MSc Program
Environmental Technology & International Affairs

The Implementation of Energy Efficiency in Austria: An analysis of the EU Energy Efficiency Directive and the Austrian Energy Efficiency Act with a focus on Energy Efficiency in companies

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Affidavit

I, **PAULA WAGNER, BA**, hereby declare

1. that I am the sole author of the present Master's Thesis, "THE IMPLEMENTATION OF ENERGY EFFICIENCY IN AUSTRIA: AN ANALYSIS OF THE EU ENERGY EFFICIENCY DIRECTIVE AND THE AUSTRIAN ENERGY EFFICIENCY ACT WITH A FOCUS ON ENERGY EFFICIENCY IN COMPANIES", 68 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted the topic of this Master's Thesis or parts of it in any form for assessment as an examination paper, either in Austria or abroad.

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Abstract

This master thesis focuses on the implementation of energy efficiency in Austria. For that, the EU Energy Efficiency Directive and the Austrian Energy Efficiency Act were analyzed as well as the role of energy efficiency in the Austrian climate and energy strategy #mission 2030. This thesis further examines energy efficiency in companies by looking into the status of energy audits. In order to get decent results, a thorough literature review was conducted together with expert interviews in the field of energy audits. The results show that energy efficiency plays a major role in decarbonization, which is the headline goal for the EU until 2050 and also in the Austrian climate and energy strategy #mission 2030. There are especially energy efficiency potentials in the mobility and buildings sectors and thus this thesis also looks into these fields in particular.

In terms of energy efficiency in companies, energy audits are a tool to increase energy efficiency within companies. It was found that the proposed energy efficiency measures are largely implemented by companies, however there is still potential for improvements not only in obligated, large companies but in several fields in Austria.

List of Abbreviations

CO2	Carbon Dioxide
EED	Energy Efficiency Directive
EEffG	Energieeffizienzgesetz
EEOS	Energy efficiency obligation scheme
EMAS	Eco-Management and Audit Scheme
EU	European Union
GWh	Gigawatt hours
ISO	International Organization of Standardization
LED	Light emitting diode
Mtoe	Mega tons oil equivalent
n.d.	No date
PJ	Petajoule
SME	Small and medium size enterprises
TFEU	Treaty on the functioning of the European Union

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1. Introduction

The following chapter introduces the subject matter of this thesis by pointing out the state of the art on the topic of energy efficiency, the Energy Efficiency Directive and the Austrian Energy Efficiency Act, followed by a description of the objective target of the thesis, the proposed research questions and describes the methodical approach on how to answer the research questions. This chapter further describes a number of terms which are relevant to the scope of this thesis.

1.1. State of the Art

Today´s expectations of an energy system include being ecofriendly, reliable and affordable. In order to guarantee that, an energy transition is necessary. Energy transition means a reorientation of the energy system. Four strategies for a reorientation according to Günther (2015) include:

- Decarbonization through renewable energy
- Energy efficiency
- Sufficiency
- Regionalization

According to the author, most important and most effective strategies include the first two: decarbonization through renewable energies and energy efficiency. (Günther, 2015) Hence, energy efficiency plays a major role as it is also one of the most economic and cost-effective measures in regard to reducing greenhouse gas emissions. (Federal Ministry of Sustainability and Tourism, 2018a) An improvement in energy efficiency further leads to improvements in security of supply, affordable energy prices, reduces energy related emissions, and improves economic competitiveness. (European Commissions, 2016a)

Energy efficiency has, therefore, also gained a lot of attention on EU-levels over the past 15 years. Consequently, the EU established legal framework conditions for energy efficiency improvements, i.e. Climate and Energy Package which includes the buildings directive, energy efficiency directive and eco-design directive. Since 2015, energy efficiency is also one of five major components of the Energy Union which are marked with highest priority. (Stadt Wien, 2018) International climate and energy targets include the EU 2030 energy strategy which aims to reduce greenhouse gas emissions by 40% compared to 1990 levels, a 32.5% share in renewable energy and to improve energy

efficiency by at least 32.5%. This together with the 2020 energy strategy aim to achieve the overall long-term goal to reduce greenhouse gas emissions by 80-95% compared to 1990 levels until 2050. (Hirzel et al., 2016) There are certain measures in order to achieve greenhouse gas reductions. One of them is energy efficiency, which accounts for one of the most economic measures and is therefore of high importance for the Energy Union and plays a vital role in Austria as well. (Federal Ministry of Sustainability and Tourism, 2018a) An increase in energy efficiency is not only important in order to reach energy and climate related guidelines, it also supports socio- and politico-economic targets, promotes the local value chain and reduces energy poverty. (Stadt Wien, 2018)

To achieve greater energy efficiency all around Europe, the European Parliament and the Council established the Energy Efficiency Directive 2012/27/EU. It was adopted in 2012 in order to implement the Climate and Energy Package of 2009, which established three main targets including to reduce CO2 emissions by 20%, to increase the share of renewable energy by 20% and to increase energy efficiency by 20% by the year of 2020. It further aims to achieve the Europe 2020 strategy for inclusive, smart and sustainable growth including the promotion of energy efficiency. (Selianko/Lenschow, 2015) Concerning the energy 2020 strategy, the European Commission stated in 2010 that "energy efficiency is the most cost-effective way to reduce emissions, improve energy security and competitiveness, make energy consumption more affordable for consumers as well as create employment, including in export industries". (European Parliament, 2016)

The Energy Efficiency Directive 2012/27/EU sets out "a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union´s 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date". (Art. 1 Directive 2012/27/EU)

An update to this Directive was proposed by the Commission on 30 November 2016. This Directive includes a new target for 2030, which is the new 32.5% energy efficiency target for 2030. It entered into force in December 2018 and Member States are obliged to transpose this Directive by June 2020. (European Commission, n.d.j)

To be in line with EU law, Austria established the "Bundes-Energieeffizienzgesetz" (engl. Energy Efficiency Act) on a national level to meet the requirements of the EED concerning energy efficiency targets until 2020. To further work on climate and energy strategies beyond 2020 and to be in line with international climate targets as well as to

contribute to international climate and energy policies, Austria established #mission2030 to further reduce CO2 emissions, improve primary energy intensity and to increase the share in renewable energies. (Stadt Wien, 2018; Federal Ministry of Sustainability and Tourism, 2018a)

However, the development of energy efficiency requires a remodeling of national framework conditions in order to meet the new requirements for 2030 and is therefore also an important part to consider in the #mission 2030. (Federal Ministry of Sustainability and Tourism, 2018a)

Energy efficiency plays a role in various numbers of sectors and needs to be addresses on all levels in order to reach the energy efficiency targets proposed by the EU and transposed nationally. The Energy Efficiency Act obliges energy provides to set energy efficiency measures for end customers as well as to stimulate energy savings for companies by implementing energy audits and energy management. Consequently, companies also play a major role in contributing to energy efficiency and are addressed in article 8 of the EED which sets the framework for obligations of companies in terms of energy efficiency including energy audits and environmental management systems. (Stadt Wien, 2018; Art. 8 Directive 2012/27/EU)

1.2. Objective Target

The following work looks at the **importance of energy efficiency in Austria** by looking into Austria´s mission 2030 climate and energy strategy and identifying crucial fields of energy efficiency. Energy efficiency, in general, becomes more and more important and is of concern on a large European scale. For that reason, the Directive on energy efficiency was established to be implemented into national law in all Member States. This work aims to **combine energy efficiency on a European** scale as well as **jurisdictional national scale with Austria´s mission 2030** climate and energy strategy with the goal to understand **how Austria has implemented the EU Energy Efficiency Directive** as well as to look at the **progress of the implementation** while also identifying the **status of energy audits** in these regards.

1.3. Research Questions

The following research questions were raised:

How does the implementation of energy efficiency in Austria look like?
Which role does energy efficiency play in the Austrian climate and energy strategy #mission2030?
How is the status of after the first round of energy audits and before the second round of energy audits?

1.4. Methodical Approach

The following will describe the methodical process which will be conducted in order to successfully answer the proposed research questions.

The basis of this paper will be **thorough analysis of the #mission 2030, the European legislation as well as national legislation.** The analysis of #mission 2030 regarding Austria´s climate- and energy strategy will look at the **importance of energy efficiency in general** as well as in terms of **reaching certain objectives** set by the state as well as the European Union.

By looking more closely into European legislation on energy efficiency, in particular the Directive 2012/27/EU as well as the framework of the European Union on energy efficiency, it will appear that due to these agreed goals and strategies it is necessary for Austria to act in terms of energy efficiency. In order to get an understanding of how Austria implements the Directive into national law, this thesis analyzes the Energy Efficiency Act with its relevant articles in regard to this thesis.

To answer all research questions, this theoretical analysis is crucial to form the basis for the qualitative research.

In order to look at the progress of Austrian companies on the application of the Directive and to get a better understanding of the Austrian implementation, it is planned to **interview experts in the field of energy efficiency and energy audits** on the basis of a qualitative research approach by conducting **semi-structured interviews**. Together with the literature research and the conducted interviews it will be possible to answer all stated research questions in the best possible manner in order to get a valuable outcome of this thesis.

The questionnaire will include **open questions** regarding energy efficiency and its importance in Austria, about energy efficiency in Austrian companies and how the implementation of the Energy Audits looks like so far, as well as about experiences with energy audits as the second round of energy audits are to be conducted in 2019.

1.5. Definition of Terms

The following sub-chapter will define a number of terms which are essential for this thesis and to get a common understanding of these.

1.5.1. Energy Efficiency

Efficiency in general can be described as the relation between the work put in and the resulting benefit out of the work which was put in. This means to get the best possible output for the least possible input. In terms of energy efficiency, this relates to the supply of an energy service with a low energetic input. The higher the value between energy output and expended energy the higher is the efficiency. (Günther 2015) The European Parliament defines energy efficiency as "the amount of output that can be produced with a given input of energy". (European Parliament 2015) In the Energy Efficiency Directive, energy efficiency "means the ratio of output of performance, serviced, goods or energy, to input of energy". (Art. 2 (4) Directive 2012/27/EU)

The primary goal of increasing energy efficiency is to reduce the energy input of the energy services. The energy efficiency can be measured by how much energy has to be put in to get out a specific energy service. Therefore, it is not about the renouncing of an energy service but rather to use the energy in a more efficient way by reducing the input while maximizing the output. Hence, energy that does not have to be put in, does not contribute to CO2-emissions, it does not bear any cost risks and also does not lead to energy supply shortages. (Günther, 2015)

An efficient use of energy can be interpreted in that manner such as to use energy in a way to achieve the maximum benefit but can also include a shift in energy consumption to points in time where energy is cheap and abundant (e.g. at night, during sunny or windy periods in case of renewable energy sources). (European Parliament, 2015)

An improvement in energy efficiency is generally possible at all stages of the energy chain from the production to the consumption of energy. Examples include combined-cycle gas turbines, combined heat and power, smart grids, smart meters, better insulated walls and windows in buildings, heat pumps, LED technology or concerning the transport

sector lightweight materials, efficient engines or aerodynamic design contribute to fuel efficiency of vehicles. (European Parliament, 2015)

Improvements in energy efficiency are said to bring numerous benefits including a reduction in energy use which reduces energy bills for industry (improving competitiveness) and for households (reducing energy poverty). This also means that energy imports from other countries can be decreased, which contributes to energy security. A reduction in energy use also contributes to protecting our climate and to the decarbonization of our economy.

However, energy efficiency improvements require initial investments and are expected to generate returns in the form of energy savings over the lifetime of the investment. When the achieved return of energy savings exceeds the costs, the energy efficiency measure is considered as cost-effective. (European Parliament, 2015)

1.5.2. Implementation of EU Directives

Article 288 TFEU states that "a directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods" (Art. 288 TFEU) It is a legislative act setting out goals which have to be achieved by all EU Member States. Yet, it is up to the Member States on how to reach those goals by devising their own laws. (European Union, n.d.) Thus, EU countries have to adopt measures which have to be transposed into national law to reach the objectives of the Directive. The adopted measures have to be communicated to the European Commission by the national authorities. (European Commission, n.d.f)

1.5.3. Energy Union

The Energy Union strategy was established in February 2015. (European Commission, n.d.e) It serves as the backbone of the EU policy on energy and climate, being one out of ten priorities of the European Commission. The Energy Union involves five closely related and reinforcing dimensions which include: climate action, energy security, energy efficiency, an integrated internal energy market, and research and innovation. (Euroheat & Power, n.d.)

