
Christian Arber	Secretary of energy commission Küsnacht Project manager energy & environment	Energy & environmental engineering Asset management District heating sales
Samuel Gerber	Project manager in heating division at Werke am Zürichsee	Energy systems engineering District heating systems
Gwen Bessire	Nature & environmental protection officer Horw Member of energy & environmental commission Horw	Geographer
Dr. Justus Gallati	Scientific researcher at IBR Lecturer at HSLU	Physics & environmental science Regional & business economics Sustainability & ecology System modelling & system dynamics

3.2.3 Analytical methods

The interviews were analysed using a thematic content approach (Canary, 2019). The interviews were summarised based on the audio recording and confirmed by the interviewee after the interview. The most important findings were extracted and used in the iterative process of stakeholder analysis and subsequently for the ecosystem analysis. The approved summaries can be found in Appendix B | Expert interviews.

3.3 Ecosystem analysis methodology

To identify the drivers, barriers and key success factors for the reference municipality Küsnacht, the ecosystem analysis according to (Huonder, Müller-Csernetzky, & West, 2018) was applied. It is important to note that the framework was only utilised from step 3 (understand the actors) onwards, as the first two steps already overlap with the stakeholder analysis (see Figure 11). The data required for this was mainly obtained from the expert interviews, as well as from literature research. To limit the scope, the analysis only refers to the stakeholders classified as key players by the SA, as they have great interest and power regarding the local energy transition and are therefore considered to be relevant actors. The key players identified by the SA were first classified using empathy cards based on (Huonder, Müller-Csernetzky, & West, 2018) to illustrate the respective pains, gains and jobs to be done, and then visually represented on an ecosystem map using the programme kumu. For a better understanding of the interconnections between the key players, the value exchange was segmented into the layers of information, service, policy, money, action and risk using different colour codes.

3.4 System thinking methodology

Finally, to better understand the system behaviour of the cause-effect relationships from the key players, two causal loop diagrams (CLD) were created according to the system thinking approach (Ross & Wade, 2015) using kumu as well. It is important to note that no programming of the system model was undertaken as part of this work, but only the impacts of certain variable adjustments were visualised using CLD to better analyse the system behaviour. This was illustrated by creating scenarios in which one key driver and barrier each previously identified in the ecosystem analysis were adapted and their effects on the system analysed. The aim was to highlight possible conflicts of interest between the actors in the system. The results serve as an implementable best practice recommendation for municipalities to overcome the identified conflict potentials and thus advance the energy transition.

4 Results

In this chapter, the results from the stakeholder analysis, the ecosystem analysis and the systems thinking approach are presented. The results of the applied methods are analysed for their significance to gain the necessary insights for the subsequent discussion chapter.

4.1 Stakeholder analysis

The relevant actors were identified through the applied stakeholder analysis based on the reference municipality of Küsnacht. The data required were obtained from the expert interviews conducted (see Appendix B | Expert interviews) and from the literature research. Küsnacht is an agglomeration municipality of Zurich and is located on the shores of Lake Zurich. Due to its attractive geographical location and low tax rate, Küsnacht is a popular residential area (Lüchinger A., Interview, 2021). The almost purely residential municipality does not have a large industrial or commercial sector but is one of the significantly larger municipalities in Switzerland with around 14,000 inhabitants (Küsnacht, 2021).

4.1.1 Stakeholder map

The stakeholders were first listed with a mind map using the programme kumu, which can be found in Appendix D | Stakeholder analysis mind map. After all stakeholders were identified, they were sorted according to different dimensions and divided into clusters to compare them with each other using several matrices. For this purpose, the dimensions interest, power, influence and priority were chosen (see Appendix E | Stakeholder analysis matrices). From the comparisons of the different matrices, the stakeholders were then finally classified according to insights gained from the expert interviews and literature from (Haus & Ladner, 2020) using the interest-power matrix shown in Figure 15.

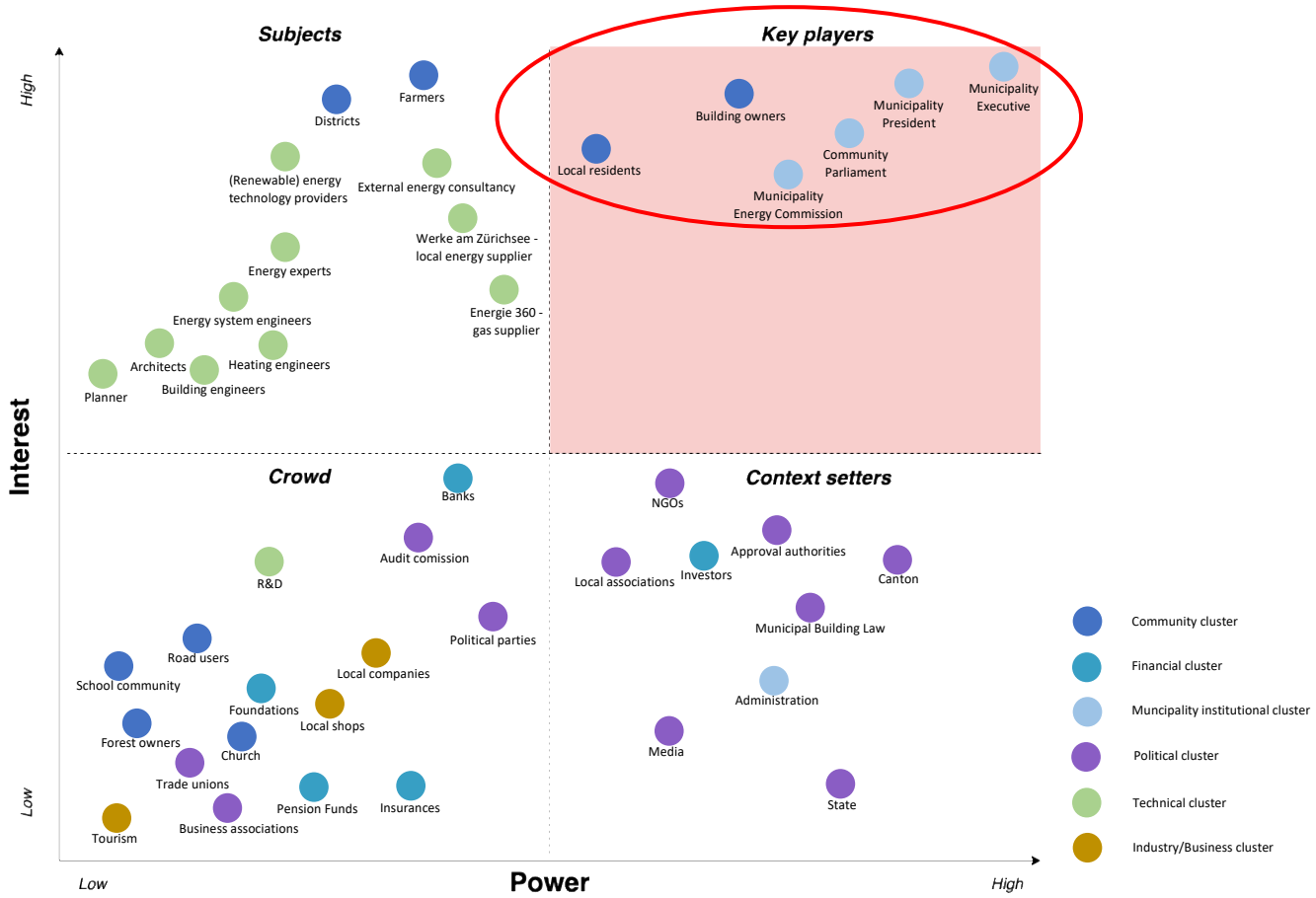


Figure 15: Results of the stakeholder analysis for Küsnacht ZH

The results of the stakeholder analysis show the stakeholders recorded in the mind map, sorted by their interest (y-axis) in the local energy transition and the power (x-axis) they can exercise at community level. This results in the four segments: subjects, crowd, context setters and key players, which are labelled accordingly. In addition, the stakeholders were divided into different clusters using colour codes (see legend in Figure 15) to gain further insights from the analysis. At this point it is important to mention that the interest-power matrix displays a qualitative representation in which the four segments cannot always be clearly separated from each other. It is therefore not always possible to clearly assign the stakeholders to one of the four segments, which must be taken into account in the analysis.

4.1.2 Crowd segment

Based on Figure 15, stakeholders were identified in all four segments. The largest number of stakeholders and the greatest heterogeneity according to the subdivided clusters can be found in the crowd segment. The stakeholders included in this segment were classified as low both in terms of their interest in the local energy transition and in terms of their power in decision-making processes. For both the political cluster (purple) and the financial cluster (turquoise), the reason is that these stakeholders do not have a specifically close relationship with the municipality of Küsnacht itself, but rather generally act as a larger player with interests that span across multiple municipalities. For the stakeholders from the community cluster (blue), the interviews revealed rather low interests and decision-making powers compared to other stakeholders. The local shops and businesses were also placed in the crowd cluster, as according to (Arber Ch., Lüchinger A., Interview, 2021) they do not make up a large proportion in the municipality of Küsnacht itself and can therefore only influence local energy policy to a limited extent.

4.1.3 Subject segment

The subject category describes actors who have great interest in the local energy transition but are not in a position to exercise great power. In this area, actors from the technical cluster are particularly visible (green). The reason for this is the generally high level of interest in getting involved in the local energy transition and the resulting opportunity to receive mandates as a company and thus support Küsnacht professionally, be it through resources such as skilled workers or technical know-how. However, the possibilities for exerting pressure are limited, as there is competition among companies on the free market and Küsnacht as a municipality can thus find several possible partners to drive forward the local energy transition from a technical perspective. The “Werke am Zürichsee” as a local energy supplier was classified in the subject segment, as they are partially owned by the municipality of Küsnacht and therefore do not have a relevantly large power influence on the local energy transition, despite their great interest.

4.1.4 Context setter segment

Context setters are mainly larger political actors (purple). Due to their size and entrenched position, they usually have a greater influence on the municipality of Küsnacht, but their interest is limited, as they are often active across municipalities and are therefore not only focused on the municipality of Küsnacht itself. Their activities usually set the framework in which influence can be exerted at the community level.

4.1.5 Key player segment

Six stakeholders were identified as relevant for the energy transition in the municipality of Küsnacht (highlighted in red). Two stakeholders belong to the community cluster (blue) and the remaining four belong to the municipality institution cluster (light blue). According to (Haus & Ladner, 2020) , the municipal council as the executive, followed by the president, has the greatest decision-making power in municipalities. This was also confirmed from the conducted expert interviews (Arber Ch., Lüchinger A., Interview, 2021). The energy commission in Küsnacht has less decisional power compared to the municipality executive.

However, if the energy commission as advisor succeeds in advising the municipality executive in such a way that the executive agrees to the advice, then the energy commission represents one of the most important actors in the energy transition at community level (Lüchinger A., Interview, 2021). Depending on how important a particular project is and how much budget it requires, it must be brought up in front of the community parliament for a final decision. The community parliament therefore has considerable interest and power of co-determination, especially in major decision-making cases.

Local residents and building owners were also identified as relevant actors, as they, as end consumers, can ultimately determine the type and origin of the energy they purchase. Thus, they have a major influence on the local energy transition (Gerber S., Interview, 2021). To counteract this, certain incentives can be created through support programmes by the municipality of Küsnacht to make renewable technologies such as photovoltaics (PV) and heat pumps more attractive. However, the decision remains with the end consumer, which leads to a great deal of decision-making power at municipal level. Moreover, since these stakeholders are directly affected by the local energy transition, the interest can be classified as correspondingly high. Therefore, it is particularly important to define key player engagement strategies to get them on board. However, potential for improvement was identified in this regard.

" With regard to the population, a general potential for improvement in communication was identified in order to get this stakeholder group on board. It is not yet possible to say exactly how these key players will be involved by the municipalities, as there is still no clear strategy to be seen on the part of the municipalities. "(Dr. Gallati J., Interview, 2021)

4.2 Ecosystem analysis

Once the relevant actors of Küsnacht have been identified, they were analysed in more detail following the ecosystem analysis of (Huonder, Müller-Csernetzky, & West, 2018) to better understand the interconnections and relationships between them. The data necessary for this was obtained from the expert interviews, so that the respective pains, gains and jobs to be done of each identified key player could be listed in the form of empathy cards. This enables a first representation of the motivations for the individual actors analysed. The different empathy cards for each classified key player can be found in Appendix G | Empathy cards. To subsequently visualise the ecosystem and the connections between the key players, the empathy cards were then placed on a map. By drawing the various connections between the relevant actors, possible drivers, barriers and key success factors could then be identified. The first draft of the ecosystem map can be found in Appendix H | Ecosystem analysis draft.

4.2.1 Ecosystem maps with visual layers

The result of the ecosystem analysis is shown in Figure 16 below in form of a kumu diagram. The value exchange was segmented into the mentioned six layers of information, service, political, monetary, action and risks using different colour codes. The thickness of the arrows is used to illustrate the intensity of the value flow, with thinner connections representing a lower value flow and thicker connections representing a stronger value flow. At first glance, it can be seen that the exchange of values within the ecosystem results in a highly complex map that is hardly readable. To better clarify the respective interrelationships, the different levels are analysed separately with highlighting the most important findings.

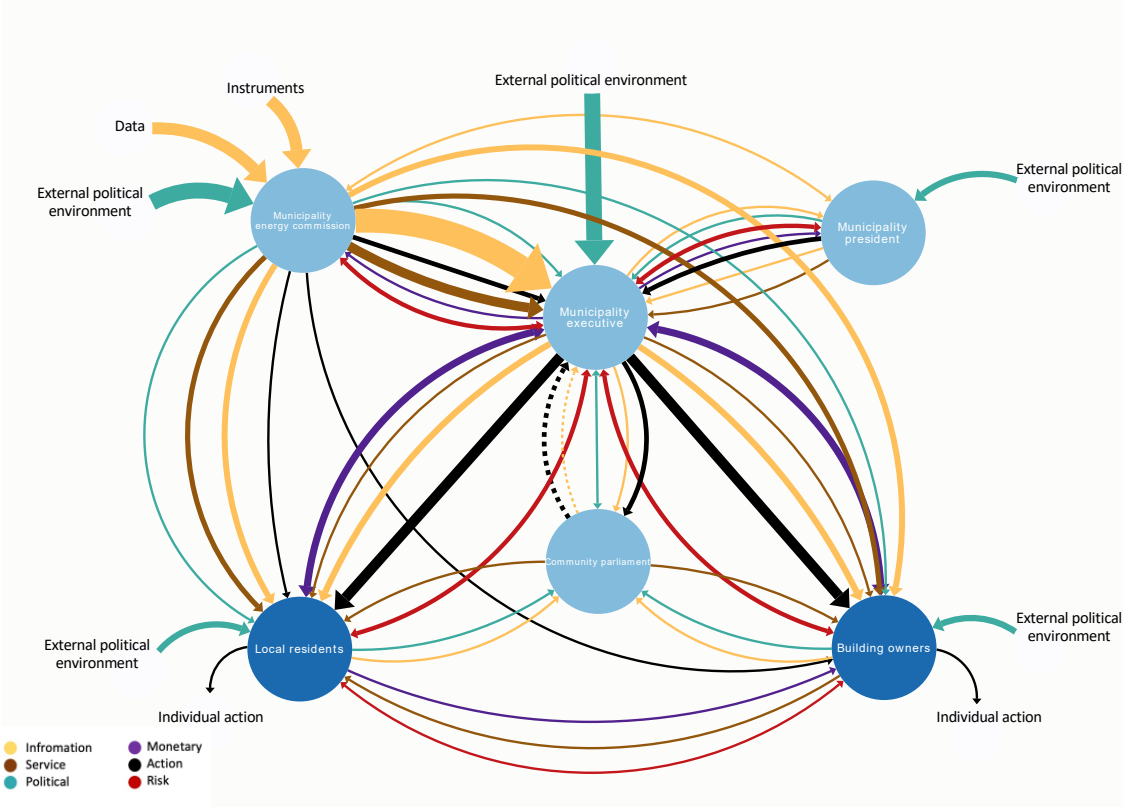


Figure 16: Ecosystem map with value exchanges

4.2.2 Information & service layer

Figure 17 below depicts the ecosystem with two (information & service) of the six important exchange layers. The flow of information between the actors is shown in orange, the flow of services in brown. The diverse and complex flow of information between almost all actors is clearly visible here. In comparison, the service connections represent a less complex network of interrelationships. An important information flow is highlighted between the energy commission and the municipality executive by a thick arrow. This is the case because the energy commission has an advisory role regarding the municipality executive in terms of local energy policy (Arber Ch., Lüchinger A., Interview, 2021).

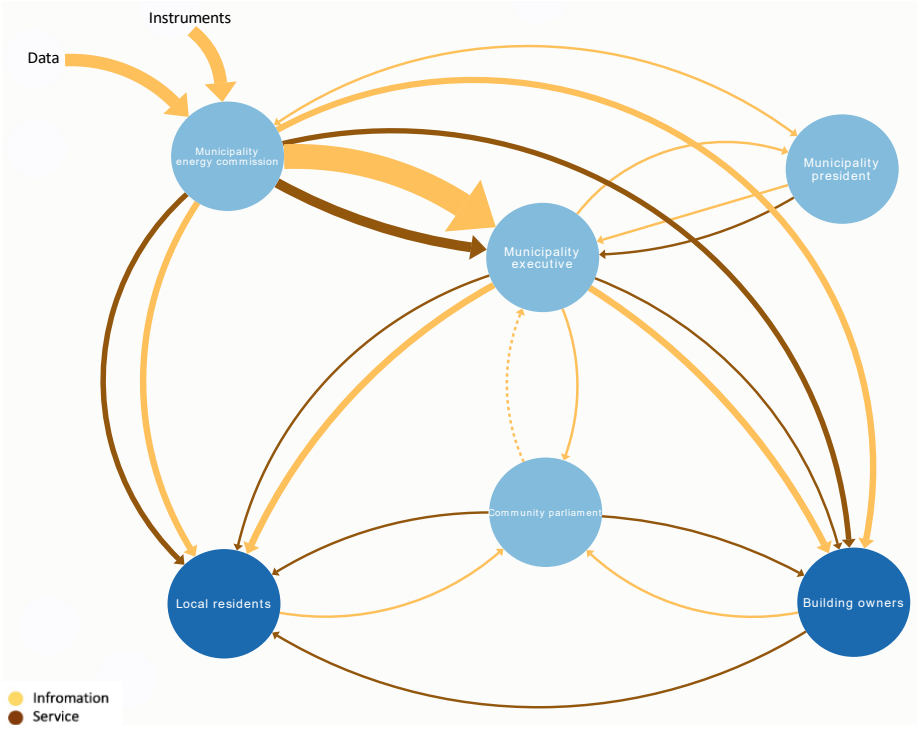


Figure 17: Ecosystem map with information & service layer

Therefore, if the energy commission as an advisor succeeds in advising the executive in such a way that it agrees to the advice, then the energy commission has a crucial role in terms of information flow. However, to advise the municipality executive competently, the energy commission depends on information inputs in the form of planning instruments and good data quality (Arber Ch., Interview, 2021). Because only through good data quality can competent advice be given to the municipality executive, which must make strategic decisions on the basis of these information. The dotted connection in the information flow from the community parliament to the municipality executive represents a connection that is assumed not being always constant. This is because the community parliament is not involved in all of the energy policy decisions made by the municipality and therefore only a partial flow of information occurs from its side to the executive. The remaining information flows can be read from Figure 17, but were assumed to be less relevant in terms of identifying drivers and barriers of the local energy transition.

For the service flows, the focus is on the advisory services provided by the energy commission. It primarily performs an advisory function towards the municipality executive and is also in direct contact with local residents and building owners, e.g. through subsidy programmes or district heating projects. Further services between other actors can be viewed in Figure 17, which are assumed to represent a lower value flow in comparison to the services offered by the energy commission.

4.2.3 Political & monetary layer

The ecosystem with the political (turquoise) and monetary (violet) layer is presented in Figure 18. As each actor in the ecosystem is exposed to the external political environment, a partly influence by political parties and their voting recommendations can be observed (Lüchinger A., Interview, 2021). However, the political demands and related pressures can be assumed to be more noticeable among the internal actors of the municipality, such as the energy commission and the municipality executive, which is reflected by thicker arrows in the ecosystem map. Particularly great political influence can be assumed in the municipality executive, as the members themselves mainly represent the SVP and FDP parties. This indicates a majority of bourgeois-conservative municipal councillors, who in turn can influence the local energy transition (Lüchinger A., Interview, 2021). However, the influences from the external political environment can also vary depending on the actor, so that not everyone perceives it in the same way. This would require more detailed research, which is not covered in this thesis.

