Technology Collaboration Programme on
Heat Pumping Technologies (HPT TCP)

Annex 42

Heat Pumps in Smart Grids

Market overview: Country report for Austria

Appendix to the Final report

Operating Agent: The Netherlands

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Market overview

Country report for Austria

Report compiled by

ABSTRACT
This appendix provides the detailed summary report discussing the market overview for Austria.

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1 Executive Summary

1.1 Austrian energy market context

- In Austria, the primary energy demand in 2012 was about 395 TWh. Nearly two thirds of it was imported, especially petroleum.
- In 2012, 25 % of the Austrian final energy demand was used in the private sector, 32 % for mobility and 43 % for industries.
- The electricity consumption in Austrian is dominated by the industry (51 % of the total consumption in 2013), followed by the domestic sector (21 %).
- With a share of 68%, the Austrian electricity supply in 2014 is dominated by hydro power.
- The share of renewable energy in electricity increased continuously within the last years resulting in 82.1 % in 2014.
- The share of renewable energies in the gross final energy consumption rose from 22.7 % in 2005 to 32.6 % in 2013. Due to the national action plans, a further increase is expected.
- The Austrian electricity supply is one of the safest in the world with an availability of 99.99 %. However, because of the increased feed-in of renewables, the fluctuations created in the electricity generation have already led to critical situations.
- New investments in transmission and distribution grids are required. In addition, smarter systems for managing supply and demand are needed.

1.2 Austrian heat pump market development

- The total sales of heat pumps (home and export market) increased slightly by 1.0 % from the year 2013 to 2014, that is from 28.959 to 29.236 heat pumps
- The growth in the domestic market was limited to the small capacity sector of up to 10 kW (+10.8 %) and the domestic hot water heat pumps (+5.2 %). The sales figures in all other power ranges and applications declined.
- In the export market, slight gains could also be achieved in larger power segments.
- The positive trend in air/water heat pump sales continued in the year 2014. The relative share of this heat pump system went up from 56 % in 2013 to 62.8 % in 2014.
- In 2014, the total number of operating heat pump systems adds up to 222.966 units. Their calculated electric energy demand is 718 GWh per year.
- By now, no market models have been established by the utilities for the grid reactive operation of heat pumps, whereas so-called smart heat pumps have been introduced to the market from the beginning of 2013. These units are marked using the German “SG ready” label that stands for a uniform interface. By mid-2015, it has been granted to 817 models from 29 manufacturers.

1.3 Challenges for heat pumps which need to be overcome to realise the potential – and capture the flexibility

- the current lack of importance of heat pumps in the electricity market
- the lack of necessary incentives such as flexible tariffs
- the lack of necessary communication infrastructure such as smart metering
- the lack of useful control strategies for “smart” heat pumps

2 Overview of the Austrian Energy Sector

2.1 Overview of main challenges in Austria

According to the Federal Ministry of Science, Research and Economy, the primary energy demand in 2012 was about 395 TWh in Austria. Nearly two thirds of the demanded energy sources had to be imported. This applies especially to petroleum. The final energy consumption was about 304 TWh.

Austria can generate major parts of its electricity by using hydropower. According to E-Control, nearly 69 % of the Austrian electricity supply was generated by hydropower in 2014, 24.5 % by thermal power and 6.6 % by other renewables (wind, photovoltaics and geothermal energy). Nevertheless, since 2001, Austria must import more electricity than it is able to export. Most of the imports are received from Germany and the Czech Republic, whereas most of the exports go to Switzerland and Germany.

In the last few years, the installed capacity of wind and photovoltaics in Austria has been steadily increasing (Oemag, 2015). According to Eurostat, the percentage of renewable energies in the gross final energy consumption rose from 22.7 % in 2005 to 32.5 % in 2013. Due to the national action plans, a further increase is expected. As in other European countries, Austrian goals comprise - besides the further increase of renewable energies - growth of energy efficiency, reduction of CO_2 emissions and improved energy independence (Smart Grids, 2015).

Nevertheless, the temporal fluctuation of renewable energies like photovoltaics and wind leads to a reduced flexibility and controllability of a considerable part of the energy generation and hampers the integration into electricity grids. Furthermore, renewable energies are mostly installed decentralized, hence changes and innovations in a so far central-driven electricity supply have to be conducted (Smart Grids, 2015) (Bletterie, 2015).

Smart grids seem to be a proper solution for this problem. These grids should enable an energy- and cost-efficient balance between generator, provider, consumer and energy storage. To integrate these concepts, that have already been used in individual technologies, into the electricity distribution grid, poses technical, economical, legal and organizing challenges (Smart Grids, 2015) (Bletterie, 2015).

2.2 Austrian electricity generation

2.2.1 Development of the Electricity Generation, Imports and Exports

According to E-Control, the electricity generation in Austria has strongly increased in the last century, especially after 1940. Figure 1 shows the annual electricity generation from 1920 to 2014 (without imports) divided by fuel type. It is obvious, that hydropower plays a key role (about 68 % in 2014), but also thermal power (gas and coal) has a significant share (about 25 % in 2014) in the electricity generation. Since the year 2000, also wind, photovoltaics and geothermal energy yield a recognizable amount (7 % in 2014) in the generation of electricity.

In Figure 2, the Austrian electricity generation in 2014 is depicted. As shown, thermal power plants mostly use coal, natural gas and biogenic fuels. Wind energy represents the most important renewable energy source in the electricity generation. In 2014, 82.1 % of the Austrian gross national electricity consumption was generated from renewable energy sources (E-Control, 2015a).

Figure 1 – Electricity generation from 1920 to 2014 divided by fuel type (E-Control, 2015i). Until 2000, there is a value for every five years, afterwards, a value for each year exists.

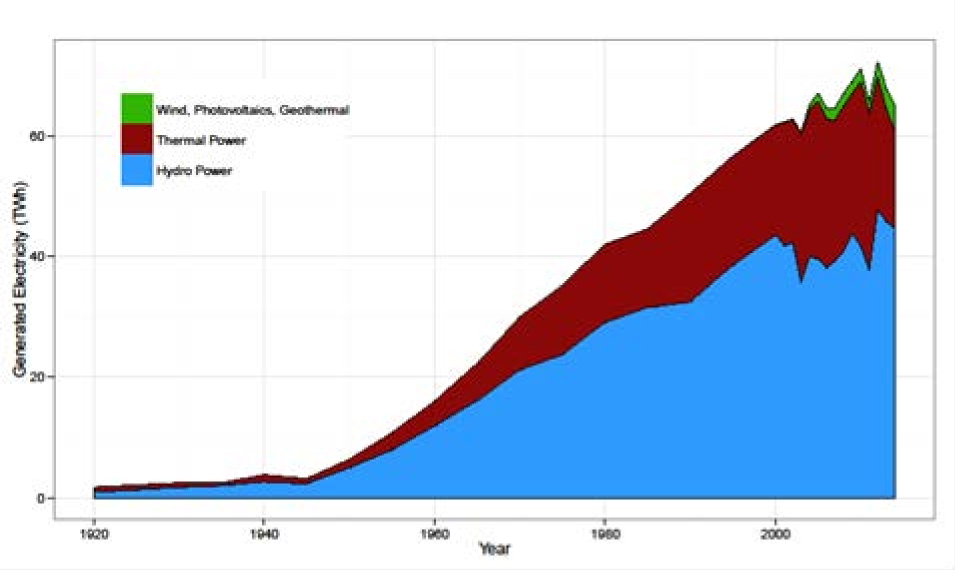
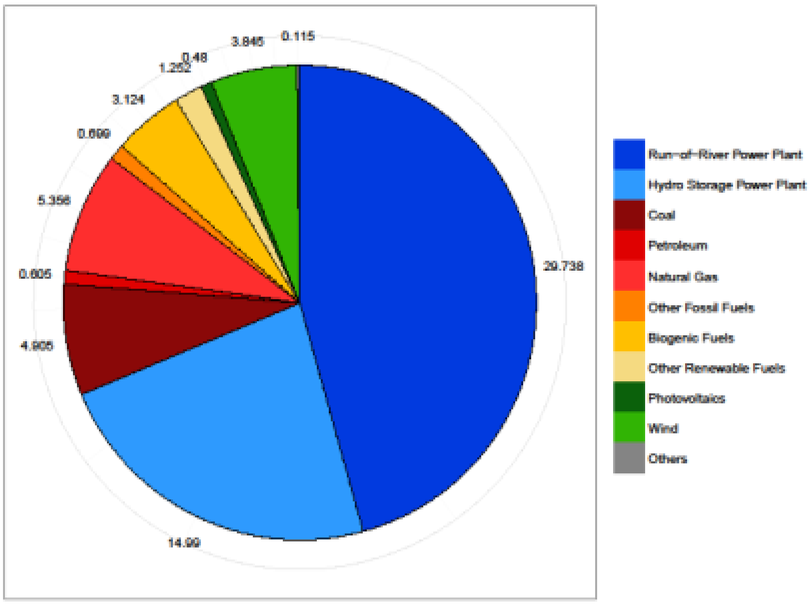


Figure 2 – Austrian electricity generation 2014 in TWh, divided by fuel type (E-Control, 2015j).

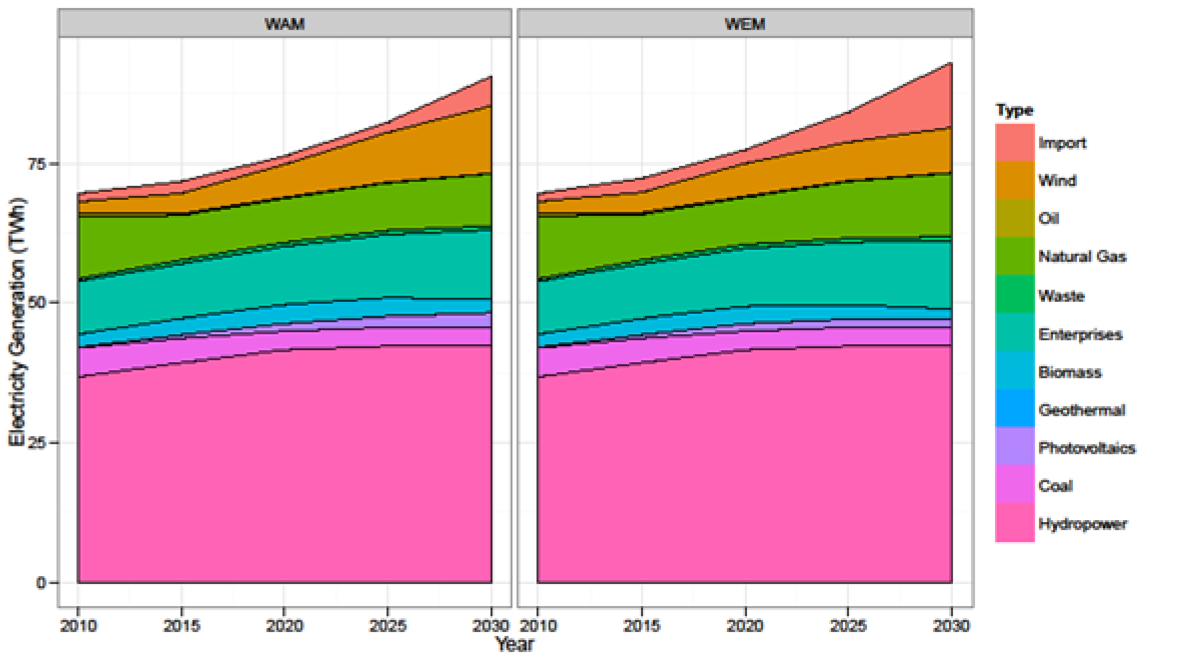


In 2013, the Austrian Federal Environment Agency has released a report, in which two scenarios for the future electricity generation in Austria have been introduced. Both include assumptions on the economic growth and the implementation of important measures.

- The WEM-Scenario (**W**ith **E**xisting **M**easures):
  This scenario considers every measure that has been mandatorily implemented until March 8th, 2012.
- The WAM-Scenario (**W**ith **A**dditional **M**easures):
  This scenario also considers measures, the implementation of which is regarded as likely.

Resting upon these two scenarios and with data from Statistik Austria, the WIFO (Österreichisches Institut für Wirtschaftsforschung, Austrian Institute of Economic Research) and estimations of the Federal Environment Agency, values for the future electricity generation in Austria have been calculated (UBA, 2013). These results are presented in Figure 3.

Figure 3 – Two scenarios for the future electricity generation in Austria (until 2030). Left: WAM-scenario, Right: WEM-scenario (UBA, 2013).



In the WAM-scenario (left), the increase of wind energy is more significant, than in the WEM-scenario (right). Generally, renewable energies are used more intensively in this scenario, which allows keeping net electricity imports lower.

The WEM-scenario (right) shows an obvious increase in net electricity imports. The contingent of oil and coal is steadily decreasing, whereas wind and photovoltaics get more and more important. The amount of biomass is nearly constant over the years, geothermal energy is barely used.

Both scenarios show an obvious increase in the total electricity generation.

Figure 4 depicts the physical Austrian electricity imports and exports from 1920 to 2014, according to E-Control. Since 2001, electricity imports (mainly from Germany and the Czech Republic, but also from Hungary, Switzerland, Italy and Slovenia) have exceeded national electricity exports, which go to Switzerland, Germany, Slovenia, Italy, the Czech Republic and Liechtenstein. Figure 5 and Figure 6 show the national physical imports and exports divided by country.

Figure 4 – Left: physical electricity imports and exports in Austria (E-Control 2015i). Right: net import.

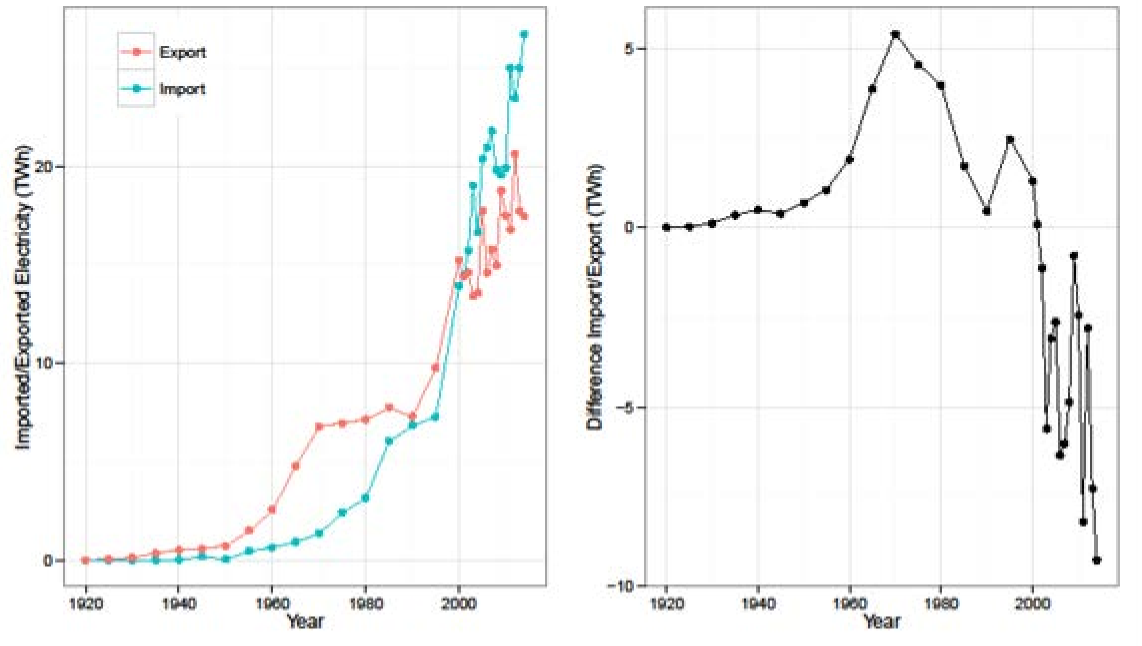


Figure 5 – Physical electricity imports to Austria divided by country (E-Control, 2015i)

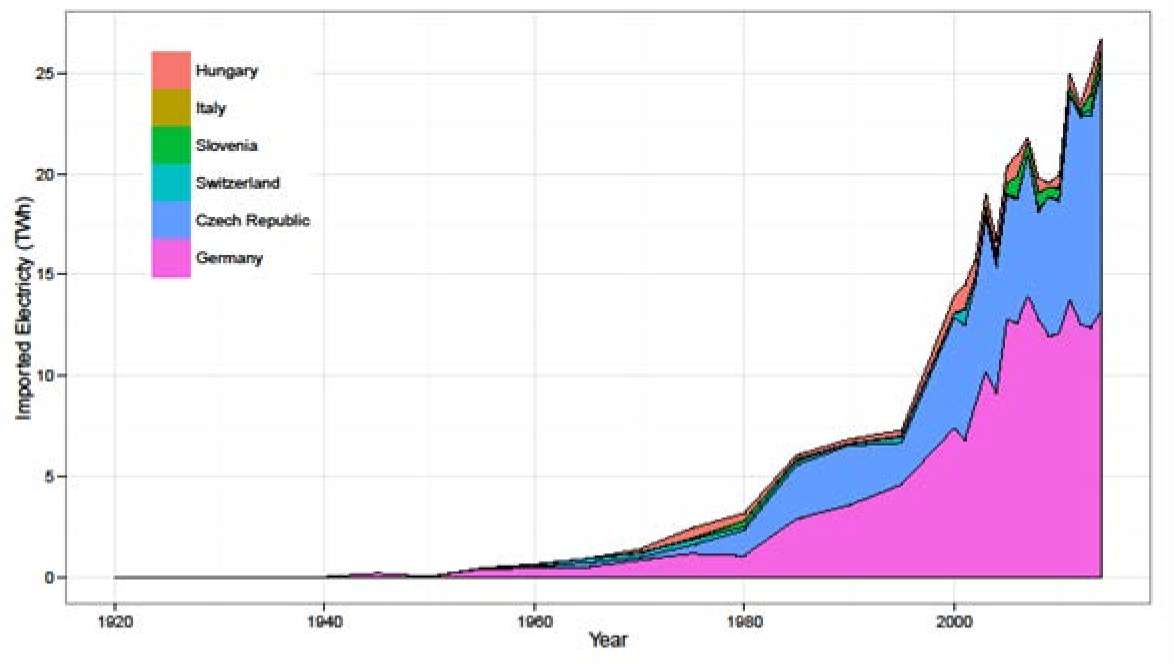
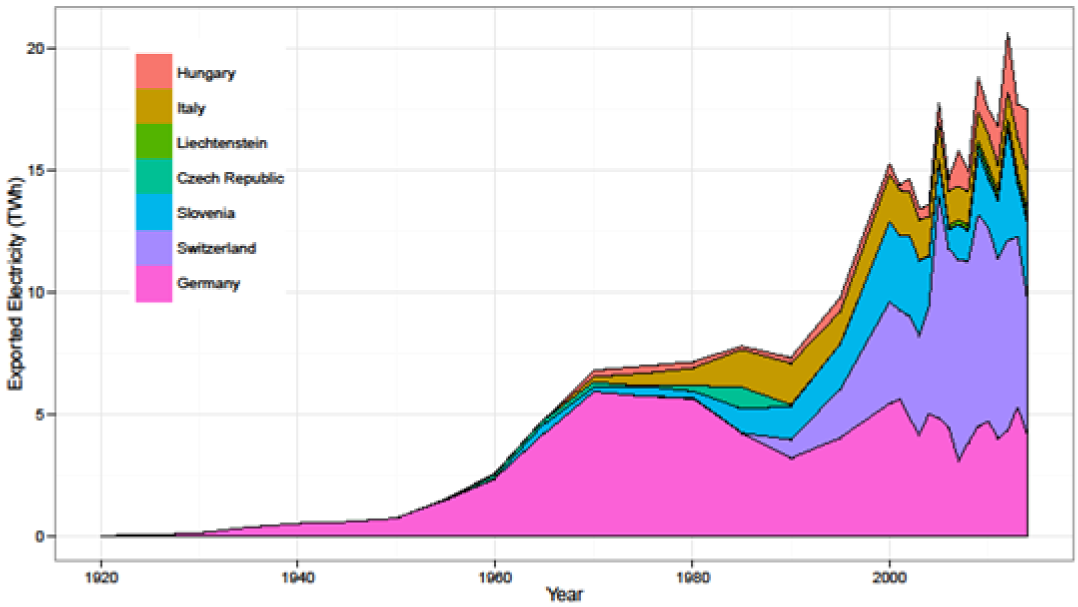


Figure 6 – Physical electricity exports from Austria divided by country (E-Control, 2015i)



2.2.2 Renewable Energies and the NREAP

In December 2008, the European Union agreed on the so-called “20-20-20-goals” aiming at a 20% increase in both renewable energies and energy efficiency, and a reduction of 20 % greenhouse gas emissions compared to the reference year 2005. The goals adapted for Austria add up to an increase of 34 % renewable energies, 20% improvement on energy efficiency and reduction of 16 % greenhouse gases for divisions that are not subject to emissions trading (21 % less for those who do) (E-Control, 2015b) (BMWFW, 2015a). The measures implemented to reach these goals are described in chapter 2.5.

