Energy! ahead

Energy Report of the City of Vienna
Year of reporting 2020 / Data for 2018

Stadt Wien | Energy Planning Department

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Vienna: Committed to becoming climate neutral by 2040

Energy is central to our lives. It provides fresh food, helps our children cope with the fear of the dark at night, connects us to the world and takes us from one place to another. Without energy from fossil energy sources, our modern society would not exist. But without the energy transition and the move to renewable energy sources, we will not be able to overcome the climate crisis. Cities like Vienna play a crucial role in expanding renewable energy.

Already, over half the world population lives in cities. The increasing urbanisation poses particular challenges for cities: they need a lot of energy in a very small area, and that energy often still comes from fossil sources, such as gas, oil and coal. To reduce greenhouse gas emissions, cities have to reduce their energy demand through efficiency measures on the one hand and use renewable energy such as photovoltaic energy or wind power on the other.

Currently, our lives seem to revolve around the Covid-19 pandemic, but that does not mean the climate crisis is on hold. In fact, it is the same as with Covid-19: the longer we wait to act, the worse the consequences and the more expensive it becomes to combat it. We cannot afford to lose any time.

Vienna is aware of this responsibility and has set ambitious goals for the coming years: Vienna will become climate neutral by 2040. To achieve this, we are expanding the use of solar energy, assessing whether municipal buildings are suitable for photovoltaic installations, and using solar power in municipal housing. Thanks to the amendment of the Building Code, new residential buildings will have to be built with PV installations. The use of buildings for energy storage is also being expanded.

The City of Vienna is committed to making large changes in the next years and implementing mandatory instruments that allow us to take targeted measures and reach our climate goals effectively. It is important to me to involve the people of Vienna in this process, because the participation of everyone is the key to successful climate protection. We can only face these challenges successfully if there is wide-spread acceptance of the measures – and acceptance is born out of participation. We all share one goal: a good life for everyone that does not come at a cost for our children.

Jürgen Czernohorszky
Executive City Councillor for Climate Protection

The paradigm shift is happening

We are already in the middle of the energy transition. We are seeing promising changes in many areas, and took important steps towards ensuring climate-compatible energy supply in the last year.

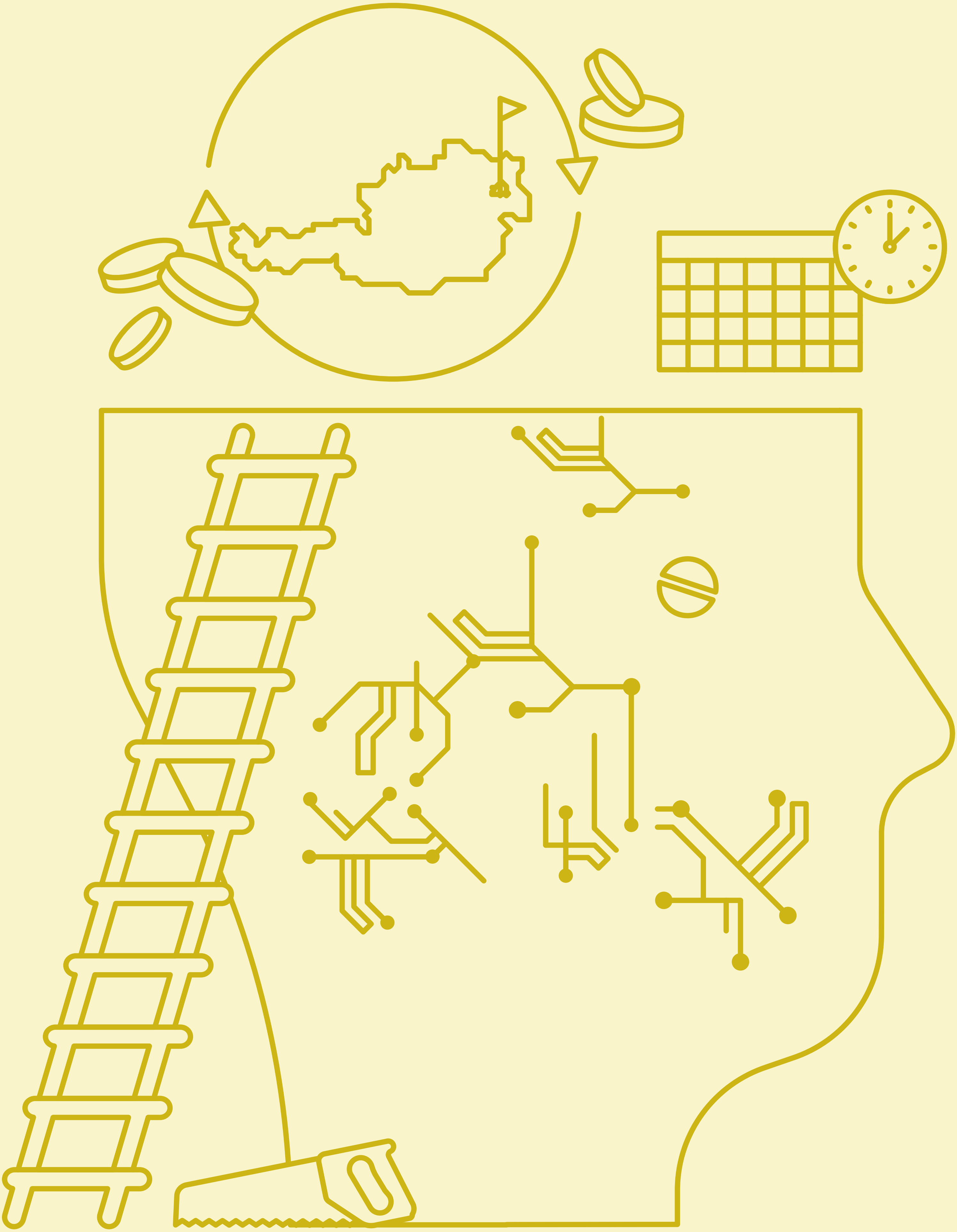
An important part of that are the climate protection zones, which have already been established in nine Viennese districts. In these zones, new buildings may no longer be built with oil- or gas-based energy supply systems. Only renewables and district heating are allowed, providing green, climate-compatible energy.

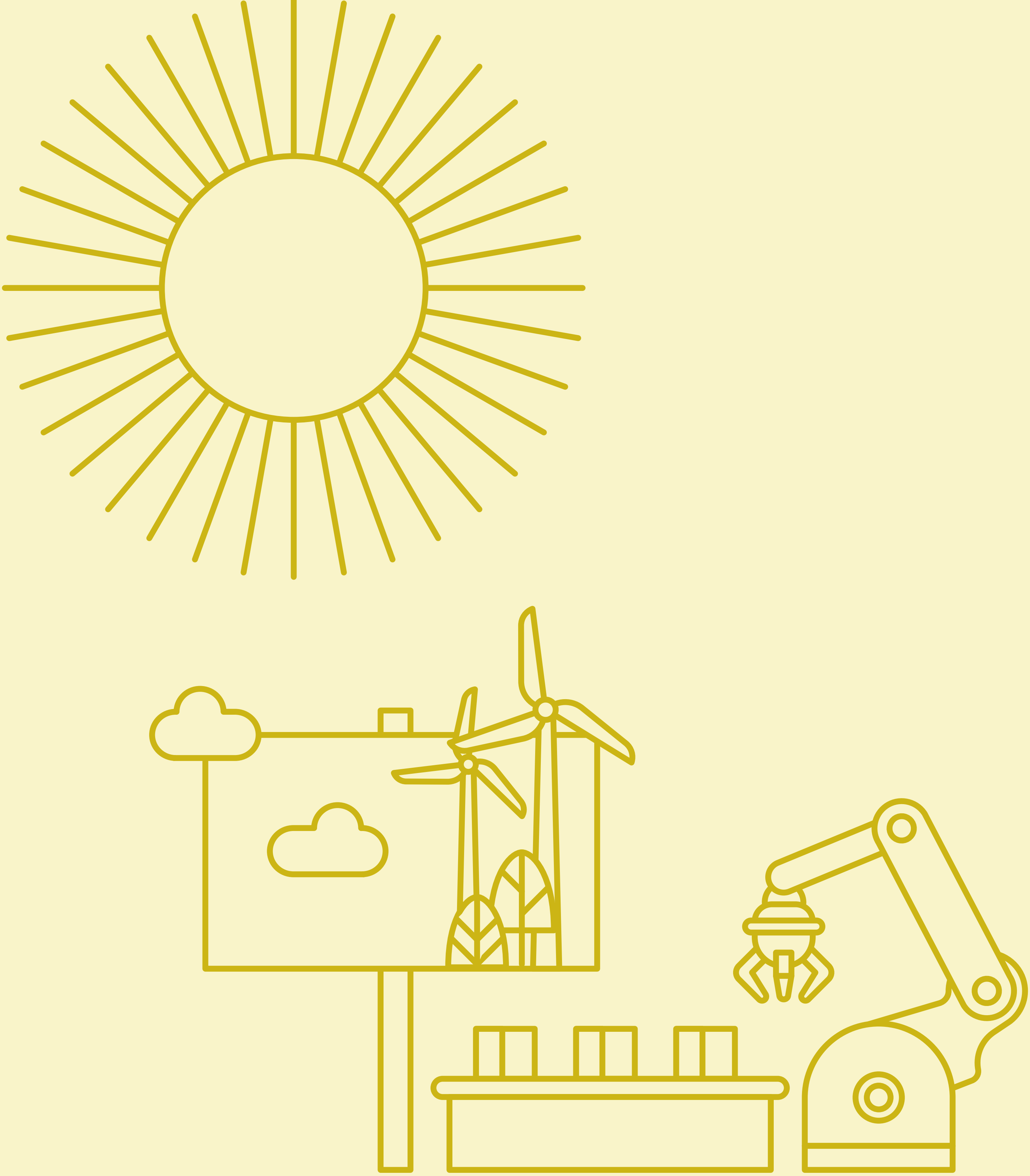
In 2020, the EU programme Deep Demonstration provided important momentum on the path to a climate-friendly future. Together with representatives of the economy, civil society and politics, the city strengthened existing initiatives and developed ambitious solutions and ideas for a climate-conscious Vienna, which was also important preparatory work for the European Green Deal.

Another highlight is the innovative education campus that is currently being built in Urban Lakeside Aspern Nord. Its heating and cooling demand will be met nearly exclusively from renewable sources, with over 95% of the energy generated on site from renewable sources. The remaining energy is supplied through the grid from renewable sources.

We are still facing enormous tasks and challenges when it comes to reaching the necessary greenhouse gas reduction targets. But with the current support for the energy transition coming from many different directions we see great opportunities for the Energy Planning Department of the City of Vienna.

Bernd Vogl
Head of the Energy Planning Department
of the City of Vienna





Energy projects and activities for Vienna's energy future

2 Energy projects and activities for Vienna's energy future

Implemented between 1 July 2019 and 30 June 2020

2.1 Deep Demonstration – the programme for more climate protection in cities

https://www.wien.gv.at/stadtentwicklung/energie/deep-demonstration-projekt.html

In 2020, the EU initiative EIT Climate KIC supported the City of Vienna on the path to achieving climate neutrality sooner. As one of 15 European cities, Vienna was part of the Deep Demonstration programme. Together with representatives of economy, civil society and politics, the city strengthened existing initiatives and developed ambitious solutions and ideas for a climate-conscious Vienna, which was also important preparatory work for the European Green Deal.

Bernd Vogl

"With the climate protection programme Deep Demonstration of EIT Climate KIC, we took some important steps on the road to a climate-friendly future in 2020. In 2021, we will continue along this ambitious path, as laws must be adapted and climate protection measures must be initiated now to ensure that we can reach the 1.5 degree target of the Paris Agreement."

BUNDLING AND REINFORCING CLIMATE PROTECTION EFFORTS

The focus of the initially one-year Deep Demonstration programme is on preparing measures for climate protection and adaptation to climate change. The aim is to reduce harmful greenhouse gases in the city in the long term. At the same time, it is important to develop concepts and solutions to slow down overheating in summer, and to make the city more resilient to and prepared for the consequences of the climate crisis.

Sarah Haas

"Talking with innovators and start ups is productive: together with over 100 different actors, the City of Vienna developed solutions for decarbonisation and resource conservation in a number of workshops as part of Deep Demonstration."

Together with economic and political actors as well as community members, the City of Vienna is developing future-proof solutions and ideas for a climate-friendly city. The focus is on the topics of urban renewal and energy supply, urban planning and green infrastructure, mobility, climate budgets as a steering instrument, innovation and the business location, as well as participation and social justice.

Roman Grünner

"The City of Vienna has been implementing various climate protection projects and efforts for years. Deep Demonstration showed us that more cooperation is important. If all departments have the same mission and are working together to implement it, we can achieve the maximum benefit of every single project and effort."

https://www.youtube.com/watch?v=CJbcUFGVvZU

The City of Vienna develops climate protection solutions together with actors from large companies, start ups and the field of innovation in workshops and networking meetings.
© Lea Fabienne

2.2 Innovative energy solutions in subsidised housing

To promote innovation with regard to sustainability and energy in subsidised housing, a developer competition was launched in 2019 for a development at Waldrebengasse in the 22nd district. The focus of the competition was on developing affordable and sustainable timber housing with sustainable energy supply.

The project is part of a city partnership with Vancouver in Canada, which is coordinated by the Energy Planning Department of the City of Vienna. The cities are exchanging know-how and experiences in the field of green building and its feasibility in subsidised housing. A project in Vancouver looks at the Vienna Model of social housing and how it can be applied to the local conditions in Vancouver. The housing complex at Waldrebengasse in Vienna, in turn, draws on the Canadian partner city's traditional experience in timber construction. Both housing projects will be built to the highest efficiency standards and maximise the use of renewable energy.

A SUSTAINABLE ENERGY SYSTEM AS A CORE REQUIREMENT

Subsidised housing in Vienna is subject to special requirements in terms of energy efficiency and quality of the building technology. Since 2007, only highly efficient alternative energy systems may be used, with exceptions only made if they cannot be implemented.

The property developer competition challenged building developers to use alternative energy systems and make do completely without the use of fossil fuels. Moreover, the development site at Waldrebengasse is not connected to the Vienna district heating network. Therefore, the Vienna housing fund wohnfonds_wien, which organised the competition, took a new approach in cooperation with the Energy Planning Department of the City of Vienna. The invitation to tender contained a detailed requirement for "sustainability and alternative forms of energy". It explicitly demanded renewable heating and categorically ruled out the use of fossil fuels. It also stipulated the use of surface heating solutions to allow their use for cooling in the summer.

Property development competition Waldrebengasse flipbook: https://www.wohnfonds.wien.at/media/file/Neubau/abgeschl_wettbewerbe/BTW2019_22_Waldrebengasse.pdf

Winning project: https://www.lainer.at/projekte/wald

Rüdiger Lainer + Partner Architekten ZT GmbH won with their concept and will implement the innovative timber project at Waldrebengasse
© oln.at

The approach was successful: Unusually many teams participated in the competition. All ten submitted projects were extremely innovative in terms of sustainability and offered a wide range of timber engineering approaches. Experienced timber engineers and building services engineers were involved in all teams. As a result, all projects were planned to a high standard and well suited for implementation.

Bernd Vogl

"The Waldrebengasse project demonstrates feasible solutions for two major issues that all cities worldwide are currently faced with: the need to build affordable housing on the one hand, and the search for carbon-neutral and sustainable building solutions on the other."

2.3 Heat transition – towards carbon-neutral space heating

Space heating and hot water account for approximately 40 percent of final energy consumption in Vienna. Despite successes in climate protection in recent years, space heating still holds a lot of potential to reach the carbon neutrality goals of the Paris Climate Agreement. To bring about a transition in heating, it is therefore important to make full use of renewable energy potentials. Both the use of renewable energy sources and the development of sustainable heating networks can be supported through energy spatial planning. In addition, the existing infrastructure for heat supply (gas and district heating network) needs to be transformed in the long term.

2.3.1 An end to gas in new buildings

Vienna is making history and setting an important milestone for a crisis-proof and renewable energy future. When the first climate protection zones were established by ordinance at the end of June 2020, the phase-out of fossil gas supply for buildings began. New buildings in climate protection areas have to be constructed with climate-compatible energy supply.

Vienna's districts 2, 7 and 16 were the first to get climate protection zones. Districts 3, 8, 9, 18 and 19 followed at the end of September 2020. The remaining districts will follow gradually by the end of 2021. New buildings in these zones can use renewable energy sources or district or local heating networks for space heating and hot water. This means there is still freedom of choice, but climate-damaging fossil energy sources can no longer be used for heat supply in climate protection zones.

New buildings in climate protection zones are supplied exclusively with highly efficient energy systems, such as renewable solar energy.
© Stadt Wien/C.Fürthner

The most effective method in fighting the climate crisis is the reduction of climate-damaging greenhouse gases. The climate protection zones ensure that over 80 percent of new buildings will have climate-friendly HVAC systems. The greenhouse gas emissions avoided in this way will contribute significantly to achieving the climate goals of the Smart City Vienna.

Andrea Kinsperger

“We are entering a new era. Especially now that there is a lot of construction activity in Vienna, we have to invest in climate-friendly buildings. If the energy transition is to succeed, we must cut back fossil gas use. This is about averting the looming climate crisis. By using green regional energy, we are strengthening Vienna’s resilience in terms of energy supply.”

2.3.2 Decarb Cities Forum 2020 – time to design carbon-neutral cities!

Experts from the fields of urban planning, research and politics met in Vienna for the Decarb Cities Forum at the beginning of 2020. The conference provided a platform for cities across Europe to exchange innovations, solutions, ideas and new technologies for CO_2-free heat supply.

Anna Ausstaller (Energy Planning Department of the City of Vienna) presented the heat map for Vienna at one of the networking tables where participants exchanged experiences and know-how.

Cooperation partners: The Decarb Cities Forum 2020 was organised by the European Heat Pump Association, the Energy Cities network, the Covenant of Mayors for Climate and Energy, and the Austrian heat pump association Wärmepumpe Austria. The Energy Planning Department of the City of Vienna supported the expert meeting.

Katri Kuusinen (head of the Urban Environment Division of the City of Helsinki) presented her city’s action plan Carbon Neutral Helsinki 2035. With it, the Finnish capital is setting an example for other cities in terms of the heat transition.

Photos: © Stadt Wien/Johannes Wiedl

Stephan Brandligt (Energy Cities Vice-President and Deputy Mayor of Delft, Netherlands) talked about the strategy of the Dutch government, which gives cities a big role in shaping the heating strategy.

2.4 Renewable energy makes economic sense

The costs of heating systems that use renewable energy sources can already compete with gas heating systems, with heating costs up to 55% lower. Calculated over 20 years, the total cost of renewable systems is up to 30% lower. The investment costs are slightly (less than 10%) higher than for gas heating systems.

Expert opinion: https://www.wien.gv.at/stadtentwicklung/energie/erp/pdf/gutachten-heizung.pdf

Heat pumps are particularly worthwhile. The running costs are significantly lower than for gas heating. This is not only borne out by practical experiences from residential and school construction, but also confirmed by an expert opinion commissioned by the Energy Planning Department of the City of Vienna. Especially when the possibility of using heat pumps for cooling on particularly hot days is factored in, these systems are already cheaper than gas.

This is especially beneficial for vulnerable parts of the population that suffer particularly from heat, such as the elderly, the sick and children. This solution is also better for the urban climate: in contrast to conventional air-conditioning systems, heat pumps do not release heat into the environment when used for cooling. Real estate experts expect that cooling systems will have an increasing impact on the value of flats.

In addition to the advantage of allowing cooling, the operating costs of heat pumps are also lower because the majority of the energy used comes from the sun, ground water, or geothermal sources, which are free. They also need less maintenance than gas-based systems.

Stefan Sattler

"A big advantage of energy solutions with heat pumps is that they can not only be used to heat, but also to cool a building in summer, with no need for electricity-hogging air conditioners. Moreover, heat pumps can be operated with renewable electricity from solar power plants or wind farms."

2.5 Buildings as energy storage

Thermal mass activation is important for the increased use of renewable energies, as a major challenge in using the wind and sun as sources of renewable electricity is their fluctuating availability. Therefore, it is good to store surplus energy for later use, for example in concrete ceilings of new buildings.

The new residential complex Neues Leben at Mühlgrundgasse in the 22nd district is the first subsidised housing project to use concrete core activation. The non-profit housing developer Neues Leben built the complex with its 155 flats, a third of which are subsidised, together with real estate developer M2plus Immobilien GmbH.

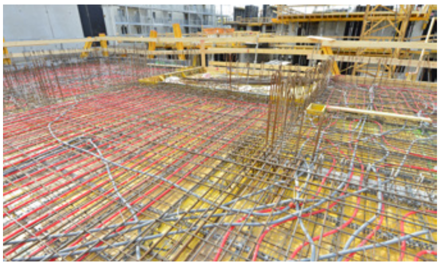
What is special about the project is that the energy demand for heating and cooling is nearly completely covered with renewable energy, using exclusively on-site ambient heat and heat pumps. For the residents, this means pleasant indoor temperatures all year round.

The heat pumps are powered with electricity from a nearby wind farm. However, this green electricity is only used when strong winds generate particularly large amounts of electricity. The excess electricity powers the heat pumps, which generate heat in winter and cool the flats in summer. Another advantage of the system is that heat can be stored in the ground via heat exchanger fields. Thanks to this sophisticated energy concept, only about a quarter of the energy demand of the heating and cooling system has to be covered using conventionally generated electricity, e.g. when no electricity is being generated at the wind farm.

Thomas Kreitmayer

"The secret to the nearly fully renewable energy supply at Mühlgrundgasse is that consumption is adapted to the available energy production. Energy storage has an important function when it comes to increasing the share of renewables in the building sector. Mühlgrundgasse is the first subsidised housing project with concrete core activation. It demonstrates that such systems can already be implemented at a reasonable cost."

Mühlgrundgasse is home to the first social housing project that uses concrete core activation for heating and cooling. © MA20/C.Fürthner



Hot or cold water is pumped through these pipes to heat or cool the building. © MA 20/A. Kromus

Renewable energy sources combined with concrete: A total of 30 borehole heat exchangers provide geothermal energy for efficient use in low-energy systems. © MA 20/A. Kromus

2.6 Vienna subsidises fossil-free mobility

The transport sector is the city's largest energy consumer and the largest source of climate-damaging greenhouse gases. For this reason, the Energy Planning Department of the City of Vienna launched two innovative funding schemes at the beginning of 2020 under the Vienna Green Electricity Fund. A total of EUR 2.8 million is available for energy-efficient mobility until the end of 2021.

VIENNESE BUSINESSES APPRECIATE ELECTRIC CARGO BIKES

The first of the two subsidy schemes provides attractive incentives for green commercial transport in Vienna by subsiding the purchase of electric cargo bikes for

Viennese businesses with up to EUR 4,000. This subsidy encourages Viennese entrepreneurs to reduce the use of cars. Especially within the city, even larger loads can be transported sustainably and energy-efficiently using electric cargo bikes.

The subsidy has been very well received. Around 90 percent of the business owners said that they had not previously used electric cargo bikes. Around 85 percent said that the uncomplicated parking situation was highly relevant to them, followed closely by wanting to switch to CO_2-free commercial transport. A majority of business owners also considered the potential time and costs saved and the image boost highly relevant.

