Energy! ahead

Energy Report of the City of Vienna

Data for 2012 / Year of reporting 2014, Municipal Department 20

City of Vienna

SMART CITY WIEN

ABBREVIATIONS

APA	Austria Press Agency
KliP	Climate Protection Programme
MA 20	Municipal Department 20 – Energy Planning
MIT	motorised individual traffic
PV	photovoltaics
VCÖ	Austrian traffic and transport association

IMPRINT

Owner and publisher:
Vienna City Administration
Municipal Department 20 – Energy Planning
Strategic coordination:
Bernd Vogl, Herbert Ritter,
Ursula Heumesser, Kristina Grgic
Municipal Department 20 – Energy Planning
www.energieplanung.wien.at
Design concept, illustration, layout:
Typejockeys, Vienna, *www.typejockeys.com*
Photo ©: Wien 3420 Aspern Development AG/dadaX
Translation: Sylvi Rennert
Printed at: gugler cross media, *www.gugler.at*
Printed on Impact by Lenzing Papier:
(CO_2 neutral, 100% recycled fibres)

Published and printed: Vienna, December 2014

DATA 2012

for the City of Vienna

by
Univ.Prof. Dr. Reinhard Haas
Dr. Amela Ajanovic
Regina Dittrich

Vienna, December 2014

COMMISSIONED BY Municipal Department 20 – Energy Planning

CARRIED OUT BY
Institute of Energy Systemsand Electrical Drives; Vienna University of Technology

Energy Economics Group

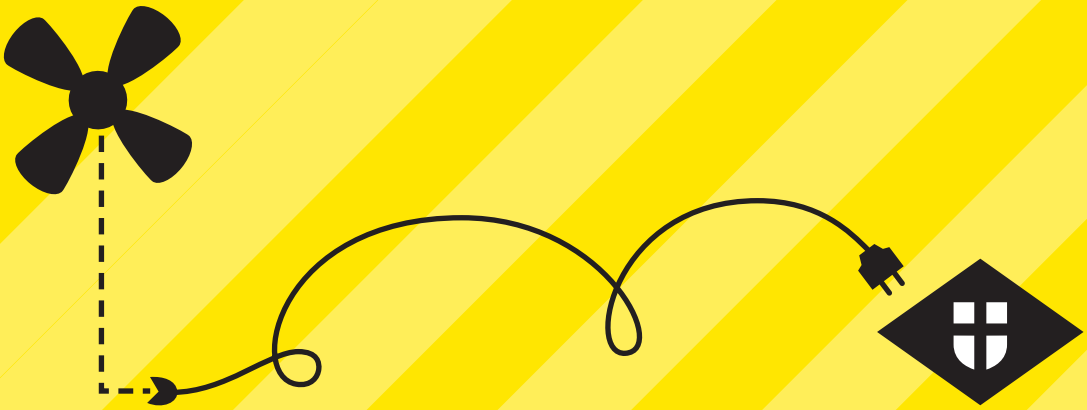
TU WIEN TECHNISCHE UNIVERSITÄT WIEN Vienna University of Technology

Wien! voraus
Energieplanung
StaDt+Wien

TABLE OFCONTENTS

PREFACE, INTERVIEW AND FINDINGS

PREFACE
INTERVIEW and FINDINGS



* **Mag.ª Maria Vassilakou**
Deputy Mayor, Executive City Councillor for Urban Planning, Traffic & Transport, Climate Protection, Energy and Public Participation

1. PREFACE CLIMATE PROTECTION WILL BE DECIDED IN THE CITIES

More and more people are moving to the city, and that is good. Vienna has become the second-largest city in the German-speaking areas, right after Berlin. By 2027, the number of inhabitants will rise to 2 million. Demand for resources and traffic volume will grow with the population. This means that we have to reimagine our city and use new ways of planning.

The core tasks of sustainable urban development are the ecologically sound refurbishment and construction of buildings and neighbourhoods, updating the infrastructures of municipal engineering in terms of technology while including renewable energy and waste heat sources, and developing a new kind of mobility. Traffic and transport are currently responsible for 36 % of energy consumption in Vienna, making them the largest energy consumer.

Over the last years, Vienna has set itself ambitious goals with the Smart City Strategy, e.g. reducing greenhouse gas emissions per capita by 80 % by 2050. Resource-conserving mobility is a key instrument for meeting our climate protection goals. Vienna is successfully increasing the share of public transport, walking and cycling. At 70 % ecomobility, Vienna ranks among the top cities worldwide.

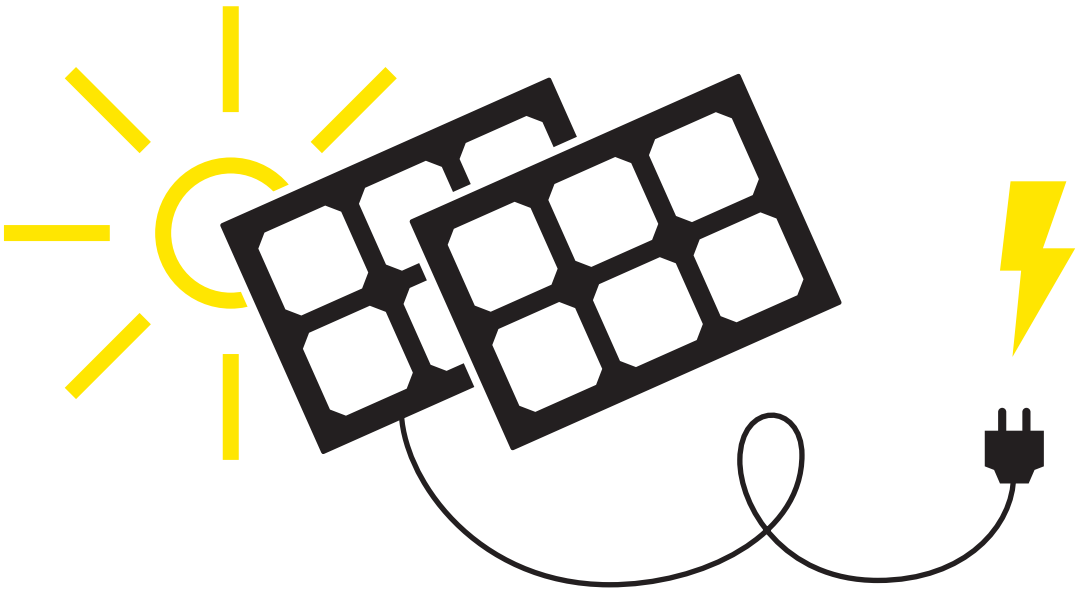
Energy generation is also undergoing positive developments. The share of renewables in Vienna has increased and will continue to grow, as many measures implemented in the last months and years will start to yield results in the years to come.

By 2030, more than 20 %, and by 2050, 50 % of Vienna's gross energy consumption will be covered from renewable sources. The groundwork has already been laid, e.g. with the solar energy standard in the Vienna Building Code and by introducing spatial energy planning at district level. In this process, spatial planning and energy planning are combined to find the optimum infrastructure and energy solutions for each site.

Mag.ª Maria Vassilakou

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

* **Herbert Ritter** has been Deputy Head of MA 20 – Energy Planning since its founding (1 January 2011). He has been working for the City of Vienna since 2009 and was previously with the Austrian Energy Agency, where he focused on energy efficiency.



2. INTERVIEW BERND VOGL/HERBERT RITTER

The Energy Report is now being published for the third time. It is no longer a completely new publication, and neither is the Municipal Department publishing it. What relevance does the Energy Report have for Vienna?

BERND VOGL: The Energy Report is an invitation to people to look at the situation of energy and the associated climate protection issues in Vienna. Our aim is to make a report that is clearly structured and also interesting to read for people who do not work in the energy field. Therefore, we emphasise the attractive and clear presentation of data. The report is also intended to answer questions regarding what individual people can do to contribute to climate protection by rethinking the way they use energy. This year, we tried to make the energy data even more transparent and accessible in order to facilitate their further use. We consider this very important.

