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

Title	**Acceptance of New Energy Efficient Technology in Housing Sector**
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Bachelor's degree program	**Bachelor in Energy Systems Engineering**
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Abstract German

Eine Studie des Kantons Zürichs hat festgestellt, dass die Rate mit welchen energetische Renovationen durchgeführt werden, in Gebäuden im Stockwerkwerkeigentum signifikant tiefer ist als zu jeder anderen Besitzform. Daher wurden Stockwerkeigentümer als Zielgruppe für diese Studie definiert.

Das Ziel dieser Arbeit ist es, Kriterien zu identifizieren, welche zum Erfolg oder Misserfolg führen können, wenn es um EEMs und RDES im Stockwerkeigentum geht. Dieses Forschungspapier basiert auf zwei Fallstudien, welche akquiriert werden konnten. Eine Fallstudie ist in Rubigen, Kanton Bern, in welcher PV installiert wurde. Die andere Fallstudie befindet sich in Thun, Kanton Bern, in welcher das Dach saniert und PV angedacht wurde.

Diese Studie erbringt den Nachweis, dass der Background und das Interesse der Stockwerkeigentümer, die Empfehlungen der Experten in Bezug auf PV, andere Massnahmen und Fördermittel, sowie das soziale Umfeld in der Überbauung und ausserhalb, entscheidende Kriterien sind für die erfolgreiche Implementierung von EEMs und RDES in Gebäuden und Überbauungen im Stockwerkeigentum.

Abstract English

A study in the canton of Zürich found that the rate of energetic renovations conducted by condominium owned housing is significantly lower than any other form of ownership. Subsequently it was decided to focus for this study on condominium owned housing.

The aim of this paper is to identify criteria for success or failure of the implementation of EEMs and RDES in condominium renovation projects. This project is based on two case studies, a condominium owned residential complex in Rubigen, which installed PV and a condominium owned residential complex in Thun, where a roof was renovated, and PV was planned.

This study provides evidence that the background and interest of owners, helpful recommendation given by experts regarding PV, other measures or subsidies and the social network within and outside the condominium complex has a significant influence on the successful implementation of EEMs and RDES in condominium owned residential complexes and buildings.

Horw, 07.01.2019

Abstract

A study in the canton of Zürich found that the rate of energetic renovations conducted by condominium owned housing is significantly lower than any other form of ownership. As there is a focus nowadays on energy efficiency measures (EEMs) and renewable decentralized energy systems (RDES) in politics in Switzerland, it was decided to focus on this group.

The aim of this paper is to identify criteria for success or failure of the implementation of EEMs and RDES in condominium renovation projects. This project is based on two case studies, a condominium owned residential complex in Rubigen, which installed PV and a condominium owned residential complex in Thun, where a roof was renovated, and PV was planned.

Initially hypotheses on why EEMs and RDES are not implemented in condominium projects were derived from initial suspicion and literature. The projects were analysed by conducting semi-structured interviews with key stakeholders, such as planers, building committee members and the property administrator.

Statements made by stakeholders were then coded and compared to statements of other stakeholders to reach a holistic view of the project. Based on the results the criteria for success and failure were concluded and the hypotheses tested.

This study provides evidence that the background and interest of owners, helpful recommendation given by experts regarding PV, other measures or subsidies and the social network within and outside the condominium complex has a significant influence on the successful implementation of EEMs and RDES in condominium owned residential complexes and buildings.

Kurzdarstellung

Eine Studie des Kantons Zürichs hat festgestellt, dass die Rate mit welchen energetische Renovationen durchgeführt werden, in Gebäuden im Stockwerkwerkeigentum signifikant tiefer ist als zu jeder anderen Besitzform. Da es heute einen Fokus in der schweizerischen Politik auf energetische Maßnahmen (EEMs) und dezentrale Energiesysteme gibt, wurde darum entschieden einen Schwerpunkt auf energetische Renovationen im Stockwerkeigentum zu legen.

Das Ziel dieser Arbeit ist es, Kriterien zu identifizieren, welche zum Erfolg oder Misserfolg führen können, wenn es um EEMs und RDES im Stockwerkeigentum geht. Dieses Forschungspapier basiert auf zwei Fallstudien, welche akquiriert werden konnten. Eine Fallstudie ist in Rubigen, Kanton Bern, in welcher PV installiert wurde. Die andere Fallstudie befindet sich in Thun, Kanton Bern, in welcher das Dach saniert und PV angedacht wurde.

Zuerst wurden Hypothesen aufgestellt, warum EEMs und RDES nicht zur Anwendung in Gebäuden und Überbauungen im Stockwerkeigentum kommen. Diese basieren auf fundierten Annahmen und Fachliteratur. Die Analyse der Projekte beruht auf halb strukturierten Interviews, die zur Datenerhebung genutzt werden. Die Interviews wurden mit Vertretern der verschiedenen Interessengruppen durchgeführt, wie etwa Planern, ausführenden Firmen, den Verwaltungen und den Stockwerkeigentümern.

Aussagen der Befragten wurden codiert, damit sie mit Aussagen anderer Befragten verglichen werden konnten. Dies führt zu einer ganzheitlichen Sicht des Projektes und des Entscheidungsfindungsprozesses. Basierend auf den Resultaten der Befragungen wurden Kriterien zum Erfolg oder Misserfolg abgeleitet und die Hypothesen getestet.

Diese Studie erbringt den Nachweis, dass der Background und das Interesse der Stockwerkeigentümer, die Empfehlungen der Experten in Bezug auf PV, andere Massnahmen und Fördermittel, sowie das soziale Umfeld in der Überbauung und ausserhalb, entscheidende Kriterien sind für die erfolgreiche Implementierung von EEMs und RDES in Gebäuden und Überbauungen im Stockwerkeigentum.

Acknowledgments

I would like to thank all interviewed condominium owners as well as Deyhle & Partner AG, Elektrobedarf Troller, EVG-Zentrum and Andreas Glatthard for their support of this industrial project. Special thanks to my supervisor Dr. Benjamin Rohrbach and Prof. Dr. Christoph Imboden, Daniel Stauffer as well as Prof. Beatrice Hunziker who supported me and gave guidance to follow through with the research undertaken. Additionally, I appreciate Mr. Cyrill Burch's effort, who helped acquiring the case studies, without his help the project would not have been possible in todays form.

Contents

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Abbreviations and acronyms

BAFU	Federal Office for the Environment (Bundesamt für Umwelt)
BFE	Swiss Federal Office of Energy (Bundesamt für Energie)
BFS	Swiss Federal Office of Statistics (Bundesamt für Statistik)
BKW	Bernische Kraftwerke AG
CO_2	Carbon Dioxide
ES2050	Energiestrategie 2050
EEM	Energy Efficiency Measure
EIV	one-time fee (Einmalvergütung)
GEAK	Gebäudeenergieausweis der Kantone
GHG	Greenhouse Gas
GWP	Global Warming Potential
HSLU	University of Applied Sciences Lucerne (Hochschule Luzern)
IPCC	Intergovernmental Panel on Climate Change
KEV	feed in tariff (Kostendeckende Einspeisevergütung)
kWp	kilowatt peak
LCZ	Low and Zero Carbon
MS	Milestone
PBT	Payback time
PV	Photovoltaics
RDES	Renewable Decentralized Energy Systems
ROI	Return on Investment
UN	United Nations
ZEV	Merger for own consumption (Zusammenschluss zum Eigenverbrauch)

1 Introduction

According to the Intergovernmental Panel on Climate Change (IPCC, 2014), energy and the increasing demand for it, mainly caused by economic growth, is one of the driving forces in contemporary society and economy. Energy is procured from various energy sources such as water, wind, nuclear and gas. Today's energy mix consists predominantly of non-renewable energy carriers. The usage of these non-renewable energy carriers such as coal, oil and gas has led to greenhouse gas (GHG) emissions into the atmosphere. GHG emissions are proven to be the major driver of manmade climate change. Provided GHG emissions are not reduced in time, the impact on the climate may be irreversible and may cause negative consequences for society and environment.

On the 4th of November 2016 the Paris Climate Agreement was implemented in the participating 195 countries and states. The Paris Agreement aims to limit the global temperature rise to ideally 1.5 Celsius or maximum 2° Celsius above pre-industrial levels. It is worth noting the Paris Agreement is based upon targets set by the individual signatories themselves, who report their progress and data to the United Nations (UN), with no repercussions specified if targets cannot be met (United Nations, 2018). According to a study of the IPCC (IPCC, 2018) a global temperature rise of 1.5° Celsius may lead to a smaller rise in sea levels and other consequences such as weather extremes compared to a 2° Celsius or higher rise. Nonetheless, the IPCC estimates an increase in sea levels by 40-63 cm by the year 2065. Even if emissions are stopped, most effects of climate change will persist for centuries.

According to the Federal Office for the Environment (BAFU) the total Greenhouse gas emissions of Switzerland, measured in million tons of CO_2 equivalent, has decreased from 53.59 million tons in 1990 to 48.29 million tons in the year 2016 (Bundesamt für Umwelt BAFU, 2017). However, this rate of GHG-emission reduction is not enough to realize the 1.5° Celsius target. As can be seen in Figure 1-1, the GHG emissions, according to economic sectors, shows a downward trend over the entire displayed time period for all but the disposal and transportation sectors. The fluctuations seen in the housing sector are partially due to temperature changes during the recorded years, which mostly depend on how many days the housing sector needs to be heated in winter and its overall heating demand. Comparing data of Meteozürich (2016) to the figure below shows that years with an higher percentage of very cold days coincide with the years in the figure with increased GHG emissions into the atmosphere by the housing sector and to a lower degree in the service sector. Over the last three recorded years there has been an increase in GHG emissions by 10% or 0.83 million tons in

the housing sector and moderate increases in the disposal and service sector. Even though the last 3 recorded years did have fewer very cold days compared to the trend line.

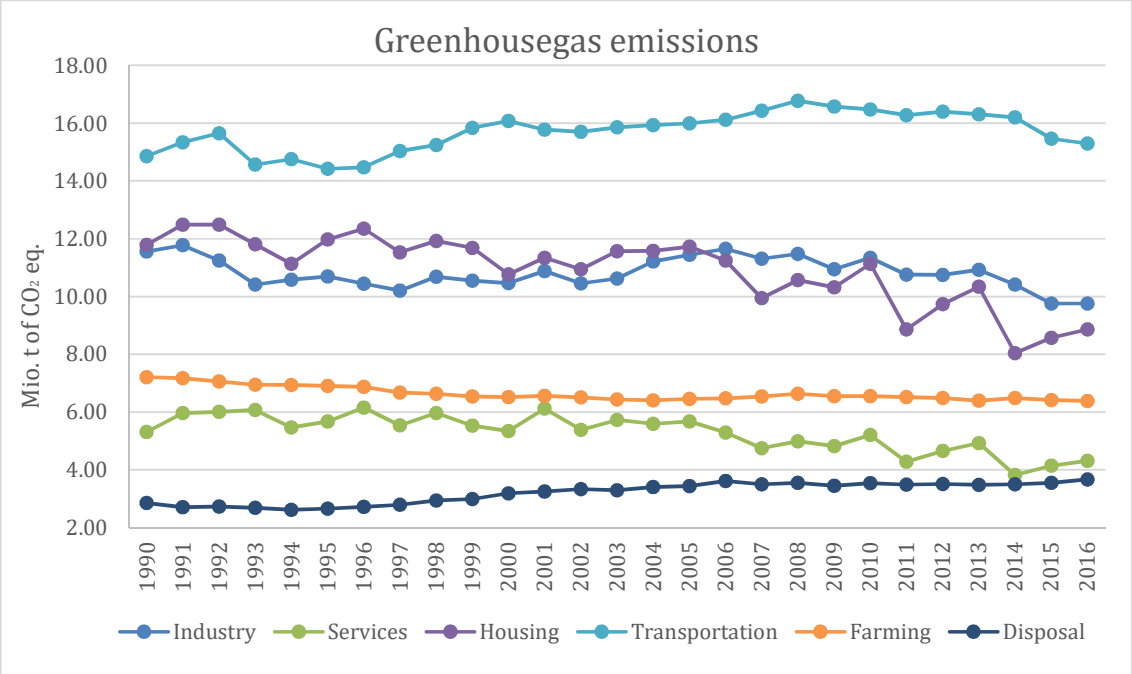

Figure 1-1: Greenhouse gas emissions according to sectors (Bundesamt für Umwelt BAFU, 2017)

This paper will focus on the housing sector, which had a total energy demand of 235.4 Peta Joule, of which according to the Swiss Federal Office of Energy 67.5% are spent on space heating and a further 13.7% on warm water production (BFE, 2018a). The remaining portion consists of electricity needs for IT, cooking, lights etc. The energy demand of a building is therefore predominantly determined by the need for space heating and warm water. The energy demand for space heating and warm water is dependent on how well insulated building and the piping are as well as the overall efficiency of the energy systems. The average age of the existing Swiss housing is 57 years, as can be seen in Figure 1-2, over 50% of the buildings were built before 1970, thus their average energy demand for heating was and still is, over 220 $\frac{kWh}{m^2*a}$, if not renovated. By contrast today's "Minergie" standard requires a maximum demand of 38 $\frac{kWh}{m^2*a}$ (Energiestiftung, n.d.). Since 1990 the space requirements per person have increased while population grew as well, which offsets efficiency gains. The rate of renovation needs to be increased according to the BFE to meet goals set (BFE, 2018a).

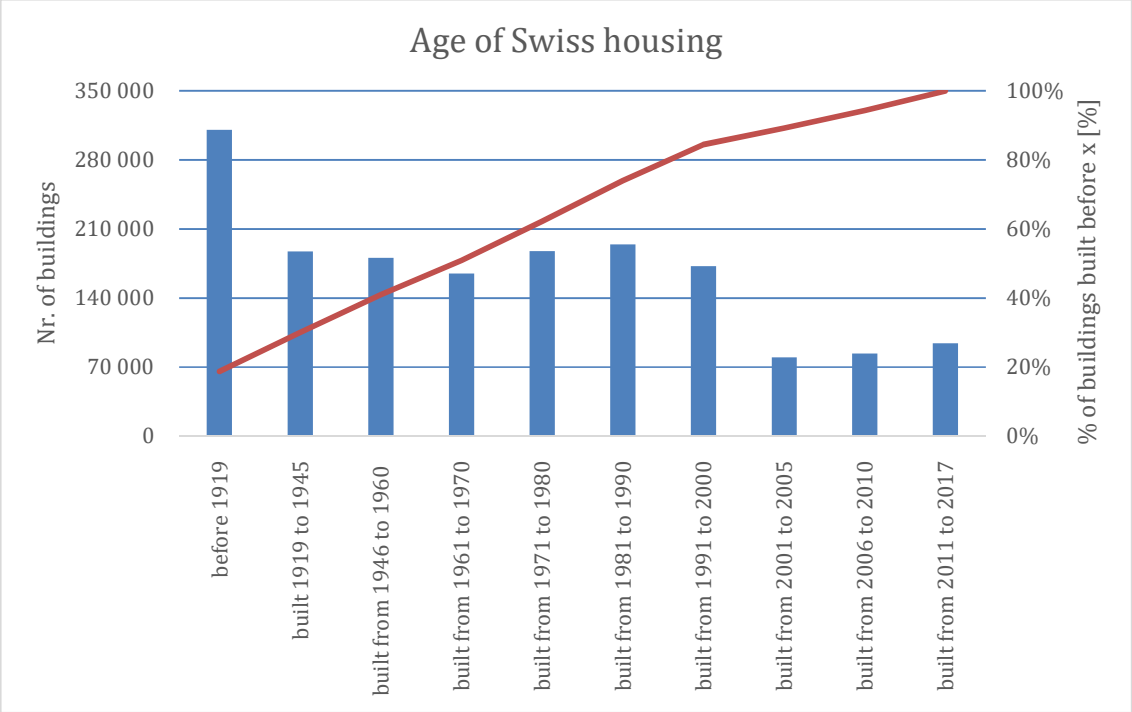

Figure 1-2: Age of Swiss housing (BFS, 2018)

To increase the efficiency of older buildings, energy efficiency measures (EEMs) as well as renewable decentralized energy systems (RDES) can be employed. To motivate building owners to renovate older buildings the Swiss government and the cantons are implementing tax breaks and offering subsidy programs. From the year 2010 to 2017 the Swiss government and its cantons incentivized energetic renovations, focusing mainly on better insulation. Since 2017 funding from the government to cantons remained unchanged, however the cantons have now sole jurisdiction over the received funds and can pass its own legislation within their canton. Furthermore, the total available yearly funds for incentives and subsidies, have been increased from 300 million to 450 million Swiss francs. The funds stem from the CO_2 tax that was introduced in 2008 and has subsequently been increased since then (NZZ, 2017).

On the 21st of May 2017 the Swiss population voted in favour of the Energiestrategie 2050 (ES2050), affirming the policy of the Swiss government. The ES2050 aims to reduce emissions and energy consumption and incentivises a more renewable energy mix in Switzerland. In order to reach the goals, set by the government, among other measures taken, renewable energies are subsidised, tax reductions for EEMs are introduced and relevant research is funded. (BFE, 2018b)

According to Figure 1-3, comparing various forms of housing and their rate of renovation, the Zürich Office for Statistics found that condominium owners' rate of renovation is considerably lower than that of other types of ownership. The study defined renovation as either employing energy efficiency measures or upgrading the existing building (Rey & Brenner, 2016).

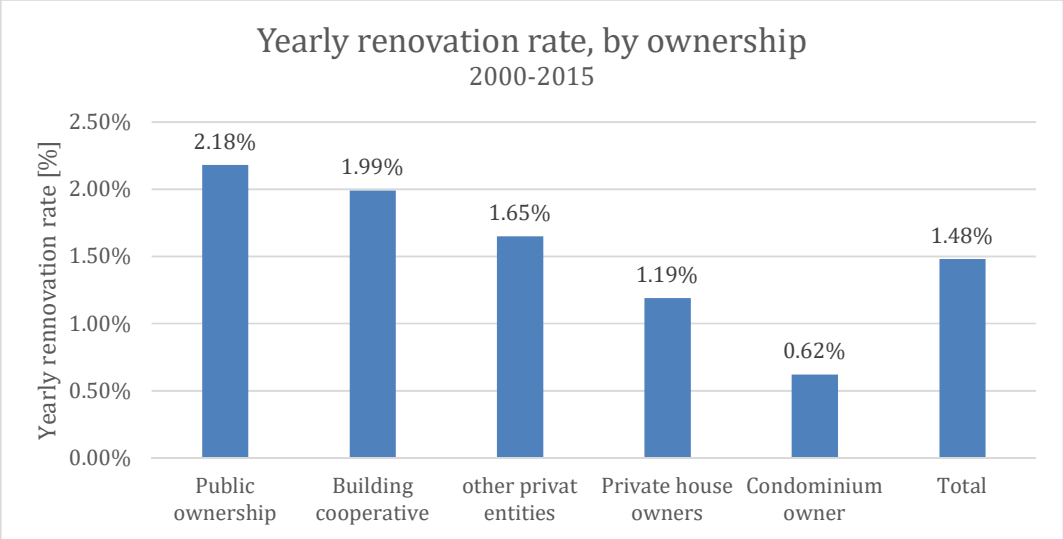

Figure 1-3: Yearly rate of renovation according to type of ownership (Rey & Brenner, 2016)

Therefore, the focus of this research are condominium owners, leading to the research question.

In the following chapter, this research question is further concretized by several hypotheses which were derived based on scientific literature and initial suspicion.

Why are Energy Efficiency Measures (EEMs) or Renewable Decentralized Energy Systems (RDES) often not considered or employed in condominium owners' renovation projects?

2 Literature review

This chapter firstly summarizes literature used for the project and secondly present the hypotheses for condominium renovation projects.

2.1 Literature

According to the International Energy Agency (2014), evidence proved that energy efficiency not only reduced energy demand but also improved other economic and social aspects. Besides, as can be seen in following literature review, in recent years most political discussions and technical assessments of energy efficiency have had focused on reduced energy demand and fewer GHG emissions.

Wilson (2015) paper with the title «Why do homeowners renovate efficiently? Contrasting perspectives and implications for policy» looked at the decision making from two different perspectives, applied behavioural research and sociological research of homeowners. This study was conducted in the United Kingdom. The main aim of Wilson's paper is to show why homeowners are motivated to implement energy efficiency measures. To do so the concept of renovation is challenged by sociological research in everyday life at home. Besides energy efficient renovations are not inherently distinctive or unique. Moreover, they should not be partitioned off from other types of household projects, large or small, with which homeowners are continually engaging as part of the motion of household life. Being the case of energy efficient renovation by exploring why owners decide to renovate their home means moving beyond immediate influences to the deeper influences that explain the emergence of renovation decisions. Understanding these levels allows applied behavioural research on energy efficiency and sociological research on domestic life to be driven by policymakers concerning the energy efficient renovations. This paper found that information policies to promote energy efficiency by removing barriers or strengthening decision making are essential (Wilson et al., 2015).

Stieß, I., & Dunkelberg, E. (2013) focused on private homeowners who adapt low and zero carbon (LZC) technologies to achieve significant reduction of CO_2 emissions vs. those who apply standard refurbishment measures. The main goal was to identify the main objective and barriers of energy efficient refurbishment and LZC technologies adoption. This paper was adapting an in depth empirical survey of 1008 single and semi-detached homeowners in Germany that were classified in two groups of "standard" and "energy" and explored the key factors influencing the decisions of energy-efficient refurbishment. It is found that, LZC technology adoption is more profitable regarding energy efficiency, however empirical results

show that homeowners often undertake such project without investing in LZC technologies. Providing financial resources in the form of subsidies or tax reductions, or launching new legal and governmental regulations, increases the motivation of homeowners and also helps to reach the overall energy reduction target.

Abreu et al. (2017), highlight the role of homeowners in energy building renovation decision making, motivations, needs and attitudes. This research took place in Portugal, where a selected group of homeowners were interviewed, as their qualitative decision has a strong impact on building renovation decision making. In this research an interview guide was accomplished that included the research questions. In most of the interview cases, houses are owner-occupied, therefore it is important to explore the expectations of homeowners as the personal project for life. The results show that also in Portugal the building renovation is influenced by needs, wishes and social practices of householders and depends on how this is negotiated at the family level. The study also covers the importance of the social network in the decision-making or renovation process. Moreover, it was perceived that different types of homeowners have different attitude towards energy renovation. The most conscious and informed house owners tend to search for more information than received from the social network and normally this type of homeowners wants to have an active role during some or all phases of the renovation process. Besides, Energy Performance Certificate seems to have a moderate role in conditioning the homeowners' choices and the rise of new policies on the social dimension of renovation. In addition, this paper shows a comparable behaviour between different countries' house owners, although countries have different social and economic environments.

Simpson et al. (2015) found that energy efficiency is often less important than other factors for home renovations and improvements. According to this research energy efficiency of houses in the UK has improved between 1996 and 2010 due to government programs. In this paper, Interviews were conducted with 20 households who lived in owner-occupied houses in UK. In order that participants represent a wide range of family structures, they were selected using a purposive sampling approach. The aim of this research was to discover the factors for home improvements undertaken by participants based on the motivation, barriers and enablers associated with the improvements. Results from the interviews were analysed, identifying the type and date of each improvement for each household. The different personas in this study shows that homeowners take different approaches for home renovation and energy efficiency is mostly not the main motivation of refurbishment however, significant life events or financials had strong impact on the renovation decision making process.

2.2 Hypotheses

This section presents the Hypotheses, which were created by initial suspicion towards certain phenomena and developed by looking at literature.

According to Stieß & Dunkelberg (2013) many house owners did not invest into EEMs or RDES even though they made sense economically. It was also seen that often potential measures were not even investigated. Moreover, it was found that government incentives or subsidies have an impact on the implementation of EEMs and RDES. Similar mechanism is assumed for condominium owners as well. However, situation differs a bit from the house owner case as many condominium owners mostly consider their apartment alone. Stakeholder that are involved in the condominium building committees may take a closer look into such subsidies and incentives, if there is an interest, otherwise it can be expected that only necessary repairs are implemented, especially if condominium renovation funds are not enough to cover additional measures. On this basis, the following hypothesis is derived:

Hypothesis 1

Possible subsidies for different measures are not known to condominium owners before the renovation project, which leads to exclusion of measures, especially if the renovation fund cannot cover for measures besides repairs.

Condominium owned residential complexes or buildings are not required to create a renovation fund but most do so. There are also no legal requirements regarding minimum funding, however according to hausinfo (“Erneuerungsfonds,” 2018) it is advised to put aside yearly 0.2% to 0.5% of buildings’ value, based on the valuation of the property by the insurance. Often such funds are created with small maintenance work in mind as well as replacement of certain aspect of the buildings such as insulation of doors and windows. Problem may arise if no renovation fund was created or if the renovation fund is undercapitalized for renovation projects. In this case finance aspects become more dominant in decision making process as each owner needs to make additional unplanned payments to proceed with the renovation project. According to Simpson et al. (2016), for many house owners, energy efficiency or electricity savings are not the main driver in the decision making process. It was found to be more dependent on costs and significant life events or circumstances. If no additional payments need to be paid, decisions will be made based up the return on investment (ROI), overall costs,

payback time (PBT) and other factors. As a consequence, the payback time compared to the estimated time that the owners plan to own the condominium, is assumed to be an important deciding making factor for the renovation (Simpson et al., 2016). Therefore, based on these explanations, the second hypothesis of this project is formulized as follows:

Hypothesis 2

In case there are not enough funds saved by the condominium for renovation, the estimated remaining time of each owner is crucial for any energetic renovation.

Regulations have changed considerably over the last few years for RDES projects. For example, since the 01st of April 2014 electricity which is generated directly from PV can be consumed directly in the property and doesn`t need to be fed into the grid first. The electricity produced and consumed by the owners can be used for own consumption for which no grid fees needed to be paid. Furthermore, this advantage is compiled by the fact that also since April 2014 the feed in tariff (KEV, Kostendeckende Einspeisevergütung) is not available anymore for PV systems with less than 30 kWp. The KEV for small PV systems was replaced by one-time compensation (EIV, Einmalvergütung) which can save costs up to one third of the total costs.

According to article 17 of the new energy law, it is also possible for multiple stakeholders living in the same area or building to create a merger for own consumption (ZEV, Zusammenschluss zum Eigenverbrauch) (Federation, 2018). However, according to article 17.1, a ZEV is only possible if produced energy can be found to be significant which is according Müller (2018), 10% of the rated power measured at the net access point. Article 17 furthermore states that during introduction of a new system people living in the houses have a legal choice to choose between the new system or receiving energy form the original energy provider (Federation, 2018). This can lead to complicated legal and technical constructs within a condominium owned building or residential complex. This may impede employment of RDES in the focus group. Furthermore, the net access point is not clearly defined. Meaning that if a group of buildings have one net access to the mainlines and only some of the buildings employ RDES the 10% barrier cannot be met depending on how the local utility implements the legal changes.