Building the Energy Union brings a lot of advantages such as making energy more affordable, secure and sustainable. This will enable every European citizen a secure supply of energy as well as a free energy flow across borders. By providing new technologies as well as renewed infrastructure, household bills can be cut, and new jobs

and skills can be created through export expansion and by boosting growth. Most of all, Europe´s economy will be more sustainable, low carbon and environmentally friendly. Furthermore, Europe will be at the forefront of clean energy technologies, renewable energy production, and at the front of fighting global warming. This Energy Union strategy builds on the 2030 energy strategy and the European Energy Security Strategy, which aims to guarantee "a stable and abundant supply of energy for European citizens and the economy". (European Commission, n.d.e)

1.5.4. Strategy 2020

The EU 2020 energy strategy "aims to reduce its greenhouse gas emissions by at least 20%, increase the share of renewable energy to at least 20% of consumption, and achieve energy savings of 20% or more". Furthermore, EU Member States are obliged to reach a 10% share of renewable energy within their sector of transport. By achieving these goals, the EU can help to contribute combating climate change as well as air pollution, to become more independent on foreign fossil fuels, and to keep energy reasonably priced for businesses and consumers. (European Commission, n.d.c)

1.5.5. Strategy 2030

The 2030 energy strategy is a new framework agreed by the EU Member States for EU-wide policy objectives and targets between 2020 and 2030 to achieve, in the long run, the 2050 targets to reduce greenhouse gas emissions. The targets include "a 40% cut in greenhouse gas emissions compared to 1990 levels, at least a 32.5% share of renewable energy consumption, and at least 32.5% energy savings compared with the business-as-usual scenario". (European Commission, n.d.b)

Critics include whether the 2030 energy efficiency target would be less enforceable since it is not binding. The Commission, however, believes not so as the 20% target of 2020 is non-binding as well and has not stopped the Commission to come forward with proposal – most notably, the 2012 Energy Efficiency Directive. (Hall, 2018)

1.5.6. Strategy 2050

Finally, the 2050 energy strategy is a long-term goal to reduce greenhouse gas emissions by 80-95% compared to 1990 levels established by the European Commission in 2011. An Energy Roadmap was set up including 4 main routes to contribute to a more

sustainable, competitive and secure energy system in 2050: energy efficiency, renewable energy, nuclear energy, and carbon capture and storage. (European Commission, n.d.d)

1.5.7. Energy - & Climate Package

The 2020 energy- and climate package was endorsed by EU leaders as an integrated approach to combat climate change. (IIASA, 2013) It was established in 2007 and ratified in 2009 and comprises a set of binding legislative measures in order for the EU to meet its 2020 climate and energy targets. The package includes three headline targets:

- 20% cut in greenhouse gases compared to 1990 levels
- 20% share in renewable energies
- 20% energy efficiency improvement

These targets are also the key targets for the Europe 2020 strategy. (European Commission, n.d.g)

1.5.8. Clean Energy Package

The EU Clean Energy Package sets the renewable energy and energy efficiency ambitions for the horizon of 2030 to bring the EU legislation on energy into line with 2030 energy and climate targets. It further aims to contribute to the Energy Union strategy to ensure affordable, secure, competitive and sustainable energy supply within the EU. (European Parliament, 2019) The package was proposed by the European Commission in 2016 and includes eight legislative acts on the governance of the Energy Union, the electricity market and consumers, energy efficiency, energy efficiency of buildings, and renewables and bioenergy sustainability. (Meeus/ Nouicer, 2018) Amongst those eight legislative acts is also the Energy Efficiency Directive. (European Commission, n.d.a) These measures were presented in order to keep the European Commission competitive in its function as global markets are changing as a response to the clean energy transition. The EU should not only adapt to the energy transition but is supposed to lead it. The proposals included in the Clean Energy Package have three overall goals: to provide a fair deal for consumers, to put energy efficiency first, and to achieve global leadership in renewable energies. (European Commission, 2016a)

The package further updates the functioning of the internal electricity market as well as the transmission and distribution grids. These measures are being set in order to drive forward the energy transition in Europe. (Meeus/ Nouicer, 2018) Miguel Arias Canete states that with these agreements “the new market will be more flexible and facilitate the

integration of a greater share of renewable energy" and that "an integrated EU energy market is the most cost-effective way to ensure secure and affordable supplies to all EU citizens". (Government Europa, 2018) The European Parliament has already approved the package in March 2019 and now the Council has to formally approve the included Directives and Regulations. The Directives must then be transposed into national law while the Regulations will enter into force right away. (European Commission, 2019a)

2. Directive 2012/27/EU on Energy Efficiency

The following chapter discusses the history and legislation of the EU Energy Efficiency Directive and goes then into detail about relevant articles of this Directive. Relevant articles include the one on buildings, on energy audits and energy management systems, and energy efficiency obligation schemes. In the end, this chapter will also look into the revised Energy Efficiency Directive and identify amendments which are crucial in respect to this thesis.

2.1. History & Background

The Directive 2012/27/EU amends Directive 2009/125/EC (Ecodesign Directive) and 2010/30/EU (Energy Labelling Directive) and repealing Directives 2004/8/EC (Cogeneration Directive) and 2006/32/EC (Directive on energy end-use efficiency and energy services), and it came into force on 4 December 2012 and is referred to as „Energy Efficiency Directive". (Directive 2012/27/EU)

This Directive is to achieve the Europe 2020 strategy for inclusive, smart and sustainable growth including the promotion of energy efficiency. For the Europe 2020 strategy, energy efficiency is a main element to guarantee sustainable use of energy resources.

Directive 2012/27/EU sets out "a common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union´s 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date". (Art. 1 Directive 2012/27/EU) Moreover, this Directive aims to remove barriers and market failures in the energy market that impede efficiency in the use and supply of energy. Those requirements are only minimum requirements for Member States. (Zygierewicz, 2016) The Directive establishes legally binding measures for Member States for a more efficient use of energy at all stages. Measures contain energy efficiency obligation schemes or other policy measures which aim to lead to improvements in energy efficiency in households, transportation sector and industries. Further measures include the public sector by being an exemplary role in that matter and also the consumers´ right to know their actual energy consumption. (The European Parliament /Council, 2012)

The Energy Efficiency Directive was established in 2012 to create binding measures for the EU to reach its 20% energy efficiency target by 2020. It requires all EU countries to a "more efficient use of energy at all stages of the energy chain, from production to final

consumption". (European Commission, n.d.h) Furthermore, all Member States need to set indicative national energy efficiency targets to ensure the reach of the EU headline target of 20% of primary and final energy consumption. (European Parliament, n.d.d) Those targets depend on different country variables and can be based on primary energy consumption or final energy consumption, primary or final energy savings but also on energy intensity. (European Commission, n.d.h.)
The target of this Directive is hence expressed in terms of energy savings, meaning an absolute decrease of energy consumption, whereas the majority can be reached by improving energy efficiency, such as "using less energy input for an equivalent level of economic activity or service". (European Commission, 2011)

2.2. Legislation

Until the introduction of the Lisbon Treaty in 2009, energy policy entered the treaty as "a policy area with its own title". In the European Community, later in the European Union, energy measures were carried out through secondary law and were not regulated under primary law. However, still no competences were transferred to the supranational level.
The basis for energy efficiency and energy policy in the EU is Article 194 TFEU and defines energy policy and common objectives at EU level. This article addresses, among others, energy efficiency and the internal energy market as EU competences. (Knodt 2017)

Article 194 TFEU states that „in the context of the establishment and functioning of the internal market and with regard for the need to preserve and improve the environment, Union policy on energy shall aim, in a spirit of solidarity between Member States, to:

a) Ensure the functioning of the energy market;
b) Ensure security of energy supply in the Union
c) Promote energy efficiency and energy saving and the development of new and renewable forms of energy; and
d) Promote the interconnection of energy networks." (Art. 194 TFEU)

Article 194(2) TFEU indicates that decisions regarding the Member States´ energy mix are not affected. Thus, EU Member States continue to regulate the settings of exploiting

energy resources in their country as well as their choice of energy sources and their energy supply structure. (Knodt, 2017)

2.3. Articles

The Directive starts off by describing the subject matter and the scope in Article 1 stating that this directive was established to set a "common framework of measures for the promotion of energy efficiency within the Union in order to ensure the achievement of the Union´s 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date". (Art 1 Directive 2012/27/EU) Energy efficiency targets are laid out in Article 3 of the Directive stating that "each Member State shall set an indicative national energy efficiency target, based on either primary or final energy consumption, primary or final energy savings, or energy intensity". Those targets shall be notified to the Commission. Furthermore, those targets shall be expressed in terms of "an absolute level of primary energy consumption and final energy consumption in 2020 and shall explain how, and on the basis of which data, this has been calculated". (Art. 3 Directive 2012/27/EU)

The following articles were chosen to be discussed in more detail as they are relevant to the scope of this thesis. This includes article 4 on buildings renovation, article 7 on energy efficiency obligation schemes and article 8 on energy audits and energy management systems.

2.3.1. Article 4: Building Renovation

Since energy efficiency in buildings is one of the pillars of the Energy Union, it is a priority for the Commission. (Business Europe Study, 2016) It accounts for about 40% of the primary energy consumption of the EU and is therefore an important sector to tackle. (European Commission, 2016b) According to Article 4 EED "Member States shall establish a long-term strategy for mobilizing investment in the renovation of the national stock of residential and commercial buildings, both public and private". It shall encompass a general overview of national building stocks, identify cost-effective ways for renovations and measures and policies to stimulate cost-effective deep renovations. It should further include a perspective for guiding investment decisions of financial institutions, construction industry and individuals as well as an estimate based on evidence of expected energy savings and further benefits. (Art. 4 Directive 2012/27/EU)

In general, there is a great potential of energy efficiency improvements in the buildings sector as 36% of EU energy consumption can be attributed to this sector and 75% of the housing stock in the EU is not energy efficient. (European Parliament, 2015)

2.3.2. Article 8: Energy Audits and Energy Management Systems

Energy audits and energy management systems play a substantial role in the Energy Efficiency Directive when it comes to energy efficiency improvements in the end-use sector. (Coalition for Energy Savings, n.d.)

Article 8 of the Directive is about energy audits and energy management systems and mostly concerns companies. It states that "Member States shall promote the availability to all final customers of high quality energy audits which are cost-effective and:

(a) carried out in an independent manner by qualified and/or accredited experts according to qualification criteria; or

(b) implemented and supervised by independent authorities under national legislation." (Art. 8 Directive 2012/27/EU)

The energy audits can be carried out by in-house experts or energy auditors. In order to guarantee high quality energy audits, Member states shall create transparent and non-discriminatory criteria which should be based on the minimum criteria of Annex VI of this Directive. Annex VI states that energy audits shall be based on the following:

(a) "be based on up-to-date, traceable operational data on energy consumption and (for electricity) load profiles;

(b) comprise a detailed review of the energy consumption profile of buildings or groups of buildings, industrial operations or installations, including transportation;

(c) Build, whenever possible, on life-cycle cost analysis (LCCA) instead of Simple Payback Periods (SPP) in order to take account of long-term savings, residual values of long-term investments and discount rates;

(d) Be proportionate, and sufficiently representative to permit the drawing of a reliable picture of overall energy performance and the reliable identification of the most significant opportunities for improvement."

Recommendations are hence the result of quality and representative data collection and calculations. These calculations are expected to be built on life-cycle cost analysis and the resulting recommendations are thus based on validated and detailed calculations which take into account the residual values and full-service life of the individual measure

and its investment. (Coalition for Energy Savings, n.d.) Based on that, energy audits are supposed to provide reliable and clear information on potential energy savings within the institution. (Annex VI Directive 2012/27/EU)

Such energy audits are "systematic procedures used to identify, quantify and report existing energy consumption profiles and energy savings opportunities in buildings, industrial or commercial operations or installations, and in private or public services. (Coalition for Energy Savings, n.d.) This procedure aims to "identify and quantify cost-effective energy saving opportunities, and to report the findings". Such audits are essential to achieve energy savings as they assess the existing consumption as well as identify a range of opportunities on how to save energy.

The findings should be presented in the form of proposals of specific saving measures for home owners, public and the management and include concrete measures on energy savings. The audits further identify and prioritize different ways of improvement Hence, the information gap, which is one of the key barriers of energy efficiency, can be tackled by conducting energy audits. Results of such energy audits may be a recommendation to replace windows in a household or to insulate piping in a factory. (European Commission, 2013a)

In contrast to the 2006 Energy Service Directive which required Member States to ensure only the availability of high-quality and efficient energy audits to all final customers, the Energy Efficiency Directive places a clear obligation on large companies to carry out energy audits on a regular basis. (Coalition for Energy Savings, n.d.)