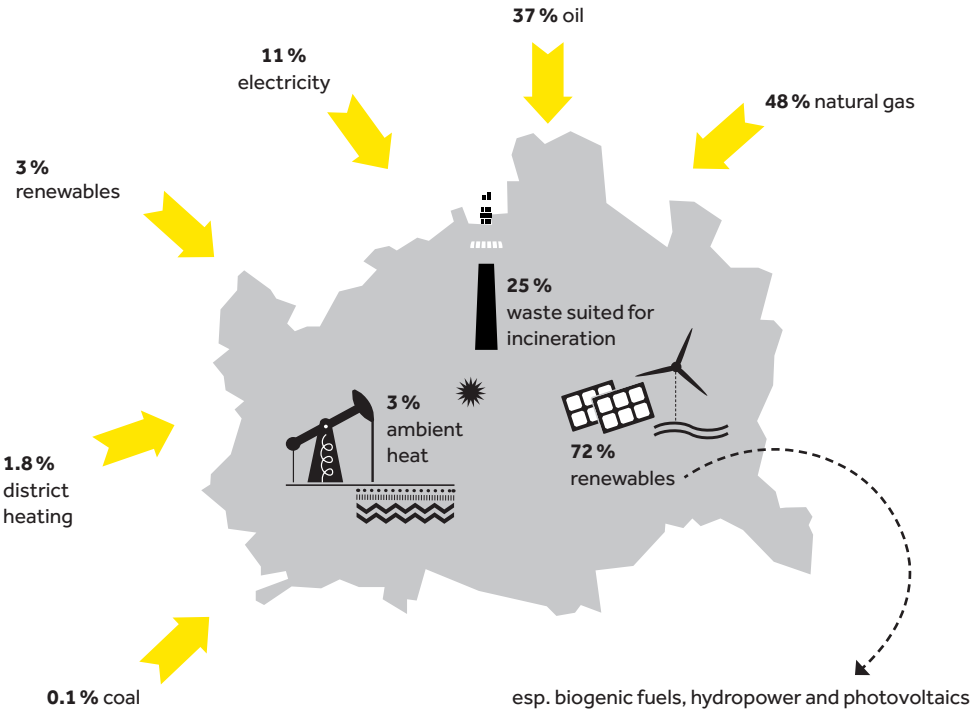
HERBERT RITTER: Each new Energy Report is both a look at past developments and a glimpse of the future. The changes over one year aren't very large, but the data show us where we need to work on measures for increasing energy efficiency and the spread of renewables. And we can also see that changes are already occurring, especially with regard to energy sources. For example, the share of renewables has increased by 5 % over the last eight years.

Where are the biggest energy saving potentials in the city?

BERND VOGL: The biggest energy consumers in Vienna are mobility and heating. Mobility is responsible for 36 % of total energy consumed, heating for 50 %. That adds up to some 33,000 gigawatt hours. We would have to build 200 km² of photovoltaics installations to generate that much energy. That is an incredible amount, but people aren't really aware of it. When people think about saving energy at home, they think about electricity. Most people don't realise that heating consumes a lot more energy.

HERBERT RITTER: These days, we take a working energy supply for granted. That was not always the case. As recently as the 1970s, heating their home was often at the forefront of people's minds, as it required physical effort. Many flats were heated with coal, which had to be carried up from the cellar. I remember how my grandfather used to spend days on the circular saw cutting wood for winter. Nowadays, heating our homes is more comfortable than it has ever been.

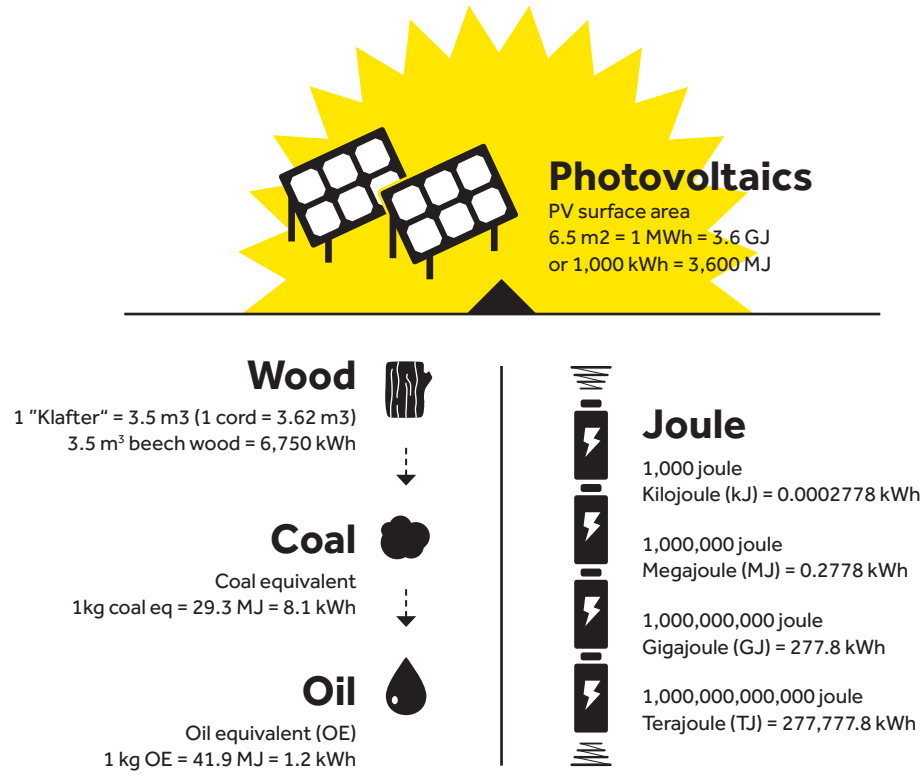
BERND VOGL: The heat market is undergoing a major transformation process. The increased use of renewable energy sources for electricity generation also changes the heat markets. Old structures have to be reassessed and changed. Importing expensive fossil energy for heating is becoming unpopular, not only because of ambitious climate protection goals, but also from a purely economic standpoint. In future, we will be increasingly using energy that is available locally. By this I mean waste heat and waste cooling from buildings that can be efficiently used by neighbouring buildings with heat pumps, as well as ambient heat from water, the ground, and the direct use of solar energy.



Vienna imports more energy than it produces (136,108 terajoule imports; 21,614 terajoule exports)

HERBERT RITTER: The energy consumption of high-efficiency buildings should not be underestimated. The energy demand for heating water is growing in these buildings and electricity consumption is constantly increasing due to the technical infrastructure (e.g. ventilation). This requires efficient solutions. Some steps have already been taken. The City of Vienna initiated the Urban Energy Efficiency Programme (SEP), whose measures have already generated considerable savings. As the framework of energy markets has changed and new technologies have emerged, we are currently developing a follow-up programme (SEP 2) to reinforce the crucial issue of energy efficiency in the city and create a new framework for future measures.

BERND VOGL: We need unconventional approaches to heating buildings. Traditionally, heating systems have been planned for a single building and seen as a closed unit. But the future of heating is an open, interconnected system that creates synergies between multiple buildings. The City of Vienna is putting a lot of effort into tapping and developing new sustainable energy sources. Which applications and technologies are implemented also depends on the framework conditions. Municipal Department 20 – Energy Planning aims to create foundations for innovation and to build networks. The Energy Report shows the developments so far. The future of energy will be multifaceted and exciting.



The report once again uses the surface area of photovoltaics installations (PV surface area) as an energy indicator. Why?

BERND VOGL: We are using the PV surface area to show that the future belongs to renewables. Photovoltaics is the measure of all things. In every era, energy has been measured using the dominant energy source. Until now the measure was litres (or barrels) of oil, before that it was coal, and even further back, wood. That fossil legacy survives to this day. In Germany, the energy balance is still shown in coal equivalents, and the EU measures energy in tonnes of oil equivalents (toe).

Using PV surface area as a unit of measurement also visualises our energy consumption in a vivid and arguably more realistic way. Comparing the areas shows that it will be possible to generate part of the energy required in Vienna from renewable sources in the city. But the majority will have to come from the environs or further away, like with food.

NOTE: For a detailed description of the PV surface area, see page **PAGE 20**.

3. MILESTONES ON THE ROAD TO A SUSTAINABLE ENERGY FUTURE

Period 1 January 2013 – 30 June 2014

3.1 THE SMART CITY FRAMEWORK STRATEGY

Sustainable energy supply requires the careful and intelligent use of resources. The adoption of the Smart City Wien Framework Strategy in June 2014 was an important milestone. Its objective is to provide maximum quality of living for all Viennese people while saving resources. This can be accomplished with extensive innovations.

The energy-related objectives of Vienna's Smart City Framework Strategy are:

- reducing per capita greenhouse gas emissions in Vienna by 80 % by 2050 (from 1990 levels)
- increasing energy efficiency and decreasing final energy consumption per capita in Vienna by 40 % by 2050 (from 2005 levels)
- reducing per capita primary energy input from 3,000 to 2,000 watt
- in 2030, over 20 %, and in 2050, 50 % of Vienna's gross energy consumption will be covered from renewable sources
- strengthening CO_2-free modes of transportation (walking and cycling), maintaining the high share of public transport and decreasing motorised individual traffic (MIT) in the city to 20 % by 2025, to 15 % by 2030, and to markedly less than 15 % by 2050
- by 2050, all motorised individual traffic within the municipal boundaries is to operate without conventional propulsion technologies, and by 2030, commercial traffic originating and terminating within the municipal boundaries is to be largely CO_2-free
- reduction of energy consumption by passenger traffic across municipal boundaries by 10 % by 2030
- cost-optimised zero-energy building standards for all new structures, additions and refurbishment from 2018/2020 and further development of future supply systems towards even better climate protection levels
- comprehensive rehabilitation activities entail the reduction of energy consumption of existing buildings for space heating/cooling/water heating by 1 % per capita and year

The Smart City Wien Framework Strategy is a long-term vision for the city and provides a structuring reference framework for the existing documents, plans and programmes. In the field of energy, these include: the Energy Strategy 2030 of the City of Vienna, the

Climate Protection Programme KliP, the supply security plan including the Renewable Energy Action Plan (RAP), the Urban Energy Efficiency Programme SEP, the new urban development plan STEP 2025 and the new detailed mobility strategy for the implementation of the goals of STEP 2025.