Furthermore, other regulations can hinder EEMs and RDES such as the Swiss constitution which describes in article 78, nature and homeland protection, to protect the overall appearance of the townscape as well as historically important sites and buildings (Federal Swiss Government, 2018). This can lead to the exclusion of many EEMs or RDES. Building laws may also impede the employment of RDES and EEMs, such as regions on which air water heat pumps are not allowed due to ground water protection or need additional effort to satisfy legalities.

Hypothesis 3

Certain regulations hindered the employment of EEMs and RDES in the studied renovation projects.

Wilson describes in his paper the reason house owner's invest into EEMs is not just due to the costs but also due to deeper influences such as upbringing and political conviction (Wilson, Crane, & Chryssochoidis, 2015). Similar influence can be identified for condominium owners in this research as well. Moreover, it is assumed that the overall social network between the various owners may impact decision making heavily. Abreu et al. (2017) found that in Portugal employment of EEMs was dependent on financials, wishes, needs and the social network. House owners with a social network, that was interested in EEMs, RDES or topics such as environmental protection, were also more likely to consider EEMS or RDES. In order to consider social network impact in our project analysis as well, hypothesis 4 is discussed as bellow:

Hypothesis 4

The attitude of certain stakeholders or their social network have a significant impact on possible planning or employment of EEMs and RDES measures.

Over the past few years in Switzerland the question of EEMs has become more political, through various initiatives and referendums such as the Energy Strategy 2050 and the Nuclear Power exit votes. This led to an increase in ideological positions on the topic renewables and EEMs. Furthermore, the bias on this topic is fuelled by misinformation such as an article posted by the Basler Zeitung (Ferruccio & Alex, 2017) with the title "The devastating record of solar energy". The article stated that a PV panel may never produce enough energy to offset the

energy used in its production. This may lead to the perception that EEMs and RDES should not even be considered. Abreu et al. (2017) found that the attitude in regard to EEMs and RDES are factors in the decision-making process. Furthermore, if the work necessary to apply for subsidies, satisfy legalities or establish an ZEV is perceived as too much effort it may cause EEMs and RDES to be excluded from renovation projects. Following this idea, hypothesis 5 will be tested in this research.

Hypothesis 5

The general perception of EEMs and RDEs in regard to costs, regulatory and other factors leads to the exclusion of such measures in renovation projects.

3 Methodology

This chapter describes the methodology and Figure 3-1 displays the methods graphically within the research process.

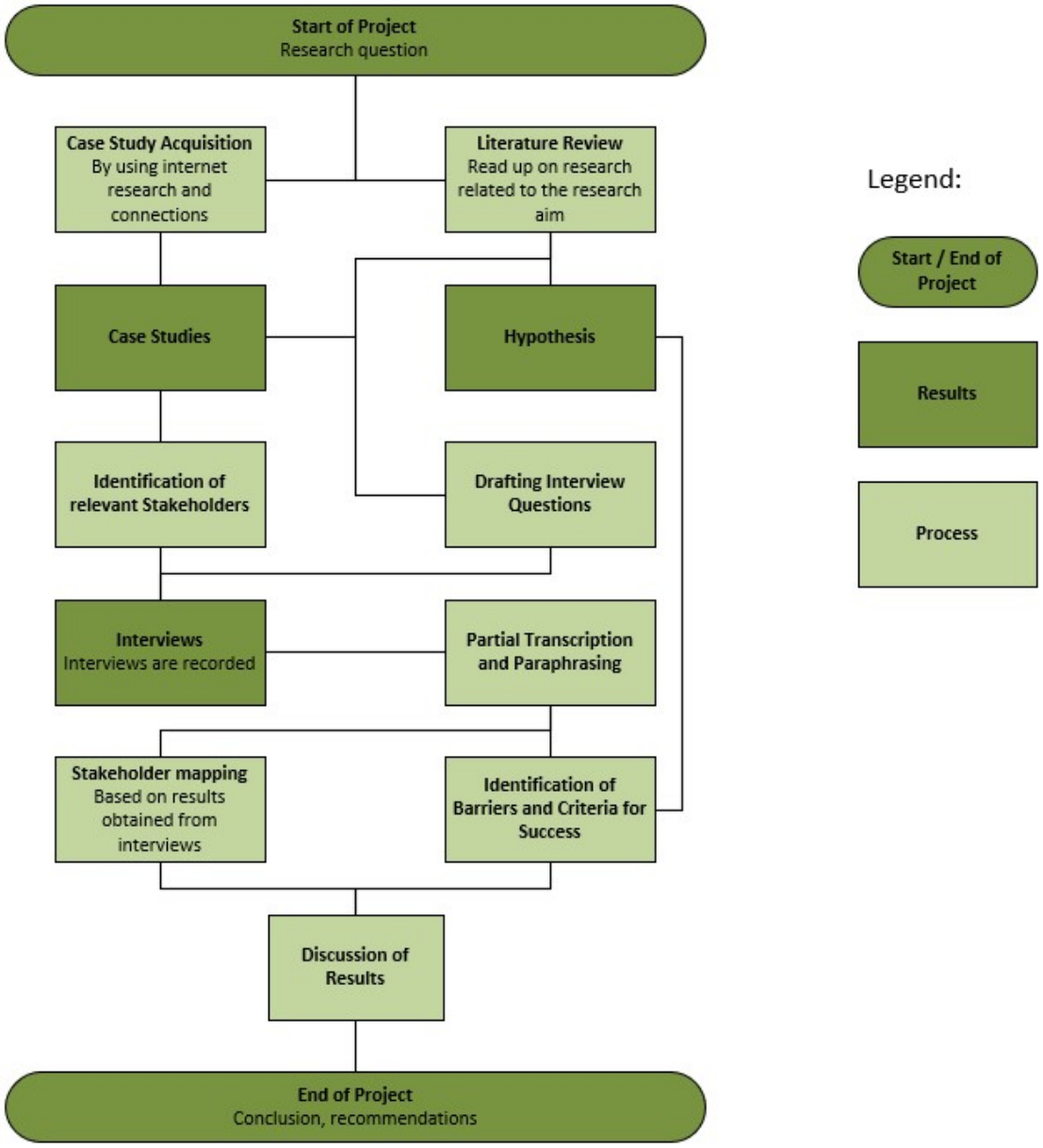

Figure 3-1; Structure of methodology

As the work largely bases on case studies, attention was given on identifying valuable cases. Information regarding potential case studies found through internet searches as well as personal recommendations. Due to data protection law it was not possible to directly identify possible case studies and no data could be accessed through governmental sources. In order to acquire the case studies, firms that manage houses of condominium owners, the personal network as well as building cooperatives were contacted. Initial contact was established by either Email or telephone, introducing the author and giving a short overview over the project. It is decided to use the official language of the areas the case studies took place to facilitate contact and conduct the interviews. This was done to make the interview process easier for the interviewees and to increase the possible sample pool as non-English speakers can be included.

A total of 35 potential case study representatives were contacted, whereof two agreed to participate in the project, resulting in three possible case studies, two of which are condominium owner projects and one building cooperative project. However, none of the case studies could be acquired by contacting companies managing condominiums. As often no feedback was received from most of the companies even after a reminder call. The three case studies acquired were arranged through personal network which facilitated the contact with a condominium owner. Firstly, contacting condominium owners directly and then asking other stakeholders to participate in the study proved to be the better choice to acquire such case studies.

The building cooperative project was not chosen as a case in this study as research shows that compared to condominium owners the rate of renovation is considerably higher and the legal structure is different, making a comparison of case studies and conclusion difficult or may falsify the results.

Hypotheses are needed in this project to set a focus, especially for the questionnaire. Initial hypotheses are found by making educated guesses on why Energy Efficiency Measures (EEMs) are often not considered or chosen in the solution finding process of a renovation project with multiple stakeholders. Which are then synthesized with insights gained from literature review leading to the final hypotheses. The final hypotheses are tested in the results chapter based on analysed interviews from the two case studies to either reject or fail to reject the hypotheses.

The literature review is conducted by finding out what has been done before in this field of research that are related to the project question and hypotheses. A focus is set on methodology used in the projects and their findings. Furthermore, the literature review facilitates further insights into the project matter and consequently will yield better questions for the interviews, positively impacting quality of data obtained from the interviews.

To be able to deduce criteria and barriers for success or failure, data is needed about the decision-making process. The data required contains topics such as timelines, interactions of various stakeholders, circumstances, options evaluated and more. Interactions between stakeholders depend on various parameters such as personal relationship, circumstances of the discussions etc. to be able to access such data qualitative interviews are chosen as the method. Semi structured interviews, recommended by Saunders, Lewis, & Thornhill (2009), are suitable to gather primary data from stakeholders, to identify timelines, options considered, mood, fundamental beliefs and influence of various stakeholders. Moreover, semi structured interviews allow for changes to the questionnaire, such as adding or adjustment of questions during the interview, which may result in further findings.

In order to write the questionnaire for the interviews, the research question, the hypotheses and the literature analysed. This resulted in various factors that needs to be explored in the interview to gain further insights and acquire the data needed to be able to consolidate the results. Firstly, interviewees are asked to describe the whole story of the renovation project in their own words, which may help indicating where to set an additional focus in the interview. In later questions, aspects such as source of information, social aspects, perceived costs, political conviction, life circumstances and the decision making process itself are asked, or can be deduced through the various questions asked, as can be seen in appendix 9A.

Qualitative interviews with key stakeholders, namely condominium owners, planners and condominium administrators are conducted to gather all relevant data regarding the decision making process of the various case studies. As for the sampling strategy, two condominium owners, one planner and the condominium administrator for each case study are interviewed to ensure that each stakeholder group is represented that have influence in the decision making process. The interviews are carried out in the limited time period from start of November until start of December. The interview length for this project are planned, not to exceed one hour in length, to not burden interviewees too much. Additionally, interviews are conducted in person at the location chosen by the interviewees. Before the interview starts, the interviewees were

asked for permission to record the meeting. Based on the recordings, interviews are partially transcribed to underline important statements, whilst the remaining part will be paraphrased to save time, and consolidate data from different interviews as mentioned by (Garz & Nagel, 1991). This section will yield relevant data for the analysis of the interviews in the results chapter.

As described by Garz & Nagel (1991) to be able to analyse with a higher quality, the interviews are paraphrased or transcribed and then grouped according to theme. This is done to keep the integrity of each interview while allowing to compare passages of each topic to each other. The interviews are introduced into an excel sheet, with a coding, the stakeholder's abbreviation as well as a time stamp, this helps if later one certain paraphrased or cited statement may need further clarification. It is possible for statements to be part of different coding groups, which can be seen in Figure 3-2. The excel sheet which contains the interviews can be found in the electronic appendix on the ILIAS platform.

As it can be seen in Figure 3-2, the coding is not only important to sort statements according to their theme but also are used to test the hypotheses, as combinations of codes can be used to test a hypothesis. Initially it was estimated which codes could be used to test the hypotheses, which was further developed following the initial analysis of the interviews.

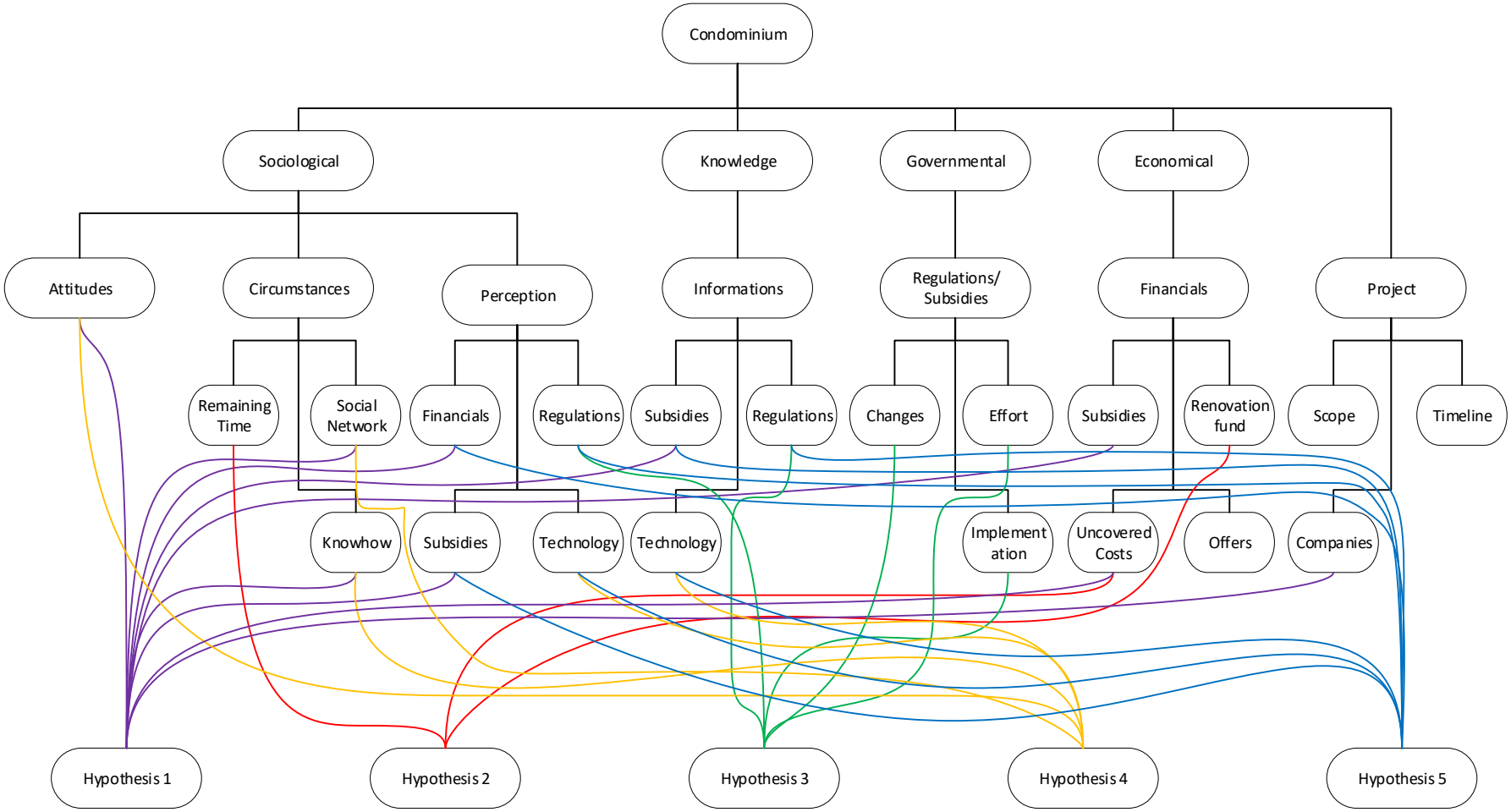

Figure 3-2: Coding tree with hypotheses

The interviews are coded into six main groups with various sub groups which helped to further identify the content of statements. Explanations for the various code groups of this project can be found in Appendix 9D.

The codes Project-Companies/Timeline/Scope were used in the following chapter to create a timeline graph and describe the case studies chronologically.

The results chapter contains six tables for each case study which sort interview statements of each participant that can be grouped and coded with other participants' statements. The tables can be found in Appendix 9E & 9F. In order to have a comprehensive view on each interview analysis, findings of the table are provided in 5.1. In order to make sure about the accuracy of findings and results, each participant's statement is provided in the table. Moreover, after Thun case study, a brief summary of both case studies, the similarities and differences in each main code group is written.

Moreover, the results from the interviews are used to create stakeholder maps for the various case studies. Stakeholder mapping is used to display influence and interest of the various stakeholders, as it is described by Smith (2000). Stakeholder mapping is a method to visualize certain aspects of the case studies that depend on the interrelationship of the various parties and their influence on each other. In the present study, this is of particular value, as it allows to show on which Milestones certain stakeholders had influence and interest, to be able to conclude who had the biggest impact on the decision making at a specific milestone.

As it is seen in figure 3-2, in order to test each hypothesis, various code groups and sub groups that have impact on each hypothesis are attached to the hypotheses by different line colours. Therefore, to be able to test each hypothesis, different sub coded groups in both case studies need to be analysed and compared. In each hypothesis section, different point of views from two case studies and from all interviewees aspects will be argued and the final result will be discussed.

In chapter 6, the discussion of results, findings from both case studies are compared to identify criteria of success or failure.

As a last step, in chapter 7, the project is concluded and recommendations for future research as well as the possible application of the findings will be given.

4 Case Studies

This chapter describes the two caste studies acquired. The first case study is situated in the canton of Bern in the village of Rubigen. The second case study is situated in the canton of Bern in the city of Thun.

4.1 Residential complex Rubigen West

The residential complex “Rubigen West” in Rubigen was built in the years 2006 to 2007. In total five buildings were built, which can be separated into a total of nine apartment houses, this can be seen in Figure 9-5 in the Appendix 9B. The total living area amounts to 5’900m² and is divided into 48 apartments consisting mostly of 3.5, 4.5 and 5.5 room apartments. The residential complex is owned by condominium owners, of which some rent out apartments. The legal structure of the residential complex is a one condominium owners’ association per apartment house and another condominium owners’ association for the whole residential complex. The residential complex can be seen in Figure 4-1. A central heating system, consisting of a heat pump and a oil-fired heating, provide the heat to the apartments. Both systems contribute about 50% of the demanded heat. The yearly heat demand of the residential complex is 480’000 $\frac{\text{kWh}}{\text{a}}$. The roofs of the buildings are built in a greened flat roof construction.

Figure 4-1: "Rubigen West" Residential complex

The renovation project in Rubigen which was initiated in 2017 and finished in 2018 installed PV panels on several houses payed by various investors, which can be seen summarized in Table 4-1. The table shows various data points of the finished PV project. The timeline of the project as well as changes to its scope are discussed further down.

PV was built on five buildings, which were separated into four ZEVs, Building C1 and C2 are combined in one ZEV. For each ZEV a new main counter needed to be installed by the local utility, Bernische Kraftwerke AG (BKW), which was done in a timely manner and faster than expected by the owners. On the site of the ZEV's private smart meters needed to be installed, which replaced the old electricity meters and could be installed at their old location. The billing is done quarterly by Deyhle & Partner AG, with the help of the technical support team of the residential complex. It was decided that each person supplied by ZEV is to pay the same price for electricity as they would with the local utility, profits are shared between investors according to their share. Furthermore, each investment by owners in the PV project was calculated for its deprecation and provided to the investors, where they can see how much their shares are worth after x years. This was done so that investors if they moved away could sell their share of the PV system, first right of purchase for other investors, or they can keep it independent of them owning an apartment in the residential complex, reaping the ROI.

Table 4-1: Info table renovation project Rubigen

Renovation project Rubigen West	Installation of photovoltaics
Companies involved	Deyhle & Partner AG, Administration (A) Elektrobedarf Troller, PV-company (Pl 1) BKW AG, Local utility company EVG-Zentrum, PV consultant
Investment [CHF]	120'000.- CHF
Scope	• Installation of PV • Installing private smart meters • Creation of ZEVs
Number of investors [#]	12
Number of panels and panel surface [#, m²]	144 panels with total of 235m² surface area
Peak power of total PV system [kWp]	44 kWp
Legal structure	4 separate ZEV over 5 buildings with 25 apartments
Estimated autarky level [%]	50%

Planed yearly production $\left[\frac{\text{kWh}}{\text{a}}\right]$	37'500 $\frac{\text{kWh}}{\text{a}}$

Initial contact to this case study was established by Mr. Burch who was involved in this project as an external expert. As described in the methodology for the interview sampling strategy it was decided to interview two condominium owners, 1 planner and the administrative company. For this case study a total of four stakeholders were interviewed which can be seen in Table 4-2. For the PV project Condominium Owner 1 (O1) was the project lead due to his background in electrical engineering. Elektrobedarf Troller (Pl 1) is one of the PV companies who handed in tenders and eventually won and executed the project. Deyhle & Partner AG (A) are since 2012 the property administrator of the residential complex and were mainly responsible for organizing meetings, forwarding information, initiate changes to insurance policy as well as consolidating tenders before sending them to O1. The scope of the project was never increased to additional measures as the buildings were built in 2006/2007, furthermore subsidies like GEAK (Gebäudeenergieausweis der Kantone) would not be available as it is only targeted at buildings built before the year 2000. ("Energieförderung - Kanton Bern," 2018)

Table 4-2: Interviewees Rubigen

Stakeholder	Function	Background
Markus Scheidegger **(Pl 1)**	Elektrobedarf Troller PV-company	Sales consultant
Selina Bruni **(A)**	Deyhle & Partner AG Administration of condominium complex	Real estate manager
Condominium Owner 1 **(O1)**	Owns a apartment, part of condominium owners building committee	Electrical Engineer, Executive Master in Business Administrations (MBA)
Condominium Owner 2 **(O2)**	Owns an apartment part of condominium owners building committee	Salesman

In Figure 4-2 the timeline for the renovation project Rubigen can be seen, the upper timeline spans from the construction of the residential complex until the end of 2018 and includes other measures and events that were done before the analysed renovation project, such as the ES2050 vote.

The PV project in Rubigen started in the first quarter of 2017 when O1 due to the discussions about the upcoming ES2050 vote found interest in PV. O1 gathered data such as consumption and roof area of the residential complex to calculate on Energie Schweiz's homepage with their solar calculator the PV potential. O1 had access to the data required as he is part of the technical support team for the residential complex together with O2. Initially O1's scope was the whole residential complex including the central heating system to feed the heat pump with electricity from the roof.

In June 2017 O1 brought the idea of PV up in a building committee meeting of the residential complex. The initial feedback was good, so it was decided to follow up on the idea by investigating the topic in more depth, by the lead of O1. Furthermore, it was decided to present the project to the owners' meeting which took place in July 2017.

For the meeting an external expert, Mr. Burch from EVG-Zentrum, was asked to present the topic of PV to the owners' meeting. This was done to present the topic by an independent party, even though O1 had a background of electrical engineering himself, as personal bias could have been an issue. The building committee asked owners in the meeting to ask critical questions and express their worries in regard to PV, which were answered directly or followed up by O1 and building committee members. This was done to combat worries from the start and increase acceptance of the project. Furthermore, building committee members approached owners in one on one discussion to win them over for the project.

Following the meeting owners were asked in the time period of July to October 2017 if they were interested in investing or if not if they would sign a contract so that the roof can be used for PV and if they would use the electricity from PV. In October 2017 about 50% of owners showed interest for investing into the project while 100% of owners said they would sign a roof usage contract, which they were then later asked to sign in the houses that PV was built.

From end of October 20017 to February 2018 O1 and O2 visited various PV trade fairs to acquire additional information as well as identifying companies who would be approached for a tender. To be selected for the call of tenders, companies needed to have competence with such projects, needed to offer all services and materials needed themselves without employing an external company and should be regionally present. Companies were asked to offer a tender for the residential complex Rubigen, structured as one ZEV and hand in the tenders to A who consolidated the tenders and sent them to O1. However, during the call for tenders the scope of the project needed to be changed as it became clear that not all buildings would join the PV

effort. Now each house was defined as its own ZEV and the costs were broken down to the building as this allowed to scale the project more easily.

On the 22nd of December 2017 Elektrobedarf Troller inspected the residential complex on site.

Furthermore, Pl 1 explains that it is not advisable to go above 30 kWp with the PV system in a ZEV because according to law this would necessitate additional measurements, for example load profile measurements, which would cause additional yearly costs.

For this project they were able to avoid the load profile measurements by creating a ZEV for each building. Now they have per building one main electricity meter by the local utility, BKW, and then private counters from Kamstrup for each apartment, which have the same size as the normal counters and could be installed at the previous counters location.

In February 2018 an investor meeting with all people who expressed their interest to invest was conducted. In the meeting the various offers and options were discussed as well as the anticipated construction time, expected payback time and return on investment (ROI) which were calculated by O1 using conservative values, which was done to not overpromise the PV system. At the end, out of 48 owners 12 decided to invest, which represented five out of nine apartment buildings and included 25 apartments with a living space of 3'300m². Because only five buildings agreed to install PV it was not possible to feed electricity into the heat pump. All the offering companies mentioned EIV and sometimes even included calculations for tax breaks, which are available in all cantons but Lucerne. Pl 1 suggests that the absence of the tax break is perceived as stifling PV demand. Elektrobedarf Troller won the contract due to their overall competence and experience. Initially Pl 1offered Engytec, a service which would do the billing, however subscription costs ensue, and owners in Rubigen decided to do the billing with A, as A promised to do it free of charge as long as the effort is within the expectations. In a next step contracts needed to be drafted for joining the ZEV and using its electricity, contracts between the local utility and the ZEV and roof usage contracts, which was seen by all participants as a lot of effort.

Following the meeting it was decided, based on an advise from Pl 1 to create a ZEV for each house separately except C1 and C2, can be seen in Figure 9-5 in the Appendix, where the placement of the panels and tubing etc. was more opportune to be done as one project and ZEV.

In June 2018 the PV project moved to its execution phase, installing the panels on the roofs, which was finished in the same month.

Following the successful installation of the PV systems Pl 1 visited the site again for initial feedback, where the option of Fronius, an app that displays the production of the PV system

and the consumption of the apartments, was offered, which was then installed. Owners mentioned that some of them try with the help of the app to time their big consumers such as dishwashers to times when a lot of electricity is produced to maximise cost savings.

According to feedback in fall 2018 an autarky level of about 50-60% was reached, without any storage in the system. Pl 1 advised to wait a few years to see if a short term battery storage is needed as it is costly and increases payback time of the overall system and will most likely drop in price in the coming years. Furthermore, it was realised that the payback time will be reduced as BKW increased the price they pay for PV electricity.