Especially regarding the expansion of renewable energies, Austria has made some efforts. Figure 7 compares the goals for renewable energies for each European country and the values achieved by 2013. Figure 8 shows the share of renewable energies in the gross final energy consumption. As depicted, the heating sector has made remarkable efforts in the use of renewable energies, whereas the transport sector still shows a very low percentage. The OeMAG (“Abwicklungsstelle für Ökostrom AG”, settlement agency for green electricity) publishes the installed capacities of all contractors every quarter. The development of these capacities can be seen in Figure 9 and show again the increase of renewable energies in Austria. The decrease of installed capacities from 1/08 to 1/09 is to be explained by the cancelling of contracts for many small hydropower plants due to the high electricity prices on the market (Oemag, 2008).

Figure 7 – European countries and their goals for renewable energy in their gross final energy consumption in 2020 (Eurostat, 2015a).

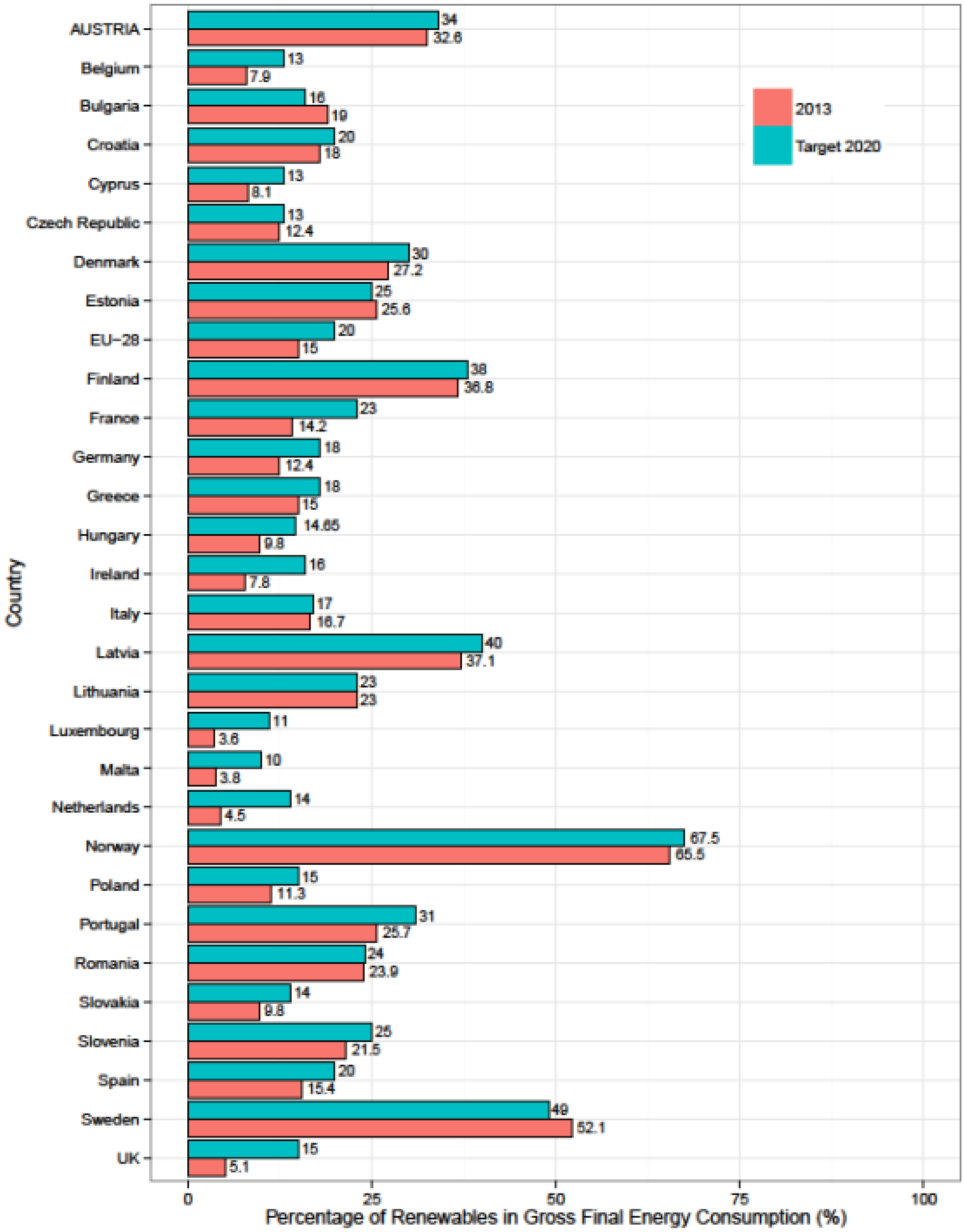


Figure 8 – Development of the percentage of renewable energy in the gross final energy consumption (Eurostat, 2015b).

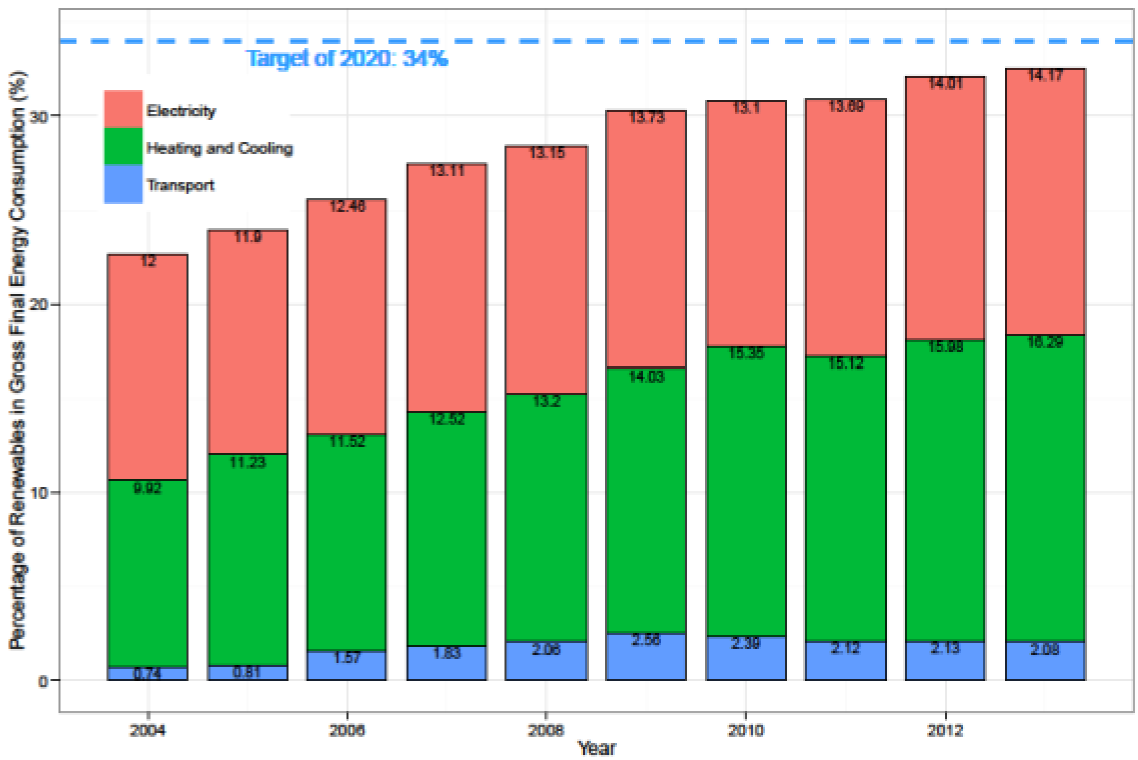
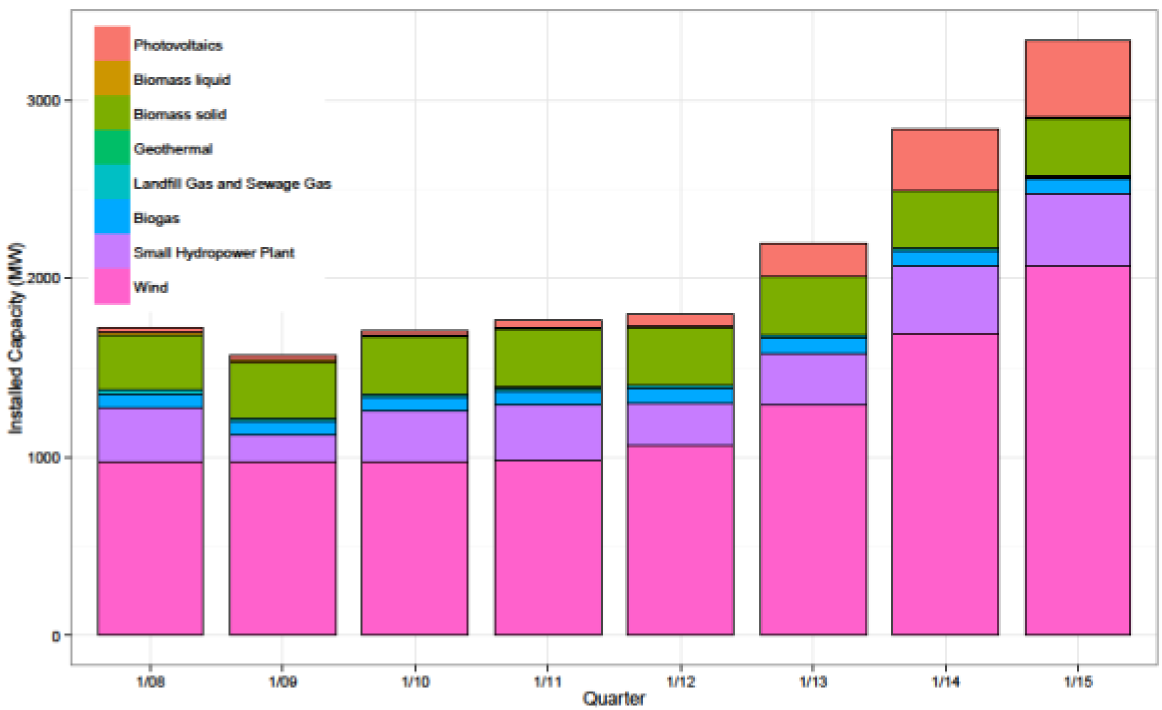
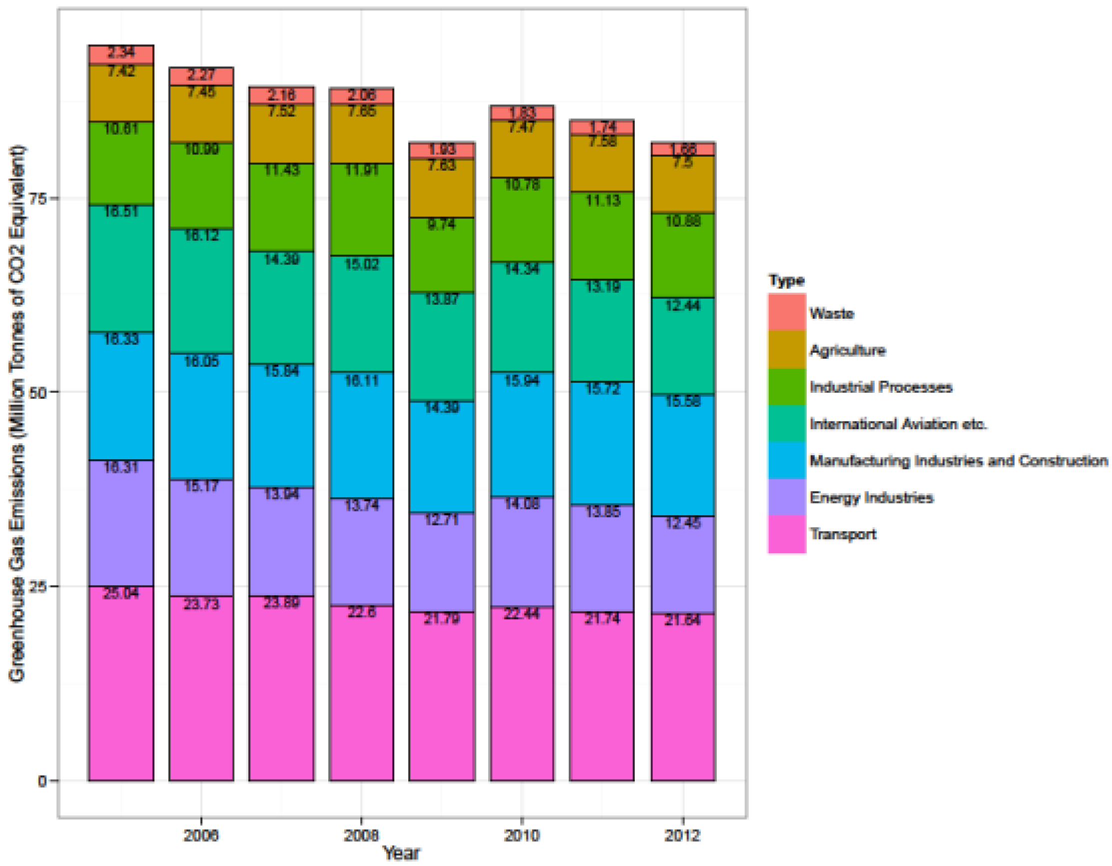


Figure 9 – Oemag installed capacity of contract partners from 2008 – 2015 (Oemag, 2015).



Concerning energy efficiency, the Federal Ministry of Science, Research and Economy states that Austria has already made an obvious progress. Greenhouse gas emissions have improved since 2005, as depicted in Figure 10. Austria belongs to the countries with the lowest emissions per kWh in Europe (Oesterreichs Energie, 2015).

Figure 10 – Greenhouse gas emissions from 2005 to 2013 (Eurostat, 2015c).



2.2.3 Total available Generation Capacity

Figure 11 shows the installed Austrian power plant capacities in January 2015 according to the APG (Austrian Power Grid) with a total available capacity of about 22,900 MW. Hydro power, gas, oil and wind represent the major energy sources.

The power plants, which are using natural gas as fuel and are registered at the EEX (European Energy Exchange AG) are listed in Table 1. According to the web pages of their operators, most of these plants (especially the large capacities) are combined cycle power plants that generate both electricity and district heat (EEX, 2015).

Figure 11 – Installed power plant capacity in GW (AGP, 2015a).

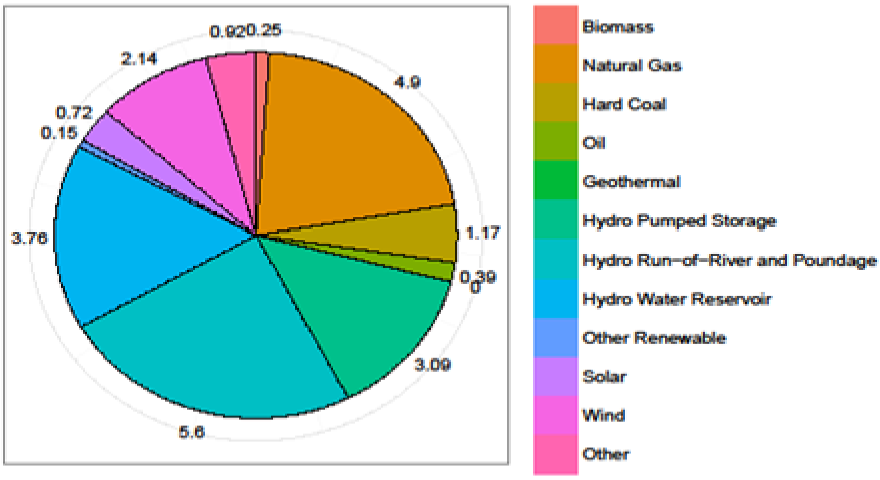
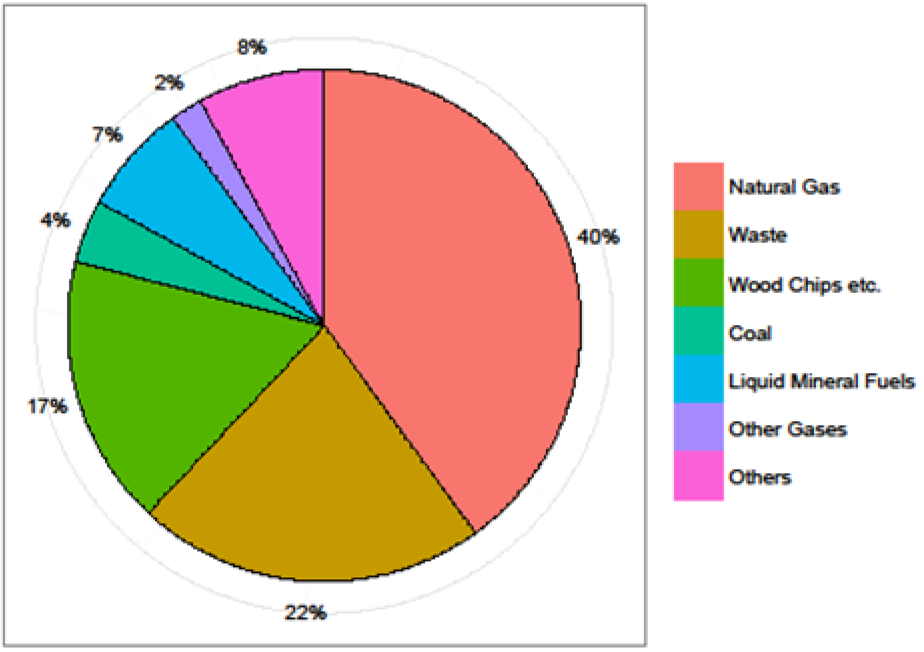


Table 1 – List of power plants using natural gas (EEX, 2015).