Applications and further information on the subsidies: https://www.wien.gv.at/stadtentwicklung/energie/foerderungen/effiziente-mobilitaet.html

https://www.youtube.com/watch?v=IkUrMn2Dkrw

Viennese business owners appreciate the advantages of electric cargo bikes. The subsidy is also available for electric cargo trailers and adaptations to specific uses (e.g. superstructures, transport boxes, etc.) as well as the installation of data trackers and additional batteries. © D. Blacher / © D. Shaked (top)

ALTERNATIVES TO FOSSIL MOBILITY IN HOUSING ESTATES

The second subsidy is available for mobility sharing projects in larger housing estates that make vehicles available for residents to borrow. At least one of them has to be an electric car. Other vehicles, such as electric bicycles or electric scooters, can also be offered. This allows residents to make do without owning a car, saves energy and reduces CO_2 emissions. The first projects funded under this scheme are already being implemented, and range from joint building ventures to a large-scale project for multiple housing complexes.

Herbert Ritter

"With these two new funding schemes, Vienna is boosting energy-efficient and climate-friendly urban mobility. The subsidies accommodate many different needs, and the projects so far show the range of what is possible. We are using the funded projects to collect the experiences made in this new area."

2.7 Renewable energy potentials shown on the Vienna city map

Numerous renewable energy sources are available within Vienna's boundaries. The online city map at wien.gv.at shows what they are and where they are located. The maps for the thematic area "Energy" were updated this year.

https://www.wien.gv.at/stadtentwicklung/energie/themenstadtplan/index.html

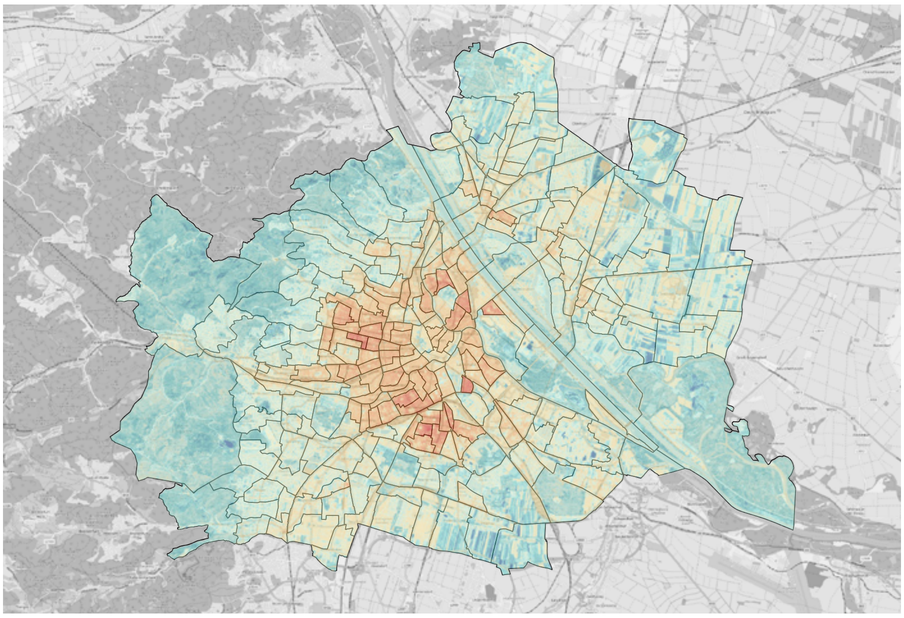
The geothermal potential cadastre, which shows the potential for groundwater and geothermal energy, was updated. The energy potential of wastewater was measured for the first time. Heat from Vienna's sewer system is a largely untapped potential source of energy. The wastewater potential map provides a first assessment of possible locations for plants for wastewater heat use and highlights potentially thermally usable sections of the Vienna sewer network. These data are being entered into the online city map continuously starting in 2020. The information on solar energy potential on roofs was also updated in 2020. In addition, the solar potential cadastre will also include an estimate of actual usable potential based on empirical data. The cadastre will be renewed in approximately five-year intervals.

2.8 Heat map helps climate change adaptation

The advancing climate crisis is making extreme weather such as heat waves more common. The increasingly hot summers are exhausting for the city's residents. Vulnerable population groups such as the elderly, the sick or children, as well as pets, suffer particularly from high summer temperatures. In order to provide relief where it is needed, it is crucial to know the potential problem areas. With the heat map, the City of Vienna now has data at its disposal to identify the locations in the city where cooling is most urgently needed.

https://www.wien.gv.at/stadtentwicklung/energie/hitzekarte.html

Red – temperature: the darker the hotter.
Blue – children and elderly: the darker the more of them live here.
Green – green spaces and water: the greener the more are available.



The heat map shows 10 hot zones, i.e. areas that are particularly affected by heat. They are located predominantly in densely built-up areas in the 5th, 10th and 16th districts. The red zones show areas that are particularly hot, with few green spaces or bodies of water and a high proportion of at-risk population.

QUICK TEMPORARY RELIEF MEASURES: COOL STREETS

Based on the heat map, several streets and squares were chosen to be transformed into so-called Cool Streets during the summer months. In the Cool Streets, temporary and, above all, fast measures against the heat are implemented during the summer. In this way, the City of Vienna creates cool oases in especially hot parts of the city that allow people to spend time outdoors, play and cool off in the neighbourhood. These “outdoor living rooms” offer additional seating, playground equipment, and misting systems for people to cool down. The first Cool Streets were very positively received by the population. For this reason, the city decided to expand the initiative to 21 streets in summer 2020. In addition, 4 streets or squares will be permanently redesigned as “Cool Streets Plus”. Trees, light-coloured surfaces, and infiltration areas, as well as seating and water features characterise these redesigned places.

https://www.wien.gv.at/verkehr-stadtentwicklung/coolestrasse.html

The “Cool Streets” provide relief in summer and a place to relax.
Photos: © Mobilitätsagentur Wien/ C.Fürthner

2.9 Energy highlights from the Vienna City Administration

2.9.1 Continuing the energy focus at the education campus

In the Urban Lakeside Aspern, the city‘s first education campus with a highly sustainable energy system is being built. The campus will be supplied almost entirely with renewable energy. The energy required will be generated directly on site through solar power and geothermal energy. The education campus will be completed by autumn 2021 and will offer space for 1,400 students.

For this project, the company "FIN – Future is Now – Kuster Energielösungen GmbH" developed an innovative energy concept based on concrete core activation in combination with heat pumps and geothermal energy. Since the campus is also open all summer, a sustainable way of preventing overheating in summer was of particular importance. Through intelligent planning and design, the building can be heated and cooled year round and largely self-sufficiently with sustainable on-site energy.
A green façade provides natural shading and rounds off the resource-efficient design concept in a visually appealing way.

A total of 54 borehole heat exchangers were installed for the education campus in the northern part of Urban Lakeside Aspern in summer 2019.

Step 1: The construction site in the summer of 2019. The overground portion of the underground line U2 is visible in the background. The two black coils in the foreground are the heat exchangers.

Step 2: Close up: the heat exchangers are delivered as coils of elastic pipe.

Step 3: The drilling rig installs the heat exchangers bit by bit. Over 9,000 lever movements are needed to lower one heat exchanger to a depth of 150 m.

Step 4: On the right is the control console, which is used to operate the drilling rig manually. Up to two heat exchangers can be inserted into the ground in one day.

The drill head up close.
Photos: © MA20/A.Kromus

Step 5: Done: In the foreground, the top end of a borehole heat exchanger is visible - the other end is embedded 150 m deep in the ground.

EDUCATION CAMPUSES WITH SUSTAINABLE ENERGY – FOLLOWING THE EXAMPLE

— Another education campus for approximately 1,100 students is being built in Atzgersdorf in the 23rd district by September 2022. To optimise construction costs and ensure long-term cost-effective operation, low-tech approaches are being pursued particularly when it comes to energy supply. To this end, the project uses passive architecture to avoid excessive use of technology wherever possible. Important aspects include natural lighting, natural ventilation, structural shading and using ambient energy (cool night air, cool soil, etc.) to prevent overheating in summer.

— An education campus with similar energy supply is also being built in Deutschordenstraße in the 14th district by 2022.

— Two further projects will be built in Rappachgasse the 11th district in and in Landgutgasse in the 10th district by September 2023. Here, too, special attention will be paid to summer suitability and optimised life-cycle costs. Furthermore, only renewable energy technologies will be used.

2.9.2 Optimising energy consumption in schools

Energy supply is a significant cost factor in the construction of a building. Much more significant, however, are the follow-up costs arising from the choice of energy system, which have a direct impact on its life-cycle costs and thus on its cost effectiveness.

Three existing schools were analysed with regard to energy. Three buildings of different sizes, with different energy supply systems and different ownership structures were evaluated. The study investigated how the goals defined during the planning phase were ultimately implemented, how the operation of the system worked in practice, whether cost and savings goals (in terms of energy) were achieved and, finally, whether the desired comfort parameters were being met by the respective solutions. In addition to the energy input and output (e.g. radiators, panel heating, etc.), it also looked at how the desired indoor air quality is achieved (particularly window ventilation or mechanical ventilation) and how satisfied the teachers and children are with the systems. The findings will be used to define specific requirements for future projects.

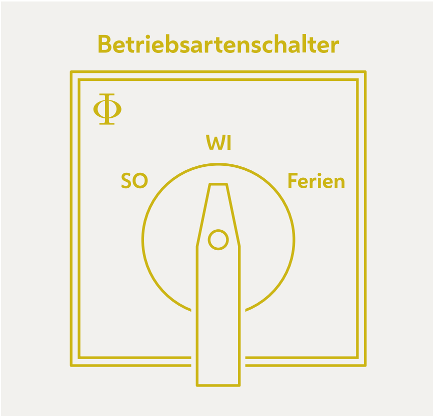
2.9.3. Reducing energy consumption in municipal buildings

Incorrect heating settings cause unnecessarily high energy consumption. Very often, small changes that can be implemented at low cost are sufficient to ensure energy-efficient operation of the systems.

In order to permanently reduce the energy consumption of buildings of the City Administration, it is worth taking a closer look at the district heating consumption. Every year, the temperature difference between the flow and the return is checked for abnormalities in municipal buildings that are supplied with district heating. If there are any abnormalities, the causes are identified and then fixed. Substantial savings can be achieved simply by optimising the control system or replacing temperature sensors that provide incorrect readings.

SMALL CHANGE, BIG IMPACT

So far, the energy consumption of 150 buildings has been optimised. This has resulted in annual energy savings of around 2,200 MWh. In total, around EUR 1.6 million and 10 tonnes of CO_2 emissions have been saved since 2014. Experience shows that optimised operation and regular maintenance of the systems can achieve annual energy savings of 10 to 30 percent. In some cases, even up to 40 percent energy (district heating and electricity) can be saved through simple optimisation measures.



A simple switch: This switch allows even laypeople to operate the HVAC system safely and easily, switching between winter, summer and holiday mode. This saves energy and costs. The primary school in Krottenbachstraße in the 19th district, for example, was equipped with this switch, ensuring energy-efficient operation.

Ursula Heumesser

"This initiative shows that even the smallest, most inconspicuous efficiency measures generate high savings over time."

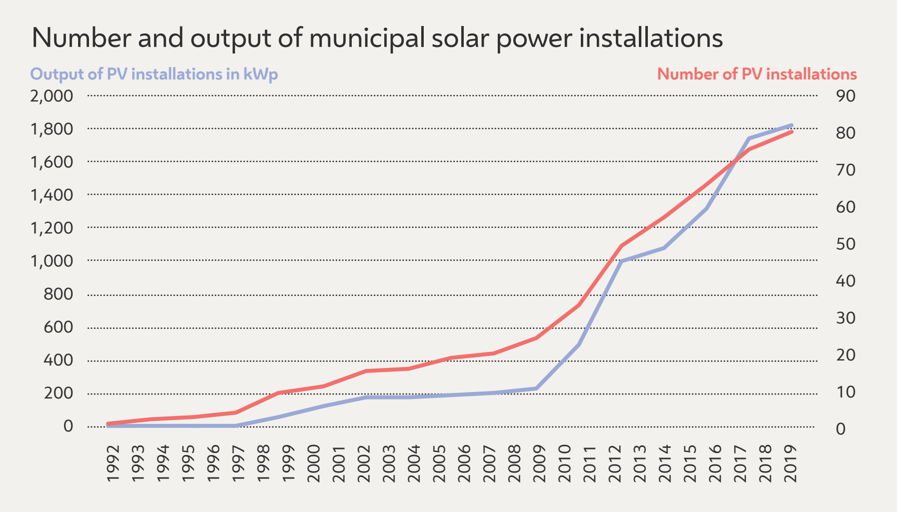
2.9.4 Energy data at a glance

The city is setting up a central energy data management system that will make it possible to identify potential for improvement even faster and to optimise energy consumption permanently. The aim is to set up a system that enables the collection, analysis and annual evaluation of energy consumption data at the building level in municipal buildings. With these sound data available, it will be possible to take targeted measures for individual buildings, such as refurbishment or optimising the heating system. All data collected are quality-checked and maintained in line with the Data Excellence Strategy.

The first energy data report was prepared in 2019. It maps the current status of electricity and heat generation and consumption in municipal buildings. In addition to the energy data, it presents information on the building stock and the annual energy costs of the Vienna City Administration. Based on this information, the report presents recommendations and starting points for the optimisation of municipal buildings in Vienna. The report serves to further develop and improve energy data management.

SOLAR POWER BY THE CITY ADMINISTRATION

An impressive amount of solar energy is generated on municipal buildings: over 80 installations on administrative buildings, kindergartens and schools, at swimming pools and at waste collection centres generate heat or electricity using power from the sun.



Number and output of municipal solar power installations

2.10 Participation in national and international projects

2.10.1 Promoting carbon-neutral heat supply

The provinces of Vienna, Salzburg and Styria are pioneering new planning principles for a carbon-neutral heat supply. For this purpose, they are developing a digital heat atlas together with Austrian research partners. It will serve as a central instrument for spatial energy planning to support carbon-neutral solutions for space heating. The digital heat atlas can also be used to plan other climate protection objectives, such as heat prevention measures or improving energy efficiency.

The heat atlas is the core of the Spatial Energy Planning for Heat Transition project. The aim of the project is to create the foundations and tools for spatial heat planning in Vienna, Salzburg and Styria.

Starting in these three provinces, the heat atlas is intended to promote the use of innovative and sustainable heat solutions and, ultimately, support the heat transition throughout Austria (and beyond). The Energy Center of Urban Innovation Vienna coordinates the work of the project partners from Vienna and the involvement of stakeholders.

ENERGY INFORMATION AT A GLANCE

The digital heat atlas will be accessible to interested stakeholders within and outside the city administration. It will provide a quick and reliable view of how much energy individual buildings or city districts need for heating and cooling. In addition, the digital heat atlas will show locations that are suitable for refurbishment initiatives, heating networks or renewable energy potentials in order to be able to supply the population with reliable, regional and affordable heat in the long term.

Further information at www.waermeplanung.at

The heat atlas is intended to provide planners and decision makers with a good starting point for developing energy plans for neighbourhoods (especially options for sustainable energy supply for an area or property), concrete refurbishment plans or heat relief measures. The digital heat atlas cannot replace concrete on-site planning, but supports it significantly. Therefore, this tool is also being integrated into ongoing urban planning processes.

The digital heat atlas is implemented as part of the city´s geoinformation system (GIS). A beta version will be available at the end of 2020 and will be tested in selected pilot areas. In addition, energy-related information will also be prepared for Vienna's municipal districts.

Herbert Hemis

"The digital heat atlas will be another milestone in successfully linking urban planning and energy planning."

2.10.2 Reliable energy data for sustainable planning

https://www.enerspired.city

Well-structured and sound energy data support the planning of sustainable energy systems in cities and municipalities. Within the framework of the national research project Enerspired Cities, Vienna is creating a joint data pool together with the cities of Salzburg and Innsbruck, the province of Salzburg, and research partners.

Energy-related basic data from a wide variety of sources will be made available to a broad range of users. One focus of the project was to consider the legal requirements (data protection, access authorisations) and the uniform preparation of the data – especially with regard to metadata. Therefore, the pilot implementation for Vienna was also closely linked to the activities of the Data Excellence Strategy. The project results form the basis for the "GEL SEP" project, which deals with the preparation, evaluation and analysis of information for various target groups.

2.10.3 Better service and higher quality for housing refurbishment

The thermal-energetic refurbishment of residential buildings not only increases the quality of living for residents, it also contributes significantly to the reduction of energy consumption.

The EU project RenoBooster aims to further promote refurbishment in private housing in Vienna and to significantly increase its quality. For this purpose, an information and service point ("Hauskunft") for refurbishment projects was created. Since 1 October 2020, it has been offering consulting services to owners of apartment buildings, flats or single-family houses on the refurbishment of their properties.

The service was developed with the participation of relevant actors from the real estate, construction, administration and financing sectors.

In addition to the City of Vienna as project leader, the partners in the consortium are wohnfonds_wien, Urban Innovation Vienna, the Austrian Real Estate Association, DIE UMWELTBERATUNG, e7 Energie Markt Analyse, 17&4 Organisationsberatung and the SORA Institute. The "RenoBooster" project was launched in 2019 and is scheduled to run for 3.5 years.

Caroline Stainer

"The aim of our one-stop information office ***Hauskunft*** *is to make refurbishment easier. After all, thermal-energetic refurbishment makes buildings fit for the future. It not only increases housing comfort, it also permanently reduces energy consumption, and with it, costs."*

2.10.4 Renewing the city together

Further Information at www.smartertogether.at

With the EU project Smarter Together – gemeinsam g'scheiter, Vienna, Munich and Lyon are promoting positive social dynamics and sustainable urban development in selected city districts. The focus is on effective measures for climate protection and for improving urban quality of life – such as integrated building refurbishment, climate-friendly energy systems or e-mobility. Experiences and research results are exchanged at local and European level. Santiago de Compostela, Sofia and Venice as well as Kiev and Yokohama also participate in this EU funding programme.

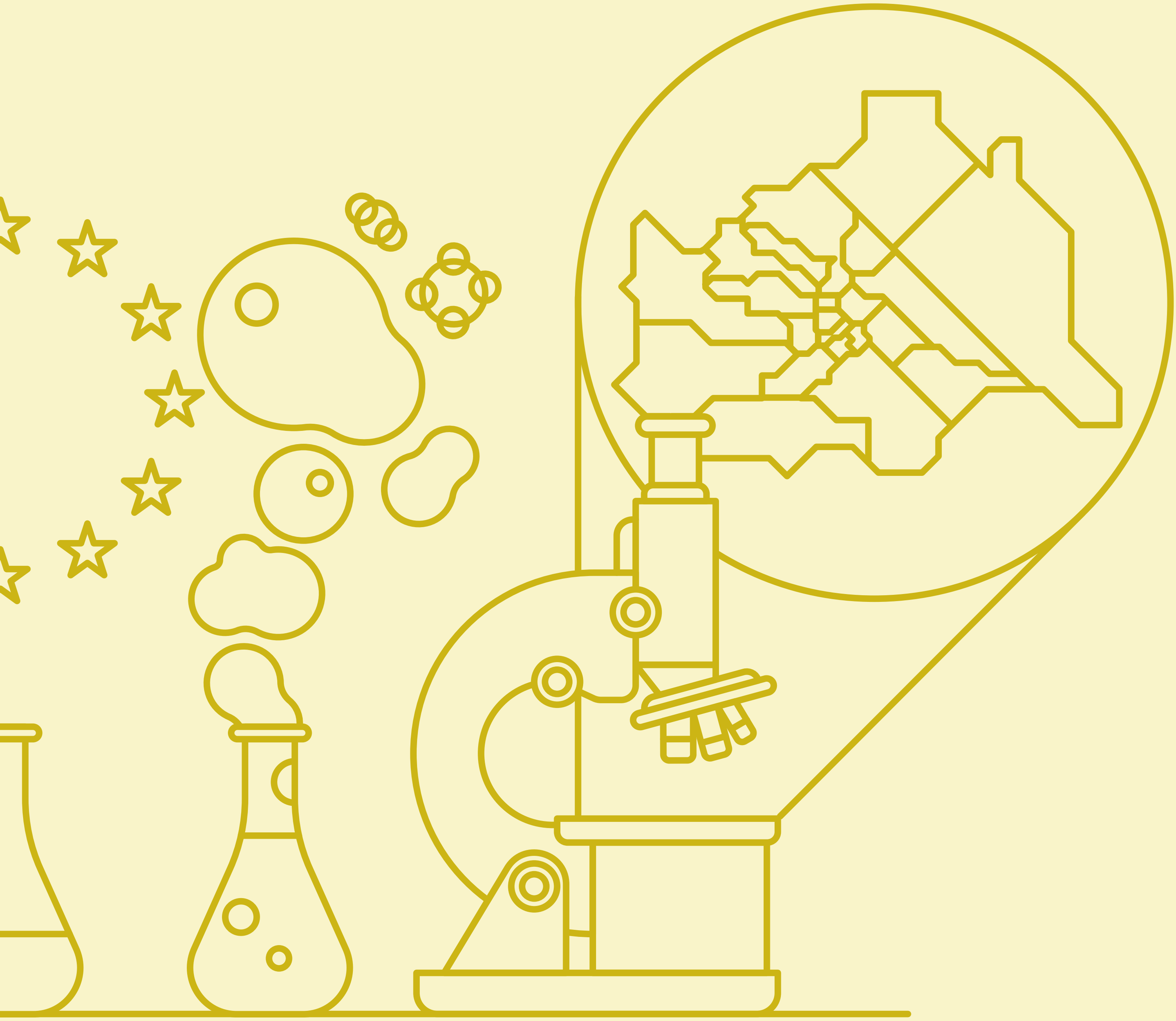
In Vienna, a large part of Simmering (the 11th district) is being renewed as part of Smarter Together under the leadership of Vienna's Urban Renewal department (MA 25). The Energy Planning Department of the City of Vienna is in charge of all energy-related matters in this project, such as processing energy data, developing the energy supply further, establishing a data platform, and visualising renewable energy in public spaces.

In 2019, the renovation of three residential complexes was largely completed, the zero-energy gymnasium of the schools at Enkplatz was completed and opened, and Vienna's first intermodal mobility hub was opened at the Simmering underground station. A solar thermal system was installed on the roof of the school building at Enkplatz, which feeds into the district heating network of Wien Energie. In the course of an "area screening", existing energy-relevant data was processed in detail, including an aggregated presentation of energy potentials at city block level and the calculation of energy demand down to individual buildings. The demand and the potentials were compared.

The measures will be evaluated through comprehensive monitoring, which will run until 2021. It will measure outcomes such as the amount of energy generated from renewable sources or the energy saved through the renovations.

Andrea Kinsperger

"Smarter Together is a fascinating opportunity for experimentation where the city is going beyond traditional refurbishment measures. It is rethinking not only the energy efficiency of the buildings, but the energy supply itself."



A wider view of energy and climate protection developments

3 A wider view of energy and climate protection developments

Worldwide trends and developments and the climate and energy policy objectives and decisions at the EU and the Austrian levels all have an impact on Vienna. At the same time, the City of Vienna is setting the course towards decarbonisation and actively shaping its energy future.

3.1 Global developments

3.1.1 Heat days on the rise

Globally, 2019 was the 43rd consecutive year that was too hot, and the second hottest year in the 140-year record of the NOAA's National Centers for Environmental Information, with an average temperature of 0.95°C above the 20th century average. Only 2016 was hotter, at 0.99°C above the long-term average. Since 1977, i.e. for the last 43 years, the average temperature has always been above the average of the entire last century. With the exception of 1998 (10th hottest year on record), the 10 hottest years were all after 2005; and the five hottest years were 2015 to 2019.