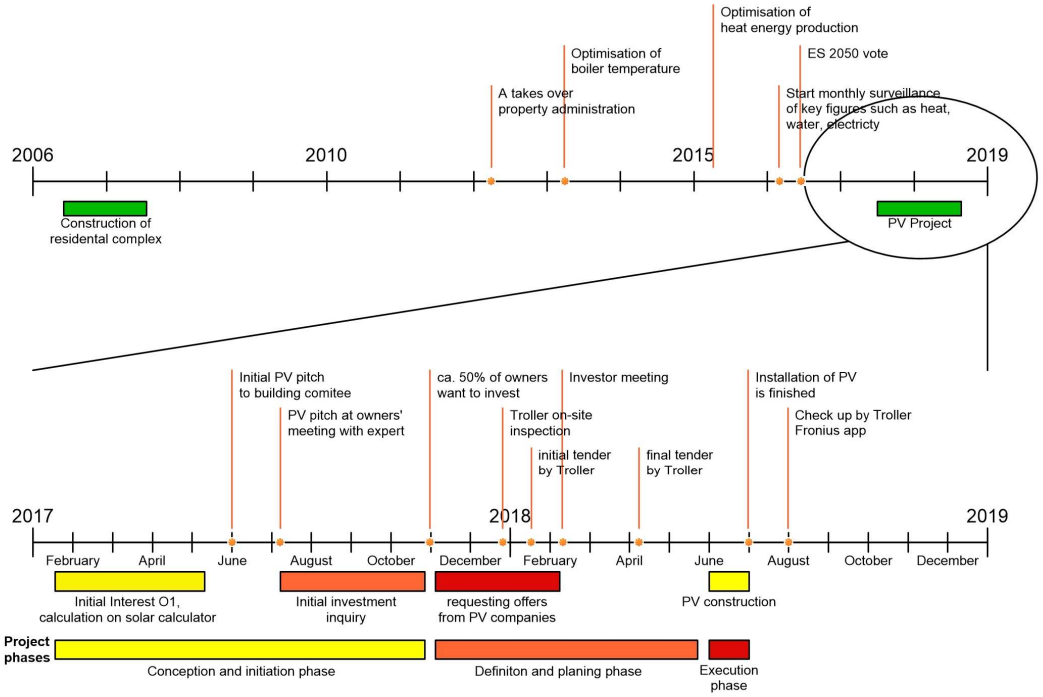

Figure 4-2: Timeline Rubigen West

4.2 Residential complex Buchholzpark Thun

The residential complex “Buchholzpark” in Thun was built in the years 1992 to 1993. In total nine buildings were built. The total living area of the affected building amounts to 1’780m² and is divided into 15 apartments consisting mostly of 3.5, 4.5 and 5.5 room apartments. The residential complex is owned by condominium owners, of which some rent out apartments. The legal structure of the residential complex is one condominium owners’ association per apartment house and another condominium owners’ association for the whole residential complex. The residential complex can be seen in Figure 4-3. The heating of the houses is done by a regulated ground heating system which is fed by a central gas heating plus two condensing gas boilers who are also responsible for warm water, helped by solar thermal collectors. The central heating is responsible for the heating of the entire residential complex.

Figure 4-3: Residential complex "Buchholzpark" in Thun

The renovation project in Thun, which was initiated in 2015 and finished in 2018, renovated the roof, planned to install PV and applied for GEAK subsidies, which can be seen summarized in Table 4-3. The table shows various data points of the various measures executed or planned. The timeline of the project as well as changes to its scope are discussed further down.

Table 4-3: Info table renovation project Buchholzpark Thun PV

Renovation project Buchholzpark Thun	Roof renovation
Measures	• New metal sheet roof • +10 cm of compressed stone wool for insulation
Costs [CHF]	20'000.- CHF, expert report 300'000.-CHF, roof renovation
Companies involved	Architect Andreas Glatthard (Pl 1) Deyhle & Partner AG, Administration (A) Tin smith Peter Künzi AG Bruni Carpentry GmbH
Status	executed
Renovation project Buchholzpark Thun	GEAK
GEAK classification, now & targeted	D → B
GEAK measures to reach target	• Roof insulation (Done) • Garage ceiling insulation • New windows • PV
GEAK subsidies [CHF]	• 1'500.- CHF for the GEAK report • 130'000.- CHF if GEAK targets are met
Costs GEAK report [CHF]	• 2'300.- CHF
Status	In discussion
Renovation project Buchholzpark Thun	Installation of photovoltaics
Involved companies	Energie Thun AG, local utility company Beosolar.ch GmbH, PV company
Scope	• Installation of PV • Installing private smart meters • Creation of ZEV
Investment [CHF]	43'000.- CHF
Number of investors [#]	15
Legal structure	1 ZEV
Status	Put on halt

Initial contact to this case study was established by Mr. Burch who was involved in this project as an external expert. As described in the methodology for the interview sampling strategy it was decided to interview two condominium owners, one planner and the administrative company. For this case study four stakeholders were interviewed which can be seen in Table 4-4. For the PV project Condominium Owner 3 (O3) was the project lead due to his background in electrical engineering. For the GEAK subsidies program the condominium owner 4 (O4) was responsible. Andreas Glatthard (Pl 2) is an architect who led the roof renovation project. Deyhle & Partner AG (A) are the property administrator of the residential complex and were mainly responsible for organizing meetings, forwarding information, initiate changes to insurance policy. The scope of the project changed at various points in the timeline that will be discussed below.

Table 4-4: Interviewees Thun

Name	Stakeholder group	Background
Andreas Glatthard (Pl 2)	Andreas Glatthard Architekt Planer roof renovation	Architect HTL
Selina Bruni (A)	Deyhle & Partner AG Administration of condominium complex	Real estate manager
Condominium Owner 3 (O3)	Owns an apartment in the residential complex	Electrical Engineer, Executive master's in business administrations (MBA)
Condominium Owner 4 (O4)	Owns an apartment in the residential complex	Salesmen

The following section describes the timeline and changes to the scope of project in chronological order. Figure 4-4 displays main events such as owners' meeting on a timeline.

In 2015 reports came to Deyhle & Partner AG (A) suggesting something might not be good with the roof of the building, as Attica owners mentioned a decrease in living comfort in the apartment. Following the reports, A carried out an onsite inspection.

A came to the conclusion that, there were some damages to the roof and recommended at an extraordinary owners' meeting at the end of 2015 to contract an expert to do an assessment of the roof as well as estimate the costs of renovation. The costs of the report amounted to 20'000.-

CHF which half of it was paid by the buildings' condominium owners' association. The other half was paid by the condominium owners' association who governs over the whole residential complex. This was done as all the buildings were built at the same time and differ only slightly from each other and some damages were already visible on other roofs of the residential complex and will need to be renovated at some point as well. Where now they can use the expert report as a basis instead of contracting another expert as soon as the roof needs to be looked at.

From the end of 2015 until May 2016 an expert assessed the roof and wrote up a report which was presented at an extraordinary owners' meeting in May 2016. The report stated that a major renovation was needed for the roof, the costs were estimated to be around 320'000.- CHF, the damages of the roof were assessed to be caused by construction errors when the building was built.

Based on the report the owners with support of A decided at the owners' meeting to find an Architect to lead the project. At the same time, it was decided to execute some small repairs on the roof to gain some time to be able to accumulate the savings needed for the renovation. The owners plan was to renovate the roof within three years. Subsequently the renovation funds yearly contribution needed to be increased, as the owners agreed to pay additionally 50k CHF per year for the next three years until the renovation started.

In May 2017 another extraordinary owners' meeting took place in which it was decided to move forward with the renovation project. Pl 2 was asked to write the call of tenders. At this meeting O3 asked the owners and Pl 2 if PV maybe could make sense, but it was not considered further at this time as the focus was on the roof. Furthermore Pl 2 suggested that PV is in his opinion not suitable for this roof as there are many sources of shadows, windows and the total usable area for PV would be small.

During 2017 it was decided that for the metal sheet roof they would use so called "chromium nickel steel +" sheets which are more expensive compared to the usually used material, titanium nickel steel. However, it offers a longer lifetime and has better suited material characteristics. This decision limited the amount of companies that could offer as the chosen material requires special tools and capabilities which not every tinsmith can offer. Furthermore, it was found that the outer hull of the roof needed to be lifted a few centimetres, which lead to a cavity. Pl 2 recommended to increase the insulation by 10cm to fill this cavity, using compressed stone wool which is according to Pl 2 better compared to normal stone wool against the heat in summer. It was decided to follow the recommendation. Attica owners decided during this time

period that they would replace the roof windows to install bigger windows allowing for more natural light in the apartment with better insulation values for heat and sound.

In May 2018 at an extraordinary owners' meeting the companies were selected based on their tenders and the recommendation of Pl 2, the owners' decided to follow the recommendation. O4 asked if there are any possible subsidies for the roof that could be taken advantage of, to which the construction companies said there are none and Pl 2 suggested that there are, but they would make no sense for this project and only would add a lot of effort.

At a building committee meeting in May 2018 O3 brought up the idea of PV again, as it would make sense to build PV while the roof was already accessible due to the roof renovation project. O3's request was granted and he led the project. Additionally, it was decided to check GEAK subsidies program for the renovation project to see if they could be eligible for any subsidies. The GEAK effort was initiated and led by O4. This report needed to be done in a short time window as it needed to be handed in to the government before construction started to be eligible for the subsidies.

From May to June 2018 an GEAK certified expert was found through the website, which lists all certified experts, and contracted the expert for the GEAK report. The expert was chosen based on the offered price and the ability to do it in a short time window. The report stated that the buildings' GEAK class was a D and needed to be improved to at least a B to be eligible for the subsides. Together with the expert, building committee members choose which measures were to be included in the report sent in to the government. Due to the way the building was constructed some measures could be excluded quickly, such as a better insulation of the walls, which in Thun's case are not easily implementable and expensive as the buildings usees a double wall construction.

Furthermore, buildings in the residential complex should have similar design according to guidelines of the condominium owners' association, which would necessitate that either all buildings redo their hull, or the design must be kept the same way. It was noted that it took many revisions to model the standard house in the report so that it resembles the actual building. This needed to be done as otherwise owners who have no background knowledge of GEAK would doubt its outcome if it can't even represent the building properly. For the report itself subsidies were requested and granted covering 1'500.- CHF of the total costs for the report of 2'300.- CHF. The remaining 800.- CHF were shared between owners.

At the end the measures selected were the roof renovation with its increase in insulation, insulating the ceiling of the garage, installing new windows with better insulation values and

installing PV on the roof. The measures were chosen to optimise benefits versus effort. If all those measures are executed the buildings' GEAK classification would increases by two efficiency classes, from D to B, which would result in subsidies from the canton of Bern of $80\frac{\text{CHF}}{\text{m}^2}$ of living space or in total around 130'000.- CHF.

From June to November 2018 the roof was renovated. The expected costs stayed within the initially estimated costs. Pl 2 was perceived as a very competent and throughout project lead for the roof renovation. Pl 2 thinks that the timeline of the project and the decisions made by owners and A were well done. Firstly, damage was discovered and an expert was asked to assess it, then Pl 2 was reached out to, to lead the roof renovation project, it was also decided to push off the renovation a few years to save money for the renovation. According to Pl 2 owners and A performed the right way.

In August 2018 at an extraordinary owners' meeting a vote was called for the PV project which was approved by 2/3 of owners. The PV project would be financed by the renovation fund. Compared to project Rubigen there would be no need for roof usage contracts. The months leading up to the vote were used by the committee to have one on one talks with the various owners, to gauge interest, answer questions and win over the owners for the PV project. Following this decision, the PV company was selected on basis of the recommendation given by O3, who recommended Elektrobedarf Troller, and O4, who recommended BeoSolar. Both companies have experience in condominium owned buildings and ZEVs. Other companies were not asked for tenders. The contract was won by BeoSolar, as the company is closer than Pl 1 and already had project experience in Thun and knew local authorities, other factors such as material or costs were too similar to make decision based on those data points.

From August to October 2018 BeoSolar moved forward on their side by applying to the city, as well as the utility. The utility, Energie Thun, initially did not answer e-mails and eventually denied the project as it did not meet internal guidelines, which specified that the 10% of the rated PV power rule was to be measured at the net access point. The net access point Thun measures, is the whole residential complex, which resulted in a too small value. Meanwhile if only the building alone is calculated the value would reach 13% and therefore satisfy the rule. The PV company and the building committee consulted BFE to clarify which side of the argument was right. BFE answered that the project reached the required 10%. Following this statement, a meeting with Energie Thun was requested by the PV company and building committee, where a member of BFE would join. However, Energie Thun denied the request and said that they would not change their opinion even if the Bundesrat asked them to. This

happened in October 2018 when the time window to build PV during the renovation project was closing and could have not been met anymore as they would need to fight Energie Thun's decision which was not possible within the time window. Therefore, it was decided to put the PV project on halt and look at it at a later point in time. Later on it was discovered that if the net access point was to be separated per house it would add costs of up to 10'000.- CHF which would lead to an increased payback time.

In November 2018 the building committee decided to continue its work to further analyse options for GEAK, PV and other measures, such as the central heating which will reach end of lifetime in a few years. The initial focus of the committee will be on the windows, which are not part of measures covered by the renovation fund. Furthermore, they plan to add more members to the committee at the next condominium owners' meeting. O3 and O4 suggest that building committees are a good way to keep oversight of the project and increase control for the owners. However, A suggests that it may be a bit too close to try to do or propose additional measures as owners just had to pay a substantial amount for the roof renovation.

Additionally, one of the measures mentioned by GEAK, to replace all windows, is according to the rules set by the condominium owners not included to be paid for by the renovation fund, requiring either a change in policy or initiative of each owner itself to replace the windows. A claims that if too often and/or too many measures are pushed to the owners, fatigue could come up and attitude would be increasingly negative for additional measures.

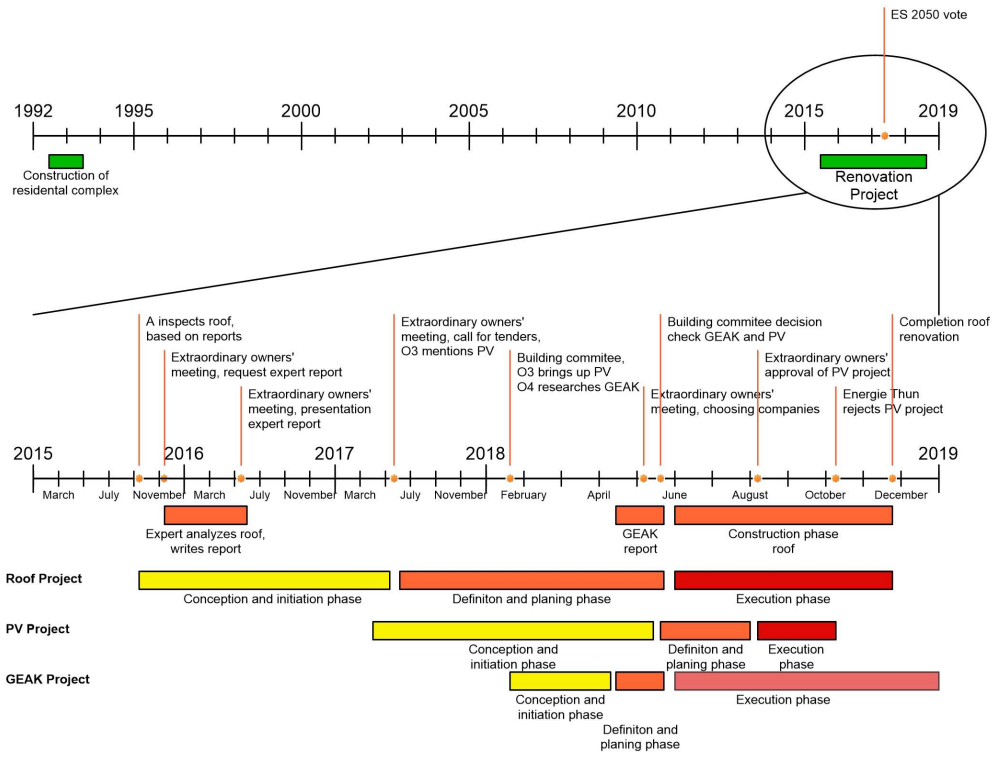

Figure 4-4: Timeline Buchholzpark

5 Results

As the results chapter consists of various subchapters a separate table of content is provided for this chapter. The analysis of interviews section compares statements made by interviewees in both case studies and draws conclusions. The stakeholder mapping section analysis the case study on basis of the stakeholder map which displays interest vs influence of the various stakeholders involved in this project. In the last section, all hypotheses derived in chapter 2.2 are tested.

Table of content - results chapter

5.1 Analysis of interviews

As described in the methodology section the interviews are coded and can be seen as an electronic file found in the appendix folder on the ILIAS platform. The data acquired by the various interviews is compared in this chapters according to their coding and conclusions will be drawn per row of statements. The coding “Project” was mainly used to gather data on the timeline, companies and scope of the project, which were compiled and used in chapter 04 and is therefore not discussed in this chapter. There is data that was not used or analysed from the interviews as they are not relevant for this case and research.

5.1.1 Case study Rubigen

Attitude

Table 9-1 comparing the various statements of interviewees made which is sorted by the code "Attitude" can be found in Appendix 9E.

All Interviewees expressed, as can be seen in row 1.1.1, that they are in support of EEMs and RDES as they are an important tool to reduce consumption and do something for the environment, however it can also be seen that while the green thought is important that measures also need to be practical in regards to other aspects such as total investment costs, payback time and ROI.

As can be seen in row 1.1.2 the interviewees had very different opinions on what caused their initial interest for PV, for O1 public discussions around ES2050 awakened his interest, causing him to do his own research which may have been helped by his background in electrical engineering. While O2 points out that from the very start of his career as a salesman he was interested in the topic of efficiency which also explains his initial interest in PV when brought up by O1. It can be seen that while there was some previous knowledge of EEMs and RDES, through media etc. it took the in depth political discussion around ES2050 and the nuclear vote to turn a general passive environmental stance into active interest which led to the project.

All interviewees mention that their opinion of PV and subsequently RDES and EEMs has improved as a consequence of the successful project, as can be seen in row 1.1.3. O1 and A even suggest that they recommend PV to other parties, from this statements as well as the statement made by O2 in row 1.4.1 it can be concluded that word of mouth can create a positive feedback loop, meaning that successful projects where expectations were met lead to happy stakeholders who will tell others about their positive experience which may cause people to consider PV for their apartments/houses.

As can be seen in line 1.1.4 A argues that it should be easier for projects such as the one done in Rubigen to be conducted in condominium owned housing where the average age is lower compared to the average age of condominium owners in Switzerland, as the attitude of older people is less positive towards PV, as they did not grow up with the technology and topics like climate change are perceived as less of an issue with increased age compared to lower age groups. However, O1 and O2 think that being too old for PV is not a valid argument as the payback time of an average PV system have been decreasing, furthermore it can be expected that the PV system itself increases the value of the apartment and can also be seen as an

investment into the future for example as part of an inheritance or part of an investment strategy as the ROI is positive.

In row 1.1.5 O2 and A suggests that if not everyone wants to invest in PV should not be taken as a negative sign, it may make more sense to proceed with owners who are willing to invest as their attitude and commitment is better compared to owners who were forced by a majority vote.

Circumstances

Table 9-2 comparing the various statements of interviewees made which is sorted by the code "Circumstances" can be found in Appendix 9E.

All interviewees, as can be seen in line 1.2.1, estimate that most owners of the residential complex will own the apartments for at least 15 years, while O1 plans 20+ years. A thinks that this fact did not have a big impact in the decision making because they plan to stay so long, however it can be argued that projects like PV that have payback times around 10 years are heavily impacted by the time parties plan to own the apartments as people who plan with 10 years or less will be less likely to invest in something they cannot reap the rewards from. However, the PV project Rubigen alleviated this issue by having the investment not directly being tied to the apartment, this way, even if investors sell their apartment they can keep the stake in the ZEV. Furthermore, it was interesting to see that also some owners who are approaching 90 invested into PV as they thought it was a good thing to do, and as O2 suggested in row 1.1.5 it is possible to see this investment also as part of an inheritance.

In line 1.2.2 Interviewees agree that the knowhow of O1 helped the project heavily as it allowed O1 and building committee members to talk from a point of strength to other owners because they were sure of their information and O1 was the project lead due to his knowhow and commitment to the project. This helped to answer critical questions of other owners, initiate the project and alleviate their fears in regards to topic such as electro sensitivity. Pl 1 furthermore argues that due to the knowhow of O1 he needed to give less inputs and information in project Rubigen compared to other PV projects, where less knowhow was present at the start of the project, pointing out that also the enthusiasm of the building committee members was an important factor in pushing the project.

In line 1.2.3 O1 argues that it was important for the project to have a core team supporting the project to be successful, as a lot of time needed to be spent with owners in individual

conversations to win them over and taking their fears. This is enforced by the statement of Pl 1 that condominium owned projects are more difficult to realise and initiate just due to the number of stakeholders in project where attitude, financials, etc. can differ heavily from owner to owner. O2 concludes that it is therefore important to know from the start that not every owner will or can invest into the project and that the process until all investors sign the contracts is longer than in PV projects with different kind of ownership of the apartments and houses. O1 even mentions that due to this core team and its work with the various owners that the overall connection between various owners improved and a team spirit could be felt in the core team and the houses who joined the effort.

Interviewees agree in Line 1.2.4 that it was important to actively approach owners to ask them about their concerns and talk to them in person as it helped to get signatures of owners for the roof usage and electricity supply contract, even though those owners were initially opposed to the project. It is argued that if this individual conversation would have not taken place that the project would have failed or been smaller in scope. O1 notes that the effort required to talk to the various owners was underestimated but necessary. It was also mentioned that the expert was laying solid groundwork for the PV project as a person unrelated to any owner, which helped to avoid having personal bias between owners influence the decision making.

Perception

Table 9-3 comparing the various statements of interviewees made which is sorted by the code “Perception” can be found in Appendix 9E.

In row 1.3.1 O2 remarks that it was interesting to see which owners initially supported the project but eventually chose not to invest with O1 remarking that there need to be owners interested in EEMs and RDES to initiate and push such a renovation project.

While O1 argues in row 1.3.2 that the decision for PV cannot be justified only by the thought of doing something good for the climate and nature it must be also based on profitability. The profitability calculations were done by O1 conservatively in order for reality to most likely outdo the calculations, leading to a better word of mouth for PV than the other way around. Pl 1 points out that most owners should have a good financial situation allowing them to see this project as a long term investment with a positive ROI.

Row 1.3.3 interviewees offer their opinion which factor was the most important in the end for the decision making of most owners. O1 and A suggest that ROI and payback time were more important than raw investment costs, for which O2 suggests that this is only true for owners

who did have the financials means to invest. Furthermore, in some cases the ideology of some owners may have let them to not invest.

1.3.4 describes the interviewees being positively surprised about how fast the project could be concluded. With Pl 1 and O1 pointing out that this was partially due to knowhow of O1 who had the project lead as it allowed to speed up certain processes and avoid costs for drawing up contracts externally. A suggests that in the future, projects such as PV and other EEMs may be initiated by building administrations as they are able to pool the knowledge.

In 1.3.5 interviewees argue that for condominium owned project at the moment it seems like the perceived effort to set up satisfy regulatory and apply for subsidies is perceived as not a deciding factor, as it is perceived as not too much effort, which O1 argues is higher in reality. Pl 1 mentions that some other projects actively avoided ZEV to minimize effort required to carry out the project and also for the billing etc.

During the interview interviewees were asked to grade the importance of various factors for the owners' decision making, see Figure 5-1. 4 is the highest importance and 1 the lowest. It can be seen that for Rubigen the payback time, investments costs and information of companies were seen as the most important ones out of the list. However, it needs to be noted that some interviewees suggested in other answers different factors to be more important or contradicted answers given here.

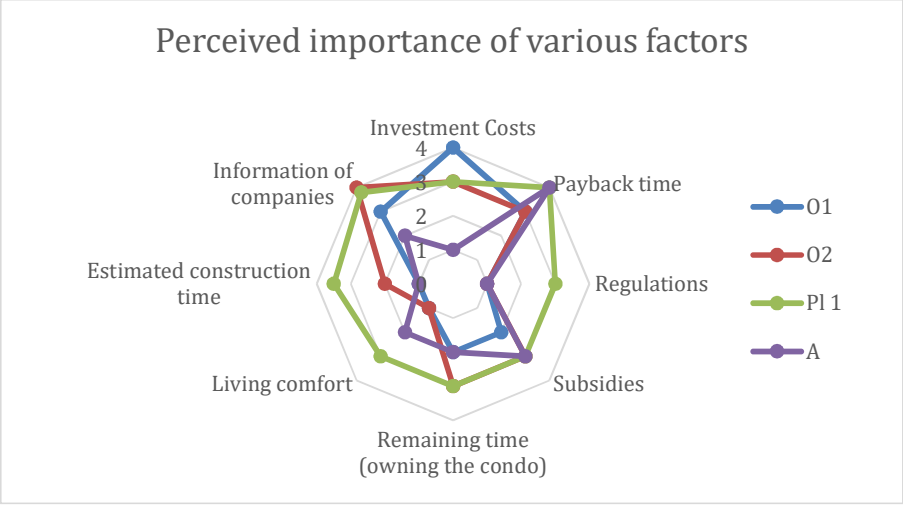

Figure 5-1: Perceived importance of various factors in the decision making process of owners in Rubigen

Information

Table 9-4 comparing the various statements of interviewees made which is sorted by the code "Information" can be found in Appendix 9E.

Interviewees express in row 1.4.1 that information regarding PV and subsidies were acquired by the owners through the trade fairs they visited as well as the internet, news and word of mouth, which in O2's case positively impacted his perception of PV. Pl 1 remarks that the advertisements they do is not targeted to any group on purpose as to be able to reach as many people as possible. A remarks that, for them the expert was an important source of information. Therefore, it can be seen that the owners who were involved in the building committee as well as A actively sought information regarding the project to deepen their knowledge and make better informed decisions.

The interviewees express in row 1.4.2 that the expert from EVG-Zentrum, Mr. Burch, was not important for the buildings committees' members' decision making as they already were informed about the topic before the presentation of Mr. Burch. However, they agree that he may have had a big impact in the decision making of the other owners, as he is an independent expert, which is not affected by personal bias between owners.

In row 1.4.3 Interviewees suggest that they themselves have heard of EIV before the project started but were not clear about the details and agreed other owners didn't seem to know about possible subsidies. Pl 1 remarks that in their tenders they not only show EIV but also, if possible in that canton, the tax deductible, which can cause further savings.

In row 1.4.4 O1 and O2 remark that the trade fairs they visited and the information events by Troller were used as a source of information but also to identify possible companies, as they wanted to employ a company that has the capabilities to do the whole project in house, not needing to outsource certain tasks, which proved to be a difficult task. Furthermore, O1 and O2 note that many companies at the trade fairs were not able to answer questions in regards to ZEV.

Regulations and Subsidies

Table 9-5 comparing the various statements of interviewees made which is sorted by the code "Regulation & Subsidies" can be found in Appendix 9E.

In row 1.5.1 O1, O2 and A argue that the effort required to satisfy regulations set by BFE was considerable and more than they expected before the project. Because they decided to not do

the projects with all owners through the condominium owners' association but only those who wanted, they needed to draft additional contracts for the usage of the roof and electricity supply which added to the effort required and even caused delays. Overall it can be concluded that the regulatory effort is time intensive which requires the dedication of a team standing behind the project.

Pl 1 argues in row 1.5.2 that they do not have a standard procedure but there are for some aspects like the local electricity provider standard formulas. Which according to O2 were not sufficient, arguing "It would be good to have at least a checklist for the various contracts so that PV projects in condominium owned buildings know at least everything that needs to be covered to follow through with the project."

Pl 1 suggest in row 1.5.3 that the effort to apply for the EIV subsidies has been increasing with recent changes, for example now additional documents need to be supplied. Furthermore, nowadays you can only apply for subsidies when the project is already finished, causing further delays until the money is paid out, which according to O1 can cause issues in condominium projects as within the timespan it takes for the subsidies to be paid out some investors may already have moved away, decreasing the positive effect of subsidies in the decision making process.

