Energy! ahead

Energy Report of the City of Vienna

Data for 2016/ Year of reporting 2018, Municipal Department 20

Stadt Wien

SMART CITY WIEN

ABBREVIATIONS

BLI	Bundesländer Luftschadstoff Inventur – survey of air pollutants in Austria
CHP	Combined heat and power cogeneration
emikat.at	Emissions and energy data management system of the Austrian Institute of Technology (AIT)
ETS	Emissions trading system
GHG	Greenhouse gases
GIEC	Gross inland energy consumption
KliP	Climate protection programme of the City of Vienna
kWp	kilowatt peak
MA	Municipal Department
MIT	Motorised individual traffic
Non-ETS	Non-emissions trading system
PV	Photovoltaics
SCWR	Smart City Wien Framework Strategy
SEP	Urban Energy Efficiency Programme of the City of Vienna
STEP	Urban Development Plan of the City of Vienna

IMPRINT

Owner and publisher:
Vienna City Administration/Municipal Department 20 – Energy Planning
Strategic coordination and editing of first chapter:
Municipal Department 20 – Energy Planning, www. energieplanung.wien.at
Bernd Vogl, Herbert Ritter, Ursula Heumesser, Alexandra Höfenstöck , Kristina Grgić
Energy Center Wien at UIV Urban Innovation Vienna GmbH
Matthias Watzak-Helmer, Michael Cerveny, Waltraud Schmidt
Informationstechnologie im Energiebereich Valuch
Monika Valuch
Design, illustration, layout:
Erdgeschoss GmbH, www.erdgeschoss.at
Copyright photos: Lukas Beck, MA 20/Kromus/Fürthner
English translation: Sylvi Rennert
Printed at: agensketterl, www.agensketterl.at
Printed on ecological CO_2-neutral paper produced following “Ökokauf Wien” criteria.

Published and printed: Vienna 2018

This report and the related data are available on the Open Government Portal
https://www.data.gv.at/auftritte/?organisation=stadt-wien

Energy! ahead

DATA 2016
for the City of Vienna

Wien! voraus

Energieplanung

Stadt Wien

TABLE OF CONTENTS

INTRODUCTION AND FINDINGS

Maria Vassilakou
Vice Mayor of the City of Vienna and Executive City Councillor for Urban Planning, Traffic & Transport, Climate Protection, Energy and Public Participation

1.1 PREFACE

The next heatwave is sure to come

2017 was the third-hottest year on record. The weather data of the past year show clear trends, and climate experts agree: temperatures are reaching record highs. In the long term, the average annual temperatures have been increasing since the beginning of modern record keeping.

Unless greenhouse gas emissions are reduced dramatically, temperatures will continue to rise. Exceptionally hot summers like the last one will become the norm, with all the negative consequences that will have for our health or agriculture. And what is more, the number of meteorological disasters will rise – not just heat and drought, but also floods, torrential rainfalls, and severe storms.

There is an immense pressure to act, because climate change is now also being felt in our region. The 2-degree goal of the Paris Agreement was a milestone that is also at the centre of the climate protection efforts of the City of Vienna. Vienna has been on a steady decarbonisation course for years and is a driver of climate protection. To bundle all efforts, we have developed an Energy Framework Strategy. We aim to reduce greenhouse gas emissions dramatically by 2050 across all sectors – mobility, energy, infrastructure, and buildings.

The data in this Energy Report show us once again that our measures are effective: At approximately 20,000 kWh per capita, Vienna has the lowest energy consumption by far of all Austrian provinces. By comparison, Lower Austria has an average consumption of approx. 45,000 kWh per capita. Nearly 30% of Viennese gross inland consumption in 2016 was from renewable energy sources or waste heat. The Austrian capital stays its course.

We must act, and we must make climate-friendly energy the norm. We must continue to be serious about our climate policy goals and do our utmost to achieve them.

Maria Vassilakou

Bernd Vogl
became Head of the Energy Planning Department (MA 20) in September 2011 after working for 18 years at the Ministry of Environmental Affairs in the field of energy planning and innovative energy systems.

2017 was a year of action, in every sense of the word: Arnold Schwarzenegger and his R20 climate initiative, which organised its first Austrian World Summit in 2017, brought together important and leading actors who create ideas for sustainable climate protection projects. Municipal Department 20 – Energy Planning (MA 20) is a key cooperation partner of this conference, which takes place annually in Vienna's Imperial Palace.

We promote international activities, especially initiated by the 2015 Paris Agreement. Since the Agreement, cities and regions have been pursuing climate protection with more confidence than ever before. They see their role as drivers of change. At the Bonn Climate Summit, the City of Vienna sent a powerful signal by signing the Bonn-Fiji Commitment. With this agreement, cities and regions commit to reinforcing their climate protection efforts, promoting adaptation to climate change, and implementing more transnational projects. We have already taken one important step: In February, we signed the first inter-city cooperation agreement. Vienna and Vancouver, both world leaders in environmental and climate protection, will join forces to strengthen their activities in the area of green buildings. The first joint project is ready to start: Vienna and Vancouver will each build an affordable residential zero-emission building as a lighthouse project.

Vienna has already begun construction on several buildings and neighbourhoods that are cooled with renewable energy and passive ground cooling methods. The city is also planning to use these technologies in education buildings. Together with the Director General of Urban Planning, Development and Construction and the Municipal Departments 19, 34 and 56, we are involved in the planning process of education buildings. With the call for tenders for the education campus projects Seestadt Aspern Nord and Atzgersdorf, we were able to set the course for renewable energy solutions in the early planning stages. Heat pumps are one of the main technologies we support and promote. This was recognised by the European Heat Pump Association with the Heat Pump City of the Year Award.

The award affirms our unceasing efforts to promote the use of renewable energies. Our aim is to pave the path for sustainable and innovative energy solutions. To this end, we have subsidies and incentives for renewable energy use, design administrative processes for energy projects, bring energy expertise to the city, and enable communication and networking. In the end, however, it is our results that count, i.e. the sustainable buildings and energy solutions implemented in Vienna and our partner cities.

Bernd Vogl

1.2 VIENNA – VANCOUVER: GREEN BUILDING CITY PARTNERSHIP

In March 2018, Ms. Andrea Reimer, Councillor of the City of Vancouver, and Vienna's Deputy Mayor Ms. Maria Vassilakou signed a Memorandum of Understanding covering five Green Building initiatives. On this basis, the two cities want to continue on the path of urban decarbonisation together.

Mr. Sean Pander, Green Building Manager of the City of Vancouver and co-author of the award-winning Greenest City Action Plan, is working hard with Vienna to significantly reduce emissions caused by new building construction in line with the goals of the Paris Agreement.

1. Vancouver is one of the most ambitious cities in terms of climate strategies and its transition to 100% renewable energy by 2050; why do you think this is?
Vancouver has been gaining global prominence for its commitments and initiatives to curb climate pollution. The city, located on Canada's west coast, benefits from a relatively mild climate as well as an abundance of renewable hydroelectricity. It has a history of good urban planning, creating vibrant neighbourhoods where residents can live, work, and play. These factors combined with recent investments in public transit, pedestrian and cycling infrastructure and the introduction of building energy efficiency programs and policies have resulted in steady reductions in greenhouse gas emissions and strong economic growth.

2. What are the main challenges you are facing to continued success in this regard?
Canada has an abundance of oil and natural gas resources which result in a reliable supply of low-cost fossil fuel-based energy. Consequently, there has been far less pressure and national commitment to develop energy efficient buildings and vehicles as compared to Europe. Despite this context, Vancouver has created a regulatory structure at the city level that has reduced greenhouse gas emissions from new buildings by over 50% in the past 5 years and will require new developments to achieve zero operational greenhouse gas emissions by 2030. While new construction is improving rapidly, existing buildings represent a much larger challenge. The City owns less than 2% of buildings in Vancouver and a large number of existing privately owned buildings require renovations to decrease their dependence on fossil fuel-based energy. One of the challenges of being one of the most liveable cities in the world and having a robust economy is that there is virtually no vacancy in residential or commercial buildings. Renovations to improve these existing buildings are inhibited by the reality that these renovations can be disruptive and are secondary to the buildings' current use. This, combined with relatively weak regulatory authority over existing buildings, low energy prices (and therefore smaller energy cost savings potential), and the fact that the new technologies are not necessarily compatible with existing building systems mean that new creativity and partnerships are required.
In regards to reducing transportation-related emissions, good urban planning has fostered an environment where public transportation choices are in high demand. Meeting this demand requires infrastructure investments which, until very recently, were not a priority for either the Provincial or Federal governments. During this time, Vancouver has been rapidly expanding protected bike lanes but as in dense urban environments around the world, reallocating street space away from private automobiles to other uses is controversial and requires careful planning in order to be successful.

Sean Pander meeting with Vice Mayor Maria Vassilakou, Bernd Vogl (MA 20) and Nicole Mothes (Canadian embassy)

3. How is Vancouver's rapid transition to renewable energy impacting business?
The move towards increased efficiency and renewable energy has been very positive to date but will grow more challenging as the demand for gas declines if the transition is not managed carefully. The City is seeing rapid and direct job growth in green buildings, waste recycling and re-use, and local food production. Indirectly, Vancouver's embrace of progressive environmental policies helps to attract creative professionals which are critical for the broader "creative" economy which is also very strong in Vancouver; witness the relocation of the Ted (Talks) Conference from Long Beach California to Vancouver as one indicator of this dynamic element of our local economy.
Despite this success, significant change is always challenging for some. Local businesses that are based upon the use of fossil fuels will be resistant to change until they can find opportunity in the transition. Vancouver is beginning work to identify local businesses and workers likely to be impacted and will start working with them to develop transitional strategies and training programmes. In an ironic twist, climatic changes are rapidly increasing market demand for air conditioning, which will likely drive the initial residential market transition to heat pumps (which can provide both heating and cooling). Companies that currently only install and service heating equipment will likely add cooling equipment to their business and allow for a gradual transition.

4. What can other cities learn from Vancouver?
One of the biggest revelations in this work has been how important it is for progressive cities to take action even in the absence of support from higher levels of government. Local governments can leverage collaborative networks with other innovative cities that expose them to new ideas and help to foster relationships with global leaders that have successfully introduced new approaches. Local governments also have a much closer relationship with the businesses impacted by proposed changes. The fundamental shift in Vancouver's approach to building energy efficiency emerged from candid dialogues with engaged building industry leaders about what was not working in our, and much of North America's, approach to date. Genuine engagement with the building sector enabled the City to eliminate ineffective

policies that were challenging for the sector and replace these with new requirements that, while strict, were sensible to the businesses they impacted. This resulted in strong support from the development industry for the requirements even as these had the effect of reducing carbon pollution from new buildings by over 50%.
A second key lesson is that pprosperity and environmental leadership are not mutually exclusive. Green business and technologies are the fastest growing segment of Vancouver's economy. The city's population and employment opportunities are growing rapidly while greenhouse gases are in decline.

5. You signed a memorandum of cooperation with Vienna on green buildings this year. What do you expect from the cooperation?
Vancouver's largest challenge is to provide affordable, high quality housing for its citizens. We hope to learn from Vienna's long history of developing affordable housing that is highly energy efficient. We hope to gain insights and foster business collaboration that leverages off-site building fabrication in combination with integrated digital design and project management tools.
In addition, Austria is a globally recognised leader in mass timber construction. Vancouver's early implementation of its Zero Emissions Building Plan has already reduced operational emissions from new construction so much that the embodied emissions of the materials used in buildings have the same climate impact as all the energy used by the building over its entire lifespan. We hope our collaboration with Vienna will help to establish business partnerships to expedite the local production of high quality mass timber products.

1.3 MILESTONES ON THE ROAD TO A SUSTAINABLE ENERGY FUTURE

75 percent of Vienna's gross inland energy demand is still covered by oil and natural gas. This highlights the dominance of fossil energy vectors as well as our dependence on energy imports. But there is cause for hope: The share of renewable energy sources is increasing steadily, rising from 5 to 10 percent in the last decade. At the same time, total energy consumption has remained the same in absolute terms, although the population has grown considerably. Worldwide trends, international energy and climate protection efforts, and decisions at the European level all have an impact on Vienna, as do decisions at the national level in Austria. At the same time, the City of Vienna is setting the course towards decarbonisation and actively shaping our energy future.

Global developments

Prices increase strongly for fossil energy, electricity, and emissions trading certificates
The upward trend on the commodity and energy markets of the last years continues.
In mid-2018,

- the oil price reached its highest peak since autumn 2014, an approximately 60 percent increase year on year,
- the price of base load electricity was the highest in over five years, approximately 40 percent higher than the previous year,
- and the price of European CO_2 emissions trading certificates was the highest since summer 2011 and triple that of the previous year.

The price of coal is also higher than last year, having risen for the last three years. Only the price of natural gas, which is important for Europe, has remained relatively stable over the last year. As varied as the reasons for the rising prices may be, the developments are good arguments in favour of increasing energy efficiency and making renewables more competitive.

Developments at EU level

"Clean energy for all Europeans" defines the EU energy and climate policy for 2020 to 2030
The energy and climate protection policies of the European Union are progressing with great strides. Just before the start of summer 2018, several decisions were made regarding energy and climate-related Directives and Regulations that had been discussed at the European level for some time (such as the Winter Package and the Clean Energy Package). An overview of the main decisions:

The Energy Performance in Buildings Directive includes:
- Roadmap to decarbonise existing buildings,
- "smart readiness indicator" for buildings, measuring their capacity to use new technologies and electronic systems,
- compulsory charging infrastructure for electric vehicles in buildings.

Governance Regulation:
- The new Governance Regulation will ensure that the European Union meets its climate and energy goals. For the first time, a "Paris compatible" goal was agreed upon: a net-zero carbon economy "as early as possible" (the original position of the EU Parliament had been "by 2050").
- It demands the Member States prepare national energy and climate plans until 2030 and 2050. These plans must be presented to the European Commission as drafts by the end of 2018 and in final form by the end of 2019.

Renewable Energy Directive:
- Goal for 2030: 32 percent of EU final energy consumption to be provided by renewables,
- increase share of renewable heat by 1.3 percent annually, 40 percent of which may be provided from waste heat.
- Enshrine rights and responsibilities of new market participants in law.

Energy Efficiency Directive:
- Goal for 2030: EU final consumption to be 32.5% below the "business as usual" value forecast for 2030 before the economic crisis,
- reduce volume of energy sales to final consumers by 1.5% annually.

Regulation on the internal market for electricity:
- Common rules for the future internal market for electricity,
- rules for new market participants, such as "active customers" and "local energy communities",
- clarifies responsibilities for storage and recharging points for electric vehicles.

Directive on the internal market for electricity:
- Aims to strengthen competition on electricity wholesale markets,
- aims to increase cross-border electricity trade in the EU,
- sets CO_2 thresholds for the capacity market.

Link to the Directives and Regulations:
https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans

Developments at the national level

The Austrian Climate and Energy Strategy
In May 2018, the Austrian Council of Ministers passed the Climate and Energy Strategy (#mission2030). With this strategy, the federal government aims to present its goals and projects in the area of energy and climate protection. These goals, which are essentially the same as those demanded by the EU's Governance Directive (see above), are:
- Reduction of greenhouse gas emissions by 36 percent from 2005 (non-ETS), in line with the EU targets for Austria. Compared to today, this is a reduction by 28 percent.
- Reduce CO_2 emissions by 7.2 million tonnes (from 22.9 to 15.7 million tonnes) in transportation and by 3 million tonnes (from 8 to 5 million) in buildings.
- Increase share of renewables in gross final energy consumption from currently 33.5 to between 45 and 50 percent by 2030.

- Cover 100 percent of electricity consumption from renewables by 2030. Not included in this goal are electricity for self-supply purposes in the industrial sector as well as control and balancing energy.
- Increase primary energy intensity by 25 to 30 percent from 2015. If primary energy demand by 2030 exceeds 1,200 PJ, the excess energy must be provided from renewables.
- Increase share of cycling from 7 to 13 percent by 2025.

It is currently too early to say how the energy and climate policies of the federal government will support those of the city of Vienna, as the presented strategy contains very little information about concrete measures. It has been announced that some measures will be presented in subordinate strategies, such as a "Heating strategy".

Developments in Vienna

Energy Framework Strategy 2030 - a fundamental part of Vienna's energy policy
A future-proof energy policy for Vienna requires the development of a sustainable energy system characterised by a high degree of supply security, stable and affordable energy prices, a significantly reduced level of environmental impact, and a clear commitment to decarbonisation.
The Energy Framework Strategy 2030, which was passed in May 2018, sets the goals for the energy and climate protection policy of the City of Vienna. It is a strategic framework that bundles existing strategies and paves the way for future plans. The Energy Framework Strategy bridges the gap between the objectives defined in the Smart City Wien Framework Strategy with its long-term decarbonisation path and the operative short-term plans and measures. In addition to raising the share of renewable energy sources in the electricity and heating market, it focuses on the increased use of existing waste heat potentials. The Energy Framework Strategy provides guidelines for six strategy areas: Sustainable energy supply, spatial energy planning, energy-efficient city, consumption, mobility, and innovation and digitisation.
Link: https: //www. wien.gv.at/stadtentwicklung/energie/energierahmenstrategie-2030.html

Staying the efficiency course with "SEP 2030"
Despite great population growth, Vienna is aiming to also reduce energy consumption in absolute figures by 2030. Increasing energy efficiency is not only of paramount importance for reaching energy and climate policy goals, it also supports social and economic policy goals, promotes local value creation, and helps reduce energy poverty.
The final draft of the Urban Energy Efficiency Programme 2030 (SEP 2030) is currently being deliberated. It is the follow-up programme for the SEP passed in 2015. It continues the efficiency efforts consistently, is based on the goals of the Energy Framework Strategy 2030 and describes the measures and instruments that will help achieve these goals. A new feature of SEP 2030 is the focus on the transportation sector. Nearly 90 percent of Vienna's final energy consumption occur in the areas of traffic and transport and buildings. Therefore, these two sectors are at the centre of the programme, with a focus on measures in the city's area of competence that can sustainably reduce energy consumption. Many of the approaches for increasing energy efficiency and saving energy contained in SEP 2030 are not new and have been pursued for years. It remains important to continue implementing and financing them, and they must also be re-evaluated and adapted regularly to account for changing conditions. The measures and instruments focus on Vienna's areas of competence as a city and federal province. By implementing these measures in its own sphere of influence, the City Administration also sets an example for others.
SEP 2030 is expected to be passed in late 2018.

Strategic concept on spatial energy planning integrates energy into urban planning processes
The fact that Vienna has the lowest per capita energy consumption of all federal provinces by far shows how important the relationship between space and energy is. Spatial and urban planning have a major impact on how a city uses energy. Spatial energy planning combines aspects of spatial and urban planning with energy planning, with a positive impact on the use of resources in Vienna. The Strategic concept on spatial energy planning, which defines the goals and energy standards for this, is currently in development. It is a part of the Vienna Urban Development Plan (STEP 2025) and is expected to be completed and passed by the end of 2018. Spatial energy planning that contributes to meeting the energy and climate protection goals by carefully considering the spatial dimension of energy consumption and supply and the necessary infrastructure and its development should become an integral part of urban development.

Spatial energy planning has the following goals:

- Reducing energy demand for infrastructure, mobility, and the construction and refurbishment of buildings.
- Meeting energy demand with maximum sustainability and efficiency, including using locally available energy sources and waste heat.
- Optimising existing infrastructure, including developing ideas for the future use of the existing gas network.

Some of the main elements of spatial energy planning are energy efficiency, the increased use of renewable energy sources, and the integration of urban planning and energy planning.

New buildings ordinance – amendment for sustainable building

The Ordinance for New Buildings is the basis for the distribution of housing promotion funds in Vienna. It was amended in May 2018. MA 20 was involved in defining key energy criteria and ensuring they were embedded in the amendment. They contribute to climate protection, in some cases considerably, as funding will be given to projects whose majority of heating energy comes from renewable sources. This funding will especially benefit new buildings in parts of the city not connected to the district heating network. In the last years, many gas-heated buildings were built in those areas. With this targeted funding effort, Vienna wants to ensure that more new buildings and projects in those parts of the city cover the majority (= over 50 percent) of their heating energy demand from renewable sources. Buildings heated exclusively with renewables receive increased funding of up to EUR 50/m^2. The hope is that this maximum funding level will make it possible for developers to build climate protection model projects.
https://www.ris.bka.gv.at/GeltendeFassung.wxe?Abfrage=LrW&Gesetzesnummer=20000087

Selected pilot projects
In addition to the City of Vienna's energy policy frameworks and energy strategies, it is innovative projects that, in the end, push decarbonisation and the energy transition. Showcase projects include:

- Large-scale heat pump
  The most powerful large-scale heat pump in Central Europe is being built in the Viennese district of Simmering. Starting in late 2018, it will convert waste heat from the Simmering combined heat and power plant into district heating, tapping an energy source that

previously remained unused. This will provide safe and green heating for 25,000 Viennese households and save 40,000 tonnes of CO_2 per year. Construction on the model project, which will have a thermal output of 27.2 Megawatt, began in November 2017.

- VIERTEL ZWEI
  Customer co-creation is the core idea of the new pilot project in the VIERTEL ZWEI quarter, where the city's energy supplier Wien Energie is actively involving its customers in innovation and research. The project is directed at the residents of 300 new flats who moved in starting in autumn 2017.
  This project also supports the practical use of photovoltaics in a multi-family house and the application of blockchain technology, allowing an increased use of renewable energy sources. An electric vehicle charging station uses a blockchain-based computer protocol with automated contracts to get its electricity either from the PV installations in VIERTEL ZWEI or the wholesale energy market in Leipzig.