In Austria, 2019 was the third hottest year on record, after 2018 and 2014. With the exception of the fifth hottest year, which was 1994, the hottest 14 years were all measured between 2000 and 2019. In Vienna, the annual mean temperature at the Hohe Warte weather station in 2019 was on par with the previous record heat year of 2018, which was two degrees above the 1981-2010 mean and 2.7 degrees above the 1961-1990 mean.

3.1.2 Unpredictable fossil energy prices

Fossil energy prices have been subject to rapid fluctuations over the past year. The price of oil (WTI) was around US$55 a barrel at the beginning of the Covid-19 pandemic, then fell to around US$20 for a few weeks, before reaching a low of US$ -40.32 dollars (you were paid to take oil) in April. Currently, the price is on the rise again and at around US$ 40 dollars a barrel. The prices for coal, fossil gas and other oil grades also fluctuated, although less dramatically. Overall, prices for fossil fuels are currently below last year's levels, partly due to the marked drop in energy consumption.

The extreme and very short-term reactions of fossil energy prices are a reflection of how slowly fossil energy production adjusts to change and highlight the unpredictability of future energy price developments.

3.1.3 Drop in energy consumption – impact of Covid-19

Energy consumption dropped significantly in regions where drastic measures were taken against the spread of Covid-19, according to an analysis by the International Energy Agency. Electrical energy demand, for example, dropped to Sunday levels, or about 20 percent below average. In the EU, demand was still about ten percent below average at the end of June 2020, whereas China was back to its usual levels. Globally, the share of renewable energy in the electricity mix increased during lockdown measures and remained higher than before even after measures were eased.

3.2 Developments at the EU level

3.2.1 The European Green Deal – a strategy for a climate-neutral Europe

https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_de

Shortly after taking office as President of the European Commission on 1 December 2019, Ursula von der Leyen presented the "European Green Deal": a climate protection roadmap for the European Union until 2050. This growth strategy aims to secure the transition to a resource-efficient and competitive economy. The overarching goals are to

— achieve zero net emissions of greenhouse gases by 2050;
— decouple economic growth from resource use; and
— leave no person and no place behind.

To achieve the goals, the existing CO_2-reduction target for 2030 will be raised to at least 50 and towards 55 percent. This will require the Member States to adjust their National Energy and Climate Plans. The Emissions Trading System (ETS) will be expanded to include aviation and shipping, and a strategy for sustainable mobility will be developed, which will include restructuring local transport while taking e-car batteries into account.

The European Green Deal bolsters the efforts with a roadmap of concrete actions in policy areas that include clean energy, sustainable industry, building and renovating, sustainable mobility, biodiversity, agriculture and forestry, and financial market regulation. It outlines necessary investments and presents financing options.

The European Commission wants to mobilise one trillion euros in the next decade to achieve climate neutrality by 2050. To this end, the European Investment Bank will become a climate bank and funds will be made available from the EU budget (over EUR 500 billion), from investment programmes (around EUR 280 billion) and from Member States (over EUR 110 billion). In addition to technical assistance for the transition to a climate-neutral society, more than 140 billion will be made available to phase out coal.

The implementation of the European Green Deal will be complemented by legislative measures in 2021, including

— a European "Climate Law";
— the Renewable Energy and Energy Efficiency Directives (adjustments to parts of the Clean Energy Package adopted in 2018);
— a revision of the Energy Taxation Directive; and
— a legislative framework on the taxation of energy production and electricity.

In addition, measures for smart sector integration of electricity, gas, heat, transport and industry will be presented.

3.2.2 More transparency for green investments

In support of the European Green Deal, the European Parliament and the Council adopted a Taxonomy Regulation in June 2020. The aim is to make it easier for private investors to recognise environmentally sustainable and green investments and evaluate them using a uniform standard in order to channel more private funds into sustainable economic activities. The regulation entered into force in July 2020 and establishes six environmental objectives that an economic activity has to meet to be considered sustainable from 2022 (targets 3 to 6 from 2023):

1. climate change mitigation;
2. climate change adaptation;
3. sustainable use and protection of water and marine resources;
4. transition to a circular economy, waste prevention and recycling;
5. pollution prevention and control; and
6. protection of healthy ecosystems.

https://eur-lex.europa.eu/eli/reg/2020/852/oj?locale=de

The regulation requires financial market participants such as investment funds to evaluate their offered products following defined ecological and sustainability criteria. Only products that meet the criteria may be advertised as sustainable. Companies that also have to publish non-financial statements must disclose whether their activities are environmentally sustainable according to the new regulations. An economic activity is considered environmentally sustainable if it

— contributes substantially to the achievement of one or more environmental objectives;
— does not significantly harm any of those environmental objectives;
— is carried out in compliance with the established minimum safeguards (labour rights); and
— complies with technical screening criteria.

3.3 Developments at the national level

3.3.1 Energy and climate protection targets of the new federal government

On 7 January 2020, the new Austrian government was sworn in. In its coalition agreement, it included many energy-relevant goals that could give a boost to Vienna in achieving its ambitious energy and climate protection goals, including:

— Climate neutrality by 2040, made obligatory through the Climate Protection Act, including the definition of emission reduction paths to comply with the CO_2 budget derived from the Paris targets

— Electricity from 100% (national energy balance) renewable energy sources by 2030, including the definition of clear expansion targets for technologies (revision of the Renewable Energy Expansion Act). This requires an expansion by 27 TWh, which is to be distributed as follows:

  – Photovoltaics + 11 TWh (output 2018: 1.44 TWh) & 1 million roofs photovoltaics programme
  – Wind +10 TWh (Output 2018: 6.03 TWh)
  – Hydropower +5 TWh (Output 2018: 37.64 TWh)
  – Biomass +1 TWh (Output 2018: 4.93 TWh)

— Increase the refurbishment rate and quality of buildings by further developing housing subsidies and building regulations.

https://www.bundeskanzleramt.gv.at/dam/jcr:7b9e6755-2115-440c-b2ec-cbf64a931aa8/RegProgramm-lang.pdf

— Phasing out fossil fuels in space heating means a phase-out of all oil and coal heating systems by 2035 and a ban on the installation of gas boilers in new buildings from 2025. Development of a heating strategy for the complete decarbonisation of the heating market based on the following principles:

  – Promoting local and district heating contributes significantly to achieving the Austrian CO_2 reduction target in the non-ETS sector.
  – Phase-out of oil and coal in space heating is regulated by federal law and accompanied by subsidies to cushion social hardship. The phased plan prohibits the use of oil and coal in new buildings (from 2020) or when heating systems are replaced (from 2021), and requires the replacement of boilers older than 25 years from 2025 and the replacement of all boilers by 2035 at the latest.
  – The legal basis for the replacement of gas heating systems will be created analogously to the phased plan for oil and coal. It will include their prohibition in new construction from 2025 and a stop to the expansion of gas networks for space heating.

— Further development and amendment of the Energy Efficiency Act for the period 2021 to 2030 in accordance with EU Directives based on the following principles:

  – The proven system of combining strategic measures (tax law, regulatory law, subsidies) and an obligation on energy suppliers to implement energy-saving measures should remain in place.
  – Option to pay into a fund instead of energy saving obligations. The fund would be used to finance energy efficiency measures in households (with special consideration for social hardship cases).
  – The catalogue of eligible measures should be adjusted to include only measures that ensure verifiable energy reductions and are not based on a switch to fossil fuels.
  – The group of companies subject to energy audits will be expanded.

— Austria positions itself as a climate protection pioneer in Europe and advocates CO_2 tariffs at European level and a Paris-compatible adjustment of the EU's 2030 and 2050 target, and takes a stance against nuclear power and for the phasing out of coal throughout Europe.

— Austria will become the number one hydrogen nation.

3.3.2 National Energy and Climate Plan

The revised Austrian National Energy and Climate Plan (NECP) was submitted to the European Commission in December 2019. It details the Austrian efforts towards reaching the European energy and climate protection efforts. As the targets at the European level are being updated, a further revision of the Austrian NECP will be necessary.

The current government programme states that the NECP will

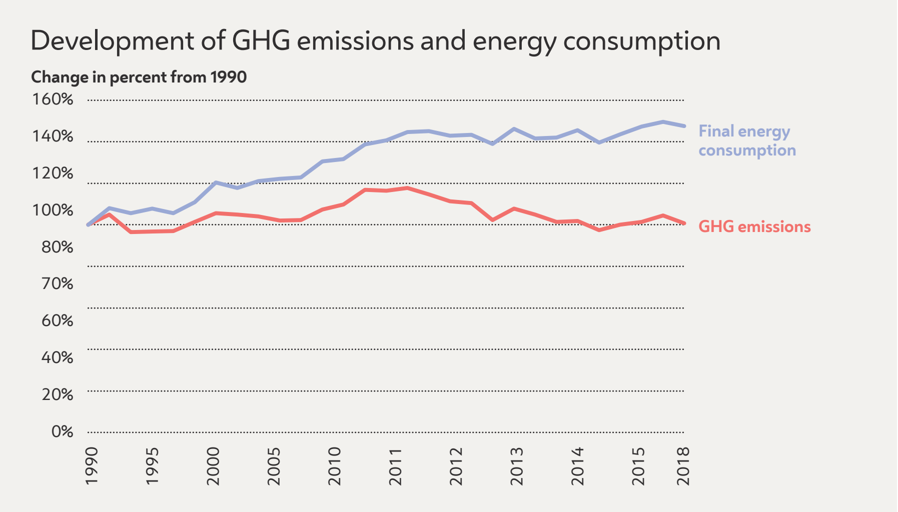
— reflect the expected increase in the Effort Sharing targets in the non-ETS sector;
— define responsibilities and a financing plan for all measures with a sufficient level of detail;
— be verified by independent and scientifically sound impact assessments to confirm the targets; and
— serve as a binding basis for climate protection.

3.3.3 Falling emissions, high energy consumption

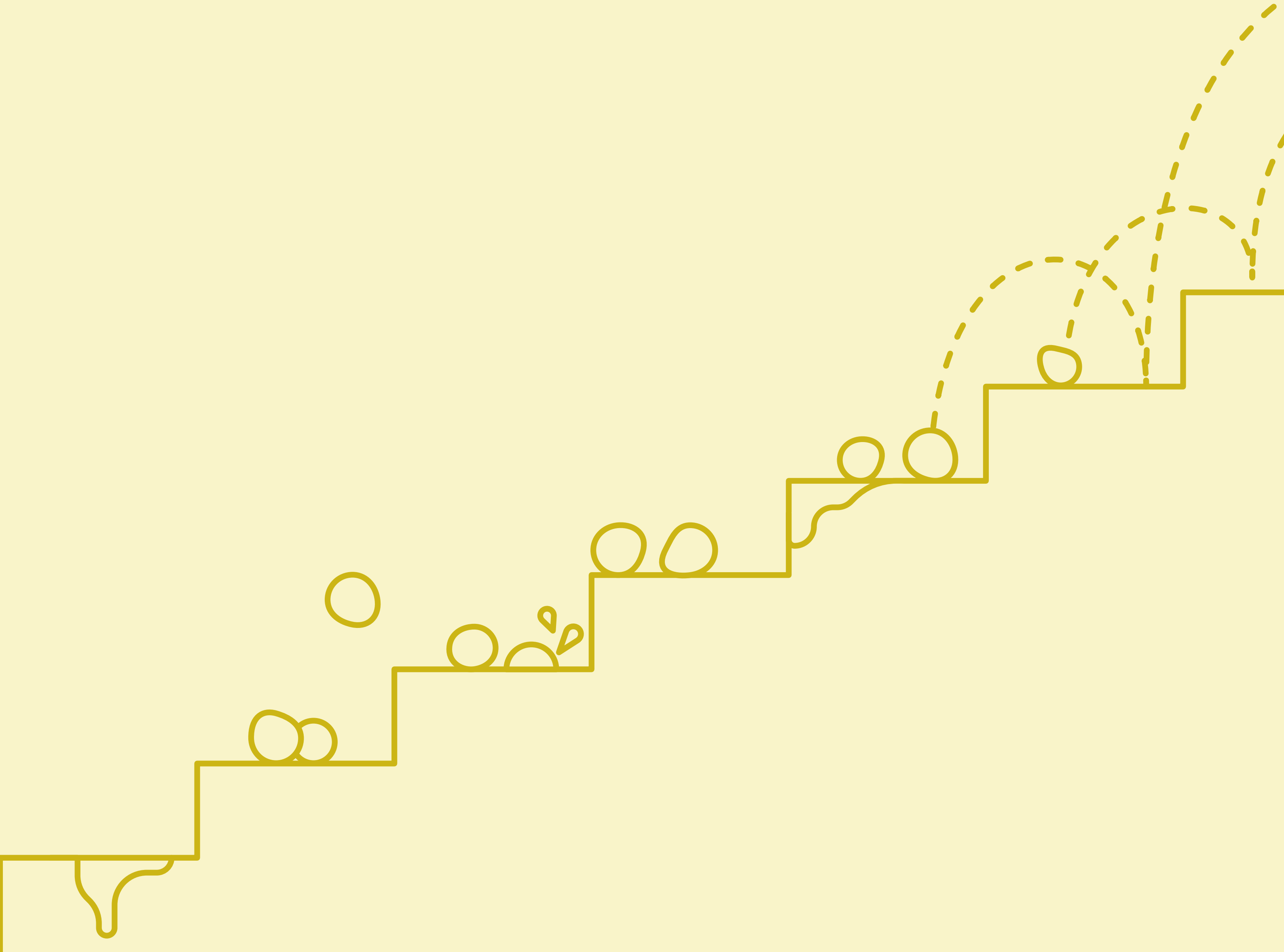
Austria's emissions in 2018, at 79,000 kt CO_2 equivalents, were about four percent lower than in 2017, but still slightly above 1990 levels. Compared to 2005, emissions went down by 15 percent.

The reduction in emissions compared with the previous year is attributable to the industrial sector (including the maintenance of a blast furnace at the VOEST steel mill) and lower emissions from energy conversion.

Energy consumption in 2018 was 313 TWh (1125 PJ), one percent lower than in 2017, roughly the same as in 2016, and two percent above the 2005 level. With the Energy Efficiency Act, Austria committed to reducing energy consumption to 1050 PJ by 2020, which corresponds to a reduction by seven percentage points within two years.



Emissions and energy consumption, Austria 1990-2018
Sources [Energiebilanz Statistik Austria] and [Luftschadstoffinventur Umweltbundesamt]



Energy – from generation to use

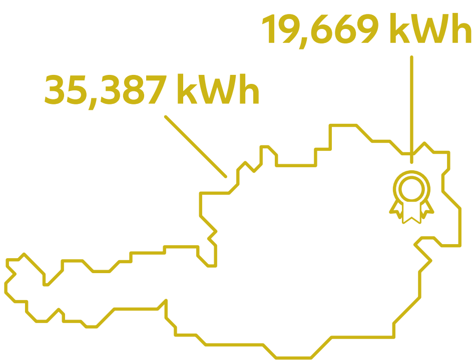
4 Energy – from generation to use

4.1 Top of the class: Vienna has lowest energy consumption in Austria

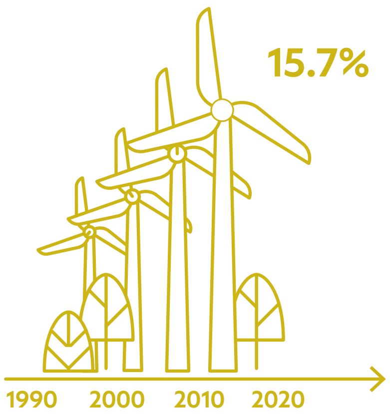
Vienna is ahead of the other federal provinces with regard to many climate indicators – in some cases far ahead. It is top of the class especially in the traffic and transport, building, and heating sectors. At 19,669 kWh per capita per year, Vienna has the lowest annual energy consumption of all of Austria. The Austrian average is 35,387 kWh per capita.

4.1.1 Overview of the main energy developments

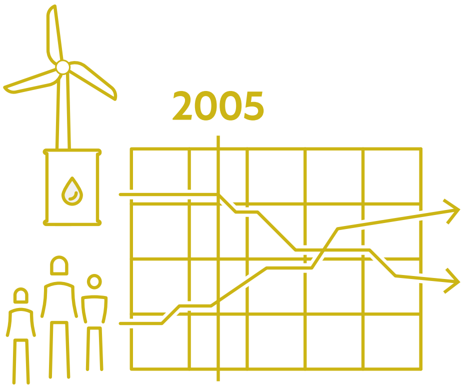
Interesting infographics comparing energy and climate data by provinces by the Energy Center of Urban Innovation Vienna: https://www.urbaninnovation.at/de/Projects/Infografiken-Energie



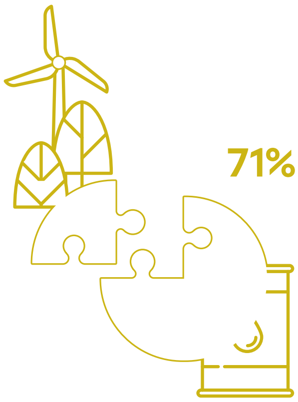
Vienna's energy consumption per capita is the lowest in Austria: 19,669 kilowatt hours a year.
By comparison, the Austrian average is 35,387 kilowatt hours.



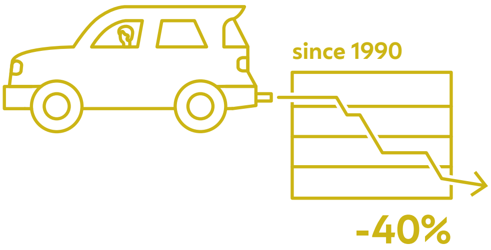
The share of renewables in final energy consumption including energy imports continues to rise in Vienna. It is currently at 15.7 percent.



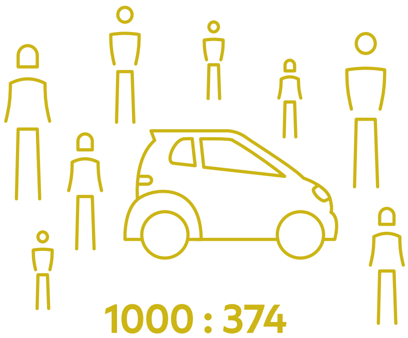
Despite strong population growth, Vienna's energy consumption has been sinking slightly since 2005.



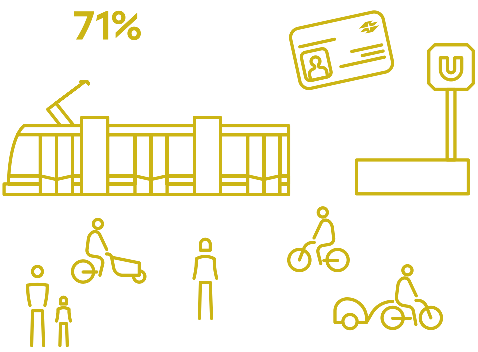
Fossil gas and petrol continue to dominate Vienna's energy consumption at approx. 71 percent.



The emission of harmful greenhouse gases per capita continues to go down (by some 40 percent since 1990).



The Viennese have the fewest cars in relation to residents of all federal provinces (374 cars per 1,000 inhabitants).



The upward trend of public transport use and cycling continues. Already, 71 percent of all trips are made by public transport, bicycle or on foot – 38 percent by public transport alone. More and more people also have an annual pass of Vienna Public Transport.

4.2 Energy flow chart of Vienna

4.2.1 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 2018 was 42,261 GWh. Approximately 10 percent of the energy needed is generated in Vienna itself, mostly from renewable sources and waste heat. 88.4 percent of the energy used comes from the surrounding region, with the fossil energy sources gas and oil making up the bulk of imports. Approximately 1.3 percent of energy is exported again; the rest makes up the gross inland energy consumption of Vienna.

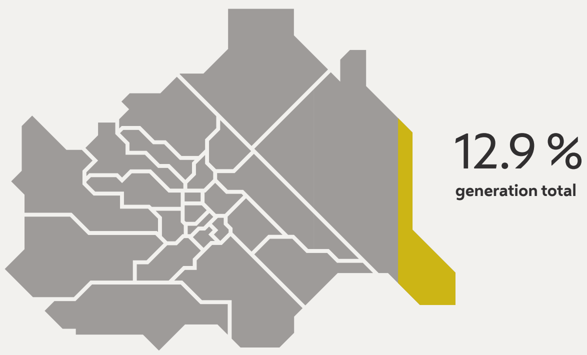
The energy flow chart shows a clear dominance of fossil energy sources (43% fossil gas and 33% fuels). Fossil gas is mostly converted into electricity and district heating. Fuels, on the other hand, are used nearly exclusively by the largest consumer, the transport sector. Nearly half the energy is lost in conversion, distribution, and mainly in end-user consumption.

Energy imports and energy generation

88.4 % Imports
32.8 % Oil
43.2 % Gas
8.1 % Renewables
0.0 % Combustible waste
1.5 % Waste heat
2.8 % Other fossil sources

1.3 % Exports

12.9 % Generation
8.8 % Renewables
4.0 % Combustible waste

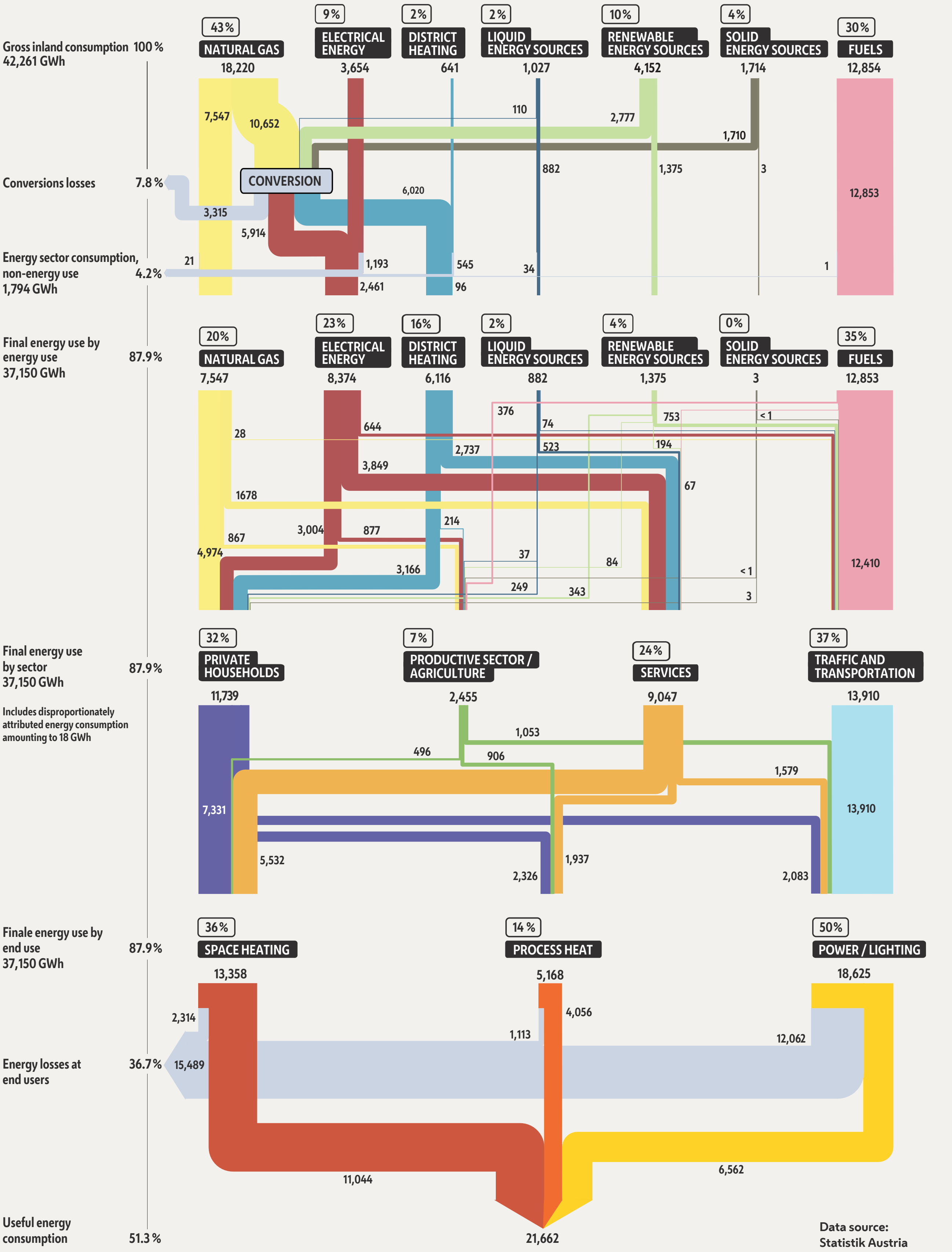


http://ma20.23degrees.io/#/sankey/00

https://ma20sg.23degrees.io/sankey/abwaerme_erneuerbar

In addition to the energy flow chart shown here, the Energy Planning Department of the City of Vienna publishes an animated, interactive version of the chart that allows a detailed analysis of energy flows. It also has 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.