Name	*Capacity (MW)*	*Operator*
KW Simmering	1.248	Wien Energie GmbH
GDK-Mellach	838	VERBUND AG
Kraftwerk Theiß	765	EVN AG
Kraftwerk Timelkam GUD	400	Energie AG Oberösterreich Kraftwerke GmbH
KW Donaustadt	395	Wien Energie GmbH
FHKW Linz Mitte	208	Linz Strom GmbH
FHKW Linz Süd	158	Linz Strom GmbH
Voestalpine KW Linz	153	Voestalpine Stahl GmbH
KW Korneuburg Block EVN	150	EVN AG
KW Leopoldau	140	Wien Energie GmbH
Heizkraftwerk Mitte	84	Salzburg AG für Energie, Verkehr und Telekommunikation
CoGen St. Pölten	10	EVN AG
CoGen Tulln	10	EVN AG

The Austrian district heating sector still shows a large dependency on fossils, especially natural gas with a share of 40%, see Figure 12. The use of waste plays also a significant role with a share of 22%, followed by biomass with 17%.

Figure 12 – District heating by fuel in percent (Fernwärme, 2015).



2.2.4 Progress of PV, Geothermal and Wind Energy

According to Photovoltaic Austria, the annual installation of photovoltaic systems has continuously increased from 1.29 MWp in 2000 to 262.1 MWp in 2013. The total installed capacity of PV in 2013 adds up to 626.0 MWp. In 2013, solar power covers 1.1% of the Austrian electricity consumption (PV-Austria, 2015).

In 2012, 195,000 heat pump systems were operated in Austria. The systems provided 2,229 GWh of thermal energy, of which 1,683 GWh were obtained from ambient heat. This led to a net saving of 431,500 tons of CO_2 (Umwelttechnik, 2015).

According to IG Windkraft (Austrian Wind Energy Association), new records on wind capacities have been achieved on a yearly basis since the introduction of the national Green Electricity Act in 2012. In 2012, 108 wind turbines with a capacity of 296 MW were installed, in 2013, the number of newly installed capacity increased to 113 wind turbines with a capacity of 308 MW. Finally, in 2014, 144 wind turbines with a capacity of 411 MW were installed (IG-Windkraft, 2015).

2.2.5 Variations in the Electricity Demand

The base load required during the day is covered by base load plants that cannot react on sudden peaks in the energy demand. They supply consistently electricity instead and are run on their maximum load. These power plants are typically run-of-river and coal-fired power plants (Verbund, 2015).

The supply of average load and peak load requires power plants that are more flexible and can react to sudden changes in the electricity demand which is usually the case in the morning, at noon and in the evening hours. During these times, the peak load power plants are deployed. As they are operated only a few hours per day, the electricity generated by them is more expensive. In Austria, usually, pumped-storage power plants and gas turbine plants are used during peak times (Verbund, 2015).

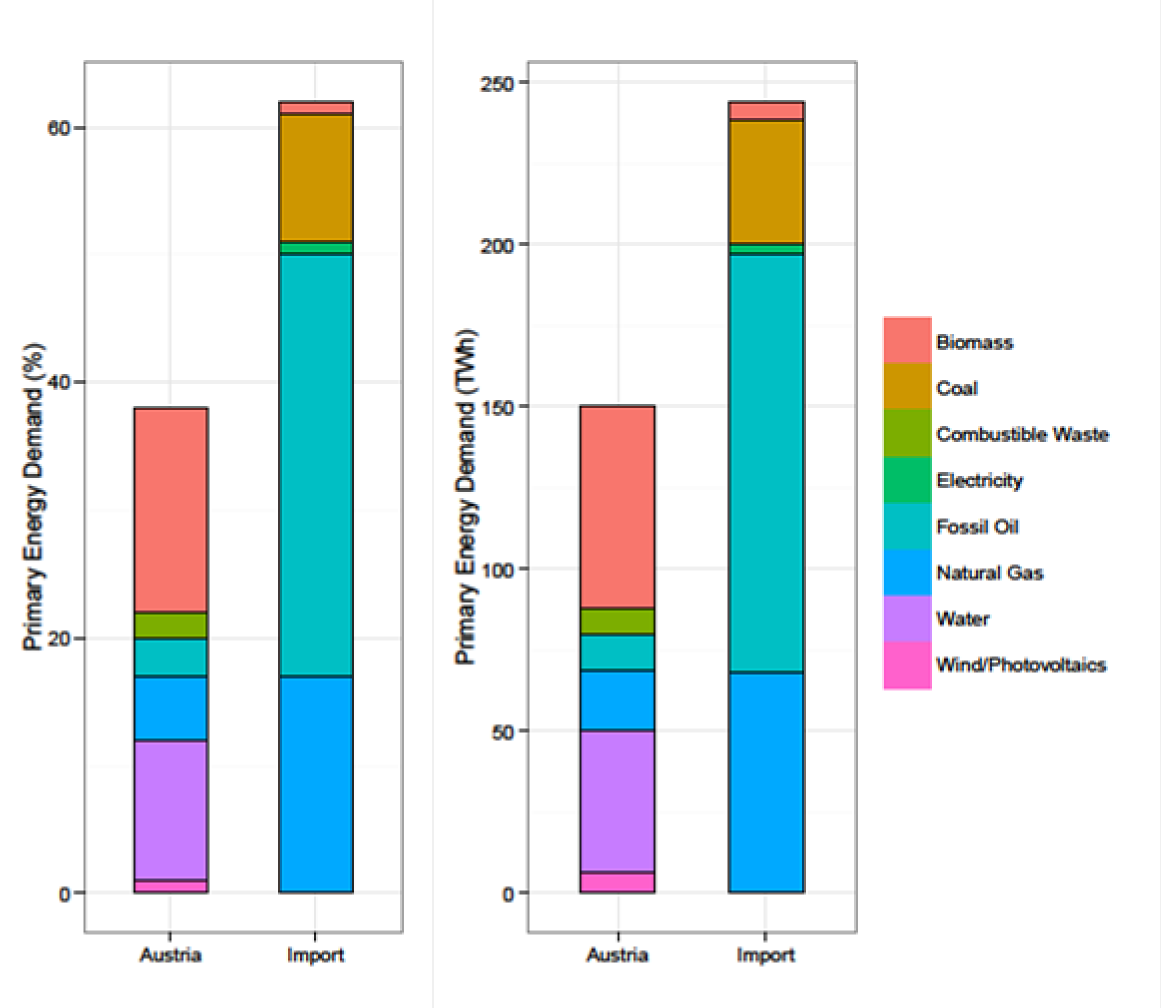
If the electricity demand is suddenly increasing, control energy is used. This energy reserve prevents the breakdown of the electricity supply and keeps the nominal frequency of 50 Hz in the electricity grid. These reserves are gained through weekly tenders of the APG, in which the participants must fulfil certain conditions (Next, 2015) (E-Control, 2015c).

2.3 Austrian Energy Demand

2.3.1 Primary Energy Demand and Final Energy Demand

Figure 13 shows the primary energy demand in 2012 divided by fuel type. The energy demand of nearly 395 TWh was achieved by domestic energy sources (38 %) and import (62 %). The domestic energy sources consist mostly of water and biomass, whereas fossil oil, coal and natural gas need to be imported (BMWFW, 2014).

Figure 13 – Left: domestic energy sources and import in % of total primary energy demand (2012). Right: primary energy by fuel type (2012). BMWFW, 2014.



The final energy consumption in 2012 was about 304 TWh. About 43 % were consumed by economy, 25 % by households and 32 % by transport (BMWFW, 2014). Figure 14 shows the final energy consumption in TWh in these sectors; Figure 15 to Figure 17 show the percentage distribution within the sectors.

Figure 14 – Final energy consumption divided by sector (2012). BMWFW, 2014.

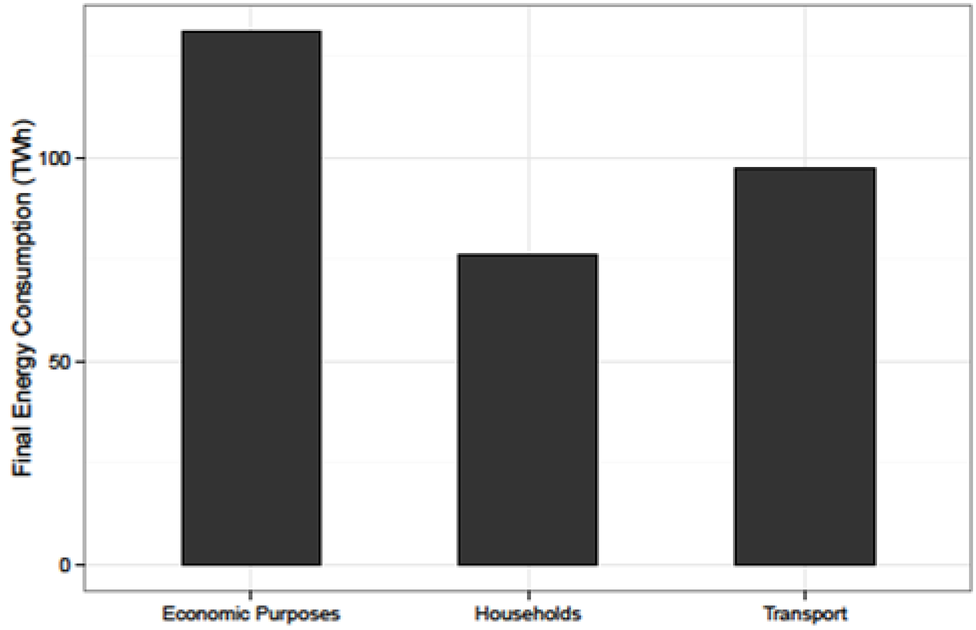


Figure 15 – Distribution of final energy consumption in the transport sector (BMWFW, 2014).

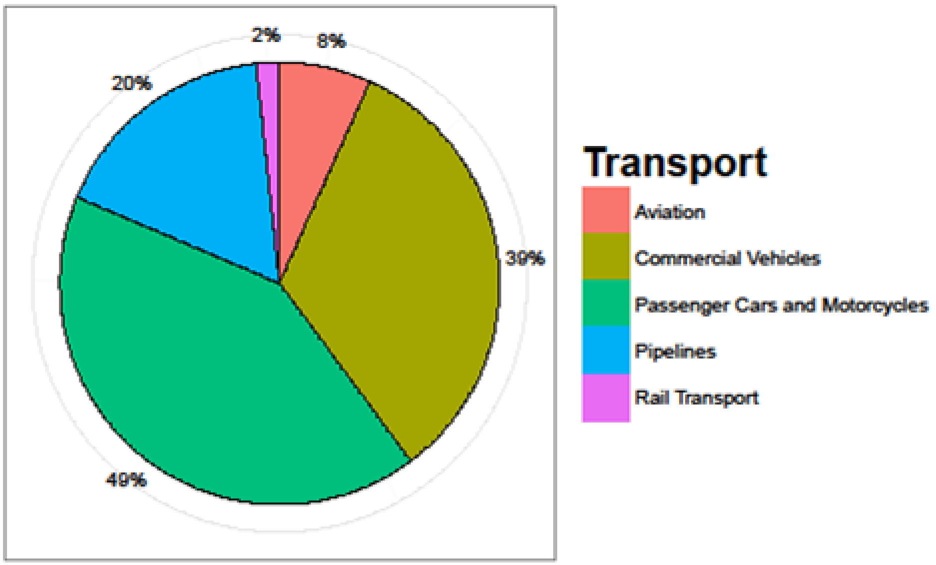


Figure 16 – Distribution of final energy consumption in the household sector (BMWFW, 2014).

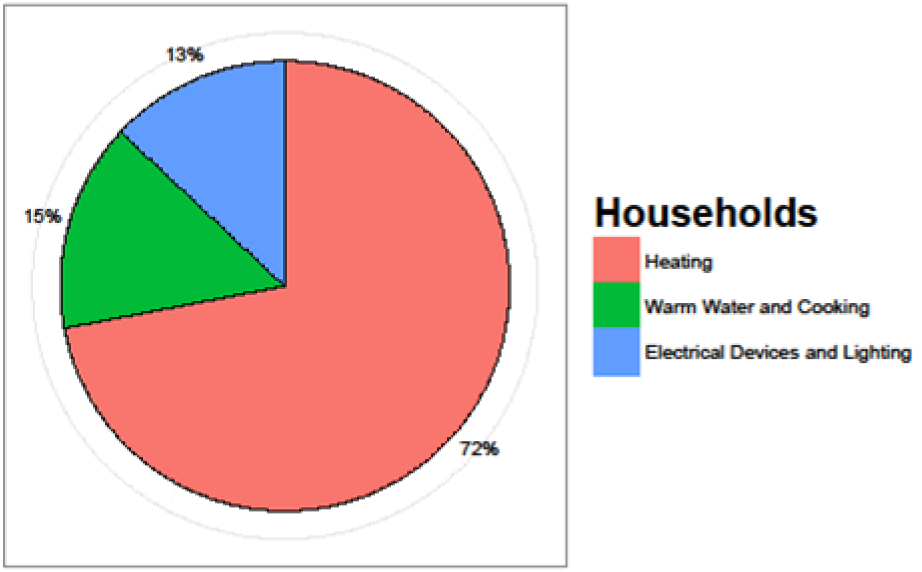
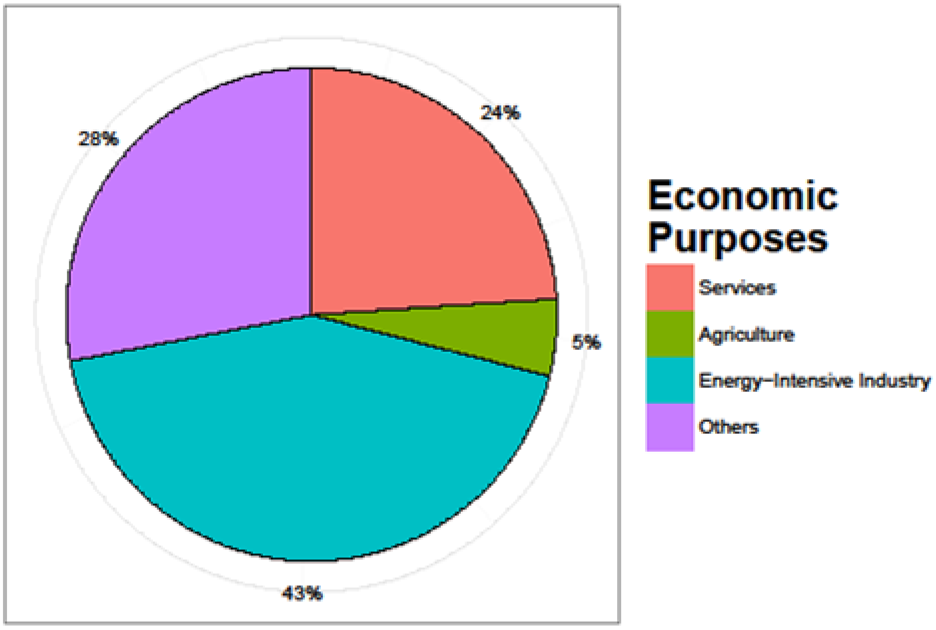


Figure 17 – Distribution of final energy consumption in the business sector (BMWFW, 2014).



According to Statistik Austria, the final energy consumption in 2013 was about 311 TWh. Traction demands the highest amount of energy, which can be seen in Figure 18. The second highest amount is demanded by space heating and cooling with a demand of over 92 TWh in 2013. Figure 19 shows the final energy consumption 2013 with the percentage amount of fuels. The highest amounts are represented by diesel, electricity and natural gas.

Figure 18 – Final energy consumption by category (Statistik.at, 2015a).

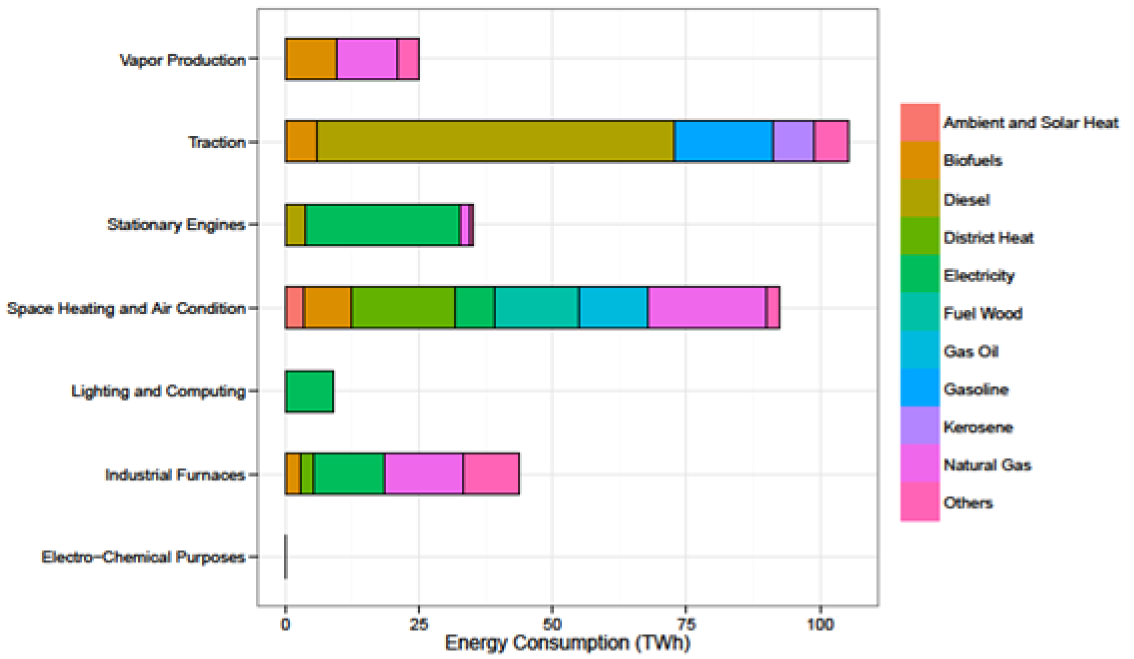
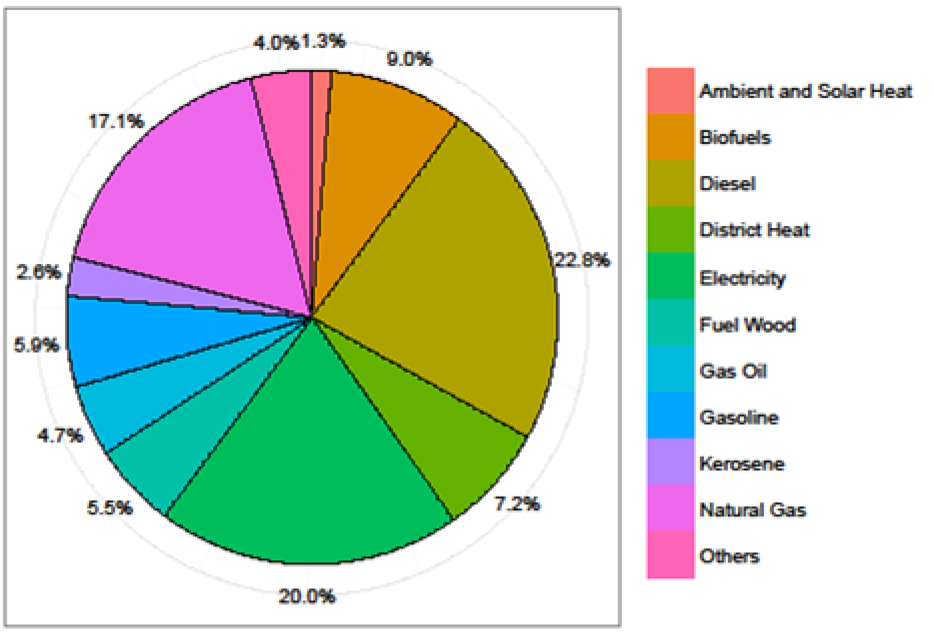


Figure 19 – Fuel contribution to final energy consumption (Statistik.at, 2015a).