- E-mobility
  Vienna is expanding the public charging infrastructure for electric vehicles. 1,000 public charging points will be set up by 2020. This increases the presence of electromobility on the road, and better visibility encourages more people to use electric vehicles. Municipal Department 33 issued the call for tenders for the expansion of charging infrastructure. It was awarded to Wien Energie in October 2017 and has begun implementing an ambitious rollout plan with public participation. This plan aims to set up at least five chargers (with two charging points each) in each Viennese district by mid-2018. In phase two, they aim to expand this network to 1,000 new charging points in the public space.

- Geothermal energy
  GeoTief, a research project coordinated by Wien Energie, is doing a large-scale study of the geology of Vienna's 11th and 22nd district as well as the adjacent towns of Raasdorf and Wittau. The first measurements began in 2017. Geothermal energy can contribute significantly to increasing the share of renewables in district heating, improving supply security. The research project examines the ground to the east of Vienna with a seismic measurement method similar to echo sounding. The preparations for the second phase of seismic measurements to start in autumn 2018 are currently underway. Then, the collected data will be analysed and used as a basis for well-founded decisions about use of geothermal energy. The scientific analysis of the data will take one to two years.

1.4 MUNICIPAL DEPARTMENT 20 – ENERGY PLANNING: SHAPING VIENNA'S ENERGY FUTURE

Between 1 July 2017 and 30 June 2018, Municipal Department 20 – Energy Planning implemented the following projects, which contribute significantly to a sustainable and climate-friendly energy future for Vienna.

Understanding energy flows
MA 20 has been publishing an energy flow chart to illustrate the energy flows in the city for years. Now, an animated, interactive version has been developed to complement the annual static PDF flow chart. The dynamic animation makes it possible to follow the distribution of different energy vectors from gross inland energy consumption to end user consumption, both overall and for the individual sectors and consumption categories. The dynamic version includes a tour that answers important questions about energy flows in Vienna and explains energy terminology in simple terms. The dynamic energy flow chart is available for desktop and optimised for mobile use and shows all data from 2005 onwards in German and English.
Link: www.wien.gv.at/statistik/energie/energieverbrauch.html

Energy showcase project database and app
Urban energy innovations are made by visionary people, businesses, research institutions and other important actors. Vienna is a city of ground-breaking ideas and energy solutions in different areas, as exemplified by numerous projects that demonstrate what forward-looking design of sustainable energy supply can look like in practice. The knowledge database "Innovative energy projects" presents concrete examples from Vienna. New projects are constantly being added to the database, which will hopefully inspire the development and implementation of even more sustainable energy solutions. The database also supports the internal knowledge management of the Vienna City Administration. The innovative energy showcase projects can be viewed via the smartphone app Energy!ahead, in the wien.at online city map, and in the Open Government Portal. The Energy!ahead app will soon allow users to plan tours to the city's highlights in sustainable energy building, including a route planning feature.

Download the app:
- Google Play
- App Store

Link: https://www.wien.gv.at/stadtentwicklung/energie/beispiele/

Energy (efficiency) criteria for education campuses
The Vienna education campus model brings together kindergarten, school and leisure time activities in one place. Together with MA 20, the Director General of Urban Planning, Development and Construction has determined ambitious energy (efficiency) criteria for five new education campuses. MA 20 not only developed the energy criteria for the general plan but will also be involved in the entire planning and implementation process of the energy supply for these buildings in a quality assurance role.
A highly innovative "education campus plus" for year-round care and education for approx. 1,400 children and adolescents is being constructed in Seestadt Aspern Nord by September 2021. Because it will be open during the summer break, it is especially important to avoid

overheating in summer. Thanks to highly efficient planning, it will be possible to cover the entire HVAC for the building entirely from renewable energy sources year round at a low cost. Heat pumps with ground probes, a photovoltaics installation, building thermal mass activation, and controlled ventilation with heat recovery will all be used.
Another education campus, this one for approx. 1,100 children and adolescents, will be completed in Atzgersdorf in the 23rd district by September 2022. The campus is being planned as a low-tech building in order to optimise construction costs and long-term operation. This will be done by utilising passive architectural measures to their full extent in order to avoid excessive use of technology where possible. Key aspects of this include natural lighting, natural ventilation, shading through building components, and using ambient energy (cool night air, cool ground, etc.) to prevent overheating in summer. Three more energy-efficient education campuses are being built in Deutschoderstraße in the 14th district, near the Gasometer towers in the 11th district, and in the Innerfavoriten part of the 10th district.

Vienna subsidises waste heat extraction projects
In order to enable and support decentralised innovative energy systems, the City of Vienna is promoting the use of waste heat, as the conditions for this are good in the city (see waste heat potential map). A subsidy for waste heat extraction was developed as part of the green energy subsidy scheme. The Province of Vienna co-subsidises such projects as an add-on to the federal environmental subsidy. Subsidies are available for investments into waste heat transportation networks, distribution centres, and distribution networks that supply at least four objects in the overall grid.
Link: www.energieplanung.wien.at/foerderungen provides information about this and all other energy-related subsidies of the Province of Vienna

Interactive map of waste heat potential in Vienna
There are numerous sources of waste heat in Vienna that remain untapped, with the energy being dissipated into the atmosphere. Many industrial processes generate waste heat, which can be refined for further use, e.g. for space heating. Previously, there was little information about where such potential sources of waste heat might be found in the city. Therefore, MA 20 surveyed the waste heat potential generated by industrial processes and made the results visible in the Vienna city map. The data are based on the findings and experiences of the Austrian Institute of Technology (AIT) regarding industrial waste heat use and on estimates based on the number of employees of each company and the average energy consumption in that industry. The map provides an initial overview that can be used as a guideline to assess available waste heat potential, to make potential heat users aware of these sources and promote more sustainable energy supply.
Link: www.wien.gv.at/stadtentwicklung/energie/themenstadtplan/abwaerme/index.html

A close look at gas-powered central heating: The future of heating in old building stock
Vienna's current energy supply is heavily dependent on fossil natural gas. One of the core challenges of the future will be to decarbonise the heating of the city's old building stock in the long term by means of optimum (re)use of existing heating infrastructure, including the gas grid. As gas-powered central heating is very common in Vienna, especially in late-19th century residential buildings, it is being scrutinised with respect to decarbonisation. While many alternatives are available and affordable when constructing new buildings, retrofitting existing buildings with modern heating solutions is technically and financially challenging.

The core findings of the short-term study are:

- There are approximately 470,000 gas-powered central heating units in approx. 38,700 buildings in Vienna.
- Available alternatives in the city are primarily district heating and electricity-based heating systems (air heat pumps, direct heating, night storage heating, infrared heating). In the long term, it might become feasible to use non-fossil gas if certain conditions are met.
- A large-scale switch from gas-based central heating to alternative technological solutions for space heating and hot water supply will certainly be a long-term project. In the given conditions (existing building stock, energy supply, provision of services), it will only be possible through the mixed use of various technologies and energy vectors.
- The reduction of energy demand should be furthered through refurbishment efforts.

Link: www.wien.gv.at/stadtentwicklung/energie/pdf/gasetagenheizungen-studie.pdf

Avoiding overheating in summer

Overheating in summer is a growing challenge, particularly in urban areas. The electricity demand for air condition and fans in residential buildings is increasing rapidly because of the frequent lack of ways to prevent overheating. However, good planning, building and structural measures, and appropriate user behaviour would go a long way toward preventing overheating of residential buildings. Together with the University of Natural Resources and Applied Life Sciences Vienna, MA 20 commissioned a planning guideline for preventing overheating in summer in residential buildings. The guideline examines the reasons and consequences of overheating of buildings. It presents measures that can be used to reduce or prevent the impact of heat and ensure that buildings are suitable for summer temperatures in the long run. Each measure is examined with regard to its feasibility for new and existing buildings, and its pros and cons are discussed. Passive measures, in particular, are affordable and save energy, enabling comfortable temperatures without energy-intensive air conditioning systems. In addition to describing different strategies for building planning, the guideline also presents some best practice examples of effective solutions (e.g. thermal building component activation combined with renewable energy use).
Link: www.wien.gv.at/stadtentwicklung/energie/pdf/ueberwaermung.pdf

National and international projects involving MA 20

EU project URBAN LEARNING

In the EU project URBAN LEARNING (2015-2017), eight major European cities and capitals addressed shared challenges, such as the decarbonisation of energy systems while faced with growing populations. Vienna, Berlin, Paris, Stockholm, Amsterdam / Zaanstad, Warsaw and Zagreb developed ways to improve the institutional capacity of local authorities for integrated urban energy planning. The project was coordinated by the Energy Center at UIV Urban Innovation Vienna GmbH and MA 20 was responsible for developing and coordinating activities related to governance and processes. An in-depth analysis of technological options, instruments, tools and governance processes in urban development generated a sound basis of knowledge. The focus was on considering energy aspects in planning processes for urban development areas and creating the necessary framework. From this starting point, the cities developed ideas to integrate energy aspects into urban development on the one hand and support their implementation through the use of appropriate instruments on the other. Each city developed an implementation plan with selected solutions and approaches. These approaches ranged from ideas for the restructuring of the city administration to strategies,

data models, actors and contract solutions to the selection of concrete planning tools. The implementation of some elements began already during the project's runtime.
Further information available at: www.urbanlearning.eu

EU project SMARTER TOGETHER
In February 2016, Vienna, together with Lyon and Munich, launched the EU project SMARTER TOGETHER, where the cities are working on developing new strategies for renewing existing neighbourhoods. The refurbishment rate as well as the quality of refurbishments must be improved considerably if we are to reach the climate goals. In Vienna, SMARTER TOGETHER is being implemented in Vienna's 11th district, Simmering, under the management of Municipal Department 25. The project includes the full refurbishment of three housing estates, the construction of a zero-energy school gymnasium, an intermodal mobility point, and the development of a data platform.
Municipal Department 20 is in charge of the energy-related aspects of the project, including preparing and presenting energy data, developing energy supply, setting up a data platform, and making renewable energy visible in the public space. In October 2017, "solar benches" were set up outside the school at Enkplatz. These benches have integrated photovoltaics modules which generate electricity that can be used to charge mobile phones and other devices.
Further information available at: www.smartertogether.at

Research project ENERSPIRED CITIES
The structured presentation of data on energy and buildings is an important building block for the planning and transformation of renewable energy supply as part of urban development. The national research project "ENERSPIRED CITIES" prepares and develops data for energy-oriented urban planning. The goal of the project is to support urban planning, monitoring and research projects by making basic data from various sources available to a wide user base in a simple and transparent way. The project consortium, consisting of the cities of Vienna, Salzburg and Innsbruck as well as research partners, is developing a concept for bringing datasets important for spatial energy planning together with a legal framework for access rights.

Public relations work

3rd International Small Wind Turbine Conference
Titled "Small wind power 2030: Evolution? Revolution?", the Small Wind Turbine Conference on 4 and 5 October 2017 once again provided a platform for international exchange about developments and challenges.
Small wind power can contribute to climate protection, if the necessary conditions are provided. Over a million small wind turbines worldwide are generating clean, green electricity. In Austria, over 300 small wind turbines are contributing to energy generation.
The conference was co-organised by Municipal Department 20, the university of applied sciences Technikum Wien, the Austrian Wind Energy Association, and the Federal Ministry for Transport, Innovation and Technologie (BMVIT) in October 2017.

Austrian World Summit 2018
The second R20 Austrian World Summit was held in Vienna's Imperial Palace on 15 May 2018. The initiative R20 Regions of Climate Action was launched in 2011 by Arnold Schwarzenegger in cooperation with the United Nations. It supports local and regional projects to help achieve the global climate protection goals and promote a green economy. As a major partner, the City

of Vienna was part of the summit and had the opportunity to present its pioneering activities in the areas of green building and spatial energy planning to an international audience.

Large Scale Heat Pump Forum 2018

The Central European Large Scale Heat Pump Forum 2018 was hosted by Municipal Department 20 in Vienna on 17 May 2018, bringing together important players in the industry. The event discussed potentials, applications, and business models of large-scale heat pump systems and the technical, political, financial and regulatory framework. Heat pumps are an important technology for energy transition. They have diverse applications, from generating energy from waste water to waste heat recovery to large-scale systems in industrial, residential and service sectors. One of the most interesting properties of heat pumps is that they allow both heating and cooling.

The forum was initiated by the Austrian, German and Swiss heat pump associations Wärmepumpe Austria, Bundesverband Wärmepumpe and Fachvereinigung Wärmepumpe Schweiz.

Smart Energy Systems Week Austria 2018

The conference Smart Energy Systems Week Austria 2018 was held from 14 to 18 May. Its topic was "Energy Infrastructure as a Consumer Product?". The conference looked at innovative energy solutions for the energy transition from the user perspective. The topics ranged from energy-generating buildings and household energy to Energy 4.0 and communal infrastructure to portfolio discussions for public utilities and grids. Municipal Department 20 was a partner of the annual event, which is held by the Austrian Ministry for Transport, Innovation and Technology and the Austrian Climate and Energy Fund together with cooperation partners from the energy sector, industry and municipalities.

Stay up to date

Stay up to date about activities of Municipal Department 20 – Energy Planning and never miss an event again by using our information channels:

Sign up for the newsletter: post@ma20.wien.gv.at

Our website: www.energieplanung.wien.at

Facebook: www.facebook.com/energievoraus

1.5 ENERGY – FROM GENERATION TO USE

a. An overview of the main concepts

AMBIENT HEAT	... refers to heat found in the environment that is used for energy generation, such as near-surface and deep geothermal energy and solar heat.
BIOGENIC FUELS	... include the organic part of domestic waste, wood pellets, wood briquettes, wood chippings, charcoal, waste liquor, landfill gas, sewer gas, biogas, bioethanol, and biodiesel.
BLI BUNDESLÄNDER LUFTSCHADSTOFF INVENTUR	... is a survey conducted by the Environment Agency Austria to analyse the development of greenhouse gases and selected air pollutants in Austria's federal provinces.
CLIMATE-CORRECTED DATA	... corrects the differences between years caused by varying weather conditions. As a result, the energy consumption for different years is shown as it would have been had the weather been the same.
CO_2 EQUIVALENT	... makes it possible to compare different greenhouse gases. Carbon dioxide is a gas generated in all combustion processes. There are also other greenhouse gases, such as methane or nitrous oxide. These different types of gases do not all contribute equally to the greenhouse effect. For example, methane has 21 times the climate impact of carbon dioxide, so it is referred to as having a CO_2 equivalent of 21.
COMBINED HEAT AND POWER (CHP)	... is the cogeneration of electrical energy and heat, for example in a heating plant.
COMBUSTIBLE WASTE	... includes industrial waste and the non-renewable share of domestic waste.
CONVERSION LOSSES	... refers to the energy that is lost during the conversion of primary energy to secondary or useful energy.
ECOBUSINESSPLAN VIENNA	... is the environmental service package of the City of Vienna for enterprises. It includes professional advice and consulting, support with the practical implementation of measures, legal certainty, and effective PR.
EMIKAT.AT	...is a data management system of the Austrian Institute of Technology (AIT) that provides an emissions inventory based on emitters.
ENERGY FLOW CHART	... is a chart depicting the energy flows within a given system, such as the City of Vienna, in one year.

FINAL ENERGY	... is the energy available to end users, e.g. in the form of electricity, district heating, petrol, diesel, wood pellets or natural gas. They can use this energy directly or transform it further.
FROST DAY	... is a day on which the minimum temperature goes below 0°C.
GROSS FINAL ENERGY CONSUMPTION	... is the energy available after conversion but before distribution to end users. It is used to calculate the share of renewables at EU level (cf. Directive 2009/28/EC).
GROSS INLAND ENERGY CONSUMPTION (GIEC)	... is the energy available in the city. It is the difference between imported and exported energy (net imports) and the energy generated in the city itself.
HEATING DEGREE DAYS	... are based on an indoor temperature of 20°C and a base temperature (exterior temperature at which the building is heated) of 12°C. This is referred to as HDD20/12. This is the sum of the differences between indoor temperature and mean outdoor temperature for all heating degree days over one year and is indicated in Kelvin x days (Kd).
HEATING PLANT	... is an installation for the centralised generation of heat for water and space heating or for use in industrial processes.
HOT DAY	... is a day on which the maximum temperature is at least 30°C.
HYBRID PROPULSION/ HYBRID CAR	... is a propulsion system or vehicle that uses a combination of different technologies. In this report, the term is used for propulsion systems that combine petrol and electricity or diesel and electricity.
ICE DAY	... is a day on which the maximum temperature is below 0°C.
KILOWATT PEAK (KWP)	... is the peak power of a solar module under strictly defined standardised test conditions.
KLIP	... is Vienna's climate protection programme.
KLIP BALANCE METHOD	... is the basis for all calculations in Vienna's climate protection programme (KliP). It is the result of BLI minus emissions trade and minus traffic emissions that cannot be attributed to Vienna. The vehicle emissions that cannot be attributed to Vienna are calculated as the difference between the emissions caused by traffic in BLI and the Austrian emission inventory emikat.at.
OTHER TYPE OF PROPULSION	... in this report, refers to propulsion systems that use liquid gas or hydrogen (fuel cells) as well as hybrid systems that combine petrol and liquid gas or petrol and natural gas.

PRIMARY ENERGY
... is the energy form or energy source in its initial state. This may be a fuel (e.g. coal, wood, natural gas, crude oil) or energy from the sun, wind or ambient heat. Primary energy can usually only be used after converting it into another form of energy.

PV AREA
... this report uses PV area as a unit. 6.5 m2 of PV area correspond to 1,000 kWh.

SECONDARY ENERGY
... is the energy that is the generated with the conversion of primary energy. This may be wood pellets, diesel fuel or electrical energy.

SUMMER DAY
... is a day on which the maximum temperature is at least 25°C.

TRANSMISSION LOSSES
... refers to the energy that is lost in transmission from the source, e.g. the power plant, to the final consumer. This includes the energy use of the energy sector, transport losses and non-energy use.

USEFUL ENERGY
... is the energy that is actually used for heating, lighting, mechanical work, propulsion, etc.

b. The average Viennese household and its energy consumption

The energy consumption of an average Viennese household is an important indicator that can be used to demonstrate energy parameters and illustrate comparisons. This value is a "virtual" value calculated based on the following sources: the "Strom- und Gastagebuch" published by Statistics Austria and E-Control, calculations of MA 20, and estimates by Energy Center Wien. (ECW: http://www.urbaninnovation.at/de/Energy-Center)

How much energy does the average Viennese household need?
An average Viennese household in 2016 consists of approximately 2 people (strictly speaking 2.014). Energy is used for three different purposes:

- Heat for heating a 73 m^2 flat, hot water, and cooking.
- Electrical energy for lighting, entertainment systems, kitchen appliances and other electric appliances.
- Propulsion energy for motorised private transport – on average, two in three households own a car, that is 0.69 cars per household.

Statistically speaking, each Viennese household used 16,500 kWh for these three purposes in 2016, with the most energy (9,800 kWh) used for heating, followed by propulsion (4,700 kWh) and electrical energy (2,000 kWh).

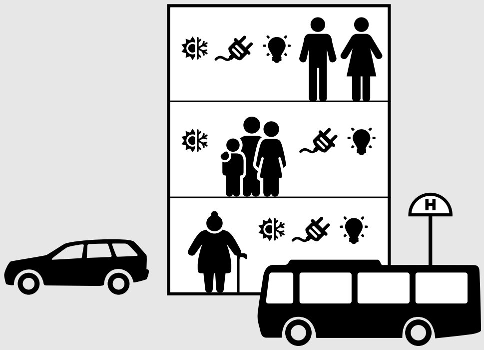
How much less does an energy-efficient Viennese household use?
What does the energy consumption of an efficient household that tries to optimise its energy use look like? How much can be saved, and where?
The greatest improvements in efficiency can be reached in heating. Living in a well-insulated or efficiently constructed building can cut heating demand by more than half.
There are also clear differences between efficient and inefficient mobility: an average diesel car consumes nearly 8,000 kWh a year, an electric car only just above 2,000 kWh, and ecomobility (public transport, cycling and walking) even less.
Depending on user behaviour and efficiency of the current electric appliances, households can increase their efficiency by up to nearly 75 percent.
An efficient household consumes approximately **4,700 kWh** of energy per year, compared to the average household with a consumption of approximately **16,500 kWh**.

c. Use of photovoltaic surface area

How can we best illustrate energy consumption?
Energy consumption can be illustrated with photovoltaic surface area (PV area) units. The average Viennese household described above with its energy consumption of 16,500 kWh would need 107 m^2 of PV area, nearly 40 m^2 more than the size of the flat. By comparison, an efficient household would need only 31 m^2 of PV area to supply it with energy. That means that a two-storey building could be supplied locally with solar energy in the annual average. If the household uses only ecomobility, the necessary area of PV panels would go down to 21 m^2. The roof of the building would then be enough to supply 3.5 floors with energy.