Energy flow chart 2018 as at December 2019

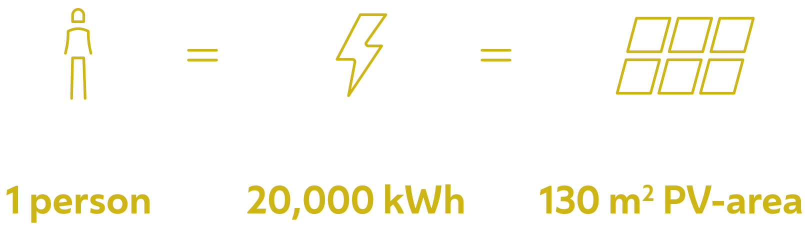


Energy unit: 1 GWh = 10^6 kWh = 3.6 TJ = 3.6 * 10^{12} Joule

Data source:
Statistik Austria
Energiebilanzen 2018
© MA20
Values are rounded.

4.2.2 Energy consumption in photovoltaic surface area

A good way of illustrating how much energy is used in the city is to convert the kWh or MWh into photovoltaic (PV) surface area: The area of PV panels that would be needed to generate the required energy with photovoltaics. 1,500 kWh, or a PV surface area of 10 m², would be needed to meet the electricity demand of the average Viennese resident.



To meet the total annual energy demand of a Viennese resident (including heating, mobility, etc.) of approx. 20,000 kWh, we would need a PV area of 130 m². The average Austrian would need an additional 100 m² of PV area to cover their higher energy consumption. In 2018, the average resident of the province of Upper Austria needed 290 m² 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

4.2.3 The energy flow chart in PV surface area

The gross domestic energy consumption of Vienna (42,261 GWh) is equal to a PV surface area of 275 km^2, or two thirds of the city's total surface area.

Out of this energy, approximately half is needed to compensate for losses:
— 29 km^2 PV area for losses in conversion and distribution to end users
— 100 km^2 PV area for end-user losses

Useful energy consumption in Vienna = 21,662 GWh
This is equal to one third of Vienna's area = 141 km^2 PV area

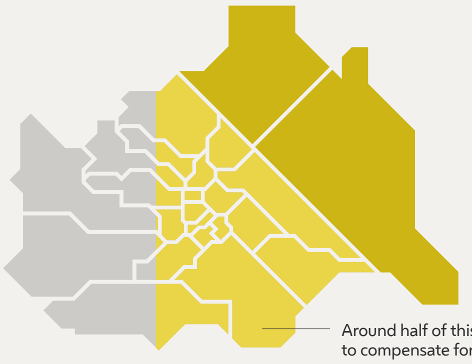
One third of Vienna's area corresponds to 37 times the size of the Danube Island, 24 times the size of the Prater, 15 times the Vienna International Airport, or the large 21st and 22nd districts taken together.

Energy consumption in photovoltaic area

The gross inland consumption of Vienna (42,261 GWh) corresponds to PV area

2/3

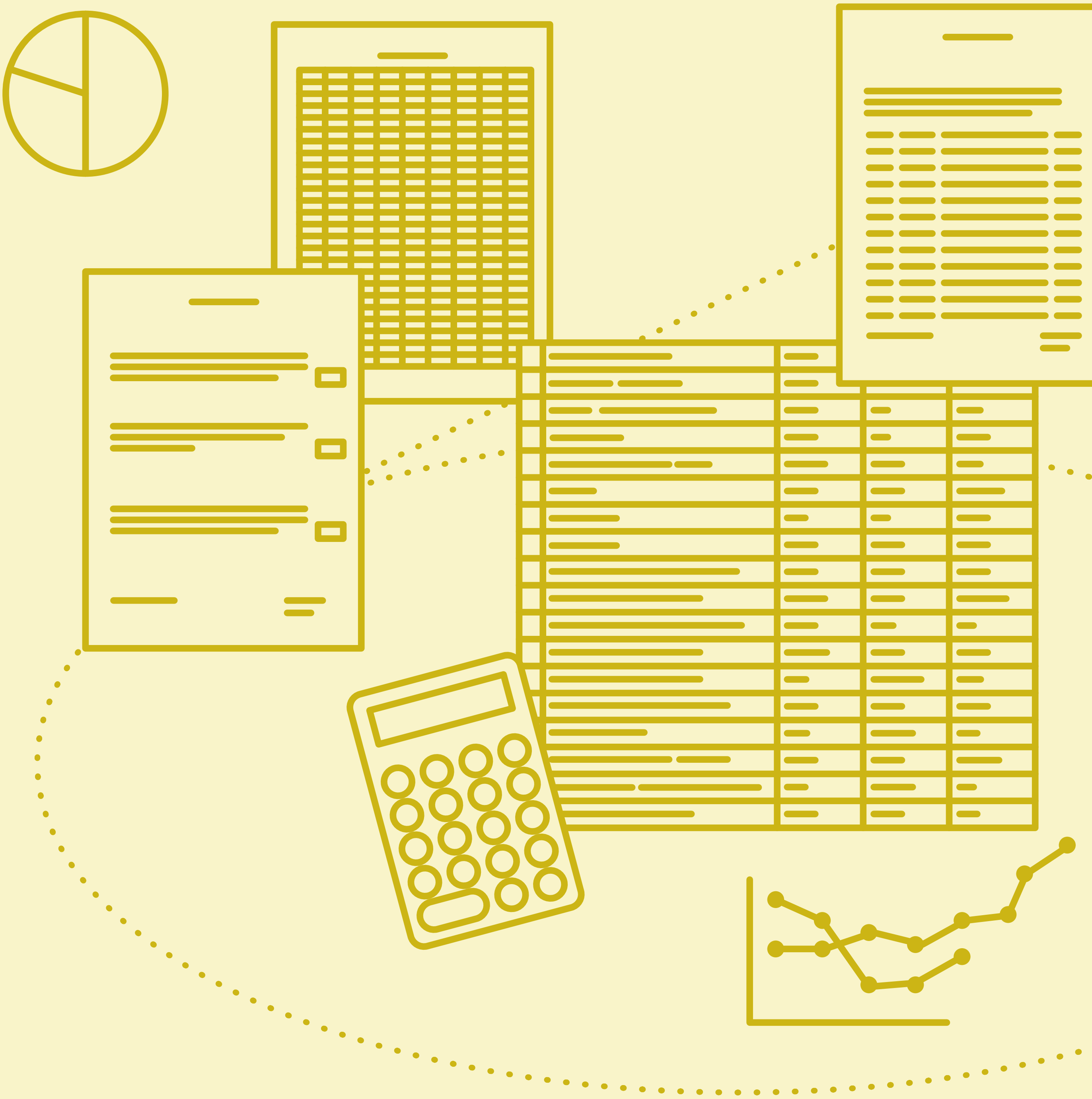
the size of Vienna
275 km²

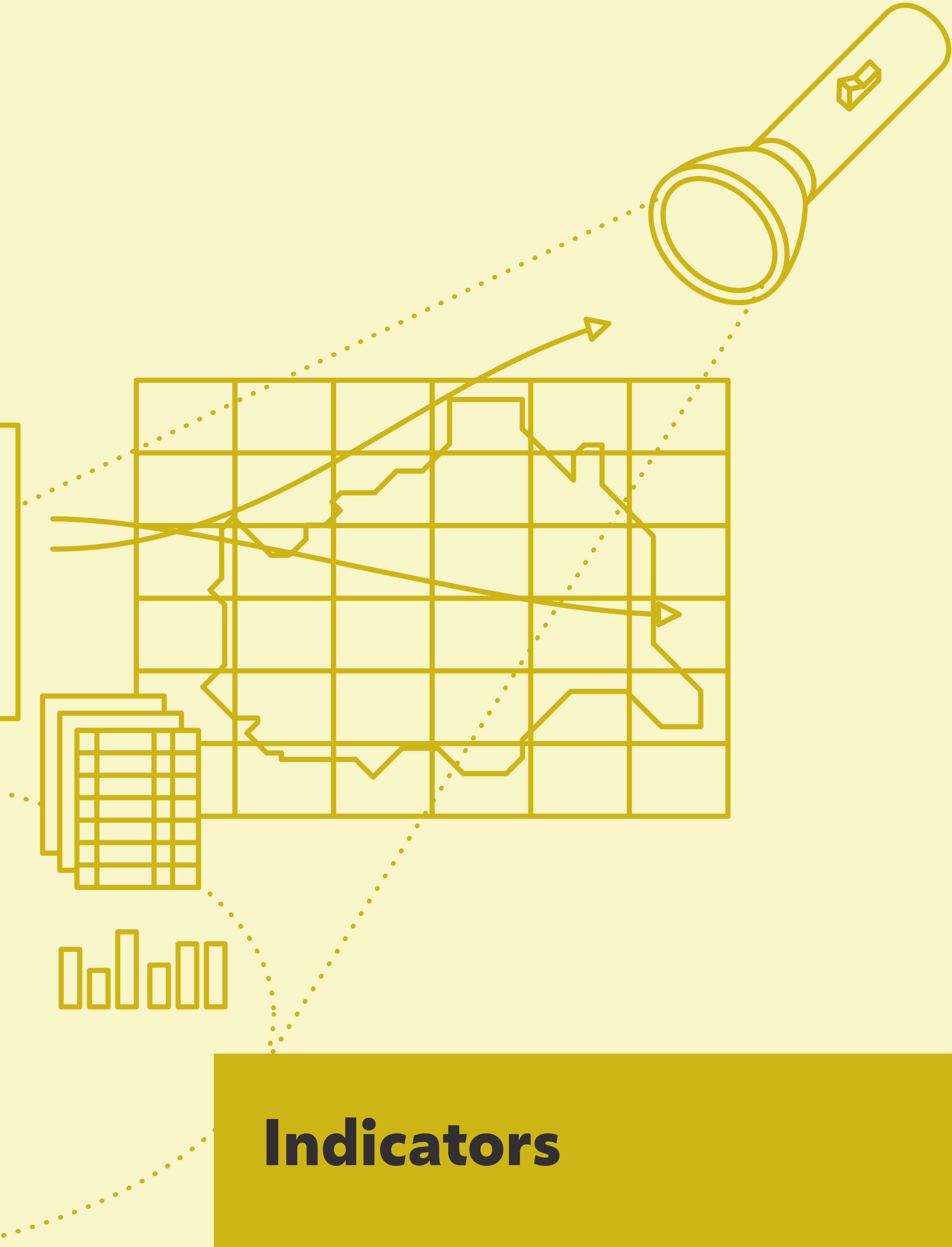


The useful energy consumption of Vienna (21,662 GWh) corresponds to a PV area

1/3

the size of Vienna
141 km²





Indicators

5 Indicators

This chapter presents indicators from the areas of energy, emissions, transport, population and climate in relation to the population and value added. The indicators show the development from 1995 to 2018 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 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 update of the strategy was completed in June 2019. As a result, this year's energy report uses revised monitoring indicators.

The Viennese have reduced their per capita energy consumption considerably since 2005, and Vienna is 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.

5.1 Indicators for the Smart City Wien Framework Strategy (SCWR)

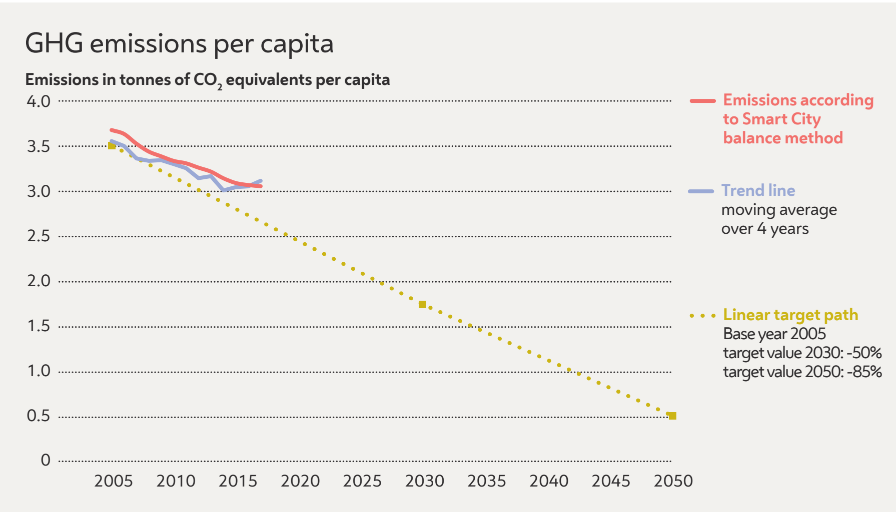
5.1.1 Resources

5.1.1.1 Local greenhouse gas (GHG) emissions per capita

Smart City Wien Framework Strategy objective: Vienna will reduce its local per capita greenhouse gas emissions by 50 percent by 2030 and by 85 percent by 2050 (from 2005 levels).

t CO_2 equivalents per capita	2005	2010	2015	2016	2017	Change [%] Base year 2005
Emissions according to SCWR balance method	3.51	3.22	2.93	2.94	3.01	-14.2%
Trend line, moving average over 4 years	3.64	3.26	2.98	2.95	2.94	-19.4%
Linear target path (Base year 2005; target values 2030: -50% & 2050: -85%)	3.51	3.15	2.80	2.73	2.66	-24.0%

GHG emissions per capita,
Sources [BLI 2017], [Bevölkerung Wien] and [SCWR]



GHG emissions per capita, 2005-2017 Sources [BLI 2017], [Bevölkerung Wien] and [SCWR]

Note: The emissions calculated with the SCWR balance method are Vienna's emissions in the BLI emissions survey conducted by the Environment Agency Austria with local traffic balancing (domestic traffic / second estimate), excluding emissions trading. The average population of each year is used to calculate emissions per capita.

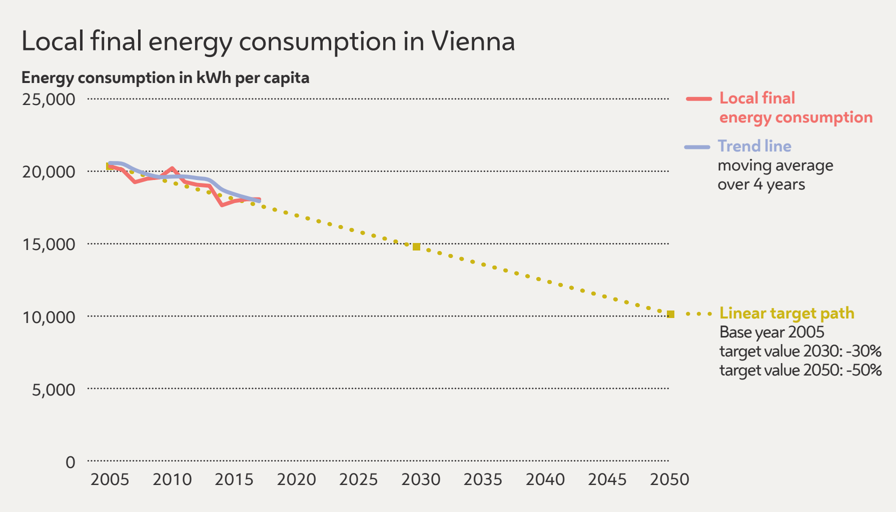
5.1.1.2 Local energy consumption per capita

Smart City Wien Framework Strategy objective: Vienna will decrease its local final energy consumption per capita by 30 percent by 2030 and by 50 percent by 2050 (from 2005 levels).

kWh per capita	1990	1995	2000	2005	2010	2015	2016	2017	Change [%] Base year 2005
Local final energy consumption	17,311	19,603	19,721	**20,345**	20,217	17,944	18,071	18,068	-11.19%
Trend line, moving average over 4 years		19,045	20,329	**20,577**	19,634	18,416	18,166	17,934	-12.84%
linear target path (base year 2005; target values 2030: -30% & 2050: -50%)				**20,345**	19,215	18,085	17,859	17,633	-13.33%

Local energy consumption per capita
Sources [Energiebilanz 2018], [BLI] and [Bevölkerung Wien]

Local final energy consumption per capita, 2005-2017
Sources [Energiebilanz 2018], [BLI], [Bevölkerung Wien] and [SCWR]



Note: Local final energy consumption is Vienna's final energy consumption according to Statistics Austria's energy balance with regionalised energy consumption of the transport sector.
The average population of each year is used to calculate energy consumption per capita.

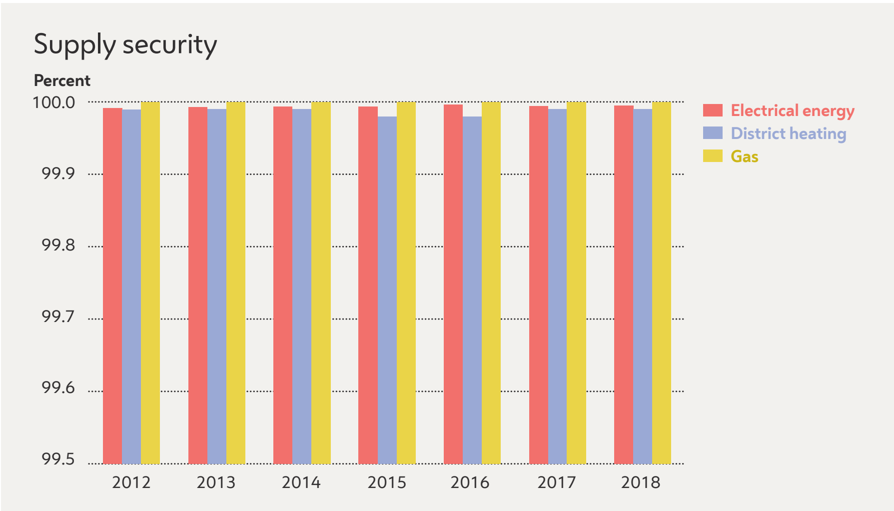
5.1.2 Energy supply

5.1.2.1 Supply security

Smart City Wien Framework Strategy objective: Energy supply security will remain at a high level.

	2012	2014	2016	2017	2018
Electrical energy	99.9914%	99.9937%	99.9963%	99.9945%	99.9949%
District heating	99.9895%	99.9900%	99.9800%	99.9900%	99.9900%
Gas	99.9996%	99.9996%	99.9998%	99.9998%	99.9998%

Supply security
Source [Wiener Stadtwerke]



Supply security, 2012-2018 Source [Wiener Stadtwerke]

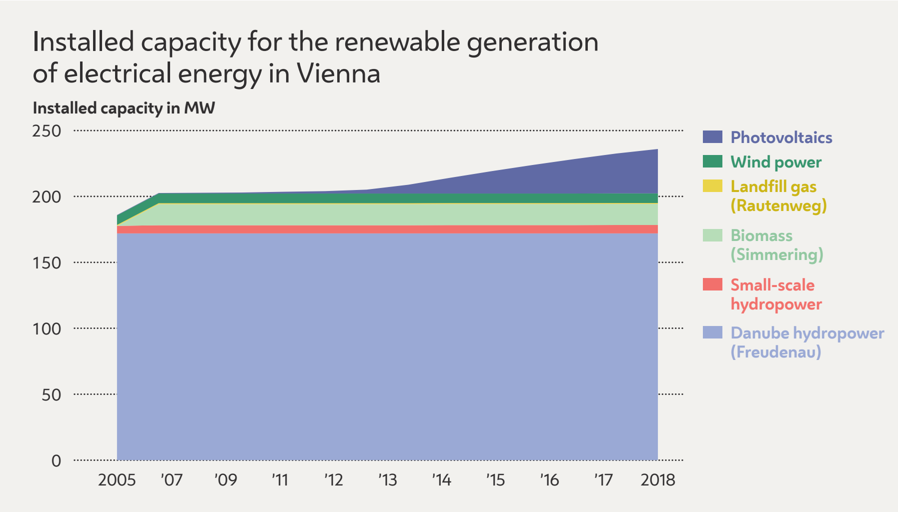
Note: Supply security indicates for how much time per year energy can be provided.

5.1.2.2 Decentralised renewable energy generation plants

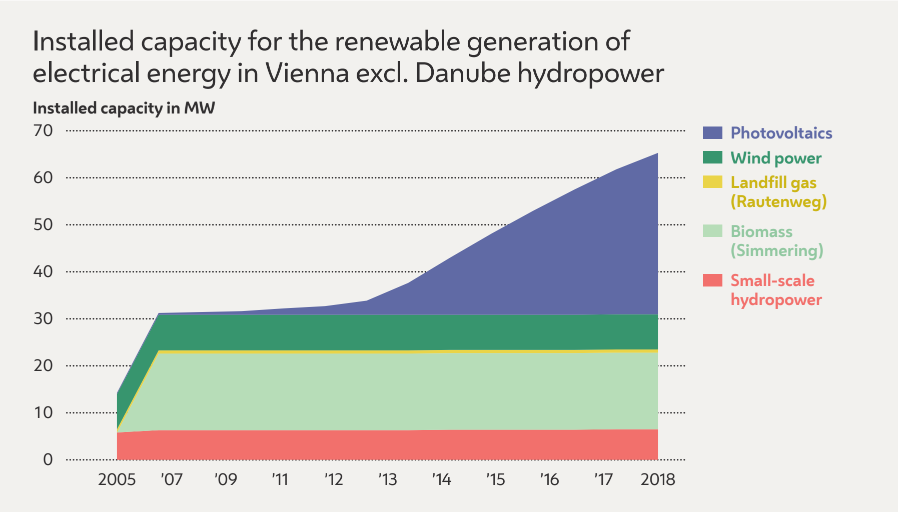
Smart City Wien Framework Strategy objective: Vienna's smart energy grid enables the decentralised generation of energy based on renewable sources.