3.2 SPATIAL ENERGY PLANNING

The urban development plan STEP 2025 was adopted by the Vienna City Council in July 2014 and includes the objective of developing integrated spatial energy planning. In order to achieve the energy efficiency objectives and increase the share of energy from renewable sources, it is important to coordinate the existing and planned infrastructure and spatial structures and use them optimally. This requires the coordination of spatial and energy management realities and planning processes. To this end, the City of Vienna started developing a spatial energy planning concept in 2013. The first steps were to develop a structure and assemble basic information for the development of energy concepts for districts and neighbourhoods. Municipal Department 20 (MA 20) is involved in developing and coordinating the creation of several energy concepts for large urban development areas in Vienna.

In order to further integrate and structure the topic of spatial energy planning in the City of Vienna, the development of a detailed strategy for integrated spatial energy planning has begun. It will provide technical information on the topics involved in order to allow participants to learn more about them while also coordinating energy and spatial planning processes so that the energy policy goals of the City of Vienna can be met. At the same time, the operational structure (organisation and staff) for spatial energy planning is being developed.

3.3 ESTABLISHING THE ENERGY COMPETENCE CENTRE

In spring 2013, the Vienna City Council decided to set up a competence centre for energy that will support the City of Vienna in reaching its climate protection and energy objectives, as laid out in the city's government programme. As preparatory work for this decision, MA 20 evaluated the feasibility and the optimal organisational structure of such a centre with the help of experiences from all other eight Austrian provinces.

Based at **TINA VIENNA URBAN TECHNOLOGIES & STRATEGIES GMBH**, this think tank has been supporting the energy activities of the City of Vienna since December 2013. The centre of excellence drives advances and supports the implementation of measures, working at the interfaces of politics and administration on the one hand and business and research on the other.

During its first months of operation, the centre has contributed to the definition of the energy and climate protection objectives of the Smart City Wien Framework Strategy and the detailed mobility strategy by processing and analysing data. Its research on international best practice examples in low-temperature heating networks are being used to inform the discussion on how to provide heating and cooling in the new urban development areas. The centre also creates connections between the city's and national and international efforts by

submitting project proposals to Austrian and EU funding agencies in order to benefit from the findings of other cities, to meet Vienna's challenges and to share Vienna's experiences with others. It also provides initial consultations on energy matters for departments of the city administration. This has already led to several energy and cost-saving changes. "We have an interesting range of tasks," says Waltraud Schmid, head of the competence centre, who addresses these different issues together with Michael Cerveny and Matthias Watzak-Helmer.

For the next 12 months, one of the Energy Competence Centre's core tasks will be to support Municipal Department 20 – Energy Planning in developing the Urban Energy Efficiency Programme SEP2 and with energy-related questions related to large-scale construction projects (e.g. urban development areas, integrated spatial energy planning).

3.4 TRAILBLAZING AMENDMENT TO VIENNA'S BUILDING CODE: THE "VIENNA SOLAR ENERGY STANDARD"

New service buildings (e.g. office buildings) will soon contribute to increasing the share of renewable energy in Vienna. In an amendment to the Building Code, the new "Vienna solar energy standard" was introduced. In newly constructed buildings, hitherto unused facades and roofs will be used to generate clean energy. Solar energy will be generated with units attached to the exterior of the building envelope. They will generate a minimum of 1 kilowatt-peak per 100 m² gross floor space. This can be reduced to 0.3 kilowatt-peak if the building demonstrably has energy efficiency measures exceeding the required standard.

CITIZENS' SOLAR POWER PLANTS – OVERWHELMING SUPPORT FROM THE POPULATION

The response of the Viennese at the consultative referendum in March 2013 was clear: More than 67 % were in favour of the development of further renewable energy projects following the model of the citizens' solar power plants.

On 4 May 2012, Vienna's first citizens' solar power plant was opened on the premises of the Wien Energie power station Donaustadt in the 22nd district. It was followed in 2012 by the solar power plant in Leopoldau in the 21st district. The model's popularity continues. In 2013, five more citizens' power stations were opened: two at the Vienna Central Cemetery, one in the 23rd district, one at the transformer station Wien West in the 13th district, and one in the 3rd district, where central Vienna's largest solar power station was opened on the roof of the Wien-Mitte railway station in December 2013.

Five plants were also constructed in Lower Austria in 2013. The trend continued in 2014: In May, a new citizens' solar power plant on the roof of a VET college in the 10th district was opened, followed by a photovoltaics installation on the roof of the headquarters of vegetable growers' cooperative LGV in the 11th district, which produces green energy to power the cooling and sorting installations. A second citizens' solar power plant at the district heating plant Fernheizwerk Süd is currently under construction. A solar power plant is also being

built on the Wipark park & ride facility in Siebenhirten, where the generated energy will be available for charging electric cars.

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

Municipal Department 20 – Energy Planning initiates and shapes the development of Vienna's energy system to make it fit for the future. As the central department for energy planning, it addresses questions of Vienna's energy future, develops concrete solutions, and implements forward-looking measures. The main focus of its activities is the development of a sustainable energy system for Vienna. This includes setting up energy supply plans for districts and neighbourhoods, promoting innovation, initiating pilot projects, coordinating and developing energy-related concepts, bundling competences, and transferring knowledge on the ongoing development of a sustainable energy system.

Between 1 January 2013 and 30 June 2014, the following projects and measures were implemented and continued:

ALTERNATIVE FINANCING MODELS FOR ENERGY SUPPLY

The results of the consultative referendum on the participation model initiated an in-depth look at alternative financing models. In spring 2013, a study was commissioned to examine financing models that allow the participation of citizens or institutional investors.

It presents models from Austria and abroad and analyses their applicability for Vienna. In a workshop, institutional investors and energy providers recognised the need to expand the range of financing models, especially for energy infrastructure.

The study "Alternative Finanzierungsmodelle für die Energieversorgung" is available as a free download in German at www.energieplanung.wien.at under "Publikationen".

SUBSIDIES FOR PHOTOVOLTAICS DRIVE DEVELOPMENT

One of Vienna's tools for promoting the use of solar power is the photovoltaics subsidy scheme – an important contribution to creating a sustainable energy future. Since 2011, the number of applications has soared. In 2013, subsidy applications were filed for more than 150 PV installations.

In the last three years, over 135,000 m² of PV installations were granted subsidies. Today, there are more than 1,100 PV installations in Vienna, among them many showcase projects on roofs of public buildings. They generate some 23,000 MWh of solar power annually, enough to supply more than 8,400 households with electricity.

ENERGY QUIZ 2013: KNOWLEDGE SAVES ENERGY!

Many people in Vienna consider the sustainable use of resources important, and the Vienna City Administration seeks to support and reinforce this trend by creating strong incentives. Therefore, an energy saving campaign was conducted in the autumn of 2013 for the second time. The aim of the "Energy Quiz 2013" competition was to increase awareness of matters related to energy consumption. Nearly 5,000 active participants used the opportunity to improve their knowledge about energy, participate in the drawing, or get expert advice on saving energy at home.

ENERGY-SAVING EXPERT TRAINING

Saving energy not only saves money but is also an active contribution to climate protection. With the energy literacy certificate "Energieführerschein", young people learn to be energy-aware, save energy and address environmental and climate protection issues.

The energy literacy course was launched by environmental consultancy "die umweltberatung" and Municipal Departments 20 and 22 in autumn 2013. 43 apprentices with Vienna Public Utilities and the REWE Group have already completed the course successfully. Over 300 people have registered to acquire the certificate as part of the courses to complete compulsory schooling at the Vienna Public Learning Centres. The energy literacy certificate is an additional professional qualification. Apprentices with the Vienna City Administration can currently attend the course free of charge.

EFFICIENT LIGHTING GUIDE

The guide for interior lighting shows where energy can be saved in service buildings. The lighting guide explains the fundamental terminology and characteristic values of lighting technology and presents their advantages and disadvantages for different applications. The focus is on LED technology as well as new legal requirements (EU Ecodesign Directive and energy labelling) and security aspects. The guide is a tool that supports experts and decision makers in construction projects in evaluating technologies for different applications.