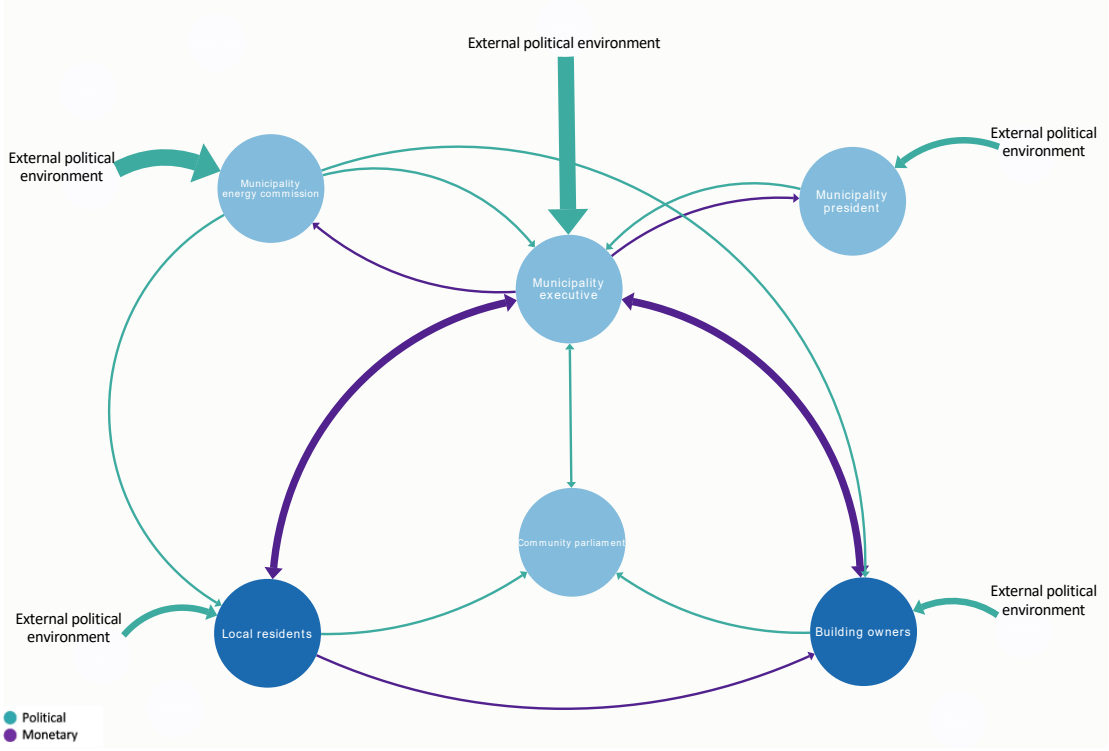


Figure 18: Ecosystem map with political & monetary layer

Looking at the monetary value flows, it can be seen that the largest flow is mainly between the municipal executive as an internal actor and the local residents and building owners as external actors (thick violet arrows in Figure 18). This assumption is mainly derived from the fact that residents and building owners pay the municipality as a political institution taxes, for the usage of the municipal infrastructure. On the other hand, financial incentives in the form of subsidy programmes are set in favour of the local residents and building owners, which leads to a monetary flow in opposite direction. Further cash flows, which can be seen in Figure 18, arise from payments for services, which flow to several actors in opposite direction of the services presented in Figure 17 before. It is assumed that the services of the energy commission and the community parliament for the residents and building owners are remunerated by the municipality executive.

4.2.4 Action & risk layer

In a further diagram (Figure 19), the ecosystem is displayed with the layers action (black) and risks (red). The action layer contains only those actions that are related to local energy policy of Küsnacht. It can be seen that the municipality executive has the greatest action flow and power influence (thickest arrows) on local residents and building owners (Haus & Ladner, 2020). This action takes place mainly through the creation of the local energy policy programme, in which visions and guiding principles are defined and the corresponding measures are determined. These measures in turn mainly influence the actors external to the municipality, such as the local population and building owners. The municipality president, the community parliament and the energy commission also have considerable action power (Haus & Ladner, 2020), which is indicated by the slightly thinner arrows. However, since the community parliament is not involved in all energy policy decisions here either, this actor only has a partial action on the executive, marked by the dashed connection. The remaining action flows can be read from Figure 19, whereby both local residents and building owners can perceive individual action fields that influence their personal lifestyle, which in turn can have an impact on the local energy transition.

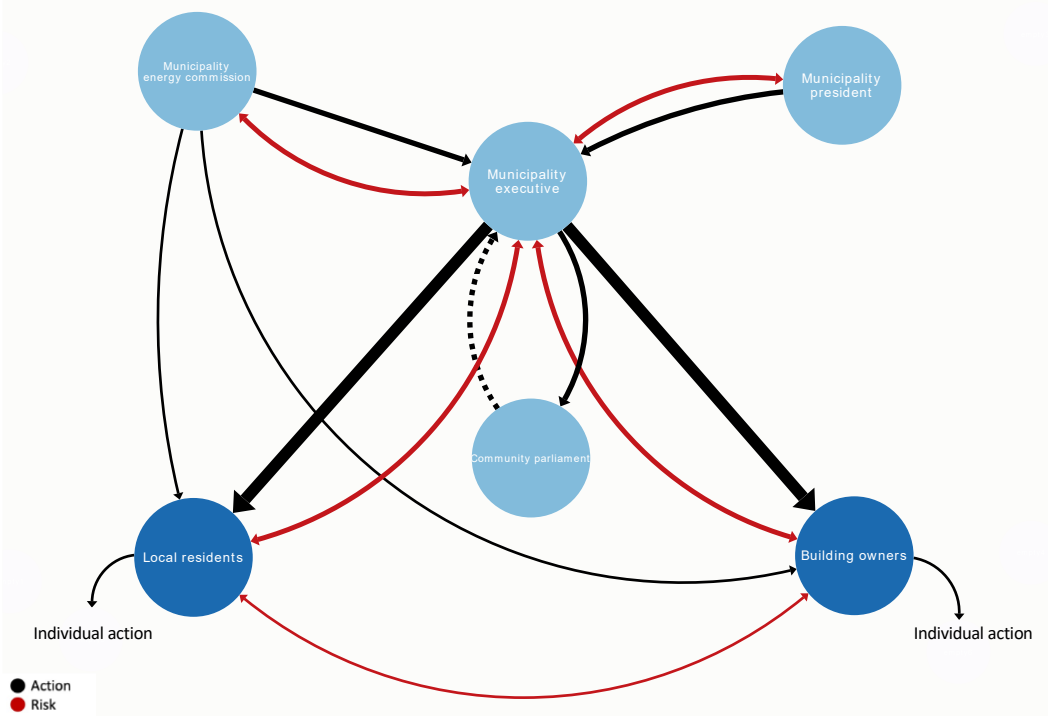


Figure 19: Ecosystem map with action & risk layer

The risk layer is represented by red connections in Figure 19. These connections serve to illustrate where potential problems influencing the local energy transition are most likely to be found. As can be seen in the diagram, the municipal executive is at the centre of most risk connections, reflecting again the great power of this actor. Internal municipal risks are mainly found in the linkages between the energy commission, the executive and the municipality president. This can be assumed as the energy commission and the president can influence the decision-makers of the executive through their personal interests and can thus partially impact the local energy transition. In the event of disagreements, this can lead to internal conflicts which can prevent a successful implementation of the local energy transition. On the other hand, the influence of individual internal personalities can also bring the necessary drive and will to push the municipality forward representing therefore a driver for the energy transition of Küsnacht (Lüchinger A., Interview, 2021). Furthermore, there may be some risk potential between residents (in this case tenants) and building owners. This assumption originates from the risk that rents may be increased by building owners to compensate for the additional costs they incur due to the measures of the local energy policy programme. It should be noted that the rent can only be increased by value-adding investments. However, the extent to which this risk may apply is not covered in this thesis.

4.2.5 Driving forces & barriers

Using the ecosystem analysis for the municipality of Küsnacht on the basis of different layers, the interconnections and relationships between the relevant actors could be identified. The insights gained from this serve to define the driving forces and barriers for the implementation of the energy transition at municipality level. The main findings are summarised and documented in this section.

Driving forces

Through the analysis at the action and risk level, the strong role of composition for the energy commission, the municipality executive and the municipality president were identified. The political composition as well as the individual personalities with the respective interests of the community actors thus have a significant influence on the local energy transition and can serve as a decisive driver or barrier. In the case of Küsnacht, the occupation of internal community actors was classified as driver, as little internal resistance is perceived in relation to the local energy transition. A further finding gained from the interviews and the ecosystem analysis is, in the case of Küsnacht, the strong financial resources and the ambition as a municipality to take on a pioneering role (Arber Ch., Lüchinger A., Interview, 2021). Küsnacht has a low tax rate compared to other municipalities and is a somewhat wealthier municipality. This is reflected in the above-average living space and higher heating requirements. The ambition to drive the municipality forward is also perceived by the population, since so far, the inhabitants have always approved the subsidy budget in the energy sector without discussion (Lüchinger A., Interview, 2021). This shows that financial resources can be helpful for a successful energy transition, but that the necessary will of actors and a low level of internal resistance must also be present for a municipality to move forward.

Barriers

On the other hand, also barriers were identified through the ecosystem analysis. An important aspect found is the complexity to break down the energy issue so that municipalities understand what national strategies mean concretely for them as a community. According to (Arber Ch., Interview, 2021), this is not yet the case for Küsnacht. Therefore, additional binding guidelines from the canton would be helpful to facilitate the political persuasion of the municipality as an authority (Arber Ch., Interview, 2021).

"The municipalities know where they want to go, but they do not yet know exactly what that implies."
(Dr. Gallati J., 2021)

However, it cannot be assumed that every municipality holds this opinion, as the interview with Horw makes clear, in which strong cantonal support is already noticeable and therefore further regulations on the part of the canton are not necessarily desired (Bessire G., Interview, 2021). Another barrier identified is the lack of data quality and access to reliable planning instruments for the respective local energy commission. This data quality, which is simply lacking for profound decisions, makes it difficult to follow a defined strategy. To make the best use of certain tools, municipalities depend on good data quality. Only with accurate data can a municipality create a path that everyone can follow (Arber Ch., Interview, 2021). Besides this, a certain discrepancy could be identified for Küsnacht that the inhabitants of the municipality have always agreed to the subsidy budget in the energy sector without discussion but are not really willing to make concessions to their high standard of living. Therefore, to achieve the ES 2050 targets as a municipality, it is imperative to involve people more actively, to make them aware of their responsibility and to win them over for the achievement of the ES 2050 goals (Lüchinger A., Interview, 2021).

The involvement of the population however also has its limitations, which were identified in the consideration from a technical perspective. One of the biggest technical challenges in implementing the ES 2050 in Küsnacht was identified as the creation of action plans that enable owners to replace their current oil and gas heating systems. This is because a large proportion of owners cannot implement the necessary measures (e.g. installation of heat pumps) themselves, as in the case of groundwater heat pumps the subsoil of the house has its technical limitations. This means that energy reduction is often possible, but the goal of net zero emissions cannot be achieved, even if the motivation was there (Lüchinger A., Interview, 2021). An overview of the driving forces and barriers identified for Küsnacht can be found in Table 3.

Table 3: Overview of drivers and barriers for the municipality of Küsnacht

Driving forces	**Barriers**
Supportive composition of the energy commission, municipality executive and municipality president	Complexity of breaking down the topic to understand what energy transition means for Küsnacht
Strong financial resources	Lack of cantonal binding guidelines
Ambition to take on pioneering role	Lack of accessible, good data quality & planning instruments
Little resistance within the municipality to push ahead the energy transition (budget approvals)	Discrepancy between budget approval and lifestyle adjustment
	Lack of population involvement in the transition process
	Technical limitations

Besides the drivers and barriers identified for Küsnacht, another important finding from the interview with Horw is the limited time and human resources the municipality has as an institution.

> *"Due to the current 70% workload [with one full-time staff member], time for the energy sector is limited. This will change in the future with an increase in staff in summer." (Bessire G., Interview, 2021)*

Although this statement may seem inconspicuous at first glance, it suggests that especially in smaller and medium-sized municipalities, where an increase in staff may not always be possible, time and human resources can be an obstacle for the local energy transition and can lead to a delay in implementation. The reason for this may be that the municipal employees are dealing with other tasks that occur and are therefore only able to deal with the increasingly important and complex topic of energy transition to a limited extent.

4.2.6 Key success factors

From the identified drivers and barriers, the most relevant factors for a successful implementation of the energy transition at community level could be derived, which is presented in this paragraph.

One key success factor is the access to reliable data of correspondingly good quality as well as access to helpful planning tools for the energy commissions of municipalities. As already mentioned, only with correct data can a strategy be defined and the current status in relation to this strategy be checked and, if necessary, appropriate measures be initiated. Furthermore, it is important to involve local actors (residents) in the transition process so they can drive the energy transition forward on their own initiative as well (Bessire G., Interview, 2021). An important factor here is the long-term communication strategy of the municipality towards the local actors, which according to (Lüchinger A., Interview, 2021) and (Dr. Gallati J., Interview, 2021) still has increasing potential for improvement. Thus, the identified discrepancy can be addressed to the effect that the local population, in addition to agreeing to subsidy budgets in the energy sector, is also willing to adapt their personal lifestyle. This can be conditionally influenced by financial incentives from the municipality through subsidy programmes.

4.3 System thinking

After the drivers, barriers and key success factors for Küsnacht were identified, the system dynamics of Küsnacht's local energy transition was analysed. For this purpose, one previously identified driver and barrier each was selected and adjusted to analyse their effect on the system. The two scenarios were visualised with the help of CLD with the aim of better understanding how the ecosystem reacts to possible driver or barrier changes and what impact they can have. From this, possible conflict potentials could be identified which are highlighted in a second stage. The results obtained are presented in this chapter.

4.3.1 Causal loop diagrams

The important loops in the CLDs were labelled with a loop identifier, which serves to indicate whether the feedback is positive (reinforcing: R) or negative (balancing: B). For some arrows there is a delay marker (||), which means that the effect of the variable is not immediate but time delayed. Finally, it is important to note that the relationship polarities only describe the structure of the system and not the magnitude or behaviour of the variables as such (González, Sandoval, Acosta, & Henao, 2016). The first CLD (Figure 20) addresses the strong financial resources of Küsnacht representing a driving force for its local energy transition. The question which now arises is how adjustments to the financial resources of the municipality affect the holistic dynamic ecosystem. The scenario with its cause (here financial resource) and the corresponding effects on the ecosystem can be depicted from Figure 20 below.

Figure 20: Causal loop diagram, scenario financial resource

The CLD in Figure 20 consists of three reinforcing loops (R_1-R_3) and one balancing loop (B_4). For each loop, the starting point is Küsnacht's financial resource (red rectangle). The CLD shows that support programmes can create greater incentives for residents to install renewable energy systems (RES) on their properties by having significant large starting capital within the municipality. This, in turn, can result in a return of financial resources to the municipality, as the installation of RES can cause increased revenues for local businesses. These are then returned to the municipality through increased tax payments (R_1). In addition, the financial incentives or installation on RES may also be affected by state or cantonal regulations, as illustrated by the red path. The second loop (R_2) displays the impact of financial resources on pollution and greenhouse gas (GHG) emissions. The larger share of RES decreases the locally produced emissions (negative polarity), which leads to less environmental depletion. This in turn leads to lower clean-up costs, resulting in increased financial resources for Küsnacht. Finally, the third loop (R_3) highlights the impact on location attractiveness, as lower environmental pollution increases the perceived benefits of the local population, which can lead to improved location attractivity. However, it should be noted that the change in environmental depletion does not have an immediate impact on health conditions and perceived benefits, as this is associated with a significantly large time delay, which is indicated with a delay symbol accordingly. Furthermore, due to the lower environmental depletion, a benefit can also be perceived on a mental level. Ultimately, increased location attractiveness leads to increased housing density, which in turn leads to greater financial resources for the municipality due to additional tax payments. The balancing loop B_4 shows a limit which the location attractiveness has in relation to the increased housing density. This means that after a certain time the location attractivity no longer increases (or even decreases) because the municipality has a to large housing density.

Looking at the first CLD as a whole, one can see how the financial resources would continue to increase exponentially over time, as there are more reinforcing than balancing loops. Important to mention here is that this CLD only represents the beginning of the local energy transition and thus does not consider the long-term saturation that will be reached in terms of financial resources at a certain point in time.

In the second CLD (Figure 21 below), the scenario is displayed in relation to the identified barrier of poor data quality for Küsnacht. Also in this case, the starting point for each loop is the data quality (red rectangle). The question that the CLD tries to answer here is what impact the current lack of data quality for Küsnacht has on the entire dynamic ecosystem and what would change if the data quality was improved.

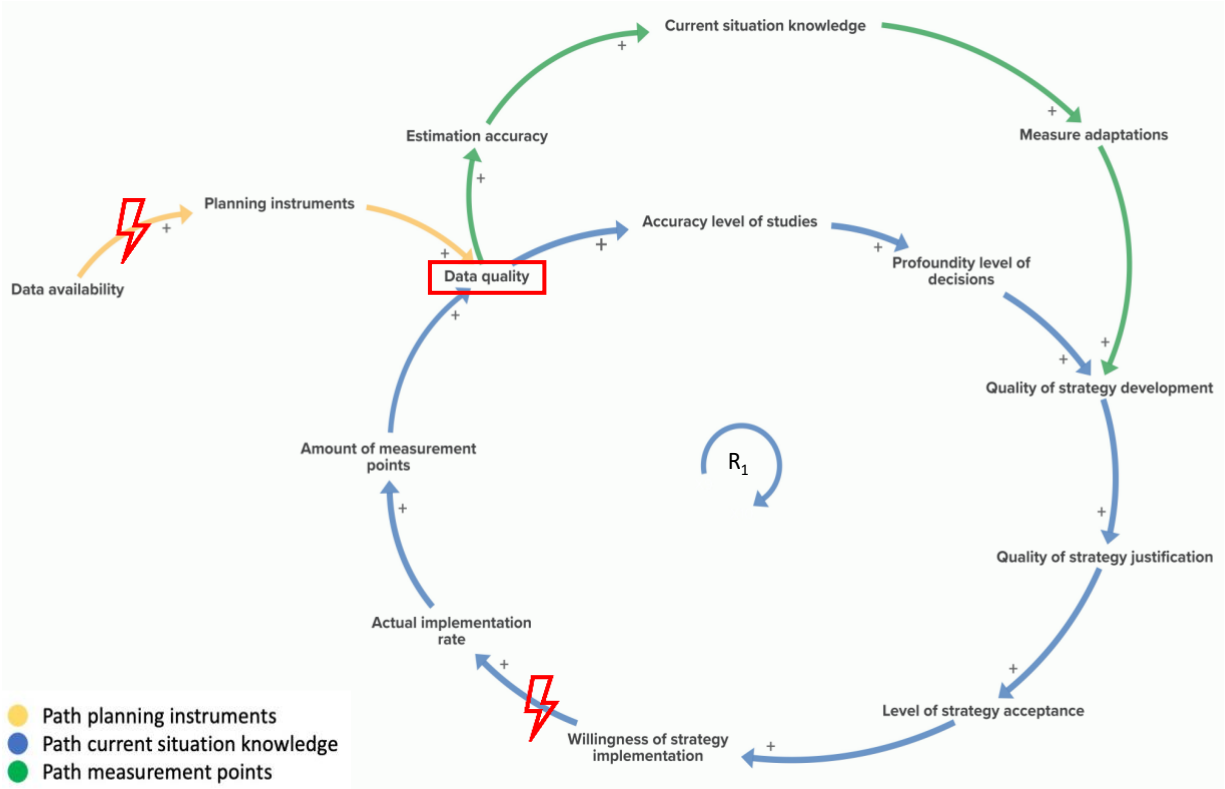


Figure 21: Causal loop diagram, scenario data quality

Compared to the first scenario, this CLD contains only one reinforcing loop (R_1). The lack of data quality is triggered by the poor data availability and the poor overview of applicable planning tools (orange path) that could be helpful to Küsnacht in achieving a successful energy transition. The lack of data quality in turn influences a chain of various other factors. On the one hand, it is difficult for Küsnacht's energy commission to gain an overview of the current situation without precise data, which in turn makes it difficult to implement appropriate measures (green path). On the other hand, without precise data, it is challenging for the municipality to make profound decisions that lead to a well-developed implementation strategy. Thus, it can be assumed that strategies based on inaccurate data have a lower chance of being accepted and implemented by the local population. As a result, fewer projects in the field of energy system transition will be realised, which leads to less measurement data and therefore to a deterioration in data quality. Therefore, it can be assumed that if Küsnacht's data quality would be improved, more strategies could be implemented, which reflect reality. By assuming such strategies being more likely to be accepted and implemented by local stakeholders, more measurement points would be created, which in turn would improve Küsnacht’s data quality.