Thus, this article affects "large enterprises" (> 250 employees and more than EUR 50 million turnover or a balance sheet over EUR 43 million). Hence, large enterprises are thise that are not Small and Medium Enterprises (SMEs), defined as "enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding EUR 50 million and/or an annual balance sheet total not exceeding EUR 43 million". In this way, the main criterion is the number of employees complemented by a financial criterion, which is turnover or the total of the balance sheet. (European Commission, 2013a) Member States shall further ensure that energy audits are carried out independently as well as in a cost-effective way by accredited and/or qualified experts at the latest by 5 December 2015 and every four years after the previous audit.

SMEs are not obliged to take actions, however, it is mandatory for Member States to ensure that initiatives are set to encourage SMEs to conduct measures on energy efficiency. (Kaar, et al, 2017; Art. 8(2) Directive 2012/27/EU)
The reason why there is a threshold for the size of the companies which have to carry out energy audits is, that large companies have a higher energy consumption than SMEs, and hence there are greater energy saving potentials. Furthermore, such audits are a smaller cost burden for larger companies than they are for SMEs, households or smaller end-users. (Coalition for Energy Savings, n.d.)
Although SMEs are not required to carry out energy audits, the Directive actively promotes that Member States should bring energy audits and management systems to the attention of SMEs to give them the possibility to also get out such valuable information and to have the chance for energy improvements by implementing the resulting recommendations. Subsequently, the Directive allows to set up support schemes, including state aid, for SMEs for carrying out and implementing energy audits. Such support schemes or incentives are also allowed for non-SMEs to help them implement the recommendations which result out of the energy audits. (European Commission, 2013a)

Energy or environmental management systems are exemptions to the regular energy audits as provided in Article 8(6) Directive 2012/27/EU. This paragraph further states that the management system concerned needs to include an energy audit which is based on the minimum criteria of Annex VI. (Art. 8(6) Directive 2012/27/EU) An energy management system is a "set of interrelated or interacting elements of a plan which sets an energy efficiency objective and a strategy to achieve that objective". They need to be "certified by an independent body according to the relevant European and International Standards". Together with an energy management system, enterprises carry out a regular energy review process to reduce and control energy use. These results are equivalent to the energy audits as they review energy consumption and also identify opportunities to save energy. Additionally, separate energy audits may be carried out. (European Commission, 2013b; Art. 8 Directive 2012/27/EU) Such energy management systems need to be based on European or International Standards. This includes, for example, EN ISO 50001 or EN ISO 14000/1, which also includes an energy audit. (Coalition for Energy Savings, n.d.)

However, the usefulness of the carried-out energy audits largely depends on the effective and useful implementation of the resulting recommendations of the audits. (Coalition for Energy Savings, n.d.)

2.3.3. Article 7: Energy Efficiency Obligation Schemes (EEOS)

Directive 2012/27/EU obliges each Member State to meet certain targets related to energy savings between 1 January 2014 and 31 December 2020. In doing so, Member States need to use energy efficiency obligations schemes or other policy measures leading to energy efficiency improvements in **households, buildings, and the industry and transport sectors.** (International Energy Agency, 2014)

For the implementation of Article 7 of the EED, the following policy measures need to be in place or be established: energy efficiency obligation schemes or alternative policy measures. Either one of those measures, or a combination of both, is required.
Each Member State needs to follow certain steps which are:

1. Quantity of **energy savings** to be achieved and the spread of the **obligation period** need to be established
2. Decision about the use of **EEOS or alternative policy measures or both** and the design of the schemes or measures while ensuring that the criteria are met
3. Establishment of **targeted sectors and individual actions** to achieve the required amount of energy savings as well as establishing the way of calculating individual actions
4. Ensure **monitoring and transparency, verification and control** of the schemes or alternative measures
5. Results need to be **reported and published** (European Commission, 2013b)

Energy efficiency obligation schemes are the main instruments of the Energy Efficiency Directive. It requires "obligated parties determined by Member States – energy distributors and/or retail energy sales companies – to reduce the volume of energy sales to final customers by 1.5 % annually." (Wilson/ Sajn, 2018) Article 7 of the Directive goes more into detail about energy efficiency obligation schemes, which "shall ensure that energy distributors and/or retail energy sales companies that are designated as obligated parties (…) operating in each Member State´s territory achieve a cumulative end-use energy savings target by 31 December 2020 (…)". (Art. 7 Directive 2012/27/EU)

Alternative measures may include energy or CO2 taxes, fiscal incentives, financing schemes, energy efficiency standards and norms, Energy Efficiency National Fund, regulations and voluntary agreements, training and education and norms and labelling that goes beyond those which are mandated by the law of the EU. Eventually, it is up to the Member States how to achieve the savings, with currently having 477 different measures in use. (Wilson/ Sajn, 2018; European Commission, 2013b) Business Europe has found out that 16 Member States use EEOS under Article 7, whereby 4 of them use it as only measure and the other 12 Member States have EEOS with a combination of alternative measures. The remaining 12 Member States use only alternative measures. (Business Study Europe, 2016)

The graphs below show the expected versus realized measure types for energy savings. (Kaar, et al 2017)

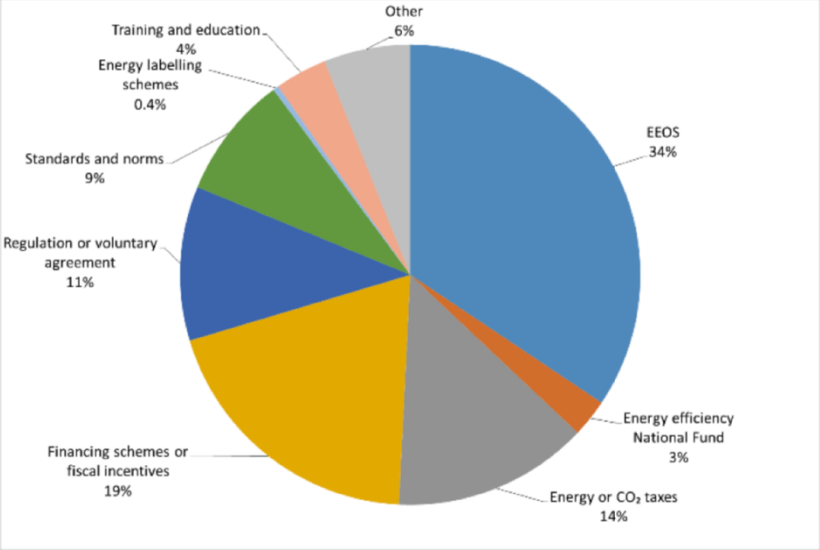

Figure 1: Realized energy savings (DG Energy in Kaar et al, 2017)

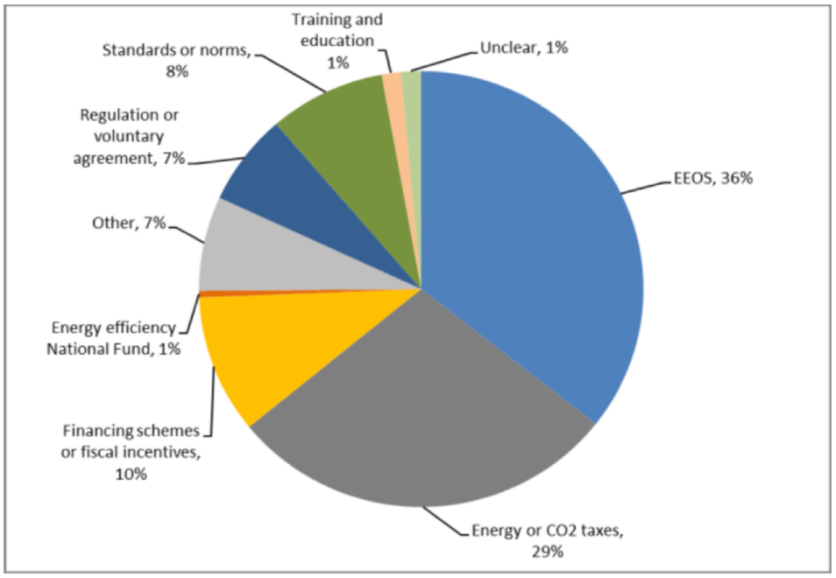

Figure 2: Expected energy savings in 2014 (DE Energy in Kaar et al, 2017)

The graphics indicate that energy efficiency obligation schemes delivered the most savings of 36%, slightly more than expected (34%), followed by energy or CO2 taxes (29%), which was expected to only contribute 14% of savings. Financing schemes or fiscal incentives only made up 10% of savings, although 19% were expected. Other measures used are training and education (1%), standards and norms (8%), regulation or voluntary agreement (7%), energy efficiency national fund (1%), other (7%), and unclear (1%). (Kaar et al, 2017)

The quantity of energy savings which has to be achieved over the period of 1 January 2014 to 31 December 2020 is calculated in the same way irrespective of the used methods to achieve the target. The Directive, in general, requires that all final energy sold to legal or a natural person needs to be included in the calculations. Generally, Member States "have to calculate the overall amount of savings required, the average of the annual energy sales, by volume, to final customers of all energy distributors or all retail energy sales companies for the three years before 1 January 2013 (i.e. 2010,2011, 2012)". The average of these figures is then to be multiplied by 1.5%, as this is the amount set by the Directive. The required amount of savings is then cumulated year-on-year up to 2020. So, when starting in 2014 with 1.5% and considering an average energy use of 100Mtoe in the years 2010, 2011 and 2012 it would amount to 10.5% in 2020 which would result in total savings of 42.0Mtoe. (European Commission, 2013b)

2.4. Directive 2018/2002 amending Directive 2012/27/EU

As part of the Clean Energy Package, the European Commission presented on 30 November 2016 a proposal for a revised Energy Efficiency Directive, which "aims to align and adapt EU energy legislation with the 2030 energy and climate goals (….), as well as to contribute to the Energy Union strategy". (European Commission, 2015) The legal framework of the European Union was constructed around the 2020 energy efficiency target of 20%. This needs to be updated with a 2030 perspective. By setting a new target, Member States and investors get a long-term perspective and hence can plan policies and investments and can so adapt their strategies to achieve energy efficiency. The European Parliament and the Council agreed to a 32.5% binding EU energy efficiency target, providing a clause indicating an upwards revision by 2023. (European Commission, n.d.i) Member States should base their indicative contributions as of 2021 on either primary energy consumption (max. 1.273 Mtoe on EU level) or on final energy consumption (max. 956 Mtoe on EU level). (Austrian Energy Agency, n.d.a)

According to projections, the primary energy consumption[1] in 2030 would amount to 1887 Mtoe resulting in a reduction to 1273 Mtoe in 2030 and final energy consumption[2] would amount to 1416 Mtoe with a reduction to 956 Mtoe in 2030. (European Parliament, 2015)

However, at Member State level there are no binding targets, but Member States are encouraged to set their national energy efficiency contributions in the light of the Unions 2030 energy consumption. (Directive 2018/2002 (6))

The following will go into detail about the amendments which were made compared to the Directive 2012/27/EU concerning the scope of this thesis and articles described above.

The energy efficiency targets in Article 3 were adapted to the new objective of 32.5% energy efficiency improvements by 2030. It was further added that the extent of the 2020 objectives have to be evaluated by the Commission in 2022 to see how they have been met. Additionally, the Directive states that the 2030 objectives have be revised and potentially adjusted in 2023. (Van de Water, 2019)

[1] "The gross inland production, excluding non-energy uses." (Art. 2(2) Directive 2012/27/EU)
[2] „All energy supplied to industry, transport, households, services and agriculture." (Art. 2(3) Direcrtive 2012/27/EU)

The objective of the Directive 2012/27/EU to draft long-term strategies in terms of renovation of the Member States´ building stock was moved to the Directive 2010/31/EU on Energy Performance in Buildings as it was evaluated to be a better fit in that Directive. (Van de Water, 2019) This Directive sets out a "common framework for calculation and certification of buildings' energy performance, requires regular inspection of heating and air conditioning systems, and obliges Member States to set minimum energy performance standards for new buildings, major renovations and the replacement or retrofit of building elements". (European Parliament, 2015) It further introduces the idea of "nearly zero-energy building" which will become the new standard for new buildings erected after 2020. (European Parliament, 2015)

Nevertheless, measures taken from these strategies can still be accounted for energy savings measures under article 7.

Article 7 originally only concerned energy efficiency obligation schemes mostly, but not only, referring to energy distributors. It is now comprised of three parts:

- Article 7: on general requirements for energy savings:

  This article includes which amount and type of energy has to be saved, i.e. energy sales of the annual final energy consumption to final customers. It further specifies which type of measures may be taken into account and how the savings can be calculated.

- Article 7a: on energy efficiency obligation schemes

  This article comprises the original article as in Directive 2012/27/EU.