2.3.2 Heating Demand in Households

Figure 20 shows the overall consumption of all fuels by purposes, regarding data published by Statistik Austria (2013). Space heating demands the highest amount of energy with over 52.5 TWh in 2011/12. Figure 21 shows the percentage amount of fuels by purpose. Electricity, gas and oil have a major role in the heating sector. The total fuel consumption in the year 2011/2012 was, according to Statistik Austria, over 75.67 TWh (including about 10.4 TWh of electric energy that were used for other reasons). The heating sector required about 65.3 TWh.

Figure 20 – Left: energy consumption in Austrian households (2011/2012). Right: energy consumption per person and m² (2011/2012). Statistik.at, 2015b.

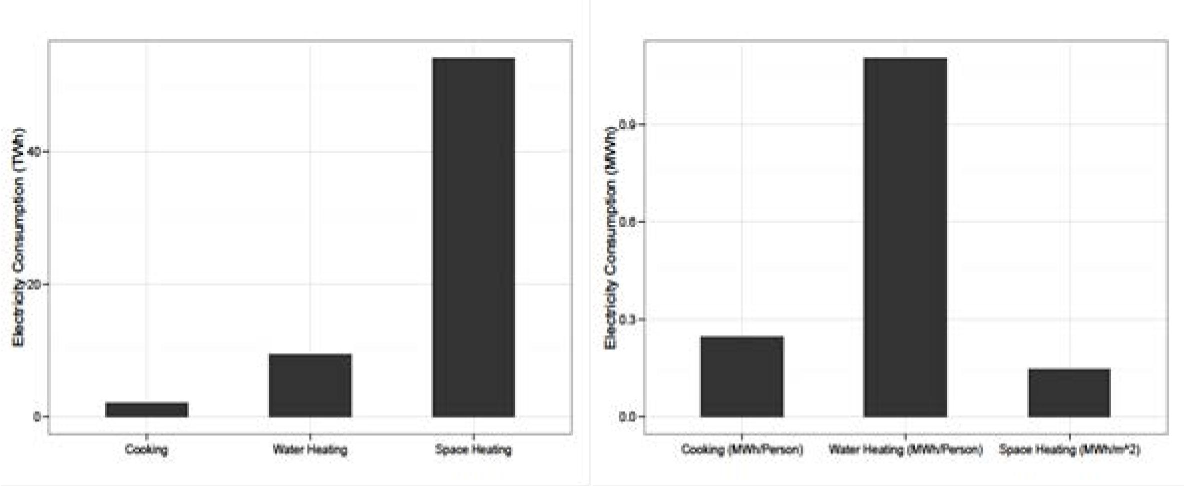
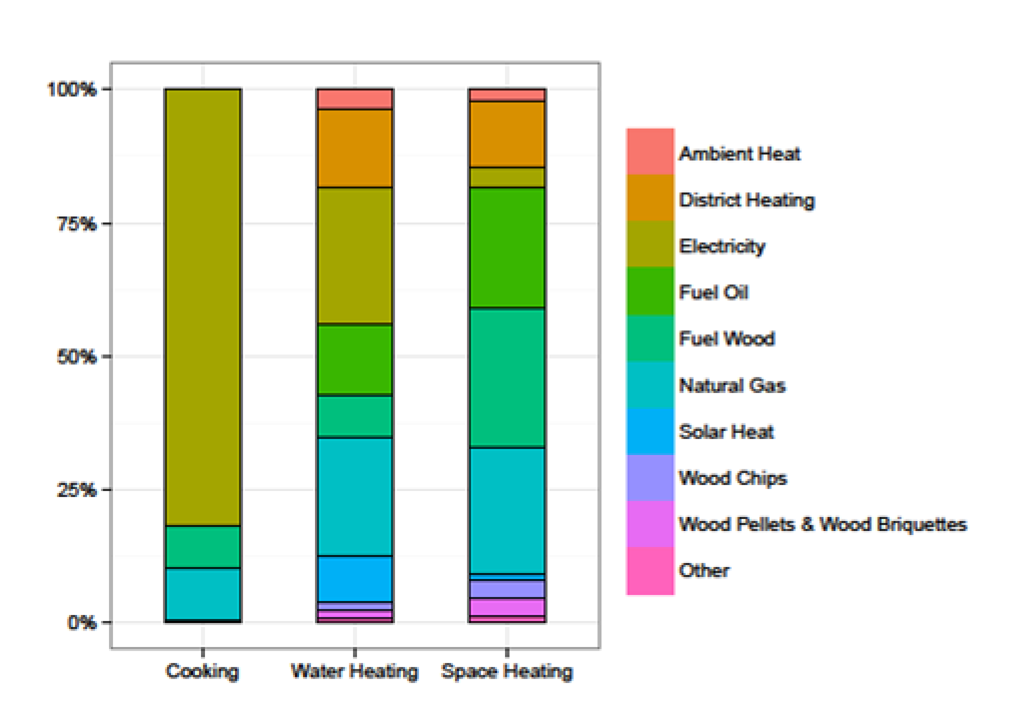


Figure 21 – Fuel use by purpose in 2011/2012 (Statistik.at, 2015b).



2.3.3 Electricity Demand in Households

The demand of electric energy in an Austrian household is strongly dependent on the number of persons living in it, its size and its quality (single-family house or housing construction). Statistik Austria has published data on the average electricity demand in households considering its size and the number of persons living in it. This data is presented in Figure 22 and Figure 23.

Regarding Figure 22, it is obvious that the demand of electricity is dependent on the number of persons living in a household, but not proportional to it. Major differences in the energy demand only exist in the need of warm water and heating, lighting, washing machine and stove and oven. Despite of the different number of persons, the other categories require about the same amount of electricity or only differ a little.

Figure 22 – Average electricity demand by number of persons and type of use in household (2012). Statistik.at, 2015b.

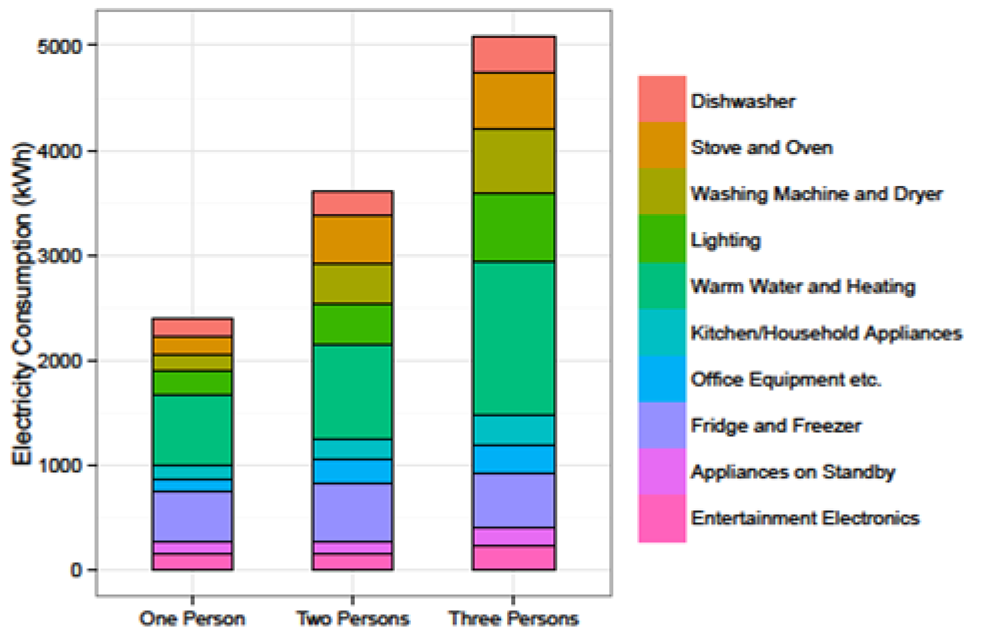


Figure 23 – Average electricity demand by house area and use type (Statistik.at, 2015b).

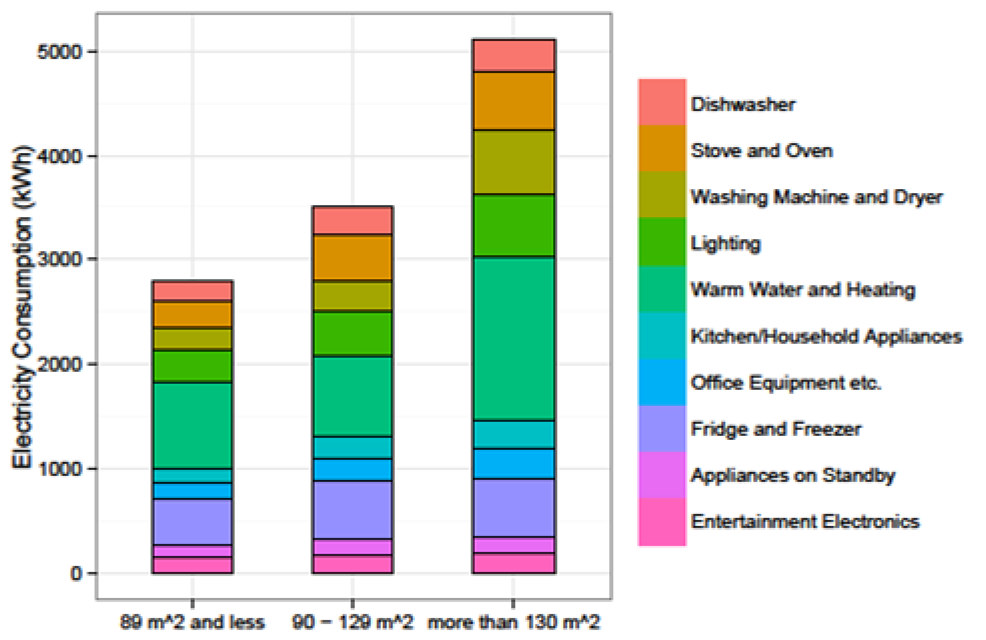
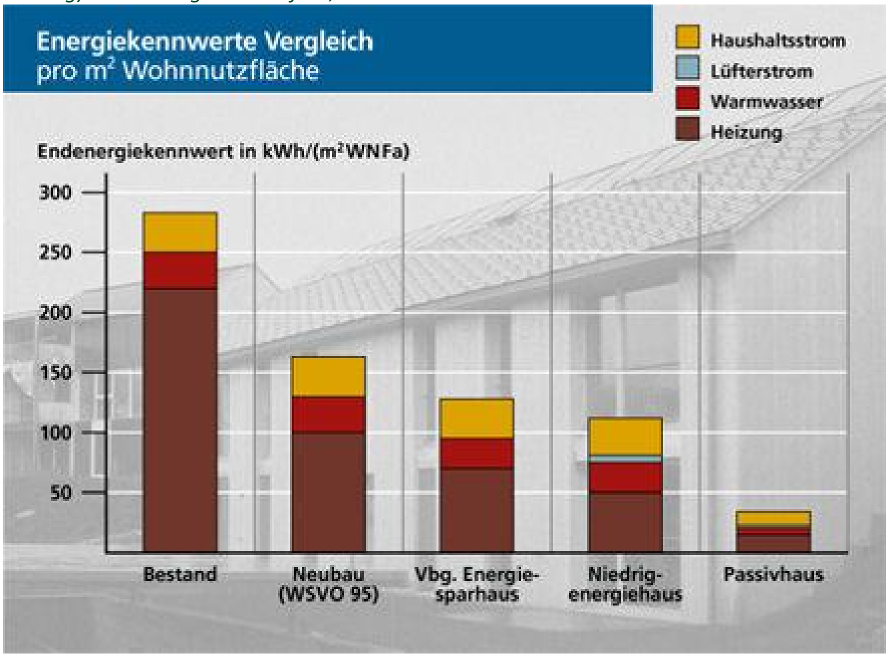


Figure 23 shows that the major difference in the electricity demand regarding different sizes of households is due to a greater need of lighting, washing machine, warm water and heating in larger homes whereas the other categories remain about the same again.

Of course, it should be remembered that distinct types of buildings demand a different amount of energy. This can be seen in Figure 24. Old buildings typically demand the highest amount of energy, whereas passive houses and so-called “zero-energy-buildings” comparatively only need very little energy.

Figure 24 – Energy performance index of different building types (yellow = electricity, red = hot water, brown = space heating). Nachhaltig wirtschaften, 2015.



2.4 Austrian Energy Infrastructure

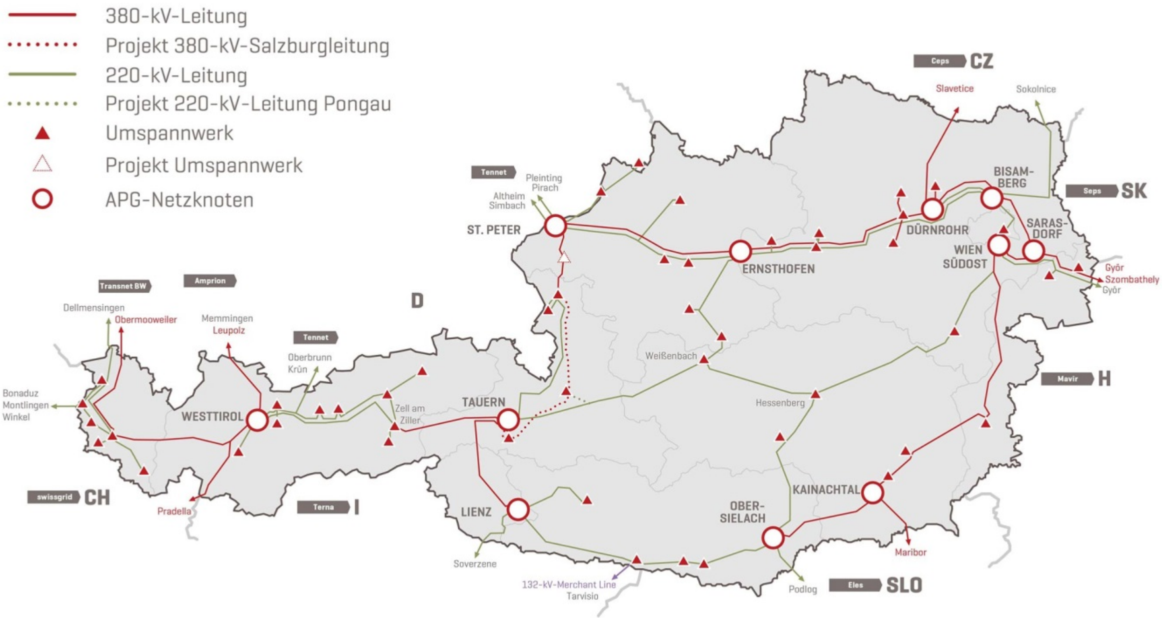
2.4.1 Electricity Network

The Austrian electricity grid has a total length of 253,000 km. It is separated into the low-voltage-level (up to 1kV), which represents about 66 % of the total network and is used to supply e.g. households with electricity, and the medium- and high-voltage-level (1kV to 110kV), that represent about 27 % of the total network (Österreichs Energie, 2015a).

The maximum-voltage-level (220kV to 380kV) is used for a low-loss transfer of substantial amounts of energy, Figure 25. Large power plants make use of this level to inject the generated electricity directly into the network (Österreichs Energie, 2015a).

So far, the Austrian electricity supply is one of the safest in the world with an availability of 99.99 %. But due to the increase of renewables, the electricity grid must handle fluctuations in the electricity generation that already lead to critical situations. Moreover, the decrease of net tariffs within the last years has led to postponements of important investments. In 2013, the time of electricity cuts that were not planned amounted 33.36 minutes per customer. Although this is a very high security of supply compared to the rest of Europe, the value has increased in comparison to the preceding year. This shows that further investments are required to guarantee a secure electricity supply further on (Österreichs Energie, 2015a) (Österreichs Energie, 2015b).

Figure 25 – Austrian power grid (APG, 2015b).



2.4.2 Gas Network

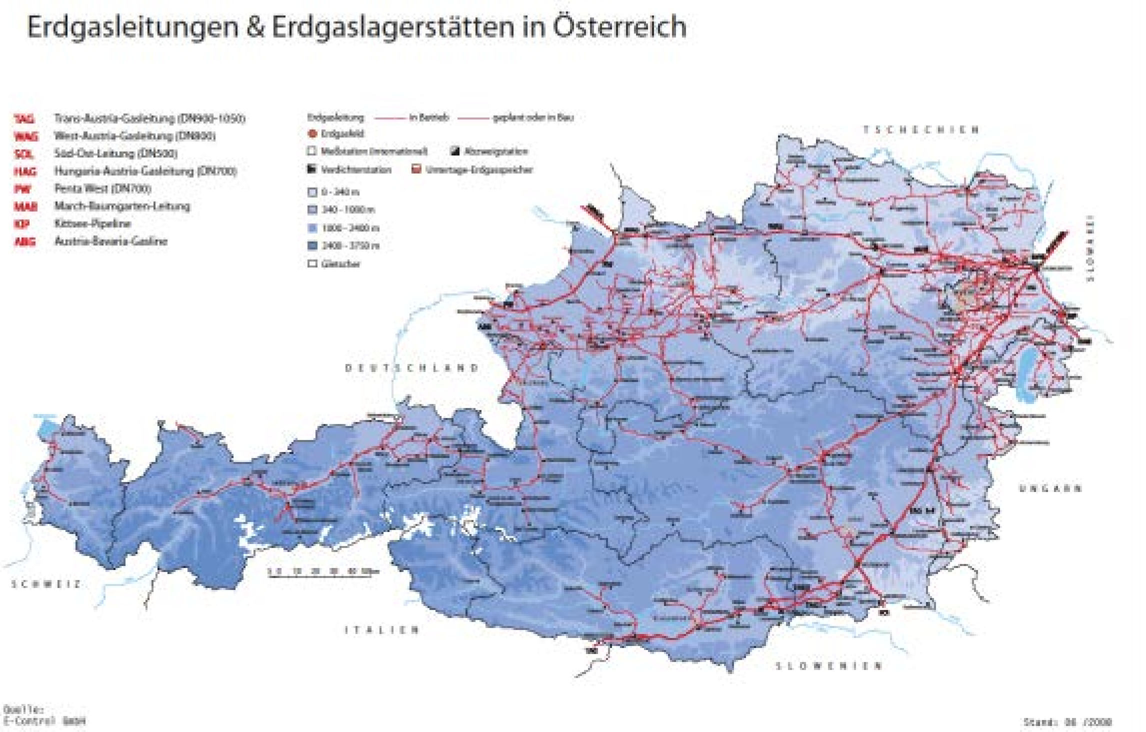
Austria covers about 16 % of its gas demand with inland gas resources; the majority of gas (over 50 %) is imported from Russia, the remaining amounts from Norway and Germany. The gas grid has a total length of over 38,000 km (Figure 26) (Green Gas Grids, 2015).