ENERGY CONSULTING FOR LOW-INCOME HOUSEHOLDS

The continuing rise of energy prices hits at-risk-of-poverty households particularly hard. To address this issue, the NEVK project (Nachhaltige Energieversorgung für einkommensschwache Haushalte – "Sustainable energy supply for low-income households") was launched in 2012. An important part of the project were 500 on-site energy consultations, where people received personalised recommendations for reducing their energy consumption and increasing energy efficiency tailored to their individual situation. This was supported with funds of the Federal Ministry of Labour, Social Affairs and Consumer Protection and other cooperation partners.

Following the positive experiences of the NEVK project, energy consulting was made a regular part of Vienna's energy support scheme. The Vienna office of environmental consultancy "die umweltberatung" provides on-site energy consultations, which are the basis for the implementation of tailored energy saving measures. To coordinate these efforts, a new team responsible for the Vienna energy support scheme was created in Municipal Department 40 – Social Welfare, Social and Public Health Law. The team is in charge of managing requests, supporting the clients in implementing the recommended measures, and providing follow-up counselling.

SOLAR THERMAL ENERGY IS WORTH IT!

Using solar thermal energy is one of the simplest ways of reducing the energy input required for heating. Solar thermal systems can be used to heat water and contribute to space heating. The City of Vienna subsidises their installation. The funding guidelines have been revised and the scheme has been extended until December 2015 to meet the needs of applicants. The city subsidises stationary solar thermal installations and combined solar thermal and heat pump systems for water and space heating. The new funding guidelines are available at www.energieplanung.wien.at .

GUIDE FOR THE INTEGRATION OF PHOTOVOLTAIC AND SOLAR THERMAL SYSTEMS INTO THE CITYSCAPE

The City of Vienna advocates and supports the wide use of solar energy. A clear framework is necessary to ensure a structured development of the increasingly popular large-scale PV installations and allow a high degree of planning reliability. The guide on the use of open spaces for PV and solar thermal systems developed by Municipal Department 20 – Energy Planning provides a clear explanation of the guidelines for the development of large-scale installations. In general, photovoltaic and solar thermal systems should primarily be installed on already used areas, such as roofs or facades. That means that they can be installed in all types of areas and on buildings or other structures, such as retaining walls, fences, flying roofs, noise barriers, grandstand roofs, etc. Their installation in open spaces is more restricted, especially in housing development zones and green zones.

The guide is available as a free download in German at www.energieplanung.wien.at under "Publikationen".

OPTIMUM ENERGY PLANNING FOR WHOLE-BLOCK REDEVELOPMENT

A considerable part of Vienna's building stock consists of old buildings that are worthy of preservation and offer large potential for more efficient energy use. The Smart Block project examines how energy use can be optimised in the refurbishment of houses built in the mid to late 19th century. The scope extends beyond the usual thermal insulation and new windows: The project aims to provide inter-building energy solutions, new mobility concepts and possible financing models.

4. KEY DATA ON ENERGY DEVELOPMENTS IN VIENNA

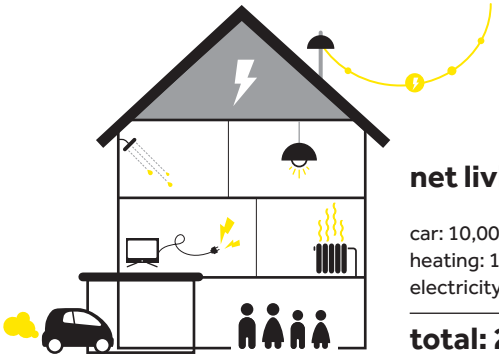
4.1 USING PV SURFACE AREA TO MEASURE ENERGY

In keeping with the idea that fossil energy is the past and renewables are the future, the Energy Report has decided to continue the tradition of using the currently dominant energy source to measure energy. Therefore, the report uses photovoltaic surface area (PV surface area) in order to replace fossil energy sources with solar energy as the standard unit of measurement.

On average, 6.5 m² of solar modules are required to generate 1,000 kWh of PV electricity. This is the conversion factor between other energy units and PV surface area. For large amounts of energy, the Energy Report uses square kilometres as a unit, while the unit for smaller amounts of energy is square metres.

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

ENERGY CONSUMPTION of single-family house vs. apartment buildings. 4-person households.



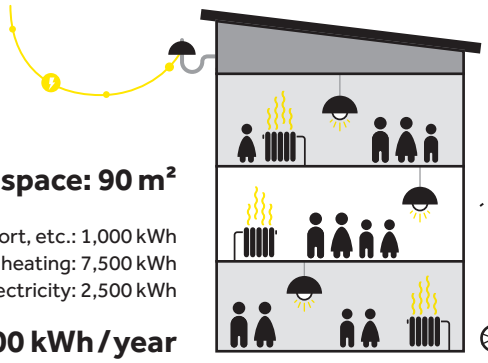
Typical life in a single-family house in the suburbs

net living space: 150 m²

car: 10,000 kWh
heating: 15,000 kWh
electricity: 3,000 kWh

total: 28,000 kWh / year

VERSUS



Typical car-free urban life

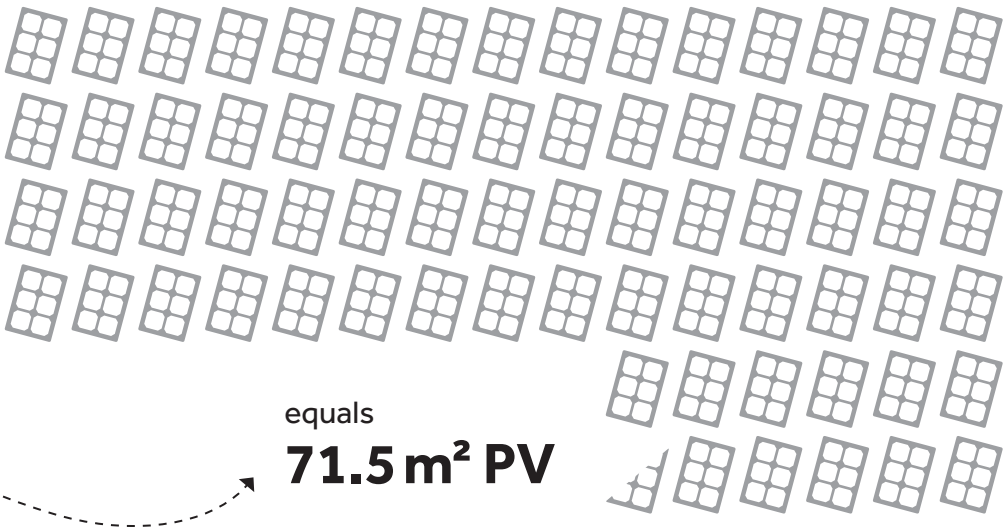
net living space: 90 m²

bicycle/public transport, etc.: 1,000 kWh
heating: 7,500 kWh
electricity: 2,500 kWh

total: 11,000 kWh / year

equals

182 m² PV



equals

71.5 m² PV

AREA COMPARISONS GWh/PV

Reference area: Vienna's total area

Other areas of reference

- Vienna Prater **6 km²**
- Vienna Airport **10 km²**
- Danube Island **3.9 km²**

Final energy Vienna
= 38,134 GWh

▶ **248 km²**
PV surface area

approx. the size of Vienna without districts 2, 20, 21 & 22

Renewable energy in Vienna (final energy)
= 5,284 GWh

▶ **34 km²**
PV surface area
= 3.5 × Vienna Airport

Renewable energy in Austria (available final energy)
= 119,160 GWh

▶ **774 km²**
PV surface area
= 200 × Danube Island

Renewable electricity in Vienna
= 1,252 GWh

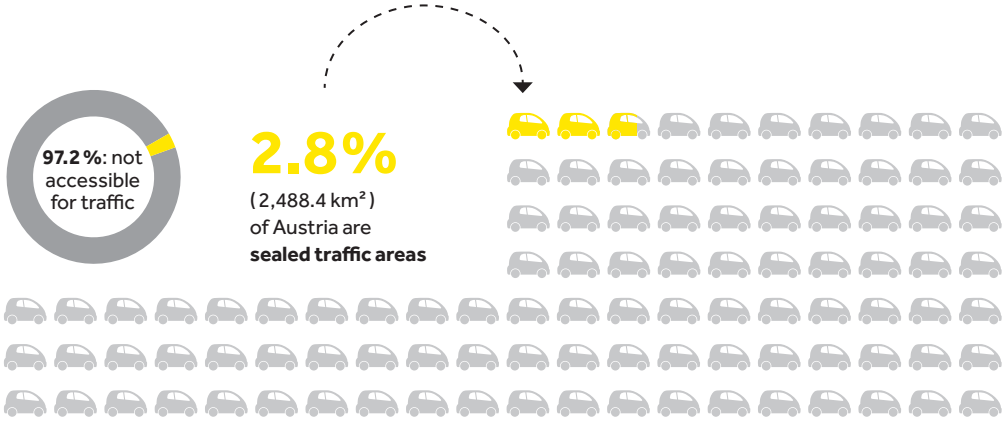
▶ **8.1 km²**
PV surface area
= 1 × Vienna Airport

