STEP 2025

THEMATIC CONCEPT

WERKSTATTBERICHT 182

ENERGY ZONING PLANNING

Vienna! ahead
Energy Planning

City of Vienna

THEMATIC CONCEPT

ENERGY ZONING PLANNING

A TERMINOLOGICAL NOTE

Energy zoning planning (Energieraumplanung)

In the German language, it is customary to form new words with new meanings by endlessly combining nouns. For this reason, we will attempt to explain the term “Energieraum-planung” in the context of “Raumplanung” so it becomes easier to contextualise.

“Raumplanung” as well as “Raumordnung” is often translated into English as “spatial planning”, a term which is understood in some European countries (cf. ESDP European Spatial Development Planning), but not used as such by international experts. The terms “urban planning” and “regional planning” are more widespread as there is no word that would serve as a direct translation of “Raumplanung” in the English-speaking countries; “land use planning” is the expression that comes as close as possible (the administration office in charge often being referred to as “Land Use Planning Department” or “Urban Planning Department”).

The word frequently used in practical application is “land use zoning”. When it comes to instruments of “Raumplanung”, which primarily refers to “Flächenwidmungsplan” or “Flächennutzungsplan”, the term “land use plan” is used at times; however, in an international context, the latter often refers to a general strategic plan, e.g. a “Stadtentwicklungsplan” (“urban development plan”). The word “zoning plan”, or more generally speaking, “zoning regulation” (sometimes also called “zoning ordinance”) is more commonly used. In the context of energy, the aim of planning is to steer energy supply in defined areas. This is why the term “energy zoning (planning)” or “integrated energy planning” is probably best understood internationally. As we are dealing with an urban context, the term “urban energy planning” would also be comprehensible.

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FOREWORD

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City of Vienna sets new standards for renewable energy and energy efficiency

The global climate crisis is one of the greatest challenges for the future of human race. Cities are particularly affected by the negative consequences of climate change, and they also play an important role in climate protection. For the smart city of the future, comprehensive climate protection is one of the most urgent tasks. In order to achieve the ambitious and necessary climate policy goals, we must actively pursue an increase in energy efficiency and an expansion of renewable energy use in all areas. In addition to the transport sector and business in general, the issue of how we heat - and increasingly cool - the buildings of our city is also a key point when it comes to reducing climate-harming emissions.

For the City of Vienna, energy zoning planning is the way to create an effective basis for ensuring that the use of fossil fuels becomes a thing of the past as soon as possible. To decarbonise the urban energy system, a far-reaching and systematic conversion of current energy supply is required. We must optimize existing and planned infrastructure, meet energy demand with renewable energies and waste heat to a greater extent, and promote the use of innovative energy solutions in new construction projects.

In order to reconcile the growth of the city population and the declared climate protection goals, energy zoning planning will be an integral part of urban development in the future. Based on the basic strategies of the urban development plan and the objectives of the Smart City Vienna framework strategy, the new thematic concept defines Vienna‘s approach to energy zoning planning. The resulting priorities for action are oriented towards the three thematic areas of “efficiency“, “waste heat“ and “renewable energy“, with a special focus on heat zoning planning.

With the present thematic concept, Vienna is laying a future-oriented foundation for the development and establishment of energy zoning planning in the city. Energy efficiency and the intelligent use of locally available energy resources and potentials are not only important for climate protection, but also for sustainable zoning, as well as for the security of supply and economic efficiency of our city‘s energy system.

Maria Vassilakou
Deputy Mayor
Executive City Councillor for Urban Development, Transport, Climate Protection, Energy Planning and Citizen Participation

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Ill. 3: Seestadt Technology Centre (Technologiezentrum Seestadt)

MISSION STATEMENT

ENERGY SYSTEM TRANSFORMATION - A PART OF PLANNING REALITY

How many different energy resources are needed to supply a region or a city and how existing, environmentally friendly energy sources can be used efficiently - among other things, this is a key issue of zoning and urban development. The fact that, compared with the other federal provinces, Vienna has by far the lowest per capita energy consumption[1] (►) goes to show how important the relationship between space and energy is: compact urban structures are a prerequisite for energy-efficient urban development whose forms of construction, mobility and use are inextricably linked to the demand for energy. In this context, the thematic concept of energy zoning planning will function as a bridge. It will enable a proactive approach to combining zoning and urban planning with energy planning and thus allow for Vienna's energy resources to be used much more efficiently, in support of a long-term transition to renewable sources.

2014 marked the year when for the first time, Vienna identified energy zoning planning as a goal in the Urban Development Plan (STEP) 2025.