Conversion factors	**(1 km² = 1,000,000 m²)**
1 kWh = 0.0065 m² PV	1 TWh = 6,500,000 m² PV = 6.5 km² PV
1 MWh = 6.5 m² PV	1 TWh = 3.6 PJ
1 GWh = 6,500 m² PV	1 PJ = 1.8 km² PV

Comparison of an average and an efficient household

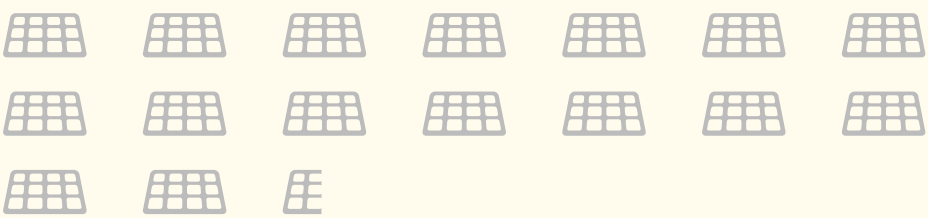


Flat parameters

People per flat	2
Flat size in m²	73
Cars	0.69

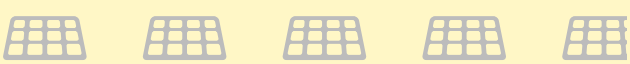
AVERAGE HOUSEHOLD

	kWh/household	PV area [m²/flat]
Electric appliances	2,000	13
Heating	9,800	64
Car using fossil energy (diesel, petrol, natural gas)	4,700	31
Total	**16,500**	**107**



EFFICIENT HOUSEHOLD

	kWh/household	PV area [m²/flat]
Electric appliances	1,000	7
Heating	2,200	14
Electric car	1,500	10
Total	**4,700**	**31**



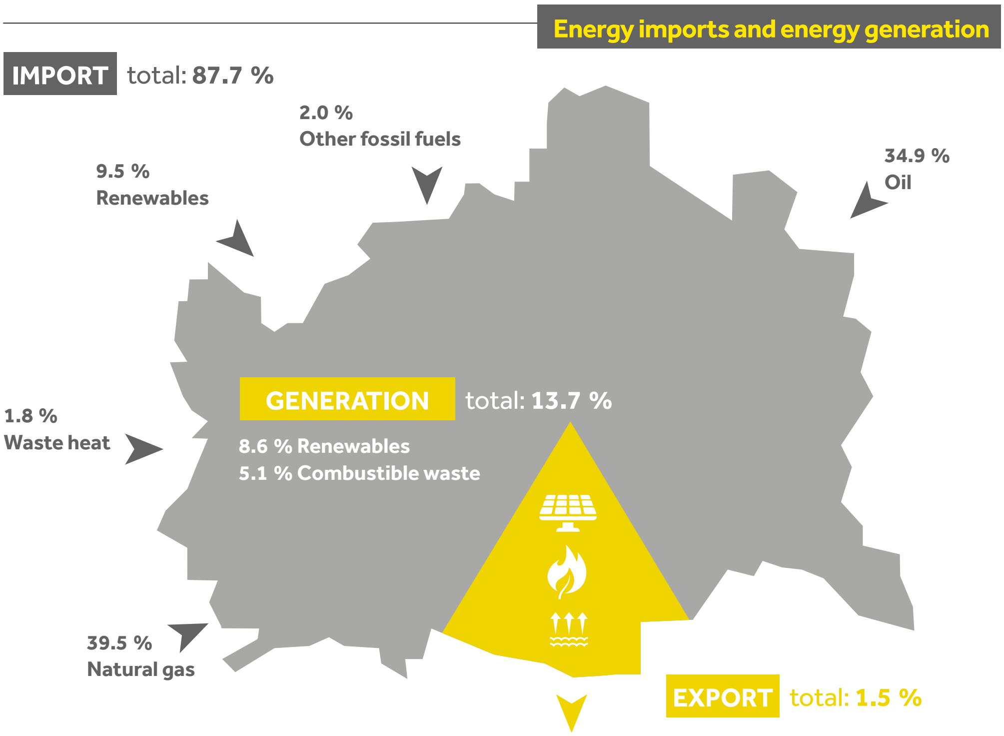
Note: One PV icon corresponds to a PV area of 6.5 m², or 1,000 kWh of energy.

Fig. 1,1
Energy consumption and PV area required for an average household and an efficient household in Vienna

d. Energy flows in Vienna[1]

How much energy is needed to run a whole city? Where does that energy come from?
The energy flow chart of the City of Vienna shows how much energy is required to supply the city, how that energy is transformed and distributed, and where it is finally used. Gross inland consumption in Vienna is 41,855 GWh. Approximately 14 percent of the energy needed is generated in Vienna itself, mostly from renewable sources. 88 percent of energy comes from the surrounding area, with the fossil energy sources natural gas and oil making up the majority of imports. Approx. 1.5 percent of energy is exported again; the rest makes up the gross inland energy consumption.

Fig. 1,2
Energy generation and energy imports in Vienna, 2016



What enormous energy flows move through the city and where are they used?
The chart shows a clear dominance of fossil energy sources (40% natural gas and 35% fuels) in the city's energy mix. Over half the natural gas is converted into electricity and district heating. Fuels and mineral oils (petrol, diesel, and other petroleum products), on the other hand, are used nearly exclusively by the largest consumption sector, transportation.
The energy flow chart also shows energy losses, which amount to over 20,000 GWh, or 48% of gross inland energy consumption. These losses occur during different phases of the energy flow, with approximately 4,600 GWh lost before arriving at the end user (conversion losses, transport losses, etc.) and approximately 15,500 GWh losses in end-user consumption.

[1] This energy flow chart shows combustible waste and coal together as solid energy surces. Details are available in the next chapters.

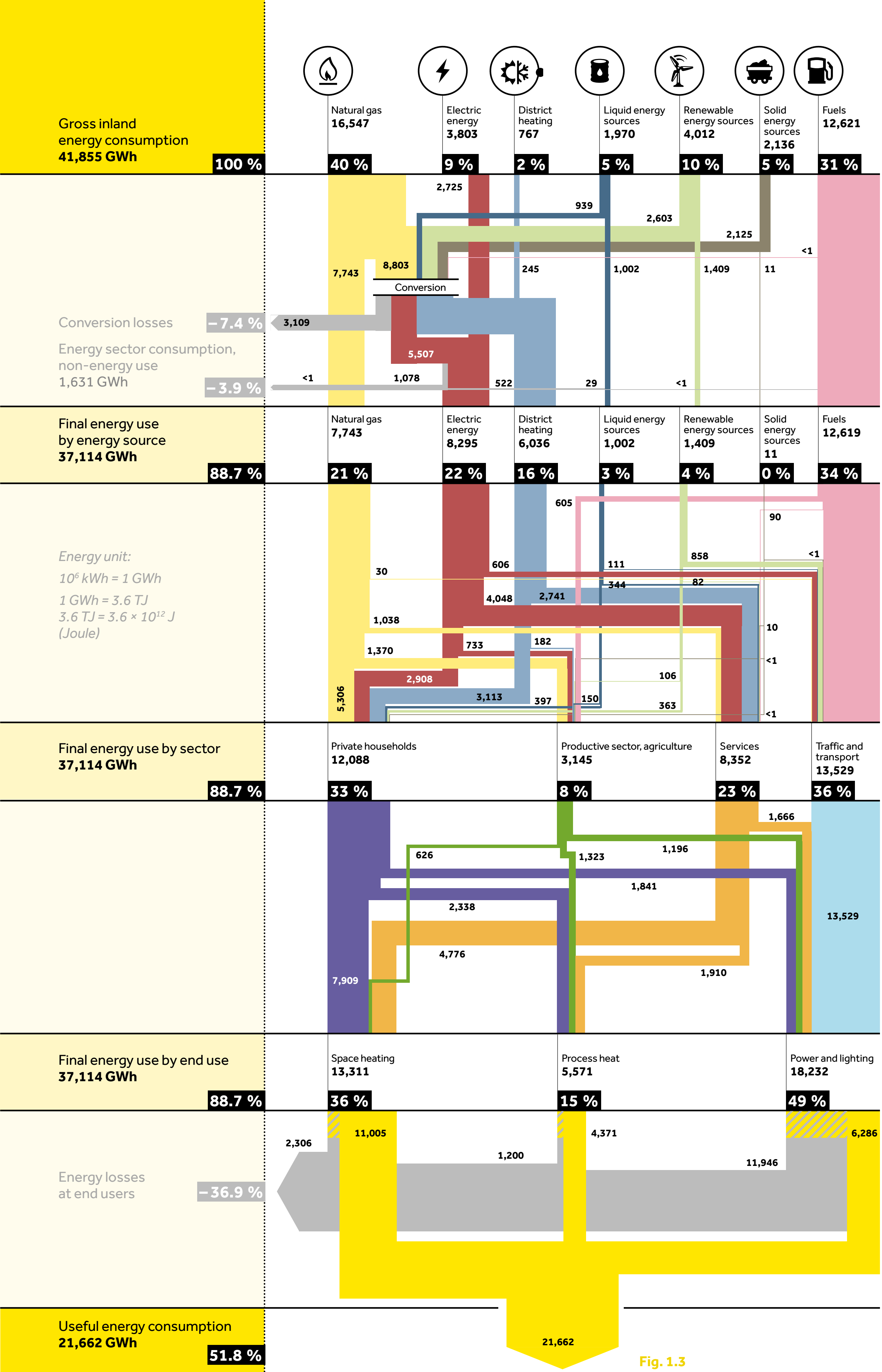


Fig. 1.3
Energy flow chart of the City of Vienna 2016 *Source: Wien Energie*

The energy flow chart in PV surface area

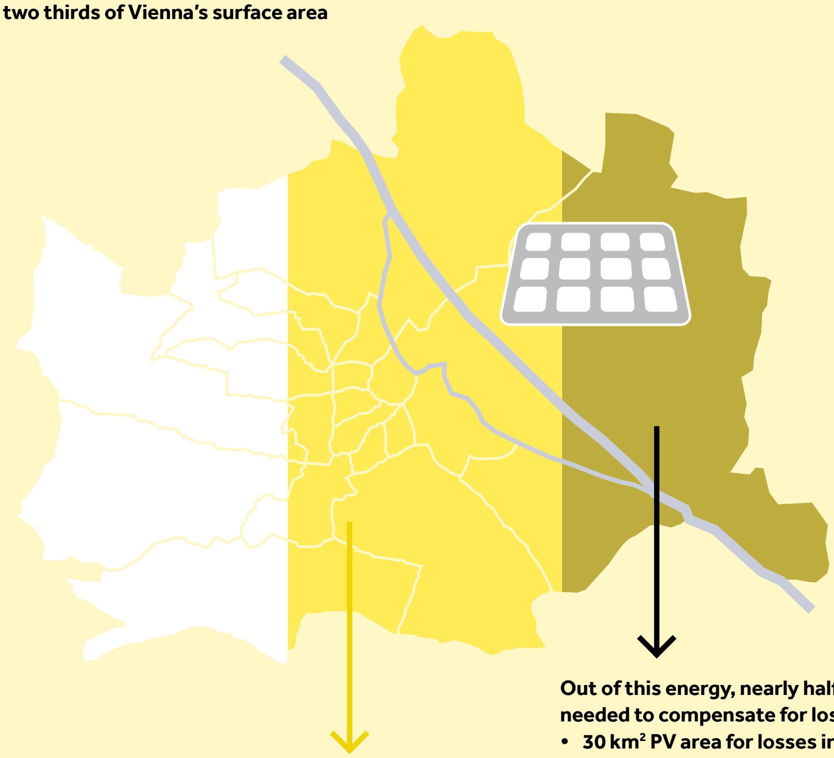
For the following illustration, the data from the energy flow chart was used. Gigawatt hours were converted into PV area. To meet Vienna's energy demand, approx. 272 km² of its 415 km² total area would have to be covered with solar panels. If the energy could be used without losses, only half that area, or 141 km², would be needed.

Fig. 1,4
Vienna's energy flows in PV area

Vienna's energy flows in PV area

GROSS INLAND ENERGY CONSUMPTION IN VIENNA

41,855 GWh
= 272 km² PV area
= two thirds of Vienna's surface area



Out of this energy, nearly half is needed to compensate for losses:

- **30 km² PV area for losses in transmission and distribution to end users**
- **101 km² PV area for end-user losses**

USEFUL ENERGY CONSUMPTION IN VIENNA

21,622 GWh
= 141 km² PV area
= one third of Vienna's area

This

- 36 x the size of the Danube Island
- 23 x that of Prater
- 14 x Vienna International Airport, or
- the 22nd and 13th districts taken together.

This chapter presents indicators from the areas of energy, emissions, transportation, population and climate in relation to the population and value added. The indicators show the development from 1995 to 2016 for Vienna and provide comparisons with Austria overall and the other federal provinces. Data for regional value added are available from 2000.

The adoption of the Smart City Wien Framework Strategy in June 2014 was an enormous step towards sustainable energy supply through the conservation and intelligent use of resources. The strategy defined energy-relevant targets for different areas, such as efficient energy use, renewable energy sources, mobility, and buildings. The indicators for monitoring the energy-relevant targets and evaluating the development are shown in section 2.1.

The Viennese have reduced their per capita energy consumption considerably since 2005 and have begun using more renewable energy and waste heat. This is reflected in a reduction in greenhouse gas emissions. Mobility habits have also become more sustainable in the last year; the number of cars per inhabitant has been dropping since 2010 and the number of annual passes for Vienna Public Transport sold is increasing considerably. A comparison of Austria's provinces shows that Vienna has the lowest energy consumption (final energy consumption total, private households, electrical energy) both per capita and in relation to value added. Most federal provinces have been able to reduce their per capita final energy consumption over the last years, and all provinces have reduced final energy consumption in relation to value added. The use of electrical energy has grown considerably in all of Austria. Vienna has the highest population growth of all provinces.

INDICATORS

2

2.1 MONITORING INDICATORS FOR THE SMART CITY WIEN FRAMEWORK STRATEGY

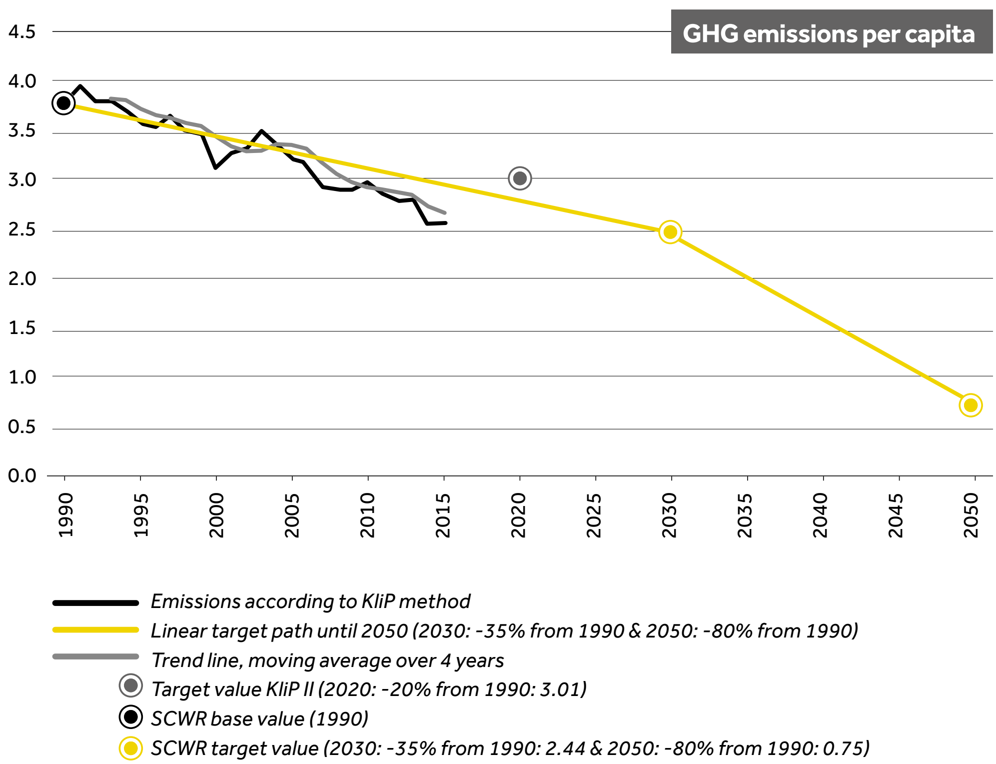
2.1.a Emissions per capita

Smart City Framework Strategy (SCWR) target:
Reducing per capita greenhouse gas emissions in Vienna by 80% by 2050 (from 1990 levels).[1]
Intermediate target: Reducing per capita carbon dioxide emissions in Vienna by at least 35% by 2030 (from 1990 levels).

Tab. 2.1
Per capita greenhouse gas emissions in Vienna
Sources: BLI 2015 and emikat.at 2015

t CO_2 equivalents per capita	1990	1995	2000	2005	2010	2014	2015	Change [%] base year 1990
Emissions according to KliP method	3.8	3.6	3.1	3.2	2.9	2.5	2.6	–32.6 %
Trend line, moving average over 4 years		3.7	3.5	3.4	2.9	2.7	2.7	
Linear target path until 2050 (2030: -35% from 1990 & 2050: -80% from 1990)	3.8	3.6	3.5	3.3	3.1	3.0	3.0	–21.9 %

Fig. 2.1
Per capita greenhouse gas emissions in Vienna, 1990-2015, SCWR target
Sources: BLI 2015, emikat.at 2015 and SCWR



Note: The emissions calculated using the KliP balance calculation method are the basis for all calculations for Vienna's climate protection programmes (KLiP I and KLiP II). The trend line is included to mitigate deviations caused by weather and leap years.

[1] This target as well as all the following climate and energy targets in this chapter can only be achieved if the activities of the City of Vienna receive support in the form of suitable framework conditions by the federal government and the EU, including the consideration of early actions.

2.1.b Final energy consumption per capita

Smart City Wien Framework Strategy objective:
Increasing energy efficiency and decreasing final energy consumption per capita in Vienna by 40% by 2050 (from 2005 levels),[1] reducing per capita primary energy input from 3,000 to 2,000 watt.

[kWh per capita]	1990	1995	2000	2005	2010	2015	2016	Change [%] base year 2005
Final energy consumption	18,743	21,002	21,663	24,130	23,346	20,312	20,168	–16.42 %
Trend line, moving average over 4 years		20,577	22,122	24,129	22,657	20,959	20,583	
Linear target path until 2050 (-40% from 2005)				24,130	23,058	21,985	21,771	–9.78 %

Tab. 2.2
Final energy consumption per capita in Vienna
Sources: Energy balance 2016 and population data

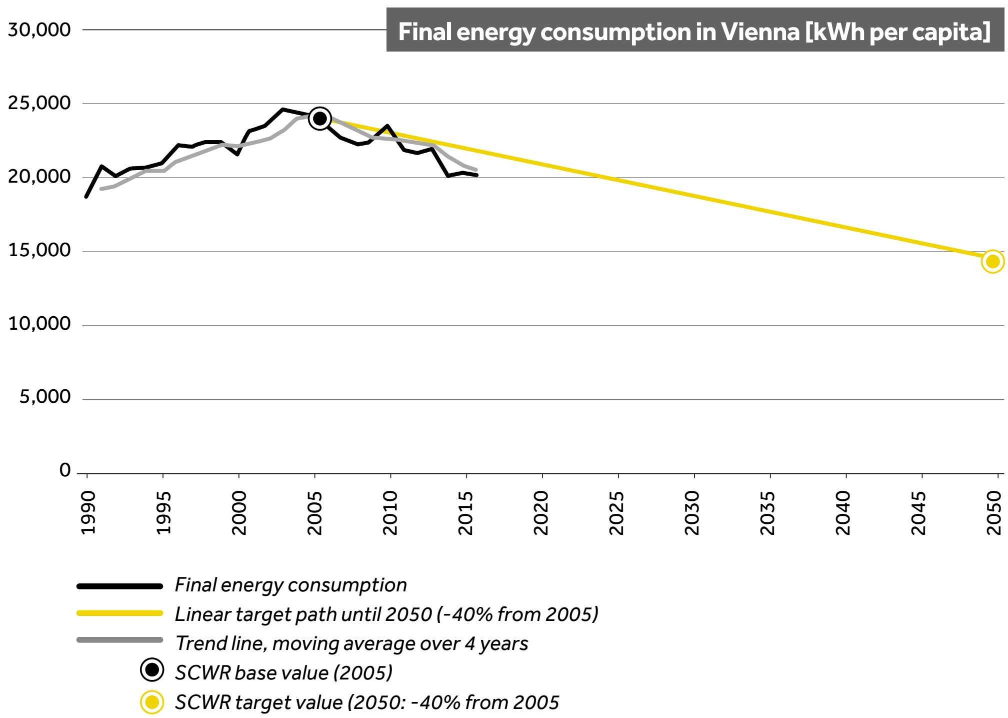


Fig. 2.2
Final energy consumption per capita in Vienna, 1990-2016, SCWR target
Sources: Energy balance 2016, population data and SCWR

Note: The trend line is included to mitigate deviations caused by weather and leap years.

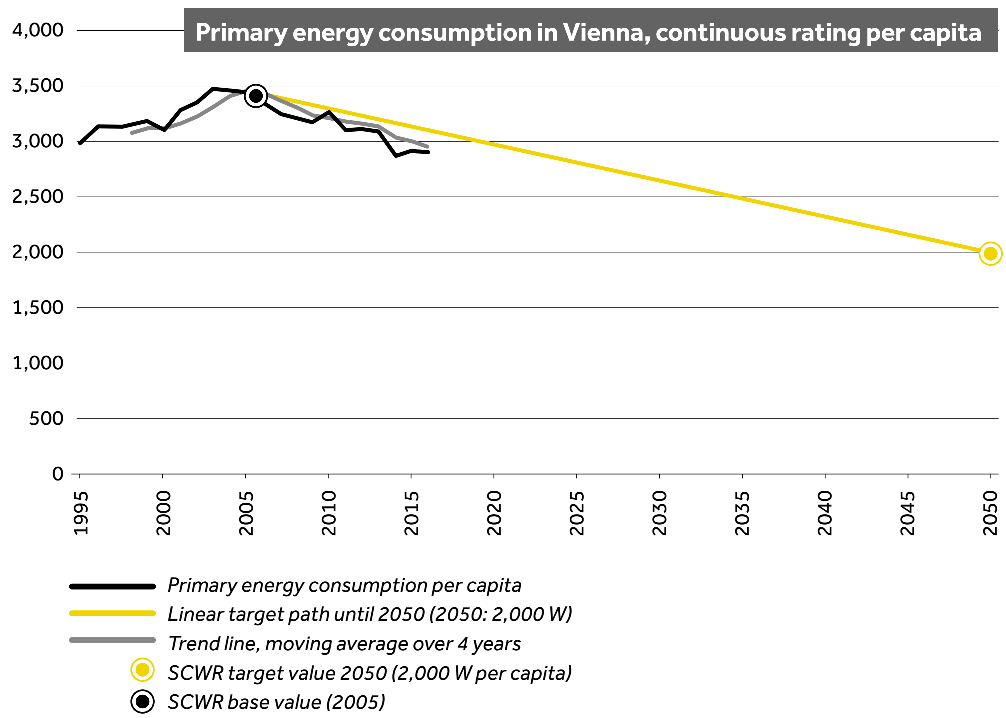
2.1.c Primary energy consumption per capita

Smart City Wien Framework Strategy objective:
Increasing energy efficiency and decreasing final energy consumption per capita in Vienna by 40% by 2050 (from 2005 levels) reducing per capita primary energy input from 3,000 to 2,000 watt.