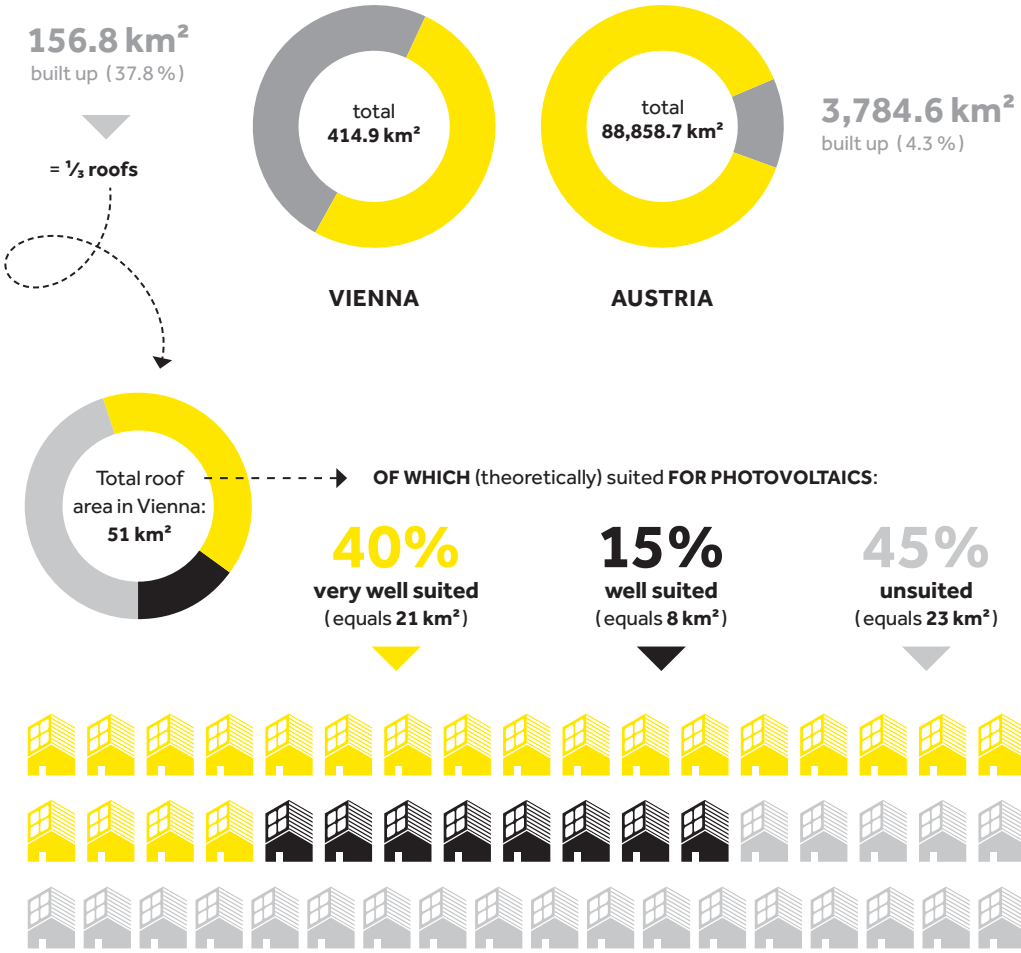
Renewable electricity in Austria (available final energy)
= 46,589 GWh

▶ **302 km²**
PV-Fläche
= 50 × Vienna Prater

Built-up areas – *Source: UBA, 1999*

Built-up areas = total of building area, real estate database, traffic areas



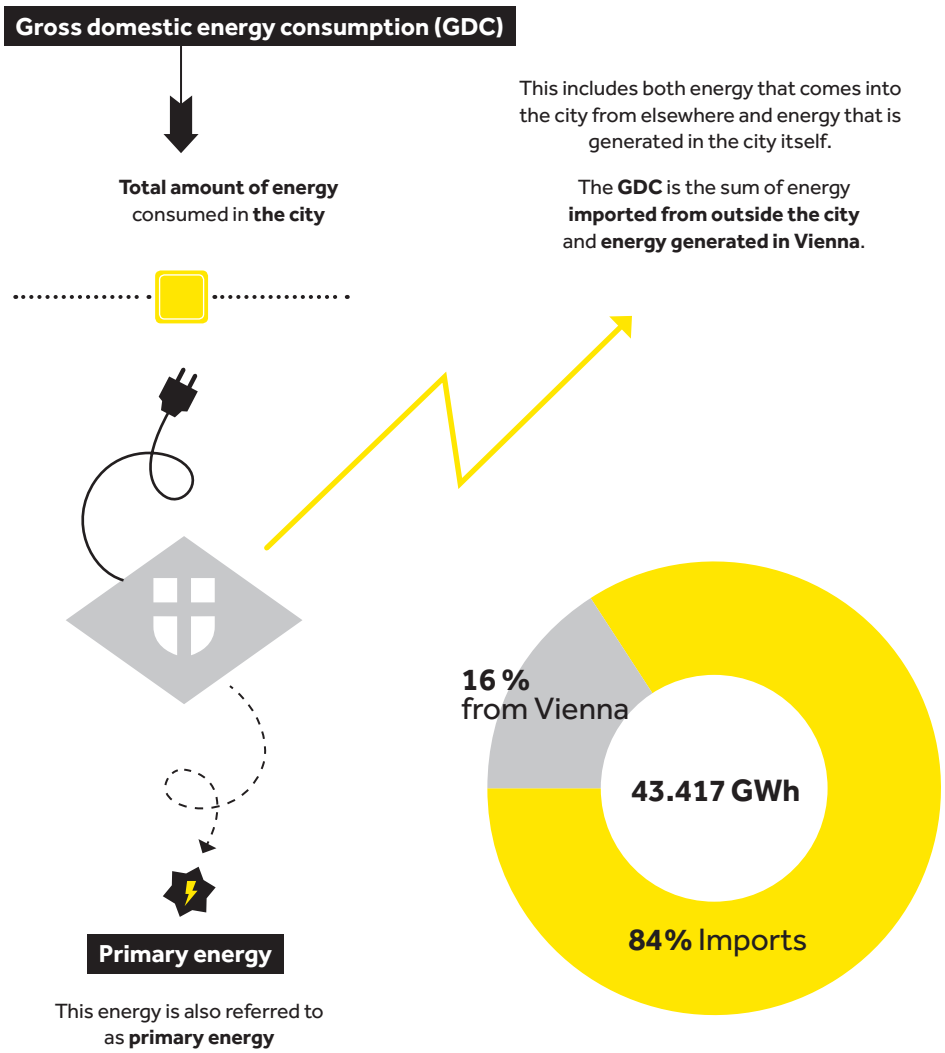


ENERGY CONSUMPTION IN VIENNA

Energy flow chart and energy conversion
How much energy is needed to run a whole city? What enormous energy flows move through the city and where are they used? The energy flow chart attempts to answer these questions. It shows how energy moves through the city and how it is converted until it is finally used to provide heating, lighting, mobility, etc. In order to utilise primary energy sources such as natural gas, hydropower, wood or crude oil, power plants and refineries convert them into commercial final energy sources such as district heating, electricity, petrol, wood pellets, etc.