4.3.2 Possible conflict potentials

In both scenarios, possible conflict potentials were identified through the cause-effect analysis of the CLDs. These are summarised and presented in this paragraph.

Scenario I: Financial resource

With respect to the first CLD, one main potential conflict could be identified. The relationship between financial incentives and the installation of RES (red lightning Figure 20). The reason for this is that it cannot be assumed there will be an immediate increase in the amount of RES installed as soon as larger financial incentives are given through support programmes. The likelihood that this is the case will increase, however it is not possible to define the precise magnitude of how many people are willing to change their energy consumption due to which incentives created. In addition, many other factors play an important role in this context, such as general openness or motivation to participate in the local energy transition, which were not considered in this analysis. The conflict which the municipality of Küsnacht faces here is that, as a political institution, it can only influence the behaviour of local residents to a limited extent through financial resources. Overcoming this critical point and forcing installations of RES locally can therefore only be done through legal and regulatory guidelines from the canton or the federal government, as shown in Figure 20 by the red path.

"The biggest challenge lies in changing the end consumer's mind to accept the current additional costs in order to move away from conventional energy sources and switch to alternative energy. Ultimately, a lot can be done, but as long as the end customer is not willing to accept a certain extra effort, it is difficult to drive the energy transition locally." (Gerber S., Interview, 2021)

Scenario II: Data quality

In the second CLD, two main potential conflicts could be identified. First, in the relationship between data availability and planning tools, and second, between willingness of strategy implementation and actual implementation rate (red lightnings Figure 21). The first conflict turns out to be the main cause that negatively affects all other factors of CLD. This is because, as already mentioned, no planning tool can be used meaningfully without having data available. Without data availability, Küsnacht can therefore only create a limited extent of realistic local energy strategies to advance the energy transition.

Secondly, the CLD identified another conflict that is closely related to the one from the first scenario and also concerns the effective implementation of the local population. Just because a community strategy is based on reliable data and therefore more likely to be accepted, does not mean that the residents of the community are also willing to change their lifestyle and implement the strategy accordingly. Therefore, the municipality as a political institution can only influence the behaviour of the residents to a certain extent through improvement of data quality.

5 Discussion of results

The aim of this chapter is to discuss the results obtained from the stakeholder analysis, ecosystem analysis and systems thinking and to evaluate and compare them to the literature review. Furthermore, it presents how the results relate to the brief of the introduction and the objectives set at the beginning of this thesis and helps to highlight the most important findings. Finally, a recommendation for best practice for municipalities is derived from the results discussed and a recommendation for further research is presented.

5.1 Stakeholder analysis

The stakeholder analysis was applied to the municipality of Küsnacht as a reference. It was found that especially actors within the municipality institution (energy commission, municipality executive and municipality president) have a great interest and power in the local energy transition and were thus identified as key players. In addition to the municipality actors, local residents and building owners were identified as further key players. For Küsnacht, the industrial and commercial sectors play a minor role, as Küsnacht is practically a purely residential municipality. The analysis was mainly based on two expert interviews, both conducted within the Küsnacht energy commission. The results of the two interviews largely confirm each other, which carries the risk of only being able to gain limited or one-sided insights about Küsnacht's relevant actors, as a certain bias prevails. However, the interviews confirm the findings of (Haus & Ladner, 2020) that at Swiss municipal level primarily the municipality executive and the municipality president possess the greatest power.

The same internal actors were identified as key players in the interview with the municipality of Horw. However, they are not generally transferable to all other municipalities as stakeholders differ depending on the size of the municipality (Dr. Gallati J., Interview, 2021). Since Küsnacht and Horw, with around 14,000 inhabitants, are among the larger Swiss municipalities, no general statement can therefore be made specifically for smaller and medium-sized municipalities. In the case of smaller municipalities, it can also be assumed that they do not partially own the local energy supplier like Küsnacht does with the “Werke am Zürichsee”. Thus, this actor can play a more prominent role in smaller municipalities compared to Küsnacht. The industrial and commercial sector can also have more influence in other municipalities, depending on the size of the sector. Therefore, it can be expected that for other municipalities more actors would have to be considered as key players in the stakeholder analysis.

Stakeholder engagement, especially of the local population, was mentioned as crucial in all interviews and was partly classified as a challenge for the municipalities nowadays (Bessire G., Dr. Gallati J., Interview, 2021). Although stakeholders in Küsnacht are involved through public events, thematic events and round tables, a general potential for improvement with regard to the long-term communication strategy could be identified from further research projects on municipalities in the energy transition (Dr. Gallati J, Interview, 2021).

The reason for this is that the municipalities have not yet reached the point in the energy transition process where concrete engagement strategies have been worked out with the key players. Therefore, a more pragmatic approach by the municipalities could be observed so far (Dr. Gallati J., Interview, 2021). This finding underlines the results of the stakeholder analyses carried out in the city of Maputo (Sarmento dos Muchangos, Tokai, & Hanashima, 2017) and the municipality of Gela (Falcone, 2018), in which a general potential for improvement in stakeholder engagement was identified when it comes to designing a successful policy intervention at municipal level (see chapter 2.3.1).

As a sensitivity analysis, the identified stakeholders were also classified and evaluated in influence-size and priority-influence matrices (see Appendix E | Stakeholder analysis matrices). This allowed for a comparison to create a final classification of stakeholders based on the interest-power matrix presented in chapter 4.1.1. From the sensitivity analysis, it can be seen that stakeholders within the municipality institution are also highly ranked in the dimensions of influence and priority, which underlines their role as key players. Interestingly, most identified key players were found to be small in terms of size. However, due to the high priority of each and the corresponding influence through direct involvement, the size dimension has a relatively low influence on the key player identification. This leads to the conclusion that even small stakeholders can represent relevant actors in the local energy transition system.

The first research question of this thesis, namely, to identify the relevant actors (key players) and their influence on the energy transition for municipalities, could therefore be answered.

5.2 Ecosystem analysis

By analysing the individual ecosystem maps with their combination of depicted connection layers, it was possible to uncover crucial connections and thus offer opportunities to better understand the ecosystem of Küsnacht's energy transition with its key players. The identified drivers and barriers as well as the key success factors refer exclusively to the municipality of Küsnacht, as this was chosen as the reference municipality. In addition, the visual layers do not include a time layer, which leads to a limited analysis, as it can be assumed that Küsnacht's energy transition represents a dynamic system that changes over time. Therefore, the time aspect can play an important role in the analysis and the resulting conclusion. The data used for this analysis is based on the expert interviews conducted (see Appendix B | Expert interviews). The findings from the ecosystem analysis are the identified drivers and barriers as well as the key success factors presented in chapter 4.2. The drivers mentioned, such as the supportive composition of the municipality's internal actors, the strong financial resources and the ambition to take on a pioneering role as a municipality (see Table 3), can be individually attributed to the municipality of Küsnacht and cannot be assumed to be representative for other municipalities. Some identified barriers, on the other hand, could also be found in other research projects of municipalities in the energy transition. Such as the complexity of breaking down the topic of energy transition for municipalities which was also found to be an obstacle in other Swiss municipalities (Dr. Gallati J., Interview, 2021). This is reflected in relation to the ES 2050 in the fact that this strategy is still perceived as a diffuse goal by the municipalities. Although it is written on paper, it is not concretised and makes it difficult for the individual municipalities to draw conclusions about what exactly it means for them as an institution (Dr. Gallati J., Arber Ch., Interview, 2021).

The same was also found in the survey study of the eleven Danish municipalities, where despite the general motivation to promote the energy transition, municipalities perceive their role in the process as not sufficiently defined. The study also suggests that the energy planning authorities should further clarify the role of municipalities through institutional frameworks (Sperling, Hvelpund, & Vad Mathiesen, 2011). This is also underlined from the literature of fourteen interviews conducted by regional centres in Lower Saxony Germany, which found incomplete vertical knowledge sharing leading to a deficit at the local municipality level for a successful energy planning process (Bickel, et al., 2020). Therefore, the identified barrier of lacking cantonal building guidelines is not very surprising for Küsnacht, although Horw does not necessarily share the same opinion. It should be noted, however, that only one interview was conducted with Horw, which may raise the question of the extent to which this interview is representative for the whole municipality. Based on the interviews conducted and the literature examined, it can therefore be concluded that one of the greatest challenges with regard to the local energy transition is the concretisation of strategies for municipalities.

A concretisation could facilitate the work of the municipalities as authorities to convince the population to make certain changes in the living behaviour (Arber Ch., Interview, 2021). This could in particular counteract the identified discrepancy (chapter 4.2.5), so that ultimately the behaviour of end consumers is changed, on which the municipality, has so far only limited influence. In Switzerland, the ES 2050 gives higher priority to the energy transition as a whole and, depending on the municipality, allows this issue to be enacted in the long term and at different levels. However, the economic opportunities that ES 2050 can create for municipalities are perceived as still too little present (Dr. Gallati J., Interview, 2021). This is shown by the fact that the economic opportunities were hardly mentioned in any of the interviews conducted.

The additional identified barrier of poor data quality and unclear access to planning tools for Küsnacht was also identified in the study from Lower Saxony. Due to the lack of empirical data, it is often not possible for municipalities to correctly measure their impact on the energy transition in quantitative terms, which leads to limited areas of action (Bickel, et al., 2020). Therefore, municipalities are particularly dependent on external advice to get the necessary support.

By means of ecosystem analysis, it was therefore possible to answer the second and third research questions of this thesis, namely the identification of drivers, barriers and key success factors of the energy transition at the municipal level.

5.3 System thinking

Through systems thinking, Küsnacht's energy transition was examined more closely for its cause and effect of variable changes on the system. One driver (financial resources) and one barrier (lack of data quality) was selected for this based on their specific reference to the municipality of Küsnacht. For both derived scenarios, conflict potentials were identified that are strongly entangled with each other. This illustrates how deeply interwoven the ecosystem is, not only in terms of actors, but also in terms of effects. Although the cause-effect analysis is limited by the two selected driver and barrier, an important insight can be drawn from it, confirming certain learnings from the ecosystem analysis. A large part of the effects remains with the end user, in this case the local resident, and his or her lifestyle. Therefore, the findings from the ecosystem analysis can also be confirmed by system thinking, in which, besides access to reliable data, communication and involvement of the local population is a key success factor and thus represents a conflict potential for the local energy transition.

If the system thinking approach was to be applied to other municipalities, it can be assumed that non-identical CLDs would result. This is because different drivers and barriers would already be found in the ecosystem analysis, as different or additional stakeholders would have to be considered depending on the size and type of municipality. Nevertheless, literature theory has shown that despite the great heterogeneity among municipalities, similar barriers such as a lack of concretisation and data quality also exist for transnational municipalities and thus also similar conflict potentials.

Systems thinking therefore made it possible to identify conflict potentials of interest in the energy transition at municipal level.

5.4 Sensitivity analysis

The political and environmental situation mentioned in chapter 2.1 led to the fact that all countries having signed the Paris Climate Agreement had to define their own greenhouse gas reduction path in terms of laws and regulations. The laws and regulations that apply in Switzerland (chapter 2.2) consequently differ from the strategies defined in other countries. This in turn has a differing influence on the municipalities of the various countries. Although the role of the Swiss municipality as an institution is defined in the literature (Fiechter, 2010), it does not state the exact role of the municipality in relation to the local energy transition. Only the area of the community utilities is defined as the municipality's area of responsibility (see Table 1). In addition, the heterogeneity of Swiss municipalities is not addressed, as municipalities differ considerably in terms of size and type.

The type of municipality is mainly defined by the governance model, which according to (Canton Aargau, 2016) exists in four different models (see paragraph 2.3.2). Küsnacht, which serves as reference municipality in this thesis, can be classified in the executive governance model (Figure 24) according to its organisation chart (Appendix F | Organisation chart Küsnacht) and the assessment of Küsnacht's energy commission secretary.

It is therefore assumed that most of the results of this thesis would vary between municipalities. However, some of the findings, especially the barriers and key success factors, using Küsnacht as a reference, can be transferred to municipalities of similar size (approx. 14,000 inhabitants) and with same governance models (executive governance model).

5.5 Recommendation for best practice

Now that the key players of Küsnacht have been identified at community level, the municipality can integrate them into its local energy strategy. This mainly refers to the local residents and building owners, as the other identified key players are internal municipality players representing the community as an institution itself. An elaborated engagement strategy leading to long-term communication is essential here. Although Küsnacht already points to the local energy transition through support programmes and thematic events, clearer strategies should be defined on how to get these key players on board and thus willing to adapt their lifestyles on their own. For other municipalities that differ in size and governance style, the first step is to identify the key players, understand their mindset, motivation and concerns, and build on this to develop an appropriate engagement strategy that follows the whole municipality as an institution. Only through such participatory processes can the identified discrepancy be overcome, and local stakeholders be engaged in the energy transition process. However, since it was found that the municipality executive and the municipality president possess the most power, it is up to the institution itself (and the parliament through the right of vote) to occupy these positions with personalities who want to drive change, as in the case of Küsnacht.

With regard to the identified barriers, access to improved data quality and technical limitations can be addressed by municipalities in addition to the engagement of local stakeholders. Given the lack of data quality as well as the lack of overview on applicable planning tools, partner projects with other neighbouring municipalities and local universities could be a supportive approach. Through resource synergy, faster progress can be made, from which all stakeholders could benefit. Municipalities would thus achieve improved data quality leading to enhanced support in the local energy transition, while creating attractive opportunities for university research projects. With the existing know-how, the universities could help to develop improved smart meter technologies in cooperation with energy suppliers and make them available to the municipalities. In addition to improved data quality, there is also the potential to optimise planning tools for providing added value to municipalities through a better overview.

Given the technical limitations, municipalities could participate in further research projects and promote the development of innovations also at regional level by providing infrastructure for real testing purposes. This has the advantage that innovation companies can receive feedback on technological innovations more quickly through willing citizens and thus optimise them more efficiently to market them with lower risk.

At political level, the municipalities can only exert limited influence, as they are bound by the respective cantonal laws. However, through associations of different municipalities with similar interests, attention could also be drawn at the policy level on the lack of cantonal guidelines for local energy strategies. How realistic and feasible this approach is, however, can be questioned.

5.6 Further research

The framework of this thesis serves as a first assessment of the challenges faced by municipalities in the energy transition. Furthermore, this thesis refers to the municipality of Küsnacht as a reference, which only represents a specific type of municipality in terms of size and governance model. Although similar identified barriers were also perceived in other municipalities according to literature research, no general conclusions can be drawn for all Swiss municipalities as there is a great heterogeneity among them. Therefore, follow-up projects comparing the results of this thesis with particularly smaller municipalities compared to Küsnacht would be of great interest to analyse whether the same findings regarding key players, drivers and barriers can be made.

Next, further research is needed in relation to the stakeholder engagement strategies mentioned earlier. It is important for municipalities to elaborate possible participatory processes for stakeholder engagement, which can serve as a guide depending on the stakeholder group. The findings from this thesis indicate that municipalities are in need of such support.

Finally, the economic significance of the local energy transition should be examined more closely to understand what opportunities and threats the energy transition represents for municipalities from an economic perspective. In addition, the impact on the location attractivity should be examined to analyse what costs or benefits the energy transition may have for the municipalities in the future. An examination of the extent to which the economic dimension is or should be included in the decision-making process would be of great importance as well.

6 Conclusion & recommendations

Based on the results discussed, this chapter summarises all relevant findings and provides a final recommendation for the municipality of Küsnacht in particular.

6.1 Conclusion

Climate and environmental changes as well as demographic, economic and technical developments are changing living conditions on earth in the 21st century as never before. The availability and quality of the vital resources water, air and food depend on these changes. The importance of climate and environmental issues is not only reflected in the awareness of the population, but also in corresponding laws and regulations. While laws and framework conditions are mostly set at (inter)national level, implementation is mainly regional and local. This can also be observed in the energy transition, where municipalities are confronted with complex new tasks. The aim of this thesis was therefore to analyse the challenges faced by municipalities during the energy transition, using Küsnacht as reference municipality.

Based on stakeholder analysis and expert interviews, the relevant actors in the energy transition at community level were identified. Furthermore, an ecosystem analysis was used highlighting the drivers, barriers and key success factors to determine whether and which steps are necessary to realise a successful local energy transition. Possible conflict potentials were illustrated through systems thinking by analysing how changes in barriers and drivers affect the local energy transition. A recommendation for best practices for municipalities was then derived from the findings.

It was found that mainly municipality-internal actors act as key players in the energy transition. These include the municipality executive, the energy commission, which has an advisory function on the executive, and the municipality president. In addition, local residents and building owners were identified as further key players acting as external stakeholders. All these key players have a relevant role in the local energy transition, as they have a high interest and power at community level. Therefore, the consideration of these stakeholders in the decision-making process of the energy transition is essential for the municipality of Küsnacht.

As drivers, the following aspects were identified for Küsnacht: strong financial resources, the will of the municipality to take on a pioneering role and the occupation of key positions within the municipality with ambitious personalities. On the other hand, also barriers were found which hinder the energy transition of Küsnacht. These include insufficient role definition of the municipality in the energy transition process, lack of cantonal guidelines, poor access to qualitative data and planning tools, and lack of strategies to engage local stakeholders. Although these results refer to Küsnacht, the same barriers could also be identified in other municipalities of Switzerland and abroad.

System thinking was used to analyse the system dynamics of the local energy transition in Küsnacht to uncover potential conflicts. For this purpose, one identified driver and one barrier each were selected and adapted to analyse their impact on the ecosystem using CLD. The scenarios presented largely confirmed the findings from the ecosystem analysis and emphasised the limited influence of the municipality on the behaviour of energy consumers. It became clear that municipalities can only influence the behaviour of end consumers to a limited extent through strong financial resources or access to good data quality. Ultimately it is the energy consumer who influences the progress of the local energy transition through his or her consumption behaviour.

For municipalities, it is therefore essential to involve the identified key players more strongly in the energy transition through engagement strategies. In this way, long-term communication can be established, which is necessary for participatory processes. To develop appropriate strategies, municipalities require qualitative data that can be cultivated through partner projects with neighbouring municipalities, external consultants and local universities. Through the resource synergy and the know-how, it contains, improved smart meter technologies can be developed in cooperation with the energy suppliers and standardised planning tools can be designed. This leads to the necessary support municipalities need to successfully deal with the complex tasks of the energy transition at local level.

6.2 Final recommendations

It is time for Küsnacht, with its strong financial resources and ambitions, to take the lead among Swiss municipalities and set a good example. Municipal support programmes alone are no longer sufficient to successfully master the energy transition. To this end, Küsnacht must develop in-depth strategies with the population, despite the commitment that already exists in some cases, which are then also effectively pursued by the entire municipality as an institution. For this, however, the municipality relies on support, which can be given through partner projects with the neighbouring municipalities of Zollikon and Erlenbach, as well as through consultants from the Lucerne University of Applied Sciences and Arts. In this constellation, a platform can be created in which innovations, especially in the energy-related building sector, can be promoted. This can be achieved through pilot projects that can be used as testing infrastructure for companies to verify their innovations under real and low risk conditions before an official market launch. Through voluntary residents, quick feedback can be obtained, which increases the efficiency of the innovation process.

However, this alone will not be enough. As identified in this thesis, the support of the canton is necessary as well to drive the local energy transition forward. Küsnacht, together with other municipalities that share the same opinion, must therefore try to demand more binding guidelines from the Canton of Zurich. Only in this way can the behaviour of the citizens be directly influenced, and the set national energy goals be achieved.