Although hydropower contributes the major part to the national energy generation, the significance of natural gas is increasing. In 2010, 23.8 % of the Austrian gross energy consumption were derived from natural gas (Green Gas Grids, 2015).

The gas grid is mainly in the possession of private companies; the transportation grid belongs and is run by the OMV Gas GmbH. The regulators for natural gas are the E-Control Austria and the Regulatory Commission of E-Control. The assignment of the ÖVGW ("Österreichische Vereinigung für das Gas- und Wasserfach", Austrian Gas and Water Association) is to develop technical and economical methods for gas and water supply. For this reason, the ÖVGW establishes the required technical standards (Green Gas Grids, 2015).

So far, there are 175 (Erdgasautos, 2015) CNG (compressed natural gas) stations in Austria, but the gas industry has the target of 200 public stations within the next few years. The five-point-action-program, which was launched in 2006 by the OMV and the Federal Ministry of Agriculture, Forestry, Environment and Water Management, encouraged the use of natural and biogas as fuel (Green Gas Grids, 2015).

Figure 26 – Austrian natural gas grid (E-Control, 2015k).



2.4.3 Heating Network

The Austrian heating network is mainly based on natural gas and biogenic fuels. The major part (more than 90 %) of district heating is used for space heating and hot water. As a large part of district heating comes via ultra-efficient CHP (combined heat and power) facilities, a noticeable reduction of the Austrian CO_2-emission could be achieved. Local and district heating represent about one third of the final energy consumption in Austria (Energy Innovation, 2015) (BMWFW, 2015b).

The length of the hot water network is steadily increasing (+ 6.8 % from 2012 to 2013) and has a length of about 5,000 km. Heating suppliers plan a further expansion - between 2014 and 2023, 71 km per year should be built in average (Energy Innovation, 2015) (BMWFW, 2015b).

2.5 Austrian Energy Policy

In 2013, the Ministry of Environment has published a program of measures for the achievement of the national climate target between 2013 and 2020. These measures concern the sectors energy and industry, fluorinated gases, agriculture, buildings, transport and waste management. The responsibility for the implementation lies with the Ministry of Environment, the Ministry for Transport, Innovation and Technology, the Ministry of Finance, the Ministry of Science, Research and Economy and the federation states ("Bundesländer"). The program required among others advisory programs, new subsidies, the continuance of existing ones and measures for better energy efficiency with reduced greenhouse gas emissions. Concerning the heating sector this includes thermal rehabilitations, changes in the right of abode to enforce them more easily and support for the construction of housing. It has already been achieved that every building needs an energy certificate that includes important characteristic values like the heating energy consumption that has to be expected. The certificate has to be shown to the tenant or buyer before the conclusion of the contract and is at most 10 years valid (BMLFUW, 2013) (Energieausweis, 2015).

In 2015, a further program of measures has been published by the Ministry of Environment, including an energy strategy for the years from 2015 to 2018. The Ministry states that the program of measures from 2013 has already led to positive effects in the Austrian energy goals for 2020. Nevertheless, the calculated value for the CO_2 emission in 2020 with already existing measures would be about 49.15 million tonnes CO_2 equivalent in divisions that are not subject to emissions trading, but the target value should be 48.8 million tonnes.

Therefore, additional measures are needed, concerning especially the traffic sector but also investments in other sectors (e.g. further thermal rehabilitations of buildings) (BMLFUW, 2015).

Moreover, the Ministry for Environment offers a climate initiative, called "klimaaktiv". This initiative is intended as a consulting network and seeks for the progressive implementation of Austria`s climate targets. It offers advices in issues like energy efficiency, renewable energies and reduction of greenhouse gases, in private and public. The initiative collaborates with many Austrian municipalities and several companies (Klimaaktiv, 2015a**).**

To encourage the expansion of renewable energy sources, the climate and energy funds and the Ministry for Environment have agreed upon three promotional actions that started on February 24th, 2015: One for private or commercial photovoltaic systems, one for the change from heating systems with fossil fuels to a climate-neutral heating system and one for solar thermal systems. 25 million euros were invested in these subsidies (Klimaaktiv, 2015b).

The following two policies have especially encouraged the further use of renewable energies and a better energy efficiency in Austria:

2.5.1 The Green Electricity Act in 2012

In July 2011, the Austrian Parliament passed a new law that came into force in July 2012. It provided among others the expansion of renewable energies, more subsidies, climate and environment protection and the independence of Austria from nuclear power imports within the next years (Klimaaktiv, 2015c**) (**Sorger, 2015**).**

2.5.2 The Energy Efficiency Act in 2014 (cf. BMWFW, 2015c)

The EEffG ("Energieeffizienzgesetz", Energy Efficiency Act) has been decided in 2014 (BMWFW, 2015d). Its target is the improvement in the balance of in- and output of energy and thereby, to attain cost savings. Due to this policy, Austria expects to gain 6,400 new jobs and an increase of the gross domestic product of 550 million euros.

The EEffG includes three major obligations:

- Energy suppliers (as far as they supply 25 GWh or more) must conduct measures concerning the energy efficiency in a minimum extent of 0.6% of their previous year's energy sales. This policy is expected to lead to a saving of about 14 million tonnes of greenhouse gas emissions (which where about 82.8 tonnes in 2011).
- Large companies must implement a management system or use energy audits every four years. Suggestions of the management or the energy audit are not mandatory.
- The federal government is obliged to refurbish 3% of its building space. Not only thermal refurbishments are permitted, but also improvements in the facility management etc.

2.6 Energy Prices, Tariffs & Structures

2.6.1 Electricity Price

In Austria, the price for electric energy is composed of three main parts: The system charges, taxes and surcharges and the energy price itself (E-Control, 2015d).

Of course, electricity is subject to VAT, which means that 20 % tax is added to each component of the energy price. Furthermore, a fee of 1.5 Cent/kWh and a contribution for the support for renewable generating stations must be paid by the customer. Other charges are set by the state, the federal provinces or municipalities (e.g. community levies for the use of public property for electricity grids). The system charges are paid to the system operator and set by the E-Control Commission. They are dependent on the electricity consumption and include a charge for the grid use, a charge for grid losses and a metering charge (E-Control, 2015d - f).

The variable part of the electricity price is the energy price itself, which is set individually by the Austrian energy suppliers, which leads to a competition on the energy market (E-Control, 2015d) (E-Control, 2015f).

Figure 27 – Composition of electricity price for households (Stromliste, 2015b).

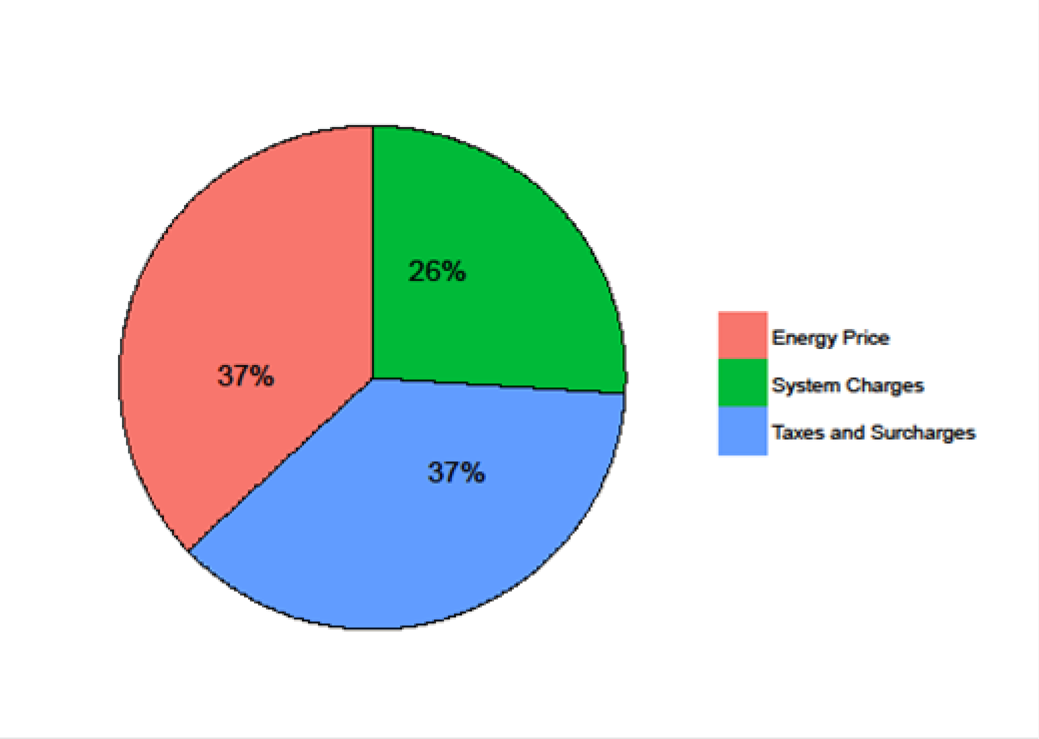
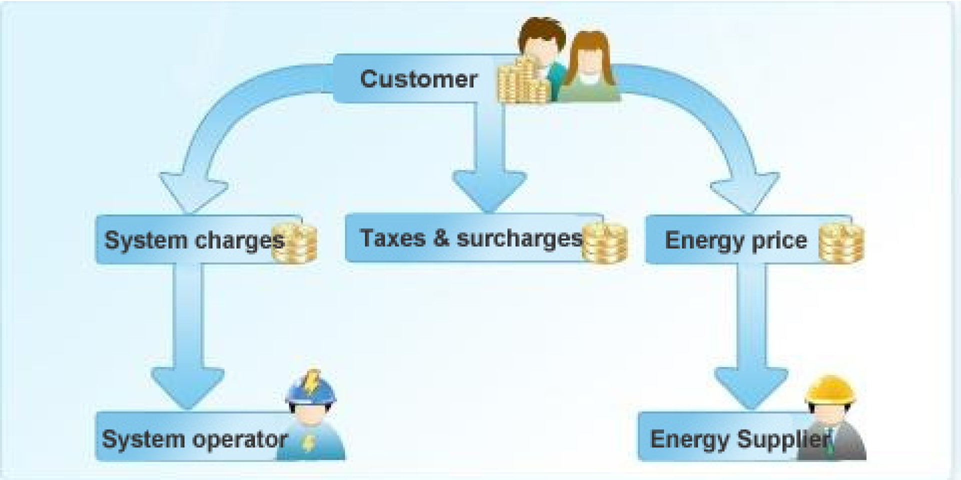


Figure 27 and Figure 28 show that the price components represent respectively about a third of the electricity price.

Figure 28 – Price composition for electricity.



2.6.2 Gas Price

As for electricity, the gas price is composed of the same three parts. It is also subject to VAT (20%) and in addition to that, a fee of 6.60 Cent/Nm³ must be paid by the customer (E-Control, 2015d) (E-Control, 2015f). Figure 29 shows the amount of system charges, taxes and surcharges and the energy price in the total costs.

Figure 29 – Composition of gas price for households (E-Control, 2015d).

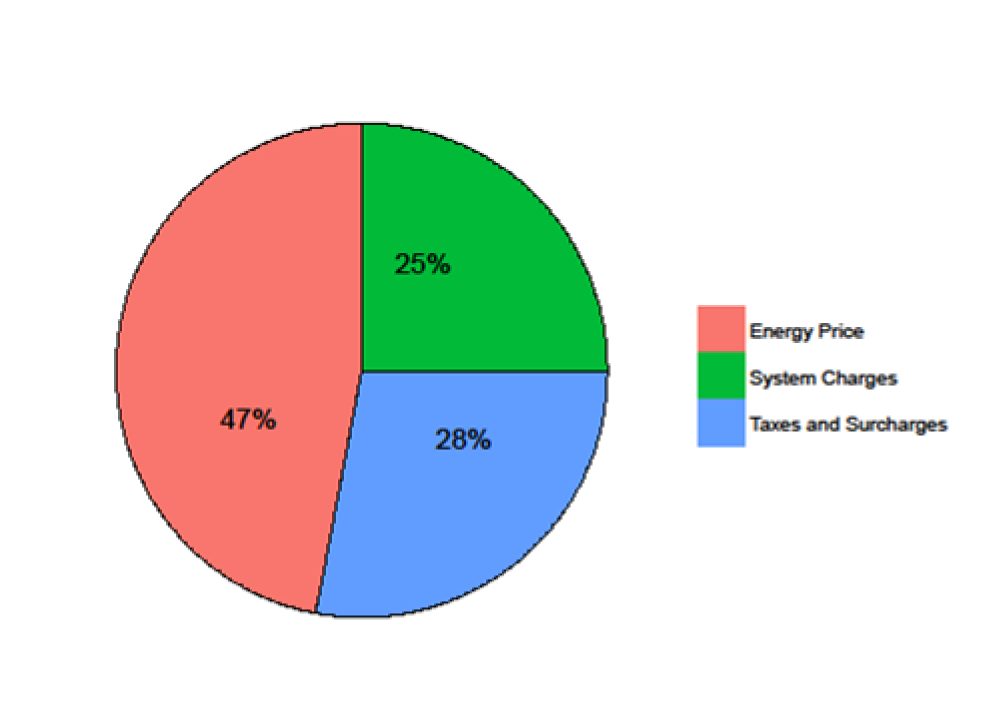
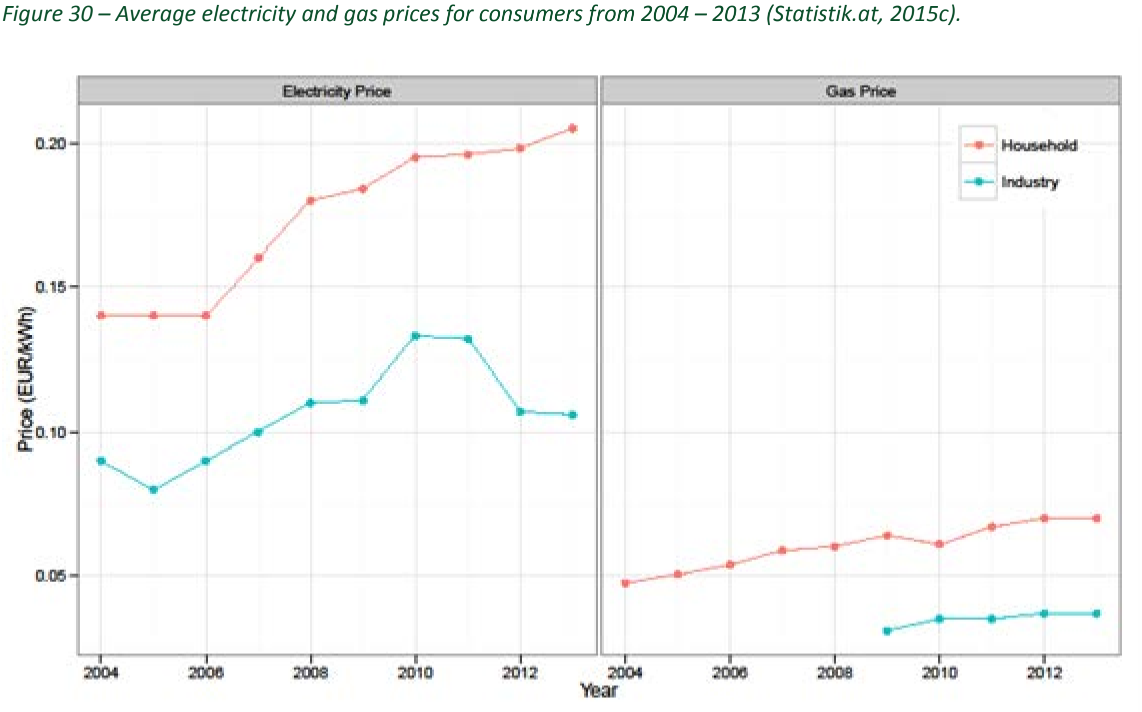


Figure 30 shows the development of average gas and electricity prices from 2004 to 2013. It should be remembered, that these prices are variable and strongly dependent on location, consumption and supplier. 1 kWh of electricity nowadays costs between 14 and 30 Cents in Austria (E-Control, 2015g).

Figure 30 – Average electricity and gas prices for consumers from 2004 – 2013 (Statistik.at, 2015c).



2.6.3 Types of Tariffs (cf. Stromliste, 2015a)

In Austria, the major part of electric energy is made from renewables. Therefore, more than 80% of the Austrian electricity suppliers offer exclusively tariffs for eco-power. This large amount can be explained by the usage of hydropower, which is very common in Austria. Since the generation costs for electricity from hydro power are low, tariffs for eco-power and others show only slight differences.

Electricity that is only made from photovoltaics, biomass or wind energy is more expensive, because there are only few plants so far. The Viennese supplier oekostrom AG and the Carinthian supplier AAE Naturstrom are two of the few suppliers that offer these types of tariffs.

Basically, suppliers have the right to adjust their prices anytime to price hikes on the market. Nevertheless, some suppliers offer tariffs that are not changed very often, so that a fixed price can be guaranteed for an agreed period. Others offer index-bound tariffs, where prices are adjusted every month or quarter. As an advantage, customers can profit by a sudden decrease of the energy price on the market. On the other hand, customers can be affected by sudden market increases.

The Austrian suppliers offer three distinct types of interruptible supply:

- **Night tariffs**
  These types of tariffs offer the possibility to take advantage of low energy prices in the time of low current, which is between 10 pm and 6 am. Especially night storage heaters can charge their storages during this time in advance to their daily consumption.
- **Heat pump tariffs**
  Heat pumps take about 75 % of the heating energy from the environment (e.g. water or geothermal energy). In addition to this, heat pumps always need electricity for the heating and therefore interruptible electricity prices because of daily recharging.
  Some suppliers also offer special heat pump tariffs during the day that are cheaper than the normal tariffs.
- **Tariffs for facilities with a high energy demand**
  This tariff is for instance used for saunas or pools. Normally, the prices do not distinguish very much from the prices for heat pump tariffs. Simply the supply is interrupted more often and is not available in time of peak load.

Outlook: As fewer and fewer people use electric heating, night tariffs get less important. On the other hand, tariffs for heat pumps are getting more relevant. In consequence of the EU energy efficiency policy, Austrian government has decided to install smart meters (starting with 10 % of the households in December 2015 and covering 95 % of the households in 2019). These smart meters should enable energy prices that are dependent on the consumption and should allow the consumer to use variable prices at different times of the day and night, so that it is clearly obvious, when electricity is most cheaply. A few suppliers like Linz Strom already offer tariffs especially for users of a smart meter.