MW	2005	2010	2015	2017	2018	Change [%] Base year 2005
Danube hydropower (Freudenau)	172	172	172	172	172	0%
Small-scale hydropower	6	6	6	6	6	12%
Biomass (Simmering)	0	16	16	16	16	
Landfill gas (Rautenweg)	1	1	1	1	1	0%
Wind power	7	7	7	7	7	0%
Photovoltaics	0	2	22	30	34	12511%
Total	186	204	224	233	236	27%
Total without Danube hydropower	14	32	52	61	64	359%

Installed capacity for the renewable generation of electrical energy
Source [Energiedatenbank MA 20]



Installed capacity for the renewable generation of electrical energy, 2005-2018
Source [Energiedatenbank MA 20]



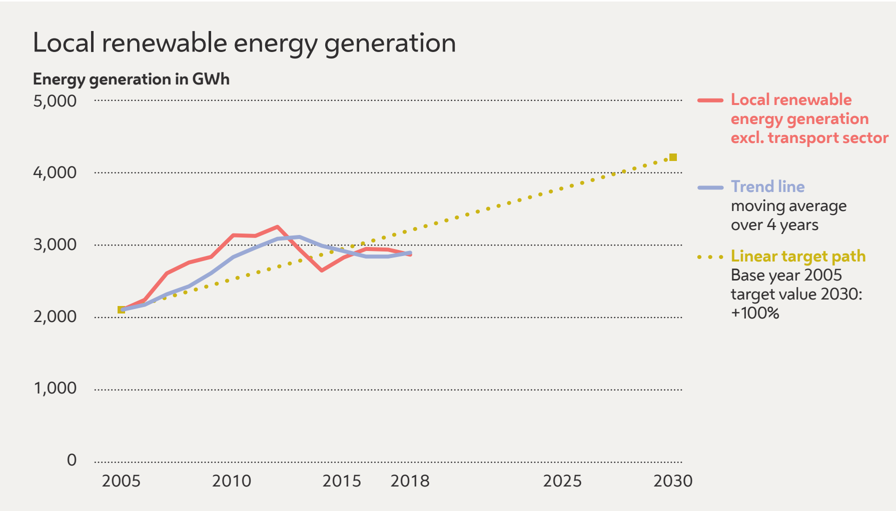
Installed capacity for the renewable generation of electrical energy
Source [Energiedatenbank MA 20]

5.1.2.3 Local renewable energy

Smart City Wien Framework Strategy objective: Renewable energy generation in the city will double from 2005 to 2030.

GWh per capita	2005	2010	2015	2017	2018	Change [%] base year 2005
Local renewable energy generation excl. transport sector	2,109	3,136	2,831	2,939	2,869	36.1%
Trend line, moving average over 4 years		2,837	2,918	2,842	2,897	
linear target value (base year 2005; target value 2030: +100%)	2,109	2,531	2,952	3,121	3,206	52.0%

Electricity and district heating generation from renewable sources plus renewable on-site energy
Source [Energiebilanz 2018]



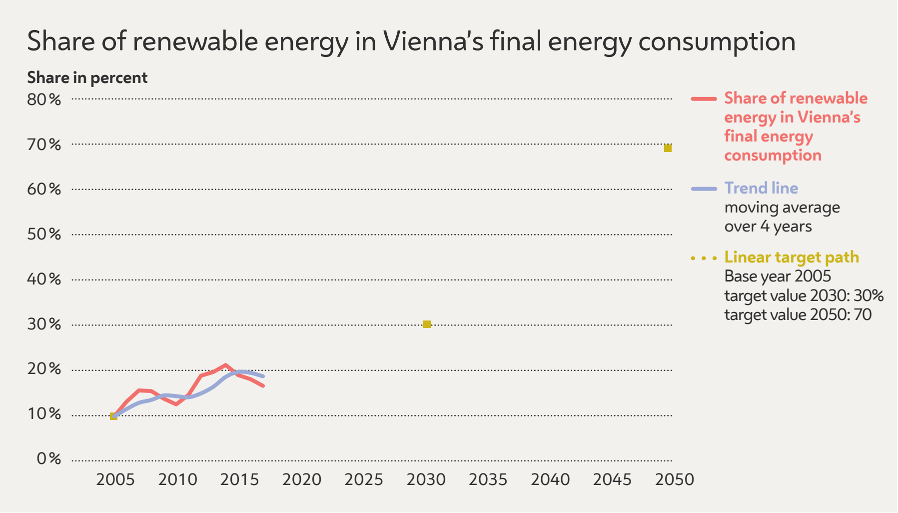
Electricity and district heating generation from renewable sources plus renewable on-site energy, 2005-2018 Sources [Energiebilanz 2018] and [SCWR]

5.1.2.4 Share of renewable energy in final energy consumption

Smart City Wien Framework Strategy objective: In 2030, 30 percent and in 2050, 70 percent of Vienna's final energy consumption will be covered from renewable sources

%	2005	2010	2015	2016	2017	Change [%] Base year 2005
Share of renewable energy in Vienna's final energy consumption	10%	12%	19%	18%	17%	+69.1%
Trend line, moving average over 4 years	10%	14%	20%	19%	19%	+90.6%
Linear target path (base year 2005; target values 2030: 30% & 2050: 70%)	10%	14%	18%	19%	20%	+98.7%

Share of renewable energy in Vienna's final energy consumption
Source [Energiebilanz 2018]



Share of renewable energy in Vienna's final energy consumption, 2005-2018 Sources [Energiebilanz 2018] and [SCWR]

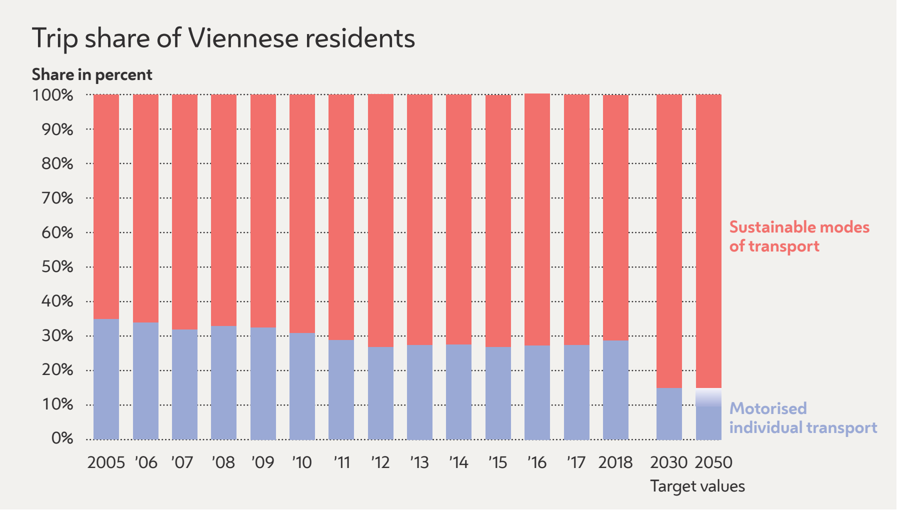
5.1.3 Mobility & transport

5.1.3.1 Choice of mode of transport

Smart City Wien Framework Strategy objective: The share of trips made using sustainable modes of transport in Vienna will increase to 85 percent by 2030 and markedly over 85 percent by 2050.

%	2005	2010	2015	2016	2017	2018	Change [%] base year 2005
Motorised individual transport	35.0	30.9	26.9	27.3	27.4	28.8	-17.7%
Sustainable modes of transport	65.0	69.1	73.0	73.0	72.6	71.1	+9.4%

Choice of mode of transport
Source [Wiener Linien]



Choice of mode of transport, 2005-2018
Sources [Wiener Linien] and [SCWR]

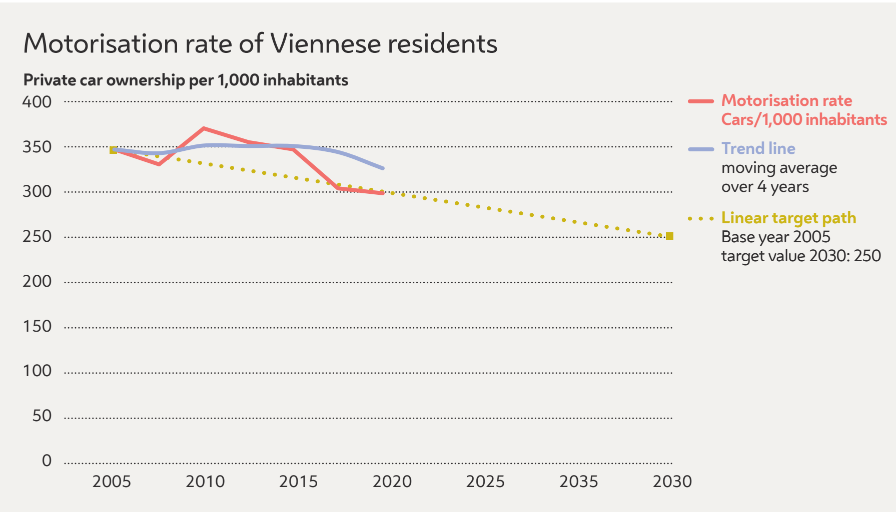
Note: Sustainable transport includes public transport, cycling, walking, bike sharing and car sharing.

5.1.3.2 Motorisation rate (private car ownership)

Smart City Wien Framework Strategy objective: The motorisation rate will sink to 250 privately owned cars per 1,000 inhabitants by 2030.

Cars per 1,000 residents	2005/2006	2009/2010	2015/2016	2017/2018	Change [%] Base Ø 2005/2006
Motorisation rate private cars per 1,000 inhabitants	347	370	304	299	-5.8%
Trend line, moving average over 4 years	347	351	344	326	-6.2%
Linear target path (base year 2005; target value 2030: 250)	347	332	308	301	-19.2%

Motorisation rate (private car ownership)
Sources [Private PKW] and [Bevölkerung Wien]



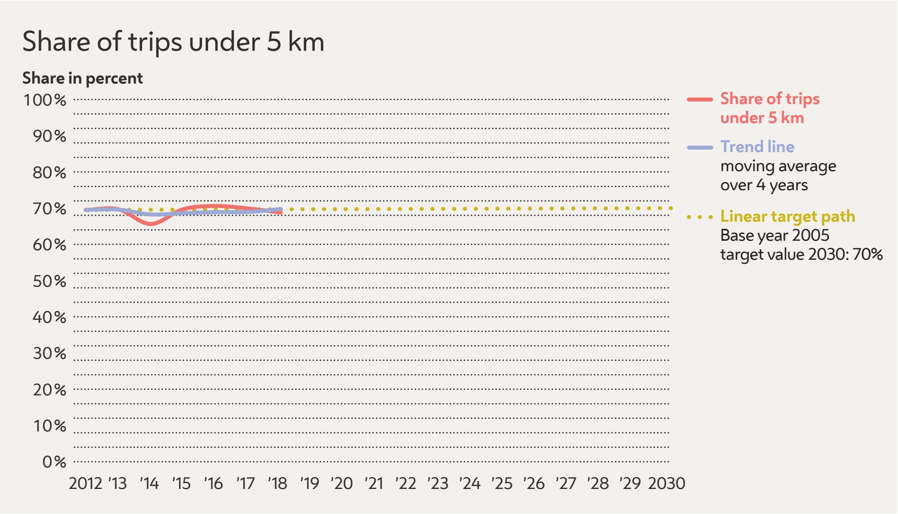
Motorisation rate (private car ownership), 2005-2018 Sources [Private PKW], [Bevölkerung Wien] and [SCWR]

5.1.3.3 Short distances

Smart City Wien Framework Strategy objective: Short trips of up to 5 km will continue to make up at least 70 percent of all trips in Vienna and are mainly made on bike or on foot.

%	2012	2015	2017	2018	Change [%] Base year 2012
Share of trips under 5 km	69.5%	69.7%	69.9%	68.8%	-1.0%
Trend line, moving average over 4 years	69.5%	68.6%	68.9%	69.8%	+0.4%

Share of trips under 5 km
Source [Stadt Wien]

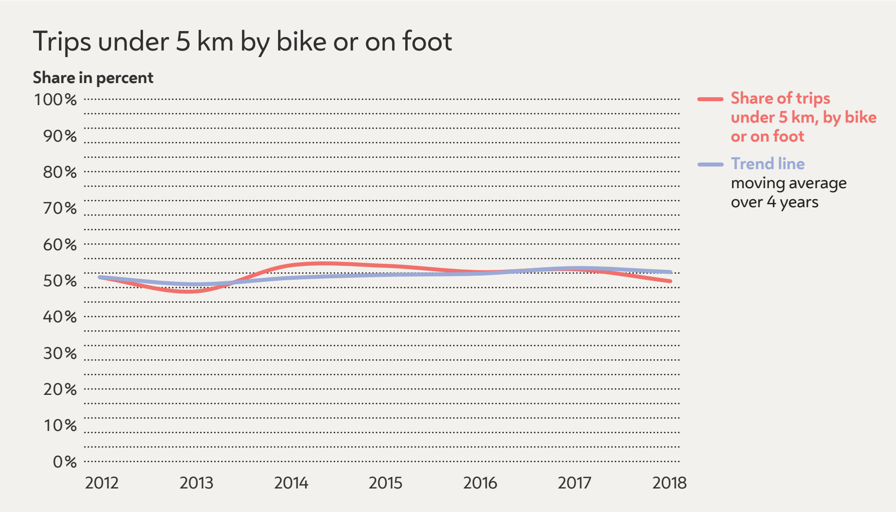


Share of trips under 5 km, 2012-2018
Sources [Stadt Wien] and [SCWR]

Note: Data on short trips only available from 2012.

%	2012	2015	2017	2018	Change [%] Base year 2012
Trips under 5 km, by bike or on foot	51.8%	54.7%	53.8%	50.8%	-1.9%
Trend line, moving average over 4 years	51.8%	52.4%	54.1%	53.1%	+2.5%

Share of trips under 5 km by bike or on foot
Source [Stadt Wien]



Share of trips under 5 km by bike or on foot, 2012-2018
Sources [Stadt Wien] and [SCWR]

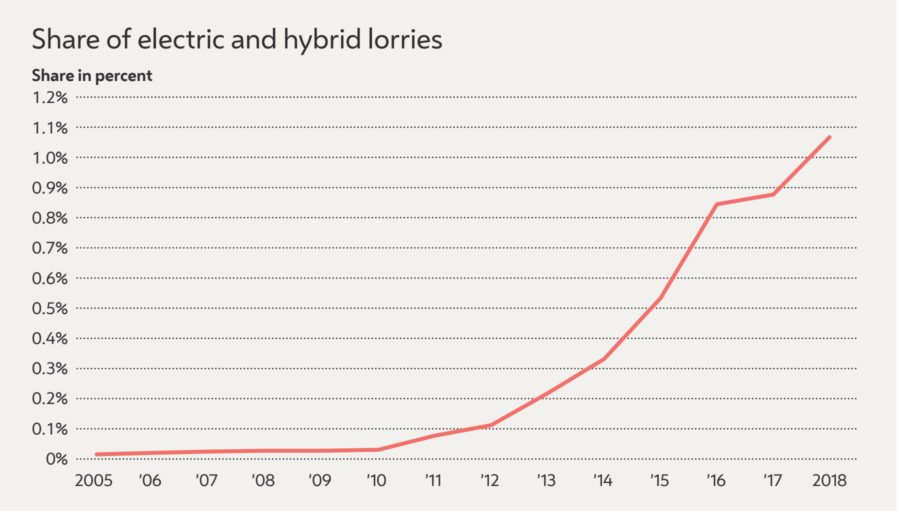
Note: Data on short trips only available from 2012.

5.1.3.4 Share of electric and hybrid lorries

Smart City Wien Framework Strategy objective: By 2030, commercial traffic within the city will be largely CO_2-free.

Share of electric and hybrid lorries	2005	2010	2015	2016	2017	2018
Vienna	0.015%	0.03%	0.53%	0.84%	0.88%	1.07%

Share of electric and hybrid lorries
Source [KFZ-Bestand]



Share of electric and hybrid lorries, 2005-2018
Source [KFZ-Bestand]

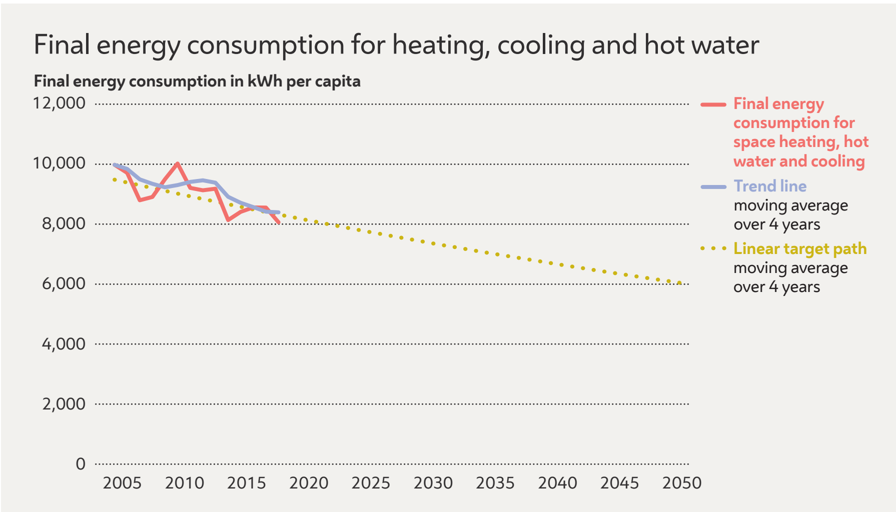
5.1.4 Buildings

5.1.4.1 Final energy consumption and GHG emissions for space heating, cooling and hot water

Smart City Wien Framework Strategy objective: Final energy consumption for space heating, cooling and hot water in buildings will go down by 1%, the related carbon dioxide emissions by 2% per capita and year.

kWh per capita	2005	2010	2015	2017	2018	Change [%] Base Ø 2005-2010
Final energy consumption for heating, cooling and hot water	9,979	10,020	8,412	8,551	8,063	-15.0%
Trend line, moving average over 4 years		9,305	8,713	8,414	8,396	-11.5%
Target path (base year 2005; base value: 2005-2010 average; target path -1% p.a.)	9,484	9,019	8,577	8,407	8,323	-12.2%

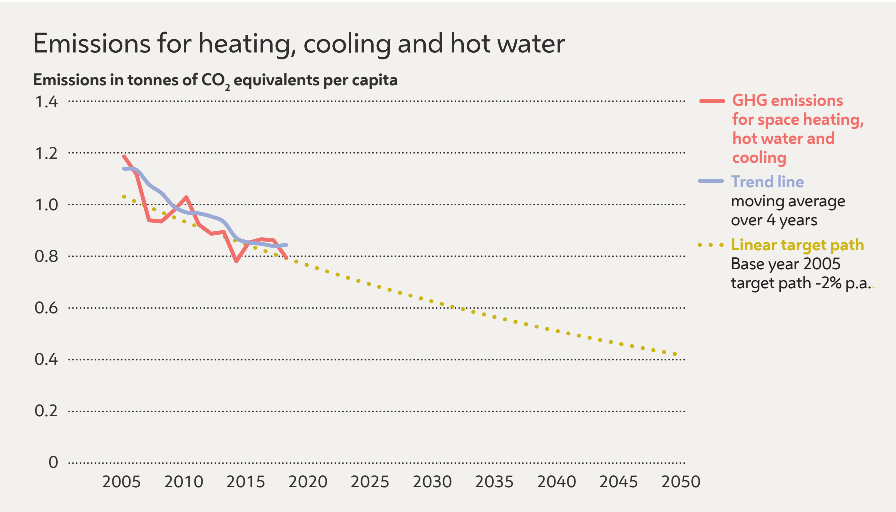
Final energy consumption for space heating, cooling and hot water per capita
Sources [Nutzenergieanalyse 2018] and [Bevölkerung Wien]



Final energy consumption for heating, cooling and hot water per capita, 2005-2018 Sources [Nutzenergie-analyse 2018], [Bevölke-rung Wien] and [SCWR]

t CO_2-equivalents per capita	2005	2010	2015	2017	2018	Change [%] Base Ø 2005-2010
GHG emissions for heating, cooling and hot water	1.19	1.03	0.85	0.86	0.80	-22.8%
Trend line, moving average over 4 years	1.14	0.97	0.85	0.84	0.84	-18.1%
Target path (base year 2005; base value: 2005-2010 average; target path -2% p.a.)	1.03	0.93	0.84	0.81	0.79	-23.1%

GHG emissions for space heating, cooling and hot water per capita
Sources [Nutzenergieanalyse 2018] and [Bevölkerung Wien]



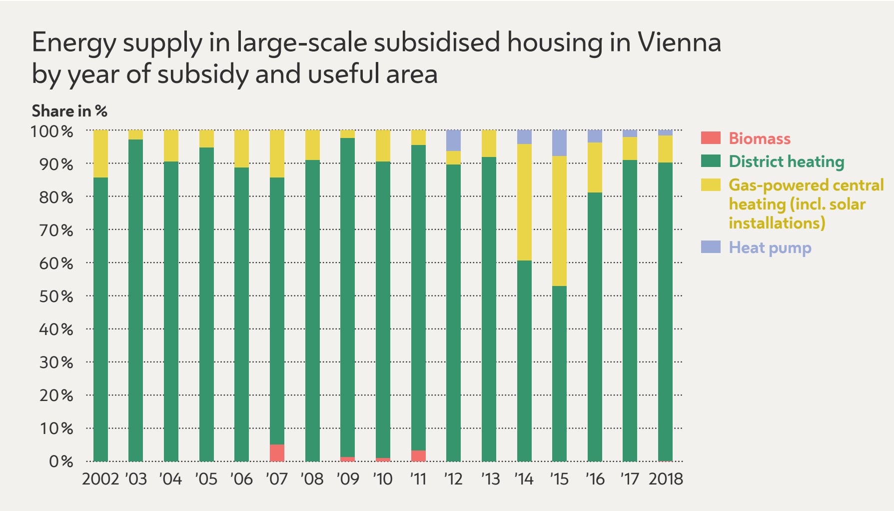
GHG emissions for heating, cooling and hot water per capita, 2005-2018 Sources [Nutzenergie-analyse 2018], [Bevölke-rung Wien] and [SCWR]

5.1.4.2 Energy supply of new buildings

Smart City Wien Framework Strategy objective: From 2025, the heating demand of new buildings will generally be covered with renewable energy or district heating.

Share of useful area [%]	2005	2010	2015	2017	2018	Change [%] Base year 2005
Biomass	0%	1%	0%	0%	0%	
District heating	95%	90%	53%	91%	90%	-4.9%
Gas-powered central heating (incl. solar installations)	5%	9%	39%	7%	8%	+55.8%
Heat pump	0%	0%	8%	2%	2%	

Share of energy supply in subsidised new buildings
Source [Stadt Wien]



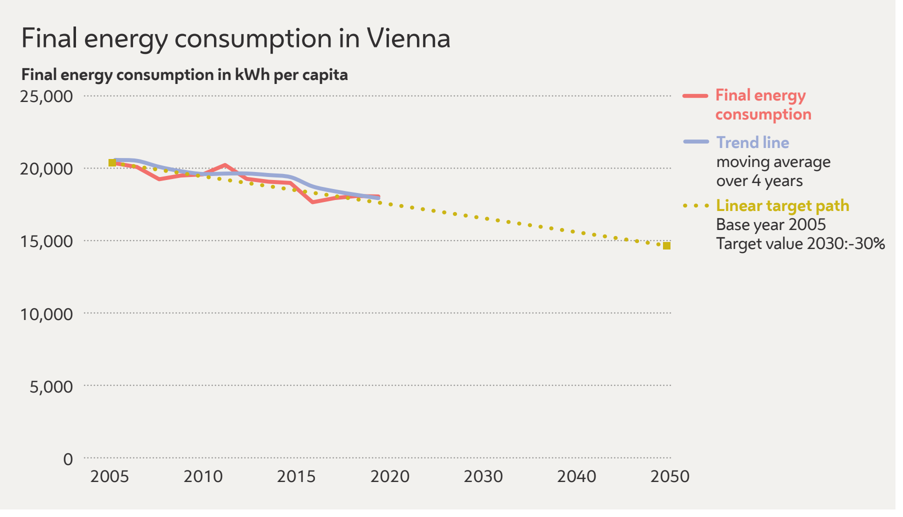
Share of energy supply in subsidised new buildings, 2002-2018
Source [Stadt Wien]

5.2. Indicators for the Urban Energy Efficiency Programme 2030 (SEP 2030)

SEP 2030 objective: A reduction in final energy consumption by 30 percent from 2005 levels was defined as an indicative goal for the SEP 2030.