Tab. 2.3
Primary energy consumption in Vienna
Sources: Energy balance 2016, population data, SCWR, TU Wien

[Watt per capita]	1995	2000	2005	2010	2015	2016	Change [%] base year 2000
Primary energy consumption	2,967	3,090	3,451	3,284	2,907	2,900	−16.0 %
Trend line, moving average over 4 years		3,121	3,429	3,231	2,992	2,940	
Linear target path until 2050 (2050: 2,000 W)			3,451	3,290	3,129	3,096	

Fig. 2.3
Primary energy consumption in Vienna, 1995-2016, SCWR target
Sources: Energy balance 2016, population data, SCWR, TU Wien



Note: Primary energy consumption is calculated based on final energy consumption for Vienna and regional conversion factors (see study "2000-Watt Gesellschaft in Wien", TU Wien, 2017). The trend line is included to mitigate deviations caused by weather and leap years.

2.1.d Share of renewable energy in gross final energy consumption

Smart City Wien Framework Strategy objective: In 2030, over 20%, and in 2050, 50% of Vienna's gross energy consumption will be covered from renewable sources[2].

GWh	2005	2010	2014	2015	Change [%] Base year 2005
Renewable energy in Vienna	2,244	3,964	3,843	3,528	+57.2 %
Net imports of renewable electrical energy to Vienna	1,322	968	3,180	2,962	+124.0 %
Gross final energy consumption in Vienna	41,127	41,279	38,097	38,665	–6.0 %
Share of renewable energy in Vienna	5.5 %	9.6 %	10.1 %	9.1 %	+67.2 %
Net imports of renewable electrical energy to Vienna	3.2 %	2.3 %	8.3 %	7.7 %	+138.3 %
Total share of renewables in Vienna	**8.7 %**	**11.9 %**	**18.4 %**	**16.8 %**	**+93.6 %**

Fig. 2.4
Share of renewable energy in gross final energy consumption in Vienna
Sources: Energy balance 2016, e-Control market report and SCWR

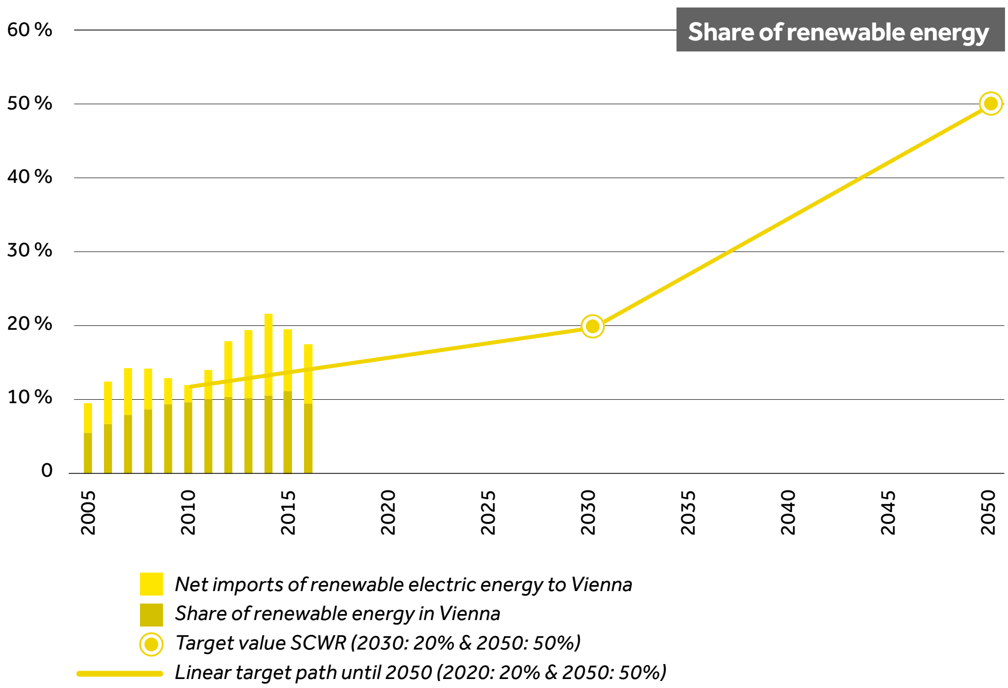


Fig. 2.4
Share of renewable energy in gross final energy consumption in Vienna, 2005-2016, SCWR target
Sources: Energy balance 2016, e-Control market report and SCWR

Note: The share of renewable energy in Vienna is calculated pursuant to EU Directive 2009/28/EC. In 2016, Statistics Austria received no notification of sewage sludge; as a result, the share of renewables is reduced by that proportion compared to the previous year. It is expected this will be corrected in next year's energy balance. The imports of renewable electrical energy are calculated based on the energy source mix for electricity generation in Austria excluding Vienna according to the energy balance of Statistics Austria. The share of renewables in electrical energy imported to Austria is calculated based on the ENTSO-E (until 2009: UCTE) electricity generation statistics for Europe published in the electricity market report of energy market regulator E-Control.

[2] These do not necessarily have to be located in the city itself.

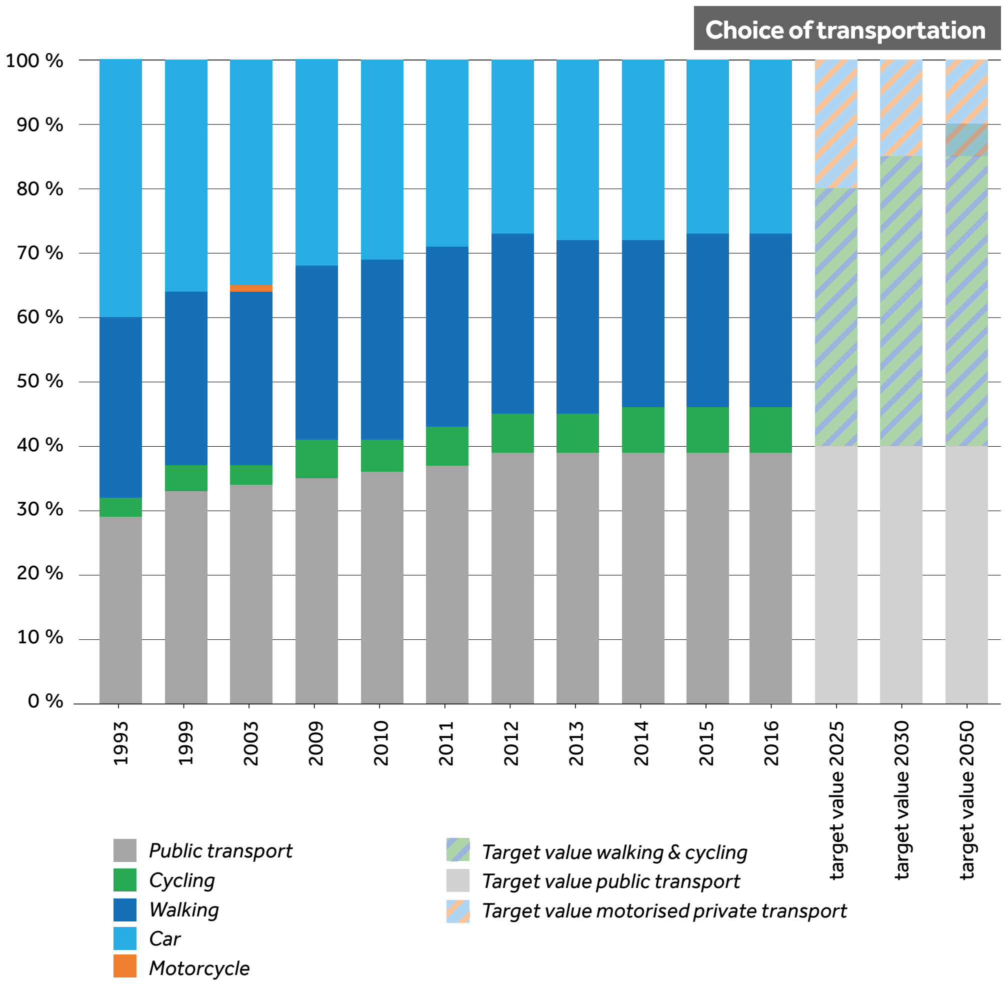
2.1.e Choice of transportation in Vienna

Smart City Wien Framework Strategy objective:
Strengthening CO_2-free modes of transportation (walking and cycling), maintaining the high share of public transport and decreasing motorised individual traffic (MIT) in the city to 20% by 2025, to 15% by 2030, and to markedly less than 15% by 2050.

Tab. 2.5
Choice of transportation, residents of Vienna
Source: Wiener Linien

Choice of transportation	1993	1999	2003	2009	2010	2012	2014	2015	2016	Change [%] base year 2010
Bicycle	3 %	4 %	3 %	6 %	5 %	6 %	7 %	7 %	7 %	+40.0 %
Motorcycle	0 %	0 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %	
Public transport	29 %	33 %	34 %	35 %	36 %	39 %	39 %	39 %	39 %	+8.3 %
Car	40 %	36 %	35 %	32 %	31 %	27 %	28 %	27 %	27 %	–12.9 %
Walking	28 %	27 %	27 %	27 %	28 %	28 %	26 %	27 %	27 %	–3.6 %

Fig. 2.5
Choice of transportation in Vienna, 1993-2016
Sources: Wiener Linien and SCWR



%	1993	1999	2003	2009	2010	2012	2014	2015	2016	Change [%] base year 2010
Motorised private transport	40 %	36 %	36 %	32 %	31 %	29 %	28 %	27 %	27 %	–12.9 %
Linear target path until 2025, 2030					31 %	30 %	28 %	27 %	27 %	–14.2 %

Tab. 2.6
Share of motorised private transport in the modal split
Source: Wiener Linien

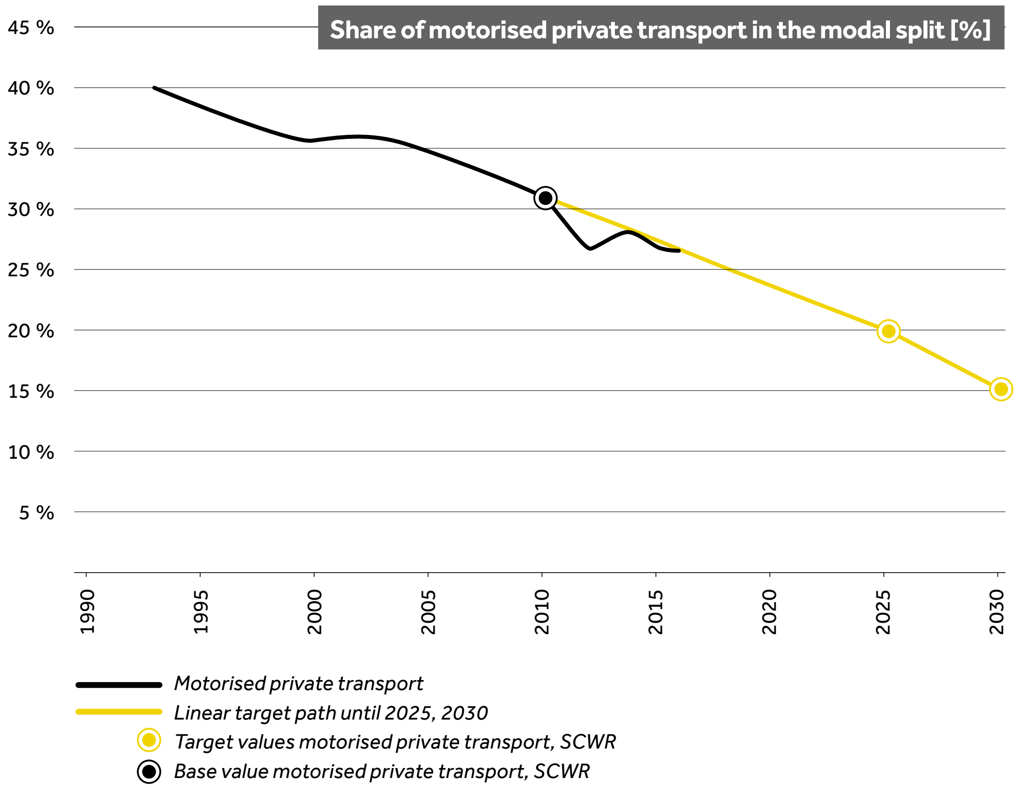


Fig. 2.6
Share of motorised private transport in the modal split, 1993-2016
Sources: Wiener Linien and SCWR

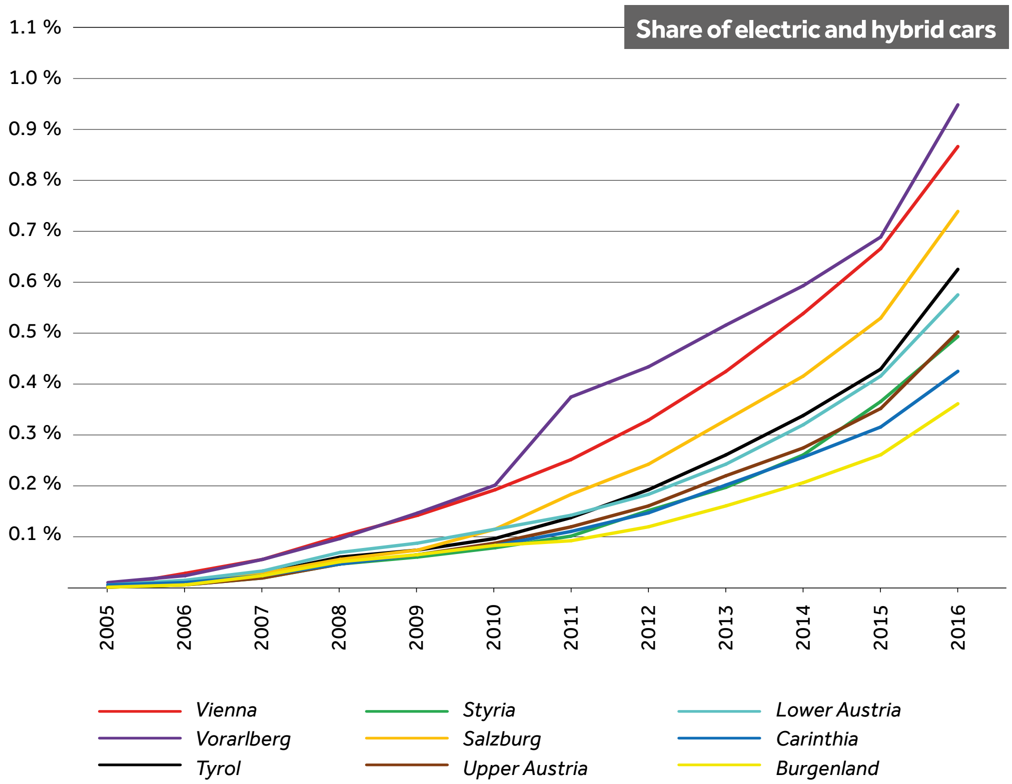
2.1.f Share of electric and hybrid cars

Smart City Wien Framework Strategy objective:
By 2030, the largest possible share of MIT is to be shifted to public transport and non-motorised types of traffic or should make use of new propulsion technologies (e.g. electric vehicles). By 2050, all motorised individual traffic within the municipal boundaries is to operate without conventional propulsion technologies.

Tab. 2.7
Share of electric and hybrid cars by federal province
Source: Vehicle registration figures

Share of electric and hybrid cars	2005	2010	2014	2015	2016
Vienna	0.003 %	0.19 %	0.54 %	0.67 %	0.87 %
Vorarlberg	0.009 %	0.20 %	0.59 %	0.69 %	0.95 %
Tyrol	0.002 %	0.10 %	0.34 %	0.43 %	0.63 %
Styria	0.002 %	0.08 %	0.26 %	0.37 %	0.50 %
Salzburg	0.003 %	0.12 %	0.42 %	0.53 %	0.74 %
Upper Austria	0.001 %	0.09 %	0.28 %	0.35 %	0.50 %
Lower Austria	0.005 %	0.12 %	0.32 %	0.42 %	0.58 %
Carinthia	0.005 %	0.08 %	0.26 %	0.32 %	0.42 %
Burgenland	0.001 %	0.08 %	0.21 %	0.26 %	0.36 %

Fig. 2.7
Share of electric and hybrid cars by federal province, 2005–2016
Source: Vehicle registration figures



Note: Statistical data for hybrid motors available from 2006.

2.1.g Share of electric and hybrid lorries

Smart City Wien Framework Strategy objective:
By 2030, commercial traffic originating and terminating within the municipal boundaries is to be a largely CO_2-free.

Share of electric and hybrid lorries	2005	2010	2014	2015	2016
Vienna	0.015 %	0.03 %	0.33 %	0.53 %	0.87 %
Vorarlberg	0.012 %	0.03 %	0.16 %	0.18 %	0.95 %
Tyrol	0.003 %	0.01 %	0.15 %	0.16 %	0.63 %
Styria	0.006 %	0.02 %	0.21 %	0.24 %	0.50 %
Salzburg	0.021 %	0.01 %	0.13 %	0.12 %	0.74 %
Upper Austria	0.005 %	0.01 %	0.13 %	0.14 %	0.50 %
Lower Austria	0.010 %	0.03 %	0.19 %	0.24 %	0.58 %
Carinthia	0.012 %	0.04 %	0.26 %	0.26 %	0.42 %
Burgenland	0.007 %	0.02 %	0.06 %	0.10 %	0.36 %

Tab. 2.8
Share of electric and hybrid lorries by federal province
Source: Vehicle registration figures

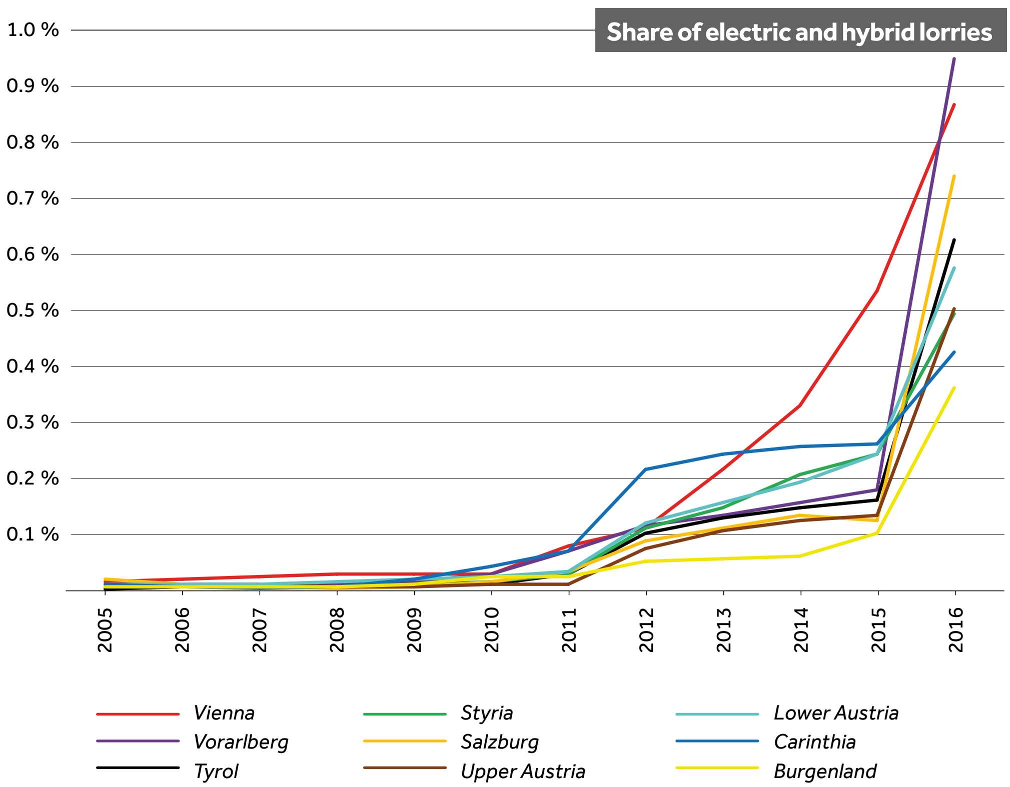


Fig. 2.8
Share of electric and hybrid lorries by federal province, 2005-2016
Source: Vehicle registration figures

Note: Commercial traffic both originating and terminating in Vienna is currently not being measured. Not all commercial vehicles registered in Vienna are used for trips within Vienna. The target value cannot be exactly monitored with the currently available data. Included vehicles: Lorries and semi-trailer towing vehicles (category N) as well as motorised transport trolleys. Statistical data for hybrid motors available from 2006.