2.6.4 Electricity Market Structure (cf. Energiemagazin, 2015)

In the following, the most important participants of the Austrian electricity market are named (E-Control, 2015h):

- Electricity feeders: Generators of electric energy that feed the electricity into the grid.
- Transmission system operator: In Austria, the TSO is responsible for the load-frequency control within a control area. Furthermore, this person or registered partnership has the responsibility of operating and developing the transmission system and to look after the maintenance of the network.
- Distribution System operator: The DSO operates the distribution network with a frequency of 50 Hz (same frequency as the transmission grid). DSO and TSO are both responsible for the metering and handling of the data from grid users. Information must be submitted non-discriminatorily to the market participants. Furthermore, the DSO has the responsibility of operating and developing the transmission system and to look after the maintenance of the network.
- Trader: A person/commercial undertaking that sells electricity to make profit.
- Supplier: A person/commercial undertaking that provides electric energy.
- Consumer: A person that is buying electricity for his/her own use.
- Market operator: A person that has the permission to operate a clearing settlement agency for the organisation and accounting of the distribution of balancing energy in a control area.
- Balance group representative: An entity for representing a balance group in front of the market participants and the market operator.
- Balance group members: A balance group consists of customers and suppliers and has the purpose of balancing injection and withdrawal of electricity.

The league of Austrian power industry is called "Oesterreichs Energie" and consists of 140 members, which are suppliers, generators and distributors. The main challenge is the representation of common interests in front of the EURELECTRIC (European holding organization of power industry), in politics, publicity and administration.

As the energy market in Austria is liberalised, general legal, economic and technical conditions had to be set by governmental departments and public authorities. To fix network charges, guarantee a secure energy supply or regulate network access, Oesterreichs Energie and E-control, the regulatory agency for electricity and gas, collaborate.

The general secretariat of Austrian power industry consists of several divisions like generation (e.g. electricity generation, security of supply), commerce and distribution (e.g. prices, tariffs, energy efficiency, competition) and networks (management, technical issues, congestion management).

Future problems and challenges of the energy market are the increasing amount of renewable energies that cause fluctuations in the energy generation and complicate a stable electricity supply. A goal of the market is to invest in a new and communication system, so that the balance between generation and consumption can be better regulated.

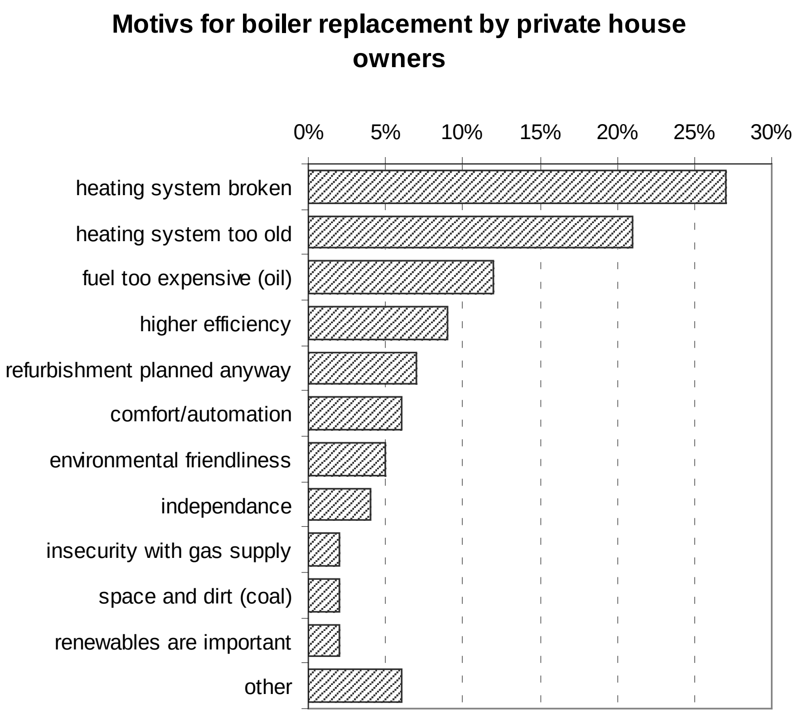
The legal standard for the electricity market can be found within the European law (Electricity Market Directive). The most important policies for the energy industry in Austria can be found in the federal law. Nevertheless, there exist various laws for the different federal states. Technical and organisational rules ("TOR") for operators and users of electricity grids are published by E-Control.

3 Analysis of the Austrian housing stock & heating market

3.1 Overview of main challenges in Austria

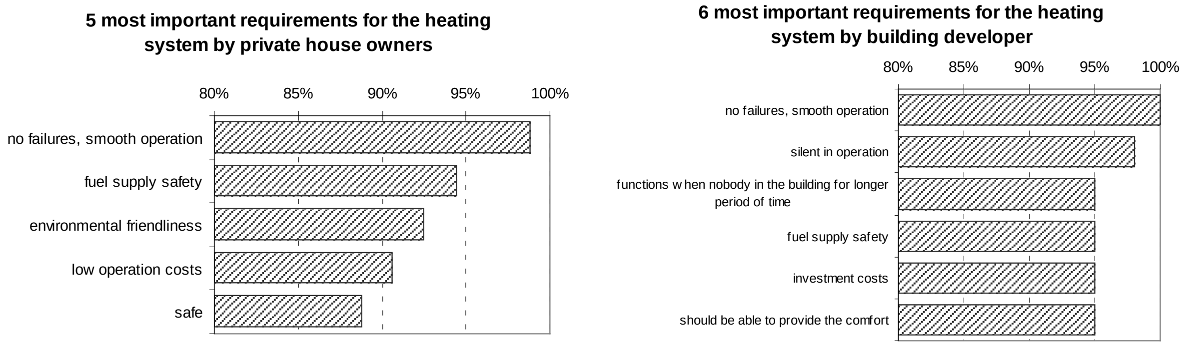
Approximately more than one third of the building stock in Austria has been built in the period before 1960 which states high potential for refurbishments in terms of heating systems and insulation. According to a study carried out by Austrian Energy Agency (AEA, 2008), the most important motive in the group of private owners for a boiler replacement is malfunctioning of the present system (Figure 31).

Figure 31 – Motives for boiler replacement by private house owners (AEA, 2008).



Furthermore, house owners and property developers or building companies have partly different opinions when it comes to requirements which a heating system must fulfil. Figure 32 gives an overview. It is interesting to note, that one of the outcomes of this study was that investment costs are not a critical criterium when choosing the system (AEA, 2008).

Figure 32 -Most important requirements to the heating systems by house owners and house builders (AEA, 2008).



Since private house owners represent approximately 40% of the ownership relations in Austria, reliability of smart heat pump system will be an important requirement for decision makers. A similar situation can be found for building developers although supply safety, cost and silent operation become more important.

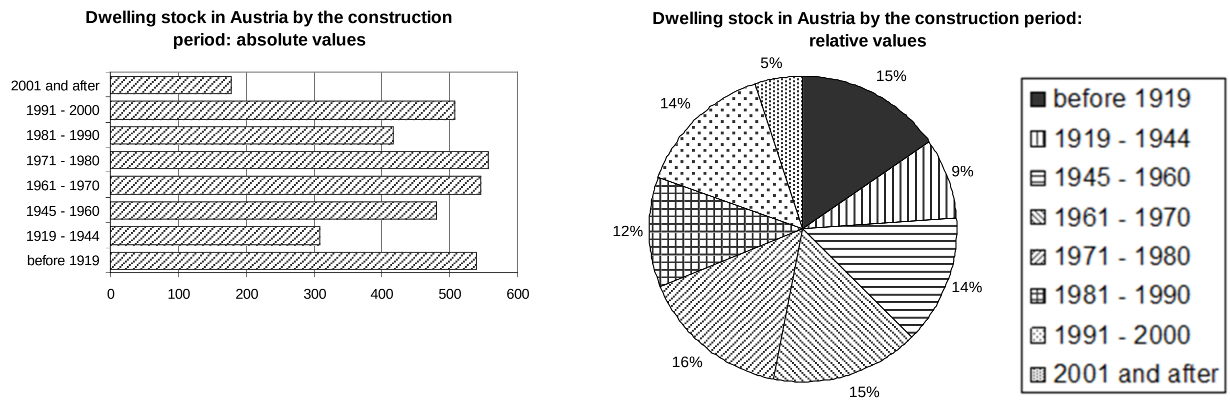
3.2 Austrian Housing Stock Characteristics

In 2011, 2.2 million buildings and 4.44 million dwellings were counted in Austria (Statistik Austria, 2013a). These numbers represent the latest comprehensive data available. In 2013, the microcensus gave a number of 3.7 million main residence dwellings in Austria. The average number of living space per person in 2011 was 44.2 m^2. (Statistik Austria, 2014)

3.2.1 Building age and ownership

The Austrian housing stock consists dominantly of buildings built in the sixties, seventies and before 1919. Figure 33 shows the absolute and relative numbers. The share of buildings before 1919 is about 15 %. Dwellings built according to the newest regulations make up about 5 %.

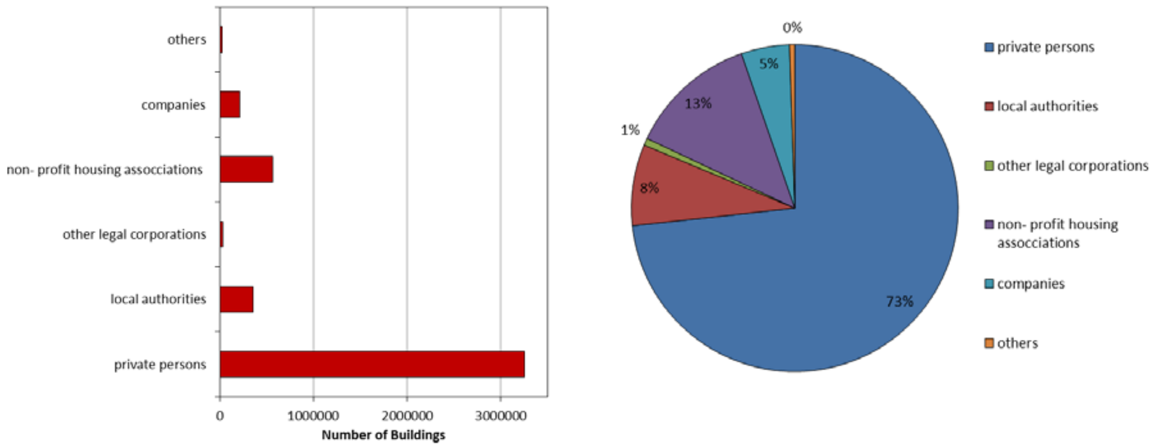
Figure 33 – Construction period of Austrian dwellings (Statistik Austria, 2008a).



The existing housing stock in Austria provides a high potential for refurbishments due to the relatively high fraction of dwellings constructed in the sixties and seventies and before 1919.

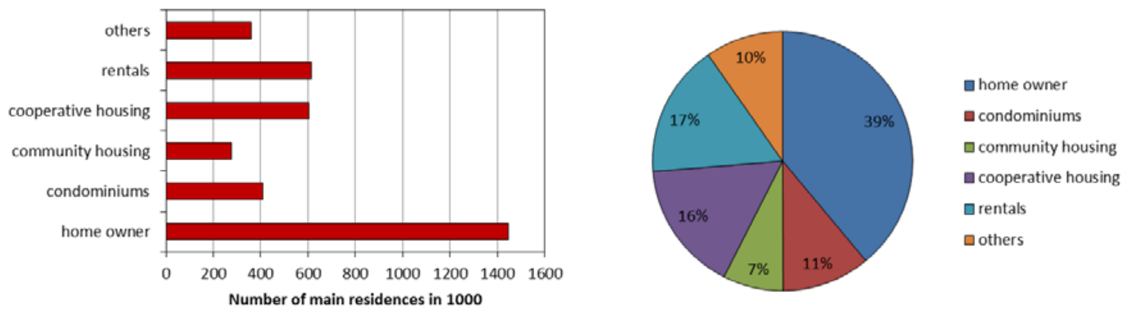
In Austria, the dominant fraction of dwellings is privately owned with a share of 73 % which results in an absolute number of 3.25 million (see Figure 34, Statistik Austria, 2013a). The second biggest owners are non-profit housing associations with a fraction of 13 % followed by local authorities with 8%. Other companies make up 5 % of the total number of dwellings in Austria.

Figure 34 – Ownership relations of buildings (Statistik Austria, 2013a).



Among the principal residences in 2011 a number of 1.44 million are home owners which make up 39 % of the total amount. 11 % are condominiums. Community housing provides about 7.5 % of the total amount of principal residences. Another big part in Austria is cooperative housing with 16 %. The absolute and relative numbers are illustrated in Figure 35 (Statistik Austria 2013a).

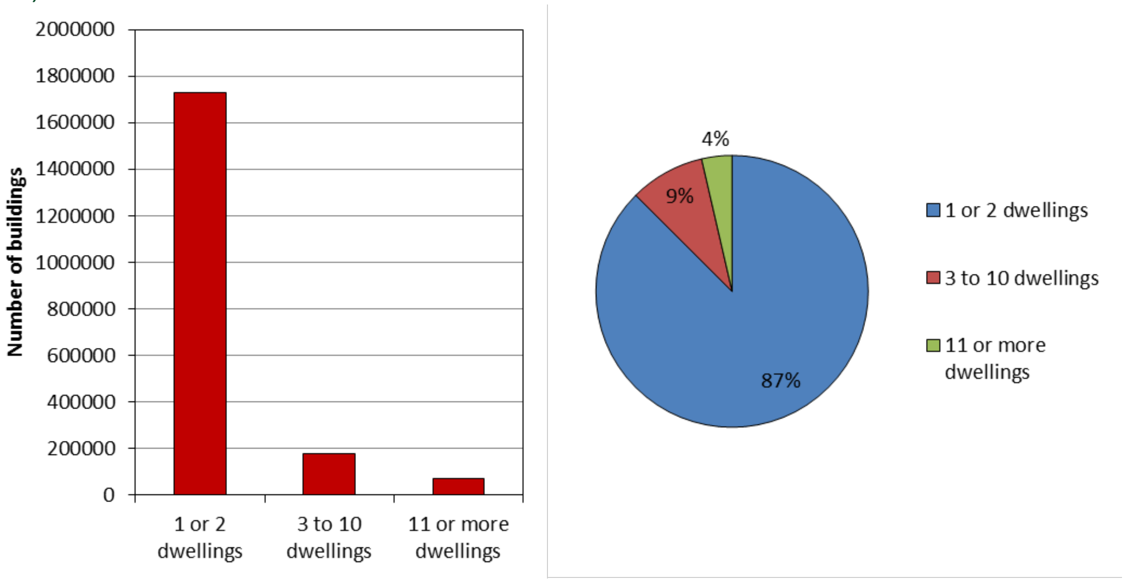
Figure 35 – Ownership relations of main residences. Absolute (left) and percentage (right). Statistik Austria, 2013a.



3.2.2 Type of dwellings in Austria

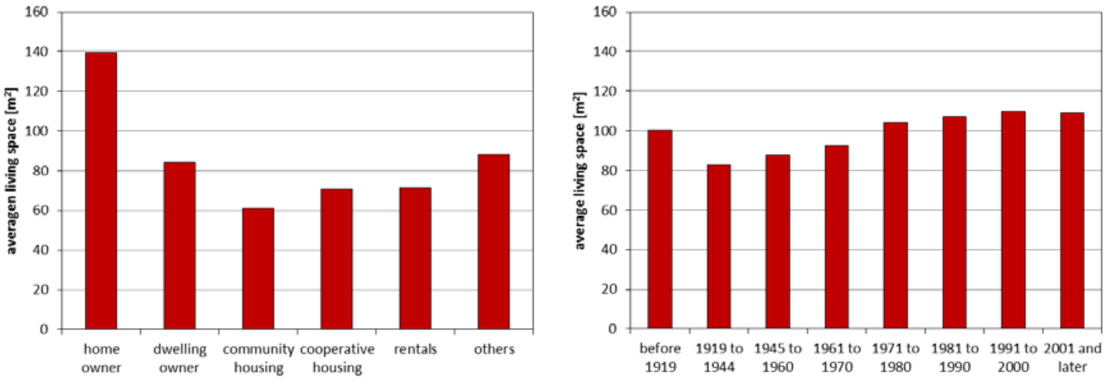
By far the majority of Austrian flats or houses in the year 2011 are buildings with one or two dwellings. The number is approximately 1.7 million which is illustrated in Figure 36. Buildings with 3 to 10 dwellings only make up 176 000 and buildings with 11 or more make up 76 000 of the total housing stock (Statistik Austria, 2013b).

Figure 36 – Building stock by number of dwellings per building. Absolute (left) and percentage (right). Statistik Austria, 2013b).



The average living space in Austrian dwellings in 2013 was about 100 m^2. The average living space for different dwelling types and building age are illustrated in Figure 37 (Statistik Austria, 2014).

Figure 37 – Average living space by ownership (left) and construction period (right) in 2013 (Statistik Austria, 2014).

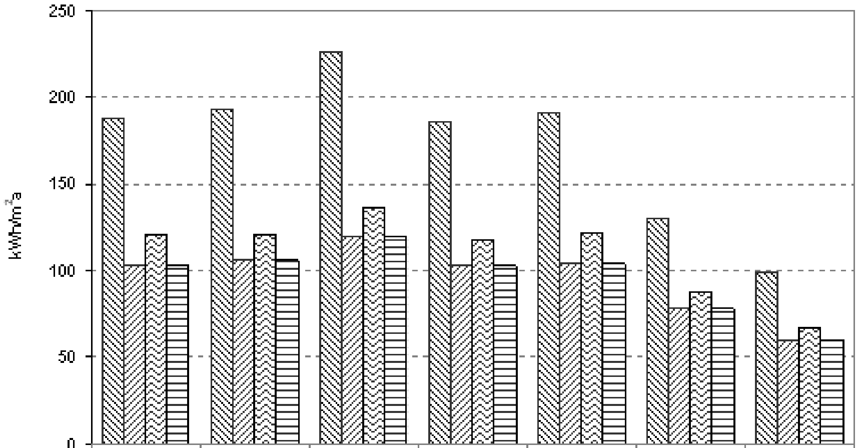


Home owners are describing the highest amount of living space with 139.5 m^2. Condominiums have an average living space of 84.3 m^2. Buildings constructed after 2001 show the highest average living space per dwelling with 109 m^2.

3.2.3 Heat demand

The heat demand is very much dependent on the year of construction and possible thermal refurbishment of the building envelope. As shown in Figure 38, buildings with one dwelling built in Austria before 1945 have a specific useful energy demand for space heating of about 190 kWh/(m^2a). For dwellings built between 1945 and 1960 this value rises to 230 kWh/(m^2a). This period was the time of fast and cheap production of living space after the Second World War. Since then the specific energy demand of buildings steadily decreased, partly due to the first oil price shock in the end of the 1970s. This development was enabled by the availability of more effective insulation materials and advanced window technology, supported by a growing environmental concern. For single dwelling buildings built after 1991 the useful heating demand is in the range of 100 kWh/(m^2a), which is already less than half of the values of the period from 1945 to 1960.