[kWh per capita]	2005	2010	2015	2017	2018	Change [%] Base year 2005
Final energy consumption	24,143	23,078	20,311	20,300	19,669	-18.53%
Trend line, moving average over 4 years	24,143	22,589	20,859	20,246	20,157	-16.51%
Linear target path (base year 2005: -50%)	24,143	22,694	21,245	20,666	20,376	-15.60%

Final energy consumption per capita in Vienna
Sources [Energiebilanz 2018], [Bevölkerung] and [SEP 2030]



Final energy consumption per capita in Vienna, 1990-2018, SEP 2030 target value Sources [Energiebilanz 2017], [Bevölkerung] and [SEP 2030]

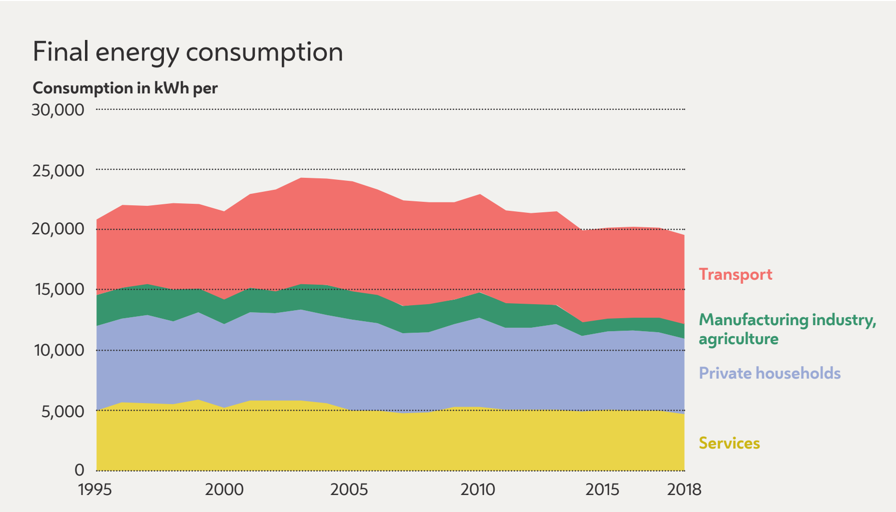
Note: The trend line is included to mitigate fluctuations caused by weather and leap years.

5.3 Developments in Vienna

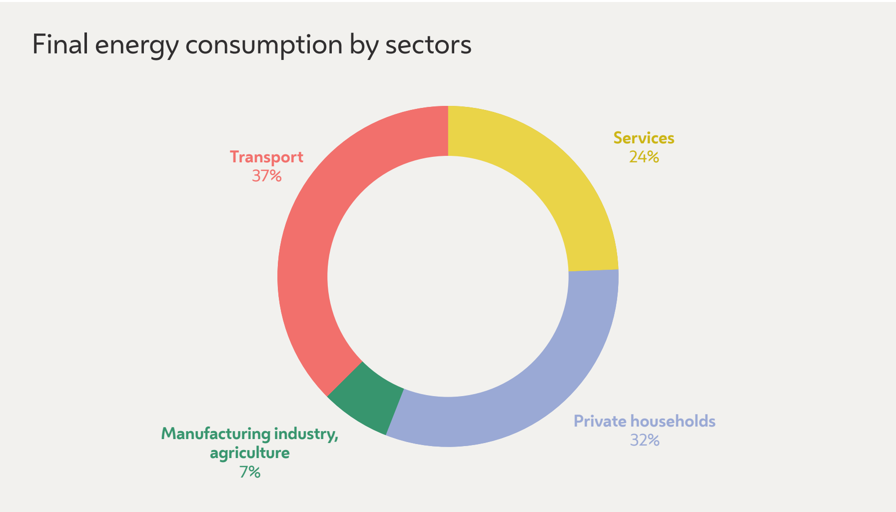
5.3.1 Energy consumption per capita in Vienna

kWh per capita	1995	2000	2005	2010	2015	2017	2018	Change [%] Base year 1995
Services	5,048	5,285	5,066	5,381	5,127	5,087	4,790	-5.11 %
Private households	7,022	6,975	7,588	7,410	6,546	6,507	6,215	-11.48 %
Manufacturing industry, agriculture	2,587	2,070	2,377	2,121	1,079	1,218	1,300	-49.77 %
Transport	6,325	7,298	9,112	8,166	7,559	7,487	7,364	16.44 %
Total	20,982	21,628	24,143	23,078	20,311	20,300	19,669	-6.25 %

Final energy consumption per capita in Vienna
Sources [Energiebilanz 2018] and [Bevölkerung Wien]



Final energy consumption per capita in Vienna, 1995-2018 Sources [Energiebilanz 2018] and [Bevölkerung Wien]

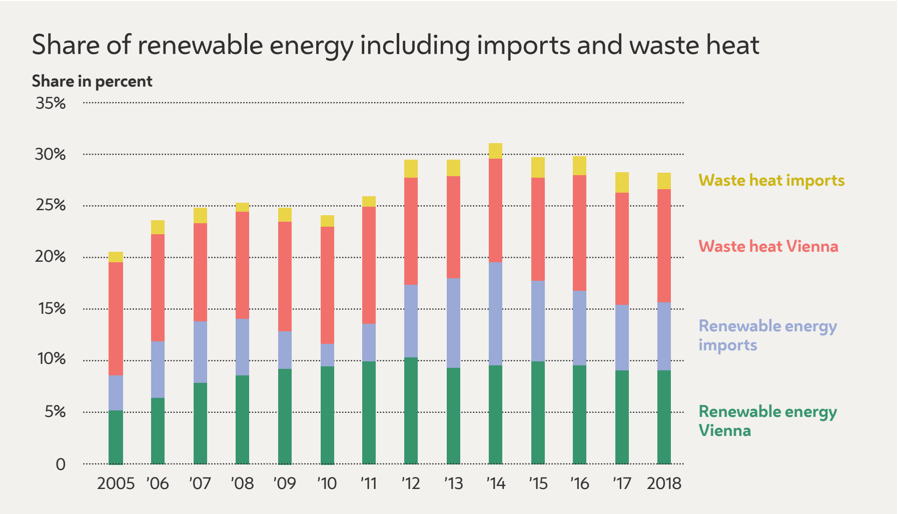


Final energy consumption per capita in Vienna, 2018 Sources [Energiebilanz 2018] and [Bevölkerung Wien]

5.3.2 Share of renewable energy including imports and waste heat

Gwh per year	2005	2010	2015	2017	2018
Share of renewable energy Vienna	5.2%	9.5%	9.9%	9.1%	9.1%
Share of renewable energy imports	3.5%	2.2%	7.8%	6.3%	6.6%
Share of waste heat Vienna	10.9%	11.3%	10.0%	10.8%	11.0%
Share of waste heat imports	1.0%	1.1%	2.0%	1.9%	1.6%
Total of shares	20.5%	24.0%	29.7%	28.2%	28.3%

Share of renewable energy including imports and waste heat in final energy consumption
Source [Energiebilanz 2018]



Share of renewable energy including imports and waste heat in final energy consumption, 1995 – 2018
Source [Energiebilanz 2018]

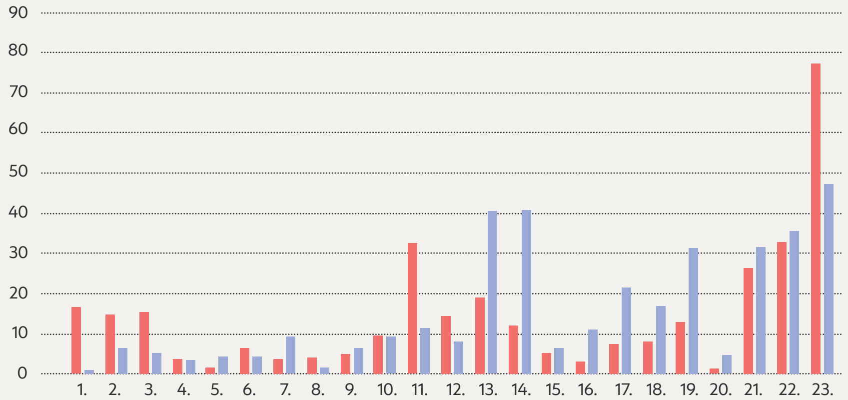
5.3.3 Use of solar energy in Vienna's districts

District		Output [kWp/1,000 inhabitants]	Area [m² /1,000 inhabitants]
Ø	Vienna average	17.83	17.24
1	Wien Innere Stadt	16.45	0.68
2	Wien Leopoldstadt	14.64	6.36
3	Wien Landstraße	15.21	5.01
4	Wien Wieden	3.60	3.29
5	Wien Margareten	1.36	4.10
6	Wien Mariahilf	6.41	4.13
7	Wien Neubau	3.55	9.12
8	Wien Josefstadt	3.83	1.46
9	Wien Alsergrund	4.71	6.43
10	Wien Favoriten	9.49	9.19
11	Wien Simmering	32.25	11.26
12	Wien Meidling	14.25	7.92
13	Wien Hietzing	18.80	40.35
14	Wien Penzing	11.92	40.77
15	Wien Rudolfsheim-Fünfhaus	5.07	6.40
16	Wien Ottakring	2.84	11.05
17	Wien Hernals	7.20	21.31
18	Wien Währing	7.95	16.83
19	Wien Döbling	12.86	31.08
20	Wien Brigittenau	1.21	4.45
21	Wien Floridsdorf	26.27	31.41
22	Wien Donaustadt	32.58	35.57
23	Wien Liesing	77.15	47.18

Output of PV panels and surface area of subsidised solar thermal installations per capita by district, 2018
Sources [Energiedatenbank MA 20] and [Bevölkerung]

Installed PV panels and subsidised solar thermal installations by district

Output of PV installations in kWp/1,000 inhabitants and area of solar thermal installations in m²/1,000 inhabitants

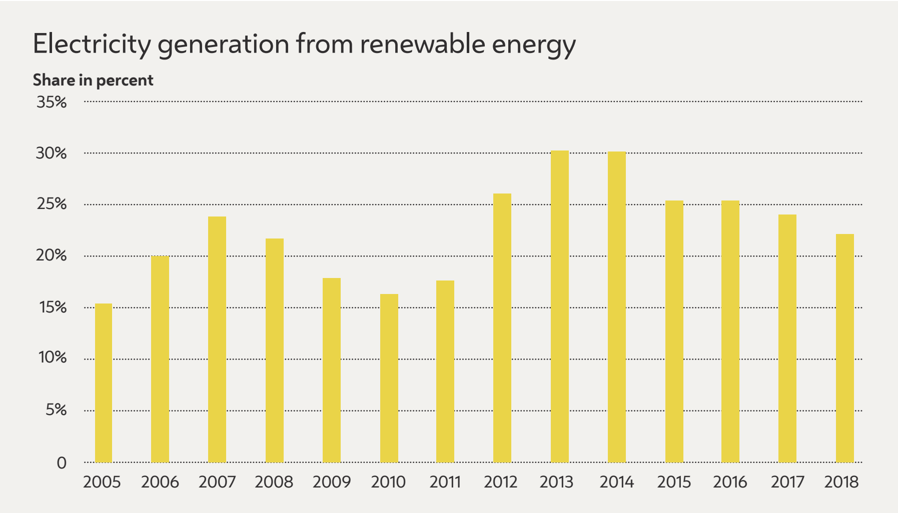


Output of installed PV installations and surface area of subsidised solar thermal installations per capita by district, 2018 Sources [Energiedatenbank MA 20] and [Bevölkerung]

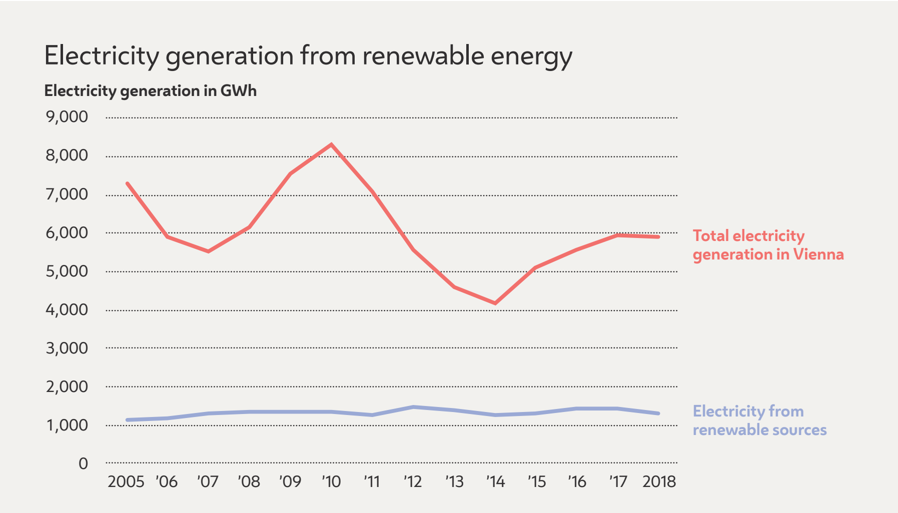
5.3.4 Electricity generation from renewable energy

	2005	2010	2015	2017	2018	Change [%] Base year 2005
Electricity generation from renewable sources [GWh]	1,127	1,358	1,296	1,428	1,316	+16.8%
Total electricity generation in Vienna [GWh]	7,312	8,293	5,103	5,925	5,917	-19.1%
Share [%]	15.4%	16.4%	25.4%	24.1%	22.2%	+44.3%

Share of electricity from renewable energy in Vienna's total electricity generation
Source [Energiebilanz 2018]



Share of electricity from renewable sources in total electricity generation in Vienna, 2005 – 2018
Source [Energiebilanz 2018]



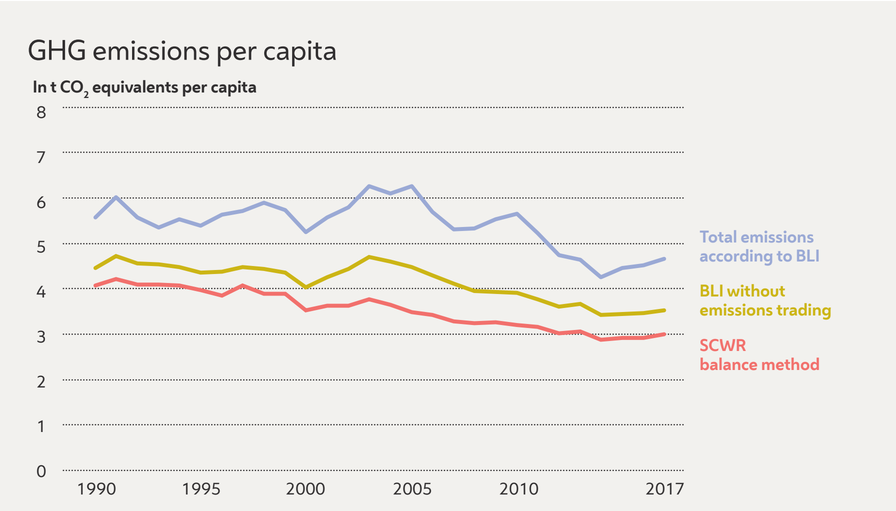
Comparison: Electricity from renewable sources and total electricity generation in Vienna, 2005 – 2018
Source [Energiebilanz 2018]

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

5.3.5 GHG emissions per capita

$t\ CO_2$ equivalents per capita	1990	1995	2000	2005	2010	2015	2016	2017	Change [%] Base year 1995
Total emissions according to BLI	5.6	5.4	5.2	6.2	5.6	4.5	4.5	4.7	-20.0%
BLI without emissions trading	4.5	4.4	4.0	4.5	3.9	3.5	3.5	3.5	-22.5%
SCWR balance method	4.1	4.0	3.5	3.5	3.2	2.9	2.9	3.0	-28.1%

Greenhouse gas emissions per capita in Vienna
Sources [BLI] and [Bevölkerung]



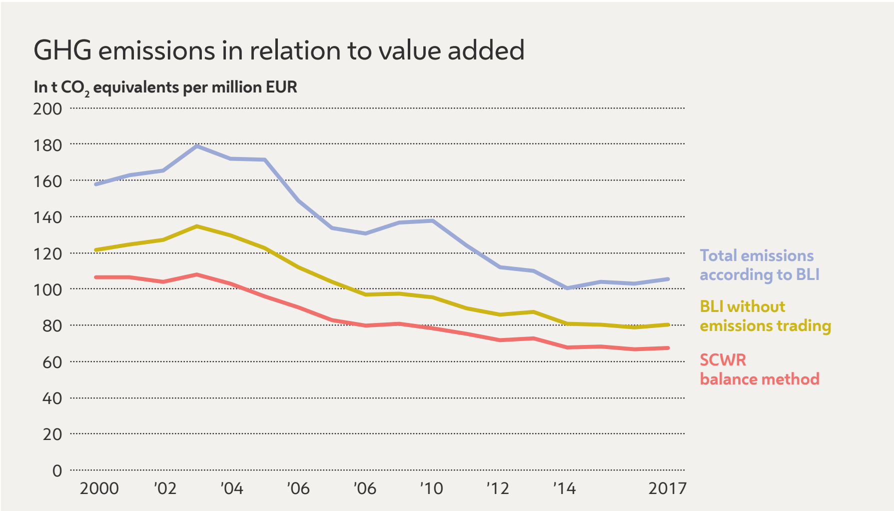
Greenhouse gas emissions per capita in Vienna, 1990 – 2017
Sources [BLI] and [Bevölkerung]

Note: At the time of writing, the emissions data for 2018 had not yet been published.

5.3.6 GHG emissions in relation to value added

t CO_2 equivalens per €1 million	2000	2005	2010	2015	2016	2017	Change [%] Base year 2000
SCWR balance method	106.4	96.1	78.4	68.2	66.7	68.1	-37.4%
BLI without emissions trading	121.8	122.8	95.3	80.6	78.7	80.2	-35.4%
Total emissions according to BLI	158.1	171.3	137.6	103.8	102.8	105.7	-35.0%

GHG emissions in Vienna in relation to value added
Sources [BLI] and [Wertschöpfung]



GHG emissions in Vienna in relation to value added, 2000 – 2017 Sources [BLI] and [Wertschöpfung]

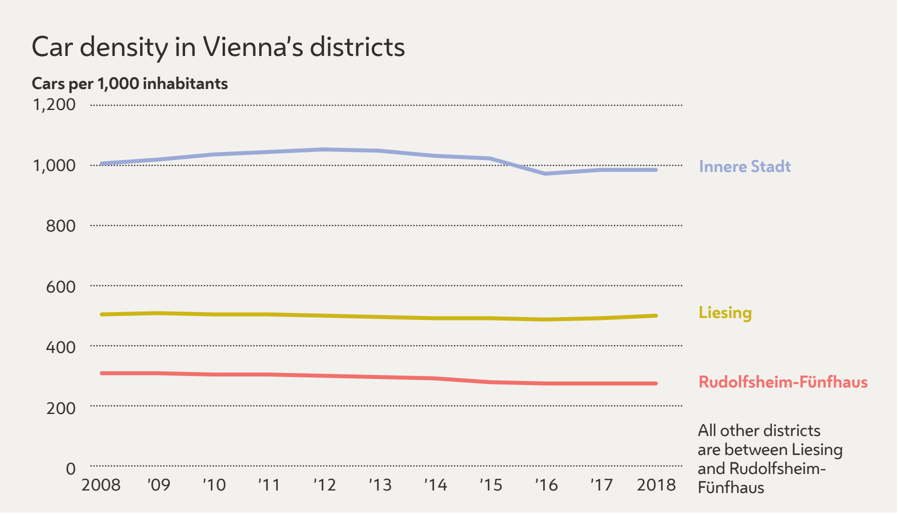
Note: Data for value added only available from 2000. At the time of writing, the emissions data for 2018 had not yet been published.