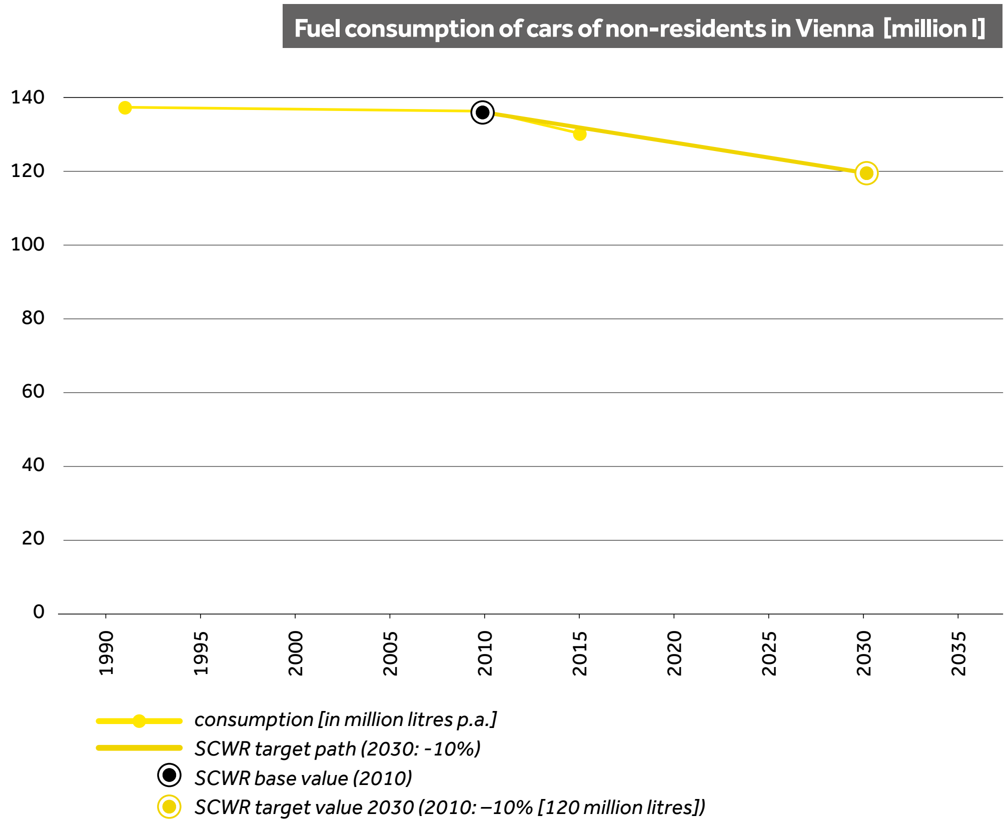
2.1.h Energy consumption of passenger traffic across city boundaries

Smart City Wien Framework Strategy objective:
Reduction of energy consumption by passenger traffic across municipal boundaries by 10% by 2030.

Tab. 2.9
Fuel consumption of cars of non-residents in Vienna
Sources: Data on private cars, City of Vienna and SCWR

Energy consumption of passenger traffic across city boundaries	1991	2010	2015	Change [%] base year 1991
Distance driven by cars of non-residents in Vienna [in million km]	1,596	1,820	1,809	−0.6 %
Average fuel consumption in Vienna [in litres per 100 km]	8.5	7.3	7.1	−2.7%
Fuel consumption of cars of non-residents in Vienna [in million litres]	136	133	128	−3.3 %
SCWR target path (2030: -10%)		133	130	−2.3 %

Fig. 2.9
Fuel consumption of cars of non-residents in Vienna, 1990, 2010 and 2015, SCWR target
Sources: Data on private cars, City of Vienna and SCWR



Note: The energy consumption of passenger traffic across city boundaries is not currently being measured. Fuel consumption is calculated based on the average consumption of cars in Vienna (Statistics Austria) and the simulated driving performance of cars of non-residents in Vienna according to the traffic model (MA 18). These figures do not match the definition of the SCWR target exactly (traffic of non-residents versus traffic across city limits), but they are a good approximation.

2.1.i Share of energy sources for space heating, hot water and air conditioning

Smart City Wien Framework Strategy objective:
Cost-optimised zero-energy building standards for all new structures, additions and refurbishment from 2018/2020 and further development of future supply systems towards even better climate protection levels.

Share of final energy consumption [%]	2005	2010	2014	2015	2016	Change [%] base year 2005
Renewable energy vectors	3.1 %	4.2 %	4.1 %	3.3 %	3.4 %	+77.3 %
District heating	32.7 %	37.9 %	39.2 %	39.6 %	39.3 %	+20.2 %
Electrical energy	9.6 %	9.4 %	10.5 %	10.3 %	10.4 %	+6.6 %
Natural gas	44.3 %	43.3 %	41.8 %	41.8 %	41.8 %	−8.4 %
Oil	9.6 %	5.0 %	4.1 %	5.0 %	5.2 %	−62.0 %
Combustible waste	0.1 %	0.0 %	0.0 %	0.0 %	0.0 %	−91.6 %
Coal	0.5 %	0.1 %	0.1 %	0.0 %	0.0 %	−77.1 %

Tab. 2.10
Share of energy sources in final energy consumption for space heating, hot water and air conditioning in Vienna
Source: Nutzenergieanalyse 2016

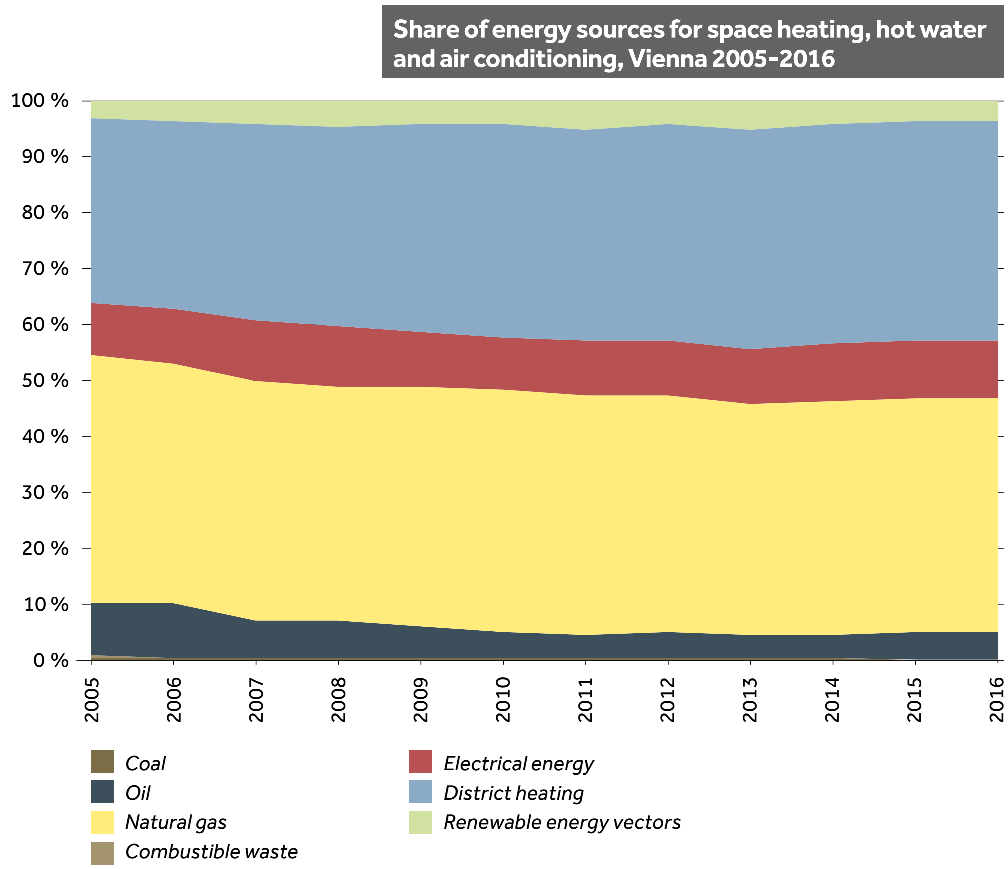


Fig. 2.10
Share of energy sources in final energy consumption for space heating, hot water and air conditioning in Vienna 2005-2016
Source: Nutzenergieanalyse 2016

Note: The Vienna district heating system uses renewables, waste heat (e.g. cogeneration) and peak load power plants (e.g. gas).

Tab. 2.11
Energy supply for subsidised large-scale housing in Vienna by year of subsidy granting and share of useful area
Source: City of Vienna

Share of useful area [%]	2005	2010	2014	2015	2016	Change [%] base year 2005
Biomass	0 %	1 %	0 %	0 %	0 %	
District heating	95 %	90 %	61 %	53 %	81 %	−44.1 %
Gas-powered central heating (including solar installations)	5 %	9 %	35 %	39 %	15 %	+653.8 %
Heat pump	0 %	0 %	4 %	8 %	4 %	

Fig. 2.11
Energy supply for subsidised large-scale housing in Vienna by year of subsidy granting and share of useful area, 2002-2016
Source: City of Vienna

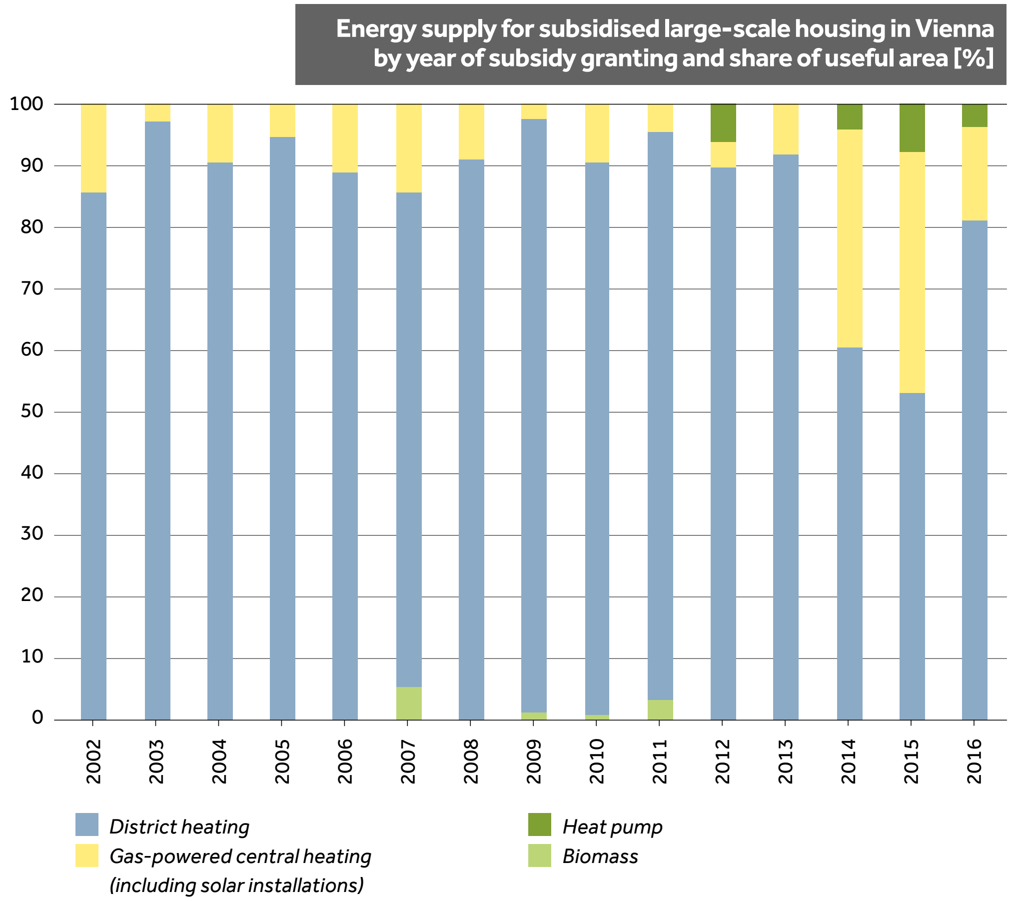
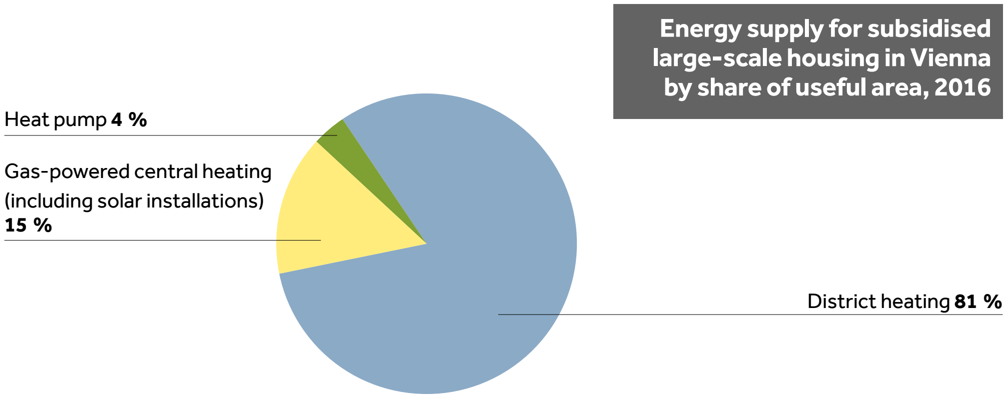


Fig. 2.12
Energy supply for subsidised large-scale housing in Vienna by share of useful area, 2016
Source: City of Vienna



2.1.j Final energy consumption for space heating, air conditioning and hot water per capita

Smart City Wien Framework Strategy objective:
Comprehensive rehabilitation activities entail the reduction of energy consumption of existing buildings for space heating/cooling/water heating by 1% per capita and year.

kWh per capita	2005	2010	2014	2015	2016	Change [%] base year 2010
Final energy consumption for space heating, hot water and air conditioning	10,006	10,379	8,092	8,452	8,277	−18.6 %
Trend line, moving average over 4 years		9,442	9,042	8,809	8,536	−6.7 %
SCWR target path (-1% per year [from 2008-2012 average])		9,540	9,164	9,073	8,982	−4.9 %

Tab. 2.12
Final energy consumption for space heating, hot water and air conditioning in Vienna per capita
Source: Nutzenergieanalyse 2016

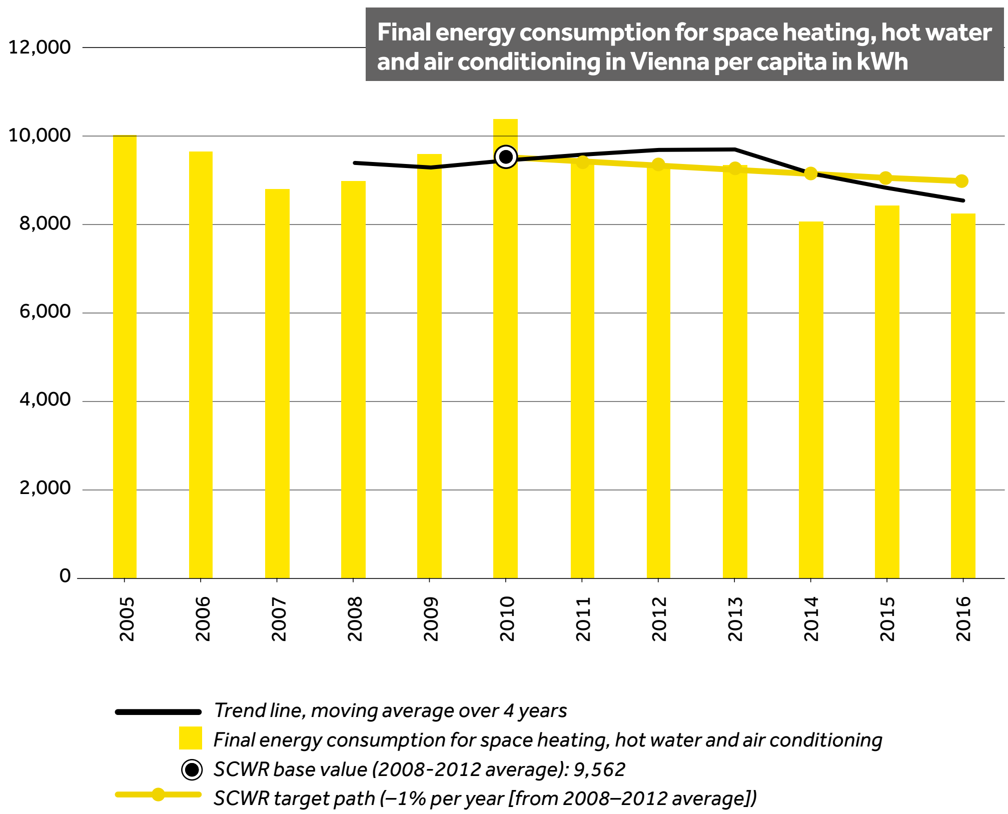


Fig. 2.13
Final energy consumption for space heating, hot water and air conditioning in Vienna per capita, 2005-2016, SCWR target path
Sources: Nutzenergieanalyse 2016 and SCWR

Note: The target path „–1 % per year from 2010" is calculated using the equation
$\text{Target value}_{(\text{Target year})} = \text{Final energy consumption average}_{(2008\text{–}2012)} * 0.99^{(\text{Target year}-2010)}$.
The starting year is 2010 and the starting value is the average of 2008 to 2012.

2.2 DEVELOPMENTS IN VIENNA

2.2.a Final energy consumption per capita in Vienna

Tab. 2.13
Final energy consumption per capita in Vienna
Sources: Energy balance 2016 and population data

kWh per capita	1995	2000	2005	2010	2015	2016	Change [%] base year 1995
Services	5,057	5,302	5,777	6,224	4,938	4,538	−10.26 %
Private households	7,032	6,992	6,879	7,029	6,451	6,569	−6.59 %
Industry and agriculture	2,587	2,070	2,409	1,996	1,508	1,709	−33.93 %
Traffic and transport	6,325	7,298	9,065	8,097	7,416	7,352	16.23 %
Total	**21,002**	**21,663**	**24,130**	**23,346**	**20,312**	**20,168**	**−3.97 %**

Fig. 2.14
Final energy consumption per capita in Vienna, 1995-2016
Sources: Energy balance 2016 and population data

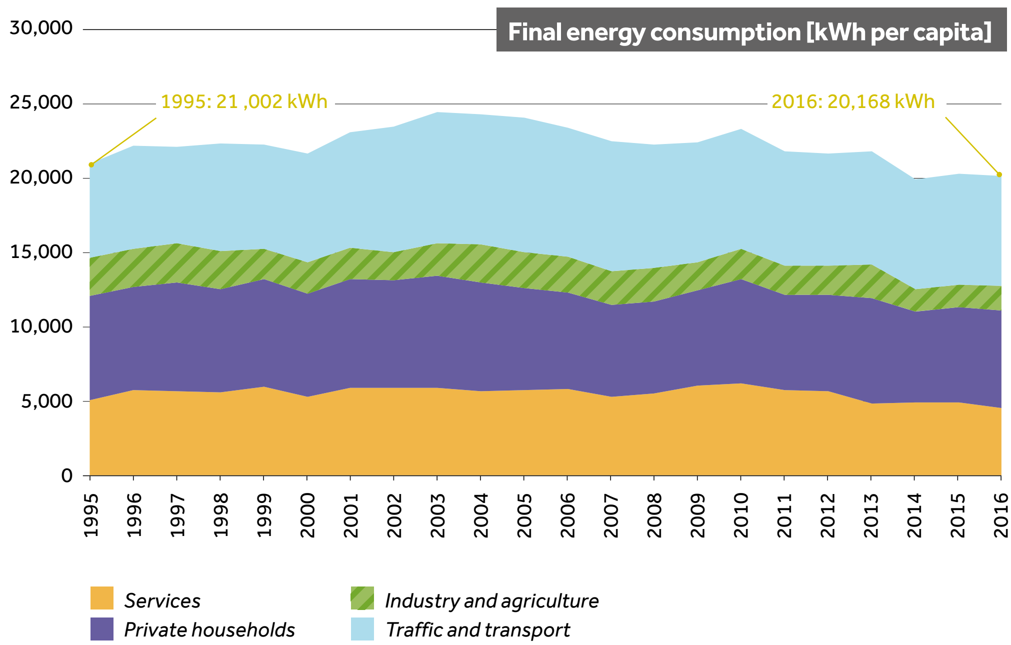
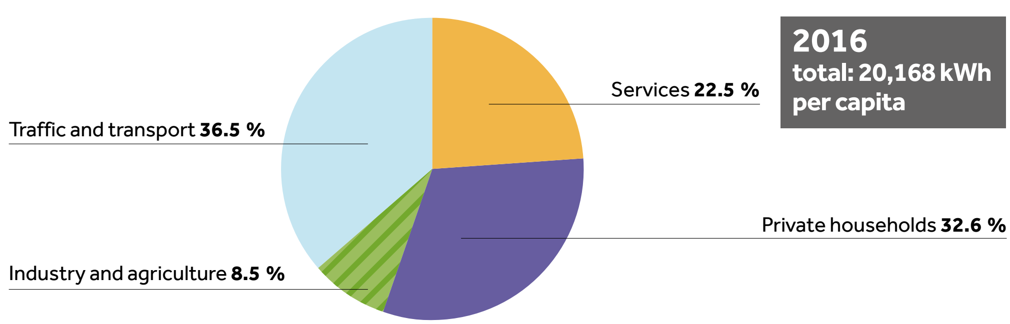


Fig. 2.15
Final energy consumption per capita in Vienna, 2016
Sources: Energy balance 2016 and population data



2.2.b Share of renewable energy including imports and waste heat as share of gross final energy consumption