Figure 38 – Specific annual energy use for heating in kWh/(m²a) of single (SDB) and multi-dwelling (MDB: B=Large, S=Small) buildings, as well as non0residential buildings (NRB) by construction period. Statistik Austria, 2008b).



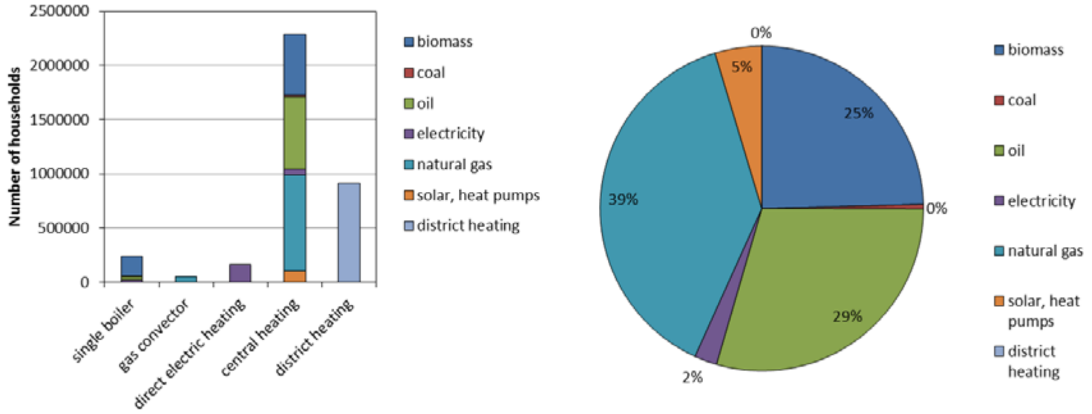
	before 1919	1919-1945	1945-1960	1961-1970	1971-1980	1981-1990	after 1990
SDB	188	193	226	186	191	130	99
MDB - B	103	106	120	103	104	78	60
MDB - S	121	121	136	118	122	88	67
NRB	103	106	120	103	104	78	60

For multifamily buildings, the value was already 60 – 70 kWh/(m²a) in 1991. The trend is in the direction of values even far lower. With building codes and subsidy schemes values of about 50-60 kWh/(m²a) for single (and two) dwelling buildings and 40-50 kWh/(m²a) for multi dwelling buildings are achieved. Houses built according to the passive house concept show that the space heating demand can be decreased to 15 kWh/(m²a). The requirements to reach such small heating demands are an optimal thermal insulation of the building envelope and effective mechanical ventilation using air heat recovery. Thus, the energy demand of new buildings decreased drastically in the last 50 years (Statistik Austria, 2008b). However, the average living space per person has increased from 38 m² in 2001 to 44.3 m² in 2013 according to Statistik Austria (2014). Although the heat demand of buildings is decreasing, the opposite trend of living space compensates the decrease of the total energy consumption, to a certain extend.

3.2.4 Heating systems

The number of Austria's heating types by primary source in the period 2011/2012 is shown in Figure 39. The highest fraction of heating systems is clearly central heating with a number of 2.28 million installed in main residences. This group consists of about 39 % gas fuelled systems, 29 % Oil and liquid gas and 25 % wood and biomass. Only 5 % is stated by solar heating and heat pumps and 2 % direct electrical heating. Coal and district heating show a very low percentage in central heating systems as can be seen on the left side of Figure 39. The percentage of coal for instance, is approximately 0.5 % of the total number of central heating systems.

Figure 39 – Total number of heating systems by fuel type in main residences (Statistik Austria, 2013c).

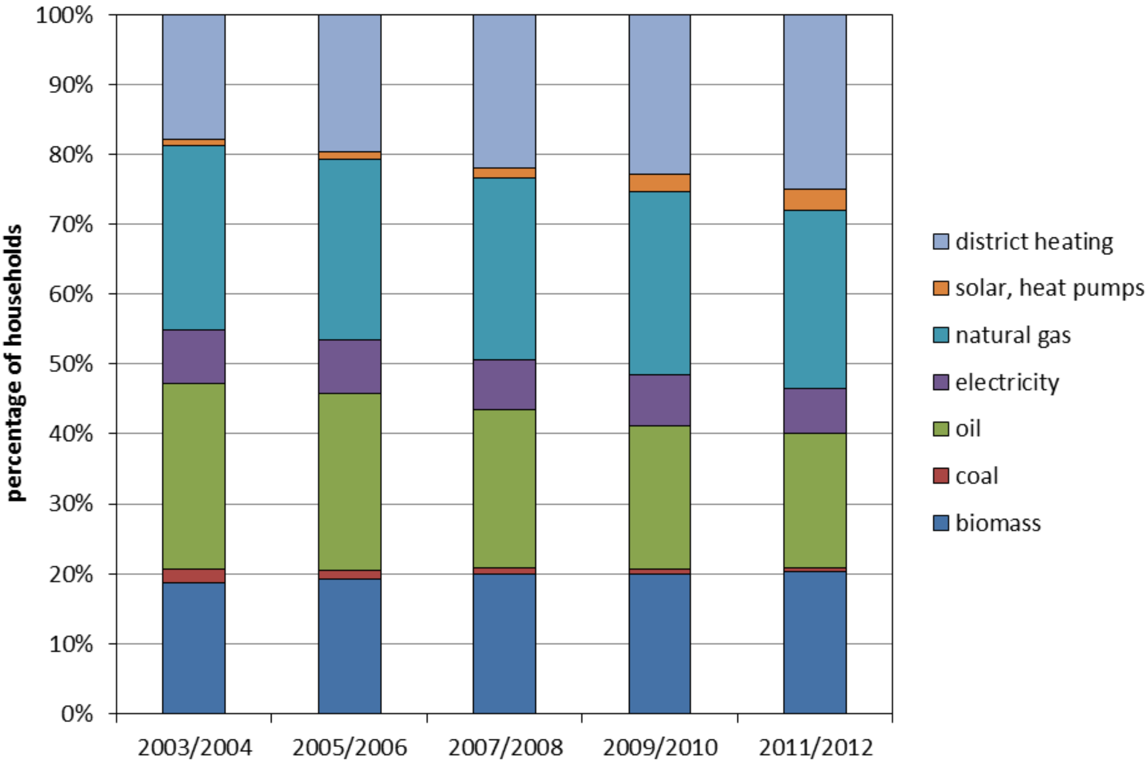


The second largest fraction of heating systems in Austria is district heating with about 913 000 installations in main residences which make up 25 % of the total amount of systems in Austria. Single boilers (located in one room) amount to 235 000 units which represent a share of only 6 %. The dominant fuel type in the class of single boilers is clearly biomass followed by oil and coal. Direct electrical heating systems represent still 4.5 % of the installed systems. Gas convectors can be barely found with a fraction of only 1.3 %.

3.3 Trends in the Heating Market

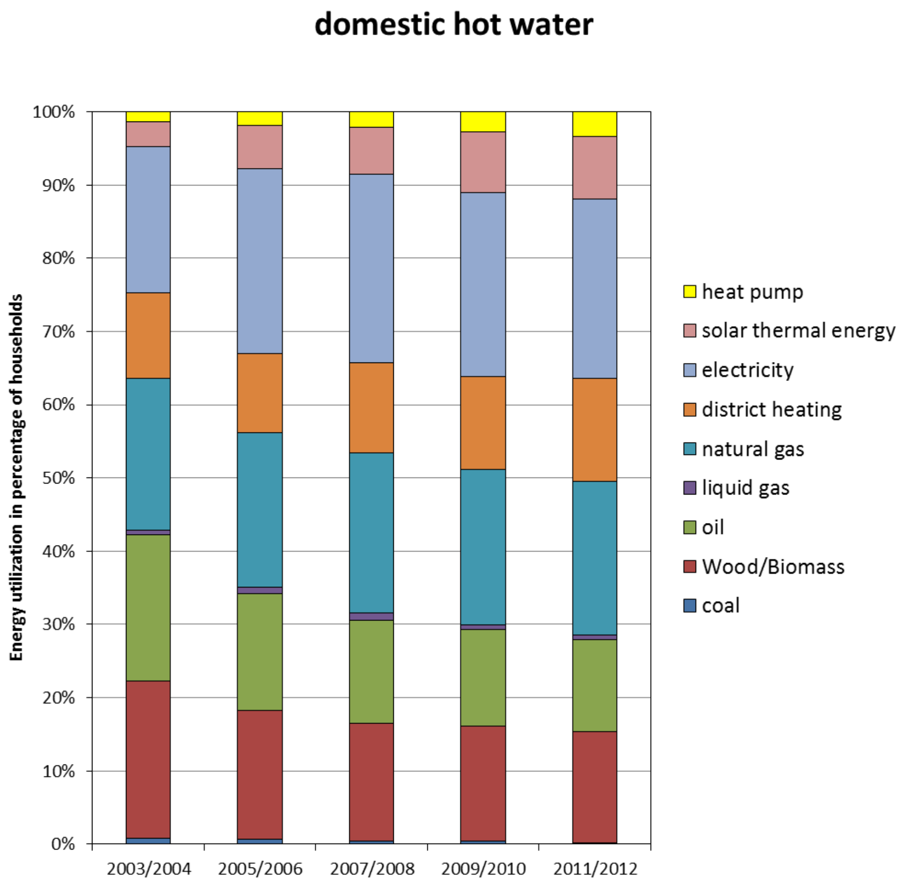
The major parts of the Austrian heating market in 2012 are district heating, natural gas, oil and biomass as illustrated in Figure 40. Minor roles are played by solar energy and heat pumps as well as electricity and coal. The relative numbers of biomass systems in Austrian main residences show an increase of approximately 15 % compared to the period of 2003/2004. A rather high decrease of 74 % can be observed with coal based systems. Also, oil and direct electricity systems are showing a decline by 23 % and 11 % respectively. Natural gas describes a slight increase in the time between 2003 and 2012 with about 3 %. A very strong development can be found in district heating systems with a plus of 48 % in the period between 2003/2004 and 2011/2012. However, the by far highest increase can be seen in the solar and heat pump segment with a remarkable number of 314 % compared to the installed systems in 2003/2004 (Statistik Austria, 2013c).

Figure 40 – Percentage of heating systems installed in main residences by primary source (Statistik Austria, 2013c).



The trend in space heating is clearly towards renewables and district heating mainly based on incentive schemes and the National Renewable Energy Action Plan of Austria (NREAP-AT, 2010).

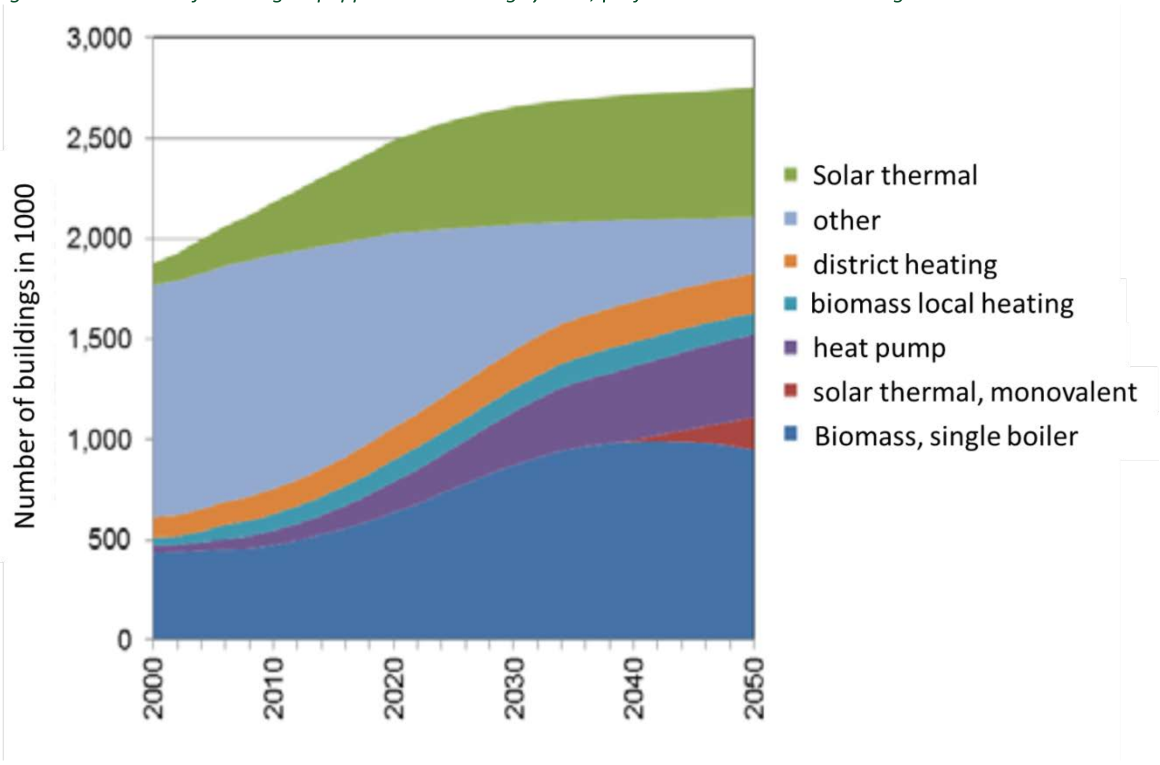
Figure 41 – Development of energy use for domestic hot water by energy source (Statistik Austria, 2013d).



A different picture can be observed in domestic hot water preparation where direct electrical systems state almost a quarter of the total installed units in households which provides the biggest share in the period between 2003 and 2012 (Figure 41, right). However, the electrical system is slightly decreasing. Natural gas systems also represent about a quarter of the total installations throughout the considered period with slight ups and downs of 0.1 % to 0.5 %. District heating has shown an increase to 15 % in 2011/2012 after a constant share of 13 %. The share of solar energy and heat pumps are higher compared to space heating and again constantly increasing from 3.8 % to 8.9 % in case of solar heat and from 1.5 % to 3.6 % in case of heat pump systems. Biomass for hot water applications has experienced a steady decline from 12 % to 10.8 % in the considered period.

Calculations have been conducted by Müller et al. (2010) based on the incentive regulations and energy policy in Austria in 2010 to predict the number of buildings equipped with a certain heating system type in 2050. The results are given in Figure 42.

Figure 42 -Number of buildings equipped with heating system, projection until 2050 according to Müller et al. 2010.



Heating systems based on fossil fuels especially oil (light blue area) will be successively replaced by renewables. District heating (orange area) will experience further increase due to the constant integration of buildings in urban surroundings. A very strong increase is expected for solar thermal (green area) and heat pump systems (purple area) as well biomass (dark blue). Starting in 2040, a rise in market diffusion of monovalent solar thermal system is expected due to improved thermal storage systems (red area). (Müller et al. 2010)

3.4 Customer Preferences

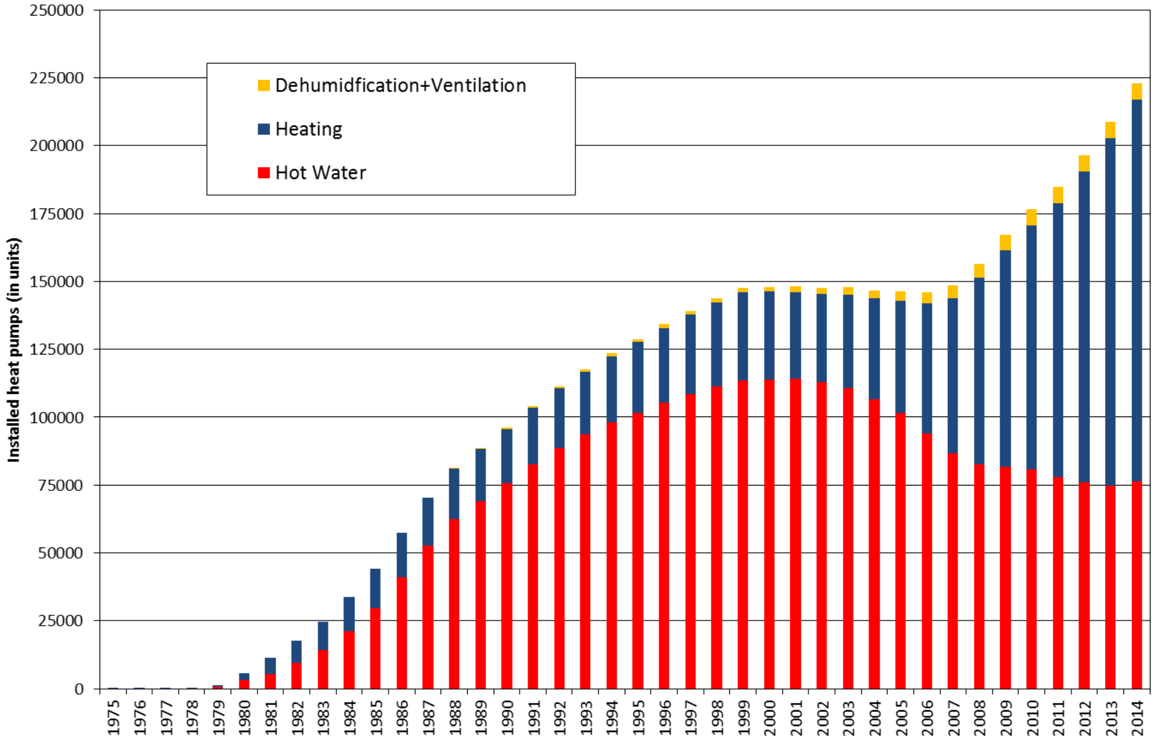
The design room temperature of Austrian dwellings during the heating season is about 20 °C to 21 °C. Since design and real room temperatures differ, a telephone survey conducted by AEA (2013) investigated the actual average room temperature and the control behaviour in Austria by questioning 1006 randomly selected private households. 28 % of the people questioned stated to have room temperatures lower than or equal to 20 °C. The second largest group lies between 21 °C and 22 °C. Only 4 % answered to have more than 24 °C. The average room temperature resulted in 21.5 °C. A night setback is conducted by 66 % with an average temperature of 17.5 °C. However, only 29 % of the questioned households are performing a setback when leaving the building with an average temperature of 17.3 °C. (AEA, 2013)

4 Analysis of the Austrian domestic heat pump market

4.1 Installed Heat Pump Capacity

Biermayr et al. (2015) estimated the number of operating heat pumps in Austria. Based on the numbers of the heat pump market development and an assumed service life of 20 years, the current operating systems are calculated. The results are depicted in Figure 43. In the year 2014, a total of 76 488 hot water heat pumps, 140 380 heat pumps for heating and 6 098 for dehumidification and ventilation purposes are in operation.

Figure 43 – Historical development of operation heat pump systems for heating, hot water and dehumidification/ventilation (Biermayr et al, 2015).