- Article 7b: on options to include alternative policy measures

This article contains, amongst others, independent verification and control measures which are proposed by Member States to ensure that such measures are proportional and statistically significant. (Van de Water, 2019) Furthermore, this article states that there have to be binding final energy savings of 0.8% of the annual final energy consumption in every Member State. (Austrian Energy Agency, n.d.a)

There have been no amendments to Article 8 in respect to the revised Energy Efficiency Directive.

Member States have now until 25 June 2020 to transpose the revised Directive into national law. (Directive 2018/2002)

2.5. Progress of Energy Efficiency on EU Level

It was generally observed that following a gradual decrease in energy consumption between 2007 and 2014, there has been an increase in energy consumption between 2014 and 2017. Reasons for this recent increase could be low oil prices, result of good economic performance and because of cold winters in the years 2015 and 2016. If the trend of increasing energy consumption continues, reaching the 2020 energy targets could be at risk. Hence, further efforts are needed to deliver energy savings to meet the targets and also to provide the right basis the 2030 period when even higher ambitions are required. (European Commission, 2019b)

However, by looking at the horizon between 2005 and 2017, there has been a general decrease in energy consumption in the industrial and residential sector but an increase in the service and transport sector. (European Commission 2019b)

In general, EU Member States have implemented measures in energy efficiency in all sectors, which have contributed to decrease the energy consumption in the EU.

A more energy efficient future also brings substantial benefits for European citizens which include:

- Energy consumption of new buildings has halved compared to the 1980s
- More energy efficient appliances will save consumers money on their energy bills – around €465 per household
- Energy intensity decreased by 16% in EU industry between 2005 and 2014
- The rolling out of millions of smart meters for electricity and gas lead to much better savings and information for consumers

Even further benefits are to be expected in the future by implementing energy efficiency legislation and energy efficiency programs in Europe. (European Commission, n.d.i)

3. Austrian Energy Efficiency Act

This chapter analyzes the Austrian Energy Efficiency Act and goes more into detail about how the Energy Efficiency Directive has been transposed into national law by looking into the articles mentioned above of the EED and how they look like in the Energy Efficiency Act.

3.1. History & Background

By implementing the Energy Efficiency Act, Austria fulfills its obligation of the Energy Efficiency Directive to transpose this Directive into national law. The EEA was passed in July 2014 and published 11 August 2014. Whereas governmental obligations entered into force 1 January 2014, obligations for companies and energy distributors entered into force 1 January 2015 and all other obligations entered into force 11 August 2014. (Bank et al., 2016) Article 3 of the EED leaves the choice by the Member States whether to set an indicative final or primary energy consumption target, a final or primary energy savings target or an energy intensity target. Austria opted for a final energy consumption target which was also communicated to the European Commission. How to reach the final energy consumption target is illustrated in the National Energy Efficiency Action Plans. (Adensam et al., 2018a)

3.2. Articles

The following sub-chapter analyzes the relevant articles of the Energy Efficiency Act in respect to the scope of this thesis and the articles of the Energy Efficiency Directive which have been analyzed above.

3.2.1. Article 4: Target

The objective of Austria aims to increase energy efficiency to reach a final energy consumption of 1.050 PJ in 2020. (Art. 4(1) EEffG)

Originally, Austria communicated a final energy consumption target of 1.100 PJ to the European Commission which was then adjusted to 1.050 PJ. (Bank et al., 2016) Austria further aims to reach a cumulative final energy efficiency target of 310 PJ. As of 2015, Austria has to report the progress of reaching its energy efficiency targets on a yearly basis by 30 April. (Art. 4(3) EEffG)

3.2.2. Article 9: Energy Management in Companies

This Article concerns the obligation to implement **energy audits or energy management systems.** It states that companies, depending on the size, have to implement measures to improve their energy efficiency and to report these measures. (Art. 9(1) EEffG) It is up to the company whether to carry out regular external energy audits or to implement certified energy management systems. (Art. 9(2) EEffG)

When opting for an energy management system, it is always combined with either an internal or external energy audit. There are different management systems which can be used which include the energy management system ISO 50001, the environmental management system ISO 14001, EMAS (Eco Management and Audit Scheme) or another energy or environmental management system which is equivalent to the systems mentioned above and is an accredited management system. (Monitoringstelle, n.d.)

When a company decides to choose carrying out an external energy audit, an expert analyzes the energy consumption of the company and derives suitable measures to improve energy efficiency. Those audits have to be in line with §17, §18 and annex III of the EEffG. (Monitoringstelle, n.d.)

Annex III EEffG identifies three categories which have to be audited in this process. These include buildings, processes and transport. In a first step, each energy consumption sector in the company is assigned to one of those categories. A category is only seen as "relevant" when the fraction in relation to the total energy consumption is above 10%. (Monitoringstelle, n.d.)

The category "buildings" includes heating, ventilation and air conditioning, cooling appliances, lighting, elevators, IT-systems, other appliances (screens, computers, kitchen appliances, etc.), photovoltaic systems etc. This category mostly concerns buildings which are not used on an industrial basis (see category "processes"). (Monitoringstelle, n.d.)

The category "processes" is comprised of operation and industrial buildings (there may be overlaps with the category "buildings"). This category covers, for example, manufacturing processes which may include systems for steam generation or for hot water, heat recovery plants, pumps, ventilation and aeration systems. In case the following examples are located in industrial buildings (e.g. in a production hall), they also

fall under the category “processes”: warehouse, packaging and logistics center, laboratories, research centers etc. (Monitoringstelle, n.d.)

The third category “transport” only involves transport processes which are associated with direct energy consumption which include:

- passenger transportation: company cars, private vehicles with an operational use, internal vehicles (e.g. busses on premises, e-bikes etc.)
- transport of goods: trucks, lift truck etc.

Indirect energy consumption of third parties can be neglected in these regards. (Monitoringstelle, n.d.)

The graphic below illustrates the distribution of the different categories divided into energy consumption and energy savings potential.

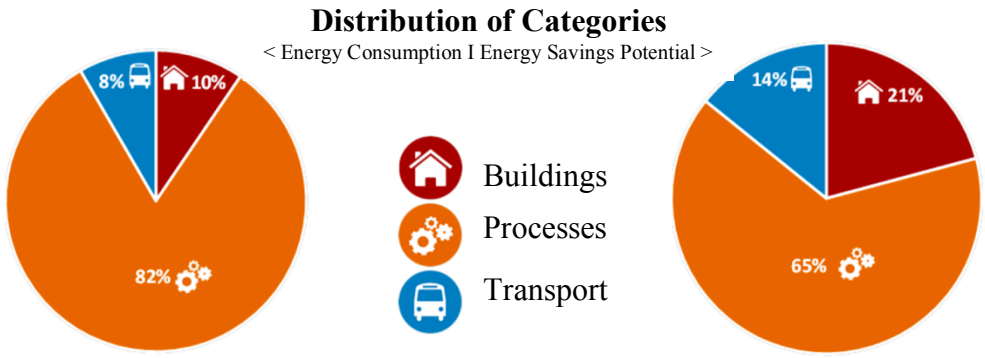

Figure 3: Distribution of audited categories (Monitoringstelle n.d.)

As a result of the energy audits it can be found that the most energy consumption is in the category “processes”. As it can be seen below, the reason for that is that 30% of the obligated large companies are from the industry sector were large parts fall under processes and industrial companies, in general, have a higher energy consumption than service companies. Furthermore, the potential for energy savings is also highest in the category “processes” whereas there is also a high potential for energy savings in the sectors buildings and transport as the current energy consumption is 18% but the potential in energy savings is 35%. (Ploiner et al., 2018)

In 2016, 1.893 companies were reported to be obligated, large companies under Art. 9 EEffG. The following graphic shows the different industries of the obligated companies,

whereby the production sector made up the largest share followed by personal services and associations. (Ploiner et al., 2018)

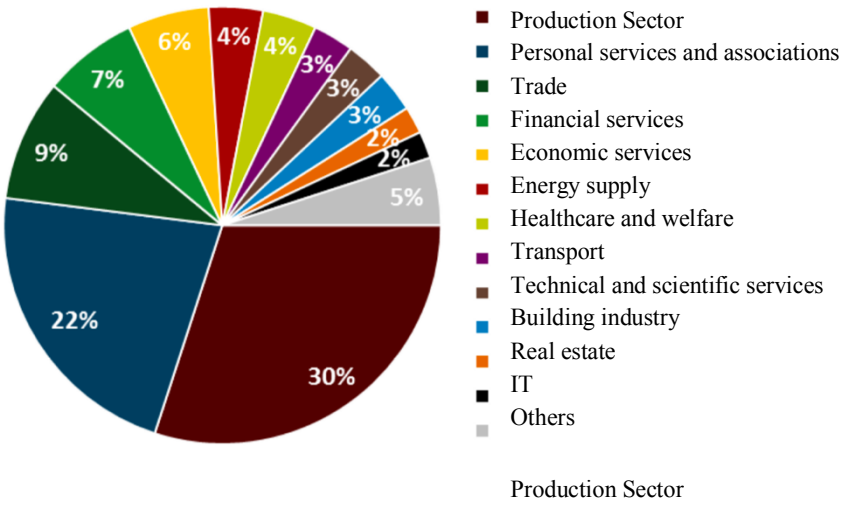

Figure 4: Sector distribution of obligated, large companies (Ploiner et al., 2018)

In total, 1.454 energy audits were carried out, divided into 901 external audits and 553 internal audits. Almost half of the internal audits were carried out in the production sector, i.e. industry. This can be explained by the fact that energy and environmental systems were already a common practice in the industry sector before the implementation of the Energy Efficiency Act and as energy and environmental systems come together with internal energy audits, the share of internal audits is highest in this sector. The most common energy management system in Austria is ISO 50001 (56%) followed by ISO 14001 (32%) and EMAS (7%). (Ploiner et al., 2018)

When adding up the energy consumption of all audited companies, it makes up around 51% of the gross domestic energy consumption. (Ploiner et al., 2018)

3.2.3. Article 8: Energy Management Obligation Schemes

The headline target in terms of energy savings that Austria communicated to the European Commission amounts to originally 1.100 PJ which was later adapted to 1.050 PJ. The graphic below shows the final energy consumption of Austria from 2005-2016 including the target of 1.050 PJ in 2020. (Ploiner et al., 2018)

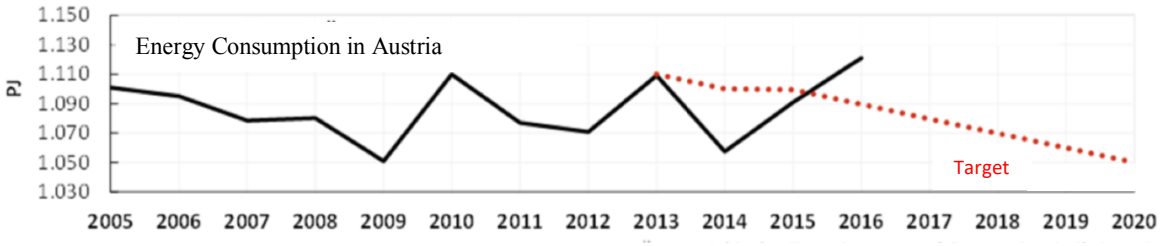

Figure 5: Final Energy Consumption in Austria until 2020 (Austrian Energy Agency / Statistik Austria in Adensam et al., 2018b)

The original figure of 1.100 PJ results out of the following calculations and assumptions based on the explanations above (Ch. 2.3.3): when considering a prognosed final energy consumption of 1.325PJ in 2020, a 20% reduction of that value results in 1.100PJ. The mean value of Austria´s final energy consumption from 2010-2012 amounts to 1.112PJ so therefore the binding 1.5% target (according to the EED Art. 7) is about **218PJ** cumulated until the year 2020, which is 7,77 PJ per year or 54,4 PJ in 2020. (Ploiner et al., 2018)

The Energy Efficiency Act, however, set a cumulative energy efficiency target of 310PJ. In case of not reaching those 310 PJ, it would not result in a contract violation with the EU as the EU obligation is only 218 PJ. (Ploiner et al., 2018)

Austria further chose to implement a combination of an energy efficiency obligation scheme concerning energy distributors (159 PJ) and strategic measures concerning public bodies (151 PJ) to reach the set target value 310 PJ. (Ploiner et al., 2018)

The following lists the reported measures of the obligation scheme and strategic measures according to the National Energy Efficiency Action Plan 2017:

- Energy efficiency obligation schemes
- Housing-, energy-, and environmental aid of the states

- Domestic environmental aid
- Energy taxes
- Highway toll for trucks
- Rehabilitation of the Austrian federal government
- Climate active mobile
- Climate- and energy fund (Adensam et al., 2018a)