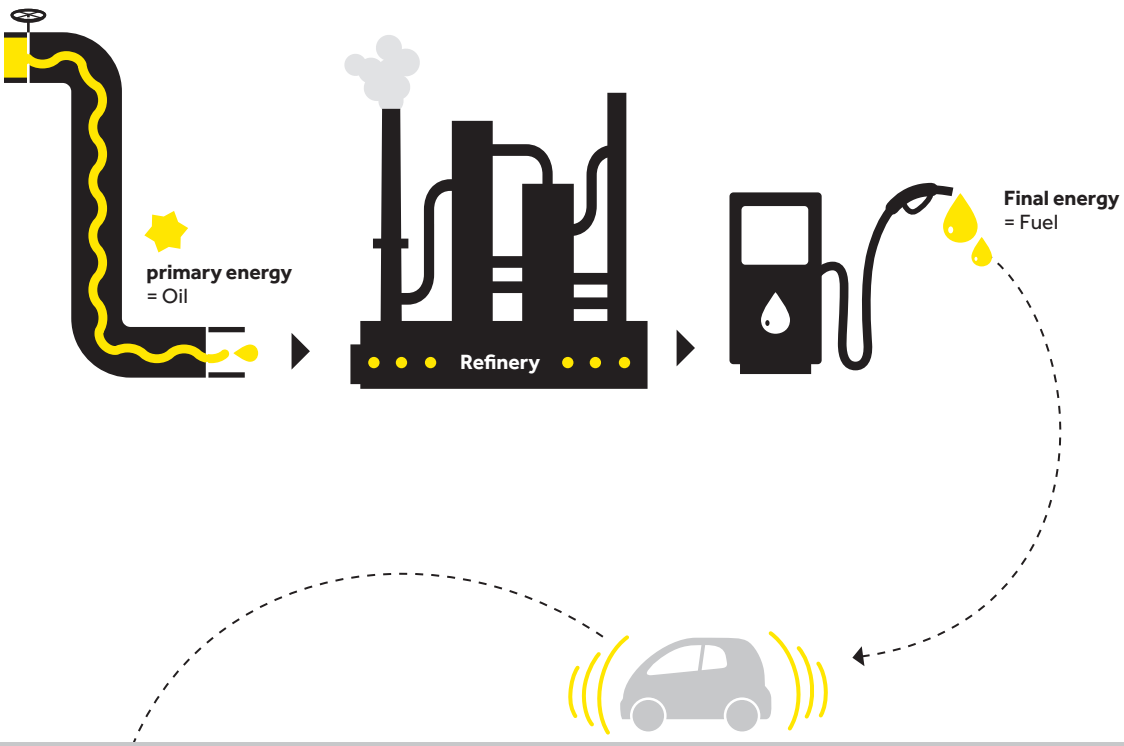
The energy flow chart shows a simplified version of the most important flows between the individual conversion steps. It also shows the energy losses that occur during energy conversion.

The following terms are used in the energy flow chart:

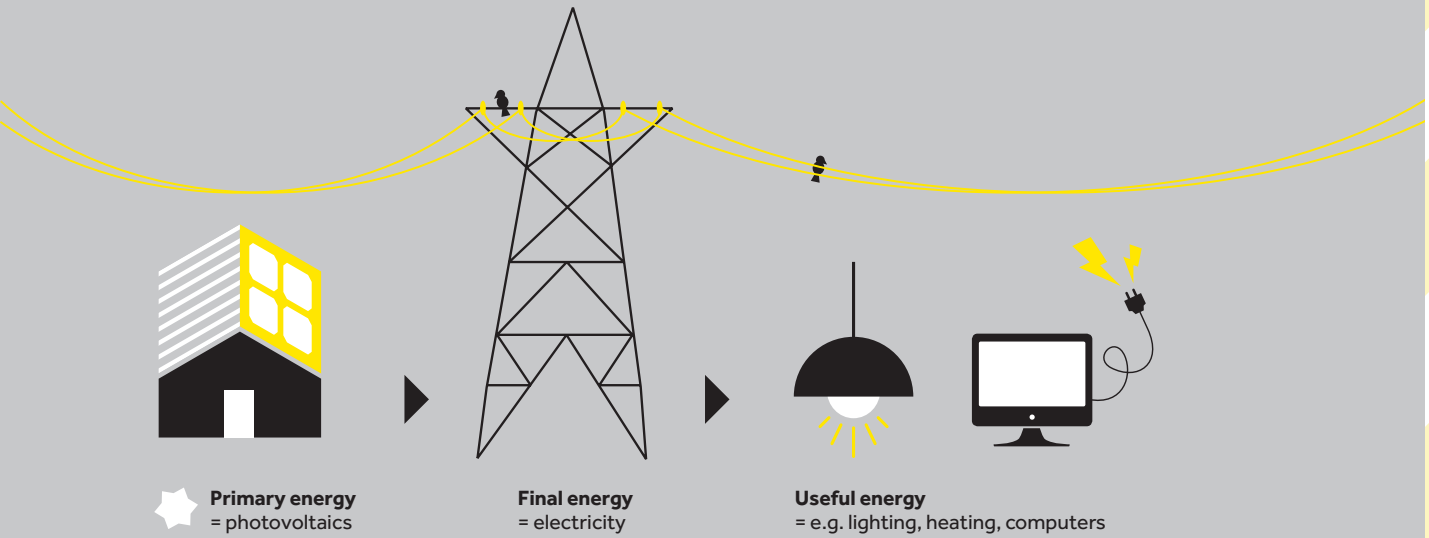


Final energy → **Energy sources available to electricity end-users after conversion,**
e.g. electricity, diesel, petrol, district heating, wood pellets

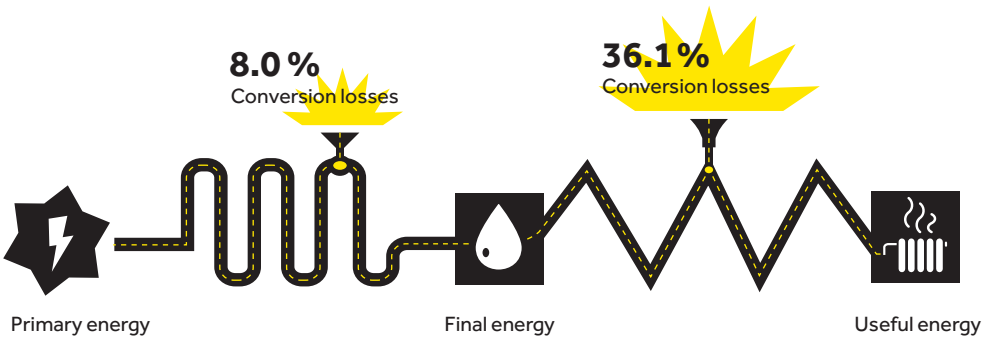
e.g.:



Useful energy → The energy that is **actually used for heating, lighting, mechanical work**, etc.

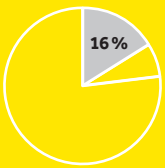


Conversion losses → **Energy that is lost** during **conversion of primary energy** to final energy and **final energy** to useful energy.



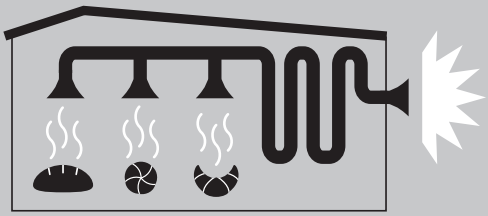
36.1 %
Energy losses at end users – distribution:

Losses 1 Space heating



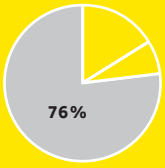
The heat that is lost while heating (e.g. losses in the heating system, water heating, distribution systems, etc.)

Losses 2 Process heat



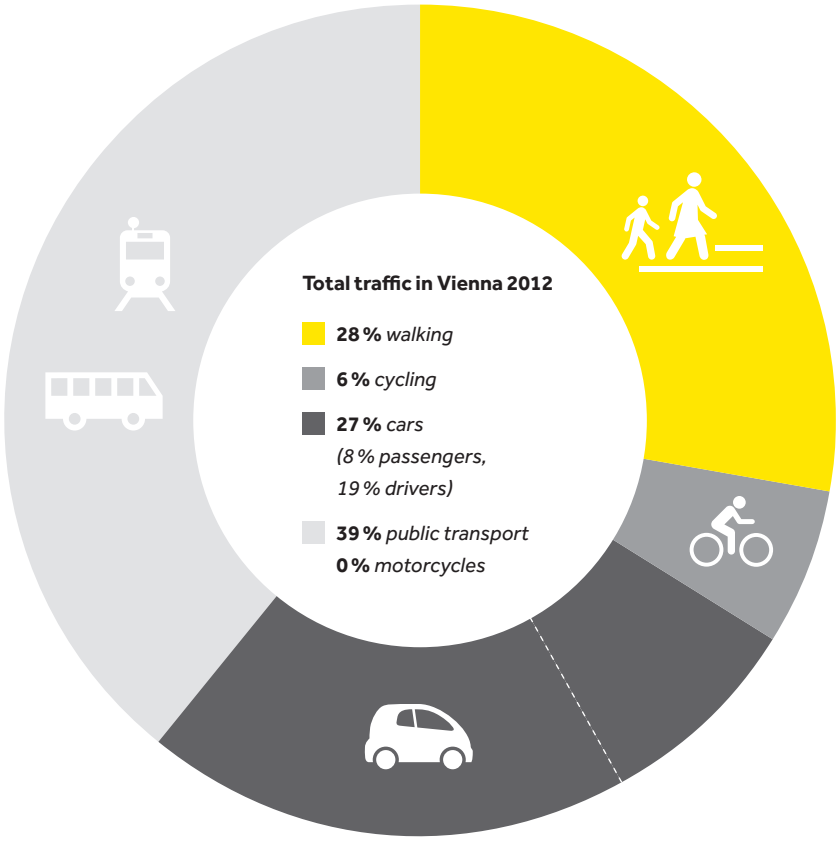
Heat losses in industrial processes (e.g. exhaust air in a bakery).

