Energy! ahead

Energy Report of the City of Vienna

Data for 2017 / Year of reporting 2019, MA 20

Vienna! ahead

Energy Planning

City of Vienna

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Data for 2017 / Year of reporting 2019,
Magistratsabteilung 20

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A new energy era

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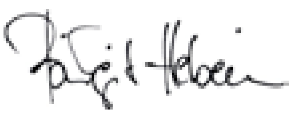
No matter where we look today, the question of how to balance human needs and environmental sustainability is ever-present. The way we address this issue will be of critical importance – not just for the coming years, but for the future of our city and all of its residents, beyond our own lifespans. Our only option in the face of the climate crisis is to end our reliance on fossil fuels like oil and gas. This is bound to mean change; it may mean leaving our current comfort zone, but it may also mean innovation. These three concepts form the basis of the City of Vienna's response to this urgent question.

We have already set out on the path towards a new urban energy system. Almost a third of the energy consumed in Vienna is generated from renewable sources and waste heat today. Per capita greenhouse gas emissions in the city have decreased by 33 percent since 1990. Many significant steps have already been taken to protect the global climate and transform our energy systems – but there is still a lot to be done.

Our goal is to halve local per capita greenhouse gas emissions by 2030. Compared to 2005 levels, emissions should even be reduced by 85 percent. Though the figures may be hard to image, the City of Vienna has clearly committed to these goals. Active commitment by political decision-makers and by the City Administration is essential here, but we will also need a sound strategic basis in order to come up with effective measures, goals and indicators. This basis is provided by the Smart City Wien Framework Strategy, which has been updated and adopted by the Vienna City Council this year, and by the Urban Energy Efficiency Programme 2030 on reaching climate protection goals, but also by Vienna's new Thematic Concept on Energy Zoning Planning, which serves as a blueprint for energy-efficient and climate-friendly urban development in the long run.

Together, the strategic documents provide an overview of all successful measures the City of Vienna has taken so far – measures that have proven effective in the short or long term. This certainly includes the recent amendment to the Vienna building regulations, which allows for the creation of climate protection zones within the Vienna city limits, and has paved the way for the end of the fossil-energy era in the construction sector. But new construction is not the only essential factor in terms of climate protection. In a city like Vienna, it is particularly important for the existing building stock to be climate compatible. Sustainable energy supply must not be a luxury reserved to the wealthy. Every city must take action to keep climate protection from becoming a social issue, and to ensure energy remains affordable for everyone who lives here. This is why Vienna offers targeted counselling for residents who struggle to pay their energy bills. For this initiative against energy poverty, the city has received an award from the Austrian Society for Environment and Technology (ÖGUT), proving that this can be a best practice model for other cities.

The City of Vienna is aware of its great responsibility as it shapes the daily life realities of all people who live here. At the same time, it is a privilege to be tasked with planning the green climate future of this city, and taking care to ensure Vienna remains loveable and liveable, but also affordable for everyone. In essence, our short-term and long-term challenge is to consume less energy in all areas– while at the same time keeping the city up and running.



Birgit Hebein
Deputy Mayor of Vienna, Executive City Councillor for Climate Protection and Energy Planning

Staying at the forefront of the energy transition

Vienna's new Deputy Mayor Birgit Hebein has pledged to make Vienna the climate capital of Europe. This clear priority gives a major boost to the city's energy planning policies, and underscores the central role climate protection has come to play by now. Frequent media headlines prove that it is no longer a niche topic but an issue of interest to the public at large.

As a key player in shaping our energy future, the Energy Planning Department of the City of Vienna perceives the increased media focus as an opportunity to show which measures the city is currently advancing and implementing to foster its transition to a sustainable energy system.

Our department prepares the ground for designing Vienna's energy future, and takes an active role in the planning process. We work in a highly networked environment based on mutual exchange of experience. After all, every growing city worldwide faces similar challenges in the field of climate protection. For this reason, we are increasingly relying on mutual exchange with experts from other cities. This is possible via EU-funded research projects that bring significant benefits for the City of Vienna, but also by partnering with other major cities like Vancouver in Canada.

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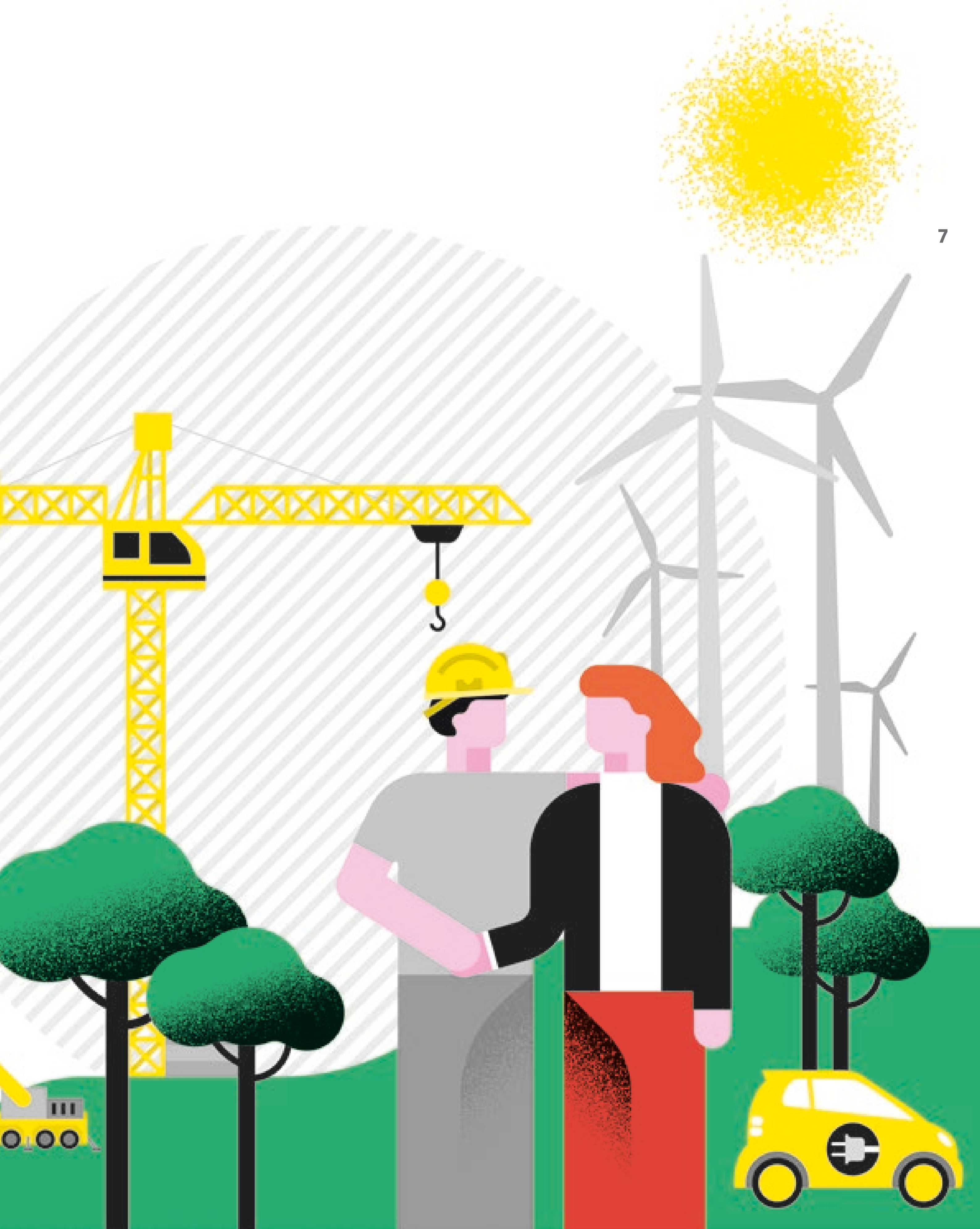
More and more people and institutions join the call for climate protection as they realise that effective climate action is urgently needed. This is why our work is focused on enabling and supporting real-life, future-proof projects in our city. The Energy Planning Department has become an important player at the forefront of the energy transition and climate protection efforts.

Bernd Vogl
Head of the Energy Planning Department

Strategic concepts for Vienna's energy future



2. Strategic concepts for Vienna's energy future

2.1 SEP 2030 – Energy efficiency first!

Climate protection is one of the major challenges of our times. In order to meet it, we need a wide range of measures in a variety of areas. Energy efficiency has a crucial role to play in this. Our objective must be to make do with considerably less energy in future in order to contribute to both climate protection and the long-term supply security of our energy systems. Increasing energy efficiency is a prerequisite for the decarbonisation of our economy, and must succeed particularly in the cities. *"Energy efficiency first"* is our guiding principle on the road to a decarbonised society. It is for this same reason that energy efficiency has been increasing in importance at the EU level as well over the last 15 years. This trend is reflected in a number of important regulatory frameworks.

Establishing energy efficiency in Vienna

In Vienna, increasing energy efficiency has long been a priority of energy policy. The City of Vienna has been on a road to energy efficiency since the 1990s. Some landmarks along this path were the transition to district heating using high-efficiency cogeneration and the introduction of a subsidy for the thermal-energetic refurbishment of residential buildings. In addition, the City of Vienna passed a comprehensive implementation programme in 2006, the Urban Energy Efficiency Programme (SEP). This has placed the goals of increasing energy efficiency and saving energy centre stage, and with success: Today, new subsidised residential housing projects need only half the heating energy they did ten years ago. Many other measures also decrease energy consumption. Between 2006 and 2015, some 180 GWh annually were saved. As a result, Vienna's final energy consumption is declining slightly despite strong population growth.

Staying fit for the future and saving energy

The current Urban Energy Efficiency Programme 2030 (SEP 2030) keeps energy efficiency firmly at the top of the city's agenda. SEP 2030 is also the city's response to the climate and energy policy requirements of the EU and the Austrian government. SEP takes into account all the energy-related objectives of the City of Vienna, including the overarching goals of the Smart City Framework Strategy, the Energy Framework Strategy, and other strategic concepts of the City of Vienna. It focuses on providing guidance and tools for reaching these goals. With these efforts, energy efficiency is being given an even higher priority in climate policy and city administration.

30 percent less energy by 2030 – the SEP energy efficiency scenario

SEP 2030 defines an indicative interim goal for 2030: *Following the SEP 2030 energy efficiency scenario, the City of Vienna aims to reduce per capita final energy consumption by 30 percent from 2005 levels by 2030.* This goal is in line with the trends of past years and the energy efficiency goal of the Smart City Wien Framework Strategy, which aims to reduce per capita final energy consumption by 40 percent from 2005 levels by 2050.

To reach this goal, it is necessary for the EU and the federal government to introduce suitable fiscal, financial and legislative frameworks.

SEP 2030 energy efficiency scenario

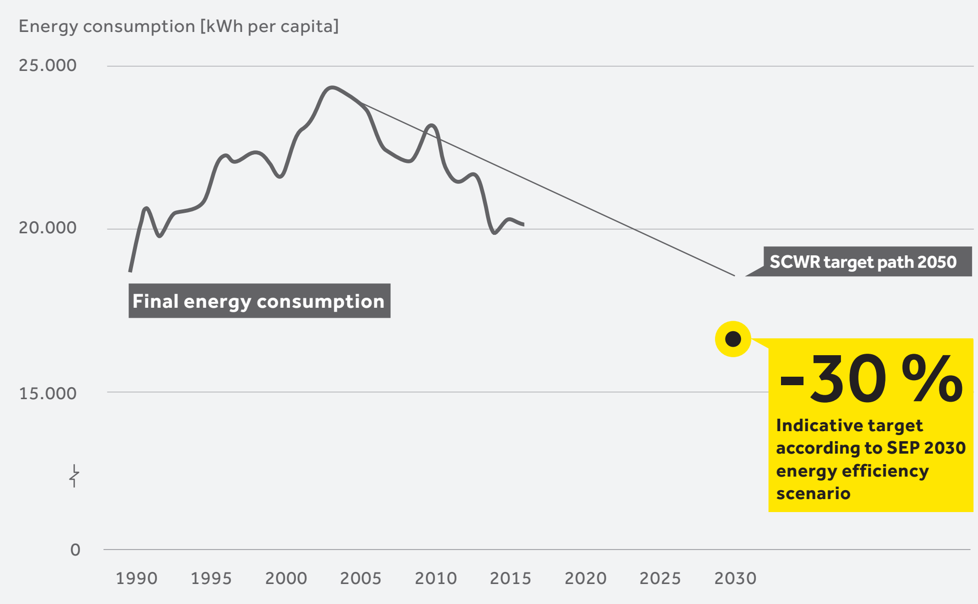


Fig. 1: Indicative energy efficiency goal of minus 30 percent per capita final energy consumption by 2030

The SEP 2030 energy efficiency scenario is calculated based on sector-specific targets formulated in the Smart City Wien Framework Strategy converted into energy units (top down) as well as an estimate of the effectiveness of the measures for reaching the goals (bottom up) to ensure the values are plausible. The SEP 2030 energy efficiency scenario is based on 2 percent annual economic growth.

Implementing measures

In keeping with the city's energy policy priorities, the focus is on measures to increase energy efficiency and reduce final energy consumption. However, in the interest of overall efficiency and energy systems becoming more intertwined, efficiency increases in the transformation chain before the meter are considered as well. A new feature of SEP 2030 is the comprehensive inclusion of the transportation sector. The measures and instruments focus on Vienna's areas of competence as a city and federal province. By implementing such measures in its own sphere of influence (e.g. its own office buildings), the Vienna City Administration also has a model function for others.

The primary target group for SEP 2030 are organisations and administrative units that are in charge of or involved with implementing the measures of the Energy Efficiency Programme. This includes offices of the City Administration and city-owned companies.[1]

With SEP 2030, Vienna is once again paving the way and committing to following the energy efficiency path it is on. Vienna continues to place "energy efficiency first"

Dipl.-Ing. Herbert Ritter Deputy Head of Department & SEP 2030 Coordinator, Energy Planning, City of Vienna

2.2 Laying foundations for spatial energy planning

Vienna is preparing for a zero-carbon future. The Strategic Concept for Spatial Energy Planning supports the decarbonisation of energy supply. Spatial energy planning combines energy planning and urban planning, creating synergies and allowing an optimum use of the available resources.

SEP 2030
Download Energy Efficiency Programme

1 https://www.wien.gv.at/stadtentwicklung/energie/sep2030.html

Considering energy supply in the early planning stages
The *Strategic concept on spatial energy planning* is the first step in developing and establishing spatial energy planning in the city. It places a focus on energy planning and becomes an important part of the urban development planning process. Energy efficiency and the intelligent use of locally available renewable energy sources protect the climate and are an important contribution to successful and sustainable spatial development.

"Opportunities for a growing city
Vienna is a dynamically growing city. That provides enormous opportunities for climate protection, as innovative and climate-compatible energy supply solutions can be integrated into the urban development process at an early stage."
Mag. Bernd Vogl Head of Energy Planning, City of Vienna

Promoting energy solutions suited for cities
In cities, the focus of spatial energy planning is on heating, as buildings have the highest energy demand. Forward-looking spatial energy planning makes it easier to integrate renewables and waste heat and to implement more efficient solutions, which are then cheaper to implement and become more competitive compared to fossil energy use. Well thought out spatial energy planning supports the efficient use of district and local heating networks, connects supply and demand, and offers suggestions for increasing density, urban development, and refurbishment measures that have benefits in terms of energy supply.

Vienna is ready
The objective of spatial energy planning is to coordinate supply and demand as well as infrastructure for low or zero-emission regional energy supply, optimised for the local conditions. This can be done in new development areas or in sustainable refurbishment projects for old and existing building stock. The focus is on integrating the opportunities of grid infrastructure and using waste heat and renewable energy from the very first steps of the planning process.

With the *Strategic concept on spatial energy planning*, the city is creating a development framework that is fit for the future and suitable for solving the challenges that climate protection in a growing city will bring.[2]

2.3 An end to fossil energy in new buildings: Vienna is creating climate protection zones

By mid-2020, 8 out of 10 new buildings in Vienna will be located in a climate protection zone. In these zones, new building projects must be supplied with renewable energy or district heating. Heating, cooling and hot water must be provided with renewables such as geothermal energy, solar energy or biomass, or district heating. This affects all new buildings in the zones, both subsidised and privately financed residential buildings, offices, business premises, as well as public buildings such as schools or kindergartens. This will, in the long run, eliminate fossil energy use in climate protection zones.

Strategic concept on spatial energy planning

"In a growing city, the new buildings sector is an important lever for effective climate protection. Buildings that are constructed today will still be there in 50 years. By introducing climate protection zones, Vienna is making climate-friendly systems the norm."
Dipl.-Ing.in Andrea Kinsperger project manager, Energy Planning

2 https://www.wien.gv.at/stadtentwicklung/strategien/step/step2025/fachkonzepte/energieraumplanung/index.html

No more oil or gas: Vienna's Building Code promotes climate protection
The definition of climate protection zones is set out in Art. 2b of the Vienna Building Code, which decrees spatial energy plans. The ordinances are in preparation and will be issued district by district, starting with districts 2, 3, 7 and 16. The other districts will follow in stages, until all of Vienna will have a number of climate protection zones by mid-2020.

Essentially, this allows the city to issue ordinances that establish criteria for the choice of heating and hot water system in new buildings. Existing building stock is not affected. In future, new buildings being constructed in climate protection zones can only use "highly efficient alternative systems" as defined in Art. 118 (3) of the Vienna Building Code for hot water and heating. These systems include essentially:

- Connection to a district or local heating grid, if the energy is generated completely or partially (at least 80%) from renewable sources or highly efficient cogeneration plants.
- Decentralised energy supply systems based on renewable energy sources (heat pumps, biomass heating, solar energy, etc.)
- Use of waste heat
- Cogeneration plants that produce electricity and feed the waste heat into a heating grid

Where can climate protection zones be established?
It must be possible to connect all plots in a climate protection zone to the district heating network, and at least one other climate-friendly heating system based on renewable energy sources or waste heat must be feasible as well. This ensures that climate protection zones continue to have a choice in terms of heating system.

2.4 Renewable energy in the urban context – priorities in Vienna

A needs-oriented, secure, affordable and environmentally compatible energy supply is one of the main requirements for economic development and social prosperity. If we are to reach the climate goals, we need to reinforce the use of renewable energy sources. Vienna has six priority areas, which will be defined in the new iteration of the Climate Protection Programme of the City of Vienna (KliP3). Vienna has been setting goals and measures for climate protection with KliP since 1999. Its third iteration, KliP3, is currently in development, and will define measures for the period from 2020 to 2030.

1. An end to fossil energy in existing buildings – getting ready for the use of renewables
   With a share of one third of total final energy consumption, Vienna's building sector has a major impact. In a decarbonised city, it must be supplied with renewable energy. Therefore, the 2018 amendment to the Building Code includes the possibility of establishing fossil-free spatial energy planning zones for free new buildings by ordinance. Additionally, strategies and solutions will be developed and demonstrated on pilot projects to show how buildings that are currently heated with natural gas can be switched over to renewables or district heating. For the existing building stock, a mix of measures will be developed that encompasses refurbishment, switching from natural gas to heat pump solutions, and gas from renewable sources.

2. Decarbonised district heating 2050
   Over 30% of Vienna's households currently get their energy for space heating and hot water from the district heating network, making them well prepared for an increase

in the share of renewables in district heating. This will be done using a wide range of heat sources distributed across the entire city. Waste heat, i.e. energy that has already been generated and would otherwise dissipate into the environment, can be utilised. For example, waste heat can be distributed within a neighbourhood efficiently and according to demand as low-temperature heat in socalled anergy grids. Large-scale heat pumps use the soil and groundwater as energy sources and feed the heat they generate into the district heating network. Sewers also have great potential as a heat source, and are currently being surveyed and integrated into the online city map in a project of Municipal Department 20 – Energy Planning. The public energy supplier Wien Energie is already implementing the first projects in this area.

3. Buildings become power plants and energy storage
The buildings of the future not only consume energy, they also produce and store it, and can distribute low-temperature heat within their neighbourhood. Photovoltaics elements integrated into facades and roofs produce electrical energy, which can be used as operating current. Combined with geothermal energy, heat pumps can be operated with solar energy and the generated heat can be stored in thermally activated building components (radiant panel heating or thermal activation). The low energy losses through the highly efficient building envelope reduce dependence on a constant provision of space heating. Energy loss through the building envelope is so low that the interior temperature does not drop significantly even after two days without active heating, preserving the usual living comfort. Additionally, such systems make it possible to cool rooms in summer and store the extracted heat in the ground until the next heating period. The decarbonisation of cities is not possible without measures for the existing building stock. A high rate of refurbishment that increases the energy efficiency and quality of buildings is crucial for a significant reduction in the city's energy demand. Switching to low-temperature heating systems makes it possible to provide renewable energy efficiently.

4. The city as a power plant
If the City of Vienna is to meet its decarbonisation goals, the effective use of the available space for energy production is indispensable. Especially building surfaces can be used for energy generation, and waste heat that is available in the city can be utilised. Photovoltaics can be installed on buildings or spaces not only to generate electricity but also as a shading or design element. For example, transparent PV modules can be used to provide shade for spaces that get very hot in summer, improving their use for recreation. Renewable energy communities create a framework where private individuals and businesses can form an energy community produce their own energy and distribute and use it across buildings. This both increases own consumption on and gives people who do not have a suitable space for a PV installation the opportunity to use solar energy.