Pl 1 remarks in row 1.5.4 that within Troller they are informed about changes to subsidies and rules on a regular basis through training sessions and information given by Swisssolar.

Financials

Table 9-6 comparing the various statements of interviewees made which is sorted by the code "Financials" can be found in Appendix 9E.

O1 mentions in row 1.6.1 that out of 5 companies sending in tenders only 3 could be considered, as it was decided that only regional companies that could do everything themselves were to be considered, one of the companies actually offered to deduct the EIV directly from the costs, therefore taking out the wait time for owners to receive subsidies, which was seen as a very good offer, however the rest of the offered price was considerably higher than other tenders even if EIV was included. The tenders were of a fairly similar structure allowing to make the tenders comparable faster. It can be seen that companies in the PV sector embrace subsidies and tax breaks, including them in their offers and information material.

The company, Elektrobedarf Troller, as described in line 1.6.2, was mostly chosen on the basis of expertise and competence, even though they did not offer the cheapest prices. Furthermore, the promise of a "finished by" date was perceived as good.

Row 1.6.3 O1 mentions that EIV was considered from the very start of the project and also included in the costs calculation, where O2 expects to receive 1500.-CHF for his investment.

Interviewees agree in row 1.6.4 that if in such a project, the work cannot be done by an owner it may increase the overall costs of the system and make it less desirable.

In row 1.6.5 it is said by Pl 1 that they initially offered a billing solution for the ZEV, however the owners decided that A, who offered to do it free of charge, should do it as it increases ROI of the overall project. Furthermore, O1 suggests that there are not enough companies targeting PV for the phase after it was installed.

O2 states in row 1.6.6 that the profitability of the PV system has increased after the project already started as BKW increased the tariff for PV electricity. Pl 1 remarks that while the last few years were not too bad there has not been much growth, even though ES 2050 vote in 2017 has put a spotlight on PV.

O1 mentions in row 1.6.7 that each investment by owners in the PV project was calculated and provided to the investors, where they can see how the system depreciates, its worth after x years etc. This was done so that investors if they moved away could sell their share of the PV system, first right of purchase for other investors, to tell them that it may even be worth it if they cannot stay all the time.

5.1.2 Case study Thun

Attitude

Table 9-7 comparing the various statements of interviewees made which is sorted by the code "Attitude" can be found in Appendix 9F.

As it was claimed by interviewees in line 2.1.1 most of the owners in Thun were supportive of PV and some were against it, about 1/3 of the owners. The negative attitude can be mainly due to the costs which were already high before PV was even considered, it didn't help that already additional measures were looked at. Furthermore, A suggest that older owners are in average less positive towards PV. Pl 2 argues that he supports EEMs and RDES if they make sense, however they did not in his opinion for this project. Pl 2's main goal was to deliver a high quality end product.

According to line 2.1.2 all the interviewees were satisfied that they tried to execute the PV project in their condominium complex, despite of the fact that this project was declined by the Energy Thun later. Interviewees were frustrated by the decision of Energy Thun, as they believed that the building has this potential to install PV. However, they are positive and looking forward trying to meet goals set by GEAK report in the future and try again with PV. O4 mentioning that without effort nothing can be gained.

It can be concluded from 2.1.3 that the attitude, interest and background of committee members had a great impact on the result of the PV project, as O3 and O4 had background and interest in these areas. O3 studied electrical engineering. O4 is originally from Germany where RDES and EEMs are more common than in Switzerland. O4 attitude towards renewables and EEMs improved due to his experience in another condominium owned object which installed solar thermal collectors to support warm water production, which was an economical successful decision. A notes that, the interest towards the overall project varied heavily from Attica apartment owners to the rest.

According to section 2.1.4, O4 and A agree that Pl 2 and the companies chosen for the roof renovation were either saying that there are no subsidies like GEAK or in Pl 2's case that they are not worth the effort needed as it is not suited for this project. Furthermore Pl 2 explained that PV for this roof does not make sense and subsequently did not support the PV effort above the necessary level. It can be concluded that if no owner challenged those statements from Pl2 and the companies that other measures would have never been considered. This shows that if there is no particular knowhow and background in the condominium owners' association the word and advice of an architect/ planer carries a lot of weight.

As it is mentioned by Pl 2 in 2.1.5 section, EEMs and RDES projects may be implemented more if planers and construction companies are informed and trained better in these aspects. A suggests that their company is starting now an effort where they want to draw up investment plans for possible renovations, which may include subsidies, as a way to inform owners better about upcoming costs and displaying different options.

Circumstances

Table 9-8 comparing the various statements of interviewees made which is sorted by the code "Circumstances" can be found in Appendix 9F.

As it was explained by four interviewees in row 2.2.1, it is expected that most of the owners of this condominium house plan to own the property for at least more than 10 years. It can be concluded that this fact has positively influenced their attitude towards the PV project, as most owners should benefit from the ROI of the PV installation. Pl 2 going so far as saying that only by special circumstances such as death, aging (age appropriate housing), loss of financials, or moving to a completely different region could cause a sale of an apartment in this condominium complex, as it is according to Pl 2 a prime location that will gain in value.

Based on section 2.2.2, it can be said that building committees are a good tool to initiate projects, if members are motivated and have some background that helps with the topics discussed. Either was building committee members have a significant impact on the result and scope of a project. O3 and O4 had both background or interest in the topics of this project, which helped the project yield good results. However, Pl 2 believes that, even if there are experts in condominium owners' building committees, problems may arise due to personal bias between owners and to the building committee members.

According to 2.2.3, based on O3 and O4 idea, the rejection of the PV project by Energie Thun could have been fought legally, however, it would be a very time-consuming case and it would have needed to be finance by the owners. Which at that time, it was decided to not continue the project further as the owners who did not vote for PV would be a further antagonised and conflicts between the owners could have been created.

As it was explained by O3 and O4 in 2.2.4, it was necessary for the PV project's approval to talk to the various owners before the owners' meeting to gauge interest, answer questions and win the over for the project. It is even suggested that without such discussions before the meeting that PV would not have been approved. O4 suggests that there were some talking points who were better received than others. (Good for environment, positive ROI, ease of access now as the roof is already worked on)

According to section 2.2.5 there are always so many owners voluntarily or non-voluntarily in these building committees who some may oppose the project or some may not contribute much. In general, as O4 claimed, it was easier to convince owners for the roof renovation than the PV project as the PV project was an optional measure while the roof renovation was a necessity.

Perception

Table 9-9 comparing the various statements of interviewees made which is sorted by the code "Perception" can be found in Appendix 9F.

Based on row 2.3.1, Pl 2 believe that PV projects are expensive, especially considering the whole system and not the panels alone. O3 and A argue that the investment costs were an important decision factor for PV as the costs of the roof were already high and drained the renovation fund. However, Pl 2 also argues that not everything needs to be decided only based on costs, estimating that PV and EEMs will be used more often in the future.

In line 2.3.2 it is argued by O3, O4 and A that Pl 2 did not actively give information about possible subsidies such as GEAK and EIV and even if asked said there are some but that PV and GEAK in this project do not make sense. Initially the owners followed this recommendation, showing the influence an architect/planer/expert can have in the decision making process. O4 points out that especially for the GEAK report subsidies it is important to know about them as the costs are the biggest factor for or against the report, as in most cases owners are at this point not sure if they will do the measures that are eventually required to reach the GEAK report goals and the subsidies in the canton of Bern for the report alone are 1500.- CHF which can cover most of the costs of the report.

Based on row 2.3.3, Pl 2 aim was to build a sustainable and high quality work and use the best material for the project, however, as O4 also claims, there were not many companies who had the capability and experience working with the chosen material on the roof to hand in a high quality of work.

In the row 2.3.4, O3, O4 and Pl 2 agree that GEAK is in principal a good idea but it is on the other hand complicated, time consuming and not very practical for every project, as some buildings are built in a way which would cause additional costs to install EEMs and RDES. A explained that there was some capabilities in their company regarding GEAK due to other project, which allowed them to estimate the amount of subsidies for the Thun project. However, O4 thinks that it was good to try GEAK report as it shows their potential and without any effort, there can't be any payoff or reward. On the other hand, he believes that subsidies for renewables in Germany are more effective than the subsidy program in Switzerland.

As it was claimed by O3, O4 and A in row 2.3.5, during the PV project, Pl 2 and companies could have been more supportive and would pushed for GEAK subsidies or other programs and also inform the customers. It is explained by A that, PV was not supported by Pl 2 as the form of the roof was not optimal and had many roof windows with source of shadows. A believes that the PV and GEAK project was mainly pushed by the owners building committee members and A and that they have a significant impact on this project. Moreover, it was claimed that Attica owners had more motivation and interest than other owners as they were

directly impacted. Also A thinks that the older age of Pl 2 could have been a reason for the not supportive attitude toward PV. However, Pl 2 claimed that, it was good that PV was tried to be executed and that's a shame that it was rejected by the Energie Thun. Besides, he doubts if owners should try to move forward with GEAK and PV in future. Pl 2 is confident that he met the expectations successfully in this project and that owners trusted him and were satisfied with his work. This statement is also confirmed by O3, that even though Pl2 didn't contribute for PV and GEAK project, he had a good performance for the roof renovation project.

According to all the interviewees in row 2.3.6, the living comfort of the Attica apartments was substantially increased due to the renovation of the roof. Before the renovation heat was lost in winter, owners had bad temperature control in rooms, an airflow was noticeable and rain noise was loud. A explains that even if the renovation were done partially to improve living comfort of the Attica apartments, there will still be some issues during construction for owners who are deeply affected by the renovation project, such as Attica owners, independent of attitude and person.

Based on row 2.3.7, all interviewees were surprised and frustrated with the rejection decision of Energie Thun. Based on O3 experience, the other PV project with other local provider gave him a different perception, especially because they would meet the 10% rule in Thun. Pl 2 believes that, local providers, as well as cities, often put big hurdles by having standards, regulations and bureaucracy, that need to be satisfied, Pl 2 suggests that bureaucracy should be reduced to allow owners to more easily built PV etc., he is furthermore of the opinion that subsidies programs in general should have an end date as once wished for actions become the new standard. However, they should be more helpful by applying more EEMs and RDES in case owners are satisfied in condominium complexes. O4 explained that they could have fought the Energie Thun decision and most likely they would have won, but the time, effort and required finances would have been too high. Therefore, it was decided to stop the PV project.

O4 suggests in row 2.3.8, that in another condominium owned building where he owns an apartment the yearly renovation fund fees Are considerably higher than in Thun, which in his opinion helped to push through measures who otherwise would have been hotly discussed and denied. This is in his opinion because the owners think of the renovation fund money not as freely available money but money with the reason of renovation attached to it which makes decision making simpler.

During the interview interviewees were asked to grade the importance of various factors for the owners' decision making, see Figure 5-2. 4 is the highest importance and 1 the lowest. It

can be seen that for Thun the investments costs, living comfort and information of companies were seen as the most important ones out of the list. However, it needs to be noted that some interviewees suggested in other answers different factors to be more important or contradicting their answers.

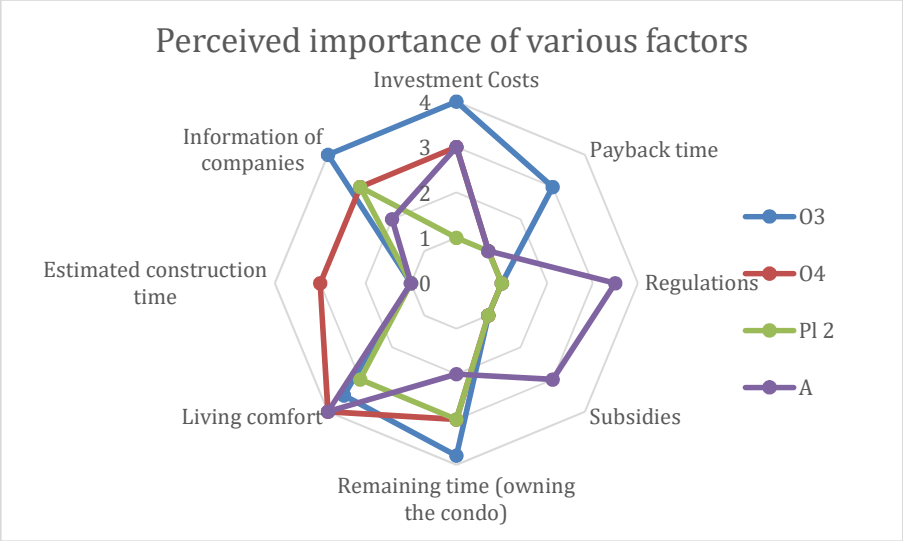

Figure 5-2: Perceived importance of various factors in the decision making process of owners in Thun

Information

Table 9-10 comparing the various statements of interviewees made which is sorted by the code "Information" can be found in Appendix 9F.

According to 2.4.1 and 2.4.2 sections, O3, O4 claimed that the initial idea and information regarding GEAK was found mostly by themselves, and via internet and none of the external companies including Pl 2 provided them supportive information regarding possible subsidies before, even when asked. Pl 2 mentions that GEAK reports can only be done by an expert who has the respective certificate, which he does not possess. O4 also confirms that, it was very difficult to find a GEAK expert to do the report within the short amount of time. A remarks that, she relied mainly on Pl 2 as the source of information regarding the roof and that for subsidies for the roof none of the companies mentioned any.

Based on 2.4.3 for GEAK it is necessary to identify which measures should be taken to reach the necessary level of improvement. In Thun case study, in order to maximize profit versus outcome, following measures were selected:

- Insulation of garage ceiling
- Better insulated windows
- PV on the roof
- Roof insulation

It is mentioned that due to the report many measures were discussed in the building committee and with the GEAK expert, which otherwise would not have been discussed. The GEAK expert also told the committee that if the heating needs to be replaced for the residential complex that they may consider a heat pump as an replacement, pointing out possible subsidies.

Due to 2.4.4 section, as the quality of the work was the deciding factor for the roof's longevity, the experiences of Pl 2 in previous projects with the same kind of roof, seamed roof, influenced the selection process significantly. Therefore, in order to renovate the roof chromium nickel steel + sheet was selected as it has a higher material quality and subsequently longer lifetime. This material is more expensive and requires special machines to process it, which not many tinsmiths have. However, many companies offered in different metal sheets, pointing out that their recommended material is easier to implement, work with and is cheaper.

Regulations & Subsidies

Table 9-11 comparing the various statements of interviewees made which is sorted by the code "Regulations & Subsidies" can be found in Appendix 9F.

Due to 2.5.1 section, although the PV project was accepted by owners, it was declined by Energie Thun as it didn't meet the internal guidelines. Internal guidelines specified that the 10% of the rated power requirement of the electricity net access needed to be met by the PV project for the whole residential complex and not only building itself. In order to implement this project, Energie Thun needed to split the access point for each building which they didn't want to. Interviewees were surprised and disappointed by the decision of Energie Thun and believed that according to law they have reached the 10% as the BFE has also confirmed it, but Energie Thun with its internal guidelines implements the regulation differently.

According to 2.5.2 Pl 2 believed that the old system before GEAK was better for wider ranges of buildings as the current calculation is too much based on the standard buildings. As it is also mentioned by O4, GEAK report is a highly standardized report which needs high amount of effort to reflect the real features of the building in it. Furthermore, O4 explains that there was not much time for them to actually do the GEAK report as it need to be handed in before construction starts.

Based on O4 explanations in row 2.5.3, PV implementation would have been easier in this project compared to Rubigen as the majority of owners decided at the owners' meeting to do PV with the buildings condominium owners' association and its renovation fund, subsequently there is no need for a roof usage contract. However, in order to become eligible for GEAK, that was necessary to do the report before the renovation of the roof.

Financials

Table 9-12 comparing the various statements of interviewees made which is sorted by the code "Financials" can be found in Appendix 9F.

According to row 2.6.1 in November 2018 the roof renovation was completed and the costs were within the budget expectation. Initially the roof was repaired this year before the renovation becomes necessary in future, in order to save money more. (Financial-roof)

Based on row 2.6.2, O3 and O4 believe that the PV project was planned to be financed by the renovation fund, however the renovation fund was already running dry due to the roof renovation. That's mainly due to low level of annual investment in renovation funds, which can barely cover normal repairs. Therefore, it was concluded that all the owners need to save more money in the renovation fund annually, to be able to accumulate enough money during 2 or 3 years and expand the financial burden over multiple years. However, A believes that renovation fund was not underfunded and the yearly fees were already above the average, but they are now making a new investment plan to check findings and prepare owners for more costs that may happen including subsidies.

As it is seen in row 2.6.3, Pl 2 recommends that the administration should conduct check-ups on the finances and also damages of the building on regular basis to control renovation funds accordingly. In this way, financing the renovation cases wouldn't be a big surprise for owners and it can simplify the decision making process. Moreover, O3 believes that A should have more responsibilities in regards to PV project and gain knowledge during time in condominium complex to reduce work and time needed in future on a PV project. (Finance-renovation fund)

It can be concluded from row 2.6.4 that there was a high price difference between the experts who offered the GEAK report. The difference is mainly due to the different level of experience and knowhow, however, the costs material used and other costs differed only slightly from each other. O4 explained that, companies were mostly selected by cost criteria's, and Pl 2 was responsible to harmonize the offers handed in by companies. (Finance, Offer)

Due to row 2.6.5, O3, A, Pl 2 was experienced through the profession when it came to the call for tenders and the entire process ran through him. Therefore, A depended largely on information given by Pl2 for the seamed roof. However, information given by PV companies didn't have a big impact on decision making or scope of the project. As also O4 mentioned, not all the PV companies have the experience and ability to manage the condominium owned projects and therefore the PV project was mainly supported by O3.

5.1.3 Conclusion of both case studies

In this section, the result of two case studies based on each topic will be compared and analysed. The result helps to accept or reject the hypotheses of this project.

Attitude

Both case studies conclude that, EEMs and RDES are an advantage for condominium owned residential complexes. Owners need to have positive attitude and interest toward these measures in order to initiate projects. However, before starting it is necessary to consider the outcome, total investment costs, payback time, and ROI as decision factors.

Moreover, initial interest and background of owners has a great impact on result of decision making regarding PV project. In both projects, owners who were also members of committee had previous knowledge about EEMs and RDES through media or other project experiences which helped the projects significantly.

All interviewees in both case studies mentioned that their opinion regarding PV and EEMs has improved and they are satisfied that they tried to implement the PV in their residential complexes. Project Rubigen is an example of successful PV implementation and therefore will be recommend to other parties as well by word of mouth. Project Thun was not successful to install PV, however, stakeholders are still motivated and look forward to fulfil the requirements in future and try again.

It can be concluded from both case studies that the average age of owners and investment factors plays a significant role in the decision making process of EEMs and RDES projects. In average the attitude of older owners is not very positive toward PV as they have not grown up with such technologies. On the other hand, if it is expected that PV systems increase the value of apartment, it can be considered as the investment into the future for themselves or inheritance.

Circumstances

It is concluded from both case studies that, the higher remaining ownership time of apartments, the higher the positive attitude towards PV project. That’s due to the fact that owners should benefit from the return on investment of the implemented project in future the longer they plan to own the apartment.

Moreover, as it is experienced in Thun and Rubigen, the high level of motivation and knowhow of building committee members regarding their respective projects had a significant impact on the good results and the scope of both projects. As these owners lead the project internally faster toward the expected outcome and help to win over the other owners.

Moreover, it is concluded from both case studies that, in order to have support for the measures like in an election campaigns, owners need to be won over for the project and need to be pushed to show up on the meetings where votes on the project take place. Interviewees mention that the personal conversation with the various owners led to them having a better understanding of the project, both financially and ecologically, and increased the chances of support for the project.

Perception

In both case studies mainly owners were the ones who supported, initiated and pushed EEMs and RDES projects. Owners in both studies believe that, PV projects need to be sustainable both financially and ecologically.

In Rubigen the regulatory effort was perceived as low before the project but after it interviewees suggest that the regulatory effort, writing up all the contracts, getting signed etc., was higher than expected and too much, with often no help in the form of checklists or standard contracts etc. In the Thun project the application for GEAK subsidies was perceived as a lot. Therefore, it can be concluded that the GEAK application as well as the regulatory effort for ZEV is considered as very high and could lead to a bad word of mouth for EEMs and RDES in condominium owned buildings and residential complexes.

Information

As the result of both case study analysis, all interviewed owners claim that the information regarding PV projects was found mostly by themselves via internet, word of mouth, news and exhibitions which had a great impact on the speed and quality of the project process. A in both case studies believes that, Pl 1 and Pl 2 were the main source of information during the project. However, it needs to be noted that in Thun neither Pl 2 or the companies renovating the roof, mentioned GEAK or any subsidies before owners mentioned them. When asked answered they that GEAK and PV do not make sense for this project.

Regulation and Subsidies

As it can be concluded from both case studies, that the regulatory effort for PV is a very time intensive task that if it cannot be done by an owner also demands high level of investment.

Moreover, based on the interviewees idea, the GEAK reports is a highly standardized product which needs high level of effort to reflect the real features of the buildings it should describe as otherwise it is perceived as not reliable by owners who are not involved in the GEAK process.

Furthermore, it can be seen that the implementation of the 10% rated power rule for ZEVs is different depending on the local utility and can cause, as seen in Thun, PV projects to stop.

Financials

Both case studies conclude that, there were high price differences between the companies which offered for PV in Rubigen, the roof renovation and GEAK for Thun. The difference is mainly due to the different level of experience and competence or materials offered.

It could be seen in Thun that if a project already has high costs, which are not covered by the renovation fund and additional measures are introduced that owners are less likely to approve the project.

For the Rubigen project the investment of all owners was calculated for every year of ownership with a lifetime of 25 years used for the calculation. This allows investors to sell their share of the PV system, which was an additional argument for the system.

5.2 Stakeholder mapping

This chapter analyses the project by applying data points and conclusion drawn from the interviews and the project into a stakeholder map to better understand the influence level of various stakeholders during the project. As the last section of this subchapter conclusions of both case studies' stakeholder map analyses will be conducted.

5.2.1 Stakeholder mapping Rubigen

In Figure 5-3 the project timeline can be seen with milestones (MS) added to help visualizing the stakeholder mapping underneath.

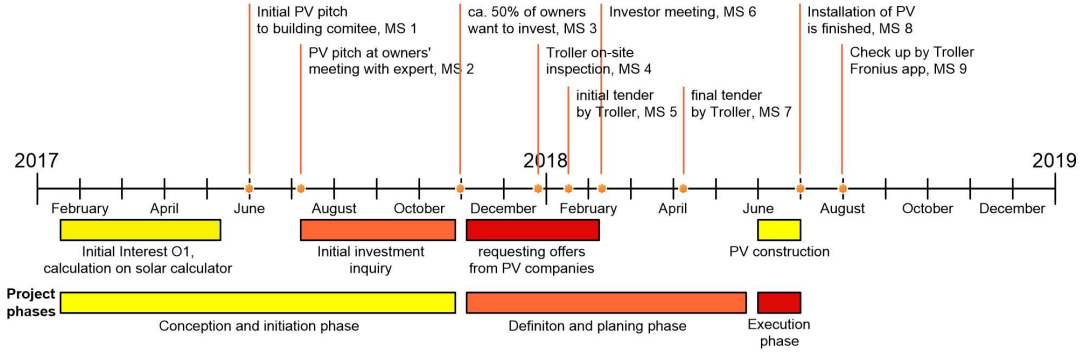

Figure 5-3: Rubigen project timeline with milestones

Figure 5-4 plots influence vs. interest of various nodes for the same stakeholder to display their development through various milestones.

The project Rubigen as previously described, was initiated by O1 with the support of O2. Subsequently it can be seen that those two stakeholders had at MS 1 the biggest interest and influence, while the other building committee members and A had moderate interest and lower influence on the project itself. The project lead for PV was in the hands of O1, who had for the rest of the project the highest influence and interest of all stakeholders. It can be noted that A supported the project by helping organizing meetings and informing owners at this point in the project.

At milestone 2 it can be seen that the interest of A in the project and also its influence increased due to the efforts required for the meetings and a proactive attitude of A. O2 influence increased as he and other building committee members started to discuss PV from this point forward with the various owners, which was perceived as one of the deciding factors that many owners chose to invest. At milestone 2 a new stakeholder, the expert from EVG-Zentrum, who presented the project to the owners' meeting showed up. This was one of the first point of contacts for many owners with the PV topic. Subsequently the expert's information was an important early factor

in the owner's decision making process. After MS 2 the expert gave information to A for PV as it was requested. From MS 3 onwards PV companies and experts at trade fairs had considerable influence on the scope and scale of the project as O1 and the buildings committee used the PV company's information and information sourced from the internet and word of mouth as a basis for the scope of the project.

At MS 6, the investor meeting showed a bigger focus on companies and their tenders which led to an increase in influence of Pl 1 on the project. This can be concluded as information from Pl 1 led to the decision to have separate ZEVs and PV systems below 30kW to avoid additional yearly costs. Furthermore, A gained more influence on the project as they offered to do the billing free of charge, which helped to reduce yearly cost of operation for the PV system and positively influenced the decision making of possible investors.

As we come to the end of the planning phase the influence of building committee members and O2 decreased a bit, while a new stakeholder in the form of BKW joined the project. BKW as the local utility needed to approve the project and install new main counters on their site and uninstall the old apartment counters which are replaced by privately owned smart meters. BKW's interest can be seen as moderate to high while influence is significant. This is shown by various statements in regards to BKW and their fast answer and good reaction, which led the project to move forward earlier than expected.

The project finished at MS 8 and it can be seen that the interest of Pl 1 and their influence increased slightly as they voluntarily visited the Rubigen project at MS 9 to look at the system again to see if everything was working as intended. On this occasion Pl 1 mentioned the Fronius app which would allow owners to check production and consumption figures of their buildings and PV systems. O2 thought that was a great idea and insisted to install it. It can be seen that the app has a positive impact on the perception of the PV system from owners and is used as a nice gadget to show of PV to their social network.