5.3.7 Car density in Vienna's districts

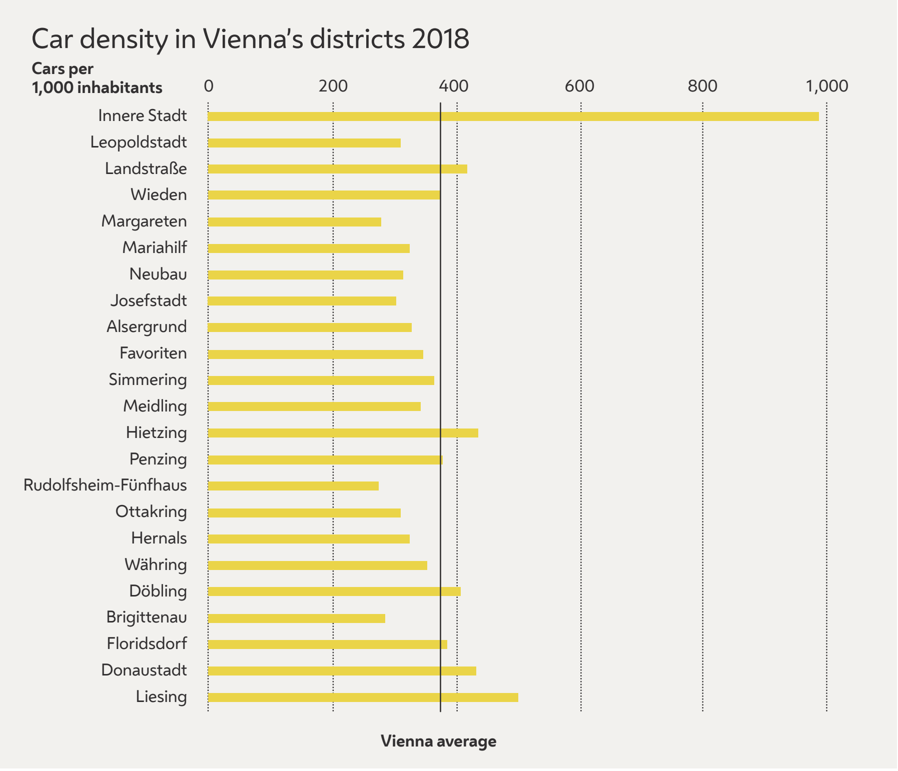
	District	2008	2010	2013	2015	2016	2017	2018	Change [%] Base year 2008
Ø	Vienna average	391	393	386	373	371	371	374	-4.4%
1	Innere Stadt	1,007	1,036	1,050	1,023	973	988	986	-2.0%
2	Leopoldstadt	334	332	324	313	311	310	312	-6.6%
3	Landstraße	442	459	436	429	424	419	419	-5.2%
4	Wieden	423	421	410	389	387	381	375	-11.3%
5	Margareten	331	324	311	294	291	288	279	-15.7%
6	Mariahilf	392	385	365	345	338	332	323	-17.6%
7	Neubau	375	368	357	334	328	325	315	-15.9%
8	Josefstadt	362	359	341	321	312	305	302	-16.6%
9	Alsergrund	404	388	370	340	338	335	327	-19.0%
10	Favoriten	349	350	344	329	330	343	345	-1.3%
11	Simmering	362	367	370	359	354	355	363	+0.2%
12	Meidling	348	352	355	345	344	340	342	-1.7%
13	Hietzing	450	450	451	428	428	429	436	-3.0%
14	Penzing	382	386	387	372	374	373	378	-1.1%
15	Rudolfsheim-Fünfhaus	309	304	298	280	276	274	273	-11.9%
16	Ottakring	325	327	326	315	312	309	311	-4.3%
17	Hernals	340	345	338	326	323	321	323	-5.0%
18	Währing	372	372	360	342	357	357	354	-4.8%
19	Döbling	419	422	417	402	400	399	406	-3.0%
20	Brigittenau	310	311	303	294	291	289	285	-8.0%
21	Floridsdorf	395	398	389	381	381	380	385	-2.6%
22	Donaustadt	433	439	435	425	428	430	433	-0.1%
23	Liesing	506	506	494	491	489	491	500	-1.1%

Car density in Vienna's districts per 1,000 inhabitants
Sources [KFZ-Bestand] and [Bevölkerung]

Car density in Vienna's districts per 1,000 inhabitants, 2008 – 2018
Sources [KFZ-Bestand] and [Bevölkerung]



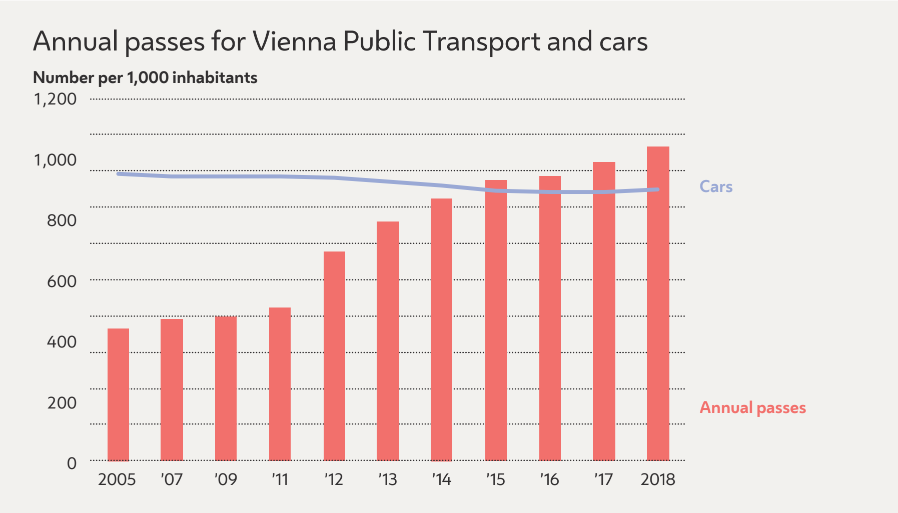
Car density in Vienna's districts per 1,000 inhabitants, 2018
Sources [KFZ-Bestand] and [Bevölkerung]



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

Number per 1,000 inhabitants	2005	2009	2012	2015	2017	2018	Change [%] Base year 2005
Annual passes	183	199	288	387	412	433	+136.3%
Cars	397	393	390	373	371	374	-5.8%

Annual passes for Vienna Public Transport and cars per 1,000 inhabitants
Sources [Wiener Linien], [Bevölkerung] and [KFZ-Bestand]



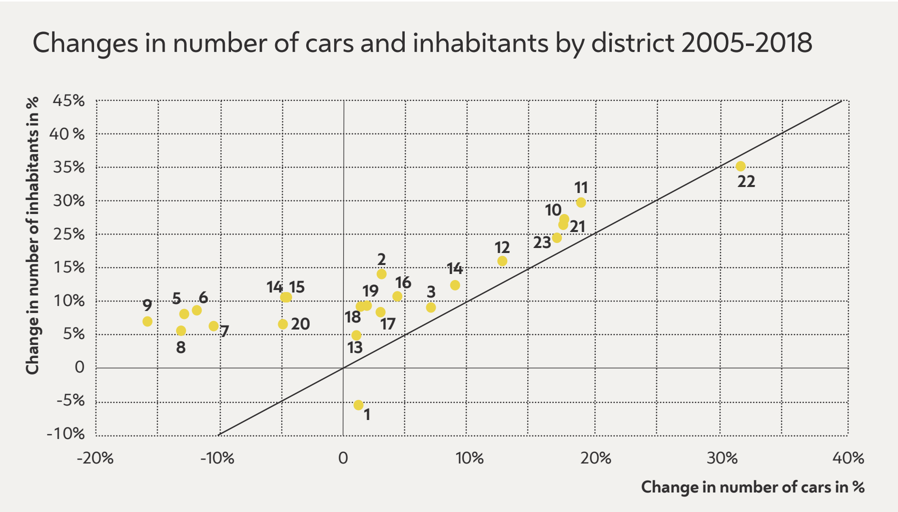
Annual passes for Vienna Public Transport and cars per 1,000 inhabitants, 2005 – 2018 Sources [Wiener Linien], [Bevölkerung] and [KFZ-Bestand]

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

5.3.9 Changes in number of cars and inhabitants by district

District		Change from 2005 to 2018	
		Cars	Inhabitants
Ø	Vienna average	+8.2%	+14.8%
1	Innere Stadt	+0.8%	-5.7%
2	Leopoldstadt	+2.6%	+13.9%
3	Landstraße	+6.5%	+9.0%
4	Wieden	-4.8%	+10.4%
5	Margareten	-13.2%	+5.5%
6	Mariahilf	-12.0%	+8.5%
7	Neubau	-10.6%	+6.2%
8	Josefstadt	-12.9%	+7.9%
9	Alsergrund	-15.9%	+6.9%
10	Favoriten	+16.9%	+22.1%
11	Simmering	+18.3%	+24.5%
12	Meidling	+12.0%	+15.9%
13	Hietzing	+0.6%	+4.7%
14	Penzing	+8.4%	+12.3%
15	Rudolfsheim-Fünfhaus	-5.1%	+10.5%
16	Ottakring	+3.8%	+10.6%
17	Hernals	+1.4%	+9.2%
18	Währing	+0.9%	+9.1%
19	Döbling	+2.5%	+8.2%
20	Brigittenau	-5.2%	+6.4%
21	Floridsdorf	+16.9%	+21.3%
22	Donaustadt	+30.8%	+30.0%
23	Liesing	+16.4%	+19.3%

Changes in number of cars and inhabitants by district between 2005 and 2018
Sources [KFZ-Bestand], [Jahrbuch 2006] and [Bevölkerung Wien]

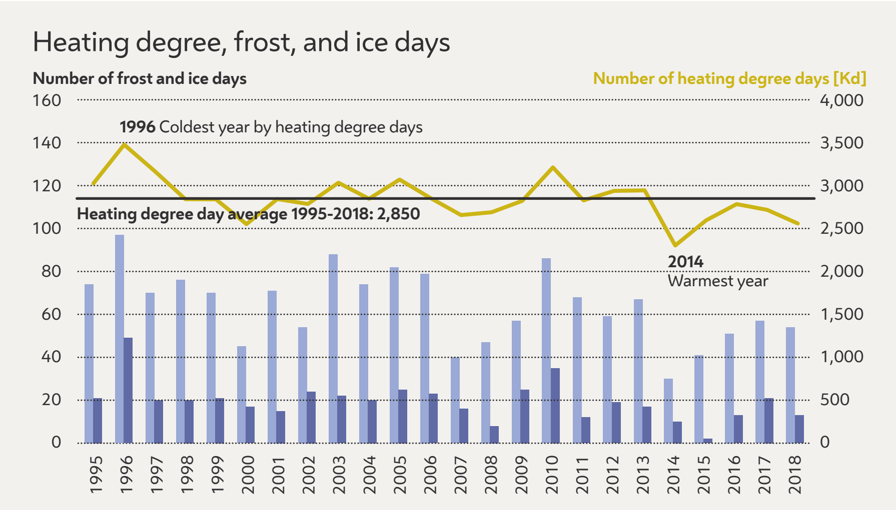


Changes in number of inhabitants of cars and inhabitants by district between 2005 and 2018 Sources [KFZ-Bestand], [Jahrbuch 2006] and [Bevölkerung Wien]

5.3.10 Heating degree, frost, and ice days

Vienna	1995	2000	2005	2010	2015	2017	2018	Change [%] Base year 1995
Frost days	74	45	82	86	41	57	54	-27%
Ice days	21	17	25	35	2	21	13	-38%
Heating degree days [Kd]	3,025	2,551	3,071	3,212	2,594	2,718	2,559	-15%

Heating degree, frost, and ice days in Vienna
Source [Statistische Jahrbücher]



Heating degree, frost, and ice days in Vienna, 1995-2018
Source [Statistische Jahrbücher]

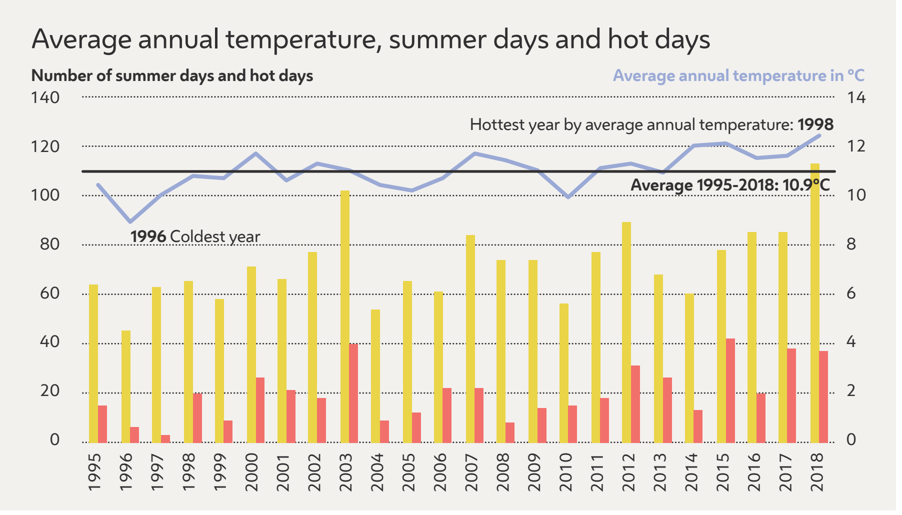
Note: An ice day is a day on which the maximum temperature is below 0°C, and a frost day is a day on which the minimum temperature is below 0°C. The metric for heating degree days is the sum of the differences between indoor temperature (20°C) and mean outdoor temperature for all heating days over one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

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

5.3.11 Average annual temperature, summer days and hot days

Vienna	**1995**	**2000**	**2005**	**2010**	**2015**	**2017**	**2018**	**Change [%] Base year 1995**
Summer days	64	71	65	56	78	85	113	+76.6%
Hot days	15	26	12	15	42	38	37	+146.7%
Annual average [°C]	10.4	11.7	10.2	9.9	12.1	11.6	12.4	+19.2%

Average annual temperature, summer days and hot days in Vienna
Source [Statistische Jahrbücher]



Average annual temperature, summer days and hot days in Vienna, 1995-2018
Source [Statistische Jahrbücher]

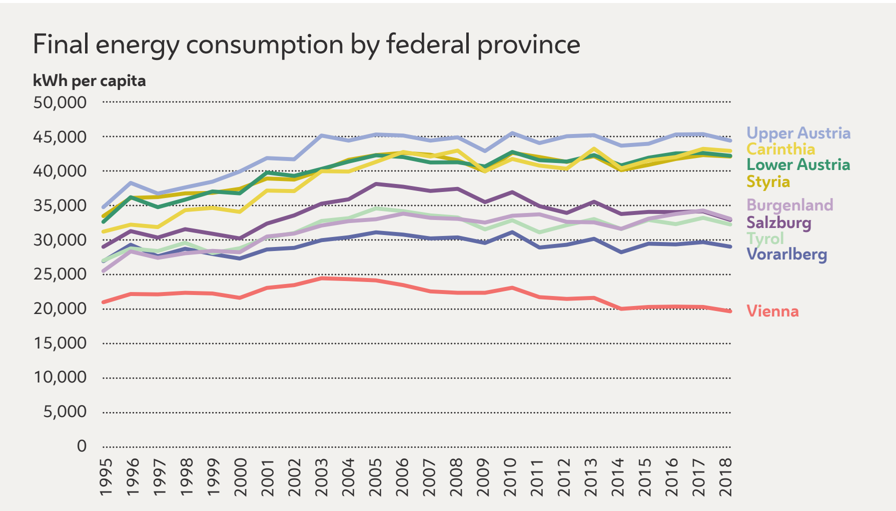
Note: A hot day is a day on which the maximum temperature is at least 30°C, and a summer day is a day with a maximum temperature of at least 25°C.

5.4 Comparison of federal provinces

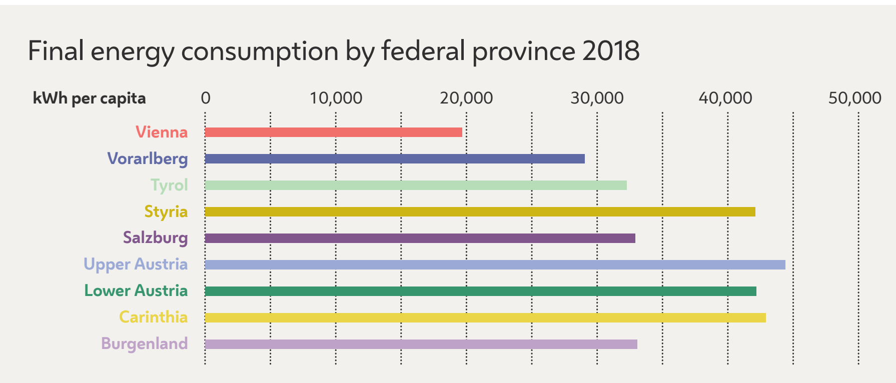
5.4.1 Final energy consumption per capita by federal province

kWh per capita	1995	2000	2005	2010	2015	2017	2018	Change [%] Base year 1995
Vienna	20,982	21,628	24,143	23,078	20,311	20,300	19,669	-6.25%
Vorarlberg	26,942	27,323	31,103	31,142	29,455	29,706	29,031	7.75%
Tyrol	27,019	28,818	34,585	32,867	32,903	33,205	32,245	19.34%
Styria	33,474	37,414	42,296	42,618	40,875	42,300	42,084	25.72%
Salzburg	29,002	30,236	38,117	36,936	34,068	34,138	32,918	13.50%
Upper Austria	34,758	39,915	45,272	45,491	43,928	45,336	44,396	27.73%
Lower Austria	32,617	36,757	42,276	42,746	41,915	42,599	42,184	29.33%
Carinthia	31,216	34,069	41,317	41,741	41,504	43,210	42,906	37.45%
Burgenland	25,527	28,236	32,998	33,509	33,093	34,275	33,054	29.49%

Final energy consumption per capita by federal province
Sources [Energiebilanz 2018] and [Bevölkerung]



Final energy consumption per capita by federal province, 1995 – 2018
Sources [Energiebilanz 2018] and [Bevölkerung]

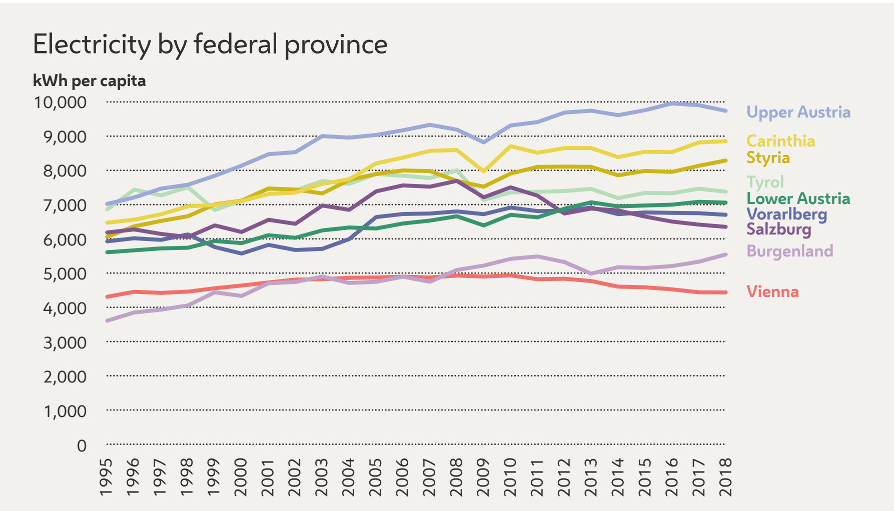


Final energy consumption per capita by federal province, 2018
Sources [Energiebilanz 2018] and [Bevölkerung]

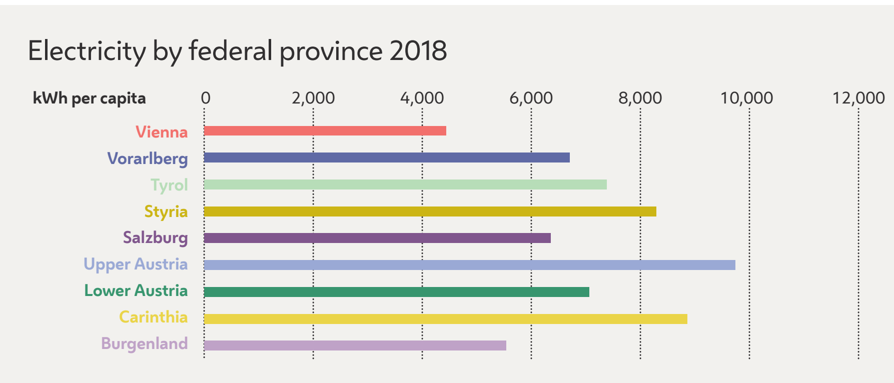
5.4.2 Electrical energy per capita by federal province

kWh per capita	1995	2000	2005	2010	2015	2017	2018	Change [%] Base year 1995
Vienna	4,307	4,635	4,873	4,931	4,583	4,441	4,434	+2.9%
Vorarlberg	5,927	5,569	6,636	6,915	6,774	6,748	6,702	+13.1%
Tyrol	6,863	7,122	7,897	7,354	7,343	7,464	7,380	+7.5%
Styria	6,058	7,116	7,896	7,911	7,983	8,135	8,291	+36.9%
Salzburg	6,185	6,199	7,390	7,504	6,653	6,415	6,352	+2.7%
Upper Austria	7,020	8,138	9,038	9,315	9,762	9,905	9,740	+38.7%
Lower Austria	5,610	5,876	6,305	6,702	6,974	7,084	7,061	+25.9%
Carinthia	6,473	7,106	8,205	8,708	8,545	8,816	8,854	+36.8%
Burgenland	3,608	4,332	4,747	5,418	5,150	5,331	5,541	+53.6%

Electricity per capita by federal province
Sources [Energiebilanz 2018] and [Bevölkerung]



Electricity per capita by federal province, 2018
Sources [Energiebilanz 2018] and [Bevölkerung]

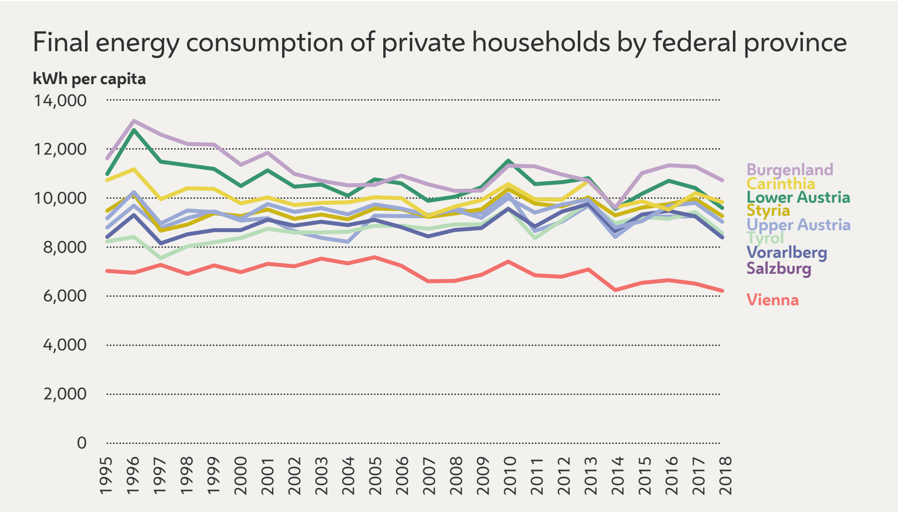


Electricity per capita by federal province, 1995-2018
Sources [Energiebilanz 2018] and [Bevölkerung]

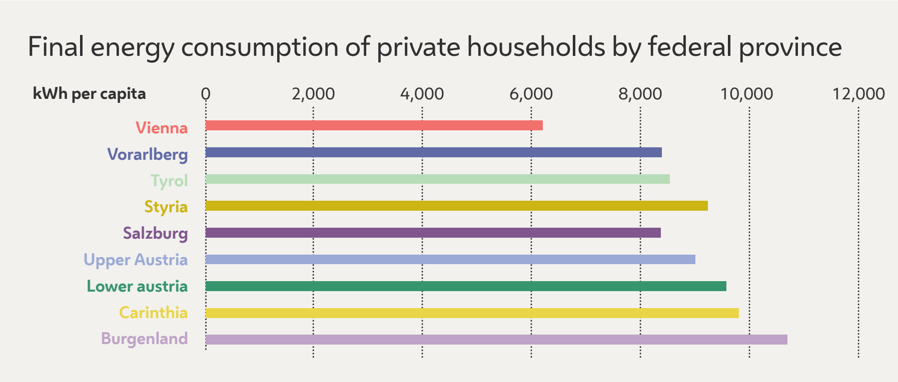
5.4.3 Endenergieverbrauch privater Haushalte pro Kopf nach Bundesländern

kWh per capita	1995	2000	2005	2010	2015	2017	2018	Change [%] Base year 1995
Vienna	7,022	6,975	7,588	7,410	6,546	6,507	6,215	-11.48%
Vorarlberg	8,793	9,079	9,275	10,147	9,238	9,258	8,407	-4.40%
Tyrol	8,229	8,368	8,867	9,558	9,232	9,430	8,560	4.02%
Styria	9,482	9,265	9,567	10,359	9,610	9,962	9,264	-2.30%
Salzburg	8,411	8,689	9,108	9,561	9,325	9,250	8,389	-0.25%
Upper Austria	9,169	9,142	9,735	9,994	9,057	9,803	9,033	-1.49%
Lower Austria	10,977	10,486	10,759	11,526	10,172	10,401	9,599	-12.56%
Carinthia	10,728	9,777	10,028	10,567	9,864	10,198	9,831	-8.37%
Burgenland	11,626	11,356	10,537	11,320	11,016	11,274	10,721	-7.79%

Final energy consumption of private households per capita by federal province
Sources [Energiebilanz 2018] and [Bevölkerung]



Final energy consumption of private households per capita by federal province, 1995 – 2018 Sources [Energiebilanz 2018] and [Bevölkerung]