If Küsnacht wants to take on this pioneering role, there is still a lot of work ahead of the municipality. Yet this work is unavoidable due to the signed Paris Climate Agreement and will affect every community. It is therefore all more important to seize the opportunity as a first mover and enable the energy transition at local level.

7 List of references

AEE Suisse. (2021). *AEE Suisse*. Retrieved from Mustervorschriften der Kantone im Energiebereich (MuKEn): https://www.aeesuisse.ch/de/politik/mustervorschriften-muken-energiebereich

AUE & AGR. (2011). *Kommunaler Richtplan Energie.* Bern: Amt für Umweltkoordination und Energie (AUE) & Amt für Gemeinden und Raumordnung (AGR).

Barnes, S.-A., & de Hoyos, M. (2012). *Analysing Interview Data.* Warwick Institute for Employment Research.

Bickel, M. W., Caniglia, G., Lang, D., Schomerus, T., & Weiser, A. (2020). *Multilevel knowledge management for municipal climate action:Lessons from evaluating the operational situation of climate actionmanagers in the German Federal State of Lower Saxony.* Elsevier.

Canary, A. (2019). *How to Analyze Interview Transcripts in Qualitative Research*. Retrieved from REV: https://www.rev.com/blog/analyze-interview-transcripts-in-qualitative-research

Canton Aargau. (2016). *Organisation der Gemeindeverwaltung - Mögliche Führungsmodelle.* GEMEINDEAMMÄNNERVEREINIGUNG DES KANTONS AARGAU.

Dadwal, V., Lin, G., & Palopoli, M. (2020). *From Causal Loop Diagrams to System Dynamics Models in a Data-Rich Ecosystem.* Springer.

Dewald, U., Grunwald, A., Poganietz, W.-R., & Schippl, J. (2019). *Die Energiewende als sozio-technische Transformation - Von der Analyse zur Gestaltung.* Wiesbaden: Springer Fachmedien Wiesbaden.

Energie Schweiz. (2019). *Kommunale Energie- und Klimapolitik – Dekarbonisierung und Wärmetransformation.* EVU in Gemeinden, c/o Brandes Energie AG.

Energie Schweiz. (2020). *Leitkonzept für die 2000-Watt Gesellschaft.* Energie Schweiz.

Energiestadt. (2021, March 15). *Energiestadt*. Retrieved from Das Label Energiestadt: https://www.energiestadt.ch/de/energiestadt/das-label-energiestadt-22.html

Falcone, P. M. (2018). *Analysing stakeholders' perspectives towards a socio-technical change: The energy transition journey in Gela Municipality.* Rome, Italy: AIMS Energy.

FOEN. (2018). *Klimapolitik der Schweiz.* Bern: Federal Office for the Environment FOEN.

Fiechter, J. (2010). *Politische Gemeinden und lokale Autonomie in der Schweiz .* Chavannes-Lausanne: Swiss Graduate School of Public Administration.

Gill, P., Stewart, K., & Chadwick, B. (2008, March 22). *BDJ*. Retrieved from Methods of data collection in qualitative research: interviews and focus groups: https://www.nature.com/articles/bdj.2008.192

González, A. M., Sandoval, H., Acosta, P., & Henao, F. (2016). *On the Acceptance and Sustainability of Renewable Energy Projects—A Systems Thinking Perspective.* MDPI.

Haus, A., & Ladner, A. (2020). *Wer hat die Macht in den Gemeinden? Eine Analyse über den Einfluss politischer Akteure auf die lokale Politik in der Schweiz.* Lausanne CH: Swiss Yearbook of Administrative Sciences.

Huonder, M., Müller-Csernetzky, P., & West, S. (2018). *Ecosystems Innovation for Service Development.* Cham CH: Springer International Publishing AG.

IEA. (2018). *Energy Policies for IEA Countries: Switzerland.* International Energy Agency IEA.

Küsnacht. (2021). *Küsnacht*. Retrieved from Zahlen und Fakten: https://www.kuesnacht.ch/page/17

Natural Resources Canada. (2014). *Stakeholder Guide.* Natural Resources Canada.

Reed, M. S., Graves, A., Dandy, N., Posthumus, H., Hubacek, K., Morris, J., . . . Stringer, L. (2009). *Who's in and why? A typology of stakeholder analysis methods for naturalresource management.* Elsevier.

Ross, A., & Wade, J. (2015). *A Definition of Systems Thinking: A Systems Approach.* Hoboken NJ, USA: Elsevier.

Sarmento dos Muchangos, L., Tokai, A., & Hanashima, A. (2017). *Stakeholder analysis and social network analysis to evaluate thestakeholders of a MSWM system–A pilot study of Maputo City.* Osaka, Japan: Elsevier.

Schweizerische Eidgenossenschaft. (2021). *Demokratie Das politische System der Schweiz*. Retrieved from Der Schweizerische Föderalismus: https://www.ch.ch/de/demokratie/funktionsweise-und-organisation-der-schweiz/der-schweizerische-foderalismus/

Schweizer Wirtschaft für CO2 Gesetz. (2021). *Schweizer Wirtschaft für das CO2 Gesetz*. Retrieved from Die wichtigsten Massnahmen: https://co2-gesetz-jetzt.ch/argumente/

SFOE. (2020). *ENERGY STRATEGY 2050 MONITORING REPORT 2020.* Bern: Swiss Federal Office of Energy SFOE.

Sperling, K., Hvelpund, F., & Vad Mathiesen, B. (2011). *Centralisation and decentralisation in strategic municipal energy planningin Denmark.* Elsevier.

UN Climate Change. (2021, March 1). *United Nations Climate Change*. Retrieved from The Paris Agreement: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

UVEK. (2021). *Eidgenössiches Departement für Umwelt, Verkehr, Energie und Kommunikation UVEK*. Retrieved from Energie Strategie 2050: https://www.uvek.admin.ch/uvek/de/home/energie/energiestrategie-2050.html

2000-Watt-Areal. (2021). *2000-Watt-Areal*. Retrieved from 2000-Watt-Areale kennenlernen: https://www.2000watt.swiss/2000-watt-areale-kennenlernen.html

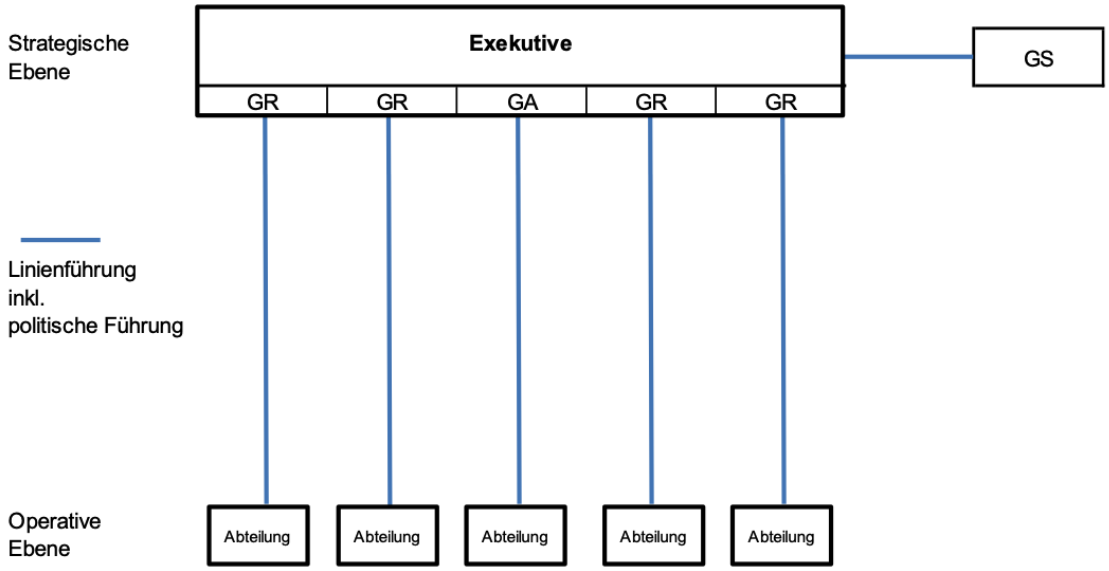
Appendices

The following pages contain relevant information that is not essential for understanding the results presented but may be helpful if certain aspects need to be explored further.

The appendix structure looks as follows:

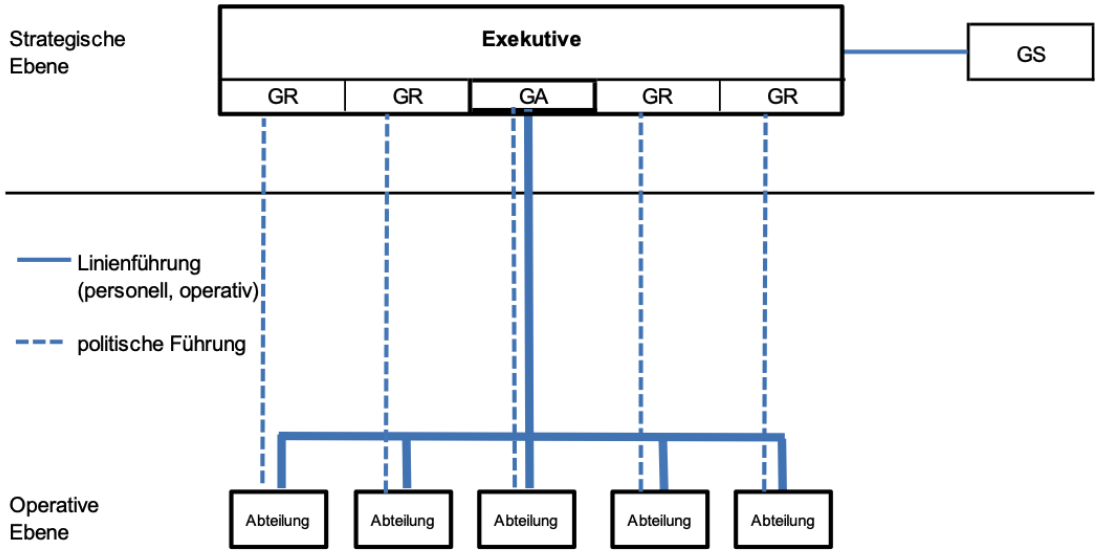
- Appendix A | Municipality governance models
- Appendix B | Expert interviews
- Appendix C | Interview comparison chart
- Appendix D | Stakeholder analysis mind map
- Appendix E | Stakeholder analysis matrices
- Appendix F | Organisation chart Küsnacht
- Appendix G | Empathy cards
- Appendix H | Ecosystem analysis draft
- Appendix I | Milestone schedule
- Appendix J | Project plan
- Appendix K | Risk management
- Appendix L | Agreed scope of work
- Appendix M | Project poster
- Appendix N | Project flyer
- Appendix O | Protocol midterm presentation

Appendix A | Municipality governance models



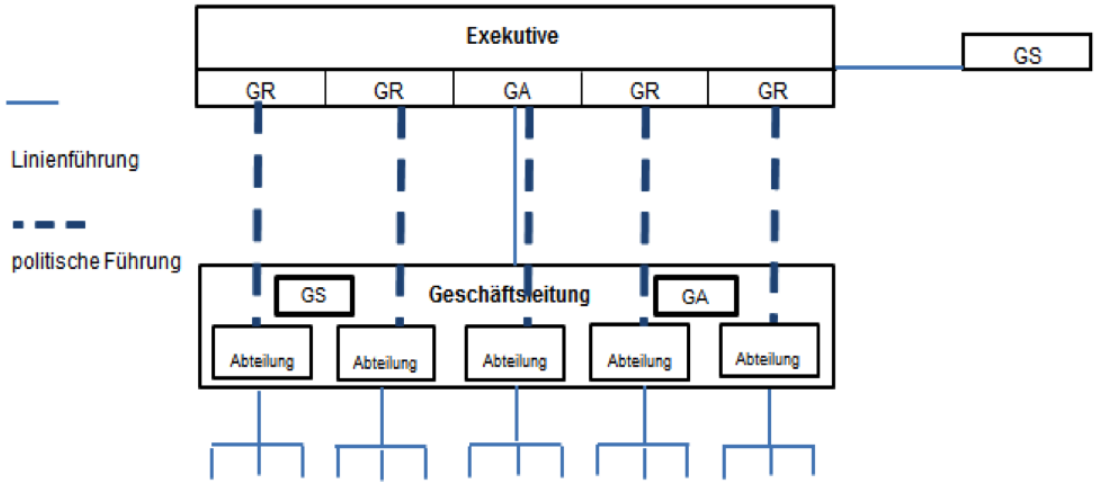
GA: Gemeindeammann / GR: Gemeinderätin/Gemeinderat / GS: Gemeindeschreiberin/Gemeindeschreiber (Stabschefin/Stabschef)

Figure 22: Operative governance model (Aargau, 2016)



GA: Gemeindeammann / GR: Gemeinderätin/Gemeinderat / GS: Gemeindeschreiberin/Gemeindeschreiber (Stabschefin/Stabschef)

Figure 23: Delegated governance model (Aargau, 2016)



GA: Gemeindeammann / GR: Gemeinderätin/Gemeinderat / GS: Gemeindeschreiberin/Gemeindeschreiber (Stabschefin/Stabschef)
Hinweis: Auch hier gilt, dass die Unterstellung der Abteilungsleitenden klar geregelt sein muss.

Figure 24: Executive governance model (Aargau, 2016)

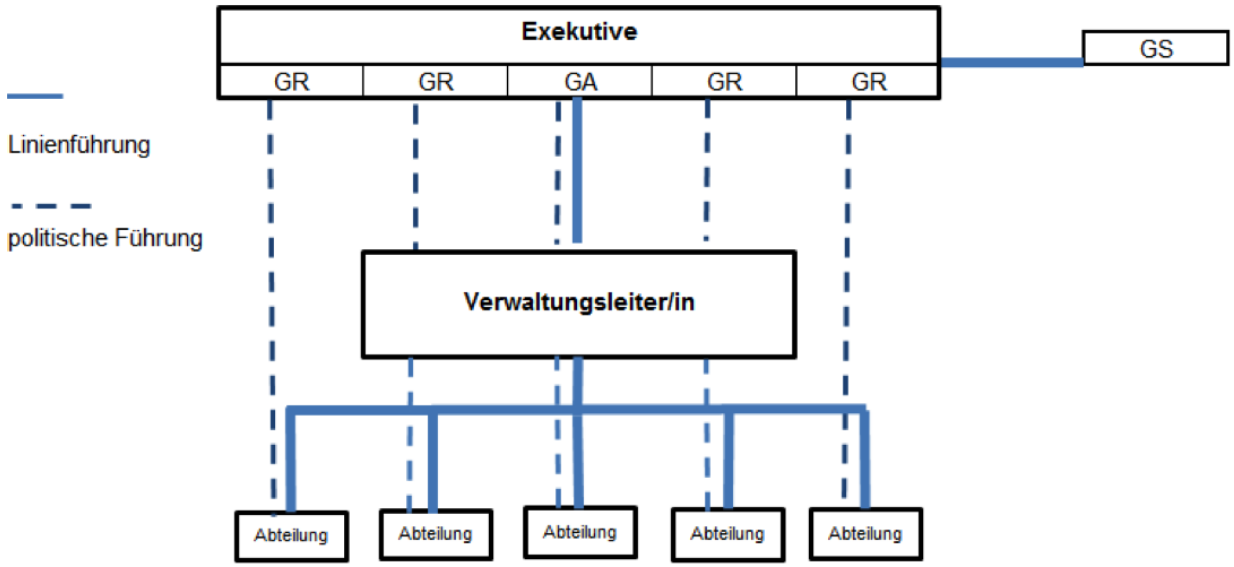


Figure 25: Administrative manager governance model (Aargau, 2016)

Appendix B | Expert interviews

Alexander Lüchinger

Interview partner: Alexander Lüchinger
Date: 07.04.2021, 08.30h
Procedure: Zoom Meeting

Questionnaire

Q1: Mr Lüchinger, can you briefly tell me something about yourself, who you are, what your background is and how you relate to the municipality of Küsnacht?

Q2: What topic is currently occupying you most in your work? And why?

Q3: How do you perceive the topic of the energy transition at community level in your work? How is the topic of energy or the energy transition perceived in the municipality of Küsnacht itself?

Q4: Where do you see the greatest challenge of the ES 2050 implementation for the municipality of Küsnacht? Where do you see opportunities? How can Küsnacht master the challenges mentioned and seize the opportunities?

Q5: Which criteria do you see as relevant for a successful implementation of the ES 2050 at communal level? Which aspects do you see as enablers? Which aspects do you see as obstacles? How can these be measured?

Q6: Which actors play a decisive role in Küsnacht and why? Which actors have significant influence on the implementation of ES 2050 specifically in the municipality of Küsnacht?

Q7: What would happen regarding energy transition at the municipal level if you had a wish at your disposal? Do you have a vision?

Interview summary – Alexander Lüchinger

The interview was conducted with Alexander Lüchinger. Mr Lüchinger has been a resident of the municipality of Küsnacht for many years and is an active member of the Energy Commission. He came into contact with the subject of energy technology and building physics and acoustics early on through his studies as a mechanical engineer. Professionally, he was mainly active in the field of energy consulting and energy planning and specialised in energy renovations of district heating systems. In Küsnacht, he was active for 20 years in the function as energy consultant at the communal level.

The interview focused on the topic of energy transition in Küsnacht by discussing where he sees the biggest challenges and opportunities for the municipality of Küsnacht in terms of implementing the ES 2050. He also identified the key players for the energy transition in Küsnacht based on his many years of experience in municipal energy policy. The discussion provided interesting insights from the perspective of an energy consultant who is still actively involved in the energy transition at the municipal level as member of the energy and nature conservation committee. The insights gained from the interview are used in the iterative process of the stakeholder analysis to identify the relevant actors and their influence on the implementation of the energy strategy at municipal level.

Küsnacht, as an agglomeration community of Zurich, is an almost purely residential community that does not have a large industrial or commercial sector. Therefore, the potential for waste heat utilisation is limited. One district heating project that supplies thermal energy to part of the municipality is the waste heat from the sewage treatment plant, which is used. However, the majority of energy consumption comes from the residential and transport sectors. Küsnacht has a low tax rate compared to other municipalities and is a somewhat wealthier municipality. This can be seen in the above-average living space and the higher heating demand.

In the municipal council, which is elected by the population of the municipality and consists of 9 members, mainly the SVP and the FDP parties are represented, which indicates a majority bourgeois-conservative municipal council, which in turn might have an influence on the perception of the local energy transition. Mr Lüchinger suspects a certain discrepancy in the fact that the residents of the municipality have always agreed to the subsidy budget in the energy sector without discussion but are not really prepared to make any concessions to their high standard of living because of their greater prosperity. Therefore, he sees it as essential to involve people more, make them aware of their responsibilities and engage them to achieve the 2050 targets. This can be achieved through support programmes, in which Küsnacht has a leading role among the municipalities.

One of the biggest technical challenges in implementing the ES 2050 in Küsnacht is the creation of action plans that enable owners to replace their current oil and gas heating systems. This is because a large proportion of owners cannot implement the necessary measures (e.g. installation of heat pumps) themselves, as in the case of the heat pump, the subsoil of the house has technical limitations. This means that energy reduction is often possible, but the net zero emissions cannot be achieved. Mr Lüchinger is therefore of the opinion that the municipality must first and foremost help the owners and implement essential measures such as the planned use of lake water heat in order to heat as much of the municipality's population as possible with renewable energies in addition to the district heating of the sewage treatment plant. On the non-technical side, local politics needs more persuasion and clearer communication to get the population on board and thus promote their own contributions, such as switching to electric mobility, as transport is a main source of emissions. As an opportunity, Mr Lüchinger sees the municipality's ambition and assets. Compared to other municipalities, Küsnacht can afford innovations in the field of energy technology. He believes that the origin of this ambition lies in the influence of individual personalities in the municipal council or administration such as Mr. Arber (Secretary of the Energy Commission), who have the necessary drive and desire to push the municipality forward in terms of the energy transition. This also includes the necessary luck, which is required for an optimal distribution of roles within the municipality. Thus, from an internal perspective, the municipality of Küsnacht is experiencing little headwind in the implementation of the ES 2050, which can be seen as a great advantage.