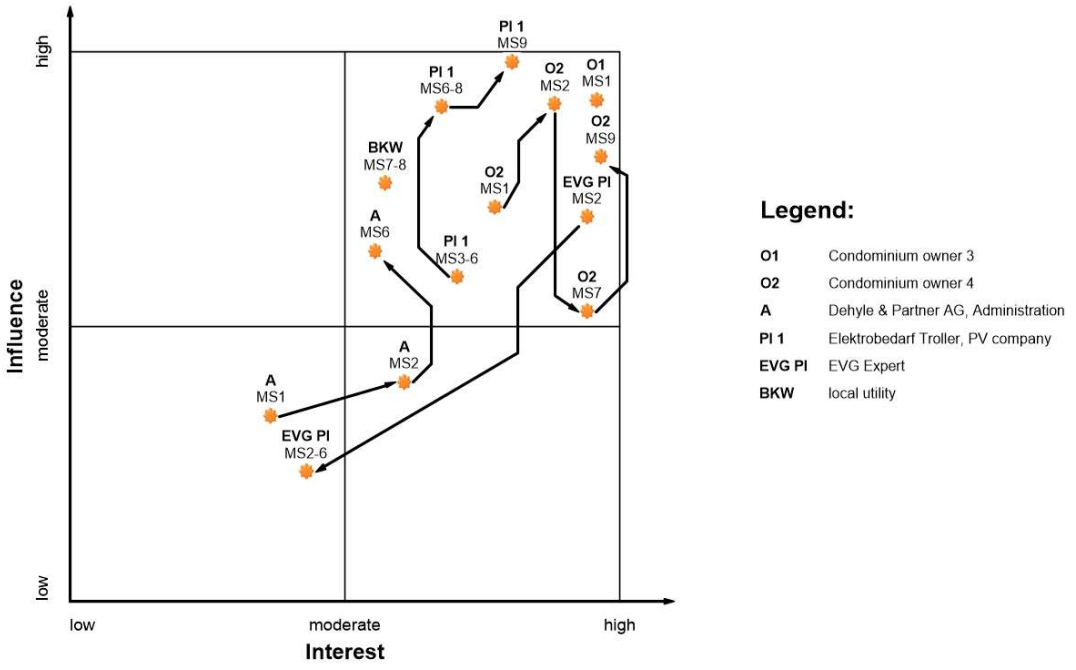

Figure 5-4: Stakeholder mapping of Rubigen project

5.2.2 Stakeholder mapping Thun

In Figure 5-5 the project timeline can be seen with milestones added to help visualizing the stakeholder mapping underneath.

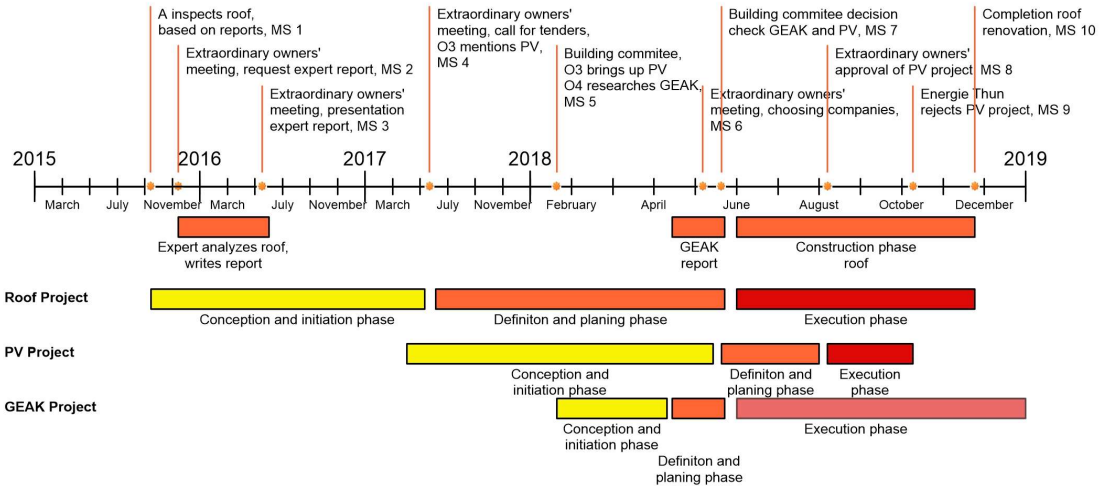

Figure 5-5: Thun project timeline with milestones

Figure 5-6, plots influence vs. interest with various nodes for the same stakeholder to display their development through various milestones.

At the start of the project A had high influence as they decided upon reports from owners to inspect the roof at MS 1, requesting an extraordinary owners' meeting. Furthermore, they have followed up their findings at MS 2 where they recommended to request help from an expert to assess the roof. From MS 3 onwards A still had considerable influence on the project, but it was decreasing as they went from a proactive role to a more supportive role.

Initially O4 had a strong interest at MS 1 and moderate influence as A acted on reports from O4 and other Attica owners. O3's interest was lower at MS 2 as he was not directly influenced by the roof damages. However, O3's and O4's interests and influences increased for milestone 3, when a decision needed to be made upon the roof experts' (R Pl) report. R Pl had with his report the biggest influence of all on the decision making for the roof renovation as based on his report it was decided to start the project. However, it should be noted that R Pl never mentioned GEAK report or any subsidies.

After MS 3, Pl 2 was contracted to lead the roof renovation project and had therefore a high influence on the project, while his interest was moderate to high. For MS 4 the interest of O3 increased to being very high as he brought for the first time the topic of PV forward. Pl 2 answered that in his opinion it does not make sense for this roof. The owners' meeting decided to follow Pl 2's recommendation, showing his great influence, while it could be seen that he was not at all interested in PV, with other stakeholders saying that Pl 2 only did what he was asked and needed to do in respect to GEAK and PV. This difference in influence and interest can be seen on the graph as Pl 2, SG. Furthermore, it was asked by O4 if there are any other subsidies to which Pl 2 answered that they exist but none of them make sense for this project.

Following Pl 2's recommendation O4's and O3's influence was increased as they researched PV and GEAK further, bringing it up at the building committee meeting, MS 5. From this point forwards Pl 2's influence on GEAK and PV diminished greatly as the project leads for those two projects were in the hands of O3 for PV and O4 for GEAK.

At MS 6 the companies for the roof renovation were selected on the basis of Pl 2's recommendation, which was followed. This displays again the influence of the project lead and an architect, can have on the project.

Following shortly after MS6 the building committee members decided to move forward and check GEAK and PV, at MS7. Especially GEAK was important as they would only be eligible for subsidies for the roof if the report was handed in before construction started. Influence of O3 and O4 increased again due to their lead for PV and GEAK.

After MS 7 a new stakeholder joined the project, the GEAK expert (GEAK Pl). in cooperation with the building committee the GEAK Pl created a GEAK report to apply for possible subsidies from the canton of Bern. During GEAK Pl's work on the report he suggested and looked at various measures the building could employ to reach the needed increase in the energy label of the house from D to B. Measures looked at are still being considered to be employed in the future showing GEAK Pl's influence on the project and maybe even the initiation of future projects, such as the suggestion to consider a heat pumps as the replacement of the central heating system that will soon reach end of lifetime.

At MS 8 O3 and O4 brought the PV project with the tenders of 2 companies forward to an extraordinary owners' meeting. The owners decided up on the basis of these tenders with a 2/3 majority to approve the PV project. This also shows the influence and interest the PV companies (PV Pl) had with their information and tenders.

From MS 8-9 the influence of PV Pl increased as they started the project, contacting the local authorities and utility, Energie Thun (ET Pl) informing them about the project and handing in required forms. Initially ET Pl did not answer, when they eventually did at MS 9, which they declined the project as it did not meet internal guidelines. Following this answer the owners and PV Pl tried to appeal this decision unsuccessfully and subsequently decided to put the PV project on halt. This displays the high influence ET Pl has on the project, while their interest in the project seems to be small, not even answering requests initially and denying meetings to discuss their decision. This stands in stark contrast to their website which seem to suggest that they promote and support every form of PV heavily.

At MS 10 the roof renovation eventually was completed. Owners are satisfied with the roof renovation and Attica owners report a significant increase in living comfort.

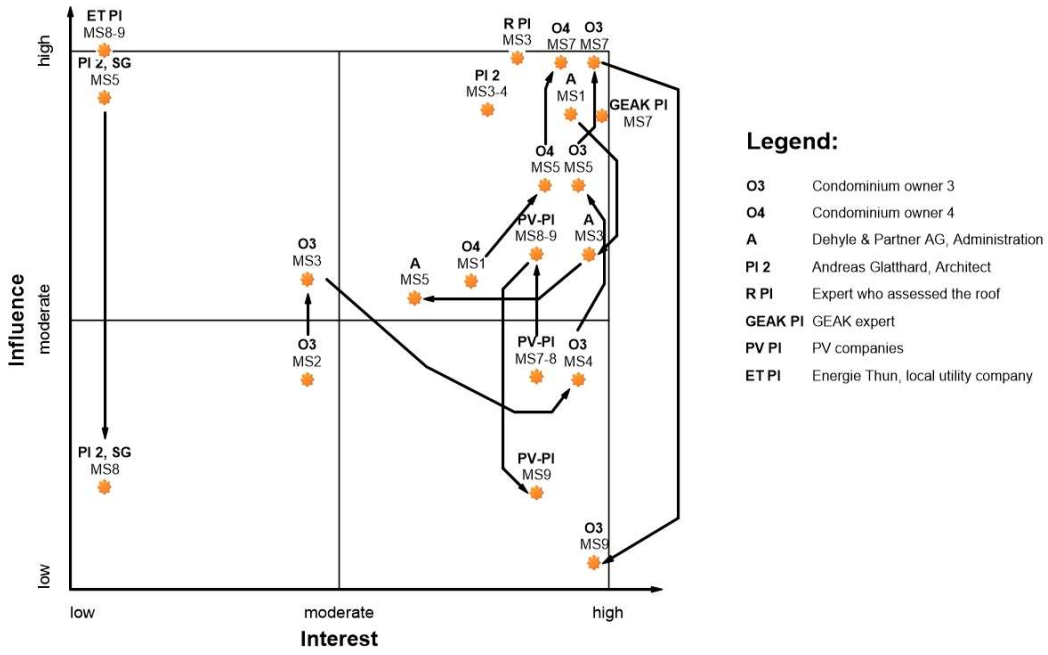

Figure 5-6: Stakeholder mapping of Thun project

5.2.3 Stakeholder mapping conclusion

The analysis of both case studies for conclusions to be drawn about the influence of various stakeholders in both projects to compare them. In both projects it can be noted that the planers had a significant impact on the scope of the project. Be it positive, the GEAK expert pointing out additional measures, or negative, Pl 2 saying that GEAK should not be considered at all for this project.

Moreover, it can be concluded that for any measure that went considerably above what needed to be done that enthusiastic owners were required to investigate the measures. Often those owners had a background that helped them with the measures and/or were willing to invest the time to familiarize themselves with the project. This means that if in other condominium owned residential complexes no owners are available with a background or interest in certain measures that they will not be looked at or installed. Even when necessary repairs are conducted, as seen with the roof renovation in Thun, companies do not point out the GEAK report, which costs can almost entirely can be offset by subsidies.

5.3 Hypothesis testing

This sub chapter, will test the hypotheses which were discussed in chapter 2.2 based on the results of the interview of two case studies, Thun and Rubigen.

5.3.1 Hypothesis 1

Possible subsidies for different measures are not known to condominium owners before the renovation project, which leads to exclusion of measures, especially if the renovation fund cannot cover for measures besides repairs.

This hypothesis focuses on the background and level of information of condominium owners before the PV project started. This fact is important to know as it has a significant impact on the initiation of projects, their scope and the decision making process of the owners.

In Rubigen case study, interviewee O1 had a background in electrical engineering, which increased the owners understanding of the technology. The public discussions around ES2050 awakened O1's interest, causing him to do his own research on PV, which led him to consider PV for the renovation project. During this phase EIV was already known from media and considered for the project. While O2 points out that from the very start of his career as a salesman he was interested in the topic of efficiency which also explains his initial interest in PV when brought up by O1. It can be seen that while there was some previous knowledge of EEMs and RDES, through media, it took the in depth political discussion around ES2050 and the nuclear vote to turn a general passive environmental stance into active interest which led to the project.

Moreover, interviewees agree that the background of O1 helped the project heavily as it allowed O1 and building committee members to talk from a point of strength to other owners because they were sure of their information. This helped to answer critical questions of other owners and alleviate their fears in regards to topic such as electro sensitivity. Pl 1 furthermore argues that due to the knowhow of O1 he needed to give less inputs and information in project Rubigen compared to other PV projects were less knowhow was present at the start. Besides, the enthusiasm of the building committee members was an important factor in pushing the project and informing other owners about PV and its subsidies.

In case study Thun, the interest and background of committee members had a great impact on the result of the PV project, as O3 and O4 had background and interest in these areas. O3 is an

electrical engineer and has some background regarding renewable energies. O4 is originally from Germany where RDES and EEMs are more common than in Switzerland. O4 attitude improved toward renewables due to his previous project experience in installing a solar heater that was a profitable decision.

According to Thun case study, owners claimed that the initial idea of subsidies program and information regarding GEAK report was found mostly by their interest via internet after the roof renovation started and was in progress as they believed that there had to be some subsidies. None of the external companies including Pl 2 provided them any supportive information regarding possible subsidies that could be useful for EEMs and RDES implementation in their condominium complex. Subsidies for PV such as EIV were already known to O3 from a previous project. Furthermore, similar to Rubigen, it was important to talk to other owners informing them about the technology and subsidies in order to gain the votes to move forward with the project.

Concluding from of all these statements, hypotheses 1 is rejected for PV but not for GEAK, as some owners in both condominium complexes were aware of EIV subsidies before starting the PV project. GEAK however was not known to the owners, O4 just assumed at the start that there must be some subsidies as he had heard something about it somewhere. If O4 did not do research GEAK and subsequently press for the GEAK report many possible technologies and measures would have never been discussed, which were discussed in the GEAK report and are still being discussed by the building committee. However, in neither case the costs were a factor for the exclusion of measures, as initially other measures were not considered at all.

5.3.2 Hypothesis 2

In case there are not enough funds saved by the condominium for renovation, the estimated remaining time of each owner is crucial for any energetic renovation.

In Rubigen case study, the renovation fund was not used for the PV project. Most of the owners only invested in the project, because they are planning to own the apartment/s for a longer time and benefit from the ROI of the PV system. Interviewees agree that most owners will own the apartments for 15 or more years. It was further helped by the fact that investors can sell their share of the PV system whenever they want, helping it to frame it as a long term investment.

In project Thun the roof renovation was paid for by the renovation fund that increased its yearly fees in preparation for the roof renovation. During the renovation of the roof it was also decided to look at PV, which was also to be covered by the renovation fund. However, the renovation fund was already depleted for the roof renovation and would have required additional investments. It was seen that apartment owners who are believed to not stay another 15 years or owners who were not willing to put even more money into the fund opposed the measure. Eventually the buildings condominium owners' association voted in a meeting with a 2/3 majority in favour of the PV project. The interviewed owners suggested that due to the low level of annual investment into the renovation fund, the fund was barely able to cover normal repairs. On the other hand, it was expected that most of the owners of this condominium house plan to own the property for at least another 10 years. It can be expected that this fact has positively influenced the attitude towards the PV project, as most owners should benefit from the return on investment for PV installation.

As a consequence of this project owners decided to invest more money in the renovation fund annually, than they invested before the damages to the roof were found.

From these results from two case studies, it is concluded that the estimated remaining time of each owner in the condominium houses has a direct and positive influence on the attitude and investment in PV renovation if owners expect to stay longer than the payback time. Based on these discussions, the second hypothesis is failed to reject and should be further investigated for different measures.

5.3.3 Hypothesis 3

Certain regulations hindered the employment of EEMs and RDES in the studied renovation projects.

In project Rubigen interviewees argued that the effort required to satisfy regulations set by BFE was considerable and more than they expected before the project. Because they decided to not do the project with all owners but only those who wanted, O1 needed to draft additional contracts for the usage of the roof and electricity supply which added to the effort required and even caused delays. However, it needs to be noted that none of the interviewees expected this amount of effort before the project started and therefore did not influence their decision.

Moreover, the effort to apply for the EIV subsidies has been increasing as additional documents need to be supplied by the owners for the application. Furthermore, nowadays only when the project is finished, owners can apply for the subsidy. This causes further delays until the money is eventually paid out and decreases the positive effect of subsidies in the decision making process of a PV project.

In the Thun case study, although the PV project was accepted by owners, it was declined by Energie Thun as it didn't meet the internal guidelines, which were derived from regulation changes in regards to ZEV and PV. Internal guidelines specified that the 10% of the rated power requirement of the electricity net access needed to be met by the PV project for the whole residential complex and not the building with ZEV itself, as the residential complex has one net access point. In order to implement this project, Energie Thun needed to split the access point for each building which they didn't want to do, due to the costs and effort involved.

Interviewees were surprised and disappointed by the decision of Energie Thun and believed that PV project could satisfy the condition set by law as the BFE has also confirmed it. Owners believed that, GEAK is a good subsidies program but mention that for their case it will be difficult to execute all measures needed in time to be eligible for the subsidy.

Overall based on the explanations from both case studies, hypothesis 3 is failed to reject as certain regulations regarding RDES and EEM projects are a burden for EEM and RDES projects. It can be argued in case of PV for the Thun project, that not the regulation itself but Energie Thun's implementation hindered the PV project. Furthermore, it can be argued that for GEAK subsidies it can be difficult to meet all requirements set by authorities to be eligible for subsidies within the time span the cantons allow, especially in cases where the renovation fund is not well enough covered.

It also needs to be noted that for the projects analysed no issues were encountered in regards to law pertaining historic value of building or overall appearance of townscape.

5.3.4 Hypothesis 4

The attitude of certain stakeholders or their social network have a significant impact on possible planning or employment of EEMs and RDES measures.

In order to test this hypothesis interviewees attitude and social network in both projects condominium owners are analysed.

In Rubigen project, all Interviewees expressed, that they are in support of EEMs and RDES as they are an important tool to reduce consumption and do something for the environment.

Besides, interviewees had very different opinions on what caused their initial interest for PV. For O1 public discussions around ES2050 awakened his interest, causing him to do his own research which may have been helped by his background in electrical engineering. While O2 points out that from the very start of his career as a salesman he was interested in the topic of efficiency which also explains his initial interest in PV when brought up by O1. Furthermore, both owners mention that their interest was further helped by discussions with people who already installed PV. Therefore, it can be seen that the social network outside the residential complex helped interviewees to make their decision in regards to PV.

Furthermore, it was important for the project to have a core team supporting the project to be successful as a lot of time needed to be spent with possible investors to persuade them and taking their fears. Which is enforced by the statement of Pl 1 that condominium owned projects are more difficult to realise and initiate just due to the number of stakeholders in project where attitudes can differ heavily from owner to owner. Interviewees argue that it was important to actively approach owners to ask them about their concerns and talk to them in person as it helped to get signatures of owners for the roof usage contract, even though they were initially completely opposed to the project.

Therefore, it can be concluded that the social network within the residential complex was an important tool to win over owners for the PV project.

In Thun case study the attitude, interest and background of committee members had a great impact on the result of the PV project as well, as O3 and O4 had background and interest in these areas. O3 is an electrical engineer. O4 is originally from Germany where RDES and EEMs are more common than in Switzerland. Both interviewee mention people talking to them about their positive experience with PV projects.

As it was explained by O3 and O4, in order to have support for the PV and GEAK projects, it was necessary to have face to face conversations with owners before the decision-making committee meeting to win them over for the project. As in these talks owners could better understand the purpose of PV financially, ecologically and the opportune situation with the roof already being accessed for the renovation.

It can be concluded from the explanations above that hypothesis 4 is “failed to reject” as the attitude and social network of stakeholders, within the building and outside, has a significant impact on possible initiation or implementation of RDES and EEM projects.

5.3.5 Hypothesis 5

The general perception of EEMs and RDEs in regard to costs, regulatory and other factors leads to the exclusion of such measures in renovation projects.

Based on Thun case study, Pl 2 believes that PV is an expensive technology, especially considering the whole system and not the panels alone. Furthermore, when asked about possible subsidies he told owners that GEAK is not worth the effort and does not fit for the project, influencing the perception of certain measures and subsidies. Interviewees believe that without subsidies for the GEAK report alone, it would be unlikely that they would have done the report. However, not everything needs to be decided only based on costs, as condominium owned houses decisions is always based on what value and outcome can you get from the investments and efforts.

Both projects mention that the regulatory effort to set up a ZEV is time intensive, which may lead to other people with no background to PV to not consider a ZEV and subsequently PV in condominium owned housing.

According to the experiences made with both projects it can be concluded that hypothesis 5 is failed to reject as the perception of PV and EEMs for some owners in Rubigen and Thun was changed by the discussion around ES 2050 and eventually led to the initiation of the PV projects. Furthermore, the input given by Pl 2 in regards of PV changed the perception of owners negatively.

6 Discussion of results

The main purpose of this paper has been to analyse the decision making process in renovation projects of condominium owned housing.

Criteria for success and failure

In both case studies the projects were initiated by owners, in Thun by reports about roof damages and in Rubigen due to the interest of O1. Furthermore, the PV and GEAK projects were initiated as well by O3 and O4. During the projects, especially in their initiation and planning phase it was important to have building committee members talking to other owners to win them over for the projects, this was seen as essential in both case studies. From that it can be concluded that one of the main driving factors is the enthusiasm and interest of single owners who feel confident to initiate a project which is a criteria for success.

In the Thun project subsidies for the roof, in the form of GEAK, were not known for a long time and not considered even after experts and Pl 2 were asked about possible subsidies. Pl 2 suggested that the subsidies program requires too much effort and is not suitable for the project, which would have almost stopped any effort for GEAK if O4 had not done some additional research. From that it can be concluded that planers and experts have a strong impact on the possible scope of projects and should be won over to promote measures such as GEAK reports, which are themselves subsidised.

The renovation project in Thun was started by the property administrator of the residential complex, Deyhle & Partner AG, on basis of reports by owners, furthermore they supported the project in Rubigen by organising meetings, gathering tenders and offering to do the billing for the ZEV's for free. It can be seen that A accumulated knowledge regarding EEMs and RDES within their company with projects like the ones analysed here. A also suggested that they want to create investment plans for the properties they manage to make owners more aware of possible costs. It can be concluded from their attitude and the influence they had on the project that A is an essential part of renovation projects in condominiums and can have positive or negative impact on projects and is therefore a criteria for success or failure.

For PV, the legal structure of Rubigen's ZEV is very interesting as it allows owners who want to invest to do so, while others only need to agree to the roof usage. For owners who do not invest nothing changes as the same prices as with the local utility apply. While investors are paid out the profit and are able to sell their shares, if they want to, or can keep them even if

they move away. This allows the project to be seen as a profitable long term investment. This approach as indicated by the case studies seems to be the better approach compared to a construction forced by vote for the social network within the residential complex. Therefore, it is concluded that the question of who pays for the PV project and how is a major factor for success of the project.

The law states, as described in the literature review, that the PV system needs to reach 10% of the ZEV's rated power of the net access. This law is interpreted by the various utilities differently as shown by the two case studies and were the reason that PV could not be built in Thun. Therefore, it can be seen that attitude of utility companies is a critical criteria for success or failure.

Additional uncovered costs were one of the main reasons owners in Thun were against the PV project, as the renovation fund was already depleted by the roof renovation, with interviewees suggesting that the yearly renovation fund fees were too small before the roof damages were discovered. It was also discussed that O4 owns an apartment in another condominium owned building which had considerably higher renovation fund fees. This led the owners to decide more easily for EEMs as the money in the renovation fund is already gone from their bank account and is appraised differently compared to the money that owners would have needed to pay extra into the renovation fund for PV in Thun. Therefore, it is concluded that the funding for the renovation fund can impact the overall scope of a project and even stop it if the fund is not sufficiently covered for the measures.

The following section will discuss similarities of findings and the literature used for the hypotheses.

Literature

At the start of the project the various hypotheses were formed on the basis of initial suspicion and inputs from literature. This literature was exclusively focused on the house owners sector, as research for condominium owned housing, which would have been relevant to the research, could not be found. From the testing section of the hypotheses it can be concluded, while the case of normal house owners and condominium owners cannot be compared directly, that processes are similar, although on different scales.

A condominium owner project compared to a house owner one requires more time in the initiation and planning phases to win over owners and finalise the project, but is more or less the same when it comes to the execution phase. Except for PV where a ZEV needs to be created,

which causes additional effort to draw up all the contracts and necessitates discussions with the local utility. The following section will discuss limitations of this paper.

Limitation of the research

This section will talk about the limitations given by the methodology as well as by the case studies investigated. The research is based in initial hypotheses on why EEMs and RDES are less often installed for condominium owned projects. By using hypotheses, a certain focus is casted which can limit possible outcome as the focus may be on factors that were not as important as other not researched ones. The semi structured interviews allow to ask additional questions or change the order of the questions actively during the interview. However, there are certain downsides to this method as certain statements cannot be verified by other owners as the question was not asked. The comparison of the various statements made by the interviewees is based on the interpretation of the author, which may be influenced by biases. Furthermore, it can be argued that sampling two case studies is not sufficient to conclude for all the condominium owned residential housing in Switzerland as the analysed projects might be outliers. Additionally, the interviews were conducted in German while the research paper is written in English which can lead to statements not being translated one to one, which may influence findings.

The case studies themselves are, as described by Pl 1, at least for their PV projects outliers as O1 and O3 had a background in electrical engineering and took over the lead for the PV projects. Compared to other cases, Pl 1 argued, he needed to give less inputs and information. Furthermore, it allowed O1 to talk to other owners with his expertise supporting him, helping to clear otherwise difficult questions or worries. The interviewees were chosen by asking O1 and O3 for contacts in both projects, which is in itself a factor limiting results as only 2 owners could be interviewed within the limited scope and time of the project. The owners interviewed all supported the measures and were part of the building committees. This can cause statements in regards to the rest of the owners to be distorted by bias. Furthermore, the interviews were conducted after the projects which may cause issues in regards to the reliability of statements made about the past. A further limitation given by the case studies is the canton, both projects were in the canton of Bern, this is important to consider as subsidies programs and regulations differ between cantons.

It can be argued that one of the biggest limitations was the short period of time allocated for this research. By having more time, additional case studies could have been acquired and more stakeholders interviewed.

The results of this study can be taken as an indication for how EEMs and RDES projects can be approached in condominium owned buildings and residential complexes in Switzerland.

7 Conclusion and Recommendations

The main purpose of this paper was to analyse the decision making process in renovation projects of condominium owned housing focusing on EEMs and RDES. This was done to identify criteria for success or failure of such projects. Two case studies were acquired and studied, a PV project in Rubigen and a roof renovation plus PV project in Thun. It was found in these specific case studies that the background and interest of owners in regards to EEMs and RDES are paramount in initiating such projects. Furthermore, it was found that the GEAK report led to the consideration of many measures, of which some are still being discussed. However, planer and experts do not mention or push the GEAK report even though there are subsidies for the report and the report may lead to a bigger scope of the project. However, several limitations shall be noted.

Due to the limited scope and time limitations set by the projects it was not possible to acquire more case studies and evaluate them. As interviewees were asked about their past, the statements may be influenced by bias and may be distorted by time. Additionally, the interviews were conducted in German while the research paper is written in English which can lead to statements not being translated one to one, which may influence findings. Although the two projects were condominium owned projects Pl 1 indicated that they may be outliers in the fact that they had an owner being an electrical engineer initiating the PV project which helped in the initiation and decision making process.