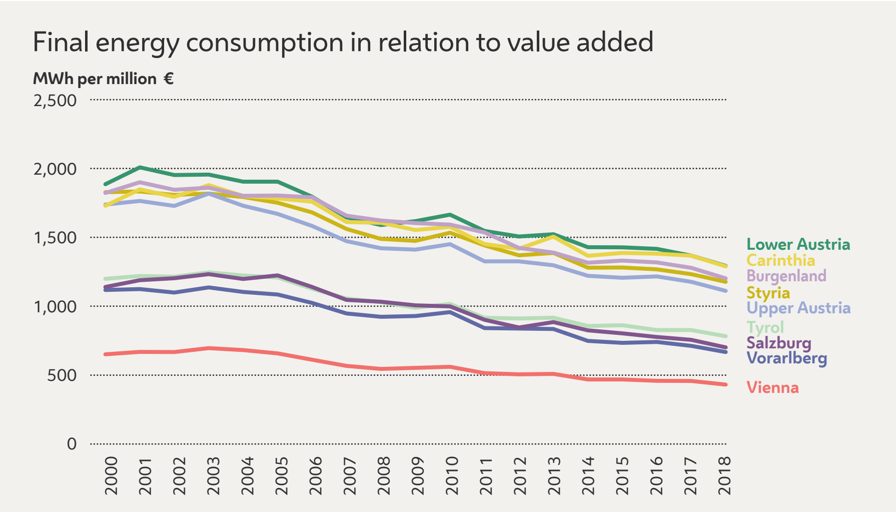


Final energy consumption of private households by federal province, 2018 Sources [Energiebilanz 2018] and [Bevölkerung]

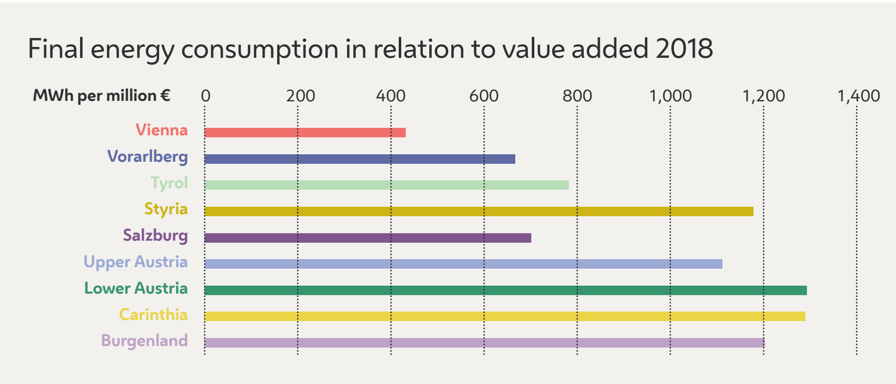
5.4.4 Final energy consumption in relation to value added by federal province

MWh/million €	2000	2005	2010	2015	2017	2018	Change [%] Base year 2000
Vienna	651	658	560	469	457	431	-33.7%
Vorarlberg	1,118	1,085	958	734	712	667	-40.3%
Tyrol	1,199	1,209	1,016	862	827	782	-34.8%
Styria	1,828	1,751	1,534	1,281	1,233	1,178	-35.6%
Salzburg	1,140	1,224	999	804	756	701	-38.5%
Upper Austria	1,738	1,670	1,451	1,207	1,177	1,112	-36.0%
Lower Austria	1,885	1,904	1,665	1,428	1,367	1,293	-31.4%
Carinthia	1,729	1,783	1,577	1,386	1,367	1,290	-25.4%
Burgenland	1,822	1,804	1,593	1,331	1,279	1,202	-34.0%

Final energy consumption in relation to value added by federal province
Sources [Energiebilanz 2018] and [Bevölkerung]



Final energy consumption in relation to value added, 2000-2018
Sources [Energiebilanz 2018] and [Wertschöpfung]



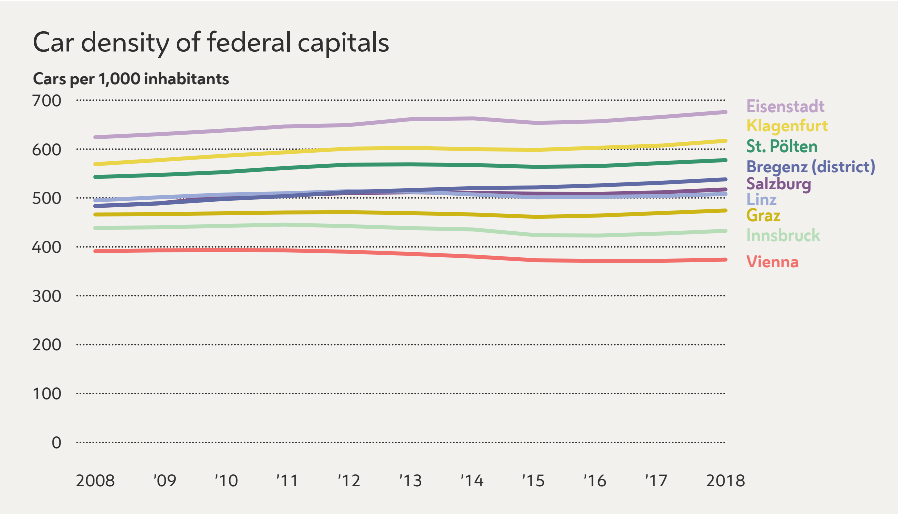
Final energy consumption in relation to value added, 2018
Sources [Energiebilanz 2018] and [Wertschöpfung]

Note: Data for value added only available from 2000.

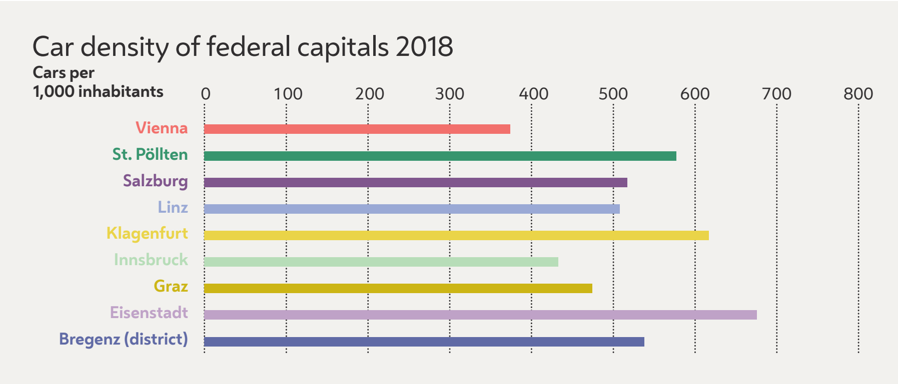
5.4.5 Car density of federal provinces

Cars per 1,000 inhabitants	2008	2010	2013	2014	2015	2017	2018	Change [%] Base year 2008
Vienna	391.2	393.0	385.7	380.2	372.5	371.5	373.8	-4.4%
Sankt Pölten	542.8	552.6	568.6	567.2	563.4	571.5	577.3	+6.4%
Salzburg	483.5	502.2	511.5	510.3	508.9	511.5	517.4	+7.0%
Linz	495.2	506.8	512.8	507.0	501.3	503.9	508.1	+2.6%
Klagenfurt	569.0	585.8	602.4	599.7	598.3	607.2	616.9	+8.4%
Innsbruck	438.6	442.8	438.1	435.4	423.9	427.4	432.9	-1.3%
Graz	466.0	468.7	469.1	466.1	461.2	469.1	474.4	+1.8%
Eisenstadt	624.1	637.6	661.0	662.6	653.4	665.9	675.8	+8.3%
Bregenz (district)	483.8	497.3	515.9	520.3	521.6	531.3	538.0	+11.2%

Car density of federal capitals by 1,000 inhabitants
Sources [KFZ-Bestand] and [Bevölkerung]



Car density of federal capitals per 1,000 inhabitants, 2008 – 2018 Sources [KFZ-Bestand] and [Bevölkerung]

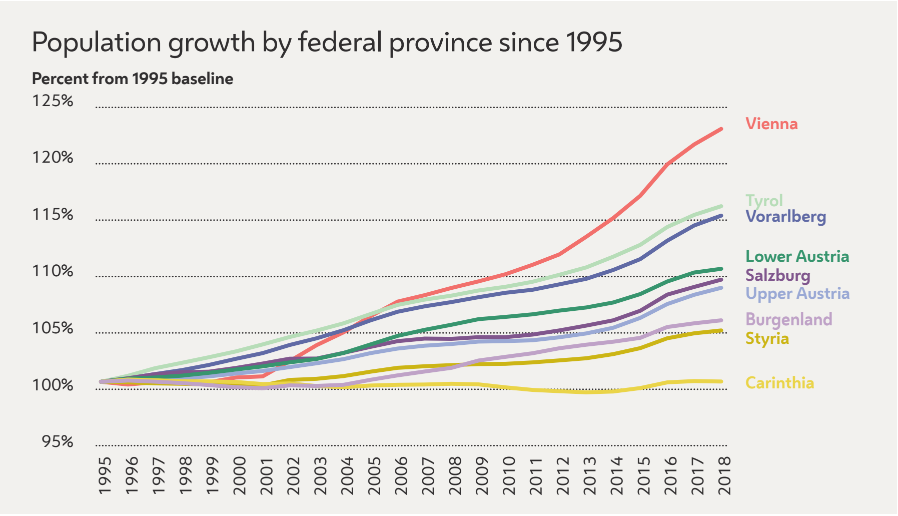


Car density of federal capitals by 1,000 inhabitants, 2018 Sources [KFZ-Bestand] and [Bevölkerung]

5.4.6 Population growth by federal province

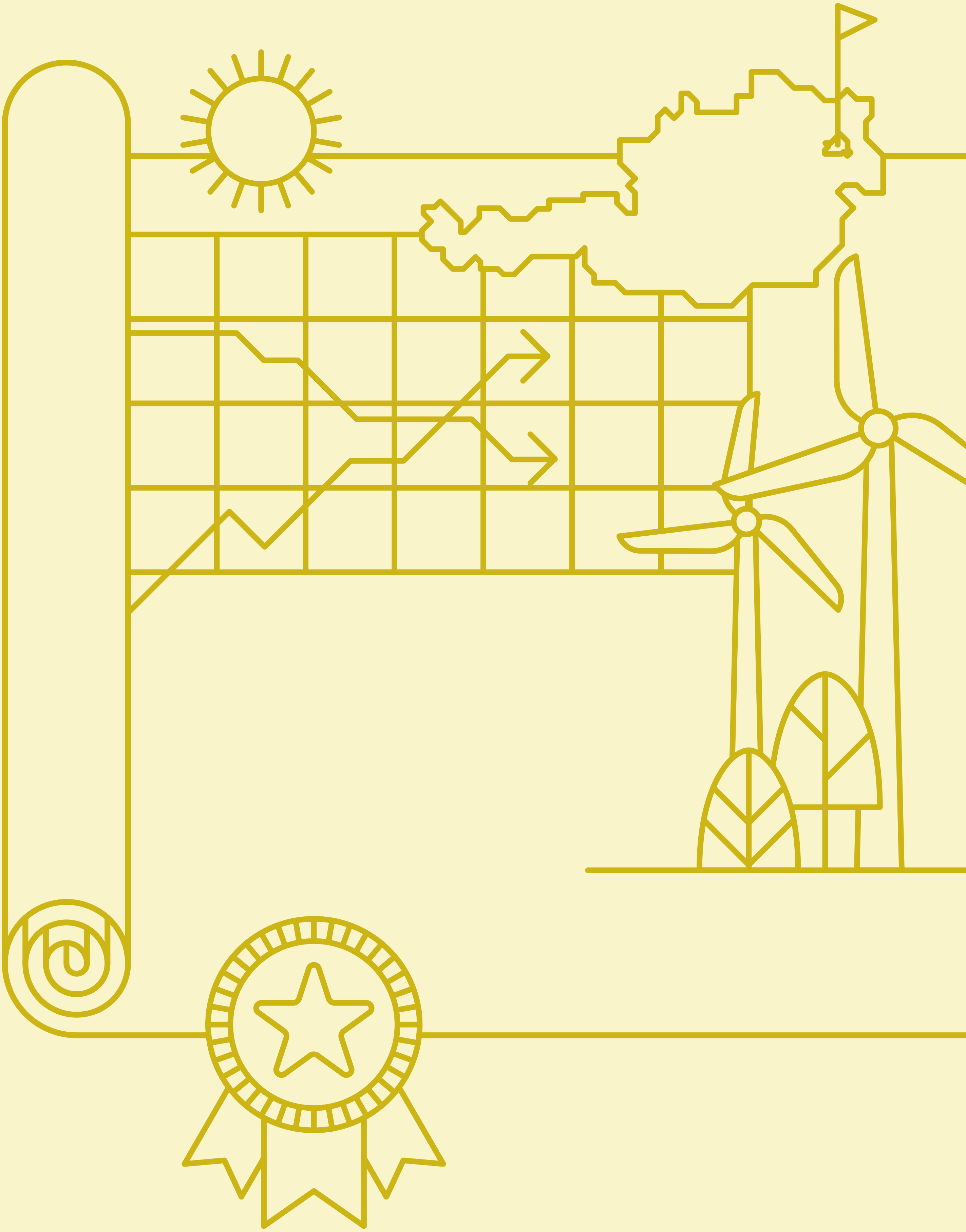
Federal province	1995	2000	2005	2010	2015	2017	2018	Change [%] Base year 1995
Vienna	1,539,002	1,553,956	1,652,449	1,702,855	1,840,226	1,888,776	1,897,491	+23.3%
Vorarlberg	342,525	350,129	362,630	369,300	384,147	391,741	394,297	+15.1%
Tyrol	653,369	671,492	694,253	707,517	739,139	751,140	754,705	+15.5%
Styria	1,185,538	1,182,441	1,200,854	1,206,611	1,232,012	1,240,214	1,243,052	+4.9%
Salzburg	508,253	514,851	524,920	527,886	545,815	552,579	555,221	+9.2%
Upper Austria	1,361,888	1,373,134	1,400,287	1,410,222	1,453,948	1,473,576	1,482,095	+8.8%
Lower Austria	1,522,804	1,539,416	1,580,501	1,609,474	1,653,691	1,670,668	1,677,542	+10.2%
Carinthia	561,845	559,571	559,277	556,718	560,482	560,898	560,939	-0.2%
Burgenland	277,843	275,956	279,127	284,581	291,011	292,675	293,433	+5.6%

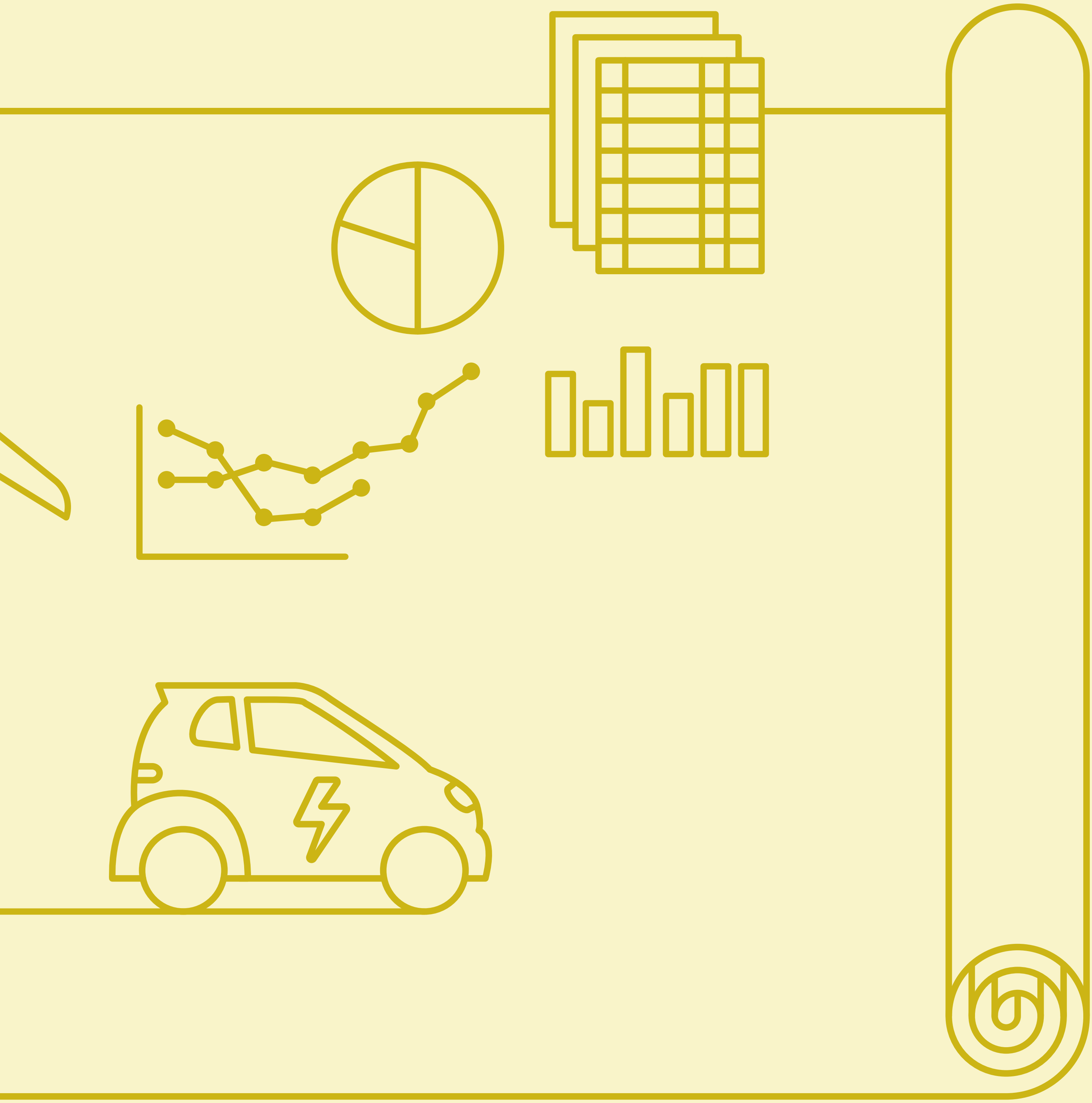
Population growth by federal province
Source [Bevölkerung]



Population growth by federal province, 1995 – 2018
Source [Bevölkerung]

Note: Year-end figures.





Appendix

6 Appendix

6.1 Glossary

Ambient heat refers to heat found in the environment that is used for energy generation, such as near-surface and deep geothermal energy and solar heat.

Biogenic fuels include the organic part of domestic waste, wood pellets, wood briquettes, wood chippings, charcoal, waste liquor, landfill gas, sewer gas, biogas, bioethanol, and biodiesel.

Bundesländer Luftschadstoff-Inventur (BLI) 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.

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

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

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.

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

Final energy is the energy available to end users, e.g. in the form of electricity, district heating, petrol, diesel, wood pellets or fossil gas. They can use this energy directly or transform it further.

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

Gross inland energy consumption (GIEC) is the energy available in the city. It is the difference between imported and exported energy (net imports) and the energy generated in the city itself.

Heating degree days are based on an indoor temperature of 20°C and a base temperature (exterior temperature at which the building is heated) of 12°C. This is referred to as HDD20/12. This is the sum of the differences between indoor temperature and mean outdoor temperature for all heating degree days over one year and is indicated in Kelvin x days (Kd).

Hot day is a day on which the maximum temperature is at least 30°C.

Hybrid car/hybrid propulsion is a vehicle that uses a combination of different technologies or its propulsion system. In this report, the term is used for propulsion systems that combine petrol and electricity or diesel and electricity.

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

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

PV area is used in this report as a unit of measure. 6.5 m^2 photovoltaics area corresponds to 1,000 kWh.

SCWR balance method: The emissions calculated with the SCWR balance method are Vienna's emissions in the BLI emissions survey with local traffic balancing (domestic traffic / second estimate), excluding emissions trading.

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

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

6.2 Abbreviations

BLI Bundesländer Luftschadstoff Inventur – survey of air pollutants in Austria
ETS emissions trading system
GHG greenhouse gases
kWp kilowatt peak
MA Municipal Department
Non-ETS non emissions trading system
PV photovoltaics
SCWR Smart City Wien Framework Strategy
SEP Energy Efficiency Programme of the City of Vienna

6.3 Sources

Bevölkerung **Info** Population statistics **Source** Statistik Austria **Link** https://www.statistik.at/web_de/statistiken/menschen_und_gesellschaft/bevoelkerung/bevoelkerungsstand_und_veraenderung/bevoelkerung_im_jahresdurchschnitt/index.html

Bevölkerung Wien **Info** Vienna population data from Open Government Data (OGD) **Source** MA 23 **Link** https://www.data.gv.at/katalog/dataset/091a085f-2652-429f-8dde-c69199440ddf

BLI 2017 **Info** Bundesländer-Luftschadstoff-Inventur **Source** Umweltbundesamt **Link** https://www.data.gv.at/katalog/dataset/68ff8db4-4a7b-430e-bbe5-5775d1d389df

Energiebilanz 2018 **Info** Energy balance for Vienna 2018, detailed information **Source** Statistik Austria **Link** http://www.statistik.at/web_de/statistiken/energie_und_umwelt/energie/energiebilanzen/index.html

Energiedatenbank MA 20 **Info** Energy database of MA 20 **Source** MA 20

Heizungen **Info** Energy use of households **Source** Statistik Austria **Link** http://www.statistik-austria.com/web_de/statistiken/energie_und_umwelt/energie/energieeinsatz_der_haushalte/index.html

HGT **Info** Heating degree days Vienna **Source** ZAMG **Link** www.zamg.ac.at

KFZ-Bestand **Info** Car ownership figures **Source** Statistik Austria **Link** http://www.statistik-austria.com/web_de/statistiken/verkehr/strasse/kraftfahrzeuge_-_bestand/index.html

MA 20 Förderdaten **Info** Data on subsidies for PV installations from MA 20/MA 27, KPC **Source** MA 20

Nutzenergieanalyse 2018 **Info** Useful energy analysis of Statistics Austria 2018 **Source** Statistik Austria **Link** http://www.statistik.at/web_de/statistiken/energie_und_umwelt/energie/nutzenergieanalyse/index.html

Private PKW **Info** Performance and fuel consumption of private cars **Source** Statistik Austria **Link** http://www.statistik.at/web_de/statistiken/energie_und_umwelt/energie/energieeinsatz_der_haushalte/index.html

OLI **Info** Österreichische Luftschadstoffinventur **Source** Umweltbundesamt **Link** https://www.umweltbundesamt.at/emiberichte

SCWR **Info** Smart City Wien Framework Strategy **Source** Stadt Wien

Statistische Jahrbücher **Info** Statistical Yearbooks of the City of Vienna **Source** MA 23 **Link** https://www.wien.gv.at/statistik/publikationen/jahrbuch.html

Wertschöpfung **Info** Gross value added at manufacturer prices **Source** Statistik Austria **Link** http://www.statistik.at/web_de/statistiken/volkswirtschaftliche_gesamtrechnungen/regionale_gesamtrechnungen/nuts2-regionales_bip_und_hauptaggregate/

Wiener Linien **Info** Energy use, modal split, length of route network, number of annual passes of Vienna Public Transport **Source** Wiener Linien: Abfragen

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Interactive infographics on other indicators are available online at
www.wien.gv.at/energiebericht2020