GWh/a	2005	2010	2014	2015	2016	Change [%] base year 2005
Share of renewable energy Vienna	5.2 %	9.5 %	9.7 %	9.7 %	9.0 %	
Share of renewable energy imports	4.0 %	2.3 %	9.9 %	8.0 %	7.1 %	
Share of waste heat Vienna	10.8 %	12.0 %	9.5 %	10.2 %	11.0 %	
Share of waste heat imports	1.0 %	1.1 %	1.5 %	2.0 %	1.9 %	
Total of shares	**21.0 %**	**24.9 %**	**30.5 %**	**29.9 %**	**29.0 %**	**+30.1 %**

Tab. 2.14
Share of renewable energy including imports and waste heat
Source: Energy balance 2016

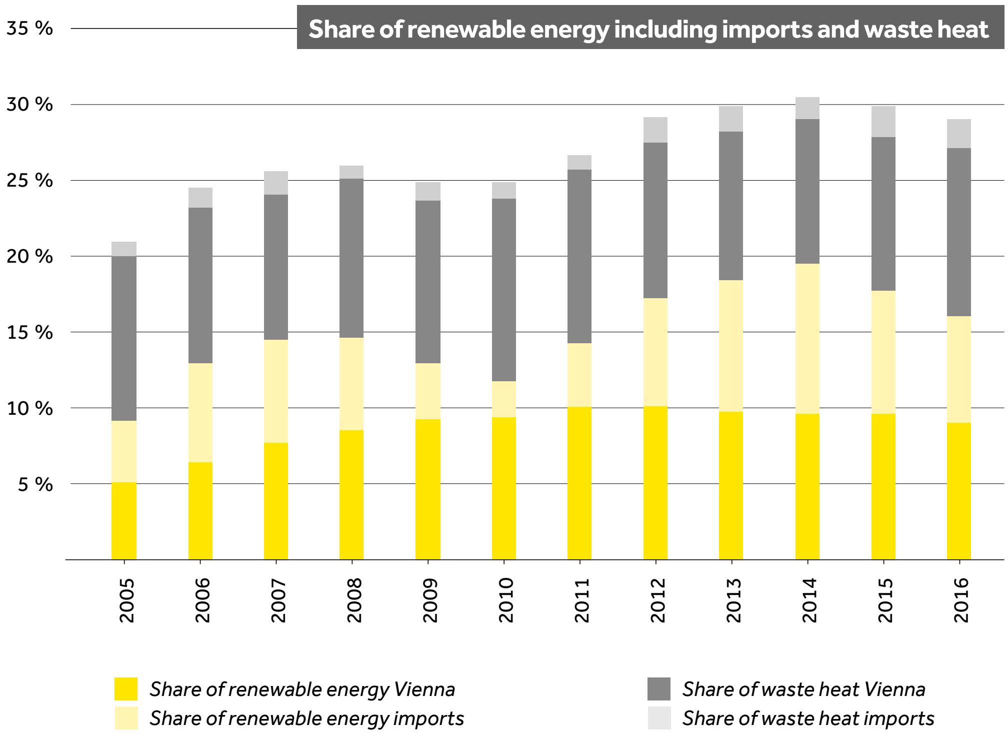


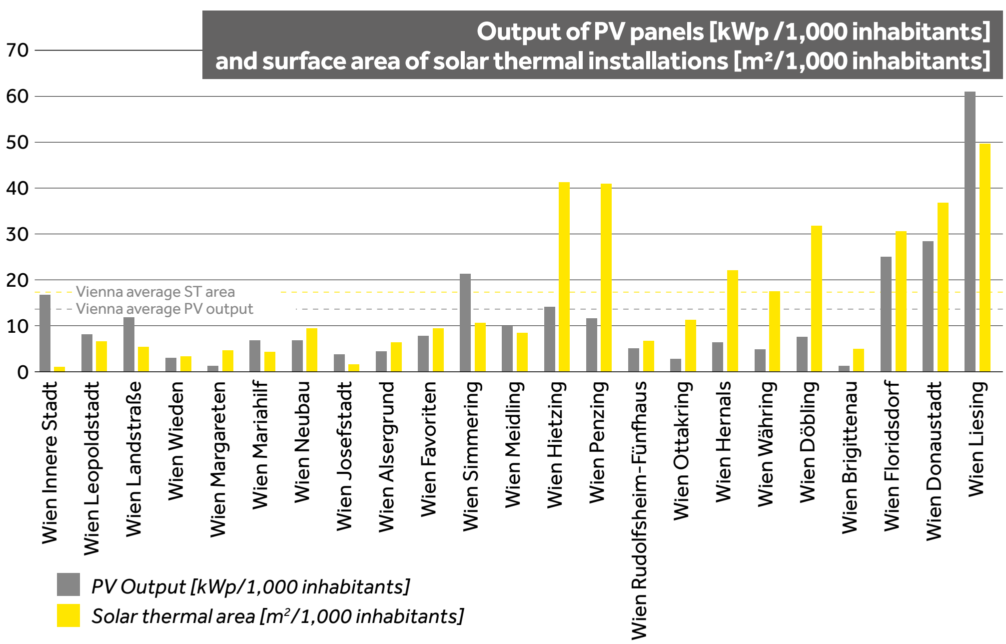
Fig. 2.16
Share of renewable energy including imports and waste heat, 1995-2016
Source: Energy balance 2016

2.2.c Use of solar energy in Vienna's districts

Tab. 2.15
Output of PV panels and surface area of subsidised solar thermal installations per capita by district, 2016
Sources: Energy database of MA 20 and population data for Vienna

	District	Output [kWp/1,000 inhabitants]	Area [m²/1,000 inhabitants]
	Vienna average	14.12	17.54
1	Innere Stadt	16.49	0.68
2	Leopoldstadt	7.95	6.24
3	Landstraße	11.58	5.06
4	Wieden	2.94	3.35
5	Margareten	1.09	4.15
6	Mariahilf	6.50	4.19
7	Neubau	6.72	9.25
8	Josefstadt	3.52	1.49
9	Alsergrund	4.35	6.35
10	Favoriten	7.73	9.35
11	Simmering	21.05	10.50
12	Meidling	10.08	8.14
13	Hietzing	14.13	40.69
14	Penzing	11.32	40.75
15	Rudolfsheim-Fünfhaus	4.83	6.45
16	Ottakring	2.53	11.27
17	Hernals	6.08	21.77
18	Währing	4.91	17.29
19	Döbling	7.33	31.53
20	Brigittenau	1.16	4.52
21	Floridsdorf	24.54	30.18
22	Donaustadt	28.03	36.54
23	Liesing	60.48	49.31

Fig. 2.17
Output of PV panels and surface area of subsidised solar thermal installations per capita by district, 2016
Sources: Energy database of MA 20 and population data for Vienna



2.2.d Electricity generation from renewable energy

GWh/a	2005	2010	2014	2015	2016	Change [%] base year 2005
Electricity generation from renewable energy	1,127	1,358	1,259	1,297	1,401	+15.2 %
Total electricity generation in Vienna	7,312	8,293	4,152	5,103	5,570	–30.2 %
Share [%]	**15.4 %**	**16.4 %**	**30.3 %**	**25.4 %**	**25.1 %**	**+65.0 %**

Tab. 2.16
Share of electricity from renewable energy in Vienna's total electricity generation
Source: Energy balance 2016

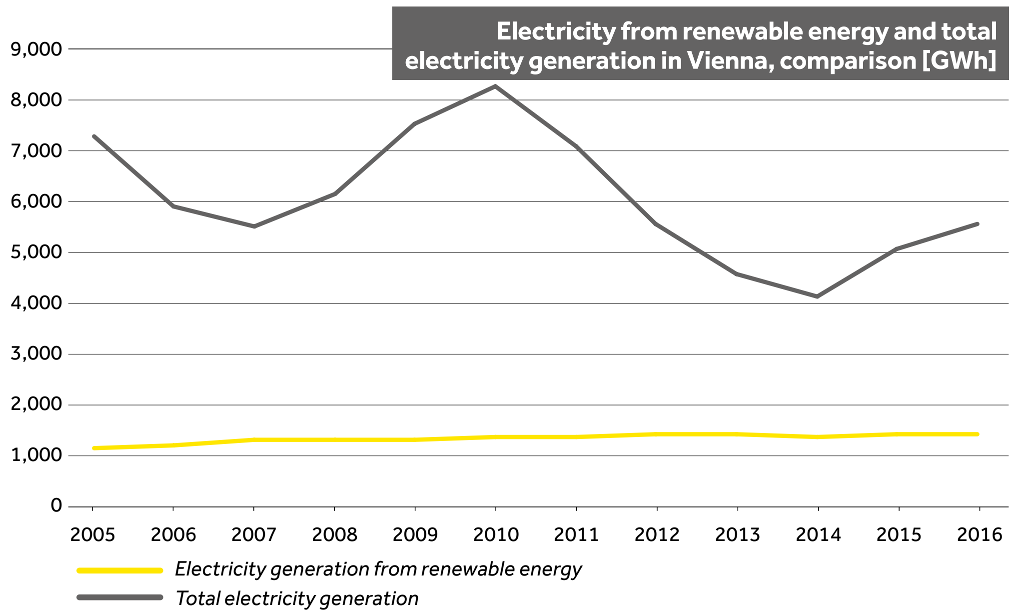


Fig. 2.18
Electricity from renewable energy and total electricity generation in Vienna, comparison, 2005-2016
Source: Energy balance 2016

Note: Electricity generation from renewables is growing slightly, total electricity generation fluctuates heavily.

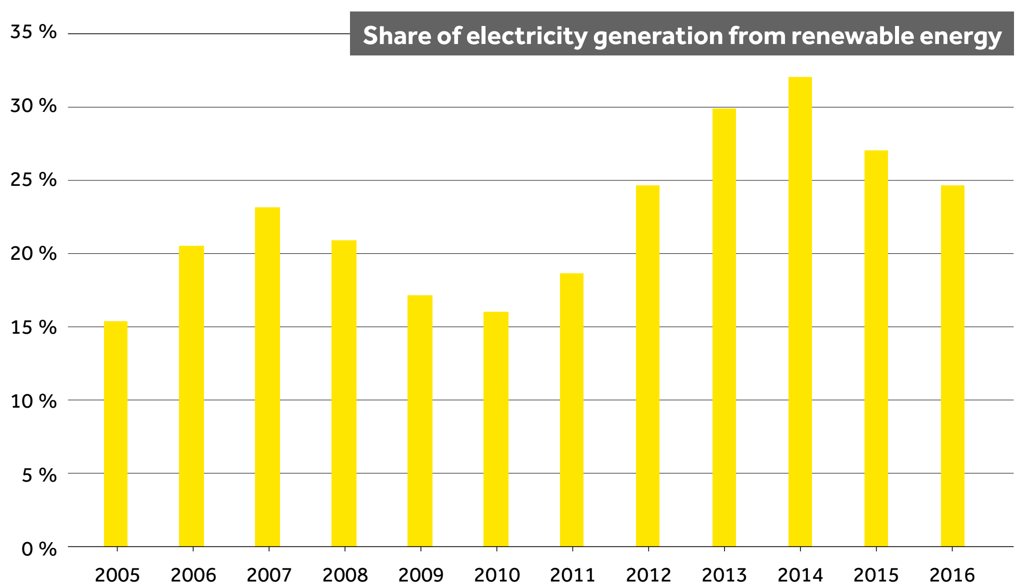


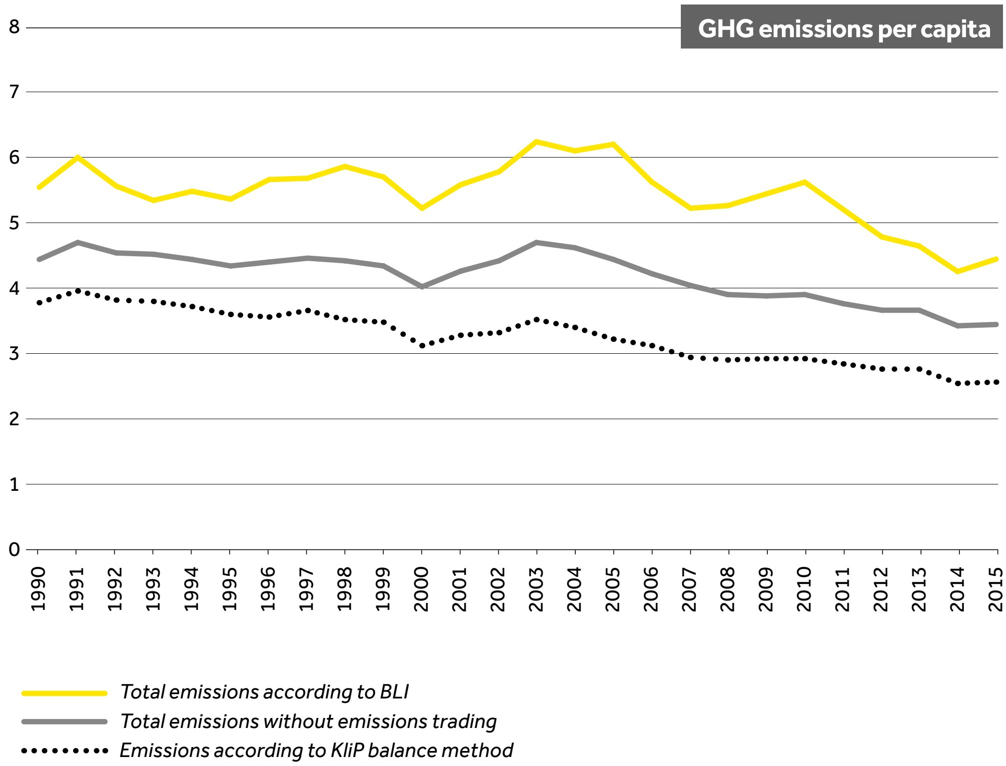
Fig. 2.19
Share of electricity from renewable energy in Vienna's total electricity generation, 2005-2016
Source: Energy balance 2016

2.2.e Greenhouse gas (GHG) emissions per capita

Tab. 2.17
Greenhouse gas emissions per capita in Vienna
Sources: BLI, EmiKat and population data for Vienna

t CO_2 equivalents per capita	1990	1995	2000	2005	2010	2014	2015	Change [%] base year 1995
Total emissions according to BLI	5.6	5.4	5.2	6.2	5.6	4.3	4.5	−20.0 %
BLI without emissions trading	4.5	4.4	4.0	4.5	3.9	3.4	3.4	−22.6 %
KliP balance method	3.8	3.6	3.1	3.2	2.9	2.5	2.6	−32.6 %

Fig. 2.20
Greenhouse gas emissions per capita in Vienna, 1990-2015
Sources: BLI, EmiKat and population data for Vienna



Note: At the time of writing, the emissions data for 2016 had not yet been published.

2.2.f Greenhouse gas emissions in relation to value added

t CO_2 equivalents per €1 million value added	2000	2005	2010	2013	2014	2015	Change [%] base year 2000
Total emissions according to BLI	94.2	88.1	71.4	64.9	59.6	58.9	–36.8 %
BLI without emissions trading	21.6	121.5	94.9	86.6	80.0	79.3	–34.2 %
KliP balance method	57.9	170.0	137.2	109.6	99.7	102.5	–36.8 %

Tab. 2.18
GHG emissions in Vienna in relation to value added
Sources: BLI, EmiKat and data for value added

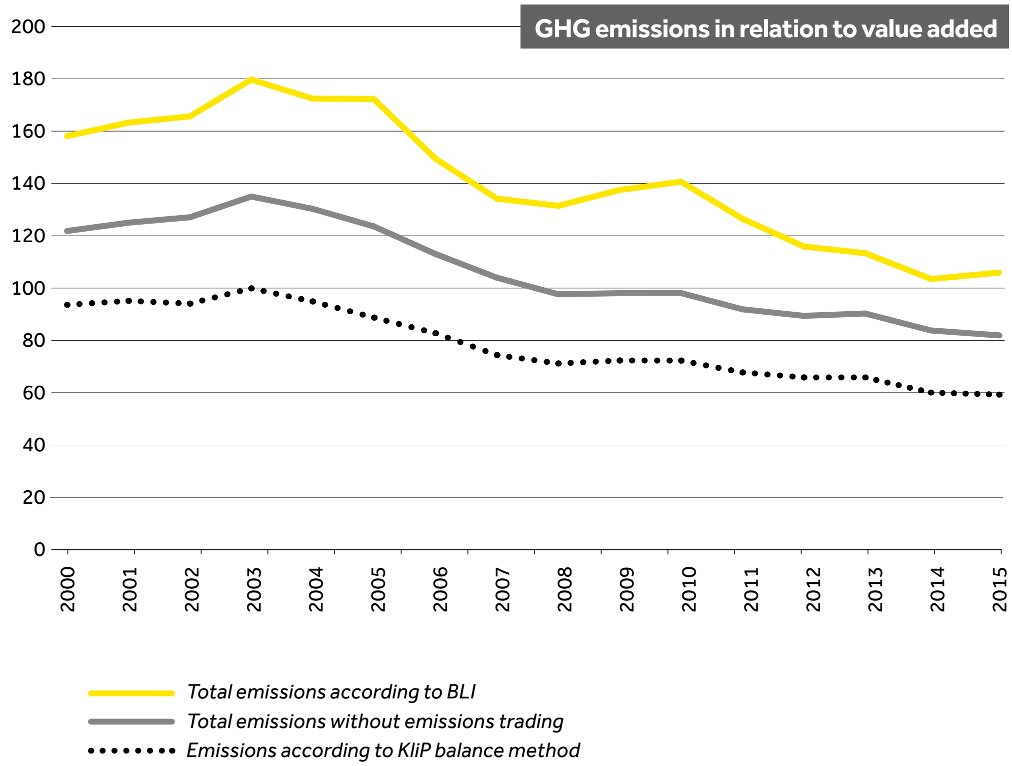


Fig. 2.21
GHG emissions in Vienna in relation to value added, 2000-2015
Sources: BLI, EmiKat and data for value added

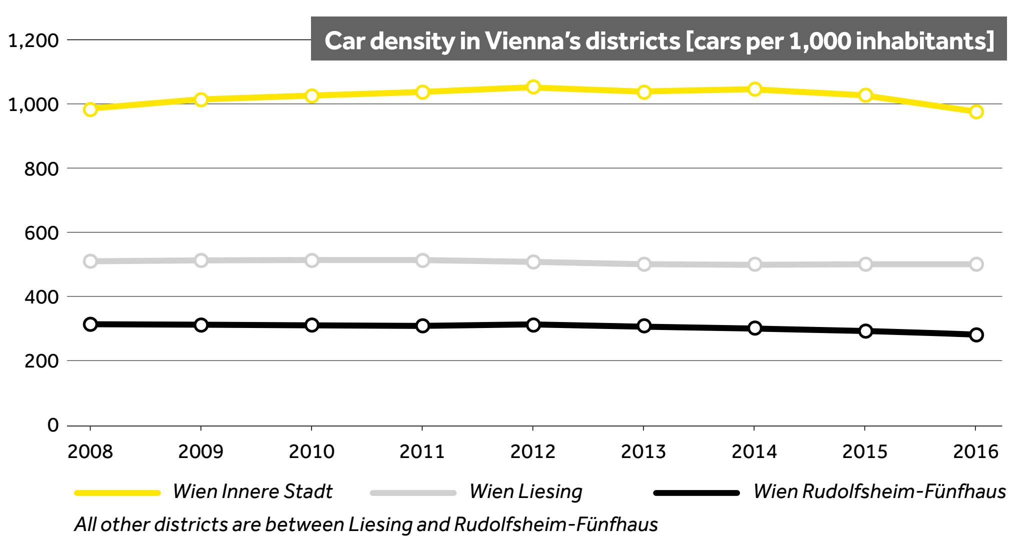
Note: Data for value added only available from 2000. At the time of writing, the emissions data for 2016 had not yet been published.