Despite the limitations, findings from this study can be applied to help realising EEMs and RDES renovation projects in condominium owned buildings and residential complexes. Therefore, this study can provide answers to its research question and hypotheses.

There is still a need for future research as due to the small sample size of this study the results are not conclusive for the population of condominium housing. For a future research project it is advised to increase the sample size to increase reliability of the results. Furthermore, it may be interesting to accompany a renovation project with EEMs or RDES in real time to see how attitudes, interests and other factors changed over time as it would allow for a more in depth analysis, which avoids the issue of interviewees answering unintentionally unreliably about their attitude and other factors before or during the project.

This paper with its focus on condominium owned housing can contribute to the overall discussion of the implementation of EEMs and RDES, as its main focus group is underrepresented in research. Furthermore, the findings of this research may have positive

implications for the future research of EEMs and RDES and their implementation in the condominium housing sector.

On basis of the findings it is recommended to increase information efforts in regards to subsidies and the GEAK report, focusing on architects, civil engineers and construction companies, such as tinsmiths and roofing contractors to improve the rate of employment of EEMs and RDES. As seen in the case studies analysed the given recommendation of an expert can be the deciding factor for or against additional measures.

As identified in this paper the regulatory effort for ZEV is seen as too high and could lead to bad word of mouth. Therefore, it is advised for interest groups such as Swisssolar to create checklists and standard forms for contracts to support projects and reduce the effort required.

It is recommended for PV projects that if there cannot be found a consensus with all owners to invest via renovation fund, the structure should be changed to a ZEV in which only owners invest who want to invest. Subsequently the other owners only need to agree to be supplied by the ZEV and agree to its usage of the roof. This can lead to a higher acceptance of the project.

For lawmakers it is suggested to prolong the time span in which requirements set by the GEAK report can be fulfilled as it would allow for condominium complexes, especially ones with lower funding, to employ EEMs and RDEA over time and reap the benefit of the subsidies.

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9 Appendices

In the electronic appendix electronic versions of the document and additional material is provided, the coded interviews will only be available on the electronic appendix which can be found on the ILIAS platform.

A. Interview questions

1 Interview

Guten Tag Herr/ Frau xxx

Gerne möchte ich mich bei Ihnen schon im Voraus für dieses Interview bedanken.

Wie sie eventuell schon wissen ist dieses Interviewteil meiner Bachelorarbeit welche ich zusammen mit der Hochschule Luzern, Technik und Architektur. Meine Arbeit befasst sich mit energetischen Renovation bei dem es mehrere Stakeholder gibt wie Baugenossenschaften oder Stockwerkeigentum. Dabei konzentriere ich mich auf den Entscheidungsfindungsprozess. Ich will mit diesem Forschungsprojekt Kriterien und Barrieren identifizieren welche bei einer erfolgreichen Implementierung von energetischen Sanierungen.

Zu meiner Person, ich studiere den Bachelor Studiengang Energy Systems Engineering und schließe nächsten Sommer ab und schreibe in diesem Zusammenhang meine Bachelorarbeit.

Mit Ihrer Zustimmung würde ich gerne, dass Interview aufnehmen. Das erlaubt mir die Resultate des Interviews, Ihre Antworten, genauer zu identifizieren zusammen mit den Notizen die ich machen werde. Auf Ihren Wunsch kann das Interview und Ihre Person in der Arbeit anonymisiert werden. Die Audio-Datei wird nicht veröffentlicht und falls gewünscht schicke ich Ihnen die Teile der Arbeit zur Durchsicht in welcher sie erwähnt werden.

1.1 Generelle Fragen

1.1.1 Bitte erzählen sie mir wie das Rennovationsprojekt ablief von der Idee, zu Ihrem ersten Kontakt bis zum Abschluss der Arbeiten. (War xxx der Auslöser)

1.1.2 Was ist Ihre persönliche Einstellung zu erneuerbaren Energien und Energieeffizienzmassnahmen?

1.1.3 Hat sich Ihre Einstellung zu Energieeffizienzmassnahmen und erneuerbaren Energien geändert nach Abschluss der Arbeiten?

Figure 9-1: Interview questionnaire page 1

1.1.4 Wurde zu Beginn des Projektes energetische Massnahmen angedacht, welche Massnahmen zogen sie in Betracht?

1.1.5 Wurden Massnahmen verworfen im Verlauf des Projektes oder kamen gar neue dazu?

1.1.6 Warum entschieden sie sich für die gewählte Massnahme?

1.1.7 Was versprachen sie sich von den Massnahmen die durchgeführt wurden?

1.1.8 Wurden diese Erwartungen an die Massnahmen erfüllt?

1.1.9 Wie war das Vorgehen bei der Vergabe der Arbeiten? (Direkt Vergabe, mehrere Offerten etc.) (Gab es infolge der Offerte(n), Kostenvoranschlags Anpassungen bei den energetischen Massnaahmen?)

1.1.10 Gab es etwas das sie überraschte?

1.1.11 Ab welchem Zeitpunkt wurden Subventionen in Betracht gezogen und von wem?

1.1.12 Woher bekommen sie Ihre Informationen?

Figure 9-2: Interview questionnaire page 2

1.1.13 Wie gross war der Einfluss der nachfolgenden Faktoren auf Ihre Entscheidung? (Evtl. als bestenliste)

	Sehr wenig Einfluss			Sehr viel Einfluss
Investitionskosten	☐	☐	☐	☐
Amortisationsdauer	☐	☐	☐	☐
Bestimmungen und Gesetze	☐	☐	☐	☐
Subventionen (verweis Literatur)	☐	☐	☐	☐
Wohndauer	☐	☐	☐	☐
Wohnkomfort	☐	☐	☐	☐
Prognostizierte Bauzeit	☐	☐	☐	☐
Informationen der Firmen	☐	☐	☐	☐

1.1.14 Inwiefern wurden Mieter in das Projekt integriert?

1.2 Stockwerkeigentümer Spezifische Fragen

1.2.1 Gab es Miteigentümer die hervorstachen zum Beispiel durch Ihren Enthusiasmus?

1.2.2 Wie viele Jahre planen sie noch in dieser Wohnung zu leben?

	5	10	20	20+
Jahre	☐	☐	☐	☐

1.2.3 Ist der Erneuerungsfonds aus Ihrer Sicht ausreichend gedeckt? (falls nein Hatte die Diskussion rund um das Thema Kostensplitting einen Einfluss auf Ihre Entscheidung?)

Figure 9-3: Interview questionnaire page 3

1.2.4 Wie gross war der Einfluss auf das Projekt der nachfolgenden Stakeholder?

	Sehr wenig Einfluss			Sehr viel Einfluss
Verwaltung	☐	☐	☐	☐
Unternehmung	☐	☐	☐	☐
Eigentümerschaft	☐	☐	☐	☐

1.2.5 Wer trieb das Projekt voran?

	Sehr wenig Interesse			Sehr grosses Interesse
Verwaltung	☐	☐	☐	☐
Unternehmung	☐	☐	☐	☐
Eigentümerschaft	☐	☐	☐	☐

1.3 Baufirmen/Installateure spezifische Fragen

1.3.1 Welche energetischen Optionen haben sie offeriert?

1.3.2 Haben sie auf andere Optionen hingewiesen, für welche sie evtl. auf Subunternehmer angewiesen wären?

1.3.3 Weisen sie Ihre Kunden auf mögliche Subventionen oder Steuerabzüge hin welche durch eine Rennovation entstehen können?

1.3.4 Helfen sie Kunden aktiv bei der Beantragung der Subventionen?

1.3.5 Ziehen Ihre Offerten Subventionen in die Berechnung mit ein, etwa mit Varianten, wenn ja wieviel Varianten schlagen sie vor? (Berner Förderprogramm)

1.4 Möchten sie noch etwas erwähnen?

Figure 9-4: Interview questionnaire page 4

B. Rubigen data sheets

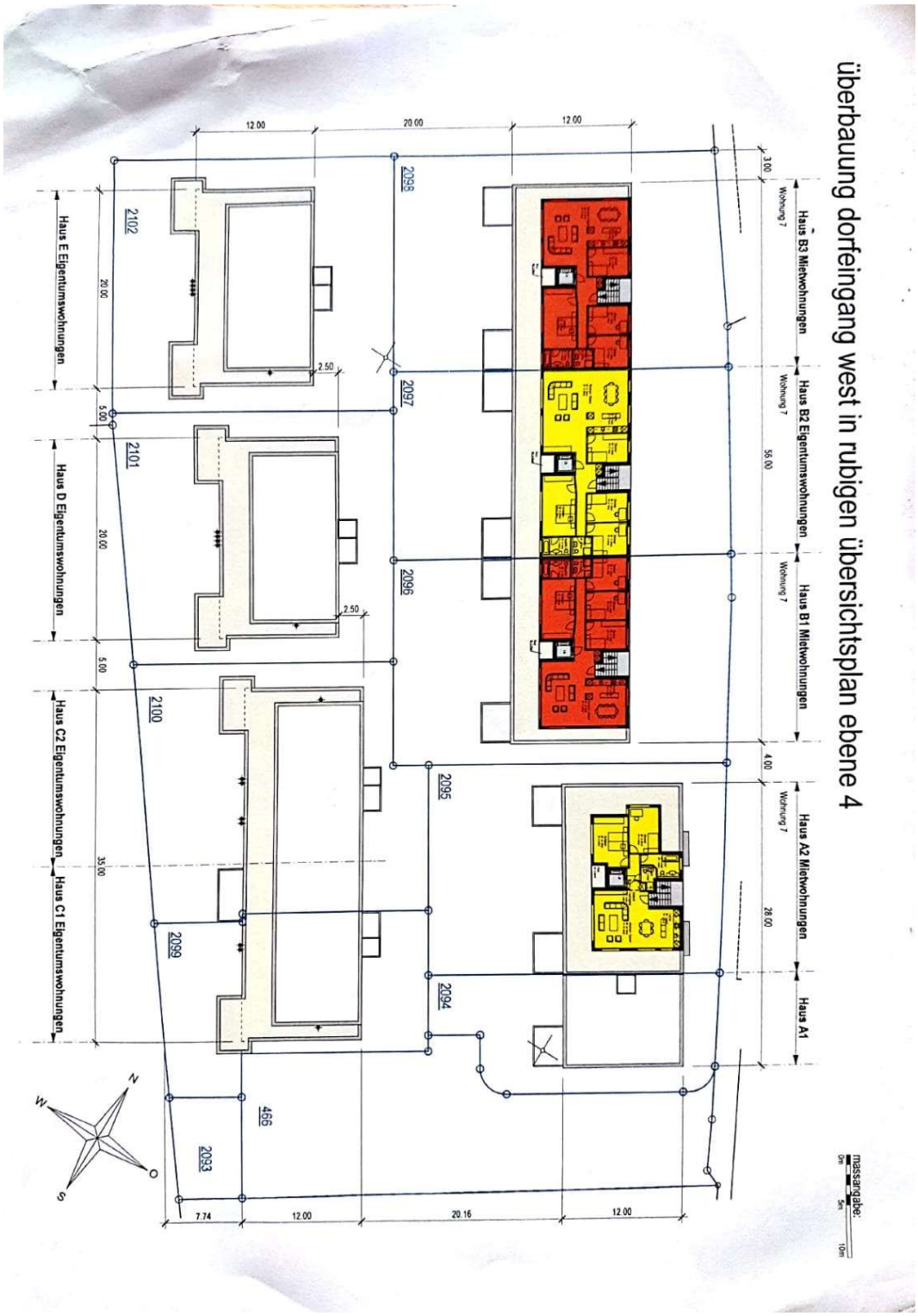


Figure 9-5: Situation residential complex "Rubigen West"

Siedlung Rubigen West Projekt Photovoltaik

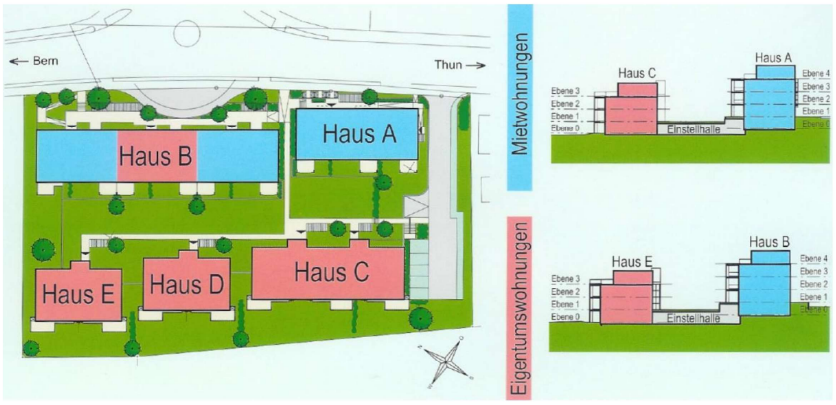
Photovoltaik Anlage für die Wohnüberbauung

Bernstrasse 1 – 17, 3113 Rubigen

Erstellung der Siedlung 2006 / 2007

Die Siedlung „Rubigen West“ besteht aus
5 Wohnblöcken mit total 48 Wohneinheiten und einer Einstellhalle

Die einzelnen Stockwerkeigentümer Gemeinschaften STWEG und Mietobjekte teilen sich wie folgt auf:
- Haus A1 Bernstrasse 1 = 2 Wohneinheiten aufgeteilt in 2 x 3.5Zi
- Haus A2 Bernstrasse 1a = 7 Wohneinheiten aufgeteilt in 1 x 2.5Zi, 1 x 3.5Zi, 4 x 4.5Zi, 1 x 3.5Zi Attika
- Haus B1 Bernstrasse 5 = 7 Wohneinheiten aufgeteilt in 2 x 3.5Zi, 4 x 4.5Zi, 1 x 5.5Zi Attika
- Haus B2 Bernstrasse 7 = 7 Wohneinheiten aufgeteilt in 2 x 3.5Zi, 4 x 4.5Zi, 1 x 5.5Zi Attika
- Haus B3 Bernstrasse 9 = 7 Wohneinheiten aufgeteilt in 2 x 3.5Zi, 4 x 4.5Zi, 1 x 5.5Zi Attika
- Haus C1 Bernstrasse 11 = 3 Wohneinheiten aufgeteilt in 2 x 5.5Zi, 1 x 4.5Zi Attika
- Haus C2 Bernstrasse 13 = 5 Wohneinheiten aufgeteilt in 2 x 4.5Zi, 2 x 5.5Zi, 1 x 4.5Zi Attika
- Haus D Bernstrasse 15 = 5 Wohneinheiten aufgeteilt in 2 x 3.5Zi, 2 x 4.5Zi, 1 x 4.5Zi Attika
- Haus E Bernstrasse 17 = 5 Wohneinheiten aufgeteilt in 2 x 3.5Zi, 2 x 4.5Zi, 1 x 4.5Zi Attika



Bauweise der Siedlung / Häuser:
Betonbau und Mauerwerk mit Aussenwärmedämmung 12cm und Verputz gestrichen
Gebäude mit begrüntem Flachdachaufbau.

25.07.2017 / Beat Gerber, Verantwortlicher Technik Seite 1

Figure 9-6: Rubigen West data sheet Nr. 1

Siedlung Rubigen West Projekt Photovoltaik

Die Heizungs-Anlage besteht aus einem zentralen Öl-Heizkessel und einer Grundwasser-Wärmepumpe.
Elektr. Energie Verbrauch der Siedlungs-Wärmepumpe = ca. 65'000 kWh p.a.
Elektr. Stromverbrauch der Siedlung / Einstellhalle (ohne Wohnungen) = ca. 23'500 kWh p.a.

Fotos und Ansichten der Siedlung

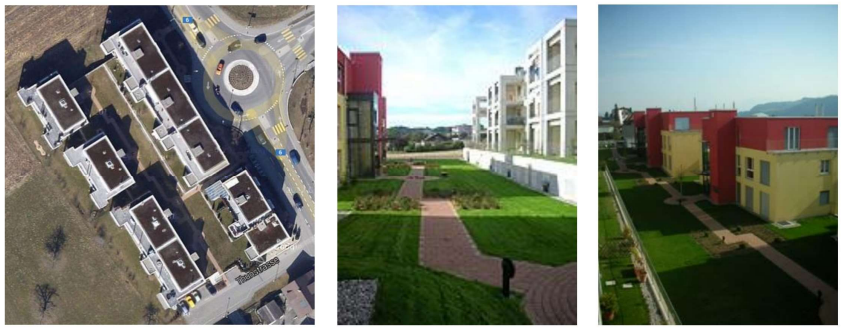


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Figure 9-7: Rubigen West data sheet Nr. 2

Siedlung Rubigen West Projekt Photovoltaik

Übersicht Stromverbrauch und PV Potenzial

	Stromverbrauch kWh pro Jahr	Kosten kCHF pro Jahr	Mögliche PV Fläche in m2	PV Potenzial kWh/Jahr
Siedlung Wärmepumpe	65'000	12.00		
Siedlung Heizung & Pumpen	17'500	4.40		
Siedlung Aussen	2'000	0.40		
Siedlung Einstellhalle	4'000	0.90		
Siedlung Total	**88'500**	**17.70**		
Bernstrasse 1 Wohnungen	5'000	0.90		
Benstrasse 1 Allgemein	1'000	0.20	41	5'819
Bernstrasse 1a Wohnungen	17'500	3.00		
Bernstrasse 1a Allgemein	3'500	0.60	65	9'144
Haus A Total	**27'000**	**4.70**	**106**	**14'963**
Bernstrasse 5 Wohnungen	17'500	3.00		
Bernstrasse 5 Allgemein	3'500	0.60	88	12'469
Bernstrasse 7 Wohnungen	17'500	3.00		
Bernstrasse 7 Allgemein	3'500	0.60	100	14'131
Bernstrasse 9 Wohnungen	17'500	3.00		
Bernstrasse 9 Allgemein	3'500	0.60	88	12'469
Haus B Total	**63'000**	**10.80**	**276**	**39'069**
Bernstrasse 11 Wohnungen	7'500	1.30		
Bernstrasse 11 Allgemein	1'500	0.30	53	7'481
Bernstrasse 13 Wohnungen	12'500	2.20		
Bernstrasse 13 Allgemein	2'500	0.40	88	12'469
Haus C Total	**24'000**	**4.20**	**141**	**19'950**
Bernstrasse 15 Wohnungen	12'500	2.20		
Bernstrasse 15 Allgemein	2'500	0.40	82	11'637
Haus D Total	**15'000**	**2.60**	**82**	**11'637**
Bernstrasse 17 Wohnungen	12'500	2.20		
Bernstrasse 17 Allgemein	2'500	0.40	82	11'637
Haus E Total	**15'000**	**2.60**	**82**	**11'637**
Gesamt TOTAL	**232'500**	**42.60**	**687**	**97'256**

Anmerkungen:
- Verbrauchswerte wurden ermittelt und geschätzt aufgrund von Vergangenheitswerten
- Das Photovoltaik Potenzial ist auf der Basis des Solarrechners «Energie Schweiz» gerechnet
- Die Investition der gesamten Anlage wird auf 275 bis 300 kCHF geschätzt

25.07.2017 / Beat Gerber, Verantwortlicher Technik Seite 3

Figure 9-8: Rubigen West data sheet Nr. 3

Rubigen West

Photo Voltaik Anlagen

Kennzahlen PVA
Messdaten Zähler

Grunddaten der PV-Anlage

5 STWEG Gemeinschaften mit 25 Wohnungen + Allgemeinstrom
4 ZEV wurden gebildet mit Privatzählern
12 Eigentümer haben total 120 kCHF investiert
144 PV Panels mit einer Fläche von 235 m2 sind installiert
Die Leistung der Anlage beträgt 44 kWp
Die geplante Energieproduktion pro Jahr beträgt 37'500 kWh
Der kalkulierte Eigenverbrauchsanteil beträgt 50%

Figure 9-9: Rubigen West PV project overview

C. Thun data sheets

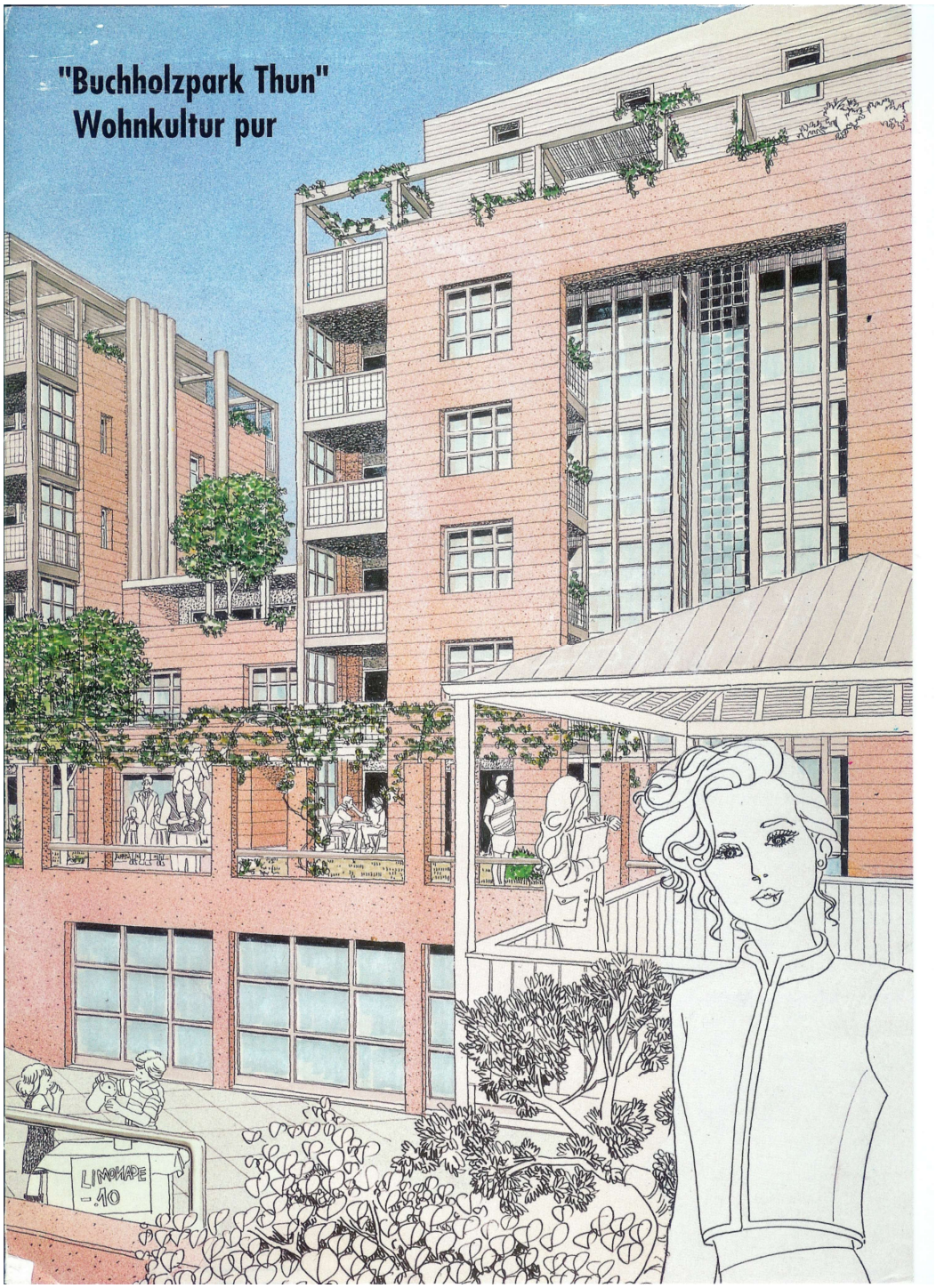
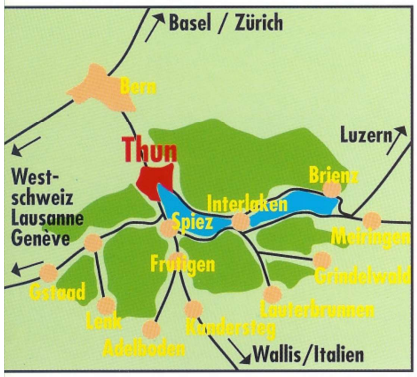


Figure 9-10: Buchholzpark Thun info sheet Nr. 1

Thun inklusive:

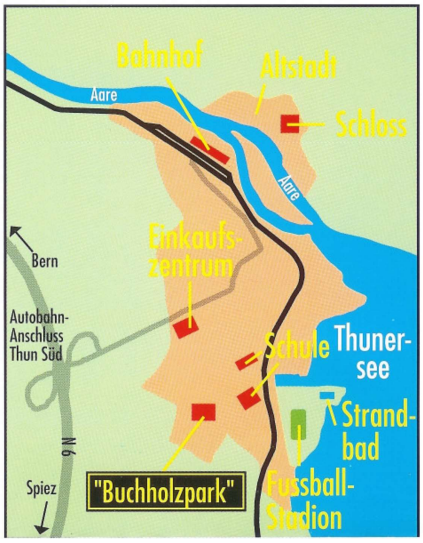
- Die alte und gemütliche Innenstadt mit der schönen Hauptgasse, dem Schloss und dem romantischen Rathausplatz
- Die äusserst gute Verkehrslage am Eingang zum Berner Oberland



- See und Berge in unmittelbarer Nähe
- Sommer- und Winterkurorte wie Grindelwald, Wengen, Mürren, Kandersteg, Adelboden, Lenk und Gstaad sind in weniger als einer Autostunde zu erreichen
- An der internationalen Eisenbahnlinie Bern–Lötschberg–Simplon gelegen. Bern ist nur 20 Bahnminuten entfernt
- Freizeit-, Sport- und Spielanlagen sind reichlich vorhanden
- Naherholungsgebiete sind per Rad, Bus, Bahn oder Auto leicht zu finden
- Theater, Konzerte und Vorträge finden regelmässig statt
- Festivals, Jahresfeste und sportliche Anlässe sind hier bereits Tradition
- Handwerk, Gewerbe und Industrie bieten vielseitige Erwerbsmöglichkeiten

"Buchholzpark" inklusive:

- **Verkehr**
  Die Bushaltestelle liegt vor der Haustüre. Sieben Busminuten bis zum Bahnhof. Eine Autominute zum Autobahn-Anschluss Thun-Süd
- **Schulen**
  Kindergarten, Primar-, Sekundar- und Gewerbeschule sowie ein Gymnasium liegen im Umkreis von 1 bis 3 km
- **Einkaufen**
  Von der kleinen Boutique über Detail- und Spezialgeschäfte bis zu den nahe liegenden Einkaufszentren ist das Angebot attraktiv
- **Freizeit und Sport**
  Der See als Segel- und Surfparadies sowie Strandbad, Tennisplätze und -hallen, Reithalle, Kunsteisbahn, Fussballstadion, Turnhallen, Wanderwege und Vita-Parcours sind in weniger als fünf Fahrminuten zu erreichen
- **Kunst und Kultur**
  Konzerte, Kleintheater, Museen und Galerien, Kursaal, Volkshochschule, Vorträge, Tanz- und Sprachkurse – das Angebot ist vielschichtig – es steht jedem frei, die Rosinen herauszupicken



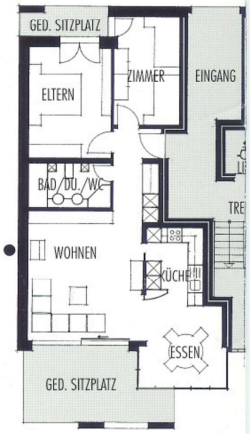
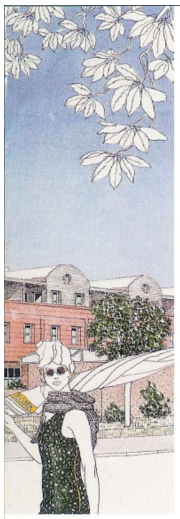


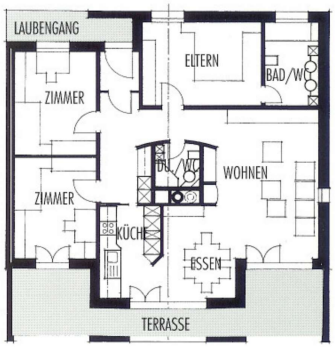
Figure 9-11: Buchholzpark Thun info sheet Nr. 1



Der "Buchholzpark" hat viel zu bieten:

- Die Siedlung ist in sich geschlossen mit einem eigenen, unverwechselbaren Charme
- Freizeitzonen sowie ein Forum – offen und gedeckt
- Kinderspielplatz, Hartplatz und Rasenspielplatz ermöglichen den Kleinen wie den Jugendlichen attraktive und sinnvolle Freizeitgestaltungen
- Freizeitgärten lassen Blumen- und Gemüsefreunde ihr Hobby voll ausleben
- Private Gärten und gedeckte Sitzplätze bilden den Privatbereich des Eigentümers
- Die Wohnungen zeichnen sich innen wie aussen durch neuzeitliche, moderne Architektur aus
- Moderner Ausbau, gepaart mit hohem Komfort. Wohntürme mit rollstuhlgängigem Lift

- Der "Buchholzpark" bietet ein vielseitiges Angebot verschiedener Wohnungstypen:
  - 1 1/2 Zimmer-Wohnungen
  - 2 1/2 Zimmer-Wohnungen
  - 3 1/2 Zimmer-Wohnungen
  - 4 1/2 Zimmer-Wohnungen
  - 4 1/2 Zimmer-Penthouses
- Wohn-, Ess- und Schlafräume sind geräumig konzipiert
- Balkone und Terrassen sind grosszügig angelegt
- Erdgeschosswohnungen mit eigenem Rasenplatz zur alleinigen Nutzung
- Fitness-, Sauna-, Party- und Gemeinschaftsräume stehen zur freien Verfügung
- Zu jeder Wohnung gehört ein eigener Wasch- und Kellerraum
- Die Nutzung von Alternativ-Energie ist vorgesehen



Bauherr Kurt Zimmermann, Thun

Verkauf und Beratung

CASA
Immobilien AG
Burgstrasse 18
3600 Thun
Telefon 033 22 66 55
Telefax 033 22 66 51

Architekt Viktor Burri AG
Architekten
Kasernenstrasse 41
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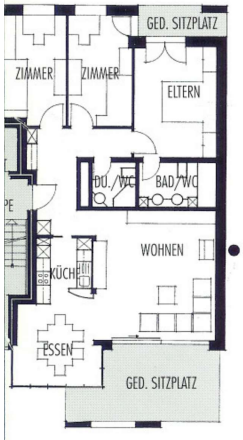

Figure 9-12: Buchholzpark Thun info sheet Nr. 1

D. Coding

Attitudes

This subgroup codes all the statements in regard to the stakeholders' tendency, attitude and conviction.