3.2.4. Article 10: Energy Efficiency for Energy Distributors

Obligations for energy distributors are regulated in Art. 10 of the EEffG. The individual obligations for energy distributors depend on the energy sales to the final customers in Austria. Each distributor who sold at least 25 GWh to domestic energy consumers over the last year has to implement energy efficiency measures of 0.6% measured by the last year´s energy sales. (Adensam et al., 2018a) In 2016, 454 companies reported to be obligated energy distributors under this article. (Ploiner et al., 2018)

Those measures can either be carried out by the distributors themselves, at the final customer or other energy consumers in Austria whereas 40% of savings have to be realized in households. (Energy Efficiency Agency, 2016) The following graphic indicates the different measures which were reported whereby the most energy savings were made in the category heating systems and warm water followed by savings through energy taxes. (Ploiner et al., 2018)

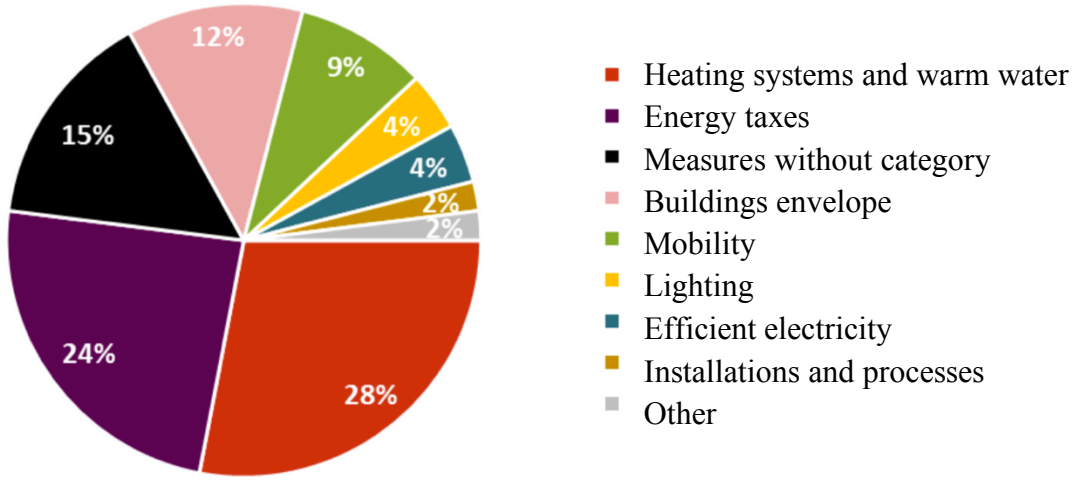

Figure 6: Sectors of energy savings (Ploiner et al., 2018)

Reports show that energy distributors in general "over-fulfilled" their obligations concerning the 40% household ratio as well as the total savings target. However, not every single distributor was able to fulfill their individual targets. (Ploiner et al., 2018)

3.3. Progress of Energy Efficiency in Austria

The following will look into the progress that Austria has made in terms of energy efficiency in the last years mainly due to the implementation of the Energy Efficiency Directive and subsequently the Austrian Energy Efficiency Act. The latest reports are mostly from the year 2018 with data from the years until 2016.

Since the oil crisis in the 1970s, Austria managed to greatly improve energy efficiency and to decouple energy consumption development from the economic development. Hence, it can be observed that funding of efficient technologies and buildings as well as through the implementation of the energy efficiency act, eco design guidelines and the directive on energy performance of buildings contributed to the decoupling of energy consumption and economic development. The following graphic supports this view by indicating gross domestic consumption and gross domestic product (real) from 2005 (base year) to 2016. (Thenius/Ploiner, 2018)

The development of the final energy consumption, in general, depends on economic growth, population growth and the temperature profile. As those are volatile and hardly influenceable indicators, it is uncertain (but likely) whether Austria reaches its target of 1.050 PJ. Based on the latest data, however, final energy consumption in the year 2016 amounted to around 1.121 PJ. (Thenius/Ploiner, 2018)

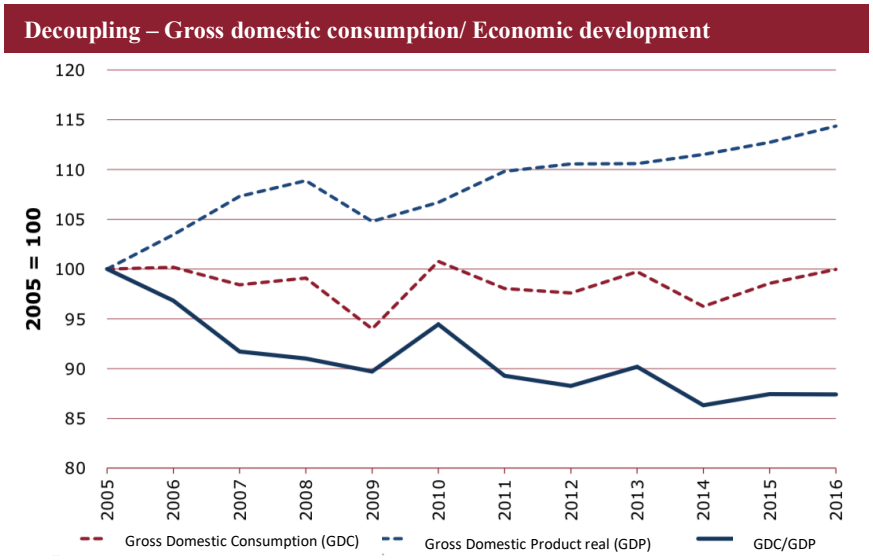

Figure 7: Decoupling: Gross domestic consumption and economic development (Thenius/Poliner 2018)

There will be an increase in final energy consumption in the sectors agriculture, services but most of all in the industry sector. Hence, there will be an increase in final energy consumption from 2020 to 2030 which regards to economic development. Although there is a general decoupling between economic development and energy consumption, there is still no complete decoupling, especially due the economic development in the industry sector with very energy intensive sub-sectors. Thus, energy efficiency improvements until 2020 will be highest in the sectors household/ buildings and mobility. Energy savings in the mobility sector can be attributed to more efficient vehicles and the increase of e-mobility and hybrids. Energy savings in households/buildings are reached mostly through building renovations. (Baumann et al, 2016)

4. Mission 2030

This chapter looks into the Austrian climate- and energy strategy #mission 2030 by elaborating crucial fields where energy efficiency plays a major role. As mentioned in the previous chapter, many energy savings can be made in the fields of mobility and buildings/households. These sectors will be looked at more closely as well as fields of action within the #mission2030 where energy efficiency also plays a role.

In May 2018, Austria presented its climate- and energy strategy #mission 2030 which was established to provide guidelines for different fields of action in climate and energy related areas until 2030 to reach decarbonization until 2050. This strategy was established to further work on climate and energy strategies beyond 2020 and to be in line with international climate targets as well as to contribute to international climate and energy policies by further reducing CO2 emissions, improving primary energy intensity and to increase the share in renewable energies. (Stadt Wien, 2018; Federal Ministry of Sustainability and Tourism, 2018a)

It focuses primarily on renewable energies and energy efficiency as new standards for investments. (Thenius/Ploiner, 2018) This climate- and energy strategy serves as framework for Austria´s federal states, cities and communities which established their own energy-, mobility-, and climate strategies (e.g. SEP 2030[3] Vienna) for further measures in these areas to achieve Austria´s energy- and climate targets. (Federal Ministry of Sustainability and Tourism, 2018a) The strategy was generally developed in order to go beyond the 2020 timeline to establish further measures until 2030 to reach the overall 2050 climate- and energy targets. (Federal Ministry of Sustainability and Tourism 2018d)

The overall target of this strategy includes the reduction of greenhouse gas emission by setting a target to reduce greenhouse gas emission in Austria by 36% compared to 2005. In order to reach that goal, energy efficiency accounts for one of the most economic measures and is therefore favored by the Austrian government as effective measure to reduce greenhouse gas emissions. As the majority of greenhouse gas emissions is energy related and is generated by burning fossil fuels, the increase of energy efficiency as well as the transformation to renewable energy are the most important instruments for a greenhouse gas reduction.

[3] Städtisches Energieeffizienz-Programm 2030

Therefore, Austria further aims to produce electricity to 100% out of renewable energy sources until 2030. In order to reach that goal, renewable energy carriers, infrastructure, and storage need to be remodeled and extended and investments in energy efficiency are needed. Hence, key areas of #mission 2030 are greenhouse gas emission, renewable energy and energy efficiency which, when compared to 2005, have made considerable progress in terms of improvements already. In terms of energy efficiency, the federal government wants to concentrate on less bureaucracy-depending energy efficiency measures in companies and households. There are many energy efficiency potentials in the buildings sector as well as in mobility and industry and SMEs. (Federal Ministry of Sustainability and Tourism, 2018a)
In order to reach the goals of #mission 2030 and to fulfill the requirements of the Energy Efficiency Act, the Austrian Energy Efficiency Act needs to be re-evaluated and adapted. This process has started in September 2018 in order to adapt to the revised EU-regulations for 2030. (Federal Ministry of Sustainability and Tourism, 2019; Federal Ministry of Sustainability and Tourism, 2018a)

As mobility and buildings are two areas with high energy efficiency savings potential, this chapter will further analyze energy efficiency in these sectors in the #mission 2030. #mission 2030 provides eight tasks on how the government plans to reach the set climate- and energy targets. These eight tasks include:

1. "Develop infrastructure for a sustainable Austria
2. Create the necessary economic framework and mobilize investments
3. Targeted adjustment of the funding and tax system to achieve climate and energy targets
4. Legal framework for a climate-friendly Austria
5. Research and innovation as keys to a successful business location
6. Each and everyone´s responsibility – education and awareness-raising for a sustainable future
7. Use technology for decarbonization
8. Make urban and rural areas more climate-friendly" (Federal Ministry of Sustainability and Tourism, 2018a)

By looking into these tasks, it can be observed that all of them involve the topic of energy efficiency and that mobility and buildings renovation play a major role.

4.1. Develop Infrastructure for a Sustainable Austria

The following will go into detail about infrastructure development in the sectors mobility and buildings.

4.1.1. Mobility

In terms of a clean mobility infrastructure, it is essential that mobility becomes climate-friendly, hence to constantly reduce fossil energy vectors. In order to do so, the physical and digital infrastructure needs to be converted. Improved public transport, mobility management as well as the use of digitalization for new mobility services like car sharing or ride sharing play a major role but also improved cycle and pedestrian path infrastructure are essential. (Federal Ministry of Sustainability and Tourism, 2018a)

Public transport will be crucial for the transport system of the future as it is much more energy efficient and space saving than cars. Therefore, the maintenance and development of public transport and thus mobility in urban and rural areas is very important.

Furthermore, cycle and pedestrian traffic need to be developed further by increasing the standard of such traffic infrastructures as the use directly depends on it. By further developing the Cycle Master Plan[4], the percentage of cycling in Austria should increase from 7% to 13% and the Walking Master Plan[5] should encourage more pedestrian traffic.

In terms of e-mobility and alternative propulsion methods, investments in the development of infrastructure, especially the charging infrastructure, are essential in order to promote that sector. (Federal Ministry of Sustainability and Tourism, 2018a)

4.1.2. Buildings

27% of Austria´s energy consumption go to space heating, hot water and air conditioning. This amount could be widely reduced provided that good thermal insulation is in place. This means that a high renovation rate is necessary for the current building stock and for new buildings, this means to strive for the highest thermal standards as well as energy supply non-fossil fuel sources. This means to switch to renewable energy systems such

[4] The Cycle Master Plan is the national cycle traffic strategy which aims to promote cycle traffic in Austria by focusing on consultation, funding and awareness-building as well as putting the economic and health factor in the center of this strategy. Also the promotion of e-bikes as well as the integration of cycle traffic within public transport play a major role. (salzburgrad.at 2015)

[5] The Walking Master Plan aims increase the status of walking traffic by increasing awareness of the importance of walking, by improving the framework conditions and by providing the right measures to promote walking traffic. (Federal Ministry of Sustainability and Tourism 2018b)

as heat pumps, solar energy or local and district heating and away central heating fueled by fossil fuels. (Federal Ministry of Sustainability and Tourism, 2018a)

4.2. Create the necessary Economic Framework and mobilize Investment

It is important to have the right economic framework in place as well as to mobilize investments in order to realize certain measures. (Federal Ministry of Sustainability and Tourism, 2018a)

4.2.1. Mobility

An economic framework has essential impact on traffic development and mobility behavior, especially funding and tax schemes and public investment and services. Hence, creating an economic environment and tailored services in freight and passenger traffic is very important for a carbon-free and sustainable transport system.