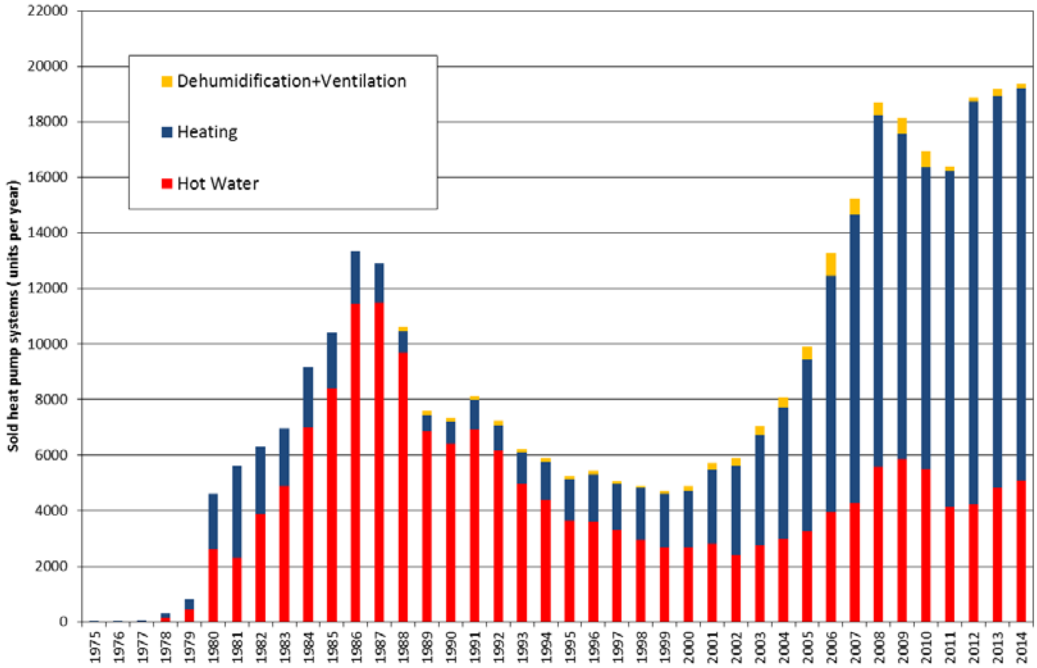


The total number of operating heat pump systems in 2014 results in 222 966 units. For operating this number of heat pumps Biermayr et al. (2015) calculated an electric energy demand of 718 GWh per year, for 1600 full load hours the connection power can be roughly estimated to 450 MW.

4.2 Trends in the Heat Pump Market

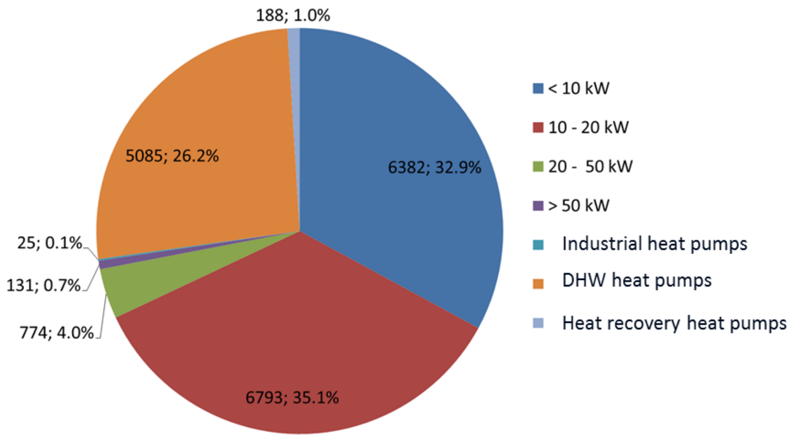
The development of the Austrian heat pump market (Figure 44) can be characterized by an early phase of technology diffusion in the 1980's (mainly heat pumps for water heating) followed by a significant market decrease and a second increase starting from the year 2001 (now mainly heat pumps for space heating). The second diffusion period came together with the introduction of energy efficient buildings which offered good conditions for an energy efficient operation of heat pumps because of low temperature needs in the heating system and low energy consumption for space heating.

Figure 44 – Heat pump market development in Austria until 2014 (Biermayr et al., 2015).



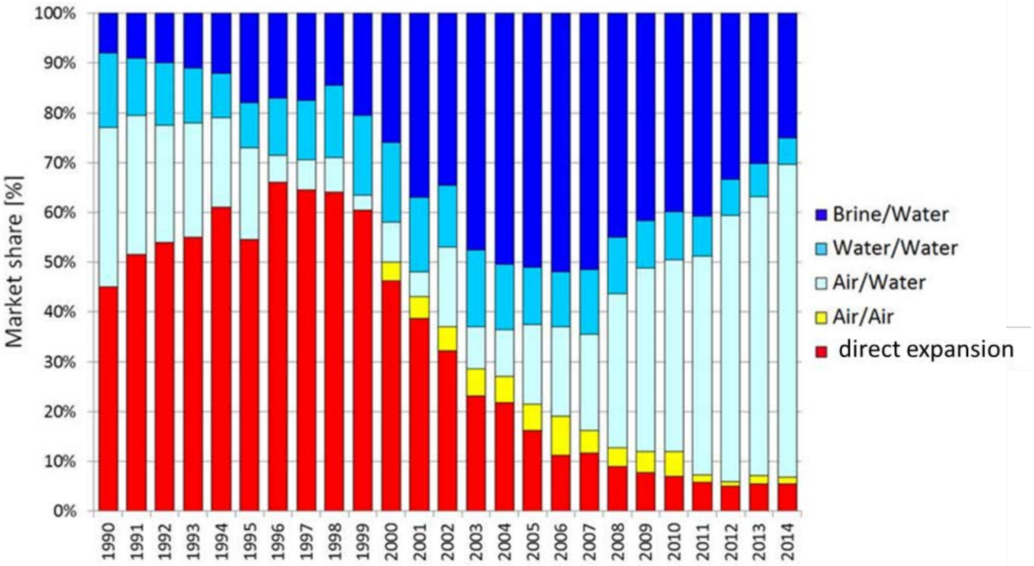
According to Biermayr et al. (2015) the total sales of heat pumps (national market and export market) increased from 2013 to 2014 by 1 %, from 28 959 to 29 236 systems. In particular, in the sector of heat pumps up to 10 kW for space heating purposes, there was a clear increase of the sales figures of 8 %. In this sector, the national market (+10.8 %) as well as the export market (+2.2 %) increased. A decrease could be observed with heat pumps in the capacity range above 10 kW. In the segment between 10 to 20 kW a slight decrease in sales of -2.7 % (national and export market) resulted. In a capacity range from 20 to 50 kW a high decrease in sales of about -12.7 % between 2013 and 2014 can be observed. Similar problems occurred in the power segment above 50 kW which shows an even higher decrease in sales with -21.6% (national and export). Since the absolute numbers in the large capacity range are quite low, already a moderate change causes a high percentage deviation. The numbers show a current trend in the Austrian heat pump market towards heat pumps for space heating in the lower capacity segment. In Figure 45 the share of the different heat pump capacity rages is shown, systems with thermal capacities smaller than 20 kW and DHW heat pumps have a share of approx. 95 %.

Figure 45 – Different heat pump capacity ranges in Austria 2014 (Biermayr et al., 2015).



The export market amounted to 33.7 % in quantity of the total sales in 2014. This is a slight decrease compared to 2013 (-0.1°%). In 2014, the Austrian heat pump sector (production, trade and installation) had an amount of total sales of 244.3 million Euro and 1 246 full time jobs. (Biermayr et al., 2015)
Figure 46 depicts the market share of the different heat pump types (Brine-to-water, water-to-water, air-to-water, air-to-air and direct expansion ground source heat pumps) in Austria from 1990 to 2014. Air-to-water heat pumps show an increasing trend for the last ten years caused by the low installation costs and due to the lower complexity of air as the heat source. Brine-to-water heat pumps show a decreasing market share since 2007 as well as direct expansion ground source heat pumps since 1998. Water-to-water and air-to-air heat pumps play a minor role on the Austrian market.

Figure 46 – Market share for heat pump sources until 2012 (Biermayr et al., 2015).



The numbers of the domestic market development in the heat pump sector relating to space heating only, from 2013 to 2014, can be found in Table 2 described by the heating capacity segments and heat source. A very interesting observable aspect is the increase in market shares of air/water heat pumps considering the total amount of heat pump systems, which continues the trend mentioned before.

Table 2 – Domestic heat pump market development for space heating only within 2013 and 2014 in different capacity segments and HP-types. Biermayr et al. 2015.

rated capacity	type	domestic market 2013 (units)	domestic market 2014 (units)	relative change 2013/2014 (%)
up to 10kW	Air/Air	240	188	-21.7
	Air/Water	3574	4379	+22.5
	Water/Water	267	227	-14.8
	Brine/Water	1638	1476	-9.9
	direct evaporation	283	299	+5.9
	total	**6002**	**6570**	**+9.5**
10 kW to 20 kW	Air/Air	0	0	0.0
	Air/Water	4008	4254	+6.1
	Water/Water	458	390	-15.0
	Brine/Water	2226	1739	-21.9
	direct evaporation	432	410	-5.0
	total	**7124**	**6793**	**-4.6**
20 kW to 50 kW	Air/Air	0	0	0.0
	Air/Water	392	305	-22.2
	Water/Water	148	101	-31.6
	Brine/Water	385	290	-24.8
	direct evaporation	77	78	+1.4
	total	**1002**	**774**	**-22.8**
50 kW and up	Air/Air	0	0	0.0
	Air/Water	20	15	-25.0
	Water/Water	73	49	-32.9
	Brine/Water	86	67	-22.1
	direct evaporation	0	0	0.0
	total	**179**	**131**	**-26.8**
Industrial heat pumps	Air/Air	0	0	0.0
	Air/Water	31	23	-25.8
	Water/Water	2	2	0.0
	Brine/Water	0	0	0.0
	direct evaporation	0	0	0.0
	total	**33**	**25**	**-24.2**
total amount of heat pumps	Air/Air	240	188	-21.7
	Air/Water	8025	8976	+11.8
	Water/Water	948	769	-18.9
	Brine/Water	4335	3572	-17.6
	direct evaporation	791	787	-0.5
	total	**14340**	**14293**	**-0.3**

4.3 Market conditions

The actual prices for oil and natural gas as well biomass have a high influence on the heat pump market. They can be a driver or a barrier depending on the current situation. Increasing oil and gas prices and relatively low electricity prices support the heat pump market development and vice versa. Also, the price for biomass is interesting since this segment makes up a significant amount of Austria`s heating market. Furthermore, a rather important aspect for the selection of a heat pump system is the installation cost, which has been discussed briefly in section 3.1.

The responsibilities on incentive schemes lie upon the different federal governments in Austria. However, only five out of nine provinces have installed incentives for heat pumps. The existing ones are lying in the categories of newly constructed buildings and refurbishment with a monetary range between 300 € and 6750 € (for low energy buildings ~ 45 kWh/(m²a)). The second option to apply for support, are incentive schemes provided by several electricity suppliers. These are connected to a supply contract with the respective company and can be a credit on the next invoice. The range is between 200 € and 6000 €. (**www.waermepumpe-austria.at**)

Challenges for a growing heat pump market are incentives schemes provided and supported by the Austrian oil economy. These schemes provide support, for example, for replacing the old heating system with an oil boiler of the newest generation with up to 3000 €. (Biermayr et al., 2015)

Based on National Renewable Energy Action Plan for Austria (NREAP-AT, 2010), building refurbishment incentives, the development of low energy building standards are agreed on and provide chances for a growing heat pump market.

A List of smart heat pump projects in Austria

LoadShift

Projekttitel: Lastverschiebung in Haushalt, Industrie, Gewerbe und kommunaler Infrastruktur - Potenzialanalyse für Smart Grids (Load shift in household , industrial, commercial and municipal infrastructure – Analysis of the potential for Smart Grids)

Objectives: The project "Load Shift" analysis the potentials of the shift of the energy demand of high- load periods in consumption valleys and analyzes the economic , technical , legal and organizational aspects of this shift. The project examines the load shifting potentials separately for the industrial, commercial, residential and municipal infrastructure, provides consistent estimates of the cost of various degrees of potential exploitation, and passes the cost curve for Austria . This results in a decision matrix, recommendations for the public and private decision makers to improve the efficiency of the Austrian energy system. However, the results address the theoretical potentials and do not include simulation results from the building or heat pump.

Participants: Energieinstitut an der JKU Linz, Joanneum Research GmbH, e7 Energie Markt Analyse GmbH, TU Graz - Institut für Elektrische Anlagen, 4ward Energy Research GmbH, E-Werke Stubenberg, Stadtwerke Hartberg, Sonnenplatz Großschönau

Time frame: 05/2012 - 04/2014

Flex-Tarif

Projekttitel: Flex-Tarif - Entgelte und Bepreisung zur Steuerung von Lastflüssen im Stromnetz (Flex Tariff - charges and pricing to control load flows in the electricity grid)

Objectives: The project Flex-Tariff deals with flexible electricity tariffs that contribute to the load shift and thus to the objectives of a smart grid (security of supply, integration of renewables, grid expansion prevention, energy efficiency), in terms of varying energy and / or power price components. In the project an optimal design of the electricity price component in the context of the listed objectives will be developed.

Participants: Energieinstitut an der Johannes Kepler Universität Linz, TU Graz - Institut für Elektrische Anlagen

Time frame: 09/2013 - 08/2014

The Bat:

Projekttitel: Die Thermische Batterie im Smart Grid in Kombination mit Wärmepumpen – eine Interaktionsoptimierung (The Thermal Battery within a Smart Grid in combination with heat pumps- and Interaction Optimization)

Objectives: The interaction of heat pumps and building integrated PV to level the electric loads and the optimized purchase and feed in of electricity in the grid will be an important issue for smartgrids in future. Such interactions are examined in “The Bat” and respective concepts are developed. The development bases upon elaborated combinations and interaction of the thermal masses of the building and the heating system und the user-optimized energy management system using predictive control. The results will be realized both in a functional model with direct coupling of PV to a modulating heat pump and in laboratory tests of the control systems.

Participants: Heliotherm, University of Innsbruck – Faculty for Civil Engineering, TU Graz- Institute for Thermal Engineering.

Time frame: 2012-2016

Projekt MacSheep:

Projekttitel: New Materials and Control for a next generation of compact combined Solar and heat pump systems with boosted energetic and exergetic
Performance.

Projektnummer FP7-ENERGY-2011-1 No.: 282825

Objectives: Development of innovative products and methods for renewable eneries through advanced (new) materials and improved information and communication technology (ICT).

Participants: HSR Hochschule für Technik Rapperswil, Högskolan Dalarna, Commissariat a l’Energie Atomique et aux Energies Alteranatives, Ceske Vysoke Ucenitechnicke v Praze, TU GRAZ, Elektrizitätswerk Jona-Rapperswil AG, Regulus Spol Sro, Viessmann Faulquemont S.A.S., Ratiotherm, Energy Solaire

Time frame: 01/2012 – 02/2016

iWPP-Flex

Projekttitel: Intelligentes Wärmepumpen-Pooling als Virtueller Baustein in Smart Grids zur Flexibilisierung des Energieeinsatzes (Intelligent heat pump pooling as a virtual module in Smart Grids for a more flexible use of energy)

Objectives: The project iWPP-Flex examines the operation of Heat-pumps-pooling for the flexibilisation of its energy consumption. This flexibility can be used to increase the energy efficiency in Smart Grids. The goal of iWPP-Flex is the development of a technical concept for Heatpumps-pooling and a tool to evaluate the profitability of the pooling concept. The results can be used as preparation of the specifications of the demo project.

Participants: AIT Austrian Institute of Technology, VERBUND Solutions GmbH

Time frame: 03/2015 - 02/2016

SmartMSR

Projekttitel: Green Building Management

Objectives: The aim of the SmartMSR project is the development of a new set of methods that optimize energy management in complex buildings. Disturbances such as the weather and the use of individual rooms show considerable potential. Particular focus is placed on the easy implementation of alternative energy sources such as solar power, geothermal heat or the connection to micro-grids. The greatest challenges are the diametrically opposed requirements of cost reduction, or energy minimization, against maximization of user comfort and user limitations in the system. The target is to develop an intelligent autopilot that uses the weather forecast, room occupation schedules and other boundary conditions (length of the effects of concrete core activation…) 24/7, 7 days a week, to optimize the building management in such a way as to save energy and costs.

Participants: Technische Universität Wien, FH Joanneum, evon GmbH

EStore-M

Projekttitel: Electricity Storage Management

Objectives: The aim of this project is to develop an adaptive scheduling controller which integrates user input, weather- and load forecast as well as a robustness against uncertainties. Key is a robust optimisation which will dynamically optimise the scheduling controller according to its inputs. Additionally meteorological energy production forecasts will be developed and energy efficiency will be analysed over the life cycle of such systems.

Participants: SCCH - Software Competence Center Hagenberg, Fronius International GmbH, BLUE SKY Wetteranalysen, Heliotherm Wärmepumpentechnik GesmbH

Time frame: 03/2015 - 08/2017

B Analysis of smart-ready products

B.1 Criteria for 'Smart-Ready': Analysis of Full Range of "Smart" Capabilities

Criteria	*Topic*	*Importance for peak shifting*	*Maturity*	*Future evolution*
Heat pump functionality	Inverter-driven compressor which can ramp down rather than switch off	High (allows for sensible adjustment)	Available on the market (but not from every manufacturer)	
	On/off	High	Mature	Mainstream
Control strategies: building thermal mass & storage	Pre-heat algorithms			
	'Learning' building thermal response	High	Research is undertaken	Hopefully further research to market initiatives
	Optimising integration with storage	High	Research is undertaken	Strongly linked to the line above
Control strategies: outside	Weather compensation & variable capacity			

Criteria	*Topic*	*Importance for peak shifting*	*Maturity*	*Future evolution*
environment	Responding to weather forecast data	Medium/High depending on thermal building mass	First heuristic approaches on the market/ ongoing research on sophisticated controllers	Hopefully further research to market initiatives for sophisticated controllers
Control strategies: energy price	Responding to dynamic price signals	High	Low	Depending on the price evolution and the volatility
	Responding to pre-set price (& CO2 signals?)	See line above		
Communication capability	2-way communication	High	Low ?	
	1-way communication	High	Mature	
Speed of response to communication signal	Dynamic response (minutes)	High		
	Needs advanced notice (hours/days)			
Communication protocol				
Thermal storage	Sensible heat storage (water tanks)	High	Mature	
	Advanced heat storage technologies e.g. phase-change materials	High		
Integration with 2nd energy source	bivalent system with set-point control to switch from HP to other source	Medium (but the idea is not to include a further source)	Mature	
	hybrid which switch between heat sources according to price, CO2			
	Sophisticated control hybrid which can switch between sources in response to dynamic tariffs			

B.2 Review of Austrian products which meet these smart-ready criteria.

There is no specific legislation or Label in Austria to classify heat pumps as smart products. But the bigger part of the products from Austrian heat pump manufacturers are labeled with the Smart Grid Ready Label (SG ready, 2013). Smart heat pumps have been introduced to the market at the beginning of 2013. Those models are marked by the “SG ready” label that stands for a uniform interface and had been granted to 817 models from 29 manufacturers by the middle of 2015. Concerning smart grid and smart market several pilot projects have been done in the recent years but there are several obstacles impeding the extensive use of smart heat pumps. By now no market models have been established by the utilities.

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