Circumstances

Circumstances-Social Network

This subgroup codes all the interactions between owners and people from their social network during, before and after the project that may have had influence on the results.

Circumstances-Remaining Time

This subgroup codes all the statements to how long owners plan to own the condominium apartments.

Circumstances-Knowhow

This subgroup codes all the statements in regard to the background or knowhow of the owners that had an influence on the project.

Perception

Perception-Financials

All statements in regard to, how the financials were perceived or how was the impression of the financial aspects during, before and after the project.

Perception-Subsidies

All statements in regard to, how subsidies were perceived or impressions of stakeholders regarding subsidies during, before and after the project are coded based on this title.

Perception-Technology

All statements in regard to, how the various technologies were perceived during, before and after the project are coded based on this title.

Perception-Regulations

All statements in regard to, how the various regulations relating to the project were perceived or the impression of stakeholders regarding regulations are coded based on this title.

Information

Information-Regulations

This subgroup gathers all the statements, in regard to how and where information was gained on regulations.

Information-Technology

This subgroup gathers all the statements, in regard to how and where information was gained on technology.

Information-Subsidies

This subgroup gathers all the statements, in regard to how and where information was gained on subsidies.

Regulation/ Subsidies

R/S-Changes

Any rules, regulations or subsidies that were changed before and during the project that had an impact are mentioned by this sub group.

R/S-Effort

All statements in regards to efforts that need to be made, in order to satisfy the regulations, subsidies and respective laws should be analysed based on this subgroup.

R/S-Implementation

Statements that describe how regulations and subsidies were implemented and their influence on the project.

Finances

Financials-Offers

This subgroup gathers all the relevant information regarding the offers, tenders, call for tenders.

Financials-Uncovered Costs

This code includes statements in regards to all the costs during the project that are not covered.

Financials-Subsidies

All information regarding the financial aspects of subsidies relevant to the case are coded by this title.

Financials-Renovation Fund

All financial aspects connected to the renovation funds are grouped by this title.

Project

Project-Timeline:

This subgroup shows the milestones of the case studies.

Project-Scope:

This subgroup shall include only statements and information that had an impact on the scope of the project, meaning where additional measures were thought of, excluded or changed.

Project-Companies:

This subgroup includes the information of all the external companies that have influence on this project.

E. Rubigen interview comparison tables

Table 9-1: Project Rubigen Attitude

Attitude	Condominium Owner 1 (O1)	Condominium Owner 2 (O2)	Deyhle & Partner AG (A)	Elektrobedarf Troller (Pl 1)
1.1.1	In O1's opinion RDES need to be financially sound to justify the investment to himself. He thinks that EEMs and RDES are an important thing to do against climate change etc. but it cannot be based entirely on conviction.	O2 has a good attitude towards EEMs and RDES if they make sense in various ways such as financial etc.	A has a positive attitude towards renewables as company but also as a private person.	"Our design philosophy is to avoid any shadowing of PV panels caused by objects on the roof, by placing the panels strategically, this allows us to maximize profit versus investment."
1.1.2	O1 thinks that his attitude is very positive towards EEMs and RDES, ever since discussions around ES2050 and other similar topics awakened his interest. His initial interest may also be partially due to the fact that he studied electrical engineering.	O2 suggests that he always had a flair for efficiency, in his job as a Swiss wide salesperson he tried to plan, as much as possible, to optimize driving routes and meetings dates to increase efficiency (further helped by company policy which defined a monthly budget of km salespeople were paid for).		
1.1.3	O1 suggests that after project ended his opinion of EEMs and RDES got even better, leading O1 to telling other people about the PV project, trying to convince them that EEMs and RDES are a good thing for the environment and are also financially sound investment. O1 offered other condominium owned residential complexes to help them with planning etc. for PV. As he thinks many condo owners in other residential complexes fear the effort that needs to be made and may not have the background to do it.	Due to the various trade fairs and the knowledge gained through talks with PV companies, O1 and experts the general attitude of O2 towards EEMs and RDES has improved further.	A suggests that their attitude improved towards projects like these after the successful project and with the knowledge and experience gained from this project they are more likely to suggest such projects to other condos.	Pl 1 claims that the initial feedback after the project finished is quite positive, which may be partially caused by the especially sunny summer which delivered more electricity than expected so far.

1.1.4	O1 thinks that arguments like: "I'm too old" or "I'm already 65" do not count as the payback time often is short enough to give a positive ROI.	An afterthought of O2 that influenced his decision making slightly was that the residential complex and the apartments themselves increase in value and keep or increase overall value in the future and will be part of the inheritance to their kids.	A suggests that such projects should be more viable in condominium owned buildings/ residential complexes with a lower average age, as the topic may be a bit closer to the stakeholders in general.	
1.1.5		O2 thinks that it is important that it is not expected that everyone who initially had interest will eventually sign and invest. Furthermore, this should not be taken as a negative sign for the project, at the end it only matters that the signature on the contracts are enough to proceed and that the others signed the roof usage contract.	A personal attitude towards EEMs and RDES is that projects such as PV in Rubigen are a good idea, even if not all stakeholders can participate or pay the same amount due to various circumstances.	

Table 9-2: Project Rubigen Circumstances

Circumstances	Condominium Owner 1 (O1)	Condominium Owner 2 (O2)	Deyhle & Partner AG (A)	Elektrobedarf Troller (Pl 1)
1.2.1	O1 plans to life at least another 20 years in the apartment.	O2 states that he plans to own the apartment at least another 15 years. According to O2 Some of the very old owners, around 90 years old, invested into the projects because they wanted to do something good and they had the money. O2 estimates that the average age of the owners is lower compared to other condominium owned residential complexes, but there are no kids.	A estimates that a larger part of owners will live or own the condos for longer than 15 years. A thinks that the remaining time owners planed owning the apartments may not have had a big impact, as most will likely stay for a long time.	Pl 1 estimates that most owners will own the apartments for another 10 to 20 years.
1.2.2	O1 suggest that in many projects condominium owners who do not have the background knowledge of PV or other RDES and EEMs but want to push for such projects may be too insecure in regard to the projects itself, possible questions from other owners and the effort required to pull through with such a project. Furthermore, they may be too insecure of their knowledge to discuss the matter with owners that have initially a bad opinion of the measures, sometimes based on	According to O2 the expertise of O1 was very beneficial for the project.	A did not have prior know how in regard to ZEV but knew some things in regards to PV. A thinks that project Rubigen may be an outliner due to the fact that there were people like O1 and O2 that had some knowledge and expertise and could support and push the project with their knowledge and enthusiasm.	Pl 1 claims that O1 had already a good knowledge basis of PV and had the passion and will to read up on the subject. O1 took the lead for contracts with the owners such as electricity supply contracts and roof usage contracts etc. Pl 1 remarks that other condominium owned PV projects were different compared to Rubigen as the amount of Input and Support required from Pl 1 was higher. Pl 1 explains that O1 was able to support the project in Rubigen heavily

	feelings or wrong data (electro sensitivity etc.) causing them to choke up.			himself and had the project lead due to his expertise.
1.2.3	In O1's opinion it was important for the success of the project to have a core team which worked on the project and helped to push it through, as during the project sometime (possible) investors suddenly wanted to drop out of the project needed to be persuaded again. O1 suggests that the teamwork and the project itself helped for a better team spirit within the residential complex.	O2 suggests that he knew from the start that not every owner needed to invest, only those who want, which allows for a faster process in his opinion which may also increase overall acceptance. O2 states that compared to other PV projects with a single owner it is more difficult and a long process to come to the decision to move forward or not.		Pl 1 suggest that due to the fact of having many owners in a condominium owned property it makes it harder to find a consensus on RDES projects such as PV and battery storage. This is also partially because their backgrounds, their varied age and attitudes differ from each other, this in Pl 1 opinion explains why RDES and EEMs are less often done in condominium owned property.
1.2.4	According to O1 after the first owners' meeting various questions came up from owners such as electromagnetic emissions, impact on taxes, if the installation of PV would damage the roof substance and more, which needed to be addressed in person. O1 was surprised by the amount of effort that was required to talk to every owner in person to win them over for the project or to alleviate fears such as electro sensitivity. O1 suggests that the expert, Mr. Burch, was laying a good basis for the project, as a person who comes outside the social network of the residential complex. according to O1 one condo owner complained, before the system was installed and only the framework was standing, that he had headaches due to electromagnetic emissions etc. The owner initially demanded things such as shielding cables and measure emissions before and after installation, at the end the owner could be persuaded by the building committee to give up his request and alleviated his concerns.	O2 remarks that the building committee asked specifically owners to ask them critical questions at the owners' meeting so that they could answer them and solve those issues before they could cause delays or stop the project or lead to issues within the residential complex. There were some critical questions in regards to radiation and electro smog, which could be answered by the committee members and fears could be alleviated. This was also done to prevent the worst case of having installed the PV system already but not being able to use them due to some issues with other owners.	A suggests that the individual conversations with owners and investors, the information and materials provided by O1 and other supporting members of the building committee, such as O2, were seen as an important factor in the decision making of various initially critical stakeholders who otherwise likely would have voted against the project or not signed the contracts for the roof usage and electricity supply.	

Table 9-3: Project Rubigen Perception

Perception	Condominium Owner 1 (O1)	Condominium Owner 2 (O2)	Deyhle & Partner AG (A)	Elektrobedarf Troller (Pl 1)
1.3.1	In O1's opinion there need to be owners in other condominium owned objects that are convinced of RDES/EEMs and do put effort into communication and planning to successfully launch and complete a project.	In O2s opinion it was interesting to see when the idea was initially proposed at the owners' meeting that there were few skeptics and a lot of owners who thought it was a good idea, however when it came to commit some of them did not join the effort who before claimed interest in the project		
1.3.2	In O1's opinion RDES need to be financially sound to justify the investment to himself. He thinks that EEMS and RDES are an important thing to do against climate change etc. but it cannot be based entirely on conviction.	In O2's and O1's opinion initial calculations by O1 were very conservative, even more so when later on BKW announced that they would pay now more for PV electricity. O2 thinks that calculating conservatively allows to keep expectations in check and if investors then see that the payback time is even better than calculated they will feel better, compared to when calculations are optimistic and then the results underperform. This may help for better and increased word of mouth for PV, which may lead to future PV projects.		Pl 1 thinks that most owners in the residential complex have a good financial situation, furthermore there are no kids living in the residential complex.
1.3.3	O1 suggests that the decision for most investors for or against PV was mostly based on the payback time and the ROI. In O1's opinion the owners who eventually invested thought that the PV project was ecologically and economically sound project with a ROI.	O2 estimates that owners who did not invest did so because their financials did not allow it or they could not identify themselves with this idea/project. "There were some owner that had a really good financial situation who did not invest, which I thought was disappointing"	A suggests that for most investors the investment costs were not such a big factor and that the payback time and ROI was more important.	
1.3.4	According to O1 people were surprised how fast the project advanced. O1 estimates that if the contracts etc. cannot be drawn up from an condominium owner the costs may increase and also lead to additional delays. In O1's opinion the PV project in Rubigen was quite fast.		A was surprised by how fast the project proceeded, especially when it just started, as there were so many owners and stakeholders involved. According to A they expected the whole execution of the project to be longer and more difficult as it eventually was. A suggests that EEM and RDES projects may	Pl 1 claims that O1 had already a good knowledge basis of PV and had the passion and will to read up on the subject. O1 took the lead for contracts with the owners such as electricity supply contracts and roof usage contracts etc.

			become a bigger part of Administrator competency in the future.	
1.3.5	O1 thought before the project that it would not be that big an effort to satisfy the legal side of the project, however the project showed differently. Even though O1 has studied electrical engineering and business law.		A thinks that the estimated legal effort was not a deciding factor.	Pl 1 suggests that customers fear the efforts required for legalities etc., however maybe more so in buildings with rented apartments as the effort for billing increases. The effort needed for ZEV is perceived by some owners in condominium owned properties as so high that some were even building PV without forming a ZEV at all.

Table 9-4: Project Rubigen Informations

Information	Condominium Owner 1 (O1)	Condominium Owner 2 (O2)	Deyhle & Partner AG (A)	Elektrobedarf Troller (Pl 1)
1.4.1	O1 suggests that most information's for PV, the subsidies etc. were found through congresses, presentations, internet and the news.	O2 remarks that he and O1 went to various trade fairs before the project. O2 found information's on the topic through the internet or by asking customers at work who installed PV about their experience and formed his attitude towards PV partly based on this feedback. For example there was a tire company, who was customer of O2, that was almost independent from the grid with PV and storage, which increased O2's positive attitude towards EEMs and RDES.	According to A a lot of knowledge was acquired by asking Mr. Burch, the EVG-Zentrum Expert, googling questions and talking to O1, this was mostly done to be better prepared for meetings and gain additional knowledge.	Trollers advertisement does not address any target group in particular, trying to advertise to everyone at places/sites where everyone can see it (not HEV for example).
1.4.2	O1 suggests that the expert, Mr. Burch, was laying a good basis for the project, as a person who comes outside the social network of the residential complex.	O2 suggests that for his decision the expert was not important as he had those information's already before from O1 and the trade fairs he visited with O1, but it may have helped other owners as it was an independent person which was not affiliated to any owner.	A thinks that inputs from companies, aside from Mr. Burch, did not have an impact in the decision making process. "While the EVG-Zentrum expert was surely helpful for the process and gave the first big input of information to the owners the direct contact of O1 and building committee members to the various stakeholders is perceived to be a bigger factor in the decision-making."	

1.4.3	O1 remarks that other subsidies programs for EEMs and RDES beside EIV are known sometimes by name but often not known into further detail. O1 says that EIV was considered from the very start of the project and was known from the news, further information was easy to find and readily available.	O2 remarks that the information regarding to EIV came from O1, the internet, and word of mouth.	According to A of all the owners coming to the owners' meeting, where Mr. Burch presented PV, not many seemed to know about possible subsidies such as EIV.	Pl 1 does show the possible subsidies and includes them in the tender calculations, offering customers to apply for EIV. Subsidies are shown on the tenders how much can be expected from EIV, additionally tax savings are also displayed. For the tax savings the PV is considered as a value adding investment into their property which is a tax deductible and conclusively a tax saving in every but one canton, the sole exception being Lucerne.
1.4.4	O1 suggests that he was getting additional info's from trade fairs, Swisssolar had some interesting evening events which had very interesting talks sometimes even by government officials, about regulations subsidies and more.	According to O2 the trade fairs were used by the committee to filter the PV-companies, deciding which may be approached for the call of tenders. However O2 mentions It was an issue to find a company who does everything for the PV system in a condominium owned building such as doing the electricity counters as well etc. O2 suggests that many PV companies at trade fairs when pressed to answer questions about ZEV and its legal and technical implementation were not able to answer.		

Table 9-5: Project Rubigen Regulations/Subsidies

Regulations / Subsidies	Condominium Owner 1 (O1)	Condominium Owner 2 (O2)	Deyhle & Partner AG (A)	Elektrobedarf Troller (Pl 1)
1.5.1	O1 remarks that due to the fact that not all participated in the PV-project they were required to write up a contract and get the signature of each owner in the houses were PV was installed so that they were allowed to use the roof. For each owner a separate contract needed to be drawn up, furthermore an additional contract needed to be signed	O2 suggests that it was taking a lot of effort to get the roof usage and electricity supply contracts signed by all necessary owners. O2 remarks that to be able to sell the electricity produced and buy electricity for the ZEV it was necessary to sign a contract with the local supplier, BKW. O2 remarks that during the project the effort required to write the	After initial interest was identified an investor meeting with owners who were thinking to invest 10k+ was conducted, which proved to be successful according to A. Next each owner of a building that wanted to build PV was approached to sign a roof	Pl 1 suggests that they can support customers for the legal efforts required for ZEV with the standard documents from Swisssolar, which should, according to Pl 1, be sufficient for most projects.

	where each owner agreed to join the ZEV. On top of that an additional contract needed to be drawn up between the ZEV and the local provider, BKW, which specified that ZEV would buy and sell electricity from and to BKW. O1 suggests that the effort to satisfy regulations such as the various contracts for the ZEV or roof usage was high.	contracts etc. to satisfy the regulations was much higher than expected. It was also higher than suggested by other people who already installed PV but were not in a condominium owned object. Because writing the contracts etc. took so much time and needed to be revised it lead to some delays in the project.	usage contract so that they were legally able to use the roof for PV. In A's opinion getting all the signatures was a time intensive task where many questions that arise form stakeholders needed to be answered. For most questions O1 was approached by the owners. A thinks that the estimated legal effort was not a deciding factor.	
1.5.2		According to O2 there were some templates that helped with the regulatory processes however not enough specifically for in condominium owned buildings PV projects and ZEV. O2 estimates that such templates are in the works, he thinks HEV is working on one. "It would be good to have at least a checklist for the various contracts so that PV projects in condominium owned buildings know at least everything that needs to be covered to follow through with the project."		Pl 1 does not have a standard procedure for ZEV as the paperwork depends on the regional energy provider, BKW has a standard formular for this case which needs to be filled out by the owners. However, Pl 1 has a standard document to gather data on possible projects such as to the owners consumption, roof space available, sources of shadows and more.
1.5.3	O1 suggests that the known delay in subsidies programs such as EIV from the time of application until pay out is a hindrance, in condominium owned EEMs/RDES projects especially, as it may cause issues in sharing the benefits of the subsidies accordingly as the money can be paid out years after finishing the project when some owners may already have moved out of the apartments.			Pl 2 remarks that as some rules changed EIV now needs to be applied for after the project is finished. Furthermore, more paperwork and documents are needed, such as a land register extract (Grundbuchauszug), which causes additional costs associated to requesting the land register extract from the municipality. Pl 1 says that their employees think of those additional measures and the overall procedure of applying for EIV as bothersome. Pl 1 thinks that if this effort is done by investors and not the companies it may lead to a bad word of mouth as the effort required is high. According to Pl 1 when EIV was initially introduced by the government it needed around 2.5 years till it was paid out, now Pl 1 calculates with 1.5 to 2 years.

1.5.4				Pl 1 remarks that information to upcoming and passed legal changes comes from Swisssolar, the boss of Troller which is quite up to date as well as external and internal training sessions, Pl 1 thinks that further sessions will be coming up in the near future in regards to ZEV in condominium owned residential complexes.

Table 9-6: Project Rubigen Financials

Financials	Condominium Owner 1 (O1)	Condominium Owner 2 (O2)	Deyhle & Partner AG (A)	Elektrobedarf Troller (Pl 1)
1.6.1	O1 says that out of 5 PV companies that handed in tenders only 2 were able to provide every service needed for the project themselves and could therefore be considered. The call for tenders specified the situation on the roof, consumption values, number of apartments and more. The tenders were requested after members of the building committee, mostly O1, were talking to the company. When comparing the tenders, the offered prices but also the competences of the companies were deciding factors to which company was chosen.	One company offered to already discount the EIV from the costs, so to entice possible customers to choose them, O2 thinks that is a good idea. However, this PV company could not be chosen as they oversized the PV plants and did not optimise the roof usage properly, such that shadows from roof windows etc. were not taken into consideration properly, furthermore they were over 20k more expensive than Pl 1 even when the pre-emptive EIV reduction was considered they were still the most expensive tender.	According to A the various offers were of a similar layout and pricing structure so that not much effort was due to make the offers better comparable, this was done by O1, as he was appointed by the stakeholders to be the project leader.	Pl 1 does show the possible subsidies and includes them in the tender calculations, offering customers to apply for EIV. Subsidies are shown on the tenders how much can be expected from EIV, additionally tax savings are also displayed. For the tax savings the PV is considered as a value adding investment into the property which is a tax deductible and conclusively a tax saving in every but one canton, the sole exception being Lucerne.
1.6.2	O1 suggests that the decision for most investors for or against PV was mostly based on the payback time and the ROI. In O1's opinion the payback time for a PV project needs to be shorter than 15 years to make sense for O1.	O2 suggests that Troller was chosen as they offered to do everything including the process with BKW. Troller was chosen even though they were not the cheapest, as they also promised an date at which they would be finished for sure.	According to A the PV company was chosen due to their competence, furthermore only regional companies were considered.	
1.6.3	O1 says that EIV was considered from the very start of the project and was known from the news, further information was easy to find and readily available.	O2 calculated that the EIV will be about 1500.- for his investment into the PV project.	A suggests that subsidies were a topic from the very start of the project and certainly were a factor in the decision making.	

1.6.4	O1 estimates that if the contracts etc. cannot be drawn up from a condominium owner the costs may increase and also lead to additional delays. In O1's opinion the PV project in Rubigen was quite fast.	O1 received a small payment for his work, that however stands in no comparison to the work delivered, a lot of costs were avoided by having the expertise and project lead of O1.	A estimates that due to the effort of O1 and other building committee members in the electricity supplier contract, roof usage contract and other parts of the project allowed costs to be reduced as no outside expert needed to be payed to do this works.	
1.6.5	A took over the electricity billing for the condos with no additional fees, granted that the effort required is not too excessive. O1 thinks that the phase after the project, when it comes to billing, maintenance etc. seems to not be well served by companies. Furthermore, he suggests that if the billing wasn't done by A free of charge but a separate company that the payback time would have been longer and would have made PV less desirable.	It helped that A supported the project and said that they accompanied already other PV-projects and now took over the billing.	A remarks that as long as the effort required for the billing is within certain boundaries that they will do it.	Initially Troller offered Engytec which would solve the billing problem, however subscription costs ensue, and owners in Rubigen decided to do the electricity counter reading themselves, delegating the billing to A.
1.6.6		It was good that after planning the project BKW increased the tariff they pay for PV electricity, but only eligible if government checked the PV system		The market situation has not change considerably this year, it is not a bad year but no big improvements in sales could be made, many possible customers, when asked, are rather reserved about the topic of PV. In 2017, before the ES2050 vote, the demand was getting smaller as especially big projects were hindered by the cancellation KEV and the insecurities caused by the vote.
1.6.7	O1 remarks that the value of each investment made by the various investors of the PV project was calculated for each year to account for depreciation etc. This allows Investors the possibility to sell their investment if the decide to sell their condominium, other investors have first buy rights in this case, but investors may also keep their investment even if they do not own a condominium in this residential complex anymore. In case of death it will be handled as part of the inheritance.			

	New condominium owners that buy an apartment, that is part of the ZEV or supplied by the ZEV, will not be able to reuse the contract for usage of the roof or the electricity supply contract.			