5. The city as an energy sponge – energy imports
Nearly 90% of energy consumed in Vienna is imported. Rural regions have more space and can therefore produce renewable energy on a large scale. This energy will replace fossil fuel imports while also boosting the regional economy. In addition to electrical energy, which is generated with low-emission methods such as PV and wind power, biomass and "green gas" will also play an important role in Vienna's energy supply. On the one hand, "green gas" is needed for industrial applications, on the other, it will be used to heat buildings whose heating systems cannot be converted to other renewable solutions.

6. Electromobility
   Another large energy consumer in the city, next to its buildings, is traffic and transport. The ongoing transition to electromobility means that buildings must provide the infrastructure necessary to connect electromobility with renewables. Cars in Vienna drive an average daily distance of 30 km and are stationary for most of the day (Statistics Austria, VCÖ 2016). "Vehicle-to-grid" systems make it possible to use of the batteries of electric vehicles for load balancing and short-term storage of renewable energy.

"In the context of climate protection and adapting to climate change, we need to not only switch our supply to renewable energy, but also respond to the increasingly hotter summers with measures that ensure Vienna remains one of the most livable cities in the world."

Dipl.-Ing. Stefan Sattler Project manager, Energy Planning

2.5 Updating the Smart City Wien Framework Strategy

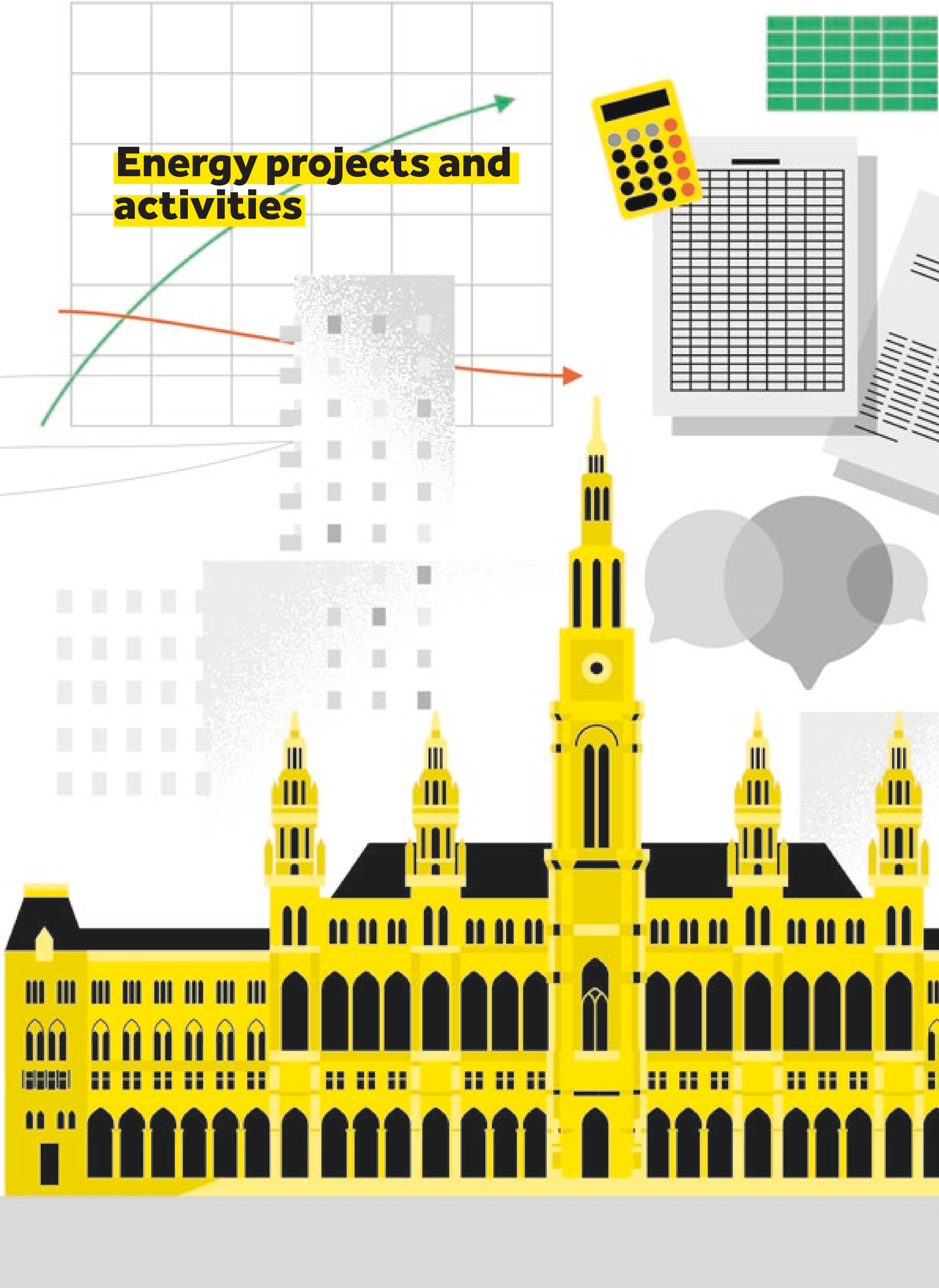
A high quality of life for all Viennese and a careful use of resources thanks to comprehensive social and technical innovations – that is the goal of the Smart City Wien Framework Strategy, which was adopted by the Vienna City Council in 2014. With the updated Smart City Framework Strategy, the City of Vienna is adopting this goal as its guiding principle for the development of the city until 2050. The objective of the strategy is to not only preserve but increase the city's traditionally high living quality, which is characterised by municipal housing, an excellent public transport system, clean drinking water, and more. A focus in future developments will be on climate and environmental protection by means of drastic emissions reduction and the circular economy, while promoting innovation and digitisation. The framework strategy has three policy areas, quality of life, resources, and innovation. These areas are interconnected and their development is defined through a total of 64 objectives. In the resource dimension, the City of Vienna has set itself three main goals as a framework that is defined more closely with 16 more specific goals in the areas of buildings, mobility and transport, and energy supply. The base year for all objectives is 2005.

Overall goals: [3]

- Vienna will reduce its local greenhouse gas emissions by 50% by 2030 and 85% by 2050.
- Vienna will reduce its local final energy consumption by 30% by 2030 and 50% by 2050.
- Vienna will reduce its consumption-based material footprint by 30% by 2030 and 50% by 2050.

3 https://www.wien.gv.at/stadtentwicklung/projekte/smartcity/rahmenstrategie.html

Energy projects and activities



3. Energy projects and activities

(Implemented between 1 July 2018 and 30 June 2019)

3.1 Illustrating developments of renewables and waste heat

A new interactive application provides information about developments in the area of renewables and waste heat use in Vienna. With the animated energy flow chart at wien.at, users can compare the figures for renewables, waste heat, and fossil energy sources. It illustrates the energy flows for the different energy sources from input to end user. The animation makes it possible to follow the distribution of the different energy vectors from gross inland energy consumption to end user consumption, and to understand conversion, losses, and the distribution of energy flows among the different sectors.

This new way of depicting energy flows is not only interesting for citizens but also helps the city evaluate its strategies and goals in the area of renewables and waste heat.[4]

3.2 Establishing energy data management in the City Administration

Upon recommendation of the Vienna Court of Audit, the Vienna City Administration is developing a comprehensive, uniform and centralised energy data management system for the city's buildings that integrates their energy use data.

The objective is to build a system that allows the collection, analysis and evaluation of energy consumption at the building level within the City Administration. The data will be updated annually and the system will be designed to be user friendly and simple. It will show all energy vectors, both grid-bound vectors such as electricity, district heating and natural gas, and off-grid energy vectors such as fuel oil, pellets etc.

A solid data basis will make it possible to introduce specific measures for individual buildings (e.g. refurbishment priorities, optimisation of heating systems, etc.), thus optimising energy consumption.

3.3 Better climate protection with the amendment to the Vienna Building Code

The Vienna Building Code was amended in November 2018 and now contains several stipulations that are significant for climate protection, renewables and energy efficiency. In addition to defining climate protection as additional planning goal, the Building Code now allows the City of Vienna to decree so-called energy spatial plans (*for details see Section 2.2*).

4 https://ma20sg.23degrees.io/sankey/abwarme_erneuerbar

The amendment introduced the following changes, among others:

- Gas boilers and oil heating are prohibited in new buildings
- Gas-based central heating in new buildings is only possible outside defined climate protection zones and combined with solar-thermal energy (twice as much as before the amendment)
- Oil and coal heating systems are also prohibited after comprehensive refurbishment

This is an important step towards implementing Vienna's Smart City objectives.

3.4 Continuing the energy focus at education campuses

A highly innovative education campus for approx. 1,400 children and adolescents is being constructed in Seestadt Aspern Nord by September 2021. An important criterion for this campus, which is based on the "education campus plus" model, is that the kindergarten and after-school club facilities can also operate during the summer break. Therefore, 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. A third education campus with a similar energy efficiency concept will be built in Deutschoderstraße in the 14th district by 2022.

3.5 Optimising energy consumption of schools

Energy supply is a significant contributor to the construction costs of a building. However, the follow-up costs of the building resulting from the choice of energy system have a much larger impact on its lifecycle costs and, therefore, its economic viability.

Three existing education buildings are currently being analysed with regard to their energy aspects. The objective of this evaluation is to optimise the requirements for future projects with the help of experiences from previously implemented projects. This project analyses three buildings of different sizes, with different energy infrastructure and different owners, and examines how the objectives defined during the planning phase were implemented, their operation, whether they meet the cost and (energy) saving targets, and finally, whether the desired comfort level can be reached with the solutions applied.

The parameters include the type of energy input and output, how the desired indoor air quality is achieved (e.g. window ventilation or mechanical ventilation) and how satisfied the teachers and children are with the systems used.

3.6 Planning efficient buildings with innovative energy solutions

The study *Neue Planungsansätze für höchsteffiziente Gebäude mit innovativen Energielösungen* ("New planning approaches for high-efficiency buildings with innovative energy solutions") presents new approaches to planning high-efficiency energy supply solutions for heating and cooling and especially showing the storage capacity of heavyweight construction. An increasing number of projects demonstrates that fully renewable energy supply is possible even in densely built-up areas. In addition to fulfilling high expectations with regard to comfort all year round, this can also contribute to significantly reducing the life cycle costs of the building.

In order to achieve optimum efficiency, sustainable energy supply and economic viability, special aspects must be considered in planning, building and operating them.

The study looks at the key criteria in all development phases of highly efficient buildings. The findings are based on implemented projects whose efficiency has been confirmed through multiple years of monitoring. The theoretical discussion is supplemented by a chapter about innovative showcase projects for a wide range of uses.[5]

3.7 Award-winning initiative for preventing energy poverty

The initiative *Energieberatung für armutsgefährdete Haushalte* ("Energy consulting for households at risk of poverty") helps lower energy costs sustainably and for the long term and prevent energy poverty. In mid-2018, the initiative received the Environmental Award of the Austrian Society for Environment and Technology (ÖGUT).

Households at risk of poverty are especially affected by cold winter temperatures. Run-down flats and outdated appliances increase energy costs dramatically. For people who already have a low income, this is an additional burden. The initiative provides free energy consulting at home and support in developing and implementing concrete energy saving measures. If needed, the City of Vienna also supports necessary energy investments financially.

The initiative was created in 2014 by Municipal Departments MA 20 – Energy Planning and MA 40 – Social Welfare, Social and Public Health Law. The on-site consultations are financed by MA 20 and carried out by energy consultancy *DIE UMWELTBERATUNG*. MA 40 is in charge of implementing and funding tailored energy saving measures. So far, over 600 households have received energy consulting including energy-saving suggestions.

3.8 Reducing energy consumption of City Administration buildings

Wrong radiator settings increase energy consumption unnecessarily. Often the energy-efficient operation of heating systems can be achieved with minor changes and at low cost.

The City Administration's internal initiative *Fernwärme auffällige Gebäude* systematically inspects buildings that use district heating. If buildings owned by the City show conspicuous differences between flow and return temperature in the annual average, an optimisation process is started.

Even small measures that incur no additional cost have generated high energy savings and, as a result, financial savings since 2014. Often only minor changes are needed, such as optimising regulation or switching out faulty temperature sensors.

5 https://www.wien.gv.at/kontakte/ma20/pdf/hocheffiziente-gebaeude.pdf

As the project has been increasingly successful over several years, the number of conspicuous buildings has already been reduced by approx. two thirds. For example, all buildings of the Vienna Hospital Association, most City Administration office buildings and the majority of schools and kindergartens have already been removed from the list and are operating efficiently.

3.9 Raising awareness for energy issues and climate protection among young people

Over 2,300 young people have already acquired the energy literacy certificate *energie-führerschein*. In the Vienna City Administration alone nearly 400 apprentices have passed the certification exam. The course teaches young people the efficient use of energy.

The course is kept interesting by combining theoretical input with numerous hands-on exercises. It covers energy efficiency and renewables and explains how energy use and climate change are connected. And it is fun, as the exclusively positive feedback from participants shows.[6]

3.10 Promoting innovation with the Green Energy Fund

3.10.1 Photovoltaics subsidy

Currently, some 2,170 PV installations feed solar power into the grid (data for spring 2019). Their total capacity 33,800 kWp (Kilowatt peak), and they generate a total of approx. 34 GWh of solar power annually.

The subsidy for PV systems was introduced in 2004 and is provided as an investment subsidy. Installations up to 100 kWp are subsidised with €250/kWp. Any additional capacity (from 101 kWp) up to a maximum of 500 kWp is subsidised with 200€/kWp or 30% of costs eligible for subsidy. The maximum subsidy is €105,000 per installation.

The photovoltaics subsidy is attractive and popular. The number of applications has increased from 56 in 2010 to 127 in 2018.

3.10.2 Subsidy for stationary electricity storage systems

A subsidy is available for stationary electricity storage systems using lithium technology when building them in combination with a PV installation or adding them to an existing one. Storage systems for single-family homes with a rated capacity of up to 5 kWh and storage for multi-family homes and business and industrial buildings up to a rated capacity of 10 kWh are eligible for the subsidy. This subsidy was introduced in mid-2015, and by spring 2019, 256 storage systems with a total capacity of 1,920 kWh had been subsidised.

3.10.3 Subsidies for energy efficiency programmes

A few years ago, a subsidy scheme for energy efficiency programmes was added to the Green Energy Fund. To be considered an energy efficiency programme, measures must have a wide reach in Vienna and be relevant to the implementation of the City's strategies. These measures can receive up to 30% or a maximum of €60,000 per year for a maximum of 5 years. This subsidy scheme is starting to become established. By spring 2019, three energy efficiency programmes had received a subsidy and two are currently in the pipeline.[7]

6 https://energie-fuehrerschein.at/

7 Overview of all energy-related subsidies of the City of Vienna: https://www.wien.gv.at/stadtentwicklung/energie/foerderungen/index.html

3.11 Participation in national and international projects

3.11.1 Vienna joins Energy Cities

Energy Cities was established in 1990 as a non-profit association of European local authorities. Since then, Energy Cities has been committed to championing sustainable energy policy and the exchange of know-how and experiences among its members. Today, the network represents 1000 member towns and cities in 30 countries. It is currently under the Presidency of the City of Heidelberg (Germany), and its board of directors consists of mayors and deputy mayors of 11 European cities, including Paris, Riga and Växjö. Energy Cities is also part of the consortium that manages the Covenant of Mayors Office, together with IC-LEI and the Climate Alliance. The City of Vienna is a long-standing member of the Covenant of Mayors, and joined Energy Cities in early 2019.

Membership in Energy Cities has many advantages for Vienna.

— Energy Cities has a strong voice in the European institutions and bodies in Brussels and is an active and progressive lobbyist for local energy transition. This is a direct avenue for the concerns and challenges of cities, among them the City of Vienna, to be heard in Brussels.

— Energy Cities is the EU-wide city network on energy issues, making it an effective multiplier for showcase examples from Vienna (e.g. in the "Best Practices" section on their website and in various publications by Energy Cities or by the Covenant of Mayors Office). Energy Cities is currently also expanding its cooperation with cities outside the EU (e.g. US, Morocco, South Africa), which opens up more opportunities.

— The Energy Cities membership provides direct visibility in Brussels, e.g. by participating in meetings with key EU representatives. Energy Cities regularly organises meetings of mayors with Energy Commissioners where the latter can hear the views of local representatives directly.

— The membership in Energy Cities facilitates access to interesting projects. Active cities are often invited to participate in EU projects, which can minimise the effort of project acquisition.

— Energy Cities provides support in making new contacts and networking with active cities. Particularly interesting contacts for the City of Vienna are the Energy Cities member cities, such as Barcelona, Helsinki, Frankfurt, Munich, Stuttgart, Paris, Dublin, Utrecht etc.

— As the first Austrian member of Energy Cities, the City of Vienna has high visibility, making it possible to introduce energy topics of particular interest for Vienna. Increased participation in energy matters is also an option, as Energy Cities is looking for the participation of active cities and new board members.

3.11.2 EU-GUGLE

EU-GUGLE is short for "European cities serving as Green Urban Gate towards Leadership in sustainable Energy" and is an EU project running from April 2013 to March 2019 with six partner cities in six countries: Aachen (Germany), Bratislava (Slovakia), Milan (Italy), Sestao (Spain), Tampere (Finland) and Vienna (Austria).

In Vienna, the project focuses on the 14th district, called Penzing, with ambitious measures for improving both living quality and energy efficiency. In the course of the project, approx.

67,000 m² gross floor area were refurbished. The cities are refurbishing a total of approx. 200,000 m² of living area in the course of the project. Penzing was chosen because it is Vienna's fourth-largest district and its historical status as an area with a large population of blue-collar workers influences its socio-spatial structure to this day.[8]

3.11.3 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 for cities and municipalities. This is the background of the national research project "Enerspired Cities", where Vienna is working with the cities Salzburg and Innsbruck as well as research partners on creating a common data basis. The aim is to make energy-related basic data from various sources available to a wide user base. A focus is on legal frameworks (privacy, access rights) and harmonised data preparation, especially coordinated metadata. The aim is to contribute to the decarbonisation of cities' energy systems by providing a reliable data set.[9]

3.11.4 Digital heat map

Nearly 40 percent of Vienna's final energy consumption is for heating and hot water, making this sector the city's largest energy consumer and responsible for a considerable share of greenhouse gas emissions.

The national project "Spatial Energy Planning" (SEP), which emerged from the comprehensive innovation project GREEN ENERGY LAB (GEL) addresses spatial energy planning and its potential for transforming the heating sector in Austria sustainably. In this project, three federal provinces (Vienna, Styria and Salzburg), their capitals and several trailblazing municipalities are working with leading Austrian research institutions on providing user-friendly resources for the introduction of differentiated spatial heating planning – leading the way for Austrian and other European cities.

The core of the project is the development of a digital heat map in all three participating provinces, which shows and explains the complex urban energy interactions, such as potential for renewables, existing infrastructure, and heating and cooling demand, in high resolution.

The objective is to provide decision-making help for municipal and regional authorities by developing suitable resources with the aim of promoting carbon-neutral heat supply on the one hand, and raising awareness for renewable energy issues by tailoring the information for concrete target groups (districts, citizens, owners, developers) on the other.

3.11.5 RenoBooster - the smart renovation hub

The project RenoBooster aims to promote effective refurbishment especially in private residential housing in Vienna (both in multi-storey residential buildings and in detached and semi-detached buildings) by bundling different consulting and subsidy services into a one-stop shop. Important players from the real estate and construction sectors as well as administration and financing are involved.

The project aims to provide individualised solutions tailored to the situation of the owners in order to improve building efficiency in the old housing stock of the city.

The new services – such as ongoing refurbishment assistance, one-stop-shop packages for refurbishing single-family homes, or special quality assurance services – are already being

8 Further information available at: http://eu-gugle.eu/de/

9 Further information available at: https://www.enerspired.city/

provided to the first refurbishment projects in the course of the project. The project also studies legal frameworks and funding tools and optimises them for future challenges. All important services and information will be presented on a web portal.

In addition to the Vienna City Administration as project lead, the consortium consists of housing and urban renewal fund wohnfonds_wien, competence centre Urban Innovation Vienna, the Austrian Association of Real Estate Management, environmental consultancy DIE UMWELTBERATUNG, energy consultancy e7 Energie Markt Analyse, sustainable development consulting and research firm 17&4 Organisationsberatung, and social research institute SORA. The project RenoBooster was launched in 2019 and has a duration of 3.5 years.

3.11.6 EU project SMARTER TOGETHER

The EU project SMARTER TOGETHER (2016-2021) focuses on renewing existing neighbourhoods. Together with Lyon and Munich as well as research partners, Vienna is developing new strategies and solutions for energy supply, mobility, refurbishment and integration of the local stakeholders. In Vienna, Smarter Together is being implemented under the management of Municipal Department 25 in the central Simmering area, i.e. the part of the 11th district around Enkplatz and Geiselberg. 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.

Additionally, the open source-based data platform (based on FIWARE) provides information on the individual projects, such as e-car sharing. The City of Vienna will use the data platform as an IoT (Internet of Things) platform to integrate real-time data from sensors and make administrative procedures easier in the long run.