With regard to the relevant actors, Mr Lüchinger mentions the decision-making process consisting of the energy commission, the municipal council and the municipal assembly. The energy commission has less decision-making authority than the municipal council, which ultimately makes the decisions. However, if the energy commission as an advisor succeeds in advising the municipal council as the decision-maker in such a way that the municipal council agrees to the advice, then the energy commission represents one of the most important roles in the energy transition at the municipal level. Depending on how important a particular proposal is and how much budget it requires, it must come before the people and be finally approved there. Therefore, for the ES 2050, the municipal assembly is the decision-maker, which is composed of the population. The population in turn is partly influenced by the political parties and their voting recommendations, which in turn means that the political parties must also be brought on board. The canton's main influence is primarily at the legislative level through measures such as the energy planning report and the licensing regulations. Mr Lüchinger sees local businesses as less relevant actors, as there is no large industry in the municipality and there are rather smaller craft businesses, which are of less importance for the energy transition.

In conclusion, it can be said that Küsnacht, due to its wealthy resources and strong ambition, is well placed to implement the energy transition at the local level. However, this requires clear emission reductions, especially in the residential and transport sectors, in order to achieve the 2050 ES targets. This can only be achieved if the energy commission and the municipal council involve the population, have support programmes for the replacement of fossil heating systems and promote individual contribution in the form of lifestyle adaptation through clear communication. In addition, actors such as the business sector in Küsnacht can be classified as less relevant, as there is no strong industrial sector in this municipality.

Christian Arber

Interview partner: Christian Arber
Date: 08.04.2021, 10.30h
Procedure: Zoom Meeting

Questionnaire

Q1: Mr Arber, can you briefly tell me something about yourself, who you are, what your background is and what your function is in the municipality of Küsnacht?

Q2: What issue is currently occupying you most in your work? And why?

Q3: How do you perceive the topic of the energy transition at municipality level in your work? How is the topic of energy or the energy transition perceived in the municipality of Küsnacht itself?

Q4: How does the municipality of Küsnacht position itself as an „Energiestadt" with regard to the implementation of the ES 2050? Which strategy do you follow concretely?

Q5: Where do you see the biggest challenge of the ES 2050 implementation for the municipality of Küsnacht? Where do you see opportunities? How can Küsnacht master the challenges mentioned and seize the opportunities?

Q6: Which criteria do you see as relevant for a successful implementation of the ES 2050 at communal level? Which aspects do you see as enablers? Which aspects do you see as obstacles? How can these be measured?

Q7: Which actors play a decisive role in Küsnacht and why? Which actors have significant influence on the implementation of ES 2050 specifically in the municipality of Küsnacht?

Q8: How do you as a municipality deal with these relevant actors?

Q9: Where do you currently see the greatest challenge in your everyday work? What do you hope for in the future? Do you have a vision/wish?

Interview summary – Christian Arber

The interview was conducted with Mr Arber. Mr Arber studied energy and environmental engineering at the University of Applied Sciences Northwestern Switzerland, where he first came into contact with the topic of the energy transition. After several years of professional experience in asset management and district heating sales, he took over the position of project manager for energy and environment in the municipality of Küsnacht in April 2020, where he is secretary of the energy and nature conservation commission. An important main task is the creation of the Vision 2050, in which the municipality of Küsnacht defines how it wants to position itself in the area of energy and the environment. The task of the energy commission is to generate the politically desired content, compile basic data and propose a direction to the municipal council.

A current topic that Mr. Arber and the Küsnacht Municipal Commission are dealing with is the revision of the Vision 2050. The current Vision 2050 dates back to 2009, which was already defined in a very progressive way for the situation at that time, according to Mr. Arber. However, due to the adoption of the ES 2050, this Vision 2050 of the municipality must now be revised in order to be able to achieve net zero by 2050. In addition, the municipal administration as a public authority has is willing to set itself the goal of becoming carbon neutral by 2030, without taking the building stock into account. How this is to be realised, however, is still open. The revised vision is also to serve as the basis for the renewal of the energy and environmental programmes, which expire by the end of 2021. In these programmes, budgets are made available for the next four years for the implementation of measures and support programmes in the area of energy and the environment. The focus is on the replacement of oil and gas heating systems and the promotion of renewable electricity, for example through photovoltaics.

However, Mr. Arber describes the starting point for this process as different from 2009, as there is no legal basis on the part of politics, but only statements and goals such as the ES 2050, on which one must build. Furthermore, the involvement of the population in the revision is an essential point, as it is clear that the topic of the energy transition is a burning issue for the population and that people want to get involved. Another challenge is that although there are a large number of instruments and databases for municipalities, the overview has been very confusing so far. Therefore, the Energy Commission is trying to generate specific data for Küsnacht with the help of greenhouse gas inventory software, based on the existing energy absorption area and the different energy carriers that can be recorded through tracking and data collection of the Werke am Zürichsee (local energy provider). However, there is a lack of reliable data quality, which complicates the whole process. For example, the local energy provider does not know exactly how many heat pumps are installed in the municipality of Küsnacht and only know the PV systems that also feed into the electricity grid. However, in order to be able to make optimal use of certain instruments such as the greenhouse gas inventory, the municipality is dependent on good data quality. Because only with accurate data can the municipality create a path that everyone can follow, says Mr Arber.

Mr. Arber sees the ES 2050 more as an overarching and superordinate strategy, which, apart from the measures in the building parks regarding energy efficiency and the promotion of renewable energies, takes place less at the municipal level. Therefore, he rather uses the climate and greenhouse gas issue to be able to push through certain projects. With regard to other areas of the ES 2050, such as the electricity grid, the municipality is dependent on clear legislation from the canton, as otherwise Küsnacht has no influence. In the area of mobility, Mr Arber is of the opinion that the municipality has so far had little influence on the citizens and must therefore act as a role model. For this reason, the municipality is striving to raise awareness among the population by purchasing electric cars itself in the future, organising events on the topic of electromobility and also promoting the infrastructure for electromobility by offering public charging stations.

With regard to the opportunities that the municipality of Küsnacht has for the communal energy transition, on the one hand there is the pride of being Energy City Gold, which should remain so in the future. This is politically undisputed across party lines. Furthermore, Küsnacht is a financially strong municipality that has the necessary resources to tackle the energy transition at the municipal level. In addition, despite the middle-class municipal council, Mr. Arber experiences practically no internal resistance with regard to the energy transition, since there is a noticeable will to make a difference as a municipality in the area of energy policy. On the other hand, the biggest challenge is to break down the topic of energy transition, which is mainly dealt with at federal and cantonal level, and to define exactly what this means for the municipalities. This requires clear communication so that Küsnacht does not float along with the energy turnaround but takes on a pioneering role, because ultimately the municipalities have to act and convince their population of the need for change. In addition, there is a lack of understanding for the complex topic of the energy transition, which cannot always be measured precisely, which in turn makes the implementation of projects in the area of energy and the environment more difficult, says Mr. Arber. Another challenge is the already mentioned data quality, which is simply lacking for well-founded decisions, making it difficult to pursue a defined strategy and to be able to measure the current status. In terms of cantonal cooperation, Mr. Arber's experience is that a lot is currently happening at all levels, but there is still a lack of concrete laws and binding guidelines from the cantons. Politically, this would make the work of the municipality as an authority much easier in order to convince the population (and the members of the public authority itself) to make certain changes.

Mr. Arber sees the population, or more precisely the property owners, who must be included in the decision-making processes, as well as the local policymakers (energy and nature conservation commission, municipal council, municipal assembly), who have a significant influence on the decision-making process, as important actors. Other important actors are the Werke am Zürichsee as local energy provider, the property management companies and building cooperatives as well as the road users. These stakeholders are involved through public events, thematic gatherings and round tables or through letters to property owners drawing attention to the support programmes of the Canton of Zurich or the municipality of Küsnacht. Local businesses and especially industry can be classified as less relevant, as they do not make up a large proportion in Küsnacht.

In summary, Küsnacht is in an optimal situation to tackle the energy transition at the local level due to its determination, resources and the organizational embedding of the European Energy Award since 2001. However, in order to implement this successfully, there is a lack of access to information with good data quality, greater involvement of the population and a clear understanding of the division of tasks between the federal government, the canton and the municipalities. In order to simplify the necessary work of convincing the inhabitants, more concrete regulations and guidelines on the part of the cantons would be a great help for the municipalities. The most important actors here are the residents and the municipal politics of the municipality itself, as they are significantly involved in the decision-making process and have corresponding influence.

Samuel Gerber

Interview partner: Samuel Gerber
Date: 12.04.2021, 13.30h
Procedure: Zoom Meeting

Questionnaire

Q1: Mr Gerber, can you briefly tell me something about yourself, who you are, what your background is, what Werke am Zürichsee AG stands for and what connection you have to the municipality of Küsnacht?

Q2: How do you relate to the topic of the energy transition at community level in your work? In your opinion, how is the topic of energy or the energy transition perceived in the municipality of Küsnacht itself?

Q3: As an energy provider, where do you see the greatest challenge of the ES 2050 implementation at municipal level? Where do you see opportunities? In your opinion, how can the municipality of Küsnacht specifically master the challenges mentioned and seize the opportunities?

Q4: Which measures are relevant for you as a local energy company to enable a successful implementation of the ES 2050 at communal level? Which aspects do you see as enablers? Which aspects do you see as obstacles?

Q5: Which actors play a decisive role in this from your perspective and why? Which actors have significant influence on the implementation of ES 2050 specifically in the municipality of Küsnacht?

Q6: What would happen with regard to energy transition at communal level if Werke am Zürichsee AG had a wish at its disposal? Do you personally have a vision?

Interview summary - Samuel Gerber

The interview was conducted with Mr Gerber. After an apprenticeship as an electronics technician and initial work experience at ABB, Mr Gerber studied Energy Systems Engineering at the Lucerne University of Applied Sciences and Arts. After completing his studies, he took over the project manager function in the district heating division at Werke am Zürichsee. Werke am Zürichsee is an interconnected company that supplies the communities of Zollikon, Küsnacht and Erlenbach with electricity, gas, water and district heating (in Küsnacht). As an energy supplier, they are entirely owned by the municipalities, with Küsnacht being the largest owner. The grids belong to the municipalities themselves, with the Werke am Zurichsee fulfilling a pure operator function. As project manager for district heating, Mr Gerber was involved in the customer-side conception, planning and implementation of the district heating network in Küsnacht, which uses waste heat from the local sewage treatment plant and currently supplies 76 properties with thermal energy.

The district heating project was set up for the first time after approval by the municipal assembly so that large customers could be connected to the heat supply. However, since the networks belong to the municipality itself, it was also the municipality's goal to connect small customers such as single-family homes to the network via the infrastructure for the large customers. This required a lot of effort in the initial stages of the actual construction project to convince the residents to connect to the district heating network. Resistance from the residents became noticeable at the latest during the price discussion, as gas heating is cheaper in direct comparison to district heating, especially with regard to the energy costs incurred during the life of the heating system. One argument in favour of switching to district heating was the MuKEN, which mandates a minimum share of renewable energy supply. In the end, many customers felt a certain pressure to move when the building project was actually implemented and the construction work had begun with the grid extension, with many residents spontaneously deciding to connect to the district heating grid. An advantage for the Werke am Zürichsee is the long investment period of 30 years that the energy supplier has, which allows a certain amount of flexibility for the amortisation of the investments.

The topic of energy transition is perceived and supported by a large part of the private population, but only as long as the neighbour does the same, says Mr Gerber. However, an increased willingness to switch to renewable options could generally be observed in recent years. Where the motivation comes from is difficult to define, he explains. Possibly it is a mixture of fear that fossil fuel prices will rise in the future and a basic willingness to do something beneficial for the environment. For public buildings such as schools, which are owned by the municipality, Mr Gerber has seen an easier approach, as the municipality has made a political commitment to reduce its emissions (net zero by 2030 for the authority itself) through the Energy City Gold Certificate. The district heating project was an ideal opportunity for this. Nevertheless, Mr Gerber sees it as very difficult to integrate the small proportion of commercial and industrial users in Küsnacht into the local energy transition. This is shown by the low number of customers from the industrial sector who have decided to connect to the district heating network. Mr Gerber sees the reason for this in the low financial resources and short-term planning horizon available due to the often small size of the companies.

Regarding the challenges for the energy transition at the local level, Mr. Gerber sees the biggest challenge in changing the end consumer's mind and accepting the current additional costs in order to move away from conventional energy sources and switch to alternative energy. Ultimately, a lot can be done, but as long as the end customer is not willing to accept a certain extra effort, it is difficult to drive the energy transition locally, says Mr Gerber. A certain resistance to new technologies, some of which are more cost-intensive, is noticeable, so that one cannot rely solely on the residents' own responsibility. It would be desirable for an energy supplier like the Zürichsee-Werke to have additional guidelines from the state and the canton that facilitate the implementation of measures for a low-emission future. As an energy supplier, the Werke am Zürichsee are caught between the municipality, which owns the facilities, and the end users, who consume the final energy, making it difficult from the energy supplier's point of view to meet the needs of all parties.

Mr Gerber sees the financial resources in the municipality of Küsnacht, which are above average compared to other municipalities, as an opportunity. These funds can be used to invest in support programmes and to influence the behaviour of end consumers (citizens of Küsnacht) through financial incentives. However, Mr Gerber considers the extent of the incentive programmes to be limited, as a municipality cannot permanently provide funds for such incentive programmes.

Mr Gerber considers it difficult for the Werke am Zürichsee as operator to take concrete measures themselves and thus influence the local energy transition, since the grids belong to the municipality itself and the Werke am Zürichsee being only operators of these grids. The possibilities for influence at municipality level are therefore limited, according to Mr Gerber. Mr Gerber clearly sees the end consumer as the biggest key player, who decides in the private sector what kind of energy he wants to purchase. The task as an energy supplier is thus limited to the creation, consultation and support of sustainable energy supply projects. However, there is room for action as an energy consumer insofar as the board of the plants could switch to alternative energies for the own consumption and thus exert a certain influence on the local energy policy.

In summary, the scope for action of the Werke am Zürichsee with regard to the energy transition is limited, as they are owned by the municipality itself. Ultimately, the end consumers have the greatest influence on the local energy transition, as they can determine the type and origin of the energy they purchase, which the energy provider Werke am Zürichsee enables them to do through supply networks. From a political point of view, clearer decisions and guidelines would make it much easier for the providers to convince the population of Küsnacht, so that district heating connections could be sold more easily.

Gwen Bessire

Interview partner: Gwen Bessire
Date: 13.04.2021, 15.00h
Procedure: Zoom Meeting

Questionnaire

Q1: Ms Bessire, can you briefly tell me something about yourself, who you are, what your background is and what your function is in the municipality of Horw?

Q2: What issue is currently occupying you most in your work? And why?

Q3: How do you perceive the topic of the energy transition at municipality level in your work? How is the topic of energy or the energy transition perceived in the municipality of Horw itself?

Q4: How does the municipality of Horw position itself as an energy town with regard to the implementation of the ES 2050? What concrete strategy do you follow?

Q5: Where do you see the biggest challenge of the ES 2050 implementation for the municipality of Horw? Where do you see opportunities? How can Horw master the challenges mentioned and seize the opportunities?

Q6: Which criteria do you see as relevant for a successful implementation of the ES 2050 at communal level? Which aspects do you see as enablers? Which aspects do you see as obstacles? How can these be measured?

Q7: Which actors play a decisive role in Horw and why? Which actors have significant influence on the implementation of ES 2050 specifically in the municipality of Horw?

Q8: How do you as a municipality deal with these relevant actors? What role does the Canton of Lucerne play in this?

Q9: Where do you currently see the greatest challenge in your day-to-day work? What do you hope for in the future? Do you have a vision?

Interview summary – Gwen Bessire

Gwen Bessire is a qualified geographer and has been the nature and environmental protection officer for the municipality of Horw for 12 years. The main topics of the nature and environmental protection office include environmental protection, energy, nature, agriculture and forestry. With around 14,000 inhabitants, the energy town of Horw is one of the larger municipalities in Switzerland and is comparable in size to the municipality of Küsnacht in Zurich. Due to the current 70-percent workload, the time available for the energy sector is limited. According to Ms Bessire, this should change in the future with an increase in the summer. In addition, Ms Bessire is a member of the Environment and Energy Commission of the municipality of Horw with an advisory vote. In addition to the daily business, the implementation of the communal energy planning, the open space concept for the valley floor and the networking concept are central projects. Currently, the statement on the cantonal climate report is being prepared.

The topic of energy transition is being perceived more and more consciously and broadly in the municipality of Horw, says Ms. Bessire. There is little resistance, especially within the municipality, and they are prepared to take on a certain role model function in order to sensitise the population accordingly. However, Ms Bessire is also of the opinion that despite cantonal laws, media and support programmes, there is still great potential. This requires not only technical solutions, but also a general willingness on the part of each individual to adapt his or her lifestyle.

The municipality of Horw pursues an energy policy programme that is renewed every 4 years. In this process, visions and guiding principles are defined and the corresponding measures are determined. In the communal energy planning, a reduction path is defined in order to achieve the requirements of the 2000-watt society and ES 2050. The climate report shows fields of action to achieve these goals. To this end, support programmes for homeowners are used and, through a mandate with the Lucerne University of Applied Sciences and Arts, prospective heating associations are approached for the conversion to renewable energies.

The opportunities and challenges for implementing the ES 2050 in the municipality of Horw depend on the different sectors. In the building sector, Ms Bessire sees good opportunities to initiate measures for the implementation of ES 2050 via instruments such as energy planning or the cantonal energy law. Ms Bessire considers the mobility sector to be only partially influenceable, as it is not necessarily determined at the municipal level. However, the greatest opportunity lies in the fact that the municipality, as an authority, is closest to the residents and can thus exert a positive influence by providing advice and acting as a role model. Ms. Bessire sees obstacles for a successful implementation of ES 2050 in Horw mainly in the access to green electricity in order to be able to meet the demand for e-mobility holistically. Another point to be clarified is the conflict of goals between the protection of the townscape and photovoltaic roofs and the promotion of green roofs, as well as the increasing installation of renewable energies such as wind turbines.

Ms Bessire describes the municipal council as the executive and the residents' council as the legislature as relevant actors in the local energy transition that have a significant influence on the decision-making process. The Environment and Energy Commission also has the opportunity to set impulses through its advisory function, which are decided in the municipal council. Of the external key actors in the municipality, residents and property owners are of central importance, as are architects, builders, engineers and planners who can influence the implementation of primarily construction projects. Ms Bessire also describes the cooperation with the canton as beneficial and close. Due to the noticeable support, there is therefore no need for further regulations on the part of the canton, according to Ms Bessire.

In summary, it can be said that for a successful local energy transition, the necessary impulses are needed from the relevant actors within the municipality, i.e. from the residents' and municipal councils. The challenge is to involve the important actors such as planners and property owners in such a way that they also promote the energy transition on their own initiative. In addition to technical solutions, the willingness of each individual to take a step towards the energy transition is also required.

Dr. Justus Gallati

Interview partner: Dr. Justus Gallati
Date: 19.04.2021, 08.30h
Procedure: Zoom Meeting

Questionnaire

Q1: Mr Gallati, can you briefly tell me something about yourself, who you are, what your background is and what you are involved with at the Lucerne University of Applied Sciences and Arts?

Q2: How do you perceive the topic of the energy transition at community level in your work? How is the topic of energy or the energy transition perceived in the municipalities themselves?

Q3: How do municipalities position themselves with regard to the implementation of the ES 2050? Where do you see challenges for the municipalities? Where do you see opportunities?

Q4: What do you think a municipality has to do to overcome the challenges mentioned and to seize the opportunities?

Q5: Which criteria do you see as relevant for a successful implementation of ES 2050 at municipal level? Which aspects do you see as enablers? Which aspects do you see as barriers? How can these be measured?

Q6: Which actors play a crucial role and why? Which actors have significant influence on the implementation of ES 2050 in municipalities?

Q7: How do you think municipalities should deal with these actors? Why?

Q8: Where do you see further potential for improvement for municipalities in the energy transition? Which strategies for measures are necessary to enable the energy transition at municipality level in the future? What do you hope for in the future?