F. Thun interview comparison tables

Table 9-7: Project Thun attitude

Attitude	Condominium Owner 3 (O3)	Condominium Owner 4 (O4)	Deyhle & Partner AG (A)	Andreas Glatthard (Pl 2)
2.1.1	O3 said that 1/3 of condominium owners were extremely against PV, as the costs were already high for the roof renovation. Furthermore, it did not help that they were already talking about future measures such as the replacement of windows of garage and ceiling insulation.	O4 suggests that the other Attica owners were not so supportive of the projects as they were trying to sell the house during the renovation and sold it shortly after, causing them to pay for the project while not reaping the rewards, of course the price for the apartment was increased by the measures but they did not offset the costs.	According to A, the average age of the owners in the Thun project is higher than in the Rubigen project and A estimates that in average the attitudes of older owners is less positive towards EEMs and especially RDES such as PV, furthermore suggesting that attitude is more difficult to change with age. A suggests that the construction time was reducing the living comfort for the Attica owners, O4, an Attica owner himself, was very tolerant towards it and furthermore pushed for additional measures such as GEAK and PV. The other Attica owner were not happy about the project as they were trying to sell the apartment during the renovation. The Attica was sold shortly after the renovation of the roof finished.	Pl 2 argues that he supports EEMs and RDEs if they are a good and practical solution for the project. Pl 2 target for this project was to build sustainable, meaning that materials used and the work done is a good quality and lends itself to a long lifetime of the roof, furthermore Pl 2 wanted a good execution of the project planning and execution phase.
2.1.2	O3 suggests that the PV company seemed highly frustrated over the Energie Thun's decision.	O4 thinks that it was good to try with PV and to do the GEAK report as it showed their potential and without any effort there cannot be any payoff or rewards, furthermore they still have time to fulfil the GEAK measures and try again with PV.	"The roof renovation project went quite well but it is a shame that the PV Project didn't work out, also because it was already set up, the owners agreed to move forward and then were blocked by Energie Thun's decision, as	Pl 2 thinks it was good that PV was looked at and would have also executed the PV project if Energie Thun would have approved it but Pl 2 is also of the opinion that it almost seems like people look strangely at Planner,

			they did not get the approval. I hope it is possible to do it another time."	who build something and do not consider EEMs or RDES.
2.1.3	In O3's opinion building committees seem to be a good tool for condominium owned buildings and residential complexes to prepare for future expenses for renovations/upgrades or to check possible measures and options. However, it is important that the members of the building committee are interested in the topics and that either expertise or curiosity is there, as otherwise this tool will not yield good results. Attitude and source of information same as O1.	O4 suggests that his initial interest towards EEMs and RDES comes also from his background, originally coming from Germany where especially RDES are more common than in Switzerland. O4 Attitude of EEMS and RDES has improved after the PV project in the other object they own, where they wanted to replace the heating system and wanted to be more renewable, initial idea was a pellet heating, which was not a good financial decision and decided to install a new oil heater to replace the old one but at least would heat the water with solar power.	It was surprising to see for A how much interest Attica owners in the committee had compared to the rest of the owners.	Pl 2 had other projects with condominiums in Biel which were better suited to employ PV due to the roof form and positioning, where the owners could not decide whether to do it or not and at the end decided to not move forward. Pl 2, however as well as the building committee decided (without informing the other owners) to at least to install hooks etc. to be able to put PV later easily on the roof.
2.1.4		O4 suggests that Pl 2 and the company contracted seemed reserved when asked about the topic of subsidies and PV, the company going so far as saying there are no subsidies for the EEMs, which was in O4's opinion too absolute so he decided to do some research. O4 says that for a condominium owned house the decision making is always based on what you can get out of the measures, if there is only a report at the end that says what you could do the question arises, will we do/consider such measures at all? --> Effort/value	A suggests that Pl 2 did what he was asked to do in regards to PV but did not do any more then he was asked to, maybe because he is already a bit older and his attitude towards PV is not so good.	Pl 2 thinks that the effort required is too big compared to the pay offs the solar panels could give as the roof has not enough area for PV to produce a lot of electricity, also there are many sources of shadows on the roof limiting area available for optimum PV placement. Pl 2 implies that it is important to him to perform well, by giving good advice to his customer, accurate cost estimation and good project management. Pl 2 thinks that effort vs output is for him the deciding factor, when it comes to decisions such a EEMs and RDES.
2.1.5			A suggests that they are now drawing up investments plans, for a lot of buildings in their portfolio estimated costs for an optimum renovation plan and a minimalistic renovation plan to check funding and also prepare owners more for possible costs that may come up. These calculations can include GEAK and other subsidies.	Pl 2 suggests that if planners and construction companies and their employees are better informed and more sensitive towards EEMs and RDES it may help to further increase acceptance on implementation of such measures as for e.g. in another project of Pl 2 the owners did not tell them to insulate the roof for a renovation project but Pl 2 as well as the construction company decided to put at least minimum insulation of about 2cm in, which did not cost a lot but at least improved the situation a bit. Pl 2 thinks it is better to inform and

				support people to install PV and EEMs instead of regulating it by law to install PV etc.

Table 9-8: Project Thun circumstances

Circumstances	Condominium Owner 3 (O3)	Condominium Owner 4 (O4)	Deyhle & Partner AG (A)	Andreas Glatthard (Pl 2)
2.2.1	O3 plans to own the condominium for a longer time, 15+ years. At the moment he is renting it out.	O4 suggest that the remaining time they plan to own the condo had a big influence in their decision making as they plan to stay for a long time in this apartment. Therefore, the living comfort which is increased by the measures as well as the savings in electricity would have reaped more rewards in their opinion than effort/money required for the time they plan to keep the apartment. O4 thinks that the average owner will keep the apartments for the next 10-20 years, most changes he expects will be due to owners dying.	According to A the time owners planned to own the condos did not have an impact into the decision making, as the roof needed to be done and most owners beside one of the Attica owners that sold their apartment plan to own the apartments for a long time, 15+ years.	Pl 2 suggests that most owners will keep the condos for many years in the future as in his opinion the location is very good with shops nearby and is also close enough to town. Pl 2 furthermore suggests that this location/ condos will increase their value. Pl 2 suggests that only by other circumstances such as death, aging (more age appropriate housing), loss of financials, or moving to a completely different region could cause a sell of this condos.
2.2.2	In O3's opinion building committees seem to be a good tool for condominium owned buildings and residential complexes to prepare for future expenses for renovations/upgrades or to check possible measures and options. However, it is important that the members of the building committee are interested in the topics and that either expertise or curiosity is there, as otherwise this tool will not yield good results.	"EEMs and RDES are good and important, but they need to financially sustainable. I am coming from a economical background (BWL) and the green thinking alone is not enough."		Pl 2 suggests that building committees can be a good tool, but problems may arise due to personal bias ideas brought forward by an owner, even if he is an expert, can be seen from other owners not as reliable as from an external expert.
2.2.3	O3 explains that the decision of Energie Thun, according to BFE, could have been fought in court, and likely won, however that would have delayed the project further and alienated condominium owners that are opposing the PV project which may have caused issues in the building between the	O4 suggests that because the decision to do the PV project, as decided by the owners' meeting, was not unanimously it would have further increased or created issues if now legal battles would have been fought, which also needed to be financed by all owners.		

	owners. Therefore, it was decided not to move further with the PV project at this point of time.	Therefore, pushing forward with PV at this point in time was not a realistic option.		
2.2.4	O3 argues that it was necessary for the PV projects approval to first talk to the various owners alone to gauge their approval, to answer questions, give explanations and more. In his opinion this needed to be done before the owners' meeting in which they decided on the PV project, as otherwise the situation may not have developed desirably. O3 compares the effort required and actions needed to be made to get the PV project approved to a vote/election campaign. For both you need to shore up support for your cause and make sure that your supporters show up for the election/vote etc.	O4 says that it was important that he and O3 did face to face talks to convince the other owners of the GEAK report/project and the PV project. In O4's opinion it would not have succeeded in the votes otherwise. O4 suggests that during the talks with other owners there were some talking points that were better received than others:1- doing something good for nature. 2- do the PV now as they were already working on the roof --> ease of access, reduced costs and other synergy effects. 3- That PV is financially sound option over its lifetime		
2.2.5	O3 explains that building committees in condominium owned buildings are often set to have x people per building to be in the committee, this can lead to members who are not completely voluntarily part of the committee which may not contribute much.	O4 suggests that there are always people who will oppose a project if so many stakeholders are included. According to O4 people living for rent were not included in the decision making process but were informed. O4 found that it was easier to convince owners for the roof renovation than the PV project, as one needed to be done while the other was more of a nice to have.		

Table 9-9: Project Thun Perception

Perception	Condominium Owner 3 (O3)	Condominium Owner 4 (O4)	Deyhle & Partner AG (A)	Andreas Glatthard (Pl 2)
2.3.1	O1 thinks that the investment cost was the most important factor when it came to the PV project, as the renovation fund was already completely used by the roof renovation.		A estimates that investment costs had a large impact for the PV project as the roof renovation itself was already expensive and depleted the renovation fund, the PV project would have added additional costs.	Pl 2 thinks that RDES are still a bit expensive, especially when considering the whole system and not the panels alone, however not everything needs to be just decided by the costs.

				Pl 2 suggests that EEMs and RDES will be more prevalent in projects in the future.
2.3.2	O3 tells that when Pl 2 answered to the question of O3 If there are any subsidies, that there are some subsidies, but they are complicated and too much a hassle for him and the owners for this project. O3 suggests that the owners initially followed this recommendation of Pl 2 as the knowledge of GEAK and EIV was not sufficient to decide differently.	O4 suggests that if there were no subsidies for the report alone they would have been less likely to do the report, at least in the short term. Additionally, it was easier to tell the owners that with the report they could be eligible for subsidies by the government, meaning they hanged a carrot in front of the owner's nose, which is easier to argue with than the report alone. O4 says that for a condominium owned house the decision making is always based on what you can get out of the measures, if there is only a report at the end that says what you could do the question arises, will we do/consider such measures at all? --> Effort/value	A claims that Pl 2 said it would be not optimal to do PV because the form of the roof was optimal with many roof windows and sources of shadows, furthermore he suggested that there could be issues with the government in regards to building regulations etc. A suggests that Pl 2 did what he was asked to do in regards to PV but did not do any more then he was asked to, maybe because he is already a bit older and his attitude towards PV is not so good,	Pl 2 thinks that the effort required is too big compared to the pay offs the solar panels could give as the roof has not enough area for PV to produce a lot of electricity, also there are many sources of shadows on the roof limiting area available for optimum PV placement.
2.3.3		O4 suggests that only a few companies were able to even offer to do the roof with chromium nickel steel sheets, as many did not have the capabilities, three in total.		Pl 2 argues that due to the material chosen for the metal sheets only a few companies had the capabilities to work on the roof, of which some had almost no experience with this kind of metal sheets, limiting possible companies to deliver quality work.
2.3.4	O3 tells that when Pl 2 answered to the question of O3 If there are any subsidies, but they are complicated and too much of hassle for him and the owners for this project. O3 suggests that the owners initially followed this recommendation of Pl 2 as the knowledge of GEAK and EIV was not sufficient to decide differently.	O4 suggests that the regulatory effort for GEAK is rather high and was not foreseeable. O4 said that Information regarding GEAK were easily found in the Internet after he specifically searched for subsidies for building renovation. O4 suggests that Germanys subsidies system for renewables is more effective than Switzerland's subsidies program. O4 thinks that it was good to try with PV and to do the GEAK report as it showed their potential and without any effort there cannot be any payoff or rewards, furthermore they	A claims that there was already some capabilities for GEAK in their company due to other projects, which allowed them to roughly estimate the amount of subsidies the project in Thun could receive.	Pl 2 thinks that GEAK is in principle a good Idea, but it's not practical for this object as for example the outer walls have a two wall construction etc. complicating measures and GEAK is very time intensive. Pl 2 suggests that programs like GEAK are not fitting for every project, as some buildings were built in a way which would cause a lot of additional costs to install EEMs or RDES.

		still have time to fulfil the GEAK measures and try again with PV.		
2.3.5	O3 claims that the Pl 2 did not further look into the option of PV, as he was not interested. he does not see the need to do a GEAK report as it is difficult and time-consuming measure which in his opinion does not make sense." O3 thinks that if none of the owners would have shown initiative for things such as GEAK subsidies/report and PV it would not have been mentioned and considered by Pl 2, A or the related companies. O3 thinks that if Pl 2 would have been more supportive of GEAK and PV, that there could have been a bigger scope of the project. O3 thinks that it would be good if Pl 2 or companies pushed a bit for GEAK subsidies or other programs or at least informed their customers. O3 said that Pl 2, even though he did not contribute for PV or GEAK was attested a good performance for the roof renovation project.	O4 suggests that Pl 2 and the company contracted seemed reserved when asked about the topic of subsidies and PV, the company going so far as saying there are no subsidies for the EEMs, which was in O4's opinion too absolute so he decided to do some research.	A claims that Pl 2 said it would be not optimal to do PV because the form of the roof was optimal with many roof windows and sources of shadows, furthermore he suggested that there could be issues with the government in regards to building regulations etc. A suggests that Pl 2 did what he was asked to do in regards to PV but did not do any more then he was asked to, maybe because he is already a bit older and his attitude towards PV is not so good. In A's opinion they had more influence on the scope and decision making in this project compared to the project in Rubigen. In A's opinion the roof renovation project was mainly pushed by them owners and the PV and GEAK project mostly by the owners, building committee members, with support from A. It was surprising to see for A how much interest Attica owners had compared to the rest of the owners.	Pl 2 thinks it was good that PV was looked at and would have also executed the PV project if Energie Thun would have approved it but Pl 2 is also of the opinion that it almost seems like people look strangely at Planner etc. who build something and do not consider EEMs or RDES. Pl 2 doubts that the plan of some of the owners to try to move forward with GEAK and PV again at a later point will be successful. Pl 2 thinks he has met the expectations he had of the project. In Pl 2's opinion nothing surprising happened, except how well the companies and the workers executed the project. Pl 2 suggests that the owners put a lot of trust in him when it came to his expertise and work. Pl 2 suggested that it was a good project which he enjoyed to work on as well with the various stakeholders involved in the project.
2.3.6	O3 mentions that the condominium owners of the Attica apartment report increased living comfort after the renovation compared to before, such as no noise from rain, better temperature control over the room due to increased insulation and more.	O4 remarks that before the renovation project the living comfort was reduced as a lot of heat was lost in winter and there was a steady air flow to the outside. O4 thinks that for them the living comfort was the deciding factor for them.	A's expectation for the renovation project was to renovate the roof qualitatively for a long lifetime, increased living comfort for Attica apartments and increase insulation of the roof up to 16cm. A suggests that there will always be some issues for owners who are as deeply affected by a renovation project, such as the Atica owners were, independent of the attitude and person.	Pl 2 suggest that the living comfort for the Attica condos was substantially increased due to the renovation of the roof.
2.3.7	O3 was surprised by this blockage of Energie Thun, as previous experience with other PV projects and their local providers gave a different perception. O3 suggests that the PV company seemed highly frustrated over the Energie Thun's decision.	O4 suggests they could have fought Energie Thun's decision legally and they most likely would have won, but the time and effort required would have been too high. Therefore, it was decided to stop the PV project for now	The roof renovation project went quite well but it is a shame that the PV Project didn't work out, also because it was already set up, the owners agreed to move forward and then were blocked by Energie Thun's decision, as they did not get the approval. I hope it is possible to do it another time.	Pl 2 thinks that the decision making of Energie Thun does not make sense as only one house builds PV and owns the plant not the whole residential complex. Pl 2 thinks that local Providers as well as cities and towns while saying they want to promote EEMs and RDES often put big

	O3 says that the planned PV would have had 13.5% of the rated power of that building, satisfying the condition set by law.		For A it is not apparent why the PV project in Rubigen was approved while the PV project in Thun was denied by the providers.	hurdles up such as too much bureaucracy etc. as could be seen with Energie Thun. They should not decide in place of the owners if EEM or RDES makes sense, it should only be the decision of the owners. Pl 2 suggest that it would make more sense to minimize bureaucracy as much as possible, which would in increase attractiveness of EEMs and RDES more than the subsidies that can be earned today.
2.3.8		O4 told that in other condominium owned houses that have a larger yearly renovation fund fee, that it is easier to initiate a project as the money is already there and already thought of being spent or reserved for renovation. It furthermore simplifies decision making as no additional costs occur.		

Table 9-10: Project Thun Information

Information	Condominium Owner 3 (O3)	Condominium Owner 4 (O4)	Deyhle & Partner AG (A)	Andreas Glatthard (Pl 2)
2.4.1	According to O3 none of the companies sending in a tender for the roof renovation mentioned GEAK subsidies or offered help for it. However, O3 suggests that it would be appreciated if companies at least informed their customers about possible subsidies. O3 explains that GEAK was not mentioned by Pl 2 at all until it was mentioned by O4, which could have been an issue as GEAK needs to be submitted before the start of the renovation.	After initially looking at PV it was decided to see if there are any further subsidies and incentives from the government that could be used for their project, which was led by O4. O4 found out that already for the GEAK report itself you could apply for subsidies. O4 said that Information regarding GEAK were easily found in the Internet after he specifically searched for subsidies for building renovation. O4 suggests that it was hard to find a GEAK expert to do a GEAK report within the short time window of 2-3 weeks to do the report.	According to A besides the PV company, none of the companies mentioned subsidies or included them in their calculations. According to A the list of GEAK experts was readily available on the internet.	According to Pl 2 to do a GEAK report a person with the respective certificate is needed, which is not every Architect and, in this case, also not Pl 2.
2.4.2	O3 tells that when Pl 2 answered to the question of O3 If there are any subsidies, that there are some subsidies, but they are	O4 suggests that Pl 2 and the company contracted seemed reserved when asked about the topic of subsidies and PV, the	For A there was no knowhow in regards to seamed roofs before the project as it is not seen so often. Therefore A depended largely	

	complicated and too much an hassle for him and the owners for this project. O3 suggests that the owners initially followed this recommendation of Pl 2 as the knowledge of GEAK and EIV was not sufficient to decide differently.	company going so far as saying there are no subsidies for the EEMs, which was in O4's opinion too absolute so he decided to do some research.	on information given by Pl 2 for the seamed roof.	
2.4.3	According to O3 for GEAK it is necessary to identify which measures should be taken to reach the necessary level of improvements.	O3 explains that the GEAK expert looked at various possible measures to reach the target, but eventually in cooperation with the buildings committee it was decided that the measures for GEAK would be: Insulation on the garage ceiling, better windows, PV on the roof and insulating the roof. Those measures were chosen to maximise profits versus outcome, furthermore the GEAK expert advised to look at Heat pumps when the heating system needs to be replaced eventually.		
2.4.4	O3 says that the roof is a special kind of metal roof, which is difficult and expensive to renovate. At an extraordinary owners' meeting it was decided to use a chromium nickel steel sheet for the roof instead of the more widely used titanium nickel steel sheets, because of its longer life expectancy. However, the choice of material limited possible companies to renovate the roof as not every company has the tools need to process the chosen material.	O4 says it was decided to use chromium nickel steel + sheet instead of the usual titanium nickel steel sheets, as it has a higher quality and subsequently longer lifetime, which were the deciding factors to choose the material.	The roof, a so called seamed roof, needs to be fixed by experts and special tools, which disqualified already many companies as this capability are not met by many. Furthermore, the quality of the work is the deciding factor for the roof's longevity and therefore prior projects with such a roof were influencing the selection process.	According to Pl 2 during the call for tenders' phase of the roof renovation project many companies that wanted to get the contract said, that it does not make sense to use chromium nickel steel sheets, as this choice of material increases costs and is hard to work with. They usually offered different kinds of metal sheets to use instead of the chromium nickel steel sheets, which in general are easier to work with but the overall longevity is reduced compared to the chromium nickel steel sheets.

Table 9-11: Project Thun regulations & subsidies

Regulations / Subsidies	Condominium Owner 3 (O3)	Condominium Owner 4 (O4)	Deyhle & Partner AG (A)	Andreas Glatthard (Pl 2)
2.5.1	The reason Energie Thun rejected the PV project was that it did not meet internal guidelines. The internal guidelines specified that the calculation for the 10% of the rated	O4 reports that at the end the PV project was stopped by Energie Thun, saying that all the buildings of the residential complex are counted together with a 600A access point,	For A it is not apparent why the PV project in Rubigen was approved while the PV project in Thun was denied by the providers.	PV was approved by the owners and then denied by Energie Thun as they calculated the

	power requirement of the electricity net access, needs to be met by this PV project by the whole residential complex and not just the building itself. This was based on the fact that the residential complex is connected as one to the electricity net. When the building committee asked the BFE, it stated that the blockage of Energie Thun is not based on law, as Energie Thun was arguing, because only the rated power of the building where PV is planned to be installed on should be considered. O3 says that the planned PV would have had 13.5% of the rated power of that building, satisfying the condition set by law.	which was not possible for the PV project to reach the legal 10% minimum power output and therefore would have needed to split the access point into an access Pont per building, which Energie Thun did not want to do. Energie Thun's decision was based on internal guidelines. However, O4 claims that according to the law they reach the 10% as BFE confirmed, the way Energie Thun added all buildings together for the calculation was not how the regulation should be applied. However, Energie Thun said, that the even if the Bundesrat would call them they would still change their decision.		demand for the whole residential complex instead of the single house.
2.5.2		O4 surmises that the GEAK report is a highly standardized product which at the end was difficult to reflect the real building in it. "It was difficult to built in the special features of the house, that the report at the end described a house/building that at least somehow resembled ours". Multiple rounds of revisions were needed until the report represented the house satisfactorily. (e.g. initially the roof was described as a pointed roof, which it isnt). O4 suggests that the regulatory effort for GEAK is rather high. O4 realized that if they wanted to get subsidies from GEAK they needed to do the report before the execution phase of the roof started as otherwise they would not be eligible.		"The old system before GEAK was better, especially for a wider range of buildings as GEAK's calculation are too much based on a standard building."
2.5.3		O4 mentions that the PV in this project would have not required any roof usage contracts as the owners decided in a majority vote that they would do the project, reducing the regulatory effort.		

Table 9-12: Project Thun Financials

Financials	Condominium Owner 3 (O3)	Condominium Owner 4 (O4)	Deyhle & Partner AG (A)	Elektrobedarf Troller (Pl2)
2.6.1	In November 2018 the roof renovation was completed and within budget expectations.		According to A the initial goal of the project was to just renovate the roof, also because those costs were already over 300'000.-.	Pl 2 suggest that the costs didn't overshoot the budget because the tender was already detailed and the cost estimations before the tender were more in depth than other planners might do it. Costs did not run over budget.
2.6.2	O3 explains that the PV project was planned to be financed by the renovation fund, however the renovation fund was already running dry from the roof renovation, which would have resulted into an additional investment by the condominium owners into the renovation fund. O3 says that the renovation fund yearly fees were increased due to the roof renovation. After the roof renovation project it was decided to reduce the fees, however it is still more than before as the gained experience showed that more money needs to be saved for possible renovations and projects. O3 suggests that after the expert report owners were surprised and afraid of the assessed renovation costs, as 320'000.- is perceived as a lot of money even if it is shared between 15 parties in the house. Furthermore, the renovation fund did not have the necessary financials to cover all the costs. Because of that emergency repair were executed and decided to increase the renovation fund yearly payments by 50k per year and delay the renovation by 2 years to accrue the necessary money.	"The renovation fund was massively underfunded, in the last 10 years only 5k were put in in it per year which barely covered normal repairs etc. With this project it became obvious to all owners that we need to save more money in the renovation fund, while the fees will be lower compared to the last 3 years, it will be considerably more than before the issues with the roof were discovered." Initially the roof was repaired to try to get few more years before the renovation of the roof would be necessary this was done to save money for the renovation, based on the plan of the Pl 2.	In A's opinion the renovation fund was not underfunded, as a roof renovation such as the done in Thun, is usually not to be expected of buildings with that age. Furthermore, the yearly renovation fund fees are according to A already above the average. However, A explains that they are making now investments plans, drawing up for a lot of buildings in their portfolio estimated costs for an optimum renovation plan and a minimalistic renovation plan to check funding and also prepare owners for more possible costs that may come up. This calculation can include GEAK and other subsidies.	According to A the owners decided to be able to pay the costs of the roof repair/renovation, the renovation fund yearly fees were to be increased in the 3 years leading up to the execution of the renovation project, to be able to accumulate enough money and spread the financial burden over multiple years. Pl 2 recommends to not keep the increased yearly renovation fund fees that were introduced 3 years ago but reduce them to a level that is between now and 4 years ago.
2.6.3	O3 suggests that it may also make sense in the future that A and other companies such as A should take over more responsibilities in	O4 told that in other condominium owned houses that have a larger yearly renovation fund fee, that it is more easy to initiate a		Pl 2 recommends to do check-ups of the housing in certain intervals, so that damages can be found and identified early. He

	regards to PV as they can pool knowledge better than each condominium project on its own, as each condominium owned building may have a different knowledge pool which may make project hard to realize or even initiate or consider at all. A should initiate a search for possible or needed measures and renovation projects. Furthermore the billing for PV in a condominium owned project could also be an additional responsibilities of the Administration.	project as the money is already there and already thought of being spent or reserved for renovation. It furthermore simplifies decision making as no additional costs occur.		furthermore suggests that the owners should contract the Administration to conduct those check ups on a regular basis as they can gather expertise and knowledge better, helping them to identify what needs, should or can be done next. This way the finances can also be better controlled and yearly renovation fun fees can get adjusted accordingly. This could also help to alleviate the concern that Pl 2s/planners/companies want to generate more work.
2.6.4	O3 explains that all tenders were received by Pl 2, who then made the tenders comparable and presented them to the owners, while giving his personal recommendation. O3 claims that the tenders received for the PV project and the roof renovation differed only slightly from each other in materials etc.	O4 suggests that the company was mostly selected on the criteria of costs. To be able to do that Pl 2 needed to harmonize the offers handed in by the 3 companies. O4 was surprised to see the rather high price differences between the experts to create a GEAK report. From 1.5k to 4.5k for the very same report, while the maximum incentive for the report is 1.5k. O4 claims that the final decision for which PV company would be chosen was done on basis of proximity, experience and knowledge of local authorities, as other aspects such as costs and material were too close to each other to base a decision on it.		While costs were a factor in who gets the contract for the roof, the main criteria were experience with the requested materials and how many projects they did with this kind of material, to guarantee the quality needed to reach a satisfying end result." Pl 2 suggests that in many projects, when offers are compared, that people weight the costs too heavily. While other factors such as quality of the products used, the quality of the work as well as the knowhow of the offering companies are not taken into consideration enough. This leads to subpar results.
2.6.5	In O3 opinion Pl 2 seemed to be experienced, throughout and professional when it came to the call for tenders and other matters related to the roof renovation project.	O4 says that the PV-companies were selected on basis of recommendations of O3, who recommended Elektrobedarf Troller, and O4 who recommended Beo Solar. No other companies were asked for tenders, as positive experience of O3 and O4 were the main factors to choose companies as not every PV company is able to do a condominium owned project as it requires special capabilities. According to O4 the PV project was mainly handled by the PV company and supported by O3.	The whole call for tender's process of the roof ran entirely through Pl 2. According to A, Pl 2 made an recommendation based on his expertise for this kind of roof on which companies should be chosen. For A there was no know how in regards to seamed roofs before the project as it is not seen so often. Therefore, A depended largely on information given by Pl 2 for the seamed roof. A suggests that information given by companies did not have a big impact on the decision making or the scope of the project.	According to Pl 2 for the call of tenders only companies from the region (until Bern area) were considered.