The implementation of all activities of the EU project will be completed by the end of 2019. At the same time, a comprehensive monitoring system is being installed to evaluate the effectiveness of the measures until 2021. This includes information such as how much energy is generated from renewable sources or how much energy is saved through refurbishment.[10]

10 Further information available at: www.smartertogether.at

A wider view of energy and climate protection developments

4. A wider view of energy and climate protection developments

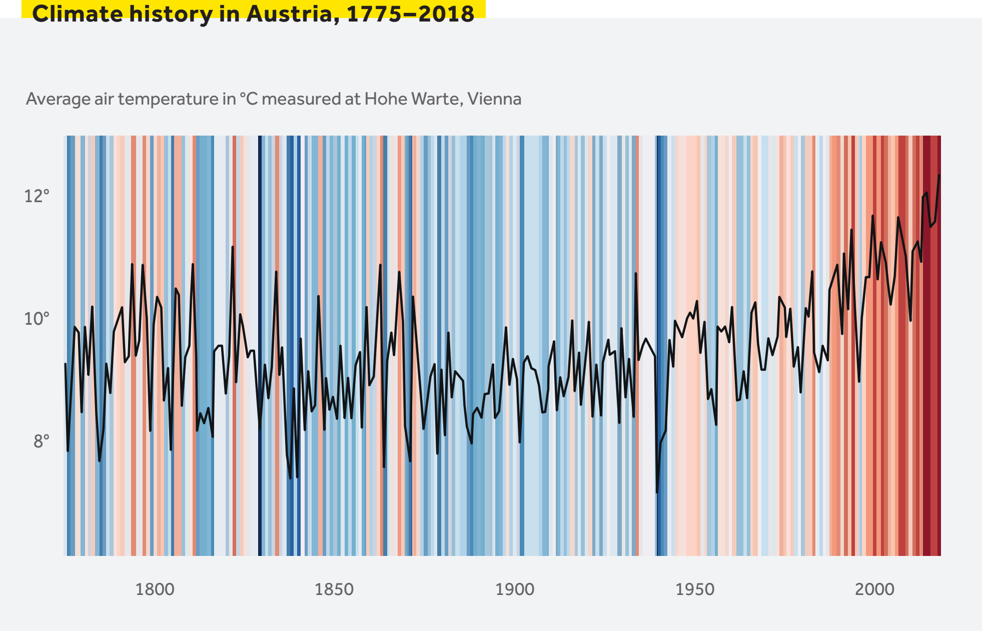
Worldwide trends, international energy and climate protection efforts, and decisions at the European level all have an impact on Vienna, as do decisions at the national level in Austria. At the same time, the City of Vienna is setting the course towards decarbonisation and actively shaping our energy future.

4.1 Global developments

4.1.1 The global heatwave continues

2018 was the fourth-hottest year on record globally in the 139-year history of record keeping by the NOAA's National Center for Environmental Information after 2016 (hottest), 2015 (second-hottest) and 2017 (third-hottest), ahead of 2014 in 5th place. This makes the last five years the five hottest years ever. In Vienna and Austria overall, 2018 was the hottest year on record, ahead of 2015 and 2014.

Climate history in Austria, 1775–2018



Source: ZAMG Hohe Warte

4.1.2 Prices increase for emissions trading certificates, sink for fossil energy

The upward trend for European CO_2 emissions trading certificates of the last years continued in 2019. At €25 per tonne of CO_2 emissions, the price was higher than ever and approx. 50%

higher than the previous year – but still below the price level that is needed to fully utilise the potential of emissions trading.

Meanwhile, the prices of fossil energy vectors (oil, natural gas, coal) and electrical energy (electricity wholesale price – EPEX Spot) sank slightly in 2018 following a rapid increase since 2014, and are now approx. 10 percent below last year's level.

4.1.3 UN climate conference COP 24
In December 2018, the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change was held in Katowice.

In the run-up to the conference, several hundred scientists of the Intergovernmental Panel on Climate Change analysed existing publications and published the widely covered *IPCC Special Report on Global Warming of 1.5°C*. The key messages of the report, which was adopted by over 100 countries, are:

- It is still possible to achieve the goal of the Paris Agreement to limit global warming to 1.5°C above pre-industrial levels. However, this would require rapid, far-reaching and unprecedented measures.
- Greenhouse gas emissions must be reduced by at least 45% by 2030 from 2010 levels and must reach net zero by 2050.
- The difference between +2°C and +1.5°C warming is significant, such as a +10 cm sea level rise and the loss of thousands of species.[11]

At the conference, the participating countries agreed on rules to implement the 2015 Paris Agreement, including the following decisions:

- A UN committee will be set up to document the progress made by individual countries in reducing their emissions in relation to their emission targets as well as the consequences of global warming.
- All countries should use uniform emissions reporting standards.
- All countries are to report every two years on measures taken to reduce emissions; industrialised countries should also report on financial aid for adaptation and climate protection. These reports will be regularly reviewed for their effectiveness in curbing global warming.

However, no agreement was reached on shipping and air traffic. So far, there are no binding global agreements for reducing worldwide emissions in these sectors, although these sectors, according to the International Energy Agency, accounted for around 5.4 percent of global emissions or more than 22 percent of transport-related emissions in 2016, with the trend rising sharply.

4.1.4 Fridays for future
Greta Thunberg, a student and climate activist, has been on school strike every Friday since August 2018 outside the Swedish Parliament, protesting for the implementation of the Paris Climate Protection Agreement and more climate protection. Thanks to her appearance at the UN Climate Change Conference COP 24, people around the world have joined the movement and now come together every Friday in cities around the world. The movement's goals include stopping the extraction of fossil fuels and abolishing subsidies for them, promoting renewable energies, and implementing an energy transition in the transportation sector. The many regional offshoots organise demonstrations on Fridays and other information events.[12]

11 All details are available at https://www.ipcc.ch/sr15/

12 Further information available at: https://fridaysforfuture.at/

4.2 Developments at the EU level

4.2.1 Long-term strategy EU decarb 2050
In November 2018, the European Commission published its vision for a prosperous, modern, competitive and climate-neutral economy by 2050, titled "A Clean Planet for all".

Based on existing technologies, the vision shows which steps are necessary to meet the goals and make the EU a model and trailblazer of climate protection. It includes all sectors of the economy and involves all EU bodies, Member States, companies and citizens. The core principles are:

- **Decarbonisation of the energy system** through comprehensive electrification and an increased use of renewables reduces dependence on third countries.
- **Clean, safe and connected mobility** decarbonises the transportation sector by expanding electromobility and promoting alternative fuels.
- **Maximum energy efficiency** will halve energy consumption by 2050 from 2005 levels.
- **A modern industry at the centre of the circular economy** will give us an edge in innovation in the field of new technologies, particularly those relevant to the circular economy.
- **Development of smart networks and interconnections** to ensure optimal sectoral integration and strengthen regional cooperation as cornerstones of the energy transmission and distribution of tomorrow.
- **Reaping the full benefits of bio-economy and creating essential carbon sinks** through more sustainable land use and agriculture.
- **Tackling remaining CO_2 emissions with carbon capture and storage** and compensating for remaining greenhouse gas emissions to create negative emissions.[13]

4.2.2 Regulating the fuel consumption of newly registered motor vehicles in the EU
During the reporting period, the EU agreed on binding targets for reducing CO_2 emissions from newly registered vehicles. As a first step, binding targets for passenger cars and light commercial vehicles were agreed in December 2018, with the agreement for heavy commercial vehicles following in February 2019:

- The average consumption of newly registered passenger cars will be reduced by 15 percent by 2025 and by 37.5 percent by 2030 compared to 2021 levels (reduction targets until 2021 already exist). The share of passenger cars with emissions below 50g / km (electric drive, efficient hybrid drive or similar) must exceed 15 percent by 2025 and 35 percent by 2030.
- The average consumption of newly registered light commercial vehicles for each manufacturer fleet must be reduced by 15 percent by 2025 and 31 percent by 2030 compared to 2020. The share of light commercial vehicles with emissions below 50g / km must exceed 15 percent by 2025 and 30 percent by 2030.
- The average consumption of newly registered heavy commercial vehicles (including buses) must be reduced by 15 percent by 2025 and by 30 percent by 2030 compared to 2019 and 2020.[14]

13 Further information and documents available at: https://ec.europa.eu/clima/policies/strategies_de

14 Details are available on the websites of the European Commission and the International Council on Clean Transportation: https://ec.europa.eu/clima/policies/transport/vehicles_de and https://www.theicct.org/

4.3 Developments at the national level

4.3.1 Increasing greenhouse gas emissions
Austria's greenhouse gas emissions have been growing for the third year running (2015, 2016 and 2017), failing to continue the downward trend of the years before 2015. The current predictions for 2018 to 2020 also expect an increase or, at best, a stagnation of emissions, meaning Austria will miss the Kyoto goals. The Austrian Environment Agency expects both emissions in 2020 and cumulative maximum emissions over the entire term to exceed targets, which could result in fines running into billions.

In the reporting period, measures were taken at the federal level to reduce greenhouse gas emissions, but there were also measures that increase emissions significantly.

Emissions could be reduced with the following:

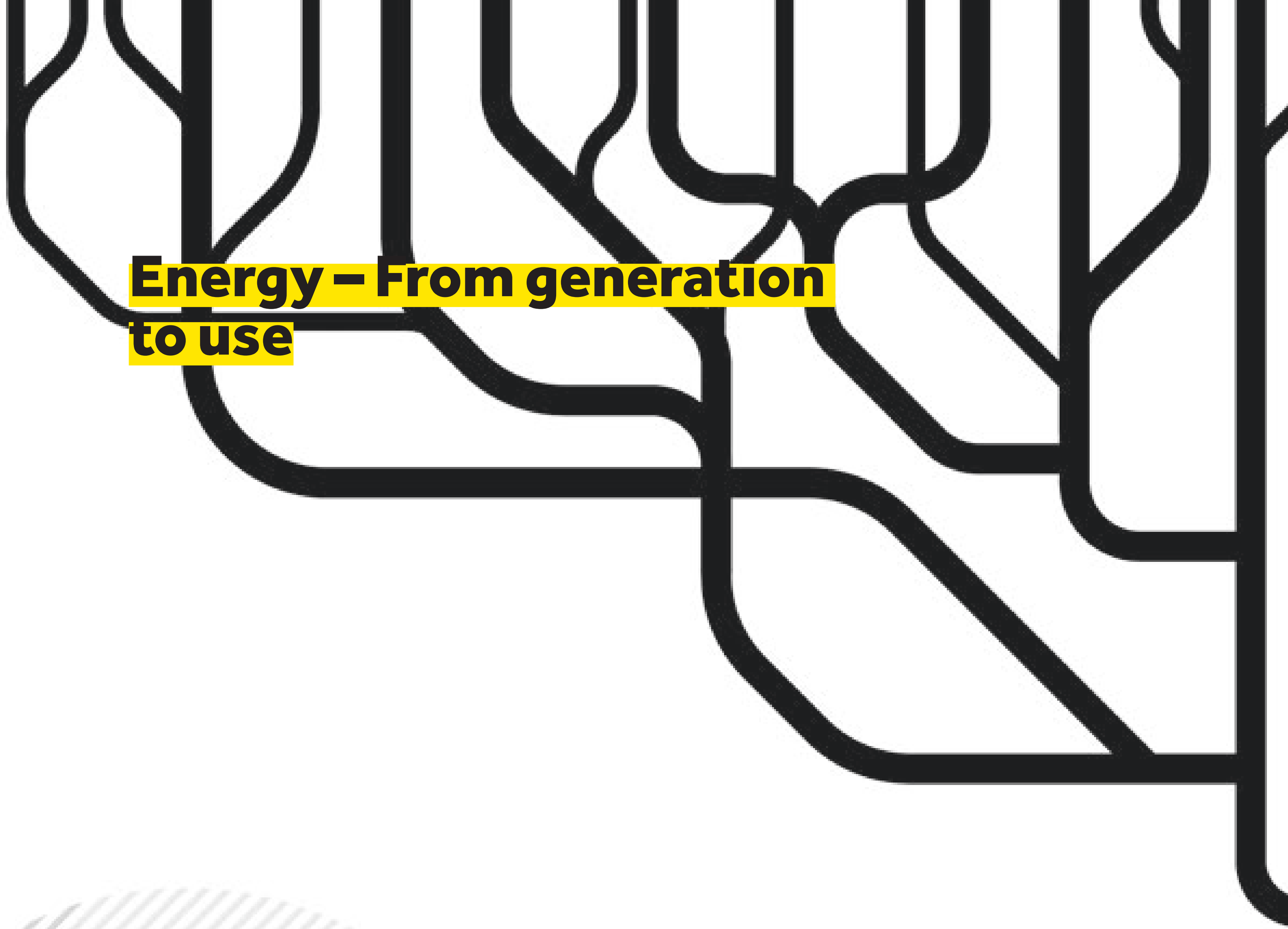
— **The draft Austrian Energy and Climate Plan** was submitted to the European Commission in December 2018. With this plan, Austria shows how it aims to meet the EU emissions target of 36 percent by 2030 from 2005 levels. Scientists (among them renowned professors Helga Kromp-Kolb of the Center for Global Change and Sustainability at the University of Natural Resources and Life Sciences Vienna and Gottfried Kirchengast of the Wegener Center for Climate and Global Change in Graz) have found the draft severely lacking; the European Commission will assess it this year. Austria must then revise the draft and submit the final strategy to the Commission by the end of 2019.

— **A heating strategy for Austria** is being developed as a sub-strategy to accompany the Austrian Energy and Climate Plan. It will include measures for making the Austrian heating market greener. It was supposed to be completed in the first half of 2019, but completion will be delayed at least until the end of the year.

4.3.2 Rising energy consumption despite efficiency goals
With the Energy Efficiency Act, Austria aimed to reduce final energy consumption by approx. 5 percent from 2010 levels by 2020, to 1050 PJ. The current development of energy consumption is going in the opposite direction: final energy consumption has been increasing since 2015 and was approx. 3 percent above 2010 levels in 2017 at 1130 PJ. The higher energy consumption has been met almost exclusively with fossil energy. At the federal level, the following measures regarding energy efficiency are currently relevant:

— OIB Guideline 6 on energy saving and heat insulation of the Austrian Institute of Construction Engineering (OIB) has been revised. The aim is to ensure the energy-efficient operation of buildings by increasing requirements for energy efficiency in new buildings and refurbishment projects.

— The validity period of the Energy Efficiency Act in its current form is ending in 2020. A successor, which would regulate the implementation of the European energy efficiency targets until 2030 in Austria, is yet to be passed.



Energy – From generation to use

5. Energy – From generation to use

5.1 Vienna's energy consumption illustrated

Absolute energy consumption in relation to value added or per capita is an important indicator that can tell us how efficiently a city or country uses energy and makes it possible to compare cities or countries.

Vienna still has the lowest energy consumption per capita of all Austrian provinces at 20,343 kilowatt hours, compared to the Austrian average of 35,768 kilowatt hours. Life in a compact city requires less energy than non-urban areas.

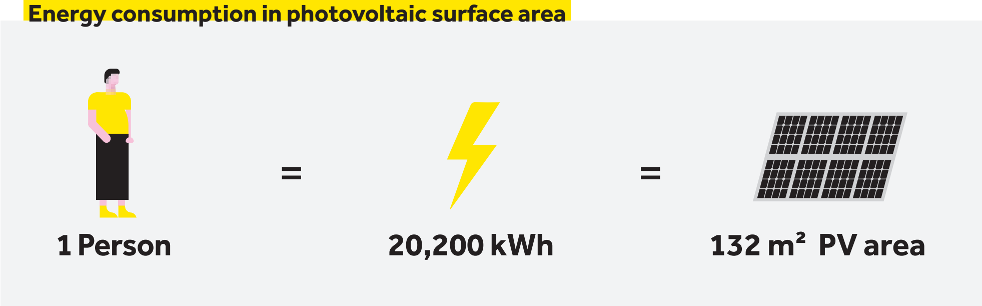
For other comparisons of Austria's federal provinces, see Chapter 6 Indicators.

Further information is also available online:

- Details on electrical energy consumption, final energy consumption and mobility: *https://www.wien.gv.at/statistik/energie/energieverbrauch.html*
- Additional infographics with energy and climate-related comparisons of Austrian provinces are available on the website of Urban Innovation Vienna: *https://www.urbaninnovation.at/de/Projects/Infografiken-Energie*

Energy consumption in photovoltaic surface area
A good way of illustrating how much energy is being used is converting the kWh or MWh in photovoltaic surface area. This PV area indicates how much space would be needed to generate the required amount of energy with photovoltaics. 1,500 kWh or a PV area of 10 m² would be needed to meet the electricity demand of an average Viennese resident.

Energy consumption in photovoltaic surface area

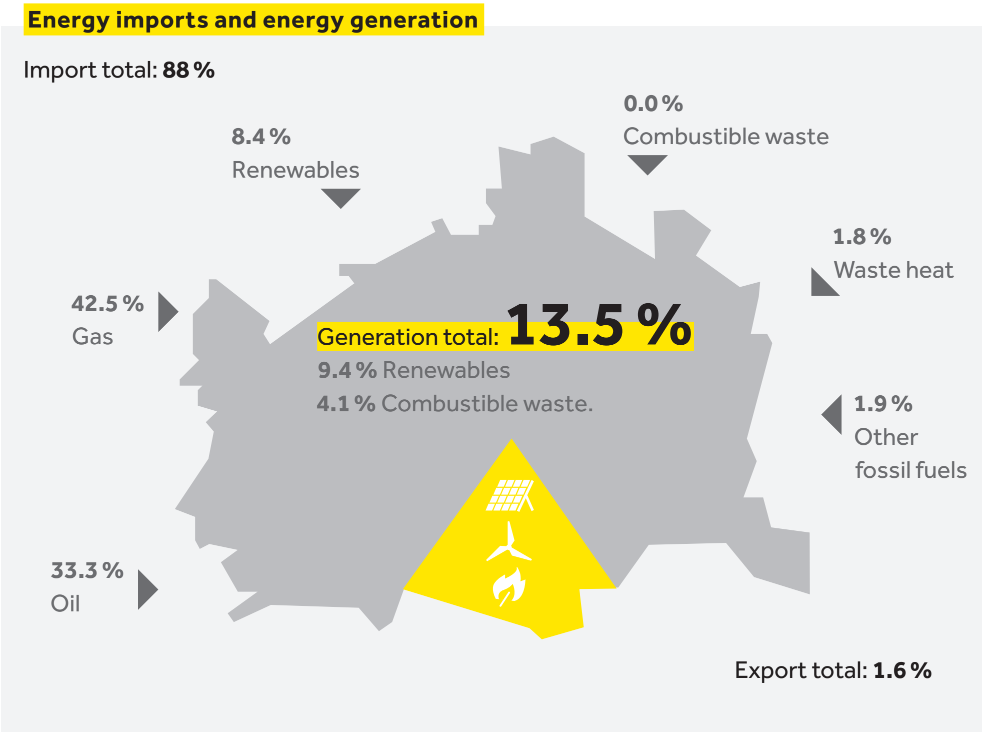


To meet their entire energy consumption (including heating, mobility, etc.) of 20,200 kWh, you would need a PV area of 132 m². The average Austrian would need an additional 100 m² of PV area to meet their higher energy demand. In Upper Austria, the average resident needed 297 m² PV area in 2017 to satisfy their energy demand.

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 m² PJ
1 GWh = 6,500 m² PV	1 PJ = 1.8 km² PV

5.2 Energy flow chart of Vienna

How much energy is needed to run a whole city?
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 energy consumption of Vienna in 2017 was 43,280 GWh. Approximately 14 percent of the energy needed is generated in Vienna itself, mostly from renewable sources. 88 percent of energy come from the surrounding area, with the fossil energy sources gas and oil making up the bulk of imports. Approximately 1.5 percent of energy is exported again; the rest makes up the gross inland energy consumption of Vienna.



The energy flow chart shows a clear dominance of fossil energy sources (43% natural gas and 30% fuels). Natural gas is mostly converted into electricity and district heating. Fuels, on the other hand, are used nearly exclusively by the largest consumption sector, transportation. Nearly half of energy is lost in conversion, distribution, and mainly in end-user consumption.