Interview summary – Dr. Justus Gallati

The interview was conducted with Mr Gallati. Mr Gallati is a physicist and environmental scientist and gained experience at the Cantonal Office for Environmental Protection Lucerne, among others. Since 2008 he has been teaching and working at the Lucerne University of Applied Sciences and Arts in the Institute for Business and Regional Economics IBR. He is particularly concerned with the topics of sustainability, ecology, system modelling and system dynamics. One of IBR's tasks is to advise municipalities on strategic issues. It was found that municipalities face the challenge of integrating the topic of energy transition into municipal management. Based on this finding, an internal university project entitled "ITC Climate Neutral Communities" was launched to address this issue. Four interviews were conducted for this purpose, including three municipalities and one interview with the Canton of Lucerne. The result was that the energy transition is an important topic in the municipalities and that a lot is currently being done on this matter. The municipalities are beginning to understand their responsibility as a local institution, but what this means for their population is not yet clear to the municipalities, according to Mr Gallati.

With regard to the ES 2050, Mr Gallati sees that it is still a diffuse goal for the municipalities, which is on paper but lacks concretisation and it is difficult for the individual municipalities to draw conclusions on what exactly it entails for them as a local authority. The municipalities know where they want to go, but they do not yet know exactly what that implies, says Mr Gallati. The municipality of Malters (one of the municipalities interviewed) stated that the ES 2050 was also not very useful for them, as it was too abstract and less of a bottom-up approach for the municipality. The long-term question that arises from this is therefore how the local bottom-up strategies of the municipalities can be combined with the top-down strategies such as the ES 2050 and what inputs are required from the municipalities for this. This requires a set of instruments for energy planning that, according to Mr Gallati, is only available in rudimentary form. Therefore, the municipalities are particularly dependent on external advice in this respect in order to obtain the necessary support. Although the ES 2050 gives the entire energy transition a higher priority and makes it possible, depending on the municipality, to enact this topic in the long term and at different levels, the economic opportunities that the ES 2050 can create for the municipalities are still too little present. The biggest challenge is to make the ES 2050 more concrete.

The key players depend on the size of the municipality, says Mr Gallati. In the municipalities studied in the ITC project, the focus was on medium-sized municipalities with about 3000-7000 inhabitants. Internal relevant actors in the municipality itself are essentially the energy commission, resorts manager and the municipality president. But here, too, it is difficult to make a general statement, as motivation and attitudes towards the energy transition are very person-dependent, according to Mr Gallati. Local cooperatives and energy suppliers also play an important role. In the industrial sector, a great heterogeneity was found, which means that there are great differences of opinion among local companies regarding the energy transition at community level. With regard to the population, a general potential for improvement in communication was identified in order to get this stakeholder group on board. It is not yet possible to say exactly how these key players will be involved by the municipalities, as there is still no clear strategy to be seen on the part of the municipalities. Mr Gallati sees the reason for this in the fact that the municipalities have not yet reached the point in the energy transition process where concrete integration strategies have been worked out for the key players. So far, the municipalities have essentially adopted a pragmatic approach, according to Mr Gallati.

In summary, it can be said that an interplay of different aspects is needed to enable a successful energy transition at the local level. Mr Gallati sees the bringing together of key players through stakeholder processes as an essential point. This requires a long-term communication strategy that deviates somewhat from the current pragmatism. In addition, there is a need for planning instruments that support the municipalities in this process, as well as a stronger focus on the economic aspects, so that the municipalities are also aware of what is in store for them at the economic level.

Appendix C | Interview comparison chart

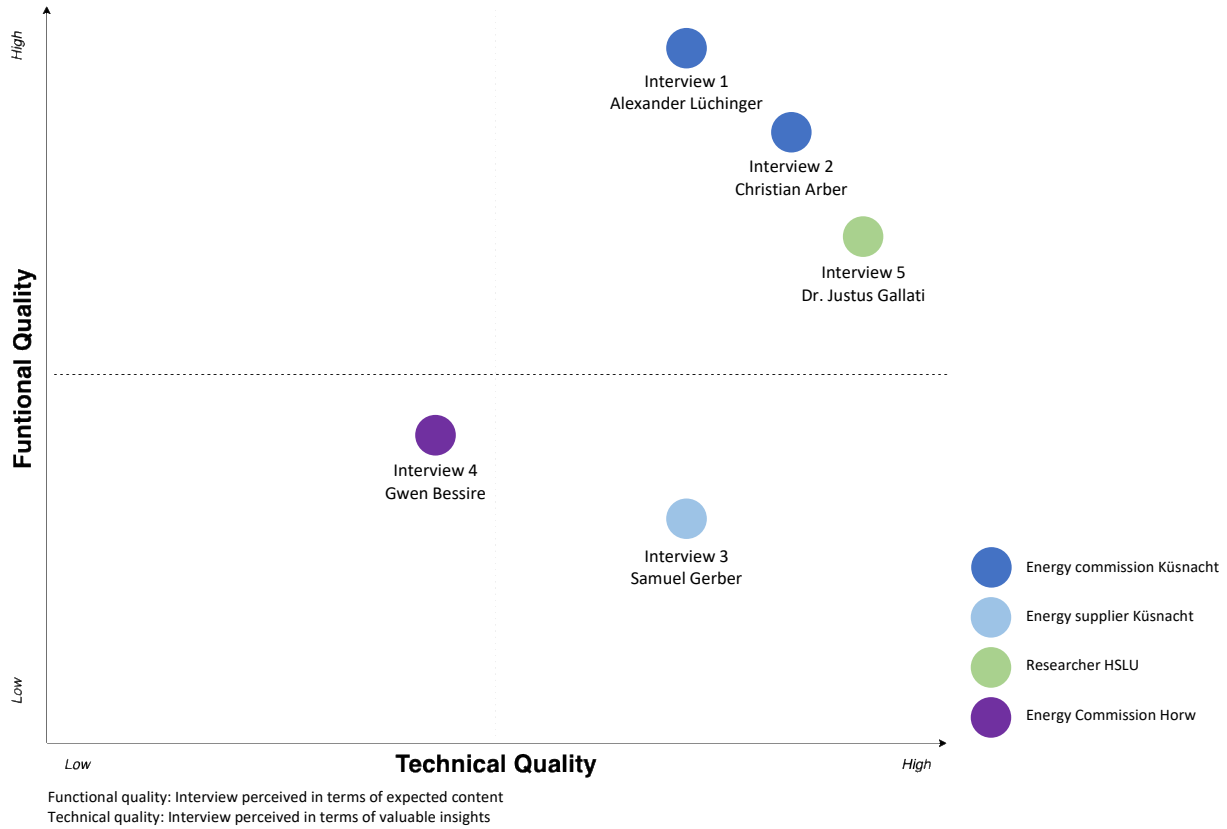


Figure 26: Interview comparison chart

Appendix D | Stakeholder analysis mind map

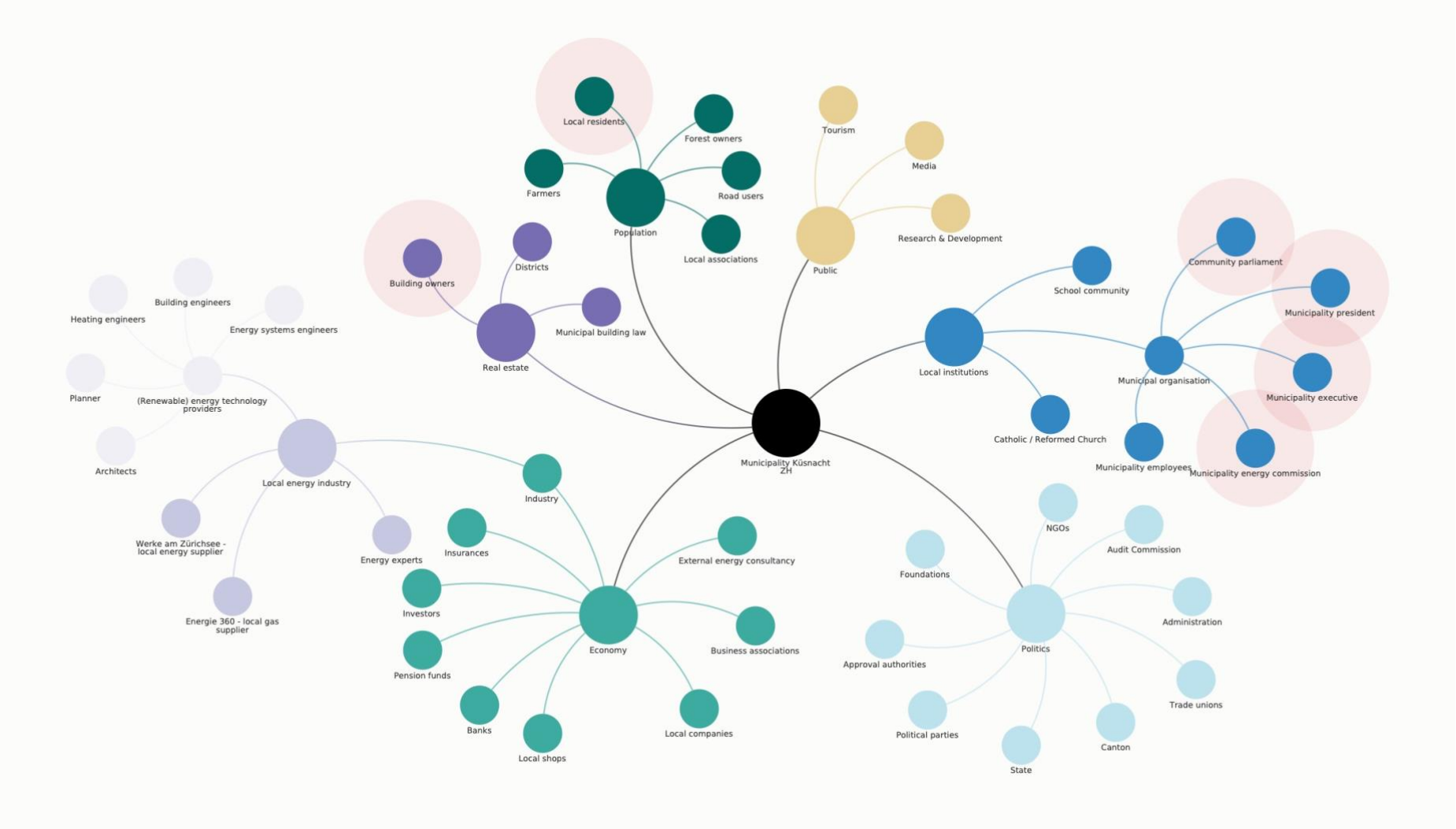


Figure 27: Stakeholder mind map for Küsnacht ZH with key players marked in red

Link for direct access: https://bit.ly/3ifXUMc

Appendix E | Stakeholder analysis matrices

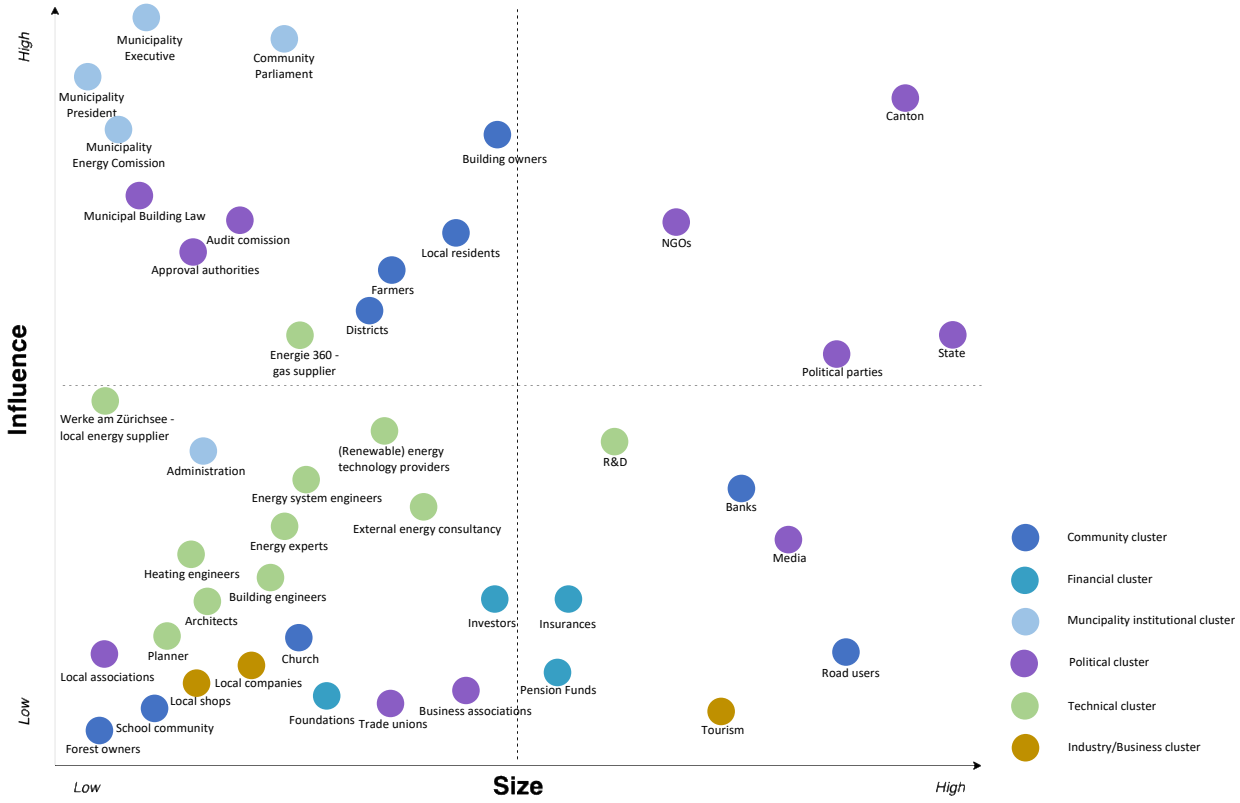


Figure 28: Influence-size matrix Küsnacht ZH

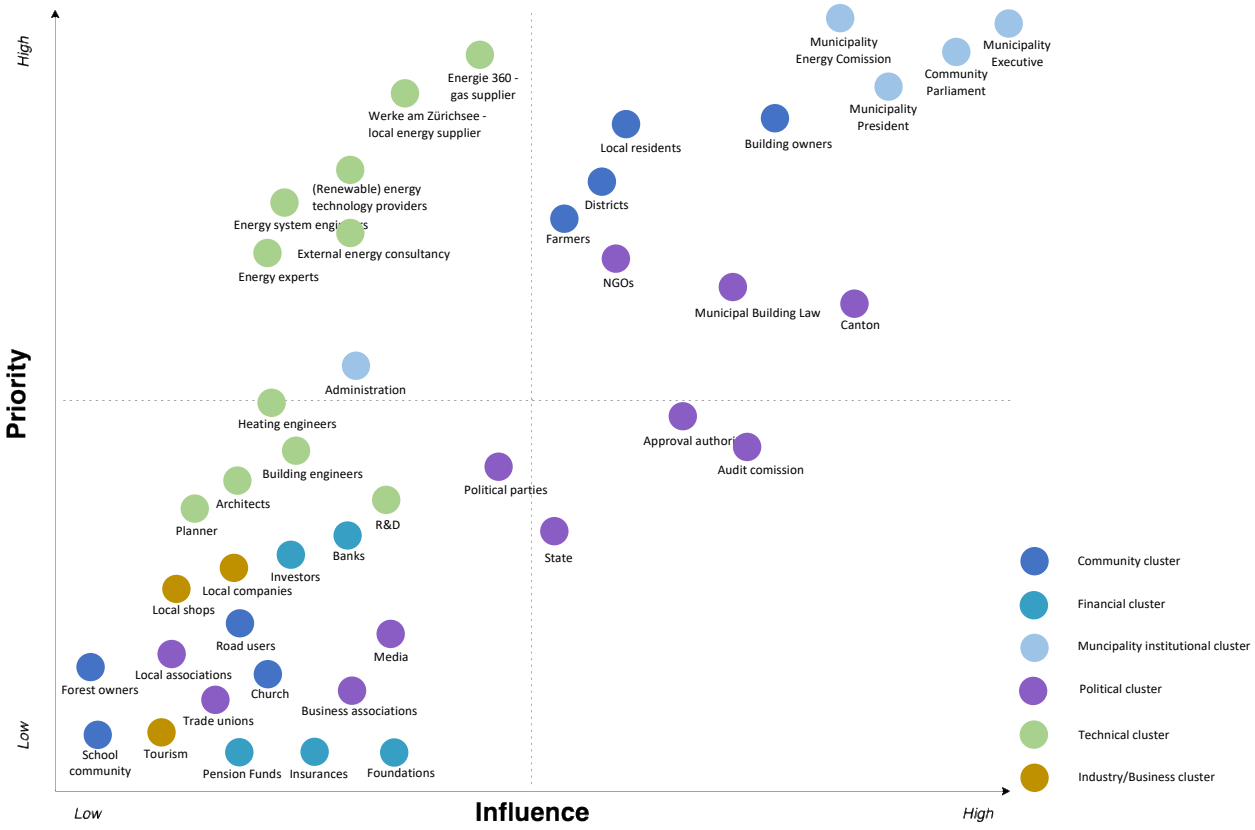


Figure 29: Priority-influence matrix Küsnacht ZH

Appendix F | Organisation chart Küsnacht

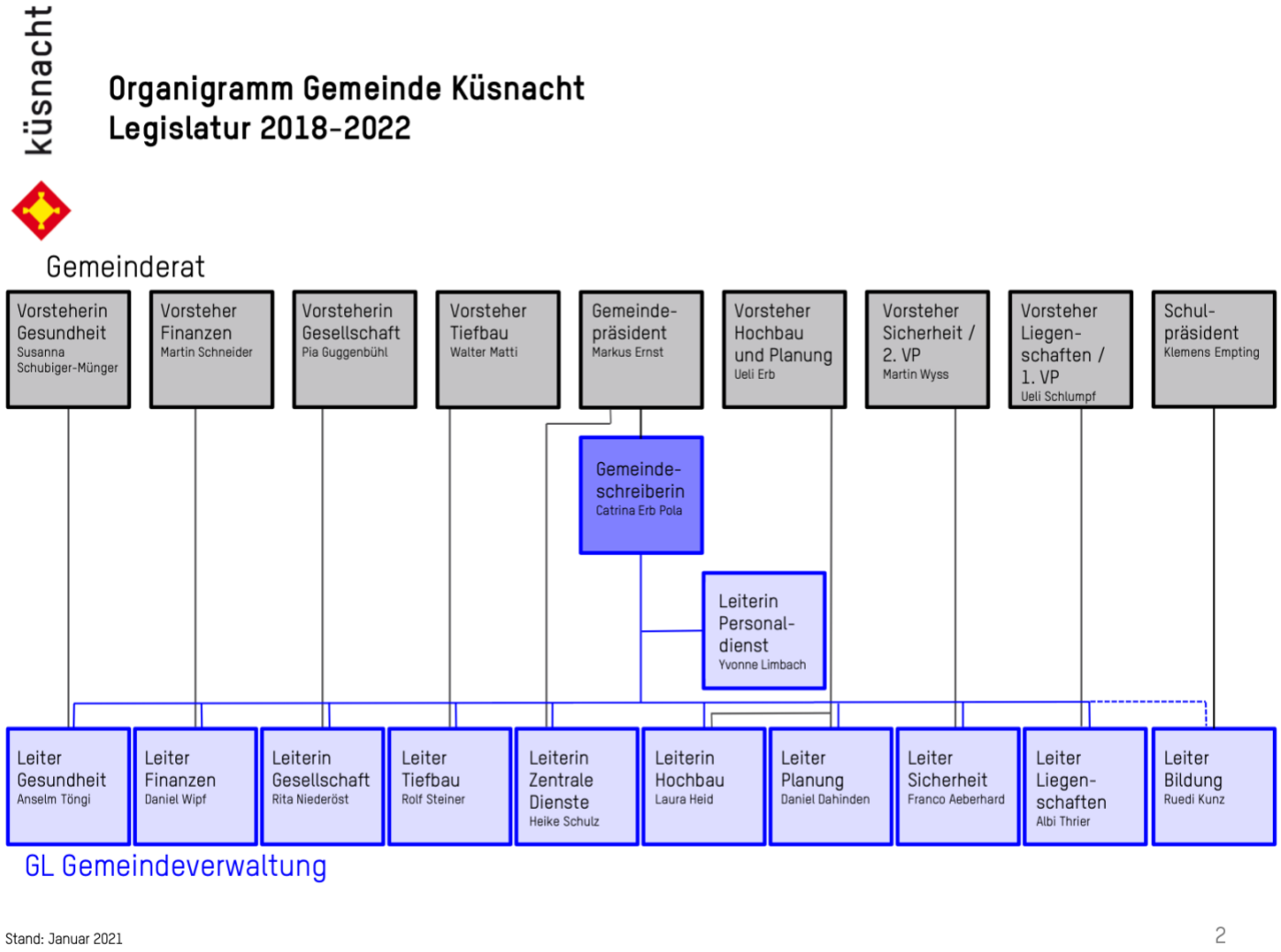


Figure 30: Municipality organigram Küsnacht (Küsnacht, 2021)