Tax incentives for the purchase and use of low-emission and more efficient vehicles need to be enforced as well as to promote traffic prevention behavior by offering tele-working or eco-friendly delivery systems. Also freight traffic plays a major role to reach the climate- and energy targets. The goal is to switch more freight to rail. This, however, is only possible by providing better services and to ensure true-cost pricing. (Federal Ministry of Sustainability and Tourism, 2018a)

4.2.2. Buildings

As around 27% of final energy consumption in Austria are attributed to space heating, cooling and hot water in buildings, the buildings sector is also key in achieving the climate- and energy targets with the goal to reduce greenhouse gas emission by 3 million tons CO2 equivalent to 5 million tons CO2 equivalent. The highest potential in these regards offers the current building stocks, but also the improvement of thermal standards in new buildings and renovations are important. Between 2020 and 2030 the rate of renovations aims to be increased from 1% to 2%. (Federal Ministry of Sustainability and Tourism, 2018a)

4.3. Targeted adjustment of the Funding and Tax System to achieve Climate and Energy Targets

Potential for investment as well as the economic framework are essential in order to achieve the targets of this strategy. It is important to ensure that climate- and energy

related measures can be financed and implemented. (Federal Ministry of Sustainability and Tourism, 2018a)

4.4. Legal framework for a Climate-friendly Austria

Besides establishing a new Energy Act to enable the development of renewable energy to allow the production of enough electricity to cover 100% of the national consumption from renewable sources in 2030, there also need to be reconfigurations in the national framework of energy efficiency post 2020. While the current Energy Efficiency Act complies with EU law to increase energy efficiency until 2020, there needs to be action in order to adapt to the new 2030 developments in energy efficiency sector within the European Union. A process has started in September 2018 to evaluate the current Energy Efficiency Act to adjust to EU rules by having consultations with important stakeholders of relevant industries. (Federal Ministry of Sustainability and Tourism, 2018a)

4.4.1. Mobility

Not only the economic environment but also the legal environment influences the development of the transport system. This concerns especially the environmental impact of different means of transport (e.g. limits on emissions) as well as to laws that govern traffic organization and sequencing (e.g. speed limits). Because of Austria´s federal structure, responsibilities are spread among federal government, regional, urban and local authorities. Hence, proper collaboration and coordination amongst all is vital to carbon-free traffic and zero-emission mobility by coordinating strategies and key areas. (Federal Ministry of Sustainability and Tourism, 2018a)

4.4.2. Buildings

Buildings which are erected after 2020 will not require renovation until the year 2050 and need to meet the highest efficiency standards and not require any fossil fuels for hot water, cooling or space heating. Necessary regulations in regard to buildings should be adopted by 2020 at the latest. Klimaaktiv[6] already developed building standards which highlight relevant requirements for the post 2020 period. There are many different types of buildings (densely built-up areas, commercial housing, small building units, office

[6] Klimaaktiv is an initiative by the federal ministry of sustainability and tourism for aktive climate protection and is part of the Austrian climate strategy. Its goal is a rapid and broad launch of climate-friendly technologies and services. (Federal Ministry of Sustainability and Tourism n.d.)

buildings, schools etc.) which have different requirements and different energy consumption profiles. Nevertheless, the building envelope of all types of buildings should be as efficient as possible in terms of heating and cooling requirements in order to consume little additional energy. (Federal Ministry of Sustainability and Tourism, 2018a)

4.5. Research and Innovation as Keys to a successful Business Location

Another goal of the climate and energy strategy is for Austria to be an innovation leader in the energy sector. In order for that to happen, it needs an increase in public-sector research and innovation. By providing direct research grants, this leverage effect aims to attract private investment in the field of energy innovation. (Federal Ministry of Sustainability and Tourism, 2018a)

4.6. 4.6 Each and Everyone´s Responsibility – Education and Awareness-raising for a Sustainable Future

This strategy wants all citizens to actively participate in the energy system. The demand for climate-friendly and energy efficient products, services and technologies can be enhanced by increasing the awareness and thus also stimulating investments.

By raising awareness, it is possible to bring the importance of climate protection and energy efficiency as well as how to deal with energy resources to the public. The success of the measures of the climate and energy strategy strongly depends on the fact whether people identify with them or not. Hence, it is vital to make sure that consumers are informed and included in the processes of reaching the targets and are motivated to make personal contributions.

By integrating subjects of energy efficiency, resource and climate protection and energy use alongside the whole education chain will help to initiate changes in behavior on the short term and a rethinking in the long term.

Another tool is energy consulting. By providing energy advice, one can guarantee that energy is being used in a more efficient way by the public. Giving out information about energy efficiency can support households in saving energy and thereby to also cut costs. Hence, energy efficiency skills need to be enhanced across the whole population in order to achieve sustainable results. (Federal Ministry of Sustainability and Tourism, 2018a)

4.7. Use Technology for Decarbonization

A number of innovative inventions come from the Austrian market, especially the eco-industry in Austria is very innovative. As the demand for environmental and energy technologies is likely to increase in the future due to the Paris Climate Agreement, it is even more important for Austrian energy and environmental engineering to express their technological and innovative leadership. Austrian firms have proven special innovation in the fields of low-emission mobility, e-mobility, bio-energy engineering but most importantly here also in the energy efficiency sector. Austria even ranks first and second in terms of new patents which are registered in the EU in the energy efficiency sector and transport/mobility sector.

In terms of mobility, especially e-mobility in the vehicle sector, a change is needed in order to establish a low-CO2 mobility framework. In these regards, the alternative to the combustion engine is e-mobility coming from renewable energy. Creating a charging and fueling infrastructure is essential, but e-mobility must also be integrated into the energy system of the future in the long term by solving the problem of energy storage. (Federal Ministry of Sustainability and Tourism, 2018a)

4.8. Make Urban and Rural Areas more Climate-friendly

Land use is an important factor in order to achieve climate objectives and for an economic energy resource use.

Cities play a major role in these respects, hence urban regions need to be more climate-conscious, functional and energy-efficient. Thus, energy standards for neighborhoods and districts need to be developed in accordance with climate-friendly energy supply systems and it needs a common approach to buildings, energy, urban development and energy systems.

Energy spatial planning is essential for the implementation of innovative energy concepts which are based on locally available and cheap renewable energy, integrated mobility systems as well as the use of waste heat. It will be further important in the future to provide businesses and buildings with efficiently produced district heating. Here the production of renewable energy sources, combined heat and power as well as waste heat produced from factories will play a vital role.

Different settlement patterns, so the distribution of land uses such as work, housing, leisure, shopping, education and services have an important impact on transport which is needed to combine all these patterns. There need to be changes in these patterns in order

to reduce transport or even avoid it at all. The link to public transport is a vital criterion as mobility is greatly influenced by the quality of environment, so is also the attractiveness of cycle or pedestrian routes. Therefore, the right land use planning and spatial planning is essential to mobility and even more important in terms of climate. (Federal Ministry of Sustainability and Tourism, 2018a)

These eight tasks demonstrate, that action is needed in order to reach Austrian climate- and energy targets. One can also observe that energy efficiency itself, as well as the sectors of mobility and buildings where there is a large energy efficiency savings potential, play an essential role in these tasks.

The climate- and energy strategy and its targets are the basis for the Integrated Energy and Climate Plan for Austria and set strategic targets in the five important fields of the Energy Union which include internal market energy, security of supply, energy efficiency, competitiveness, decarbonization and energy research. A governance system for the Energy Union entered into force in December 2018 and ensures that energy and climate targets can be reached at EU level and that each Member State contributes to achieve these targets. (Federal Ministry of Sustainability and Tourism, 2018a)

5. Implementation

The following chapter looks into the implementation of energy efficiency in companies, in particular in terms of energy audits as well as the implementation of energy efficiency in Austria in general. For that, interviews with energy audit experts were conducted to get first-hand information and experience about the state of energy audits and the progress of implementations. The interviews are backed with information from literature and different progress reports which were conducted to assess the current situation of energy efficiency.

The following will summarize the information gathered from the two experts on the topic of energy efficiency and externally conducted energy audits. The questionnaire was divided into four categories: energy audits 2015, measures, energy audits 2019 and energy efficiency. The questionnaire can be found in Annex 1.

5.1. Energy Audits 2015

In total, 1.454 energy audits were carried out, divided into 901 external audits and 553 internal audits. (Ploiner et al., 2018)

The latest report on the market development on energy efficiency measures, energy audits and other energy services conducted surveys among obligated large companies to report the following findings. The report distinguishes between large companies, which installed a management system together with internal energy audits and large companies which conducted an external energy audit.

Large companies installing a management system with an internal audit seem to prefer the internal audit over an external audit and will continue with this form (except 6% which think of carrying out an external audit the next time) due to the following reasons:

- for 25% external audits are more expensive
- 12.8% argue that economic data is better protected
- 23.1 % say that company know-how is better protected and
- for 22.4% external audits seem to influence the daily business over a longer period of time
- 10.3% other reasons

In terms of recommended energy efficiency measures in companies that implemented a management system with internal audits, over 80% of the recommended measures were realized as shown in the graphic blow.

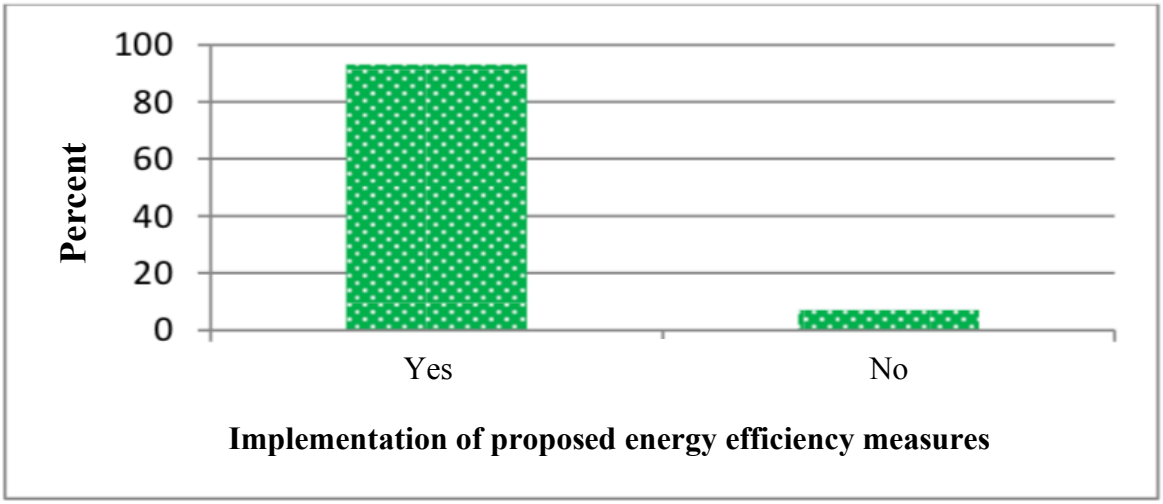

Figure 8: Implementation of recommended energy efficiency measures in companies implementing a management systems and internal audits (Schuch/Simader, 2017)

Large companies which carried out external energy audits also largely prefer to stick to this method (except 14% which consider an internal audit) compared to internal audits as:

- internal audits are more expensive
- an external energy audit brings energy efficiency know-how into the company
- Internal audits seem to influence the daily business over a longer period of time and it takes more company-own resources

The following graphic indicates that over 70% of the companies that carried out external audits also realized the recommended energy efficiency measures which resulted out of the audits.