In addition to the energy flow chart shown here, Energy Planning Vienna publishes an animated, interactive version of the chart that allows for a detailed analysis of energy flows. It also includes specific analyses of energy flows of renewables and waste heat. All data are available from 2005 on as a desktop version and optimised for mobile devices.[15]

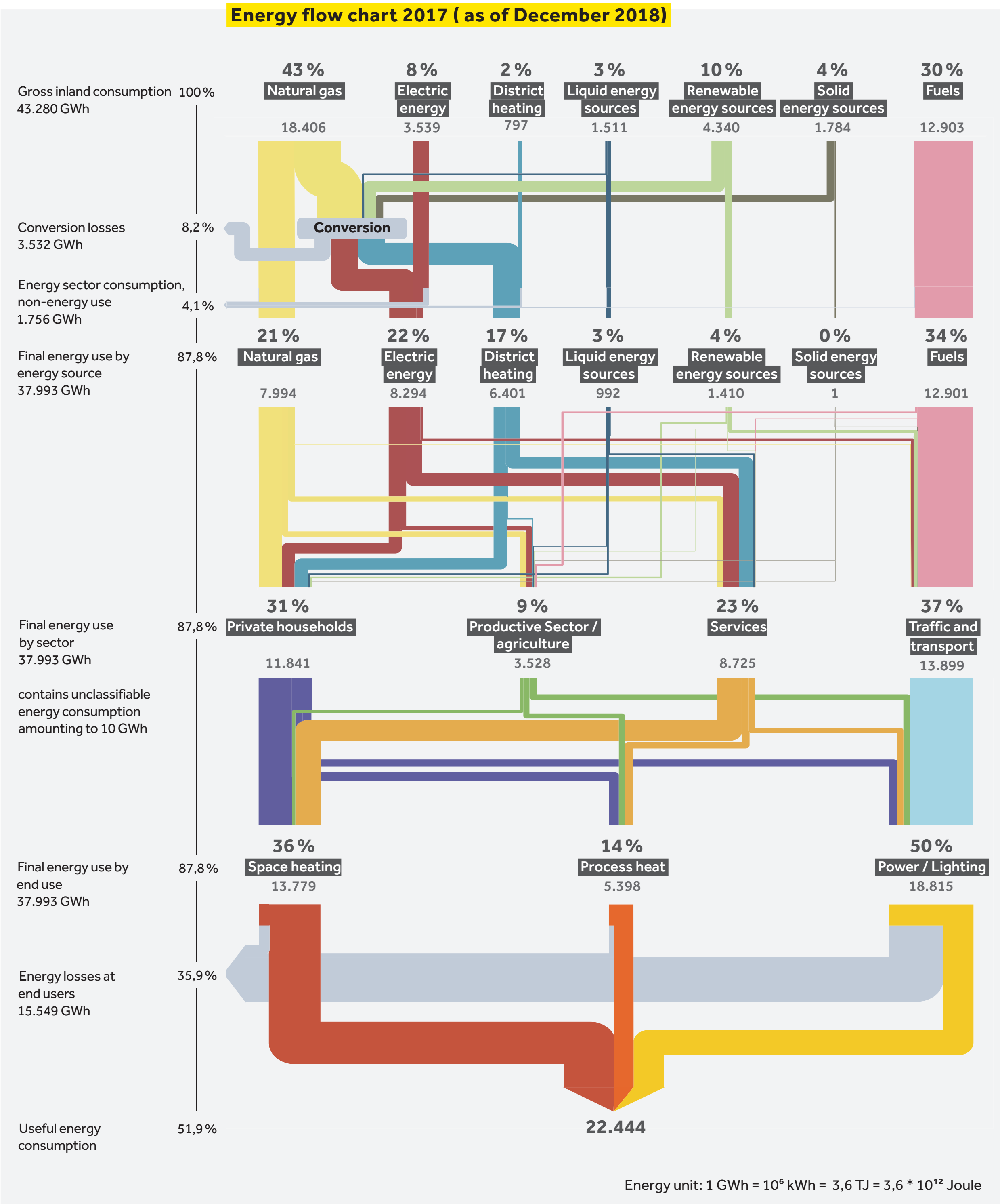


Fig.. 5.1 Energy flow chart of the City of Vienna, Source: City of Vienna

15 www.wien.gv.at/statistik/energie/energieverbrauch.html

The energy flow chart in PV surface area

To better illustrate the energy flows, the energy volumes (in Gigawatt hours) can be converted into photovoltaic area.

The gross domestic energy consumption of Vienna (43,280 GWh) is equal to a PV surface area of 281 km², or two thirds of Vienna's surface area.

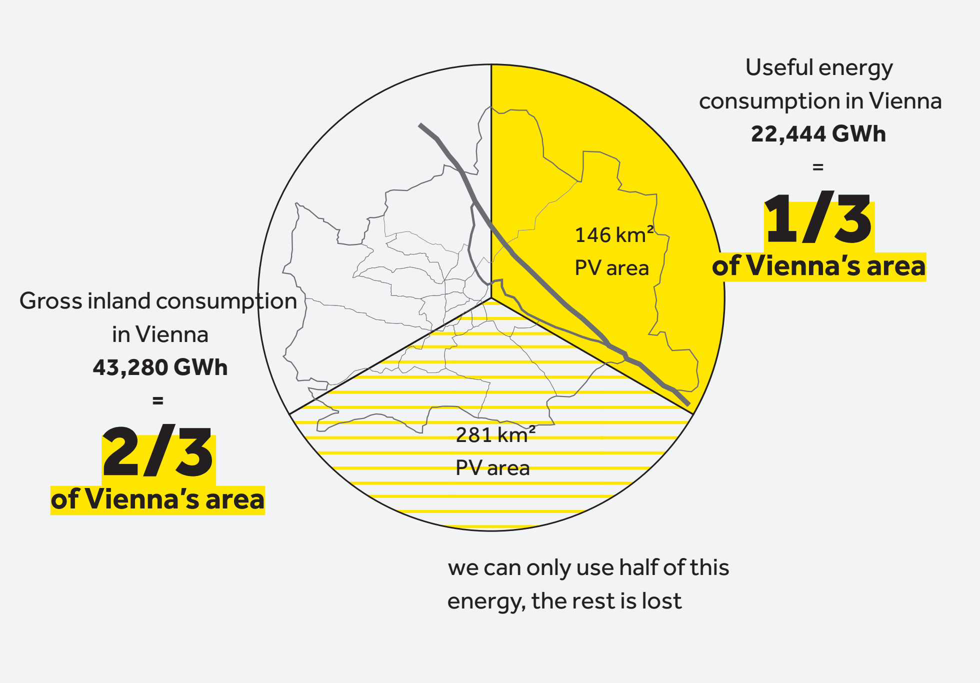
Out of this energy, approximately half is needed to compensate for losses:

— 34 km² PV area losses in conversion and distribution to end users
— 101 km² PV area for end-user losses.

Useful energy consumption in Vienna = 22,444 GWh
One third of Vienna's area = 146 km² PV area

This corresponds to 37 times the size of the Danube Island, 24 times the size of the Prater, 15 times the Vienna International Airport, or the 21st and 22nd district taken together.

The energy flow chart in PV surface area



Indicators

6. Indicators

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 2017 for Vienna and provide comparisons with Austria overall and the other federal provinces. Data for regional value added are available from 2000.

Special attention is given to the monitoring process of the Smart City Wien Framework Strategy, which defines energy-relevant targets for different areas, such as efficient energy use, renewable energy sources, mobility, and buildings. The indicators for monitoring these targets and evaluating the development are shown in section 3.1. The illustrations refer to the Smart City Wien Framework Strategy passed in 2014. The update of this strategy was in progress until June 2019 (cf. section 2.5). As a result, new indicators will be used starting with next year's energy report.

The Viennese have reduced their per capita energy consumption considerably since 2005 and using more renewable energy and waste heat. This is also reflected in a reduction in greenhouse gas emissions. Mobility habits have also improved over the last years: the number of cars per inhabitant has been dropping since 2010 and the number of annual passes for Vienna Public Transport sold is on a strong upward trend. However, these changes are not yet reflected in the modal split.

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.

6.1 Monitoring indicators for the Smart City Wien Framework Strategy (SCWR)

Due to an update of the strategy paper, new indicators will be used for monitoring the Smart City Wien Framework Strategy in future. This report uses the indicators used until June 2019.

6.1.1 Emissions per capita

2014 Smart City Wien Framework Strategy objective:
Reducing per capita greenhouse gas emissions in Vienna by 80% by 2050 (from 1990 levels).[16]
Intermediate target: Reducing per capita carbon dioxide emissions in Vienna by at least 35% by 2030 (from 1990 levels).

16 This objective as well as all following energy and climate objectives can only be achieved if Vienna's efforts are supported by suitable framework conditions by the federal government and the European Union, including the recognition of early actions.

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 %

Table 6.1: Per capita greenhouse gas emissions in Vienna,
Sources: BLI 2015 and emikat.at 2015

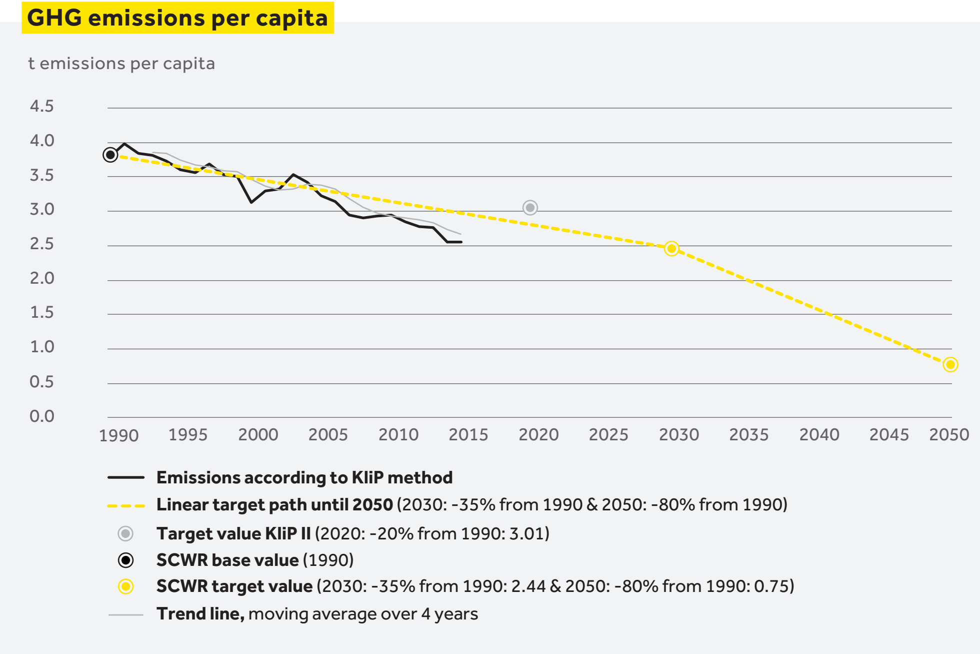


Fig. 6.1: Per capita greenhouse gas emissions in Vienna, 1990 - 2015, SCWR target
Sources: BLI 2015, emikat.at 2015 and SCWR

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.

6.1.2 Final energy consumption per capita

2014 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.

[kWh per capita]	1990	1995	2000	**2005**	2010	2015	2016	2017	Change [%] base year 2005
Final energy consumption	18,743	21,002	21,663	**24,165**	23,448	20,768	20,326	20,343	-15.8 %
Trend line, moving average over 4 years		20,577	22,122	**24,138**	22,802	21,238	20,928	20,551	-14.9%
Linear target path until 2050 (-40% from 2005)				**24,165**	23,091	22,017	21,802	21,587	-10.7 %

Table 6.2: Final energy consumption per capita in Vienna
Sources: Energiebilanz 2017, Bevölkerung and SCWR

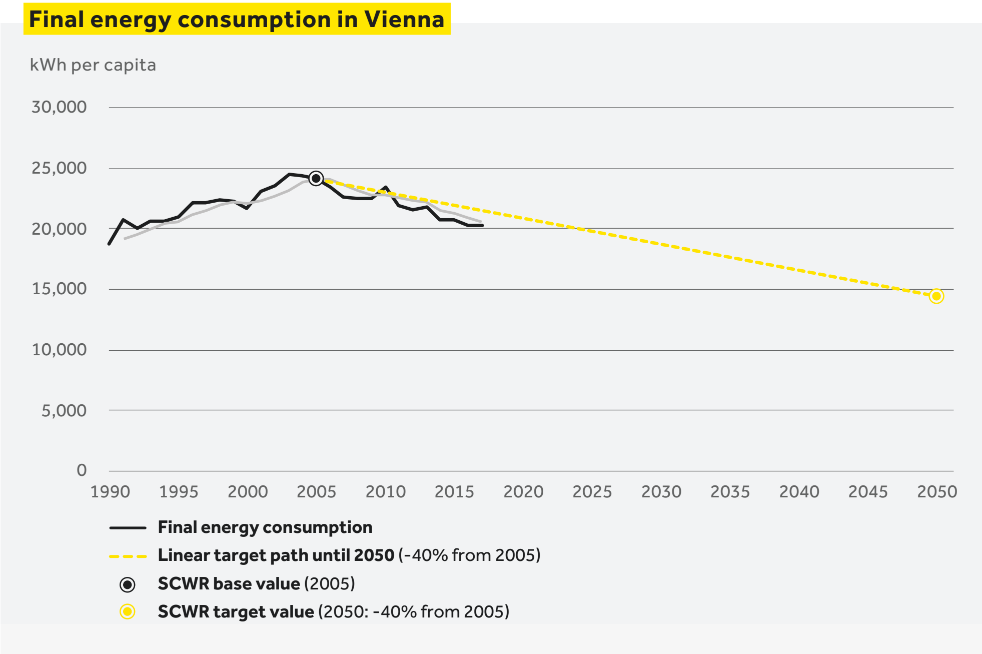


Fig. 6.2: Final energy consumption per capita in Vienna, 1990 – 2017, SCWR target
Source: Energiebilanz 2017 and Bevölkerung and SCWR

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

6.1.3 Primary energy consumption per capita

2014 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.

[Watt per capita]	1995	2000	**2005**	2010	2015	2016	2017	Change [%] base year 2000
Primary energy consumption	2,967	3,090	**3,456**	3,297	2,963	2,916	2,891	-16.3 %
Trend line, moving average over 4 years		3,121	**3,430**	3,250	3,025	2,981	2,933	-14.5 %
Linear target path until 2050 (2050: 2,000 W)			**3,456**	3,294	3,132	3,100	3,067	-11.3 %

Table 6.3: Primary energy consumption in Vienna
Sources: Energiebilanz 2017, Bevölkerung, SCWR, TU Wien

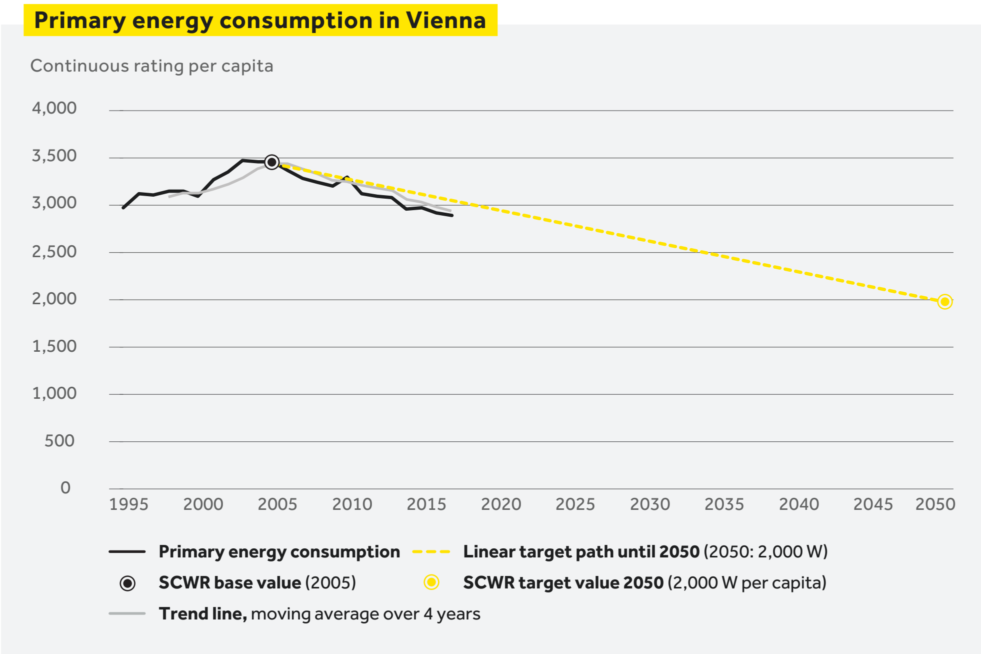


Fig. 6.3: Primärenergieverbrauch Wien, 1995 – 2017, Zielwert SCWR
Source: Energiebilanz 2017, Bevölkerung, SCWR, TU Wien

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.

6.1.4 Share of renewable energy in gross final energy consumption

2014 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.[17]

[GWh]	2005	2010	2015	2016	2017	Change [%] base year 2005
Renewable energy in Vienna	2,274	4,090	4,592	3,807	3,694	+62.4 %
Net imports of renewable electrical energy to Vienna	1,324	980	3,281	3,100	2,697	+103.7 %
Gross final energy consumption in Vienna	41,198	41,489	39,056	39,128	39,678	-3.7 %
Share of renewable energy in Vienna	5.5 %	9.9 %	11.8 %	9.7 %	9.3 %	+68.6 %
Net imports of renewable electrical energy to Vienna	3.2 %	2.4 %	8.4 %	7.9 %	6.8 %	+111.5 %
Total share of renewables in Vienna	8.7 %	12.2 %	20.2 %	17.7 %	16.1 %	+84.4 %
Linear target path until 2050 (2020: 20%, 2050: 50%)		12.2 %	14.2 %	14.6 %	14.9 %	

Table 6.4: Share of renewable energy in gross final energy consumption in Vienna,
Sources: Energiebilanz 2017, Strommarktbericht e-control and SCWR

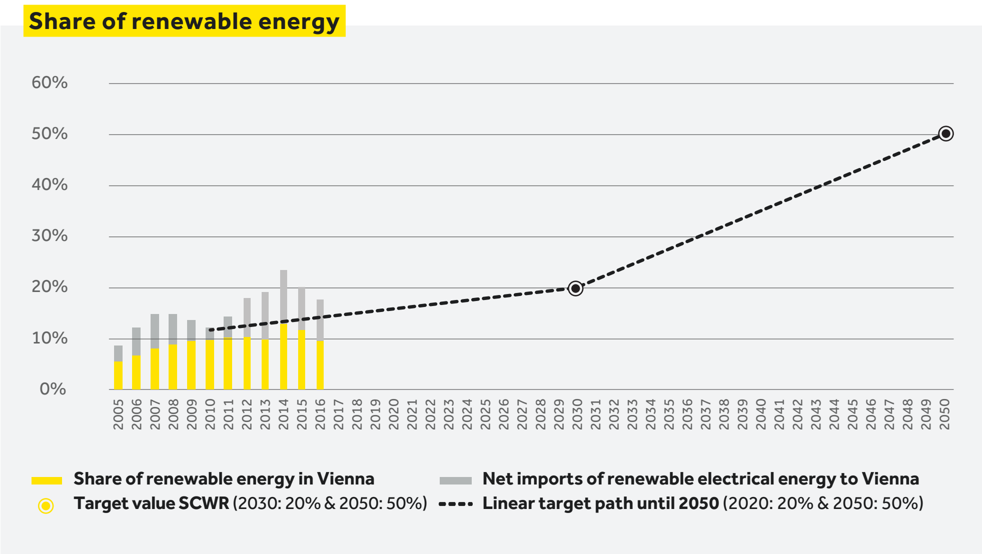


Fig. 6.4: Share of renewable energy in gross final energy consumption in Vienna, 2015–2017, SCWR target
Sources: Energiebilanz 2017, Strommarktbericht e-control and SCWR

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.

17 These do not necessarily have to be located within the city limits.

6.1.5 Choice of transportation in Vienna

2014 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.

[%]	1993	1999	2003	2009	2010	2012	2015	2016	2017	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 %	38 %	+5.6 %
Car	40 %	36 %	35 %	32 %	31 %	27 %	27 %	27 %	27 %	-12.9 %
Walking	28 %	27 %	27 %	27 %	28 %	28 %	27 %	27 %	28 %	+0.0 %

Table 6.5: Choice of transportation, residents of Vienna
Source: Wiener Linien

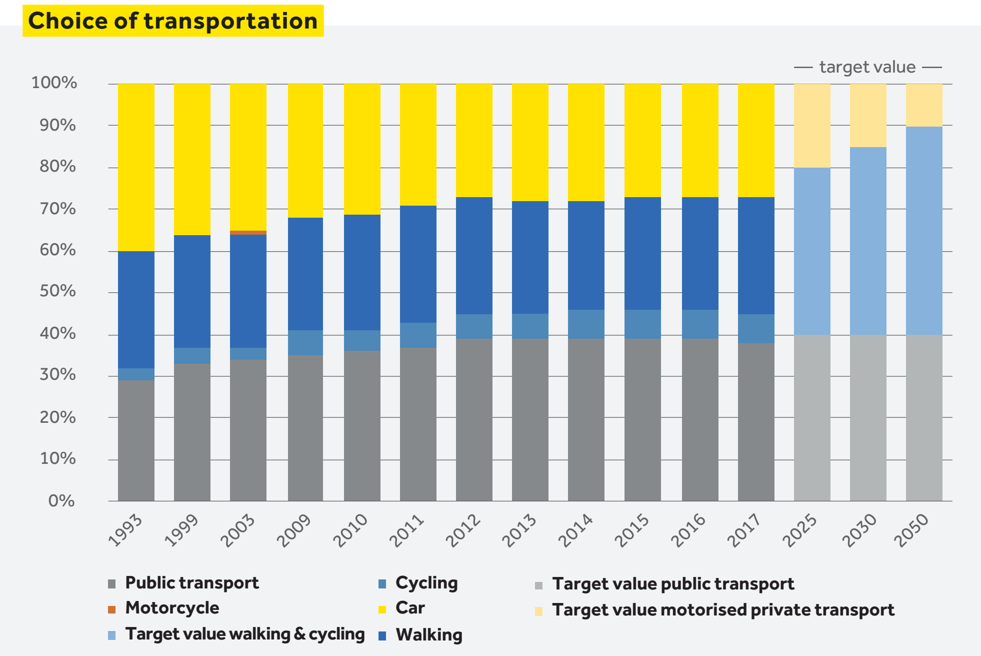


Fig. 6.5: Choice of transportation, residents of Vienna, 1993-2017
Sources: Wiener Linien and SCWR

[%]	1993	1999	2003	2009	2010	2014	2015	2016	2017	Change [%] base year 2010
Motorised private transport	40 %	36 %	36 %	32 %	31 %	28 %	27 %	27 %	27 %	-12.9 %
Trend line motorised private transport, moving average over 3 years			37 %	35 %	33 %	28 %	28 %	27 %	27 %	-18.2 %
Linear target path until 2025, 2030					31 %	28 %	27 %	27 %	26 %	-16.6 %

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Table 6.6: Share of motorised private transport in the modal split,
Source: Wiener Linien

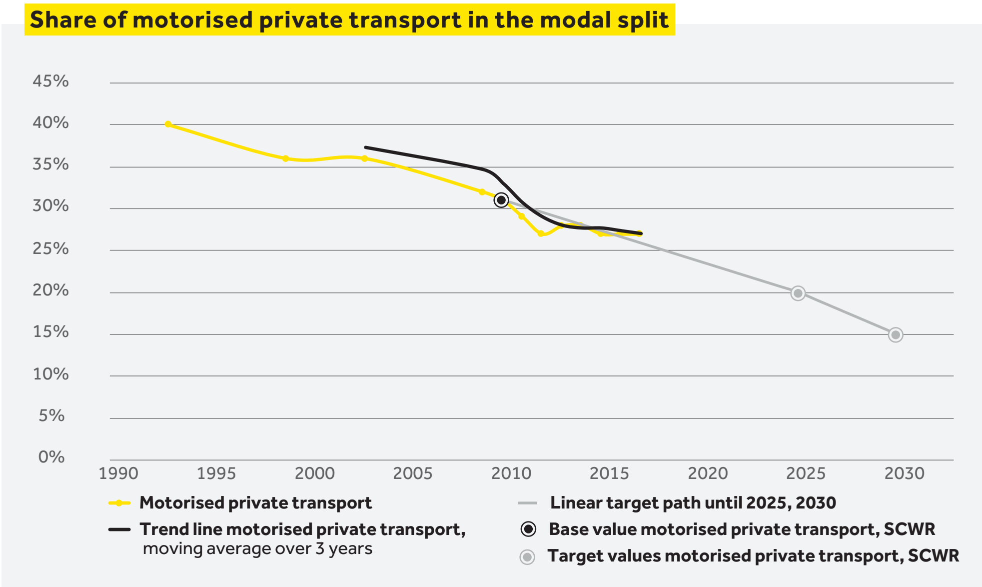

Fig. 6.6: Share of motorised private transport in the modal split, 1993 – 2017
Source: Wiener Linien and SCWR

6.1.6 Share of electric and hybrid cars

2014 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.