Losses 3 Power/lighting



Energy losses in electrical appliances and vehicles (e.g. cars) – only approx. 30% of the energy used is converted into mobility, the rest is lost

Modal Split → Share of **individual modes of transport** (private cars, cycling, walking, public transport) out of **total traffic volume**



THE FIGURE ON THE NEXT PAGE shows the energy flow chart of the City of Vienna for 2012 *. The energy flow chart shows clearly that natural gas is the dominant energy source in Vienna, at 41 % of gross domestic energy consumption. More than one third of it is converted into electricity using various processes.

The category of fuels includes diesel, petrol, and small amounts of other petroleum products. At 29 %, diesel and petrol are the second largest contributor to gross domestic energy consumption after natural gas.

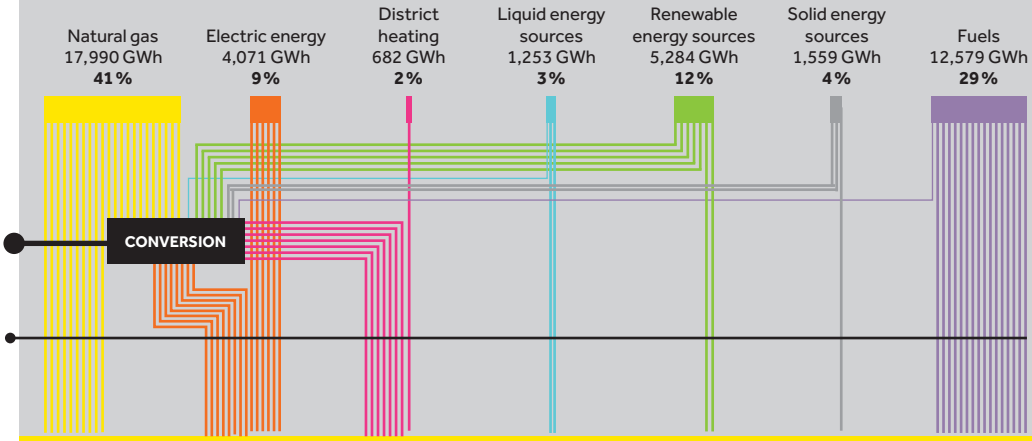
The energy flow chart also shows the conversion losses (12,504 TJ / 3,473 GWh), consumption of the energy sector, transport losses, and non-energy use (4,514 TJ / 1,254 GWh), which together make up 12.1% of gross domestic energy consumption, or 17,018 TJ / 4,727 GWh. These losses and the energy sector's consumption occur during different phases of the energy flows **(CF. FIG. ON THE NEXT PAGE)**.

* *This energy flow chart lists waste suited for incineration and coal as solid energy sources. This is only done in the energy flow chart. In the chapter on energy generation, waste suited for incineration is shown separately. In other calculations, waste suited for incineration is partially considered to belong to the renewable energy sources.*

Energy flow chart of the City of Vienna 2013, based on data from 2012
Current as at 2013 *Source: Statistik Austria*

4.2 Energy flow chart Vienna 2012

100% = 43,417 GWh = Gross domestic energy consumption Vienna 2012

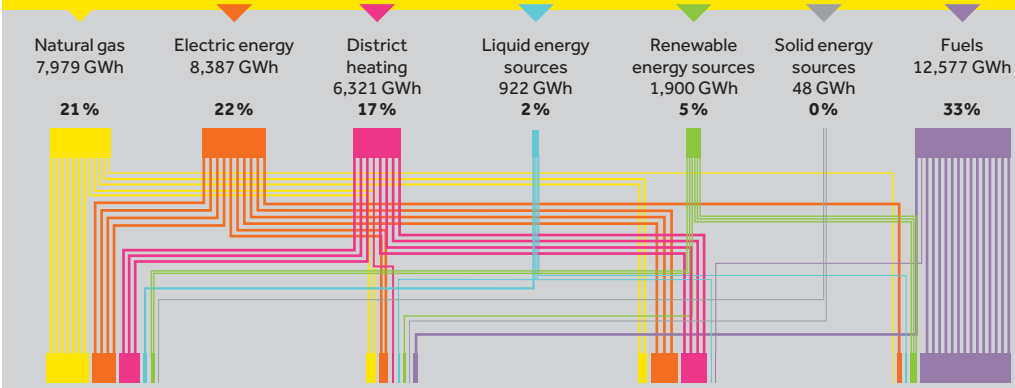


-8.0 %
Conversion losses

-4.1 %
Energy sector consumption, non-energy use 1,796 GWh

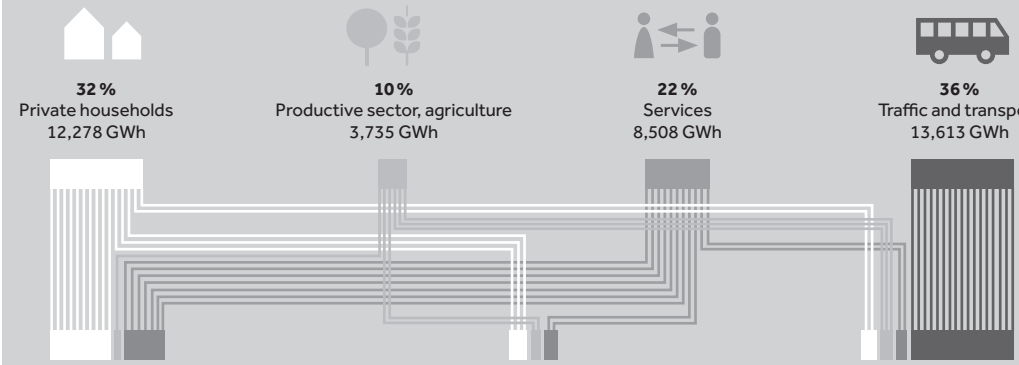
87.8 % =
Final energy use by energy source 38,134 GWh

38,134 GWh = Final energy use by energy source

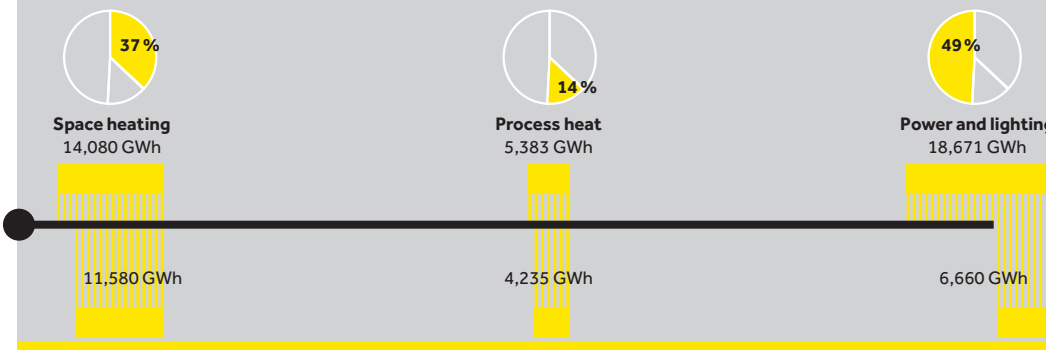


Energy unit
106 kWh = 1 GWh
1 GWh = 3.6 TJ
3.6 TJ = 3.6 × 1.012 J

87.8 %
Final energy use by sector 38,134 GWh



87,8 %
Final energy use by end use 38,134 GWh



-36.1 %
Energy losses at end users 15,659 GWh

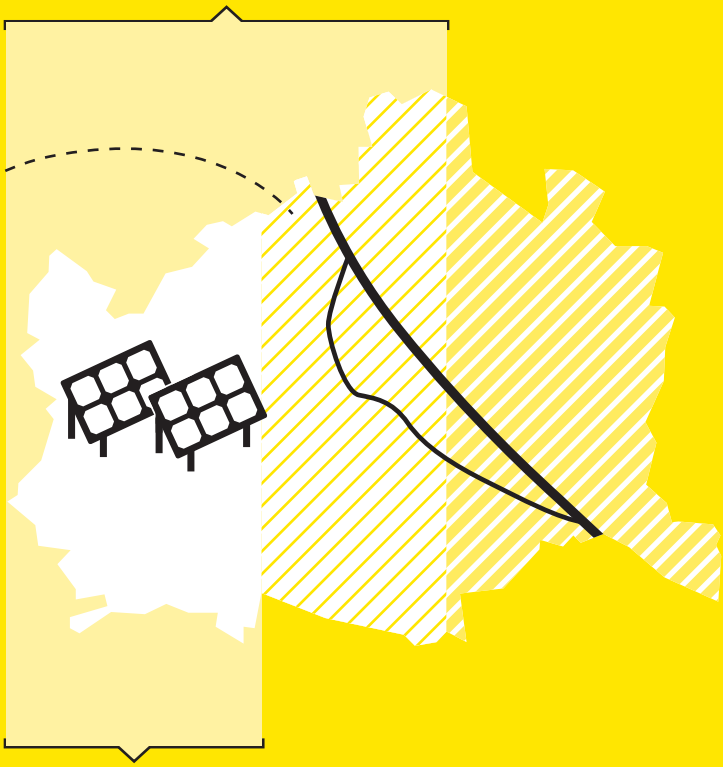
51.8 % = 22,475 GWh = Useful energy consumption Vienna 2012

For the chart below, the figures from the energy flow chart were used and gigawatt hours were converted into PV surface area.