2.2.g Car density in Vienna's districts

Tab. 2.19
Car density in Vienna's districts per 1,000 inhabitants
Sources: Vehicle registration figures and population data for Vienna

	Cars per 1,000 inhabitants	2008	2010	2012	2013	2014	2015	2016	Change [%] base year 2008
	Vienna average	393	396	396	391	387	381	377	−4.3 %
1	Wien Innere Stadt	986	1,027	1,054	1,041	1,048	1,027	976	−1.0 %
2	Wien Leopoldstadt	335	334	332	333	327	318	316	−5.5 %
3	Wien Landstraße	441	464	445	441	449	437	426	−3.5 %
4	Wien Wieden	424	424	422	417	408	402	391	−7.9 %
5	Wien Margareten	330	327	322	315	309	298	293	−11.1 %
6	Wien Mariahilf	388	384	383	371	360	352	341	−12.2 %
7	Wien Neubau	373	368	368	363	354	342	329	−11.6 %
8	Wien Josefstadt	361	358	353	346	340	328	318	−11.9 %
9	Wien Alsergrund	401	388	384	376	368	358	335	−16.4 %
10	Wien Favoriten	353	353	354	351	344	337	335	−5.1 %
11	Wien Simmering	371	371	376	374	372	367	364	−1.9 %
12	Wien Meidling	353	355	362	360	357	353	350	−0.6 %
13	Wien Hietzing	448	449	456	455	451	442	431	−3.9 %
14	Wien Penzing	383	389	396	393	388	382	377	−1.8 %
15	Wien Rudolfsheim–Fünfhaus	311	307	310	303	296	287	278	−10.4 %
16	Wien Ottakring	326	327	333	331	326	321	317	−2.8 %
17	Wien Hernals	339	344	348	344	339	330	328	−3.4 %
18	Wien Währing	373	371	371	362	358	349	363	−2.6 %
19	Wien Döbling	418	423	420	419	417	411	402	−3.7 %
20	Wien Brigittenau	311	314	309	304	301	295	294	−5.4 %
21	Wien Floridsdorf	398	402	399	396	392	391	388	−2.5 %
22	Wien Donaustadt	439	447	447	443	437	443	437	−0.5 %
23	Wien Liesing	508	512	506	499	496	499	502	−1.2 %

Fig. 2.22
Car density in Vienna's districts per 1,000 inhabitants, 2008-2016
Sources: Vehicle registration figures and population data for Vienna



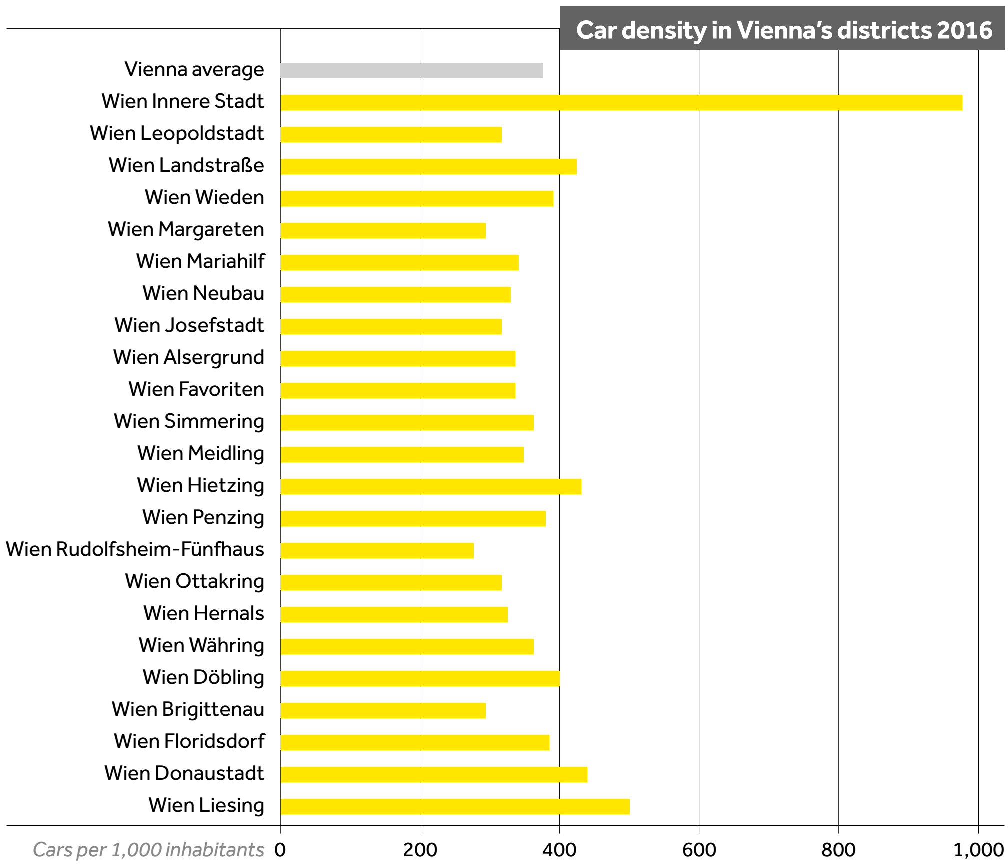


Fig. 2.23
Car density in Vienna's districts per 1,000 inhabitants, 2016
Sources: Vehicle registration figures and population data for Vienna

2.2.h Annual passes for public transport and cars per 1,000 inhabitants

	2005	2009	2012	2015	2016	Change [%] base year 2005
Annual passes per 1,000 inhabitants	186	200	292	396	398	+114.6 %
Cars per 1,000 inhabitants	402	395	396	381	377	−6.3 %

Tab. 2.20
Annual passes for Vienna Public Transport and cars per 1,000 inhabitants
Sources: Wiener Linien and population data for Vienna

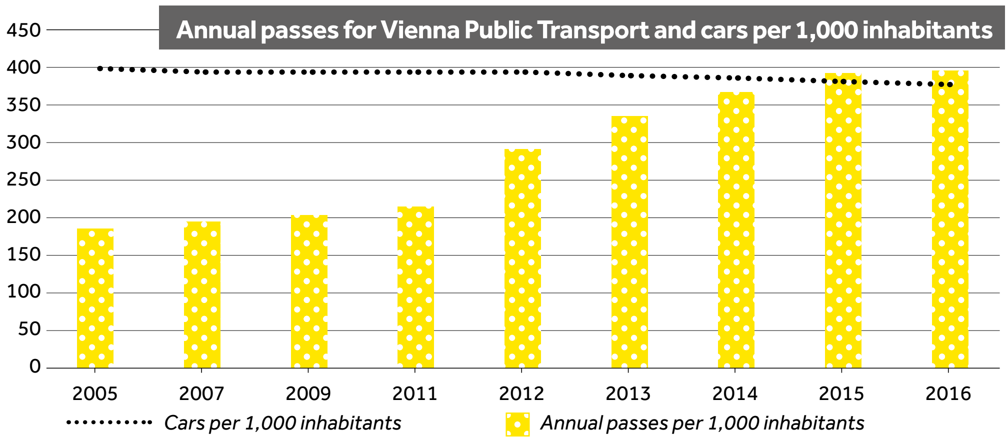


Fig. 2.24
Annual passes for Vienna Public Transport and cars per 1,000 inhabitants, 2005-2016
Sources: Wiener Linien and population data for Vienna

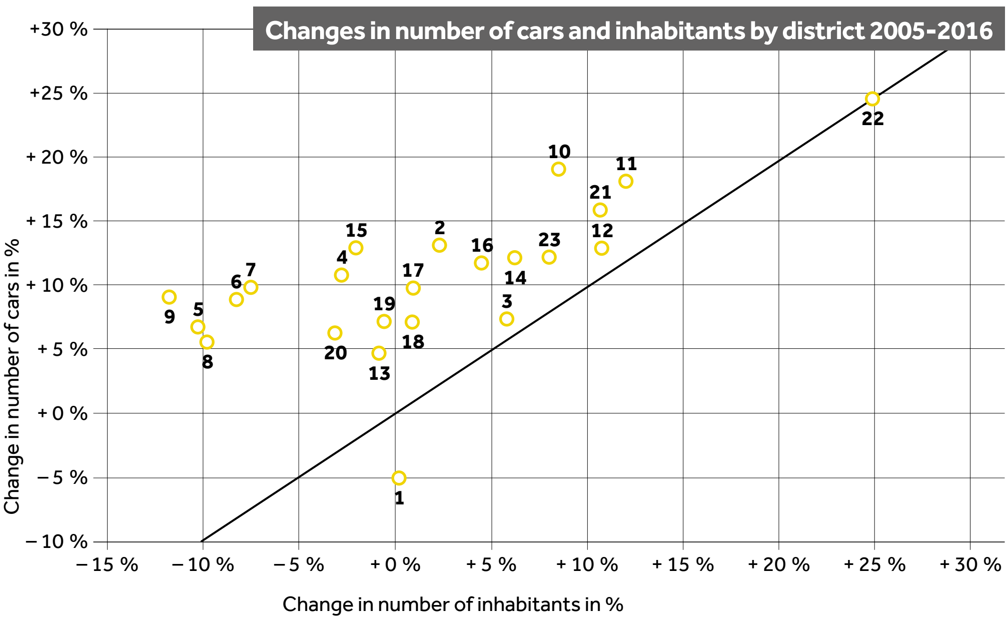
Note: On 1 May 2012, the price for the annual pass was lowered to €365.

2.2.i Changes in number of cars and inhabitants by district

Tab. 2.21
Changes in number of cars and inhabitants by district between 2005 and 2016
Sources: Vehicle registration figures, Statistical Yearbook 2006 and population data for Vienna

District		Change from 2005 to 2016	
	Name	Cars	Inhabitants
1	Innere Stadt	+0.4 %	–5.1 %
2	Leopoldstadt	+2.4 %	+13.0 %
3	Landstraße	+5.9 %	+7.1 %
4	Wieden	–2.4 %	+10.7 %
5	Margareten	–9.5 %	+5.9 %
6	Mariahilf	–7.7 %	+9.0 %
7	Neubau	–7.4 %	+9.8 %
8	Josefstadt	–9.8 %	+6.2 %
9	Alsergrund	–11.4 %	+9.2 %
10	Favoriten	+8.6 %	+19.0 %
11	Simmering	+12.1 %	+18.1 %
12	Meidling	+10.9 %	+13.0 %
13	Hietzing	–0.6 %	+4.9 %
14	Penzing	+6.4 %	+12.0 %
15	Rudolfsheim-Fünfhaus	–2.1 %	+12.8 %
16	Ottakring	+4.6 %	+11.5 %
17	Hernals	+1.1 %	+9.8 %
18	Währing	+1.0 %	+7.2 %
19	Döbling	–0.3 %	+7.0 %
20	Brigittenau	–2.9 %	+6.3 %
21	Floridsdorf	+10.8 %	+15.6 %
22	Donaustadt	+24.8 %	+24.5 %
23	Liesing	+8.1 %	+12.2 %

Fig. 2.25
Changes in number of cars and inhabitants by district between 2005 and 2016
Sources: Vehicle registration figures, Statistical Yearbook 2006 and population data for Vienna



2.2.j Heating degree, frost, and ice days

Vienna	1995	2000	2005	2010	2015	2016	2015	Change [%] base year 1995
Frost days	74	45	82	86	41	51	–31 %	–45 %
Ice days	21	17	25	35	2	13	–38 %	–90 %
Heating degree days	3,025	2,551	3,071	3,212	2,594	2,784	–8 %	–14 %

Tab. 2.22
Heating degree, frost, and ice days in Vienna
Source: Statistical Yearbooks for Vienna

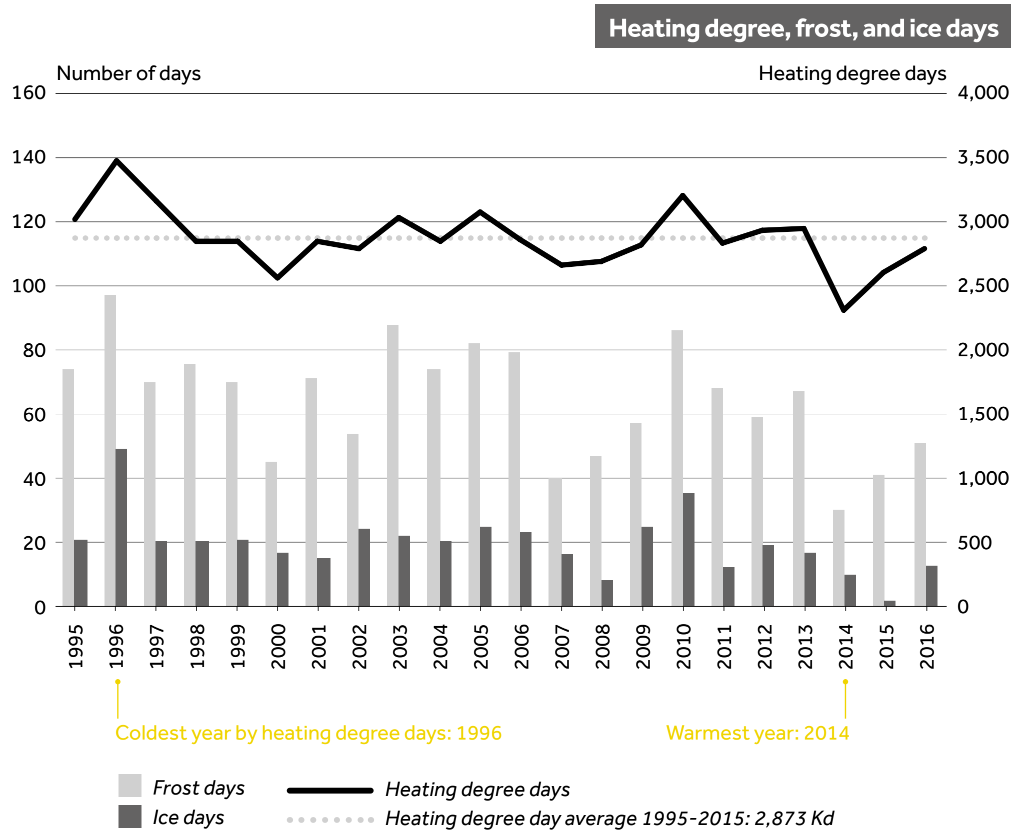


Fig. 2.26
Heating degree, frost, and ice days in Vienna, 1995-2016
Source: Statistical Yearbooks

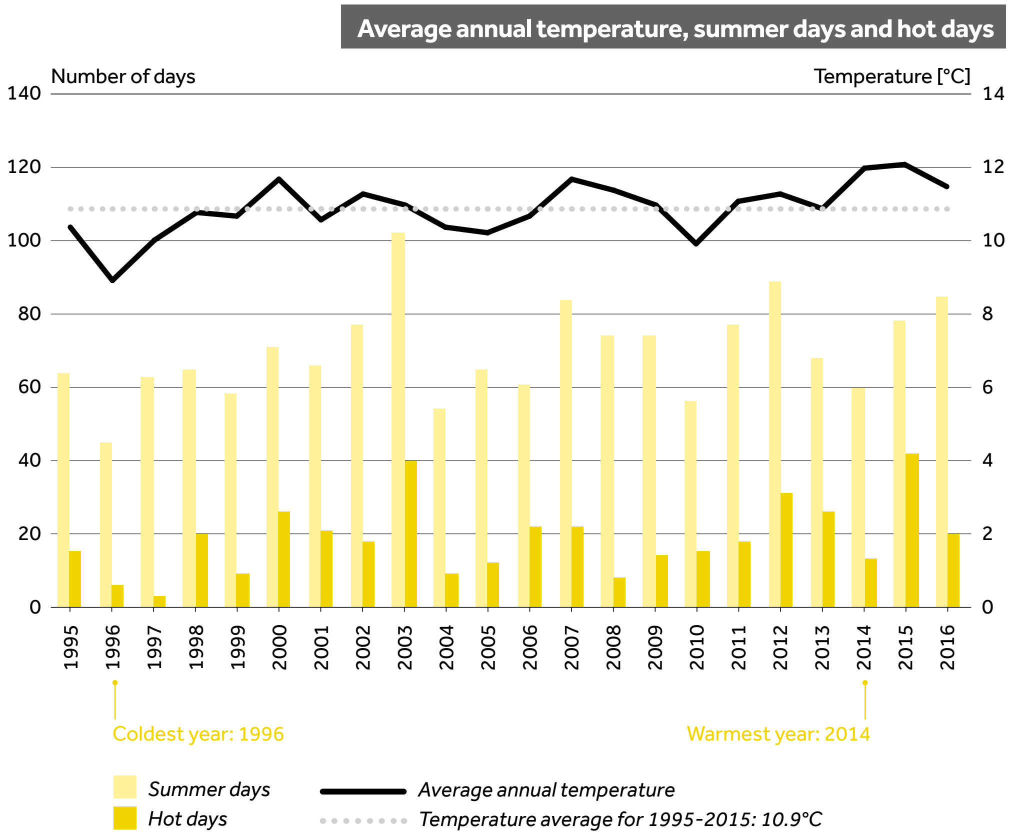
Note: An ice day is a day on which the maximum temperature is below 0° C, and a frost day is a day on which the minimum temperature is below 0° C. The metric for heating degree days is the sum of the differences between indoor temperature (20° C) and mean outdoor temperature for all heating days over one year. A heating degree day is a day on which the mean outdoor temperature is below the heating threshold of 12° C.

2.2.k Average annual temperature, summer days and hot days

Tab. 2.23
Average annual temperature, summer days and hot days in Vienna
Source: Statistical Yearbooks

Number of days or temperature [° C]	1995	2000	2005	2010	2015	2016	Change [%] base year 1995
Summer days	64	71	65	56	78	85	Hot days
Hot days	15	26	12	15	42	20	Average annual temperature
Average annual temperature	10.4	11.7	10.2	9.9	12.1	11.5	+10.6 %

Fig. 2.27
Average annual temperature, summer days and hot days in Vienna, 1995-2016
Source: Statistical Yearbooks



Note: A hot day is a day on which the maximum temperature is at least 30°C, and a summer day is a day with a maximum temperature of at least 25° C.

2.3 COMPARISON OF FEDERAL PROVINCES

2.3.a Final energy consumption per capita by federal province

kWh per capita	1995	2000	2005	2010	2015	2016	Change [%] base year 1995
Vienna	21,002	21,663	24,130	23,346	20,312	20,168	−3.97 %
Vorarlberg	26,863	27,217	31,172	30,824	30,230	30,260	12.65 %
Tyrol	26,991	28,777	35,181	33,342	32,841	32,801	21.52 %
Styria	33,482	37,403	42,373	41,800	40,281	40,942	22.28 %
Salzburg	29,012	30,261	37,666	36,368	33,357	33,903	16.86 %
Upper Austria	34,797	40,034	44,991	44,580	44,372	45,260	30.07 %
Lower Austria	32,646	36,860	41,800	42,699	41,206	42,238	29.38 %
Carinthia	31,169	33,987	41,136	41,845	42,159	43,278	38.85 %
Burgenland	25,515	28,338	33,205	34,285	32,100	32,850	28.75 %

Tab. 2.24
Final energy consumption per capita by federal province
Sources: Energy balance 2016 and population data

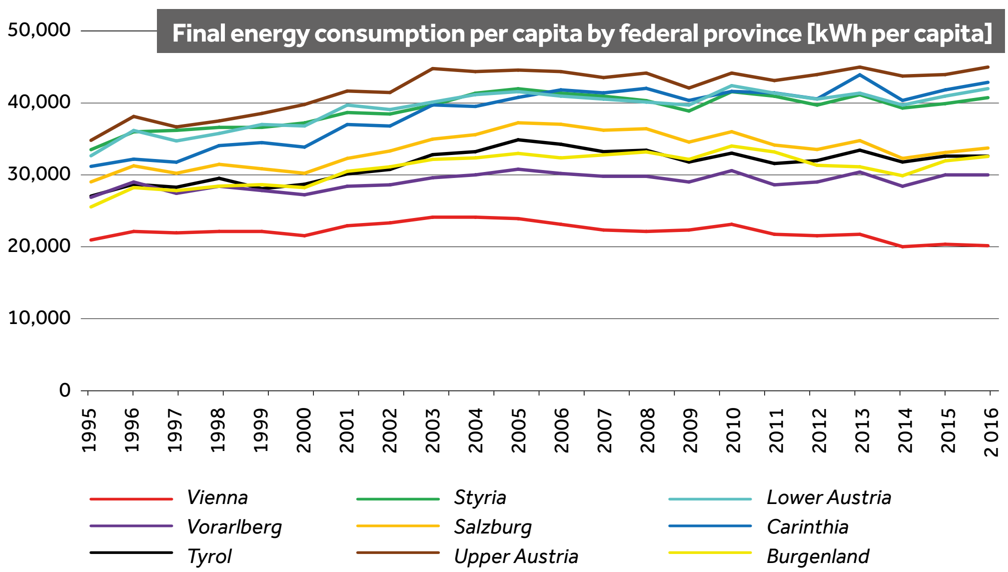


Fig. 2.28
Final energy consumption per capita by federal province, 1995-2016
Energy balance 2016 and population data

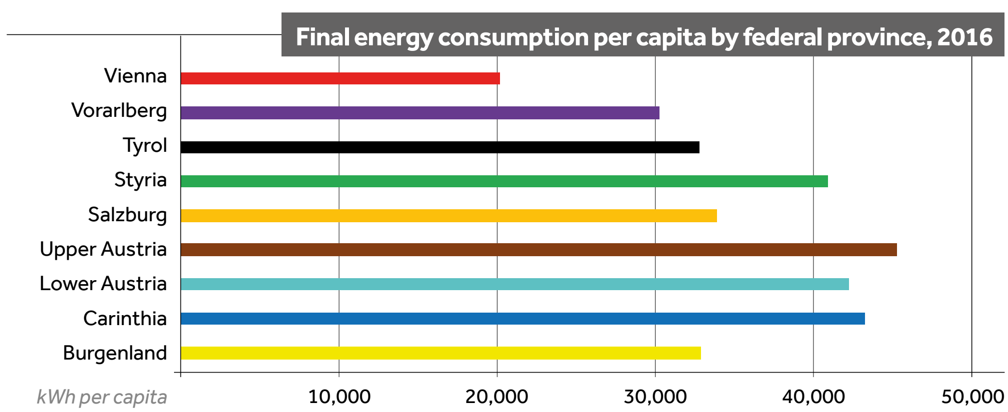


Fig. 2.29
Final energy consumption per capita by federal province, 2016
Sources: Energy balance 2016 and population data

2.3.b Electrical energy per capita by federal province

Tab. 2.25
Electrical energy per capita by federal province
Sources: Energy balance 2016 and population data

kWh per capita	1995	2000	2005	2010	2015	2016	Change [%] base year 1995
Vienna	4,307	4,635	4,873	4,931	4,583	4,508	+4.7 %
Vorarlberg	5,927	5,569	6,636	6,934	6,774	6,744	+13.8 %
Tyrol	6,863	7,122	7,844	7,361	7,173	7,158	+4.3 %
Styria	6,058	7,116	7,867	7,924	7,859	7,809	+28.9 %
Salzburg	6,185	6,199	7,341	7,514	6,487	6,478	+4.7 %
Upper Austria	7,020	8,216	9,013	9,321	9,937	10,070	+43.4 %
Lower Austria	5,610	5,876	6,275	6,707	6,899	6,913	+23.2 %
Carinthia	6,473	7,106	8,184	8,725	8,630	8,697	+34.3 %
Burgenland	3,608	4,332	4,723	5,446	5,380	5,396	+49.6 %