Share of electric and hybrid cars	2005	2010	2014	2015	2016	2017
Vienna	0.003 %	0.19 %	0.54 %	0.67 %	0.87 %	1.22 %
Vorarlberg	0.009 %	0.20 %	0.59 %	0.69 %	0.95 %	1.32 %
Tyrol	0.002 %	0.10 %	0.34 %	0.43 %	0.63 %	0.96 %
Styria	0.002 %	0.08 %	0.26 %	0.37 %	0.50 %	0.72 %
Salzburg	0.003 %	0.12 %	0.42 %	0.53 %	0.74 %	1.00 %
Upper Austria	0.001 %	0.09 %	0.28 %	0.35 %	0.50 %	0.72 %
Lower Austria	0.005 %	0.12 %	0.32 %	0.42 %	0.58 %	0.82 %
Carinthia	0.005 %	0.08 %	0.26 %	0.32 %	0.42 %	0.59 %
Burgenland	0.001 %	0.08 %	0.21 %	0.26 %	0.36 %	0.56 %

Table 6.7: Share of electric and hybrid cars by federal province,
Source: KFZ-Bestand

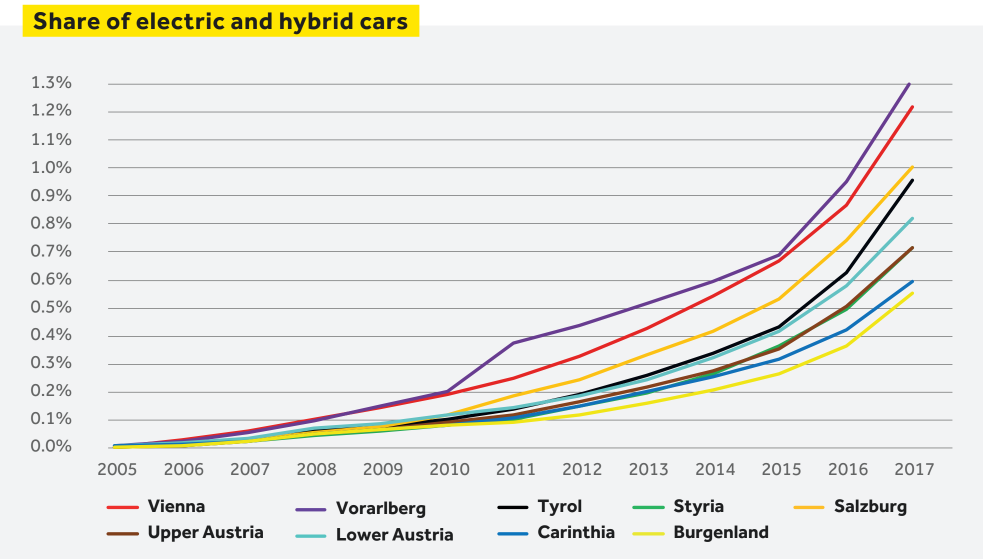

Fig. 6.7: Share of electric and hybrid cars by federal province, 2005 – 2017
Source: KFZ-Bestand

Note:
Statistical data for hybrid engines available from 2006.

6.1.7 Share of electric and hybrid lorries

2014 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	2017
Vienna	0.015 %	0.03 %	0.33 %	0.53 %	0.84 %	0.88 %
Vorarlberg	0.012 %	0.03 %	0.16 %	0.18 %	0.28 %	0.30 %
Tyrol	0.003 %	0.01 %	0.15 %	0.16 %	0.24 %	0.31 %
Styria	0.006 %	0.02 %	0.21 %	0.24 %	0.28 %	0.35 %
Salzburg	0.021 %	0.01 %	0.13 %	0.12 %	0.16 %	0.20 %
Upper Austria	0.005 %	0.01 %	0.13 %	0.14 %	0.16 %	0.20 %
Lower Austria	0.010 %	0.03 %	0.19 %	0.24 %	0.28 %	0.32 %
Carinthia	0.012 %	0.04 %	0.26 %	0.26 %	0.28 %	0.28 %
Burgenland	0.007 %	0.02 %	0.06 %	0.10 %	0.11 %	0.13 %

Table 6.8: Share of electric and hybrid lorries by federal province
Source: KFZ-Bestand

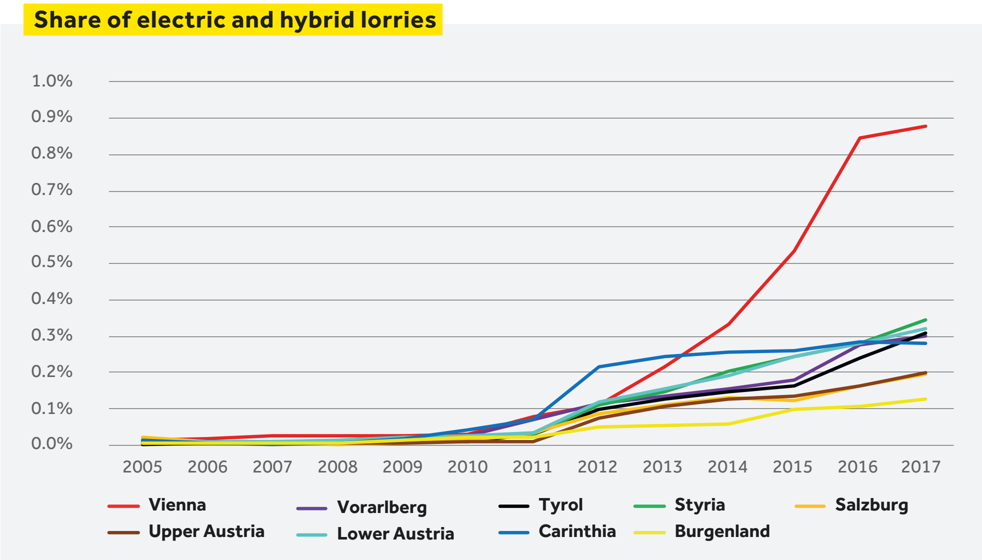

Fig. 6.8: Share of electric and hybrid lorries by federal province, 2005 – 2017
Source: KFZ-Bestand

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 engines available from 2006.

6.1.8 Energy consumption of passenger traffic across city boundaries

2014 Smart City Wien Framework Strategy objective:
Reduction of energy consumption by passenger traffic across municipal boundaries by 10% by 2030.

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	

Table 6.9: Fuel consumption of cars of non-residents in Vienna,
Source: Private PKW, Stadt Wien and SCWR

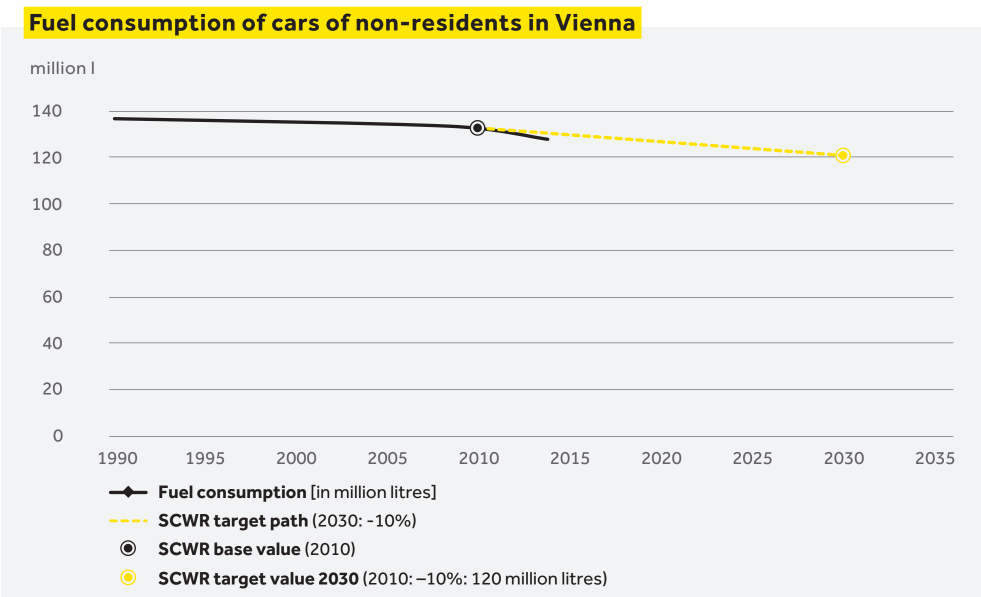

Fig. 6.9: Fuel consumption of cars of non-residents in Vienna, 1990, 2010 and 2015, SCWR target
Source: Private PKW, Stadt Wien and SCCR

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.

6.1.9 Share of energy sources for space heating, hot water and air conditioning

2014 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.

[%]	2005	2010	2014	2015	2016	2017	Change [%] Base year 2005
Renewable energy vectors	2.9 %	4.8 %	11.7 %	7.6 %	4.0 %	3.9 %	**+34.1 %**
District heating	32.6 %	37.7 %	36.4 %	38.2 %	40.0 %	40.2 %	**+23.4 %**
Electrical energy	8.8 %	8.8 %	8.9 %	8.6 %	8.8 %	8.6 %	**-3.1 %**
Natural gas	45.4 %	43.8 %	38.5 %	40.2 %	41.9 %	42.0 %	**-7.5 %**
Oil	9.4 %	4.7 %	4.3 %	5.4 %	5.4 %	5.3 %	**-43.7 %**
Combustible waste	0.4 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	**-99.5 %**
Coal	0.4 %	0.2 %	0.1 %	0.0 %	0.0 %	0.0 %	**-98.8 %**

Table 6.10: Share of energy sources in final energy consumption for space heating, hot water and air conditioning in Vienna
Source: Nutzenergieanalyse 2017

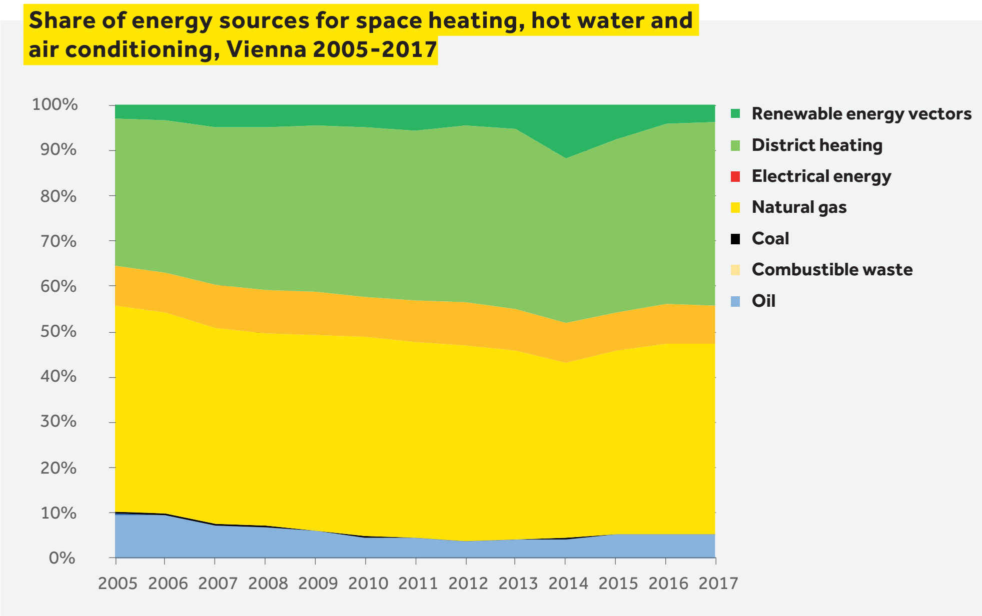

Fig. 6.10: Share of energy sources in final energy consumption for space heating, hot water and air conditioning in Vienna, 2005 – 2017
Source: Nutzenergieanalyse 2017

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

Share of useful area [%]	2005	2010	2015	2016	2017	**Change [%] base year 2005**
Biomass	0 %	1 %	0 %	0 %	0 %	
District heating	95 %	90 %	53 %	81 %	91 %	**-4.0 %**
Gas-powered central heating (including solar installations)	5 %	9 %	39 %	15 %	7 %	**+32.7 %**
Heat pump	0 %	0 %	8 %	4 %	2 %	

Table 6.11: Energy supply for subsidised large-scale housing in Vienna by year of subsidy granting and share of useful area
Source: Stadt Wien

Energy supply for subsidised large-scale housing in Vienna by year of subsidy granting and share of useful area

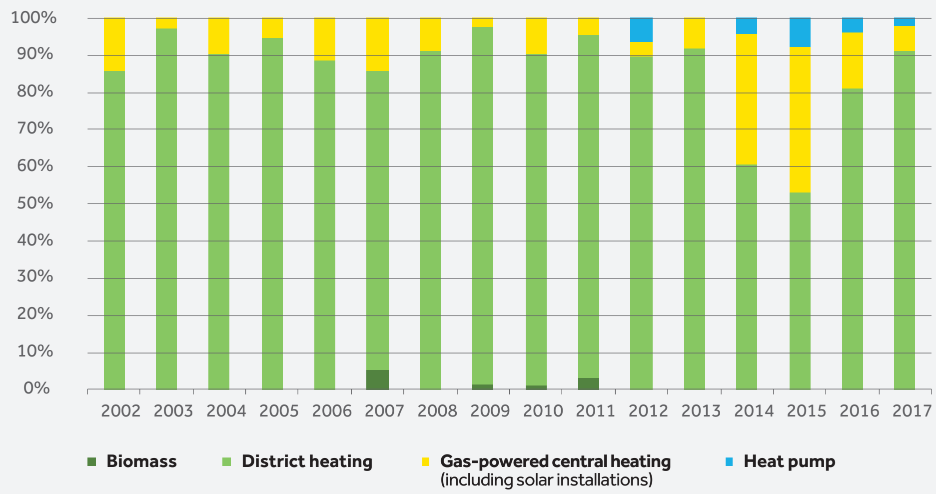

Fig. 6.11: Energy supply for subsidised large-scale housing in Vienna by year of subsidy granting and share of useful area, 2002 – 2017
Source: Stadt Wien

Energy supply for subsidised large-scale housing in Vienna by share of useful area, 2017

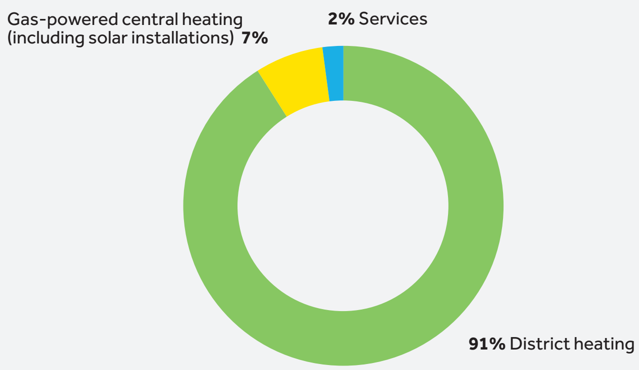

Fig. 6.12: Energy supply for subsidised large-scale housing in Vienna by share of useful area, 2017
Source: Stadt Wien

6.1.10 Final energy consumption for space heating, air conditioning and hot water per capita

2014 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	2017	Change [%] base year 2010
Final energy consumption for space heating, hot water and air conditioning	10,044	10,431	8,702	8,732	8,367	8,397	**-19.5 %**
Trend line, moving average over 4 years		9,530	9,181	9,001	8,763	8,549	**-10.3 %**
SCWR target path (-1% per year [from 2008-2012 average])		9,593	9,215	9,123	9,032	8,941	**-6.8 %**

Table 6.12: Final energy consumption for space heating, hot water and air conditioning in Vienna per capita
Source: Nutzenergieanalyse 2017 and Bevölkerung

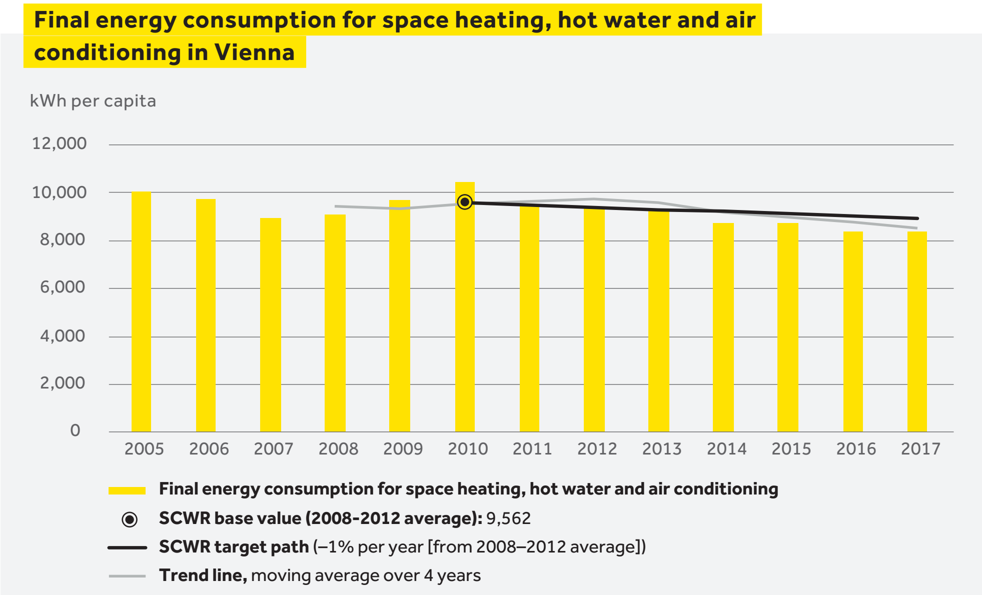

Fig. 6.13: Final energy consumption for space heating, hot water and air conditioning in Vienna per capita, 2005 – 2017, SCWR target path
Source: Nutzenergieanalyse 2017 and SCWR

Note:
The target path "-1% per year from 2010" is calculated using the equation
$Targetvalue_{Targetyear} = Finalenergyconsumptionaverage_{2008\text{-}2012} * 0.99^{(Targetyear-2010)}$.
The starting year is 2010 and the starting value is the average of 2008 to 2012.