Appendix G | Empathy cards

Energy Commission

Job to be done:
Advising the municipality executive and monitoring the current situation as well as reporting on tasks carried out

- Community pride being certified as Energiestadt Gold
- Low internal resistance
- Above average financial resources
- Chance of pioneering role in the energy transition among swiss municipalities

- Stakeholders have to be successfully involved
- Lack of data quality
- Confusing overview of supporting instruments
- Topic breakdown → what does energy transition mean for us?
- Lack of cantonal guidance and respective laws
- Energy transition is complex
- Lack of understanding of complex topic

Figure 31: Empathy card energy commission

Municipality Executive

Job to be done: Find consensus and compromise to satisfy the majority and implement decisions

- Energiestadt Gold pride
- Above average financial resources
- Pioneer role potential for Küsnacht
- Energy commission as advisor
- First mover advantages
- Less dependence on fossil fuel
- Local energy provider (Werke am Zürichsee) partially owned

- Stakeholders have to be successfully involved
- Lack of concrecte integration strategies
- Topic breakdown → what does energy transition mean for us?
- Alignment of the local bottom-up strategy with the national top-down approach
- Planning instruments only rudimentarily available
- Energy transition is complex
- Effort and investments required
- Increased political and public pressure
- Dependence on external support

Figure 32: Empathy card municipality executive

Municipality President

Job to be done: Chief executive of political community

- Energiestadt Gold pride
- Above average financial resources
- Pioneer role potential for Küsnacht
- First mover advantages
- Spotlight opportunities for position and municipality

- Risk of loosing position
- Increased political and public pressure
- In charge of taking responsibility
- Must deal with diverse opinions externally/internally
- Effort and investments required

Figure 33: Empathy card municipality president

Community Parliament

Job to be done: Control of executive and voice of local inhabitants in fundamental municipal decisions

- Participation and right of determination
- Preservation of the local environment
- Green energy
- Conservation of resources and landscape
- Community support programme

- Addtitional finanical expenses
- Complex topic to understand
- Energy demand needs to be covered
- Effort and investments required

Figure 34: Empathy card community parliament

Local Residents

Job to be done: Paying taxes for used infrastructure and consuming energy

- Environmental contribution
- Preservation of the local environment
- Green energy
- Conservation of resources and landscape
- Increased quality of life
- Less dependent on fossil fuels and corresponding prices
- Community support programme
- Potential of lower taxes in long-term
- Decrease of operating costs in long-term

- Addtitional finanical expenses
- Complex topic to understand
- Energy demand needs to be covered
- Effort and investments required
- Change in living behaviour
- Possible increase in rents
- Intangible benefits which are difficult to quantify (quality of life, etc.)

Figure 35: Empathy card local residents

Building Owners

Job to be done: Property management and supply of energy for renters

- Lower environmental impact
- New business model opportunities (e.g. roof space rental for PV)
- Green energy
- Independent energy supply
- Less dependent on fossil fuels and corresponding prices
- Community support programme
- Potential of lower taxes in long-term
- Decrease of operating costs in long-term

- Cost and time intensive
- Energy demand needs to be covered
- Effort and investments required
- Additional regulations/restirictions
- Return on investment only in the long-term
- Residential location in Küsnacht already attractive
- Missing out on opportunity recognition

Figure 36: Empathy card building owners

Appendix H | Ecosystem analysis draft

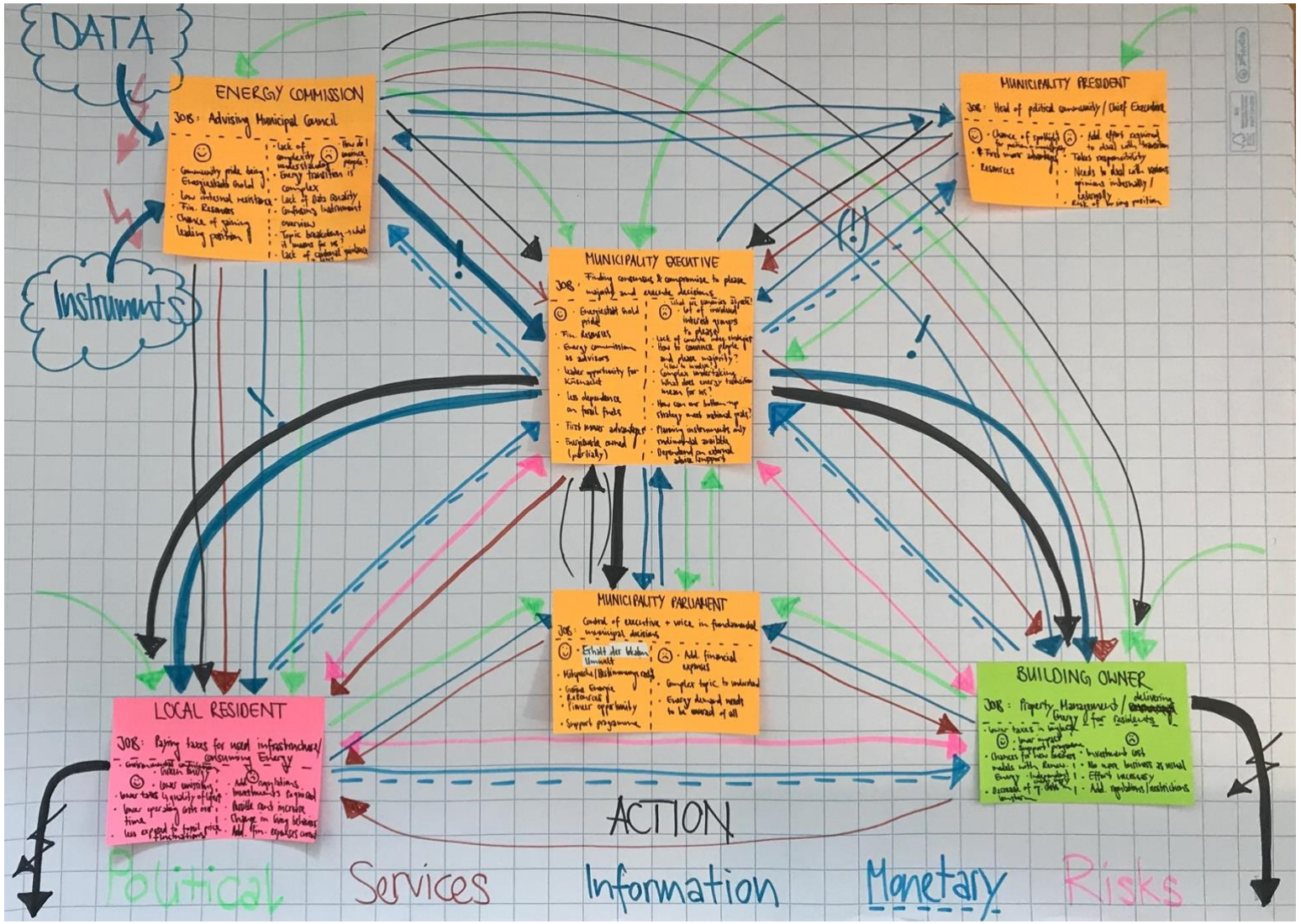


Figure 37: Ecosystem map draft on flipchart

Appendix I | Milestone schedule

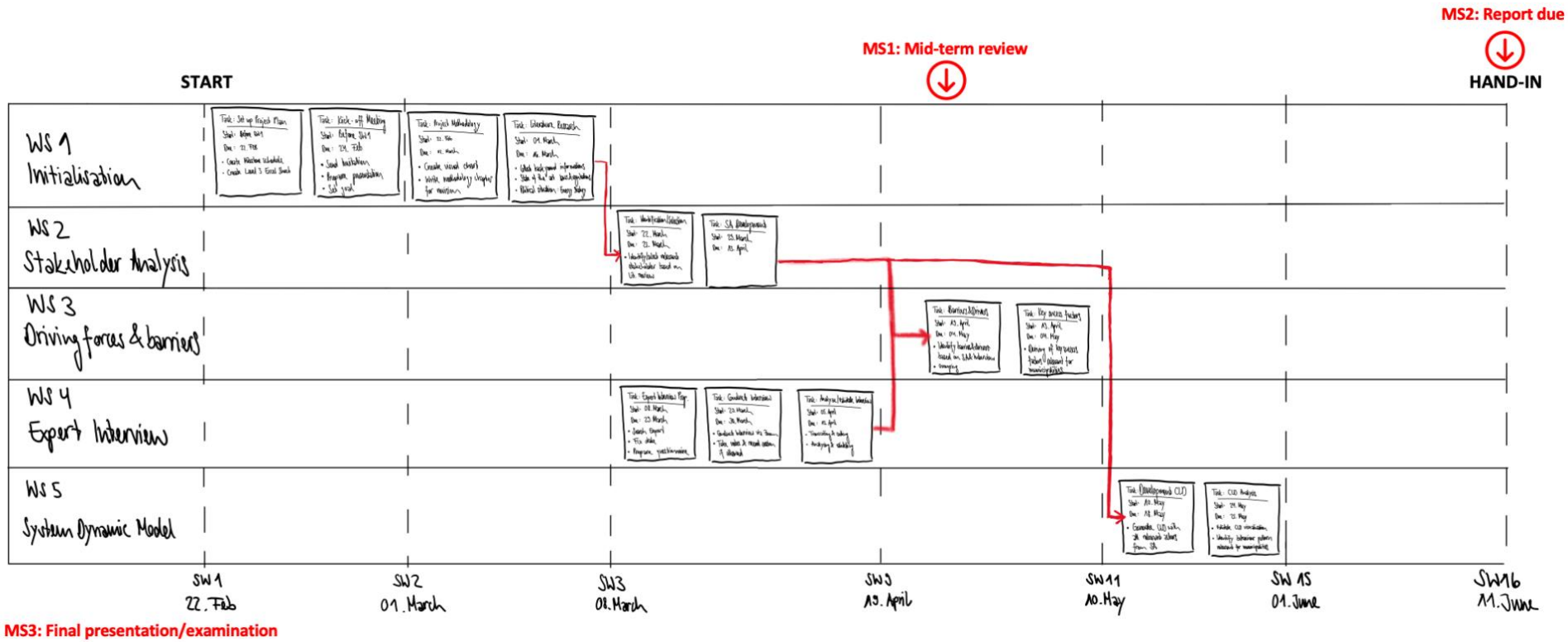


Figure 38: Milestone schedule

Appendix J | Project plan

Bachelor Thesis FS21 - Challenges of Municipalities during the Energy Transition

Project start: 22.02.21
Project leader: Yves Hauert
Coach: Richard Lüchinger
Partner: Competence Center for Power Economy

Status	Nr.	Work Package	Lead	Start	End
Done	**1.0**	**Initialisation**	Yves	22-Feb	16-Mar
Done	1.1	Project Plan	Yves	22-Feb	11-Jun
Done	1.2	Risk Management	Yves	22-Feb	23-Feb
Done	1.3	Kick-off Meeting	Yves	22-Feb	25-Feb
Done	1.4	Project methodology	Yves	22-Feb	16-Mar
Done	1.5	Project Introduction	Yves	1-Mar	9-Mar
	1.6				
Done	**2.0**	**Literature Research**	Yves	1-Mar	25-May
Done	2.1	Collection of background information	Yves	1-Mar	16-Mar
Done	2.2	Political and environmental situation	Yves	1-Mar	16-Mar
Done	2.3	Laws and regulations CH	Yves	1-Mar	16-Mar
Done	2.4	Role of municipalities in the energy transition	Yves	1-Mar	16-Mar
	2.5				
Done	**3.0**	**Stakeholder Analysis**	Yves	22-Mar	27-Apr
Done	3.1	Identification/Selection of relevant actors	Yves	22-Mar	27-Apr
Done	3.2	SA Development & Visualization	Yves	29-Mar	27-Apr
Done	**4.0**	**Ecosystem Analysis**	Yves	3-May	11-May
Done	4.1	Drivers and barriers	Yves	3-May	11-May
Done	4.2	Key success factors	Yves	3-May	11-May
Done	**5.0**	**Expert Interviews**	Yves	8-Mar	13-Apr
Done	5.1	Expert Interview preparation	Yves	8-Mar	13-Apr
Done	5.2	Expert Interview conduction	Yves	5-Apr	20-Apr
Done	5.3	Expert Interview analysis/interpretation/validation	Yves	5-Apr	20-Apr
Done	**6.0**	**System Dynamic Modelling**	Yves	17-May	25-May
Done	6.1	Development of Causal Loop Diagramm	Yves	17-May	25-May
Done	6.2	CLD Interpretation/Analysis	Yves	17-May	25-May
	6.3				
Done	**7.0**	**Project Documentation**	Yves	22-Feb	11-Jun
Done	7.1	Discussion	Yves	24-May	30-May
Done	7.2	Conclusion & Recommendation	Yves	31-May	6-Jun
Done	7.3	Executive summary & abstract	Yves	31-May	6-Jun
Done	7.4	First Draft Final Report	Yves	10-May	17-May
Done	7.5	First Proof reading	Yves	11-May	17-May
Done	7.6	First Draft ready for Shaun	Yves	11-May	17-May
Done	7.7	Final Proof reading	Yves	31-May	6-Jun
	7.8				
Not started	**8.0**	**Presentation**	Yves	n.d	n.d
Done	8.1	Midterm Presentation	Yves	19-Apr	26-Apr
Not started	8.2	Final Presentation	Yves	n.d	n.d
	8.3				
Done	**9.0**	**Visaualizations**	Yves	31-May	6-Jun
Done	9.1	Project Poster	Yves	31-May	6-Jun
Done	9.2	Project Flyer	Yves	31-May	6-Jun
	9.3				

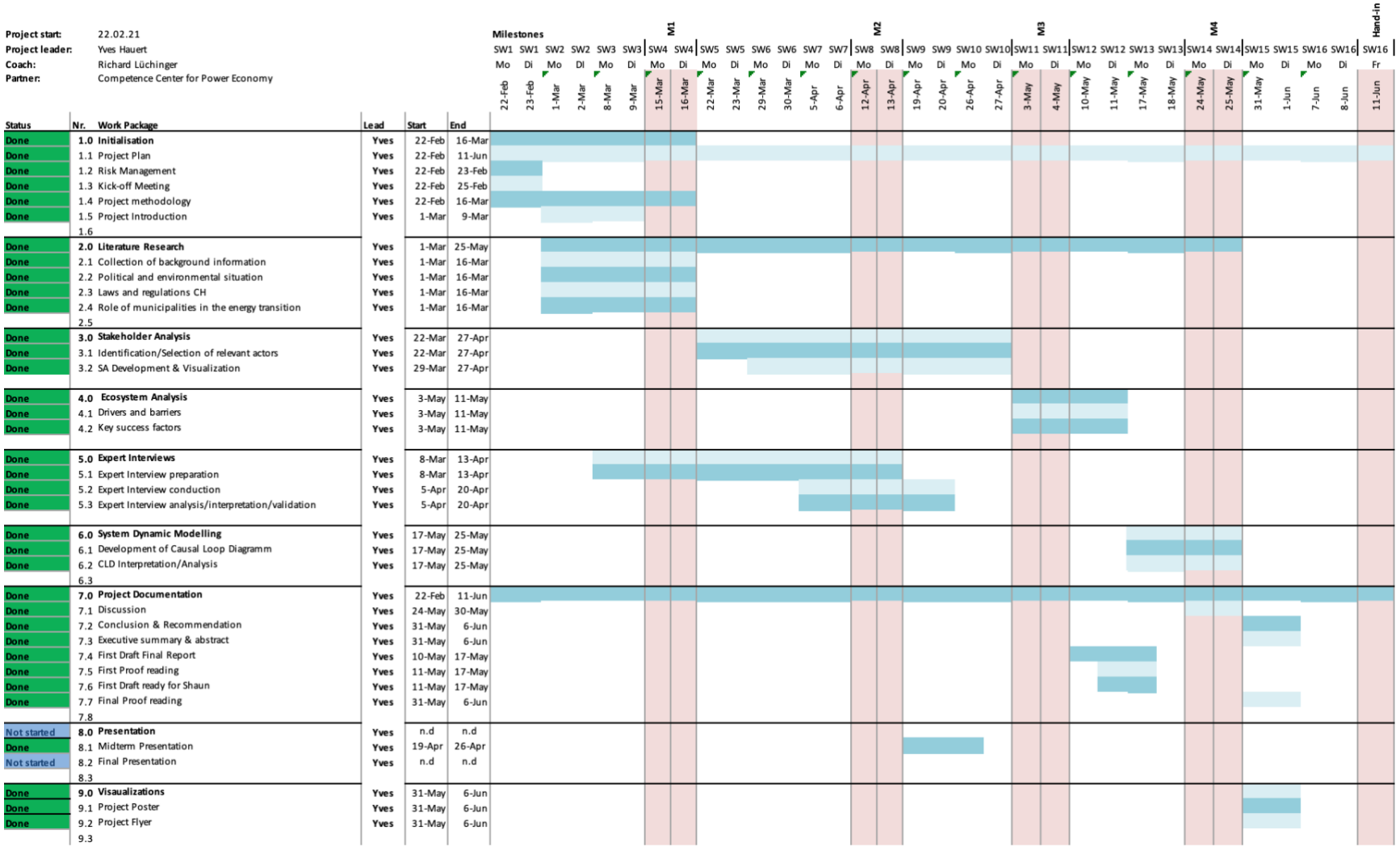


Figure 39: Project plan

Appendix K | Risk management

ID	Title	Description	Responsible	Category	Indicators of occurence	Probability	Impact	Risk score	Preventive Measure	Corrective Measure	Success factors	Probability '	Impact '	Risk score '
R1	Miscommunication	The chance of misunderstandings is heavily increased, as the physical meetings can not take place due to current situation	Yves	Projectmanagement	Project members are not all up-to-date, expectations are not met, work not done efficiently	Possible	Major	12	Clearly defined communication channels (Zoom-Meetings, weekly status reports via email, phone calls if needed), honest/attentive & direct converstations, taking notes	Rediscussion of open questions, regular re-clarification of expectations, more meetings	As few misunderstandings as possible happening	Remote	Moderate	3
R2	Meetings with Coach	Zoom fails and conference-calls with the coach are no longer possible due to network failure	Yves	Projectmanagement	Communication with coach does not work	Unlikely	Major	8	Preparation of meetings with list of questions to be answered to be used for other communication channels	Use of other communication channels (phone call, skype, email)	Information flow is consistently possible and working	Unlikely	Minor	4
R3	Project member (student/coach/expert) becomes ill	One project member gets infected or gets ill	All	Projectmanagement	Project member can no longer participate in the project for certain amount of time and work does not get done	Possible	Major	12	Everyone is aware of current situation and all bear own responsibility	Clear communication of ill project member towards other members, re-allocation of meetings/tasks, new planning	No workpackage lost and all deadlines met, even in case of illness	Remote	Moderate	3
R4	No interview partner for expert interview	No suitable interview partner can be found to conduct an expert interview	Yves	Expert Interview	No confirmation for expert interview from sent requests within time frame of project plan	Possible	Critical	15	Starting interview planification in early stage, accounting enough time for responses, get in touch with potential partners early	Ask coach for potential partners, seek for help using HSLU-network, use other networking tools like Linkedin	Interview partner found early enough in order to conduct expert interview within time frame of project plan, Justus Gallatus (HSLU)	Remote	Minor	2
R5	Time delay	Loss of one week (eastern break) in project may cause a delay on certain milestone deadlines or deadlines are met but delivered quality is poor	Yves	Projectmanagement	Stress before deadlines	Likely	Major	16	Thorough project planning, accounting of buffer time, start early	Work overtime	All deadlines are met as defined in the beginning	Unlikely	Moderate	6
R6	No sufficient literature available	The literature found is not suitable or not useful, no relevant information can be taken from the literature research	Yves	Research	No new and relevant knowledge from literature research	Possible	Critical	15	Asking coach for relevant links, getting in touch with researchers working on similar projects within HSLU	Addressing the challenge in meetings, using the library of the Lucerne University of Applied Sciences and Arts, extended internet research, using HSLU-network	Necessary and relevant knowledge could be gained from literature research in time	Unlikely	Minor	4
R7	No suitable system thinking tool available	No suitable tool available for the visualisation of the system dynamic model	Yves	Analysis	Own visualisation of systems dynamic model useless	Possible	Major	12	Early involvement with applicable programmes, consultation with coach and/or Claas Wagner	Application of the already learned CLD methods manually	Suitable visualisation tool available and usable for CLD	Unlikely	Minor	4