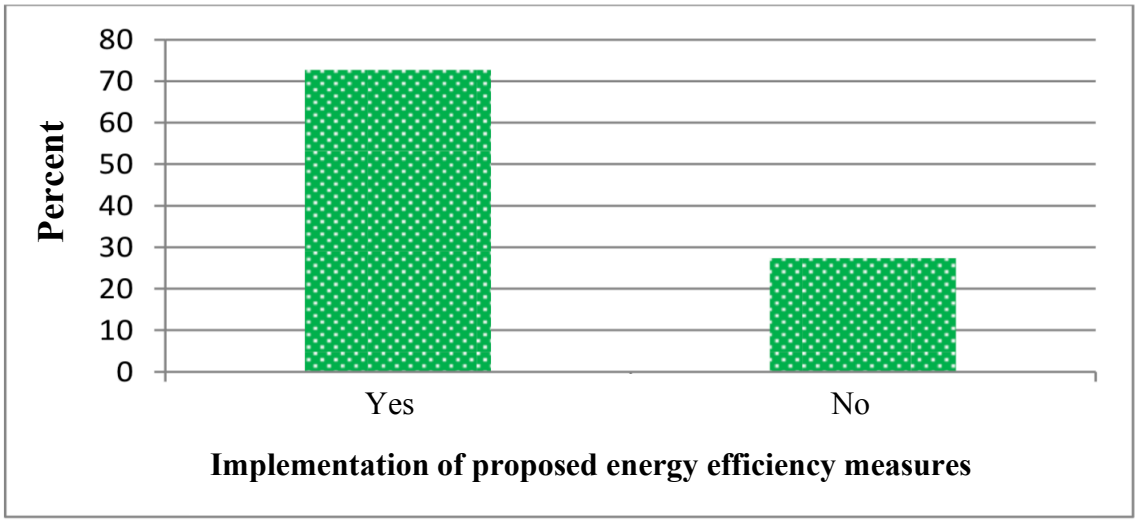

Figure 9:Implementation of recommended energy efficiency measures in companies carrying out external energy audits (Schuch/Simader, 2017)

Before energy audits were introduced, energy efficiency was already a topic in most energy intensive industries as money can be saved with energy efficient operations. However, in industries were energy did not play a vital role, companies did not really pay attention to that. (Interviewee 1 & 2, 2019) It depends on the relation of energy costs to the total costs of the company whether the subject of energy efficiency was of interest or not. Energy intensive industries such as steel, paper or the chemical industry often already head some kind of energy management as energy was already an important cost factor for the company. Interviewee 2 claims that with the Energy Efficiency Act, companies which have not dealt with their energy consumption so far are now obliged to deal with it and have a closer look at their consumption and energy efficiency potential within the company. (Interviewee 2, 2019)

Since the implementation of energy audits, the norm EN 16247-1was established and provides for the following steps on how the process of an energy audit looks like:

- Initial contact
- Kick-off meeting
- Data collection
- Field work

- Analysis
- Reporting

After the initial contact and the kick-off meeting the auditor requests energy related data of the company which are then being verified and controlled when visiting the premises of the company in the framework of the field work. After that, the data are being analyzed and measures are identified. For that, energy data from previous years (here three years) are gathered and the energy demand is analyzed to see where energy efficiency measures are possible. The findings are then discussed with the company before a report is drafted in the end stating all relevant information including energy efficiency measures. (Interviewee 2, 2019; Brandl et al., 2014)

The energy savings and energy efficiency potential as well as the most energy intensive field within a company very much depend on the different industries. (Interviewee 1&2, 2019)

In general, there are three different sectors that are being analyzed during energy audits. The three sectors in which energy audits are divided into include buildings, transportation and processes.

Energy efficiency measures for **buildings** are rather difficult to implement as most measures require a very long amortization and high investments. This sector also mostly concerns industries such as banking, insurances or corporations like REWE (Billa, Bipa Merkur) which mostly only rent the buildings and thus do not want to invest in energy efficiency measures which take 10 to 15 years to pay off. The IT infrastructure is also included in this sector, however this mostly does not play a vital role in terms of energy savings. (Interviewee 1, 2019) Largely, there is not much potential for companies which can be drawn from the buildings sector as they either require long amortization (e.g. thermal renovation), the buildings are already state of the art or easy and cheap measures have already been implemented. (Interviewee 2, 2019)

The **transportation** sector mostly concerns companies which have trucks and forklifts in their vehicle fleets rather than only passenger cars as passenger cars are mostly leased and hence do not play a role. E-mobility for passenger cars is also not a big topic in companies as it is rather inconvenient and not often seen. Electric cars which are used in companies are mostly only for marketing reasons but not really used by employees. Hence, energy efficiency measure in the mobility sector make sense where trucks play a

role. In these regards, route planning is an important measure to be more efficient. Also, a lot of companies have switched to electric forklifts. (Interviewee 1, 2019)

Energy efficiency plays the most vital role in the sector **processes** which mostly concerns the manufacturing industry. Here companies strive for energy efficient operations as money can be saved by reducing energy input. In this sector, also energy audits are most important and make the most sense. (Interviewee 1, 2019)

Generally, audits are the instrument to identify the most energy intensive fields within the company and where the company can save energy to be more efficient. Which fields that are is industry-dependent. (Interviewee 2, 2019)

5.2. Energy Efficiency Measures

In terms of implementation, interviewee 1 (2019) says that most of the proposed measures are being implemented or are being considered for future operations. Such measures, which are easy and fast to implement as well as bring quick results and benefits, are those which are mostly implemented. In these regards it is important that amortization is low. As of his experience, implementation works best in companies which also own the premises, production and buildings (mostly family-owned businesses) compared to companies which are governed by a management team (mostly large, public companies). Those companies often only rent the office places and production areas and hence are not really interested in long-term measures which require a longer amortization as the management will most likely not be there anymore. Thus, family-owned businesses think in a more long-term perspective and are more interested in implementing energy efficiency measures which also pay off in the future and are more willing to invest. The problem here is that for energy efficiency measures, it often requires initial investment but pays off later in time by saving energy costs. Family-owned businesses take that into account while large, public companies are often only concerned about short-term measures which show results rather quickly (1-2 years). An example for that includes thermal renovation of buildings which takes 10-20 years to pay off which is not of interest to a company that only rents the building compared to someone who owns it. (Interviewee 1, 2019) Interviewee 2 (2019) adds that when companies see a benefit of implementation (e.g. cost benefit) that they are more willing to implement a measure and also agrees that measures which only take one to two years to amortize are more likely being implemented. Furthermore, there need to be resources within the company (e.g. personnel

that is responsible for the implementation) for a successful realization of energy efficiency measures. (Interviewee 2, 2019)

For the audits in 2015 it was for Interviewee 1 (2019) first of all important to make energy efficiency transparent in the audited companies as many of those companies have no real responsible person who tracks energy consumption and hence have no real overview over that. Therefore, the first step was to demonstrate the overall energy consumption of the company by, for example, conducting a consumption analysis. This helps the companies to get a feeling of how much energy is used in which sector. Awareness building plays a vital role in these respects. Based on that, the energy auditor suggests measures on how to operate in a more energy efficient way. This might include in the sector mobility enhancing route planning of trucks or upgrading vehicle fleet which, however, is a more expensive measure. In terms of buildings, mostly proposed measures include adapting and improving the lighting (e.g. LED) or improvements in heating and cooling. Measures in the sector of processes highly depend on the industry but might include the smart utilization of waste heat.

In the beginning, it was kind of a "force" for companies to carry out an energy audit and was seen as "additional burden". However, most companies, which have not dealt with the topic of energy efficiency and energy consumption within their company, were positively surprised of the outcome of the energy audits. Nevertheless, this depended on the measures which were presented to them. When the measures were seen as helpful then the company was willing to change something. (Interviewee 2, 2019)

5.3. Energy Audits 2019

The second round of energy audits takes place in the year 2019 as the first round took place in 2015. Energy audits need to be carried out every four years, based on the date of the previous audit. Hence, if the first audit was carried out on 30.04.2015 then the second one needs to take place at the latest until 30.04.2019. (Austrian Energy Agency, n.d.b)

The second round of energy audits is being carried at the moment. Interviewee 2 (2019) expects that there will not be as many findings in terms of energy efficiency and energy savings potentials unless there have been substantial changes within the company. Hence, he believes it will be harder to identify measures for companies to implement. (Interviewee 2, 2019) Furthermore, most of the "low-hanging fruits", i.e. measures that are rather easy to implement and rather cheap, have already been implemented or are

being recommended in this round of audits. At some point, there might not be much measures left to implement or are too cost-intensive to the company to realize them. (Interviewee 1, 2019)

In the context of the upcoming energy audits 2019, auditors look at the energy consumption and at the measures which were already implemented, and based on that, make further recommendations to achieve higher energy efficiency. (Interviewee 1, 2019) Interviewee 2 (2019) adds that they will take the old audits of 2015, will update the data and will also look at the implemented measures. In these regards, they will evaluate and comment why measures have not been implemented and if measure heave been implement, their success will be evaluated. Unfortunately, it is hard to measure the success of already implemented energy efficiency measures after only four years. This might also be a reason why some companies shy away from implementing energy efficiency measures as their success is hard to assess but management wants to see results of the projects they invest in. (Interviewee 2, 2019)

5.4. Energy Efficiency

Interviewee 1 and 2 (2019) argue that there has been progress in terms of energy efficiency (in their field of work) since the implementation of the Energy Efficiency Act. However, the contribution has only been medium to low so far.

Interviewee 1 is of the opinion, that energy efficiency measures implemented by companies have not yet contributed much to the total energy efficiency as such measures are always linked to costs. Costs are the decision-making criterion when it comes to energy efficiency measures and companies rather opt for measures which are cheap and show quick results rather than more useful ones which take longer to be paid off but would contribute much more to the total energy efficiency. (Interviewee 1) Interviewee 2 (2019) adds that energy efficiency measures implemented by large companies contribute in general that companies are more aware of their energy consumption and in using energy more efficiently. However, when comparing the energy efficiency saving compared to the total energy efficiency, companies only contribute a small fraction. Companies with high energy intensity (i.e. where real differences could have occurred) already took care of energy efficiency issues before the audit obligation and were keen on using energy in the most efficient way as this is linked to costs. Other companies, where energy efficiency has not been a topic so far, also have not really high energy

consumption, hence measures taken there only contribute very little to the total efficiency. (Interviewee 2, 2019)

5.5. Further Outlook

Regarding the criteria on who has to conduct energy audits, Interviewee 1 suggests that it would make more sense to add the criterion of energy consumption of the respective companies additionally to number of employees and turnover or balance sheet totals. This would make sense as there are large companies which rent buildings of 400m2 to 600m2 however record very low energy consumption. In this case, only the sector buildings would apply to be audited, but since there are not so many energy efficiency measure to implement, audits do not make much sense. (Interviewee 1, 2019) Interviewee 2 adds that energy consumption plays an important role, however when considering it as compulsory criterion when selecting obligated companies, it would not make much sense to take energy consumption into account as large companies with high energy consumption mostly already have measure in place to be as efficient as possible. Interviewee 2 is of the opinion that with the Energy Efficiency Act, large companies which not already have measures in place concerning energy efficiency, are now obliged to take a closer look at their energy consumption and use the potential in these companies to implement new energy efficiency measures. (Interviewee 2, 2019)

Furthermore, if electricity prices continue to decrease or stay as low as they are now, energy efficiency measures are not very attractive to implement as the price for electricity is low anyways. Higher energy efficiency prices would hence benefit to encourage companies to act. Thus, there need to be appeals for companies in order to act or change their behavior. (Interviewee 1, 2019) Interviewee 2 (2019) agrees that electricity prices play a major role as costs very much influence management decisions regarding projects that are to be implemented.

As of now, Interviewee 1 made the experience that large companies mostly carry out energy audits because they are legally required to but not out of their own interest to improve their energy efficiency or to make a change. (Interviewee 1, 2019)

Interviewee 1 (2019) furthermore claims that the usefulness of energy audits very much depends on the auditor as an audit, on the one hand, can be very technical and superficial in which case companies do not really know what to do with the findings. On the other hand, an auditor can draw up the findings of the audit in a tangible way so that the responsible people in the company understand the figures and know what they mean in

terms of operation and energy efficiency savings. Implementation of measures works much better when the energy auditors not only carry out the audit and leave the company but also support the implementation. In this way, the customer can better understand the topic and importance of energy efficiency and furthermore, awareness can be created. (Interviewee 1, 2019)

There are many energy efficiency potentials not only in large companies, but also in small and medium sized companies. While some argue that large companies have higher energy consumption than SME´s, Interviewee 1 claims that it would still make sense to also conduct energy audits in this sector as there is a much higher number of SME´s in Austria (around 329.000) than large companies (around 2.000). Hence, SME´s can also contribute to better total energy efficiency. (Interviewee 1, Federal Ministry of Sustainability and Tourism, 2018a; KMU-Forschung Austria, n.d.) Interviewee 2 (2019) says that it would not make sense to also legally oblige SMEs to conduct energy audits as they often do not have the resources to do so. He suggests offering audits on a voluntary basis and to conduct information campaigns to suggest different energy efficiency measures for SMEs.

5.6. Challenges

Reasons for insufficient energy efficiency according to Umweltbundesamt (n.d.) include

- That electricity is sold in kWh instead of s service
- Energy prices do not reflect the real costs as external costs are not taken into account
- Legal and institutional barriers (e.g. no possibility in the decision of energy efficient appliances and heating in rental apartments)
- Lack of information often hinder the use of profitable, efficient energy technologies
- Liberalization of the electricity and gas market leads only to a competition on the supply side. There is no competition between energy supply on the one hand and efficient use of energy on the demand side on the other hand
- Energy efficiency measures often lead to a rebound effect

The rebound effect is generally a problem in terms of energy efficiency. By using more efficient technologies, real savings can be realized. However, this often leads to an over-use of such technologies, cancelling out the real savings. When, for example, a building

is thermally renovated, more rooms are being heated at higher temperatures and hence energy consumption does not decrease despite a better insulation. (Umweltbundesamt, n.d.)