Fig. 2.30
Electrical energy per capita by federal province, 1995-2016
Sources: Energy balance 2016 and population data

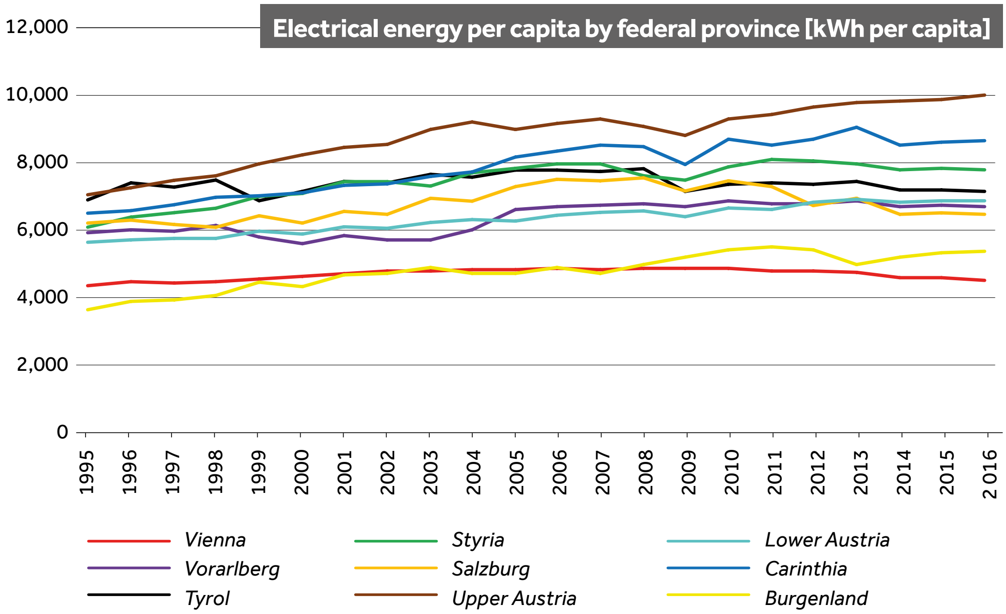
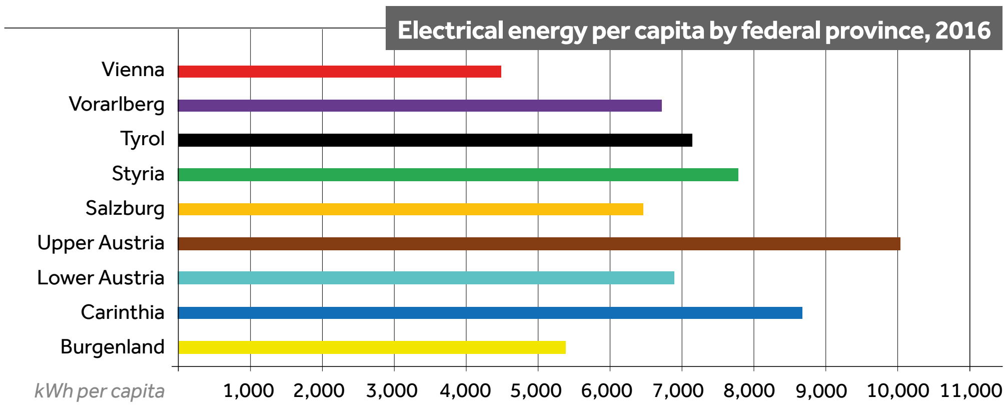


Fig. 2.31
Electrical energy per capita by federal province, 2016
Sources: Energy balance 2016 and population data



2.3.c Final energy consumption of private households per capita by federal province

kWh per capita	1995	2000	2005	2010	2015	2016	Change [%] base year 1995
Vienna	7,032	6,992	6,879	7,029	6,451	6,569	–6.59 %
Vorarlberg	8,743	9,016	7,971	8,419	8,384	8,253	–5.60 %
Tyrol	8,210	8,334	8,573	8,532	8,421	8,151	–0.72 %
Styria	9,483	9,254	9,026	9,277	9,254	9,237	–2.60 %
Salzburg	8,415	8,697	8,432	8,353	8,767	8,798	4.55 %
Upper Austria	9,192	9,154	8,669	8,912	8,599	8,945	–2.68 %
Lower Austria	10,944	10,445	9,693	10,239	9,581	10,044	–8.22 %
Carinthia	10,693	9,720	9,317	9,632	10,009	9,648	–9.77 %
Burgenland	11,609	11,359	9,719	9,891	9,824	10,157	–12.50 %

Tab. 2.26
Final energy consumption of private households per capita by federal province
Sources: Energy balance 2016 and population data

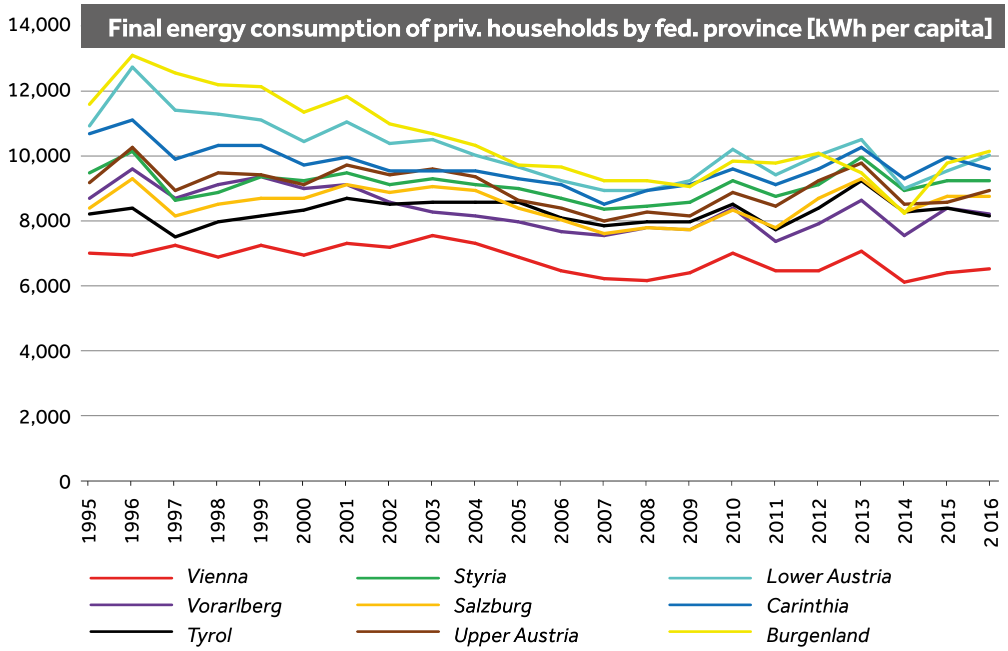


Fig. 2.32
Final energy consumption of private households per capita by federal province, 1995-2016
Sources: Energy balance 2016 and population data

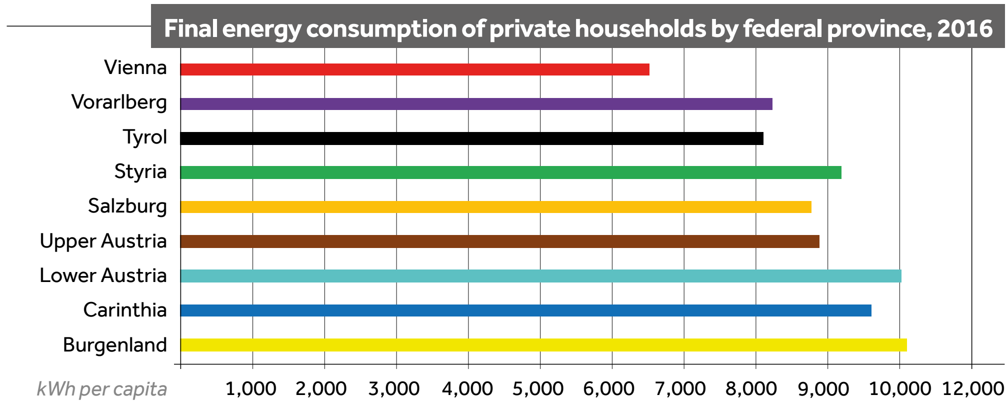


Fig. 2.33
Final energy consumption of private households per capita by federal province, 2016
Sources: Energy balance 2016 and population data

2.3.d Final energy consumption in relation to value added by federal province

Tab. 2.27
Final energy consumption in relation to value added by federal province
Sources: Energy balance 2016 and data on value added

MWh/million €	2000	2005	2010	2015	2016	Change [%] base year 2000
Vienna	652	658	567	468	462	−29.1 %
Vorarlberg	1,114	1,087	948	751	756	−32.2 %
Tyrol	1,412	1,490	1,206	1,044	1,020	−27.8 %
Styria	1,828	1,754	1,505	1,269	1,279	−30.0 %
Salzburg	967	998	840	642	640	−33.9 %
Upper Austria	1,744	1,659	1,422	1,219	1,232	−29.3 %
Lower Austria	1,891	1,882	1,663	1,407	1,427	−24.5 %
Carinthia	1,725	1,775	1,580	1,404	1,414	−18.0 %
Burgenland	1,828	1,815	1,630	1,293	1,315	−28.1 %

Fig. 2.34
Final energy consumption in relation to value added by federal province, 2000-2016
Sources: Energy balance 2016 and population data

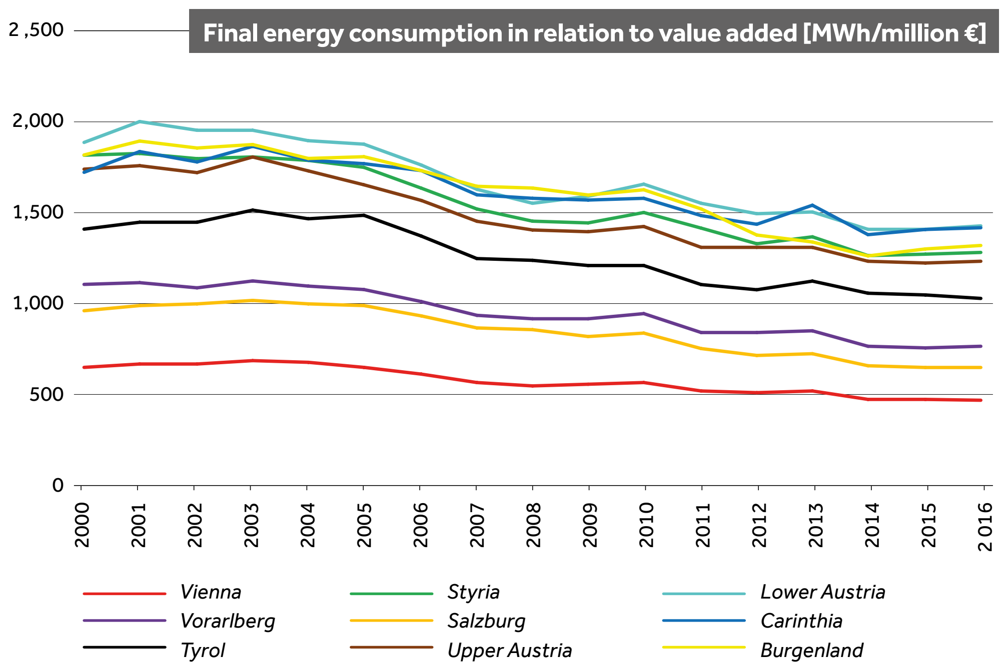
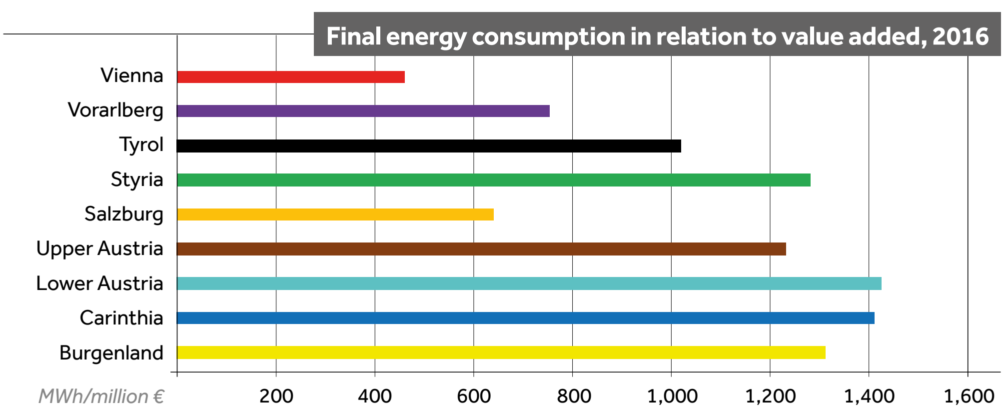


Fig. 2.35
Final energy consumption in relation to value added by federal province, 2016
Sources: Energy balance 2016 and data on value added



Note: Data for value added only available from 2000.

2.3.e Car density in provincial capitals

Cars per 1,000 inhabitants	2008	2010	2012	2013	2014	2015	2016	Change [%] base year 2008
Vienna	393.2	396.0	395.7	391.3	386.7	381.4	376.5	−3.0 %
Sankt Pölten	543.0	555.2	567.9	571.0	573.8	571.2	573.0	+5.2 %
Salzburg	483.4	502.1	511.7	514.2	516.5	517.5	513.2	+7.1 %
Linz	495.8	506.5	517.7	519.0	516.4	510.0	507.7	+2.8 %
Klagenfurt	573.0	587.7	606.9	609.9	607.4	605.9	606.7	+5.7 %
Innsbruck	440.8	445.5	452.2	445.7	443.7	437.4	427.1	−0.8 %
Graz	470.4	475.5	477.3	476.5	473.4	471.4	470.0	+0.2 %
Eisenstadt	634.0	644.0	660.5	667.9	669.7	676.2	660.9	+6.7 %
Bregenz (district)	484.7	499.9	513.9	519.5	524.5	528.7	532.2	+9.1 %

Tab. 2.28
Car density in provincial capitals per 1,000 inhabitants
Sources: Vehicle registration figures and population data

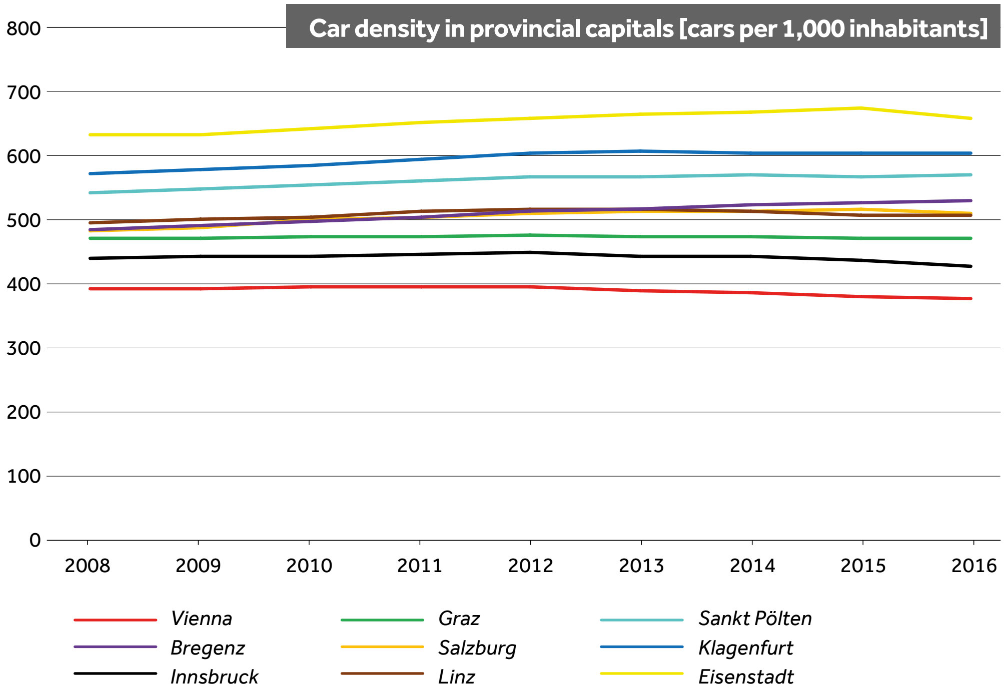


Fig. 2.36
Car density in provincial capitals per 1,000 inhabitants, 2008-2016
Sources: Vehicle registration figures and population data

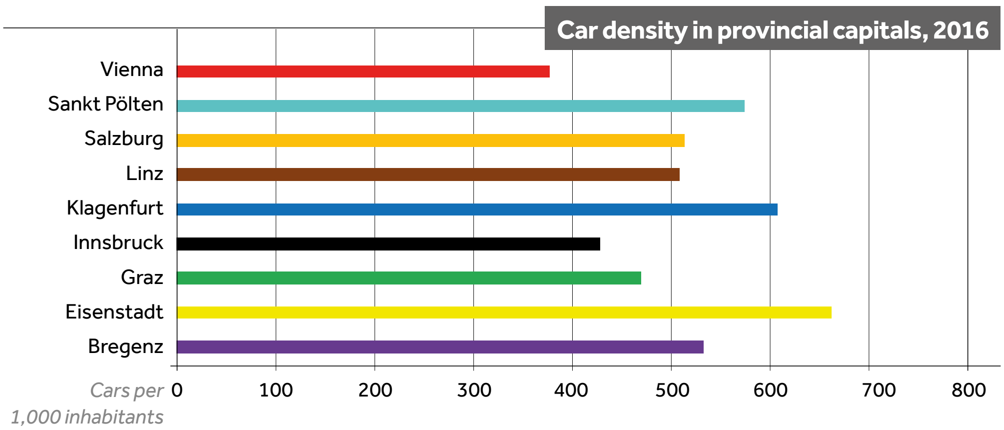


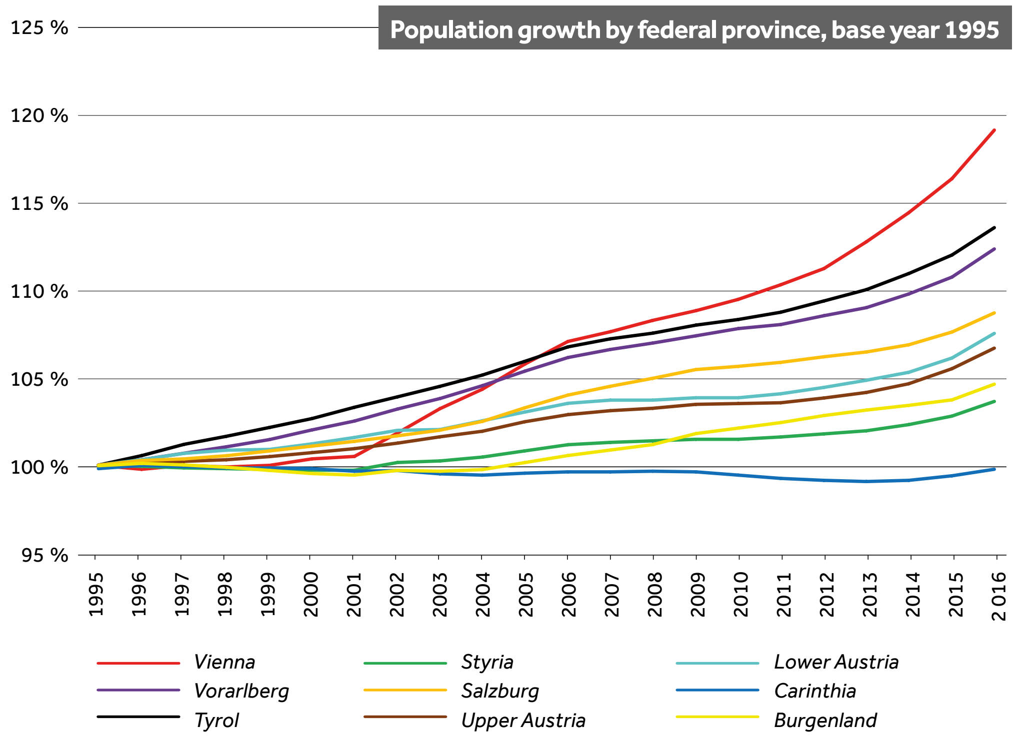
Fig. 2.37
Car density in provincial capitals per 1,000 inhabitants, 2016
Sources: Vehicle registration figures and population data

2.3.f Population growth by federal province

Tab. 2.29
Population growth by federal province
Source: Population data for Vienna

Province	1995	2000	2005	2010	2015	2016	Change [%] base year 1995
Vienna	1,542,667	1,548,537	1,632,569	1,689,995	1,797,337	1,840,226	+19.3 %
Vorarlberg	341,408	348,366	360,054	368,366	378,592	384,147	+12.5 %
Tyrol	649,875	667,459	688,954	704,662	728,826	739,139	+13.7 %
Styria	1,186,136	1,182,930	1,196,780	1,205,045	1,221,570	1,232,012	+3.9 %
Salzburg	506,626	512,854	522,369	526,730	538,575	545,815	+7.7 %
Upper Austria	1,360,051	1,370,035	1,394,726	1,409,253	1,437,251	1,453,948	+6.9 %
Lower Austria	1,518,489	1,535,083	1,568,949	1,605,897	1,636,778	1,653,691	+8.9 %
Carinthia	560,708	560,696	558,926	557,998	557,641	560,482	–0.0 %
Burgenland	277,529	276,226	278,032	283,697	288,356	291,011	+4.9 %

Fig. 2.38
Population growth by federal province, 1995-2016
Source: Population data for Vienna



More information on Municipal Department 20:
Website: www.energieplanung.wien.at
Facebook: www.facebook.com/energievoraus