The energy flow chart expressed in **PV surface area**

Gross domestic energy consumption in Vienna = 44,417 GWh

▶ **2/3** **of Vienna's area** (approximately) = **289 km² PV surface area**

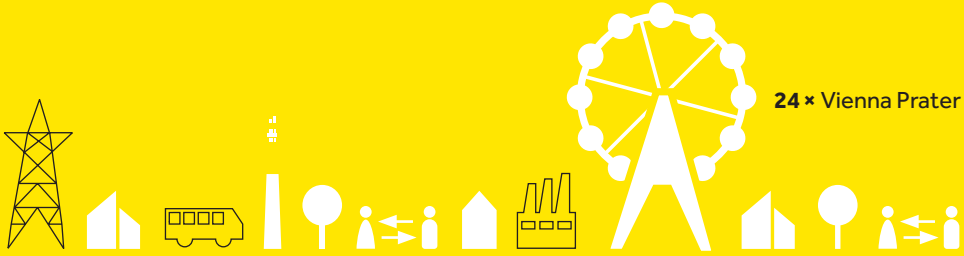


We can only use half of this energy – the rest is **lost ...**

Useful energy consumption in Vienna = 22,475 GWh

▶ **1/3** **of Vienna's area** (approximately) = **146 km² PV surface area**

24 × Vienna Prater



Share of **renewable energy and waste heat out** of final energy consumption

62 km² PV surface area

16 × Danube Island

4.3 The main findings at a glance

The developments in energy consumption and the associated greenhouse gas emissions are important issues for the City of Vienna, as evidenced, for example, by the introduction of the Climate Protection Programme (KliP), the Urban Energy Efficiency Programme (SEP), and the Renewable Energy Action Plan (RAP_Vie), which is currently being developed.

The objective of this report is to document and evaluate the historical developments and status quo of energy use in Vienna for heating, electricity, and mobility from 1995 to 2012. The main findings of the analysis of that period are the following:

ENERGY INDUSTRY

When energy consumption is expressed in PV surface area, Vienna has the lowest consumption per capita (31 m², or 4,753 kWh) and is well below the Austrian average of 47 m² PV surface area (or 7,200 kWh) per capita. This is mainly due to the fact that Vienna has the highest share of flats, which are smaller and consume less energy than housing elsewhere in Austria. Another factor is that the Viennese make considerably fewer car trips than people in the other provinces.

MOBILITY

- The modal split in transportation has changed dramatically since 1995. Although the share of car traffic had been increasing continually until 1995, rising to 46 percent, it then proceeded to fall to 27 percent by 2012. At the same time, the share of public transport grew from 29 percent to 39 percent. This is a 34 percent increase during the period under observation.
- Vienna has the lowest number of cars per capita of all Austrian provinces.
- The share of cycle traffic has increased, doubling from 3 percent in 1995 to 6 percent in 2012.

200 %

1995: 3 % ▶ 2012: 6%

CYCLING

1995: 38 TWh

2012: 43 TWh

TOTAL ENERGY

×1 BILLION

ENERGY SAVED THROUGH SEP

2006–2012:
1.096 GWh saved = 1 billion times doing laundry

600%

2012: 12%

RENEWABLE ENERGY

1995: 2%

1995 UNTIL 2012

Vienna is growing,

ENERGY CONSUMPTION REMAINS

constant.

Vienna PER CAPITA CONSUMPTION OF GREENHOUSE GASES

-19%

ENERGY GENERATION

- Total energy generation has increased over time from 38 TWh in 1995 to 43 TWh in 2012 (maximum: 47 TWh in 2005).
- Currently, 280 km² of PV surface area would be needed to produce the annual amount of energy consumed in Vienna. That would be an area of 16.7 × 16.7 km, or the surface area of all districts to the west of the Danube. Since 1995, energy consumption has increased by approx. 19 percent or 51 km² of PV surface area.
- Natural gas remains the main source of energy production in Vienna with a share of 41 percent, followed by petroleum products at 29 percent.
- The most significant change in energy generation from 2011 to 2012: Natural gas, while still making up the largest share of gross domestic energy consumption, dropped from 47 percent in 2011 to 41 percent in 2012.

ENERGY EFFICIENCY

- Total energy consumption has been relatively stable since 2003.
- The implementation of the measures of the Urban Energy Efficiency Programme (SEP) between 2006 and 2012 reduced energy consumption by 7.1 km² PV surface area, or 1,096 GWh.

RENEWABLE ENERGY

The construction of photovoltaics installations is booming. Electricity generation from photovoltaics nearly doubled from 2011 to 2012 (+45 percent). The total surface area of PV installations on Vienna's roofs by the **end of 2012 was 75,000 m².**

- The share of renewable energy sources increased most in energy generation, from 2 percent in 1995 to 12 percent in 2012.
- The share of renewables in final energy consumption doubled from 6 percent in 2005 to 12 percent in 2012. The main reasons for this were the compulsory blending of biofuels with conventional fuels and the start of operation of the forest biomass power plant in Simmering and the waste treatment facility Pfaffenau, which also burns biogenic waste.
- In 2012, renewable energy covered 16.5 of total gross final energy consumption of electricity, 16.4 percent of district heating and 6.4 percent of gross final energy consumption in the transport sector.
- Waste is the dominating energy source in the generation of renewable district heating at 42 percent. Approximately one third (34 percent) is generated from wood, and just under a quarter (23 percent) is generated from liquid, other solid (e.g. wood pellets) and biogenic fuels. The share of biogas is minimal at 1 percent.

- The share of renewable energy sources in district heating generation increased from 454 GWh in 1995 to 1,038 GWh in 2012. Between 2005 and 2012, the share grew by an impressive 20 percentage points from 32 to 52 percent.
- Hydropower generates 84 percent of renewable gross final energy.

ENERGY CONSUMPTION

- The largest increases in final energy consumption from 1995 were in electricity (+27 percent) and district heating (+42 percent).
- Total final energy consumption increased from 32 TWh in 1995 to 38 TWh in 2012 (maximum: 40 TWh in 2004); however, it has been largely stagnating since 2002.
- There have been no big changes in the share of energy sources out of final energy consumption since 1995. The largest change was in the consumption of natural gas, which went down from 27 percent in 1995 to 21 percent in 2012.
- The share of electricity increased only marginally, from 20 percent in 1995 to 22 percent in 2012, while the share of district heating grew from 14 percent in 1995 to 17 percent in 2012.
- Oil still has the largest share in energy consumption at 35 percent (almost identical to 1995), followed by electricity at 22 percent. Electricity has overtaken natural gas (21 percent; 27 percent in 1995).
- Total electricity consumption increased from 6.6 TWh in 1995 to 8.4 TWh in 2012 (+2 percent from 2011).
- Between 1995 and 2012, energy consumption increased most in the transport sector (+41 percent), followed by private households (+13 percent), while energy consumption in industry fell slightly (-7 percent).
- Space heating has showed signs of stagnation since 1995, electricity consumption since 2006.
- The share of electricity in final energy consumption increased from 20 percent in 1995 to 22 percent in 2012.

GREENHOUSE GAS EMISSIONS

- With the implementation of the KliP II (Climate Protection Programme II) measures, per capita greenhouse gas emissions are to be reduced by 21 percent by 2020 from 1990 levels.
- By the end of 2011, the climate protection programme had helped avoid 3.7 tonnes of CO_2 equivalent.
- Per capita emissions have remained unchanged since 1995 according to a survey of air pollutants in the Austrian federal provinces. However, when only the greenhouse gas emissions that Vienna can influence are considered, i.e. excluding emissions trade and traffic emissions that are not emitted in Vienna, they have gone down by 19 percent since 1995.

NOTES