In general, there exists a substantial market for energy efficiency, thus there were global investments in energy efficiency between USD 310 billion and USD 360 billion in the year 2012. However, there are many opportunities missed in terms of investments in energy efficiency although these investments would be economically beneficial. Reasons for that "energy efficiency gap" include that there are "split incentives" meaning that energy efficiency investments sometimes not benefit the investor directly, but a second party (e.g. landlord invests in building insulation but savings in heating go to the tenant). Secondly, energy efficiency may require high upfront investment costs which may discourage the investor. Furthermore, the amount of energy savings are often uncertain upfront which damps the investor confidence. Thirdly, there are behavioral obstacles including short-term thinking, lack of information and uncertainty which hinder investments in energy efficiency. And lastly, also the already mentioned rebound effects may negate or diminish energy savings that result from energy efficiency measures. (European Parliament, 2015)

6. Answer of Research Questions

This chapter will answer the proposed research questions which were raised in the context of this thesis and were elaborated by conducting thorough literature reviews as well as by conducting two expert interviews with energy auditors.

How does the implementation of energy efficiency in Austria look like?

Energy efficiency has gained considerable attention on the EU level since 2007 as it is an important mean in the context of reaching decarbonization by 2050. Not only is it rather easy to implement, it is also one of the most cost-efficient ways to reduce greenhouse gas emissions. Hence, the EU introduced the Energy Efficiency Directive in 2012 to enhance energy efficiency in all Member States. EU directives require a transposition into national law and for that reason, Austria has established the Energy Efficiency Act. By the establishment of the Energy Efficiency Act, Austria has fulfilled its obligation to transpose the Directive into national law.

The Energy Efficiency Directive requires each Member State to set energy efficiency targets. Austria decided to set its targets based on final energy consumption and thus aims to reach a final energy consumption of 1.050 PJ in 2020. In order to reach that overall goal, Austria has further developed the Austrian climate and energy strategy #mission 2030 which serves as guideline on how to reach climate and energy goals. The national climate- and energy strategy further serves as framework strategy for Austria´s federal states, cities and communities which establish their own sub-strategies to reach national goals (e.g. SEP 2030).

The scope of this thesis focuses especially on the implementation of energy efficiency in companies which includes energy audits and also looks into the field of energy efficiency for energy distributors.

In terms of implementation of energy efficiency in companies, large companies have to carry out energy audits on a four-year basis where energy auditors evaluate the company´s energy consumption and provide recommendations of how the company can be more energy efficient.

Concerning the implementation of energy efficiency of energy distributors, each distributor, who sold at least 25 GWh to domestic energy consumers, needs to implement energy efficiency measures of 0.6% based on their last year´s energy sales.

To date, the implementation has worked quite well. All obligated large companies have conducted energy audits and a lot of measures in terms of energy efficiency have been implemented.
Regarding mobility, improving infrastructure of public transport, cycle- and pedestrian paths as well as further developing the charging infrastructure for electric vehicles is key here.
In terms of buildings renovation, the aim is to reduce the amount of space heating, cooling and hot water by improving thermal standards in new buildings and conduct renovations in the current building stock as this amounts to 27% of final energy consumption. There have been developed building standards for new buildings post 2020, but regardless of the building type, the aim is to have as efficient building envelopes as possible to consume little additional energy.
In general, awareness raising of energy efficiency in all fields, be it in households, governmental field or in companies, is essential for a change in behavior and for a sustainable result.

Which role does energy efficiency play in the Austrian climate and energy strategy #mission2030?

By looking into the different tasks of the Austrian climate and energy strategy it becomes clear that energy efficiency plays a major role in achieving Austria´s climate and energy targets. This thesis looked more closely into energy efficiency in the buildings and mobility sector within the #mission 2030 as it was discovered that those fields have high energy efficiency potential.
In the mobility sector, Austria tries to go away from combustion engine vehicles to reduce greenhouse gas emissions and turn to e-mobility coming from renewable sources. In terms of energy efficiency, the aim is to promote public transportation as this is much more energy efficient and space saving. Furthermore, the development of car sharing and ride sharing is another way to be more energy efficient in the mobility sector. In order to promote these means of transportation, the strategy includes to improve public transport infrastructure to make it more attractive as convenience plays a major role in the use of public transport. The most energy efficient means of transport include cycle traffic and walking which are also sectors that require an infrastructure enhancement in order to make it more attractive for users. In these regards, Austria developed the Cycle Master

Plan and Walking Master Plan in the framework of klimaaktiv, which is part of the national climate strategy of 2015.

The buildings sector also offers many opportunities to be more energy efficient and to contribute to the national climate and energy targets. Most opportunities lie in the current building stock where renovations are necessary for those buildings to become more energy efficient. Austria aims to increase the rate of renovations from 1% to 2%. Space heating, cooling and hot water are the key areas to tackle.

In order to address the areas with high energy efficiency potential effectively, there need to be adjustments to the funding and tax system and financing is key in terms of bringing energy efficiency forward. Furthermore, the legal framework in terms of energy efficiency also needs to be adjusted as the current Energy Efficiency Act targets the objectives until 2020, however adjustments need to be made for the 2030 horizon. For that reason, consultations with relevant stakeholders have already started in September 2018 to adjust the current Energy Efficiency Act to the 2030 targets.

Furthermore, it needs technological innovation in order to bring the energy transition forward. Austrian firms have proven special innovation, especially in the field of energy efficiency and rank first and second in registering new patents in the EU.

But most of all, climate and energy related issues are each and everyone´s responsibility and thus it is important to raise awareness and to offer education in the different fields, not at last in the field of energy efficiency.

How is the status of energy audits after the first round and before the second round of energy audits?

The first round of energy audits took place in the year 2015 were 1.454 obligated large companies conducted internal or external energy audits where energy consumption is being analyzed and measures to improve energy efficiency are being proposed. Before the audit obligation of the Energy Efficiency Act, mostly only companies with already high energy use took closer looks into their energy consumption profile as energy consumption is linked to costs. Other than that, no real effort was made to an energy efficient operation. With the Energy Efficiency Act, all large companies are obligated to conduct such energy audits. The success of energy audits in terms energy efficiency much depends on whether the proposed recommendations are being implemented or not. A study by Monitoringstelle showed that over 70% of the companies which were interviewed said that they have implemented or will implement the recommended energy

efficiency measures. Just less than 30% said they would not, which is often linked to the fact that such measures are cost-intensive and it is a question of funding whether a company can implement such measures or not. In which sectors energy efficiency measures are being implemented widely depends on the industry. Classic measures include switching to LED, improving heating and cooling in buildings and route planning in terms of mobility. For companies it is important that measures do not require too high investments and to have a short amortization in order for them to realize the energy efficiency measure. If companies see that they will benefit from the energy efficiency measures (e.g. save money) they are more willing to implement them. Hence, electricity costs also play a role as lower electricity costs bear lower cost savings and thus do not really motivate companies in order to implement energy efficiency measures. This shows that there need to be benefits for companies to be motivated to implement measures of any kind.

The energy audits 2019 are ongoing at the moment. Energy auditors will check if previous measures have been implemented, will update the energy related data and propose new measure. It is expected that with this round of audits and future ones, less measures will be found unless there have been changes in the company or, for example, new machinery was added. In general, it is important that companies become aware of their energy consumption and act to operate in a more energy efficient way. However, by now energy efficiency measures in companies have not yet contributed much to the total energy efficiency according to the interviewed experts, as companies only want to realize measures which are not expensive and pay off in a short period of time. These measures also only contribute very little to the total efficiency, whereas other measure, which would require higher investments and also a longer payback period (e.g. thermal renovation in buildings), are mostly not realized. In order to realize such projects, it would need higher incentives or funding for companies, otherwise it is unlikely that such measures are being realized.

Still, the current measures which are being implemented are a start to reaching the overall energy efficiency targets of Austria.

7. Conclusion & further research

Energy efficiency has gained a lot of attention over the last decade as it is one of the most cost-efficient and effective ways in reducing greenhouse gas emission. This thesis aimed at looking into the implementation of energy efficiency in Austria by analyzing the EU Energy Efficiency Directive and its implementation into national law, i.e. the Austrian Energy Efficiency Act and in more detail the Austrian climate and energy strategy #mission 2030 which was established to reach the targets of Austrian Energy Efficiency Act. The focus lied in identifying how companies have implemented energy efficiency by looking into energy efficiency audits.

Findings showed that Austria has implemented energy efficiency in several ways. The Austrian Energy Efficiency Act builds the legal framework setting national targets. The Austrian climate and energy strategy #mission 2030 builds on the national targets and established tasks for decarbonization by focusing, amongst others, on energy efficiency. Hence, energy efficiency plays a major role in the #mission 2030. This strategy further serves as framework for Austria´s federal states, cities and communities to establish even more detailed strategies to reach decarbonization and higher energy efficiency (e.g. SEP 2030 Vienna).

There are many ways to reach higher energy efficiency. The Energy Efficiency Act obliges companies to conduct energy audits to look at their energy consumption and find out where energy can be used more efficiently. So far, companies have implemented several measures for a more energy efficient operation, however there is still more that can be done. Implementation is mostly linked to investments which is often a barrier to realize energy efficiency measures. Therefore, creating benefits for companies (e.g. funding or tax schemes) would help to increase the number and effectiveness of energy efficiency measures.

As the current energy audits are still taking place and no results have been published so far, it would be of interest to evaluate the progress of energy efficiency in companies by comparing the results of the 2015 audits with the 2019 audits as well as to evaluate which measures have been realized and which not by also looking into the reasons for that.

Furthermore, this thesis identified that the mobility sector as well as the buildings sector have high energy efficiency potential and are also of high importance in the Austrian climate and energy strategy #mission 2030. It is further suggested to take a closer look

into these sectors and identify the progress of implementation of energy efficiency measures and how much they contribute to the total energy efficiency.

In conclusion it can be said, that energy efficiency is an important tool which is already been used in many sectors, however there is still a lot of potential which can largely contribute to reaching not only Austria´s energy and climate targets but also those of the European Union.

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Annex 1

Interviewleitfaden Master Thesis
Energy Efficiency in Austria
May 2019

Energie Audits 2015

Wie laufen Energieaudits ab?

Was war bei den letzten Audits Stand der Dinge im Sinne von Energieeffizienz?

Haben Unternehmen vor der Auditverpflichtung darauf geachtet?

Was sind die energieintensivsten Bereiche in einem Unternehmen?

Wo kann am meisten eingespart werden?

Maßnahmen

Welche Maßnahmen gibt es um energieeffizienter zu sein?

Wie werden diese Maßnahmen aufgenommen von den Unternehmen?

Ist Interesse im Unternehmen da, etwas zu ändern?

Werden die Maßnahmen auch tatsächlich umgesetzt?

Wenn nein, was können Gründe dafür sein?

Energie Audits 2019

Was sind die Erwartungen an die kommenden Energieaudits?

Wurden 2019 schon welche durchgeführt?

Geht man beim Audit jetzt anders vor als bei den ersten?

Wurde auf Grund von Erfahrung aus den ersten Audits etwas geändert?

Ist es Teil davon zu sehen, ob Maßnahmen umgesetzt wurden oder nicht?

Kann man sehen, ob sich die Energieeffizienz bereits verbessert hat?

Energieeffizienz

Wie würden Sie den Fortschritt von Energieeffizienz in Österreich einschätzen?

In wie fern tragen die Energieeffizienzmaßnahmen in Unternehmen zur Gesamtenergieeffizienz bei?

Was für eine Rolle spielen Energieaudits in diesem Zusammenhang?

Annex 2

Interview Guide Master Thesis
Energy Efficiency in Austria
May 2019

Energy Audits 2015

What is the process of an energy audit?

What was state of the art during the first energy audits in terms of energy efficiency?

Did companies pay attention to energy efficiency before the audit obligation?

What are the most energy intensive sectors within companies?

Where is the highest savings potential?

Measures

Which are the different measures for an energy efficient operation?

How did companies react to the different measures?

Are companies interested in changing something?

Are measures really implemented?

If not, what are reasons for that?

Energy Audits 2019

What are the expectations of the upcoming energy audits?

Have energy audits already been conducted this year?

Are there different approaches to the previous audits?

Where changes made based on experiences of the previous audits?

Is it part to see if recommended measures have been implemented?

Is it possible to see if there have been improvements in terms of energy efficiency?

Energy efficiency

How would you assess the progress of energy efficiency in Austria?

To what extent do energy efficiency measures contribute to the total energy efficiency?

What role do energy audits play in these regards?