6.2 Developments in Vienna

6.2.1 Final energy consumption per capita in Vienna

kWh per capita	1995	2000	2005	2010	2015	2016	2017	Change [%] basis year 1995
Services	5,057	5,302	5,033	5,747	4,802	4,500	4,672	-7.62 %
Private households	7,032	6,992	7,595	7,511	6,493	6,602	6,340	-9.84 %
Industry and agriculture	2,587	2,070	2,424	2,025	1,939	1,767	1,889	-27.00 %
Traffic and transport	6,325	7,298	9,112	8,166	7,533	7,457	7,442	17.67 %
Total	**21,002**	**21,663**	**24,165**	**23,448**	**20,768**	**20,326**	**20,343**	**-3.14 %**

Table 6.13: Final energy consumption per capita in Vienna, Source: Energiebilanz 2017 and Bevölkerung Wien

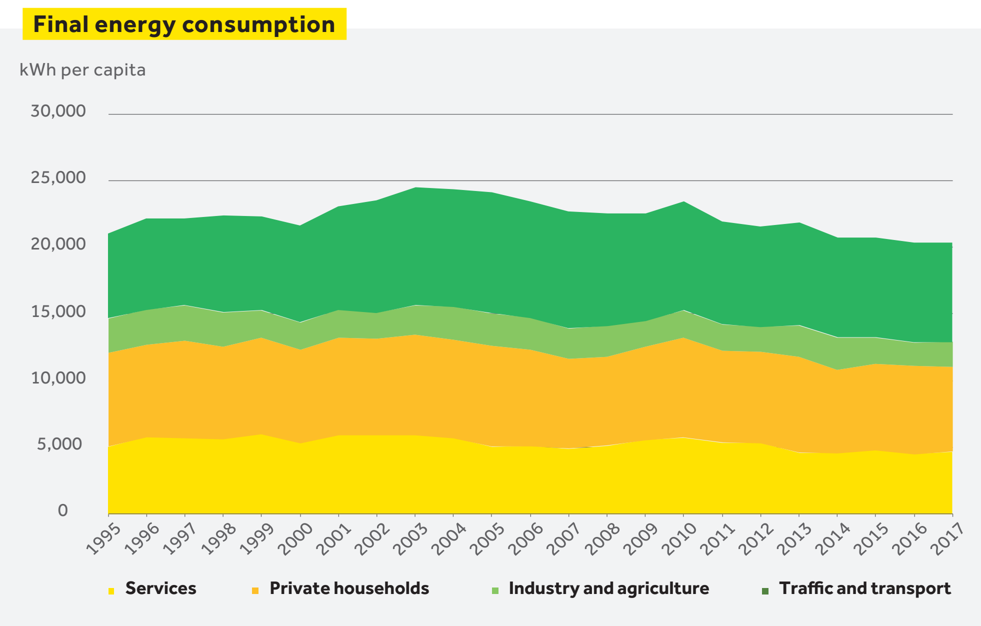

Fig. 6.14: Final energy consumption per capita in Vienna, 1995 – 2017
Sources: Energiebilanz 2017 and Bevölkerung Wien

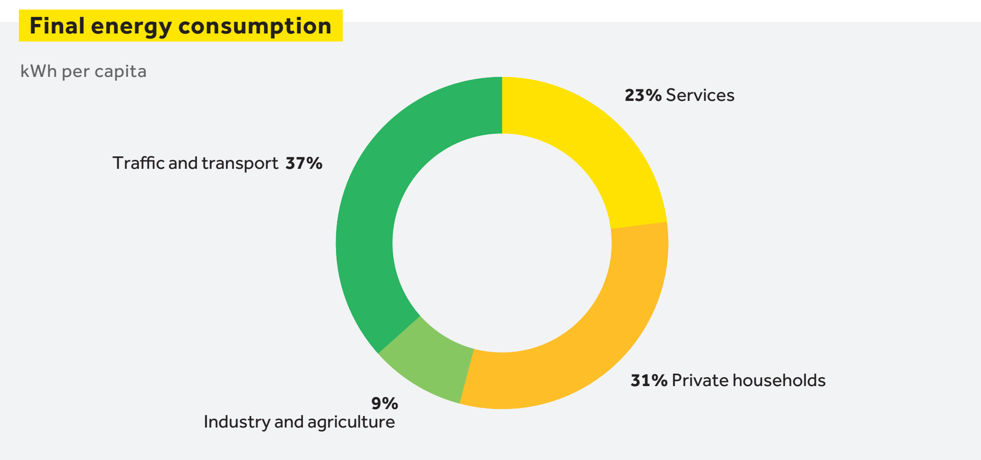

Fig. 6.15: Final energy consumption per capita in Vienna 2017
Source: Energiebilanz 2017 and Bevölkerung Wien

6.2.2 Share of renewable energy including imports and waste heat

[GWh / a]	2005	2010	2015	2016	2017
Share of renewable energy, Vienna	5.3 %	9.7 %	11.5 %	9.6 %	9.2 %
Share of renewable energy, imports	3.5 %	2.1 %	7.6 %	7.2 %	6.2 %
Share of waste heat, Vienna	10.8 %	12.0 %	9.9 %	11.1 %	10.8 %
Share of waste heat, imports	1.0 %	1.1 %	2.0 %	1.9 %	1.9 %
Total of shares	**20.5 %**	**24.9 %**	**31.0 %**	**29.9 %**	**28.2 %**

Table 6.14: Share of renewable energy including imports and waste heat,
Source: Energiebilanz 2017

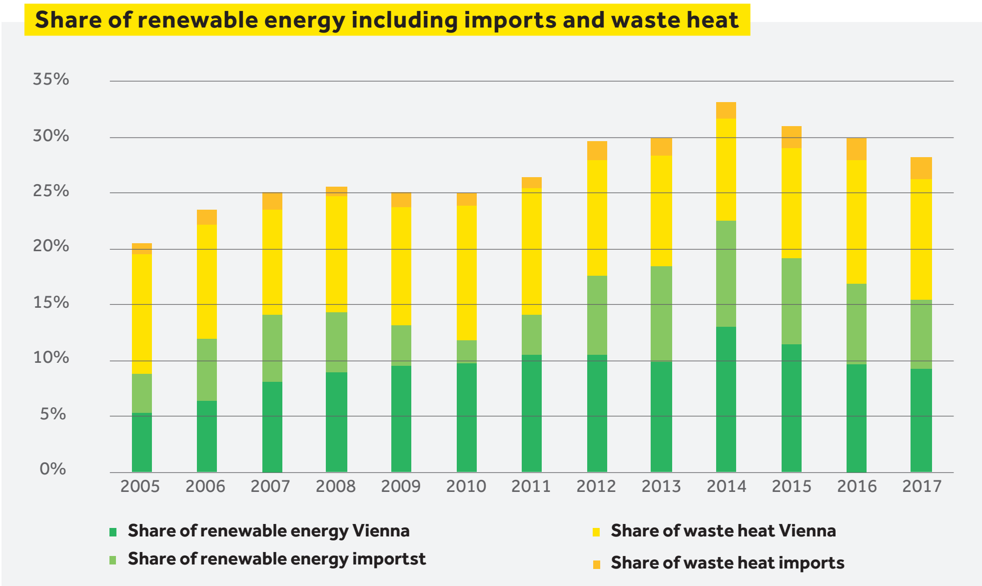

Fig. 6.16: Share of renewable energy including imports and waste heat, 1995 – 2017
Source: Energiebilanz 2017

6.2.3 Use of solar energy in Vienna's districts

	District	Output [kWp/1,000 inhabitants]	Area [m2/1,000 inhabitants]
	Vienna average	16.24	18.62
1	Wien Innere Stadt	16.43	0.68
2	Wien Leopoldstadt	14.72	6.14
3	Wien Landstraße	13.03	5.04
4	Wien Wieden	3.63	3.32
5	Wien Margareten	1.36	4.12
6	Wien Mariahilf	6.45	4.16
7	Wien Neubau	3.58	9.20
8	Wien Josefstadt	3.85	1.47
9	Wien Alsergrund	4.39	6.40
10	Wien Favoriten	8.56	9.26
11	Wien Simmering	26.61	14.26
12	Wien Meidling	10.39	8.05
13	Wien Hietzing	17.81	40.42
14	Wien Penzing	12.32	40.66
15	Wien Rudolfsheim-Fünfhaus	4.89	6.40
16	Wien Ottakring	2.80	11.09
17	Wien Hernals	6.62	21.45
18	Wien Währing	5.36	17.00
19	Wien Döbling	7.75	31.31
20	Wien Brigittenau	1.21	4.47
21	Wien Floridsdorf	25.99	29.84
22	Wien Donaustadt	30.49	35.87
23	Wien Liesing	72.68	48.17

Table 6.15: Output of PV panels and surface area of subsidised solar thermal installations per capita by district, 2017
Source: Energiedatenbank MA 20 and Bevölkerung

Output of PV panels and surface area of solar thermal installations

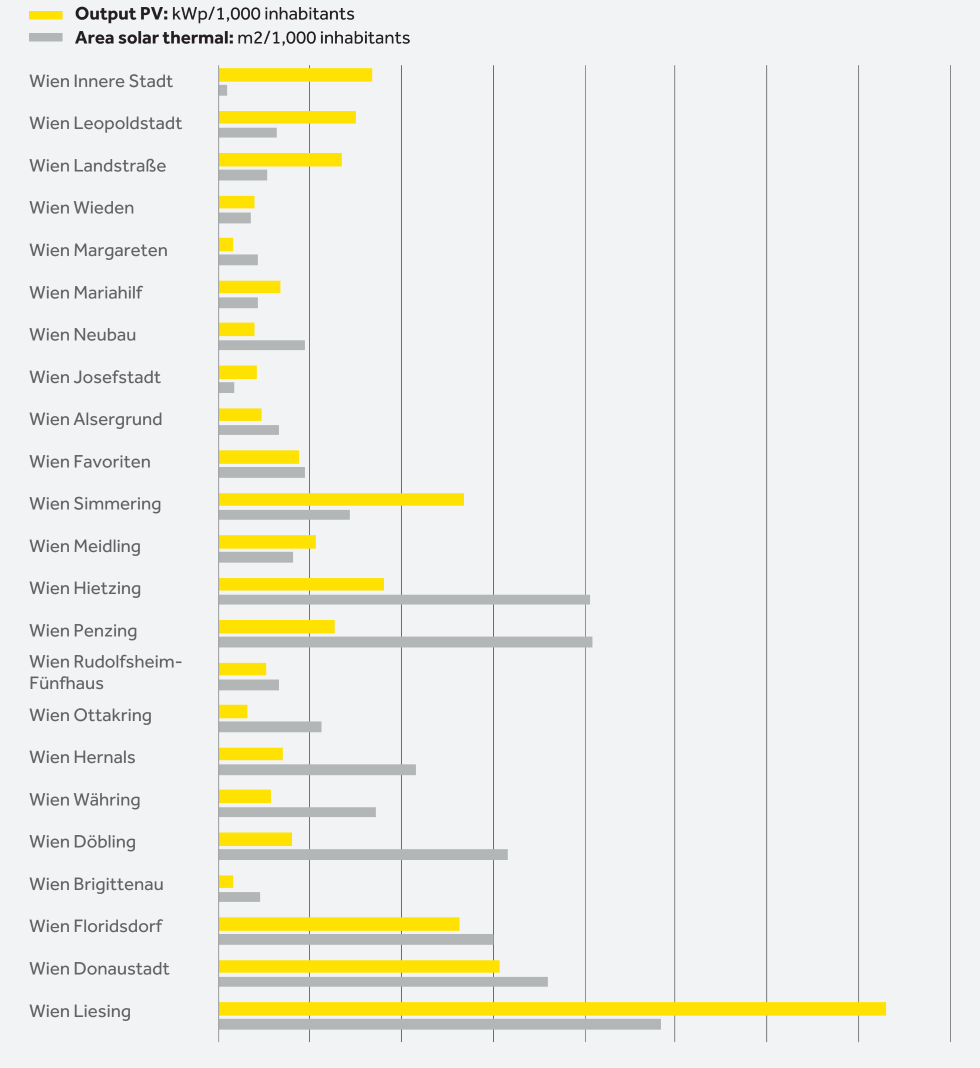

Fig. 6.17: Output of PV panels and surface area of subsidised solar thermal installations per capita by district, 2017
Sources: Energiedatenbank MA 20 and Bevölkerung

6.2.4 Electricity generation from renewable energy

	2005	2010	2015	2016	2017	**Change [%] base year 2005**
Electricity generation from renewable energy [GWh]	1,127	1,358	1,290	1,413	1,436	**+27.4 %**
Total electricity generation in Vienna [GWh]	7,312	8,293	5,095	5,557	5,936	**-18.8 %**
Share [%]	15.4 %	16.4 %	25.3 %	25.4 %	24.2 %	**+57.0 %**

Table 6.16: Share of electricity from renewable energy in Vienna's total electricity generation,
Sources: Energiebilanz 2017

Electricity from renewable energy and total electricity generation in Vienna

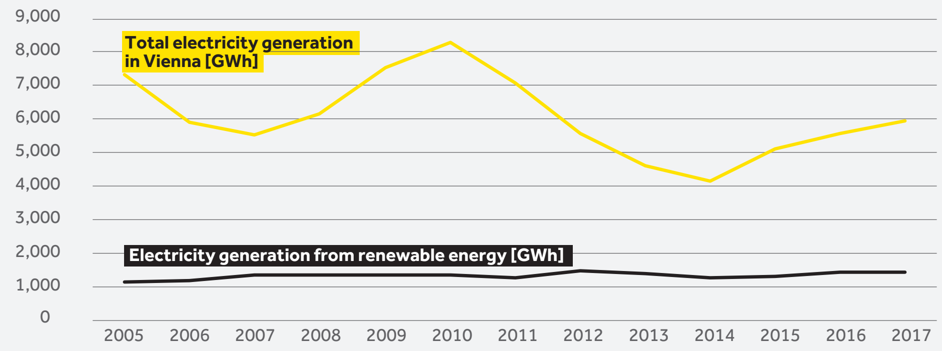

Fig. 6.18: Electricity from renewable energy and total electricity generation in Vienna, compari-son, 2005 – 2017
Sources: Energiebilanz 2017

Share of electricity from renewable energy in Vienna's total electricity generation

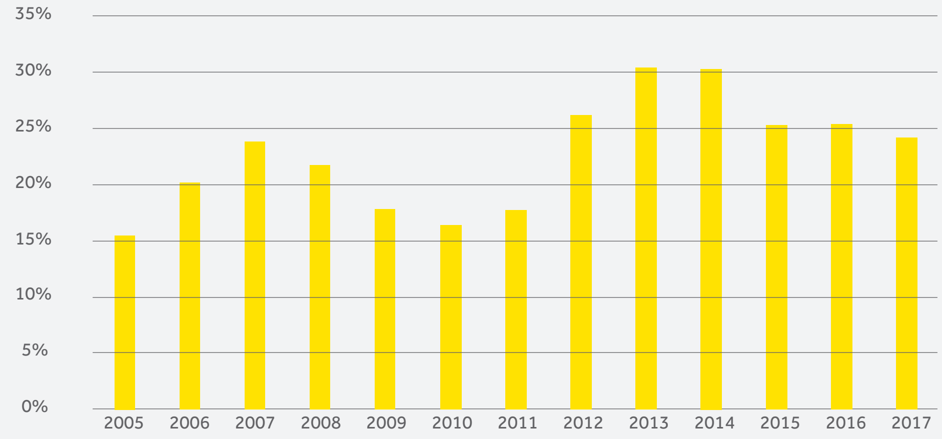

Fig. 6.19: Share of electricity from renewable energy in Vienna's total electricity generation, 2005 – 2017
Sources: Energiebilanz 2017

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

6.2.5 Greenhouse gas (GHG) emissions per capita

[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 %**

Table 6.17: Greenhouse gas emissions per capita in Vienna
Sources: BLI, emikat.at and Bevölkerung

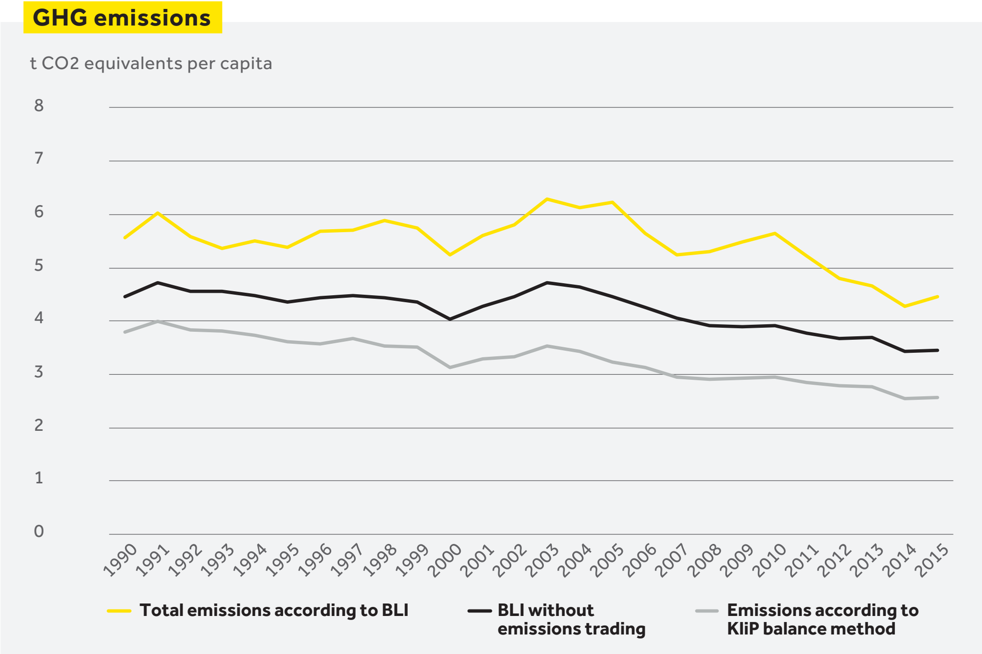

Fig. 6.20: Greenhouse gas emissions per capita in Vienna, 1990 – 2015
Sources: BLI, emikat.at and Bevölkerung

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

6.2.6 Greenhouse gas emissions in relation to value added

[t CO_2 equivalents per €1 million]	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	121.6	121.5	94.9	86.6	80.0	79.3	**-34.2 %**
KliP balance method	157.9	170.0	137.2	109.6	99.7	102.5	**-36.8 %**

Table 6.18: GHG emissions in Vienna in relation to value added
Sources: BLI, emikat.at and Wertschöpfung

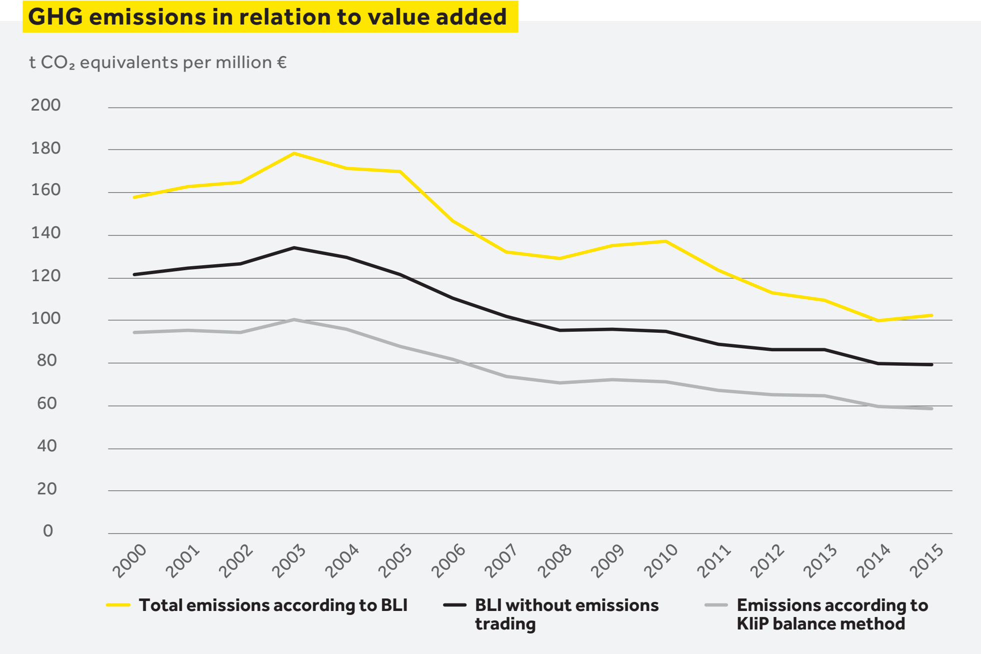

Fig. 6.21: GHG emissions in Vienna in relation to value added, 2000 – 2015
Sources: BLI, emikat.at and Wertschöpfung

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

6.2.7 Car density in Vienna's districts

	District	2008	2010	2013	2014	2015	2016	2017	**Change [%] base year 2008**
	Vienna average	393	396	391	387	381	377	376	**-4.5 %**
1	Innere Stadt	986	1,027	1,041	1,048	1,027	976	987	**+0.1 %**
2	Leopoldstadt	335	334	333	327	318	316	312	**-6.9 %**
3	Landstraße	441	464	441	449	437	426	422	**-4.5 %**
4	Wieden	424	424	417	408	402	391	384	**-9.5 %**
5	Margareten	330	327	315	309	298	293	289	**-12.3 %**
6	Mariahilf	388	384	371	360	352	341	334	**-13.9 %**
7	Neubau	373	368	363	354	342	329	328	**-12.0 %**
8	Josefstadt	361	358	346	340	328	318	307	**-14.9 %**
9	Alsergrund	401	388	376	368	358	335	334	**-16.7 %**
10	Favoriten	353	353	351	344	337	335	349	**-1.2 %**
11	Simmering	371	371	374	372	367	364	360	**-3.1 %**
12	Meidling	353	355	360	357	353	350	346	**-1.9 %**
13	Hietzing	448	449	455	451	442	431	430	**-4.1 %**
14	Penzing	383	389	393	388	382	377	375	**-2.3 %**
15	Rudolfsheim-Fünfhaus	311	307	303	296	287	278	275	**-11.7 %**
16	Ottakring	326	327	331	326	321	317	310	**-5.0 %**
17	Hernals	339	344	344	339	330	328	324	**-4.6 %**
18	Währing	373	371	362	358	349	363	361	**-3.2 %**
19	Döbling	418	423	419	417	411	402	402	**-3.9 %**
20	Brigittenau	311	314	304	301	295	294	290	**-6.7 %**
21	Floridsdorf	398	402	396	392	391	388	390	**-2.0 %**
22	Donaustadt	439	447	443	437	443	437	436	**-0.7 %**
23	Liesing	508	512	499	496	499	502	504	**-0.7 %**

Table 6.19: Car density in Vienna's districts per 1,000 inhabitants
Source: KFZ-Bestand and Bevölkerung