Figure 40: Risk table

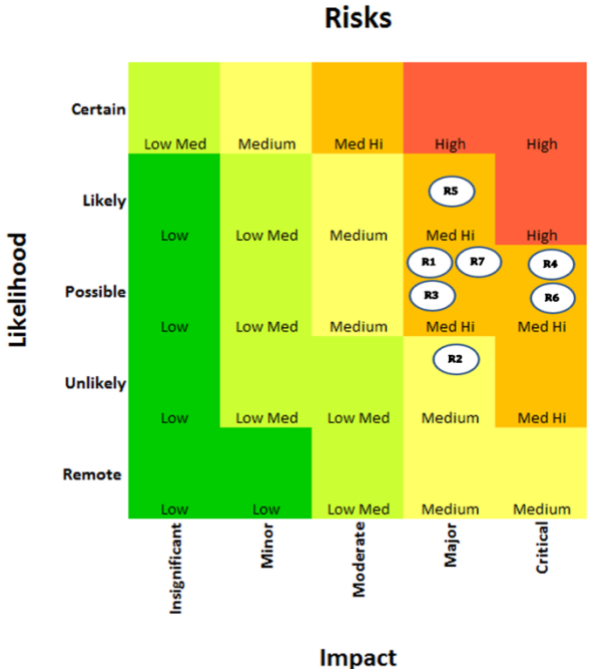


Figure 41: Risks classified before measures

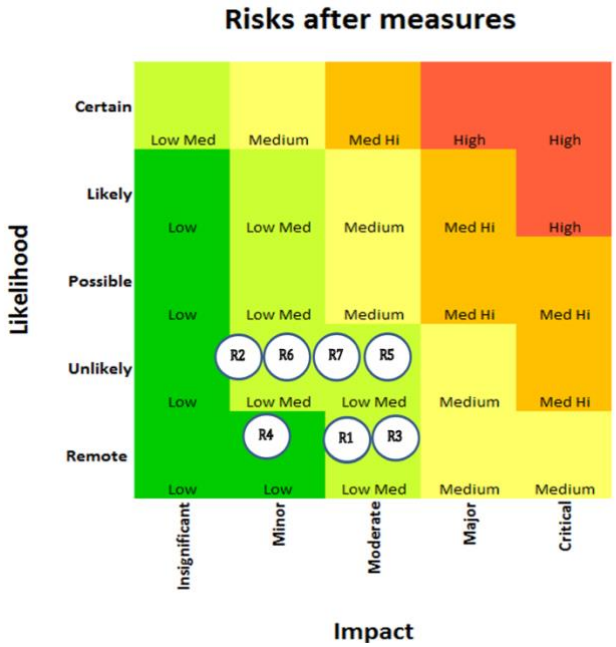


Figure 42: Risks classified after measures

Appendix L | Agreed scope of work

Page 1 of 4
22nd of February 2021
Yves Hauert
yvesmichel.hauert@stud.hslu.ch

Lucerne University of
Applied Sciences and Arts
HOCHSCHULE
LUZERN
Engineering and Architecture

Agreed scope of work

Bachelor Thesis Energy Systems Engineering

1. Project title

Challenges of municipalities during the energy transition

2. Technical theme

Energy transition at municipality level

Climate and environmental change

Energy strategy 2050

Sustainable development of municipalities

Decision-making process

Energy measures

Renewable Energies

3. Background

Climate and environmental change as well as demographic, economic and technical developments are changing living conditions on earth in the 21st century as never before. The availability and quality of the essential resources water, air and food depend on these changes. The importance of climate and environmental issues is not only reflected in the awareness of the population, but also in corresponding laws and regulations. On 21 May 2017, voters approved the revised Energy Law on the Energy Strategy 2050, which aims to promote renewable energies, reduce energy consumption and increase energy efficiency. This is intended to strengthen domestic renewable energies and reduce dependence on imported fossil energies (Federal Department of the Environment, Transport, Energy and Communications DETEC, n.d.). In addition to the Paris Agreement (2016), the Federal Council aims to reduce greenhouse gas emissions in Switzerland by 70-85% by 2050 compared to 1990 (Federal Office for the Environment FOEN, 2018). In order to achieve these goals, the three main sectors of households, transport and industry must drastically reduce their energy consumption as well as their greenhouse gas emissions by transforming the energy system. The transformation of the energy system or energy transition is a continuous, complex, incremental process that is guided by the guiding principle of sustainable development.

When it comes to climate and environmental change, municipalities are important actors. While laws and framework conditions are usually set at (inter-)national level, implementation is largely regional and local. The municipalities are thus faced with complex new tasks. They are responsible for the energy supply, which must be adapted in accordance with the Energy Strategy 2050, as well as for spatial and mobility planning. As an interface to the population, they have a key function in the implementation of the Energy Strategy 2050. Municipalities take on a special role in the creation of a permanently liveable environment, which takes place in particular at regional and local level. The creation of a more liveable environment must be pursued in parallel with the adaptation to the Energy Strategy 2050. The development and creation of a more liveable environment is an essential part of the energy transition of municipalities. Since adapting to the Energy Strategy 2050 while creating a more liveable environment is a complex undertaking, supporting and accompanying municipalities along this process is indicated and necessary. In order to find solutions to problems that arise, the analysis of the energy transition of municipalities is central.

Page 2 of 4
22nd of February 2021
Yves Hauert
yvesmichel.hauert@stud.hslu.ch

Lucerne University of
Applied Sciences and Arts
HOCHSCHULE
LUZERN
Engineering and Architecture

Agreed scope of work

Bachelor Thesis Energy Systems Engineering

4. Project aim

The aim of this thesis is to identify the relevant actors and their influence on the energy transition at the municipal level in Switzerland in order to highlight possible obstacles and success factors for municipalities in the implementation of the Energy Strategy 2050. Furthermore, concrete solution approaches to overcome these obstacles and thus facilitate the energy transition for municipalities shall be developed.

5. Project objectives

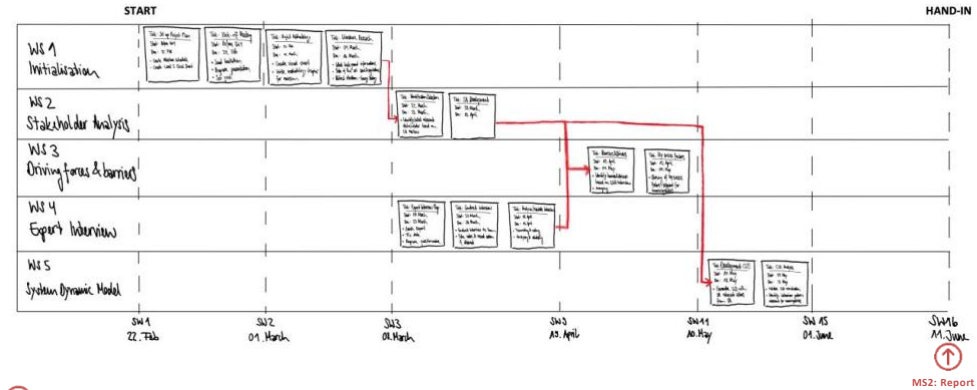
- Development of a stakeholder analysis to identify relevant actors and their influence on the implementation of the energy strategy in municipalities
- Identification of barriers, drivers and key success factors in the energy transition at municipal level
- Creation of a visual system dynamic model of the energy transition at the municipal level to identify potential conflicts of interest
- Recommendation for best practices

6. Project deliverables

- Presentation of the interrelationships between the relevant actors for the implementation of the Energy Strategy 2050 at the municipal level
- Illustration of possible conflicts of interest at municipal level between the parties involved and the corresponding approaches to resolution
- Delivery of key success factors that have significant influence on energy strategy of municipalities
- Presentation of visual system dynamic modelling for the energy transition at municipal level
- Specific and actionable recommendation for municipalities on how to overcome the elaborated barriers and enhance the energy transition

7. Project planning

Milestone schedule



8. Time Frame

Dates

Submission agreed scope of work:	22nd of February 2021
Start of the project:	22nd of February 2021
Interim presentation and reflection:	According to the specifications of the supervising lecturer
Submission report & declaration:	11th of June 2021
Submission poster:	11th of June 2021
Submission flyer:	11th of June 2021
Submission final presentation:	2 days prior to final presentation
Oral Exam:	According to the specifications of the supervising lecturer

The student is responsible for the generation of the task definition. A review regarding the definition of the objectives and tasks with the supervising lecturer and the industry partner has to be completed before submission.

The final report has to be submitted to the teaching assistant of the department Energy Systems Engineering. The confidentiality level has to be declared in advance.

9. Documentation

The final report is to be submitted in duplicate. In addition, the final report contains

- *An abstract in German and English containing 250 words maximum each.*

Other documentation:

- Submission on elearning.hslu.ch of the report including appendices with presentations, measurement data, programmes, evaluations, etc.

10. Industry/Business Partner

Company:	Competence Center for Power Economy
Address:	Technikumstrasse 21, 6048 Horw
Contact person:	Prof. Dr. Christoph Imboden
Email:	christoph.imboden@hslu.ch
Phone:	+41 41 349 37 52

11. Responsible Lecturers

Allocated coach:	Richard Lüchinger	Prof. Dr. Shaun West
Email:	richard.luechinger@hslu.ch	shaun.west@hslu.ch
Phone:	+41 41 349 33 87	+41 41 349 37 85

12. Expert (for the Bachelor Thesis only)

Contact person:	Jim Siler
Company:	jis-associates
Email:	jim@jis-associates.com

Hochschule Luzern
Engineering and Architecture

Signature Responsible Lecturer **Prof. Dr. Shaun West**	Signature Responsible Lecturer **Richard Lüchinger**	Signature Student **Yves Hauert**

Signature
Industry Partner

Appendix M | Project poster

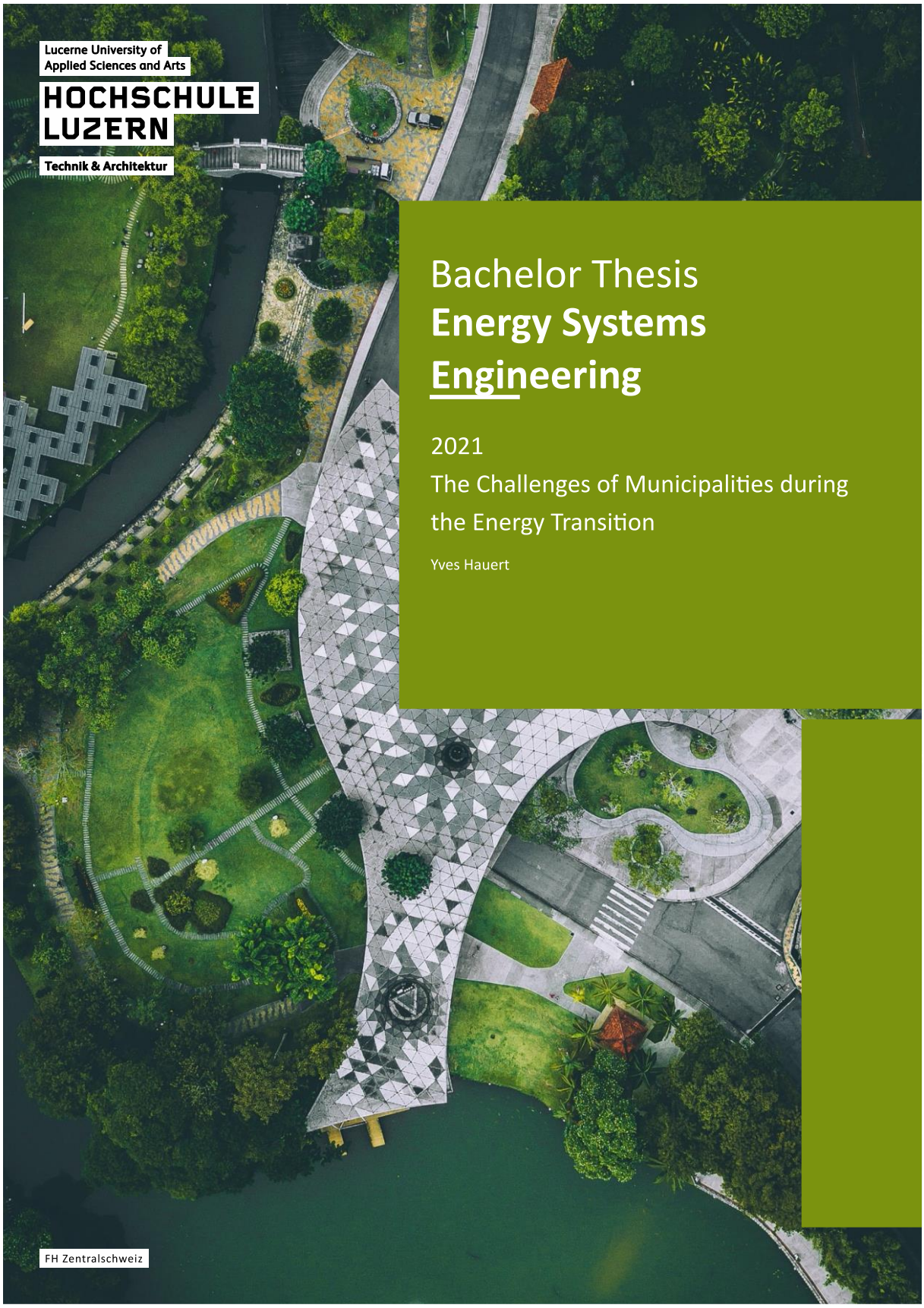
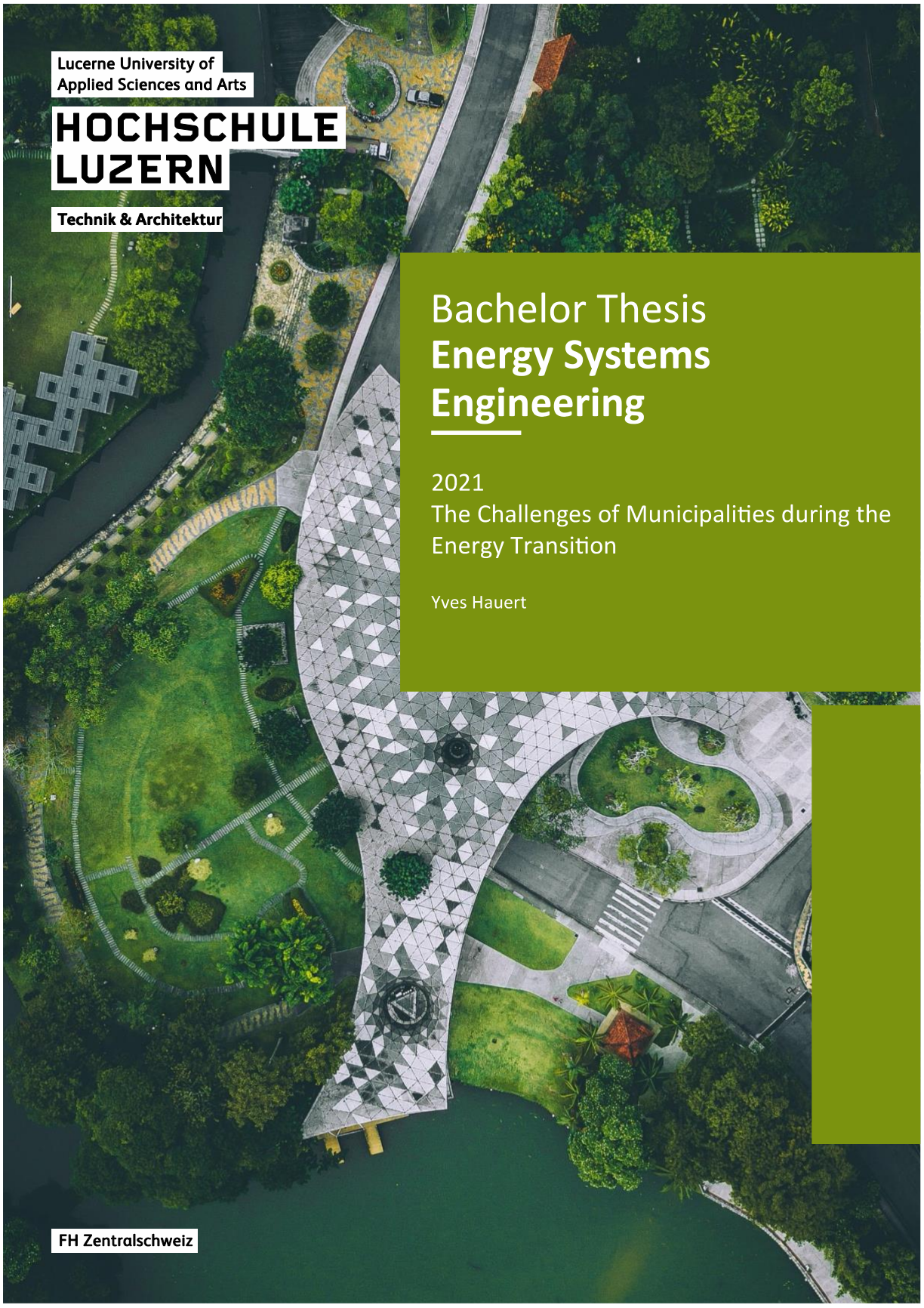


Figure 43: Project poster

Appendix N | Project flyer



Bachelor Thesis 2021

The Challenges of Municipalities during the Energy Transition

Student: Yves Hauert
Supervisors: Prof. Dr. Shaun West & Richard Lüchinger
Expert: Jim Siler
Industry partner: Competence Centre for Power Economy

This thesis evaluates the challenges faced by Swiss municipalities during the energy transition.

By means of a stakeholder analysis and expert interviews, the relevant actors were investigated for the energy transition at municipality level. In addition, an ecosystem analysis was carried out to identify drivers, barriers and success factors showing which aspects promote or hinder the energy transition locally. Possible conflict potentials were illustrated through systems thinking by analysing how changes in barriers and drivers affect the local energy transition. A recommendation of best practices for municipalities was derived from the results.

The results show that internal community actors (energy commission, municipality executive & municipality president), as well as local residents and building owners represent key players.

The financial resources and ambition of a municipality have been identified as drivers. What municipalities lack, however, is access to qualitative data and planning tools to tackle the local energy transition successfully.

This could be enhanced through partner projects with neighbouring municipalities, external consultants and local universities. Additionally, a lack of concretisation of the cantonal guidelines for municipalities to better define their role in the energy transition was found.

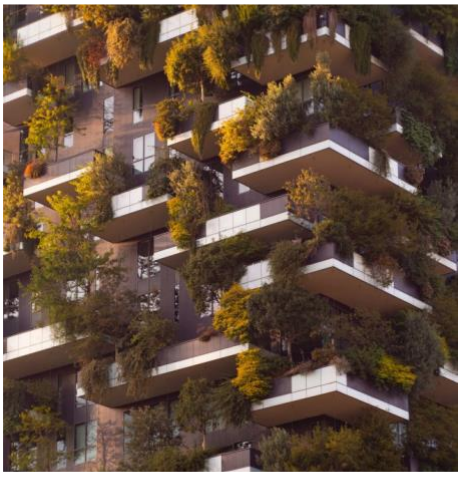


Figure 44: Project flyer

Appendix O | Protocol midterm presentation

- Use multiple 2x2 matrices to generate comparable images
- Implement Energy 360 as a stakeholder in the analysis
- Visualise the insights gained from the interviews for a direct comparison
- Implement quotes from the interviews in the final report
- For literature research as comparison: do not focus only on energy sector
- Accept SA limitation and mention this in the discussion chapter (focus on all municipalities not possible)
- Final Presentation: Pitch of 20 minutes with max. 12 slides, follow the structure of the Final Report