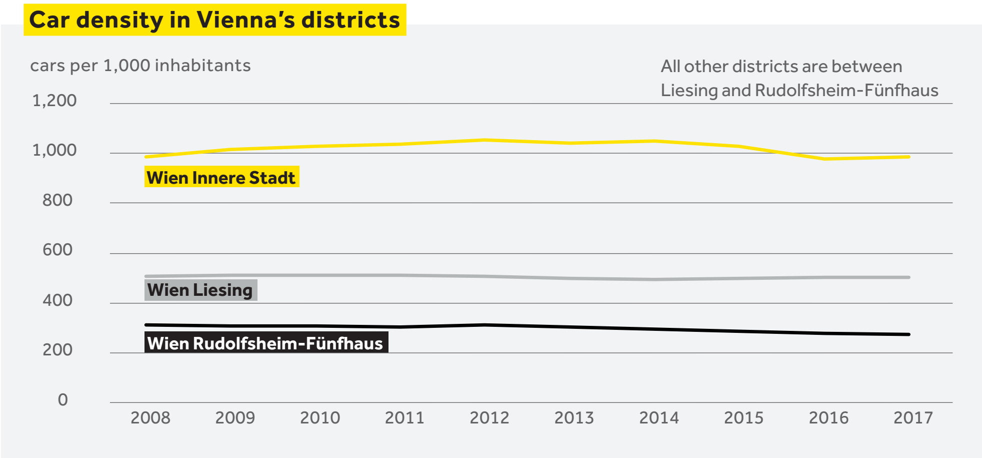

Fig. 6.22: Car density in Vienna's districts per 1,000 inhabitants, 2008 – 2017,
Sources: KFZ-Bestand and Bevölkerung

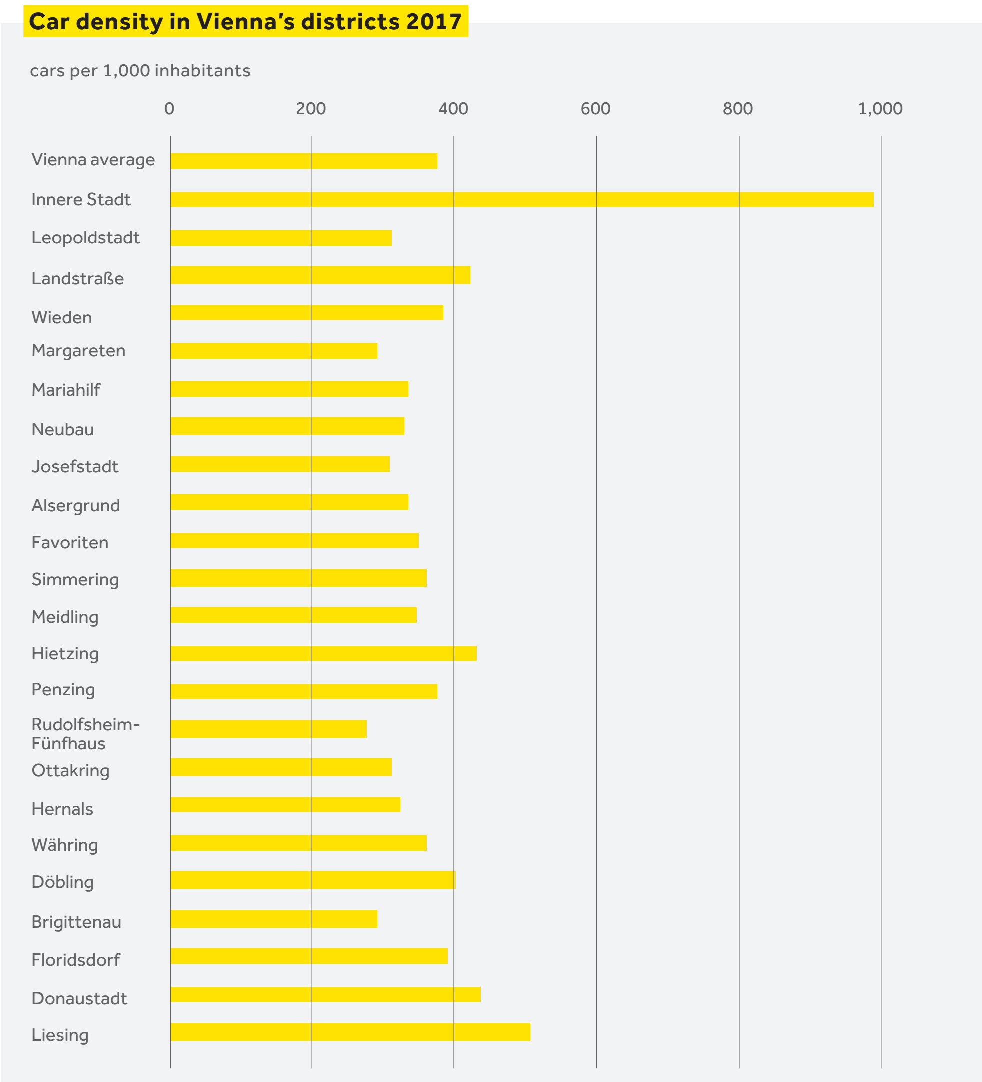

Fig. 6.23: Car density in Vienna's districts per 1,000 inhabitants, 2017
Source: KFZ-Bestand and Bevölkerung

6.2.8 Annual passes for Vienna Public Transport and cars per 1,000 inhabitants

[Number per 1,000 inhabitants]	2005	2009	2012	2015	2016	2017	Change [%] base year 2005
Annual passes	186	200	292	396	398	417	+124.5 %
Cars	402	395	396	381	377	376	-6.5 %

Table 6.20: Annual passes for Vienna Public Transport and cars per 1,000 inhabitants,
Sources: Wiener Linien and Bevölkerung

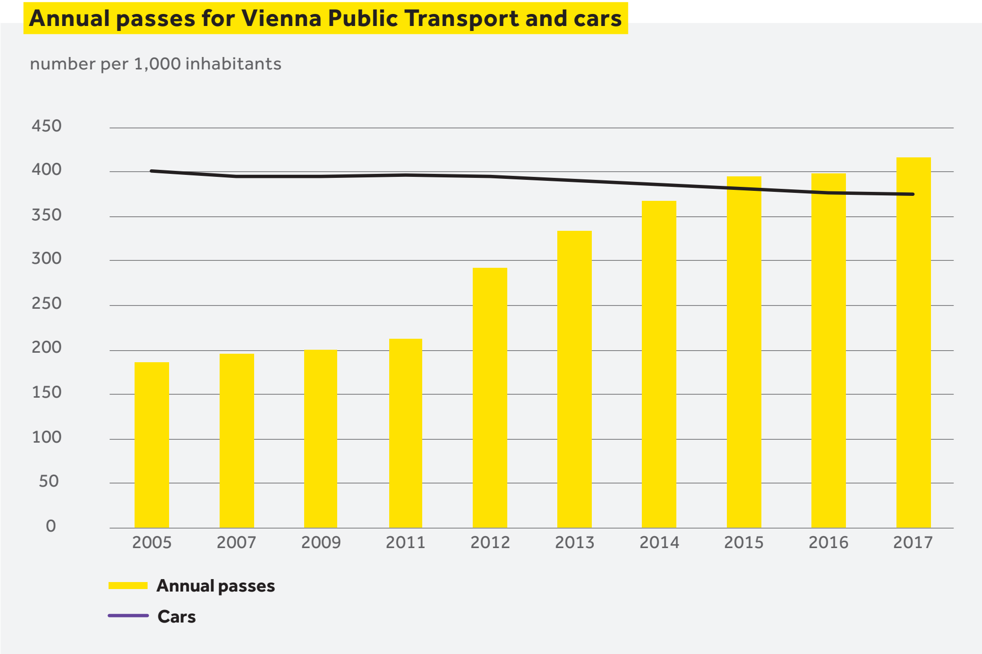

Fig. 6.24: Annual passes for Vienna Public Transport and cars per 1,000 inhabitants,
Sources: Wiener Linien and Bevölkerung

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

6.2.9 Changes in number of cars and inhabitants by district

	District	Change from 2005 to 2017	
	Name	Cars	Inhabitants
	Wien Durchschnitt	+7.0 %	+14.4 %
1	Innere Stadt	+1.9 %	-4.8 %
2	Leopoldstadt	+2.6 %	+14.9 %
3	Landstraße	+5.3 %	+7.6 %
4	Wieden	-3.3 %	+11.7 %
5	Margareten	-10.1 %	+6.7 %
6	Mariahilf	-8.8 %	+9.8 %
7	Neubau	-7.3 %	+10.4 %
8	Josefstadt	-11.2 %	+8.2 %
9	Alsergrund	-12.6 %	+8.2 %
10	Favoriten	+15.0 %	+21.0 %
11	Simmering	+13.9 %	+21.5 %
12	Meidling	+11.5 %	+15.1 %
13	Hietzing	-0.1 %	+5.6 %
14	Penzing	+6.7 %	+12.9 %
15	Rudolfsheim-Fünfhaus	-2.7 %	+13.7 %
16	Ottakring	+4.0 %	+13.4 %
17	Hernals	+1.3 %	+11.4 %
18	Währing	+2.1 %	+9.0 %
19	Döbling	+0.2 %	+7.8 %
20	Brigittenau	-3.0 %	+7.6 %
21	Floridsdorf	+13.2 %	+17.6 %
22	Donaustadt	+27.2 %	+27.2 %
23	Liesing	+11.6 %	+15.2 %

Table 6.21: Changes in number of cars and inhabitants by district between 2005 and 2017,
Sources: KFZ-Bestand, Jahrbuch 2006 and Bevölkerung Wien

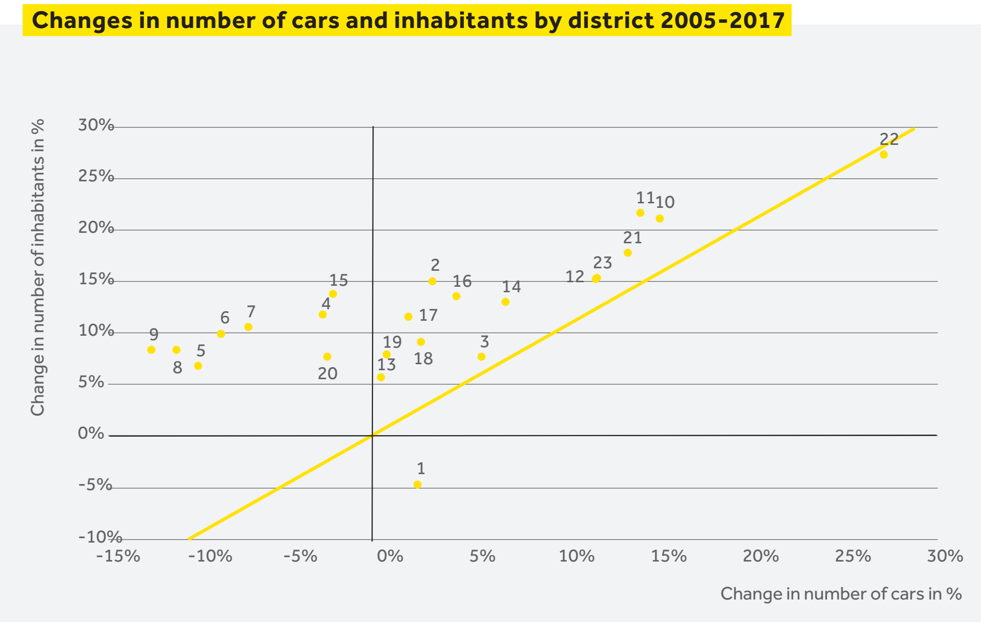

Fig. 6.25: Changes in number of cars and inhabitants by district between 2005 and 2017,
Sources: KFZ-Bestand, Jahrbuch 2006 and Bevölkerung Wien

6.2.10 Heating degree, frost, and ice days

Wien	1995	2000	2005	2010	2015	2016	2017	Change [%] base year 1995
Frost days	74	45	82	86	41	51	57	**-23 %**
Ice days	21	17	25	35	2	13	21	**0 %**
Heating degree days	3,025	2,551	3,071	3,212	2,594	2,784	2,718	**-10 %**

Table 6.22: Heating degree, frost, and ice days in Vienna
Source: Statistische Jahrbücher

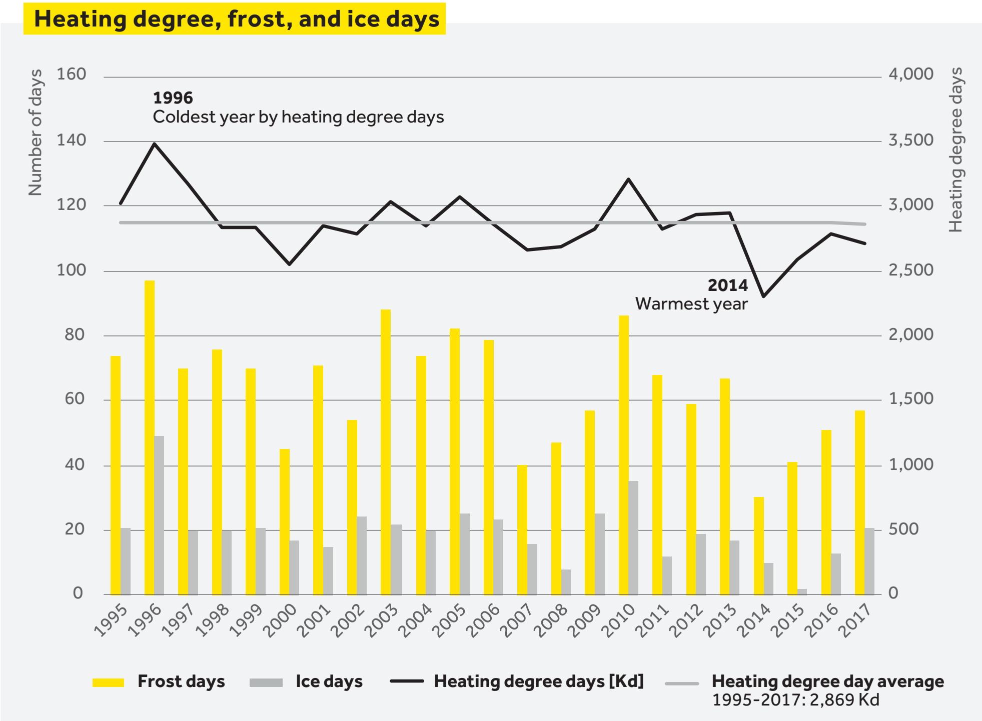

Fig. 6.26: Heating degree, frost, and ice days in Vienna, 1995 – 2017
Source: Statistische Jahrbücher

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 day is a day on which the mean outdoor temperature is below the heating threshold of 12° C.

6.2.11 Average annual temperature, summer days and hot days

Vienna	1995	2000	2005	2010	2015	2016	2017	Change [%] base year 1995
Summer days	64	71	65	56	78	85	85	**+32.8 %**
Hot days	15	26	12	15	42	20	38	**+153.3 %**
Average annual temperature [°C]	10.4	11.7	10.2	9.9	12.1	11.5	11.6	**+11.5 %**

Table 6.23: Average annual temperature, summer days and hot days in Vienna
Source: Statistische Jahrbücher

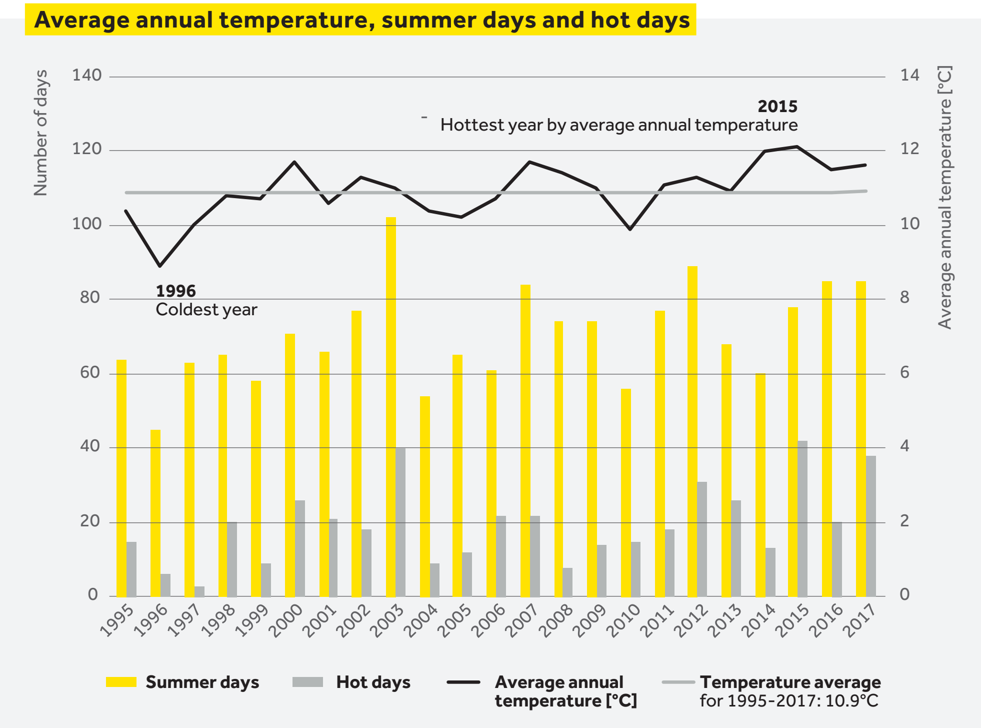

Fig. 6.27: Average annual temperature, summer days and hot days in Vienna, 1995 – 2017
Source: Statistische Jahrbücher

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.

6.3 Comparison of federal provinces

6.3.1 Final energy consumption per capita by federal province

[kWh per capita]	1995	2000	2005	2010	2015	2016	2017	Change [%] base year 1995
Vienna	21,002	21,663	24,165	23,448	20,768	20,326	20,343	**-3.14 %**
Vorarlberg	26,863	27,217	31,255	31,055	29,072	28,935	29,308	**9.10 %**
Tyrol	26,991	28,777	34,947	32,755	32,490	31,908	32,334	**19.80 %**
Styria	33,482	37,403	41,928	40,971	40,160	40,146	41,920	**25.20 %**
Salzburg	29,013	30,261	37,290	36,608	33,259	33,609	33,986	**17.14 %**
Upper Austria	34,797	40,034	44,658	44,759	44,738	45,470	45,860	**31.80 %**
Lower Austria	32,646	36,860	42,086	42,065	40,871	41,585	41,241	**26.33 %**
Carinthia	31,169	33,987	40,080	40,540	41,765	42,565	43,044	**38.10 %**
Burgenland	25,514	28,338	32,456	32,676	32,212	32,898	33,249	**30.32 %**

Table 6.24: Final energy consumption per capita by federal province,
Sources: Energiebilanz 2017 and Bevölkerung

Final energy consumption per capita by federal province

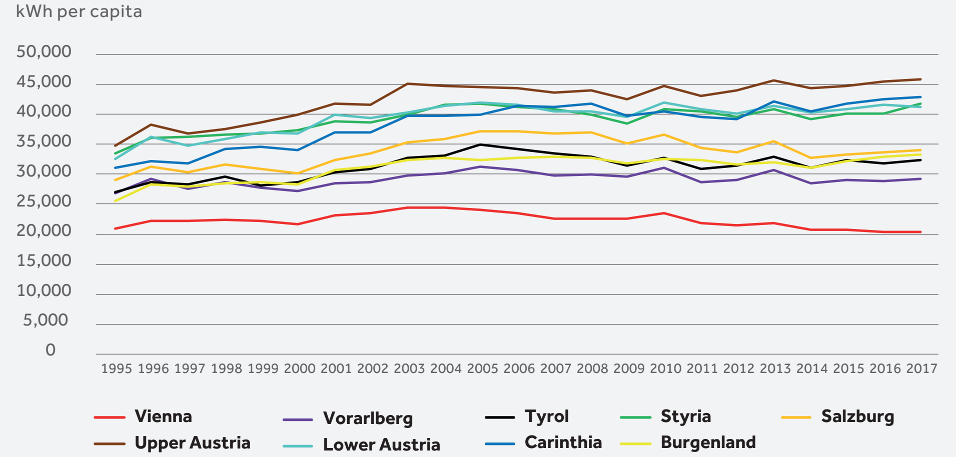

Fig. 6.28: Final energy consumption per capita by federal province, 1995 – 2017,
Sources: Energiebilanz 2017 and Bevölkerung

Final energy consumption by federal province, 2017

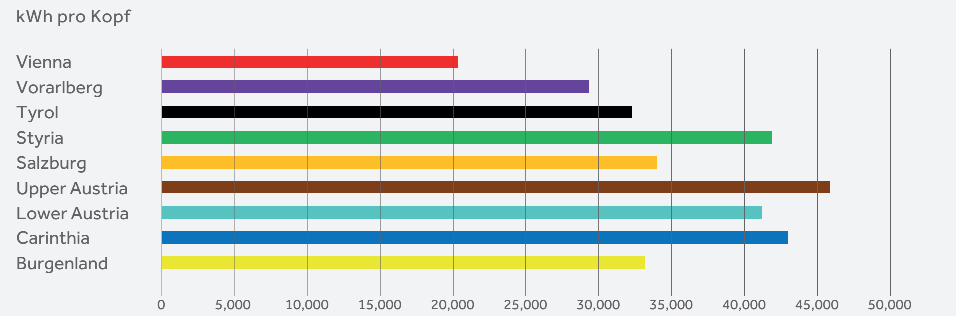

Fig. 6.29: Final energy consumption per capita by federal province, 2017,
Sources: Energiebilanz 2017 and Bevölkerung

6.3.2 Electrical energy per capita by federal province

kWh per capita	1995	2000	2005	2010	2015	2016	2017	Change [%] base year 1995
Vienna	4,307	4,635	4,873	4,931	4,583	4,522	4,441	**+3.1 %**
Vorarlberg	5,927	5,569	6,636	6,915	6,774	6,760	6,748	**+13.8 %**
Tyrol	6,863	7,122	7,917	7,343	7,110	7,107	7,094	**+3.4 %**
Styria	6,058	7,116	7,878	7,926	7,874	7,800	8,024	**+32.4 %**
Salzburg	6,185	6,199	7,373	7,511	6,537	6,520	6,609	**+6.9 %**
Upper Austria	7,020	8,216	9,054	9,303	9,833	9,963	9,968	**+42.0 %**
Lower Austria	5,610	5,876	6,305	6,712	6,895	6,925	6,987	**+24.5 %**
Carinthia	6,473	7,106	8,213	8,696	8,934	9,178	9,319	**+44.0 %**
Burgenland	3,608	4,332	4,711	5,389	5,407	5,561	5,299	**+46.9 %**

Table 6.25: Electrical energy per capita by federal province,
Sources: Energiebilanz 2017 and Bevölkerung

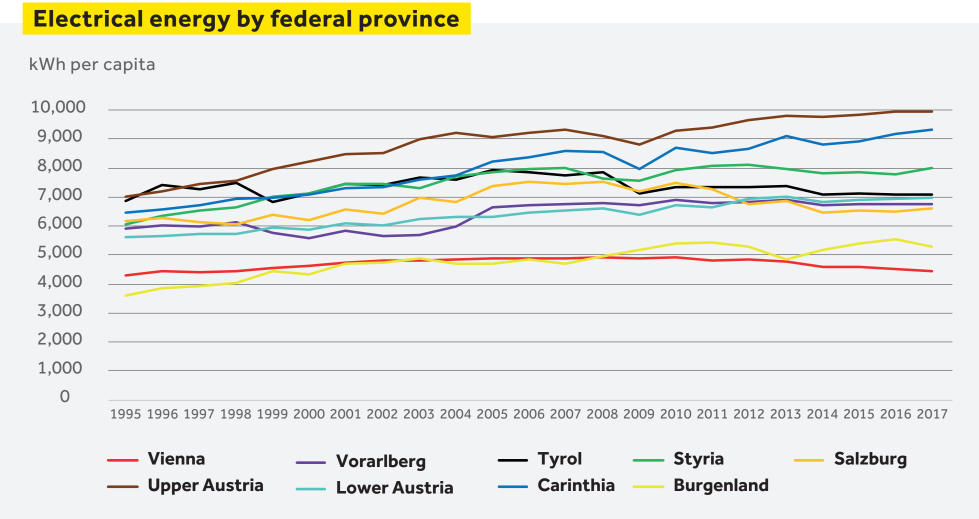

Fig. 6.30: Electrical energy per capita by federal province, 1995 – 2017,
Sources: Energiebilanz 2017 and Bevölkerung

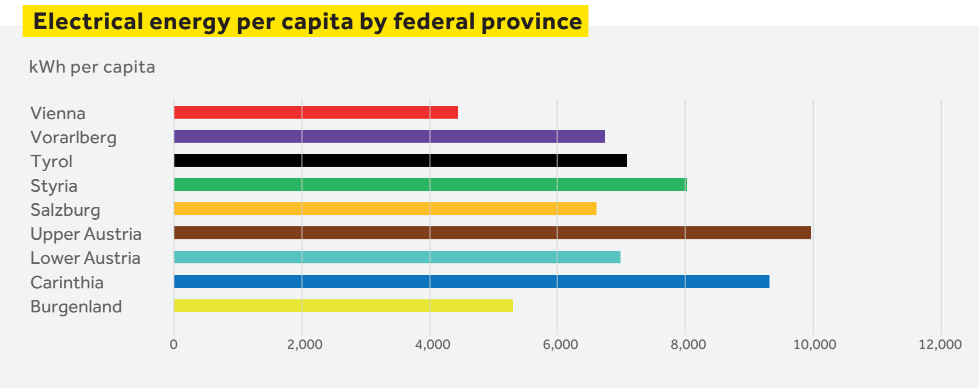

Fig. 6.31: Electrical energy per capita by federal province, 2017,
Sources: Energiebilanz 2017 and Bevölkerung

6.3.3 Final energy consumption of private households per capita by federal province

[kWh per capita]	1995	2000	2005	2010	2015	2016	2017	Change [%] base year 1995
Vienna	7,032	6,992	7,595	7,511	6,493	6,602	6,340	-9.84%
Vorarlberg	8,744	9,016	9,359	9,991	8,774	8,817	8,696	-0.54%
Tyrol	8,210	8,334	9,034	9,400	8,972	8,880	8,981	9.39%
Styria	9,483	9,254	9,139	9,259	9,075	9,162	9,392	-0.96%
Salzburg	8,416	8,697	8,752	9,258	8,506	8,559	8,671	3.03%
Upper Austria	9,192	9,154	9,212	9,499	9,243	9,641	9,708	5.61%
Lower Austria	10,944	10,445	10,497	10,398	9,457	9,688	9,753	-10.88%
Carinthia	10,692	9,720	9.157	8,999	8,951	8,650	8,918	-16.59%
Burgenland	11,609	11,359	10,048	10,523	10,114	10,211	10,318	-11.12%

Table 6.26: Final energy consumption of private households per capita by federal province,
Sources: Energiebilanz 2017 and Bevölkerung

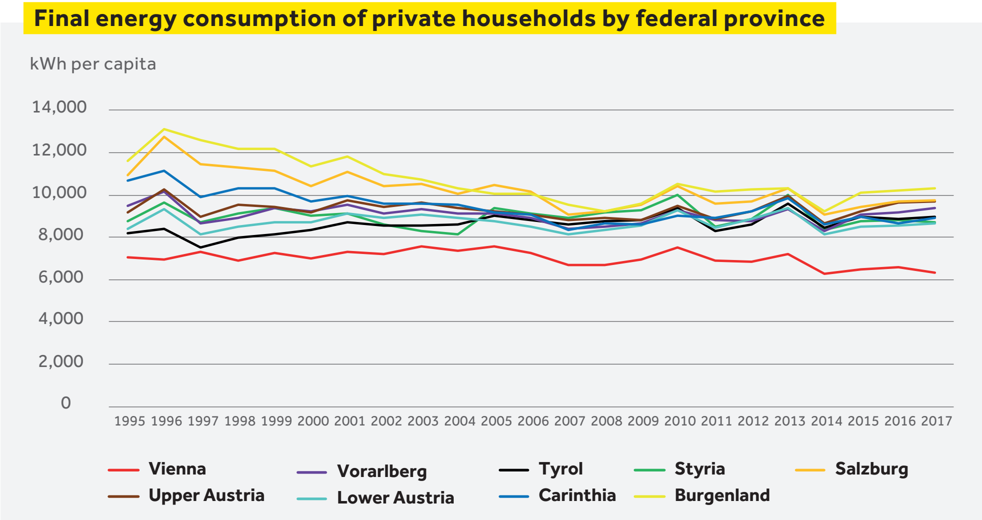

Fig. 6.32: Final energy consumption of private households per capita by federal province, 1995 – 2017,
Sources: Energiebilanz 2017 and Bevölkerung

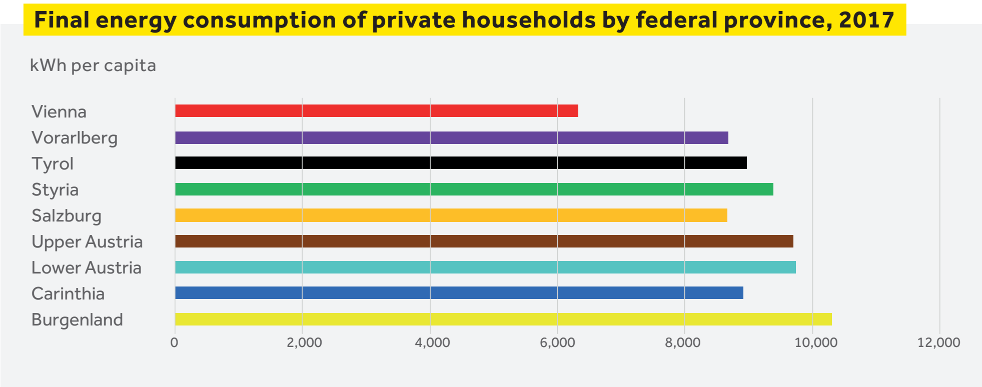

Fig. 6.33: Final energy consumption of private households by federal province, 2017,
Sources: Energiebilanz 2017 and Bevölkerung

6.3.4 Final energy consumption in relation to value added by federal province

[MWh/million €]	2000	2005	2010	2015	2016	2017	Change [%] base year 2000
Vienna	652	659	569	480	460	454	-30.4 %
Vorarlberg	1,114	1,090	955	724	731	729	-34.6 %
Tyrol	1,412	1,480	1,185	1,037	988	979	-30.7 %
Styria	1,828	1,735	1,475	1,260	1,229	1,231	-32.6 %
Salzburg	967	988	846	643	635	619	-36.0 %
Upper Austria	1,744	1,647	1,428	1,229	1,222	1,188	-31.9 %
Lower Austria	1,891	1,895	1,638	1,393	1,394	1,343	-29.0 %
Carinthia	1,725	1,730	1,531	1,395	1,396	1,338	-22.4 %
Burgenland	1,828	1,774	1,553	1,296	1,289	1,242	-32.1 %

Table 6.27: Final energy consumption in relation to value added by federal province,
Sources: Energiebilanz 2017 and Wertschöpfung

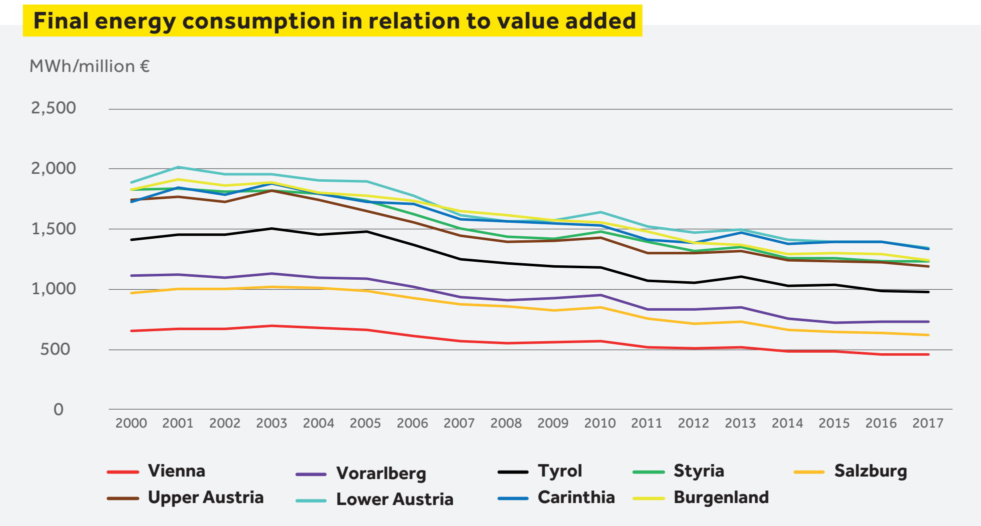

Fig. 6.34: Final energy consumption in relation to value added, 2000 – 2017,
Sources: Energiebilanz 2017 and Wertschöpfung

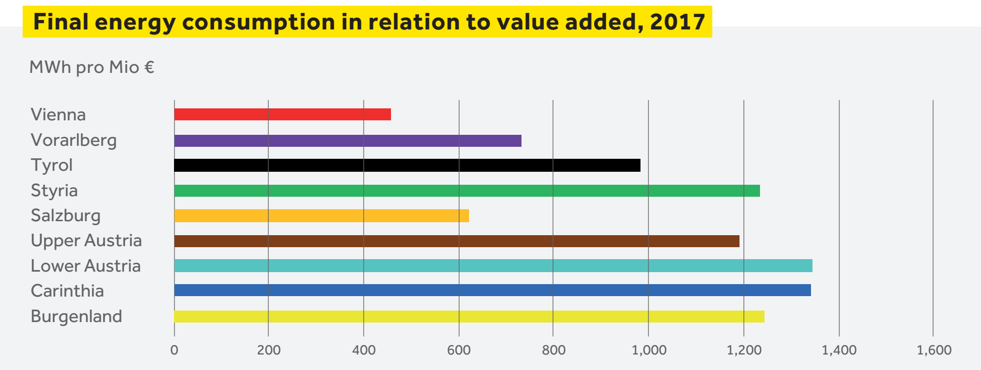

Fig. 6.35: Final energy consumption in relation to value added, 2017,
Source: Energiebilanz 2017 and Wertschöpfung

Note:
Data for value added only available from 2000.

6.3.5 Car density in provincial capitals

Cars per 1,000 inhabitants	2008	2010	2013	2014	2015	2016	2017	Change [%] base year 2008
Vienna	393.2	396.0	391.3	386.7	381.4	376.5	375.7	-4.5 %
Sankt Pölten	543.0	555.2	571.0	573.8	571.2	573.0	576.1	+6.1 %
Salzburg	483.4	502.1	514.2	516.5	517.5	513.2	514.9	+6.5 %
Linz	495.8	506.5	519.0	516.4	510.0	507.7	508.4	+2.5 %
Klagenfurt	573.0	587.7	609.9	607.4	605.9	606.7	610.7	+6.6 %
Innsbruck	440.8	445.5	445.7	443.7	437.4	427.1	428.3	-2.9 %
Graz	470.4	475.5	476.5	473.4	471.4	470.0	473.1	+0.6 %
Eisenstadt	634.0	644.0	667.9	669.7	676.2	660.9	672.4	+6.1 %
Bregenz (district)	484.7	499.9	519.5	524.5	528.7	532.2	534.7	+10.3 %

Table 6.28: Car density in provincial capitals per 1,000 inhabitants,
Source: KFZ-Bestand and Bevölkerung

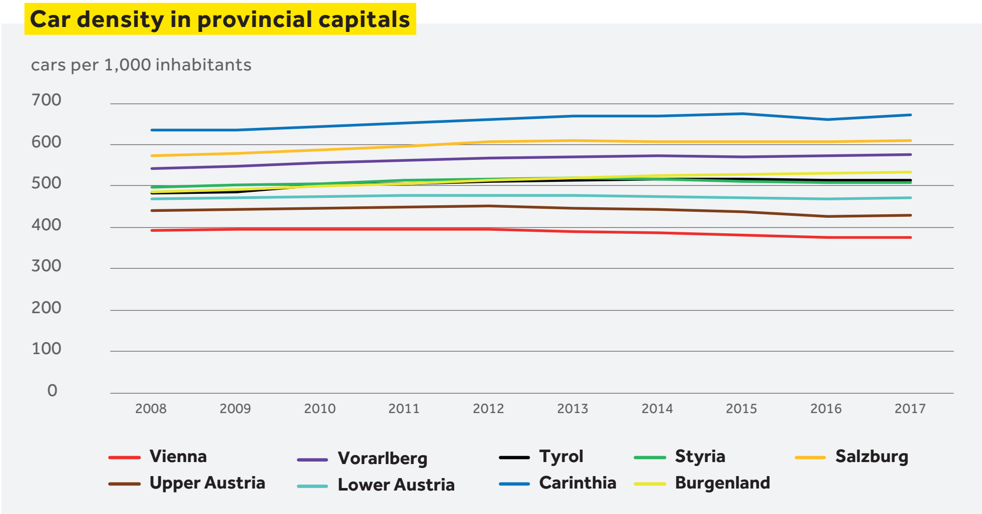

Fig. 6.36: Car density in provincial capitals per 1,000 inhabitants, 2008 – 2017,
Source: KFZ-Bestand and Bevölkerung

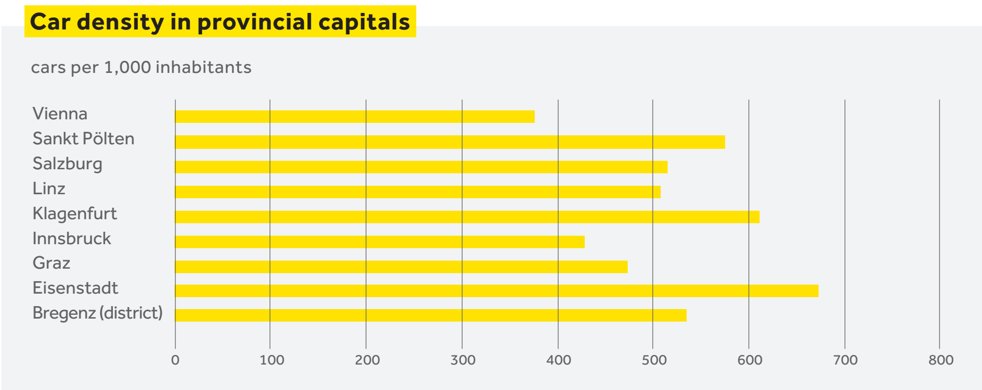

Fig. 6.37: Car density in provincial capitals pro 1.000 Einwohner, 2017,
Sources: KFZ-Bestand and Bevölkerung

6.3.6 Population growth by federal province

Province	1995	2000	2005	2010	2015	2016	2017	Change [%] base year 1995
Vienna	1,542,667	1,548,537	1,632,569	1,689,995	1,797,337	1,840,226	1,867,582	+21.1 %
Vorarl-berg	341,408	348,366	360,054	368,366	378,592	384,147	388,752	+13.9 %
Tirol	649,875	667,459	688,954	704,662	728,826	739,139	746,153	+14.8 %
Styria	1,186,136	1,182,930	1,196,780	1,205,045	1,221,570	1,232,012	1,237,298	+4.3 %
Salzburg	506,626	512,854	522,369	526,730	538,575	545,815	549,263	+8.4 %
Upper Austria	1,360,051	1,370,035	1,394,726	1,409,253	1,437,251	1,453,948	1,465,045	+7.7 %
Lower Austria	1,518,489	1,535,083	1,568,949	1,605,897	1,636,778	1,653,691	1,665,753	+9.7 %
Carinthia	560,708	560,696	558,926	557,998	557,641	560,482	561,077	+0.1 %
Burgen-land	277,529	276,226	278,032	283,697	288,356	291,011	291,942	+5.2 %

Table 6.29: Population growth by federal province,
Source: Bevölkerung

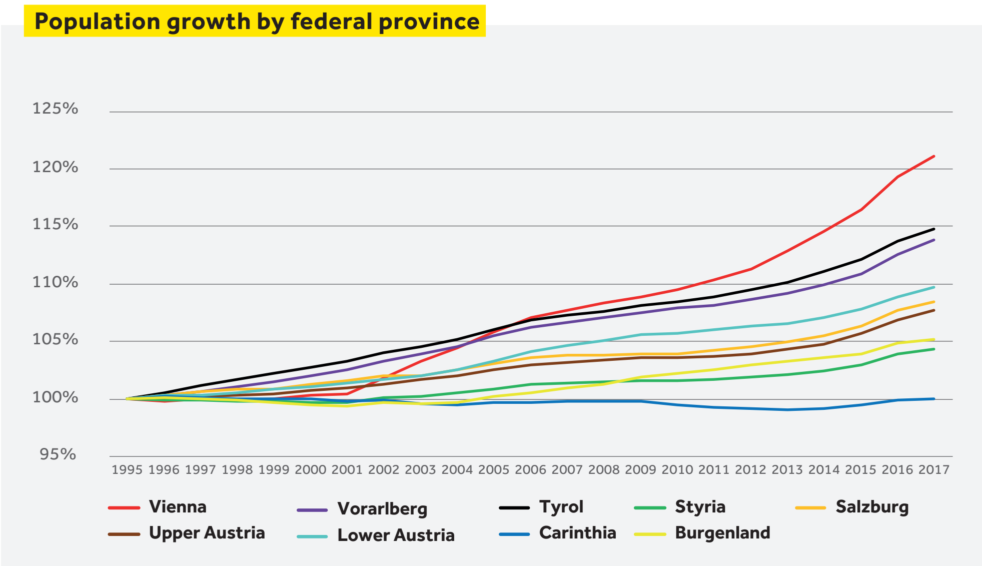

Fig 6.38: Population growth by federal province, 1995 – 2017,
Source: Bevölkerung

7. Glossary

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.

Combustible waste
includes industrial waste and the non-renewable share of domestic waste.

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.

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.

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.

Ice day
is a day on which the maximum temperature is below 0°C.

emikat.at
is a data management system of the Austrian Institute of Technology (AIT) that provides an emissions inventory based on emitters.

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.

Energy flow chart
is a chart depicting the energy flows within a given system, such as the City of Vienna, in one year.

Frost day
is a day on which the minimum temperature goes below 0°C.

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.

Kilowatt peak (kWp)
is the peak power of a solar module under strictly defined standardised test conditions.

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.

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.

Combined heat and power (CHP)
is the cogeneration of electrical energy and heat, for example in a heating plant.

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

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.

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.

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.

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.

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.

Conversion losses
refers to the energy that is lost during the conversion of primary energy to secondary or useful energy.

More information about Municipal Department 20:
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Publishing information

Owner and publisher
Vienna City Administration, Municipal Department 20 – Energy Planning

Vienna City Administration, Municipal Department 20 – Energy Planning
Municipal Department 20 – Energy Planning, *www.energieplanung.wien.at*
Mag. Bernd Vogl, Dipl.-Ing. Herbert Ritter, Ing.[in] Ursula Heumesser,
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Energy Center Wien at UIV Urban Innovation Vienna GmbH
Dipl. Ing.[in] Monika Valuch, BSc

Design concept, illustration, layout
buero bauer, www.buerobauer.com

Photos
MA 20 / Kromus

Printed at
Magistratsabteilung MA 21B - Druckerei der Stadt Wien

Printed on ecological CO_2-compensated paper produced
following “Ökokauf Wien” criteria

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