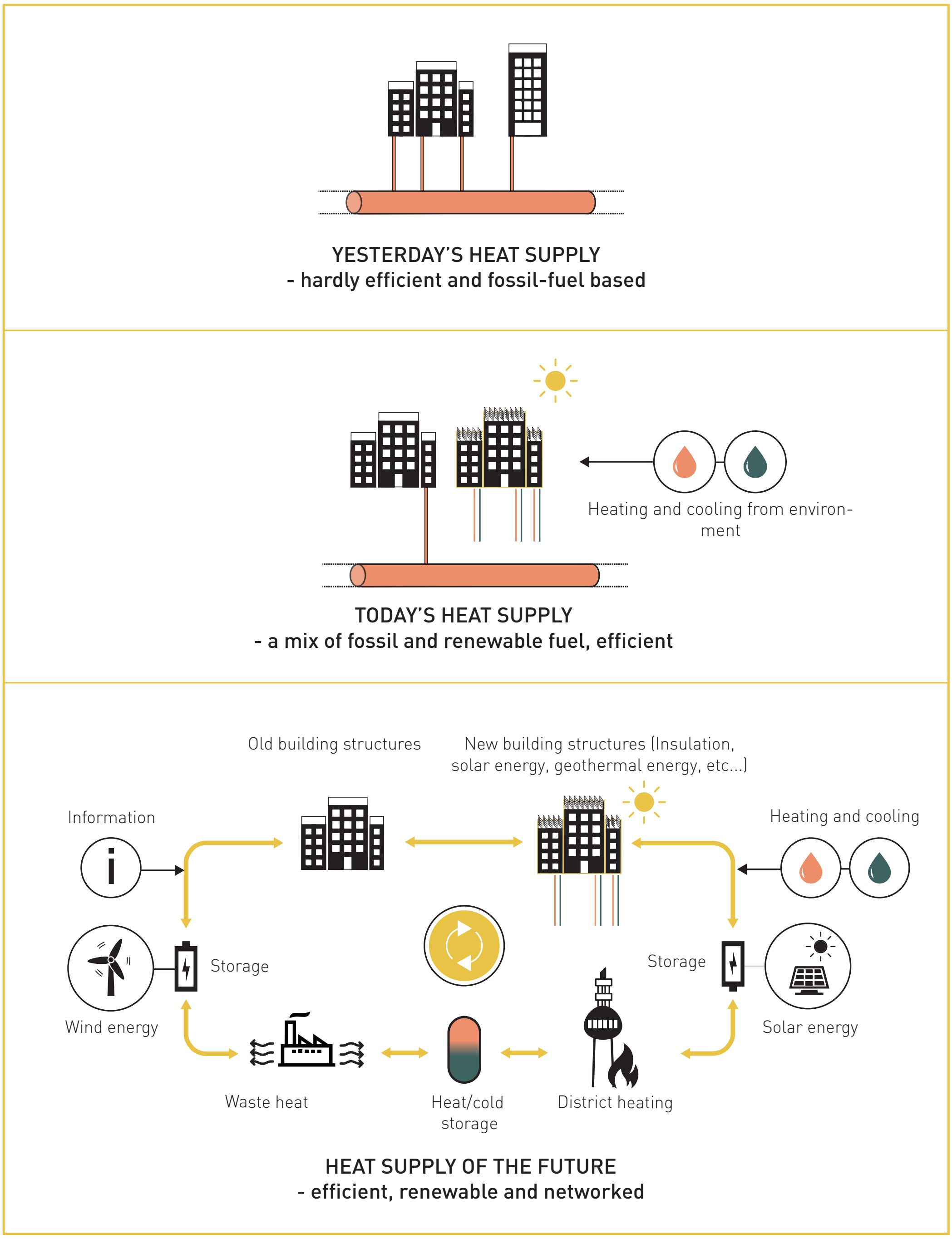
Taking into account the complementary effects of zoning and energy issues, energy zoning planning is an essential building block in the development of an integral, resource-conscious planning practice. Vienna is thus not only making a proactive contribution to climate protection but is also creating a sustainable development framework to meet the challenges arising from a dynamic development situation.

Moderate population growth is expected in the coming years. At the same time, with the Smart City Vienna framework strategy, the city set itself the goal of extensively decarbonising (►) the energy system by 2050. In order to balance growth and the decarbonisation objective, energy zoning planning will form an integral part of future urban development. Based on STEP 2025, which requires systemic solutions for energy and infrastructure adapted to the needs of the respective location in the context of energy zoning planning, already specifying the need for the development of a thematic concept on "integrated energy zoning planning", this thematic concept is the prerequisite. Building on the objectives of the Smart City Vienna Framework Strategy (SCWR) and the Energy Framework Strategy 2030 for Vienna as well as the Climate Protection Programme of the City of Vienna, the building blocks of the thematic concept are presented here. The resulting priorities for action are aligned according to the three areas of "efficiency", "waste heat" (►) and "renewable energy", with heat zoning planning being particularly noteworthy in this context.

This thematic concept aims to illustrate the background, the strategic potential and the related scope for action as well as the instruments of energy zoning planning.

The thematic concept of energy zoning planning pursues an integrated and dynamic approach: it is not intended to be a static product, but a productive concept seeking continuous development and implementation through the planners.

1 See Energiebericht der Stadt Wien (Energy Report of the City of Vienna),data of 2015, 2017, p. 60



Ill. 4: Heat supply yesterday, today and tomorrow

A

FRAMEWORK CONDITIONS OF ENERGY ZONING PLANNING

Ill. 5: Schellenseegasse passive house

WHY ENERGY ZONING PLANNING NOW?

A1

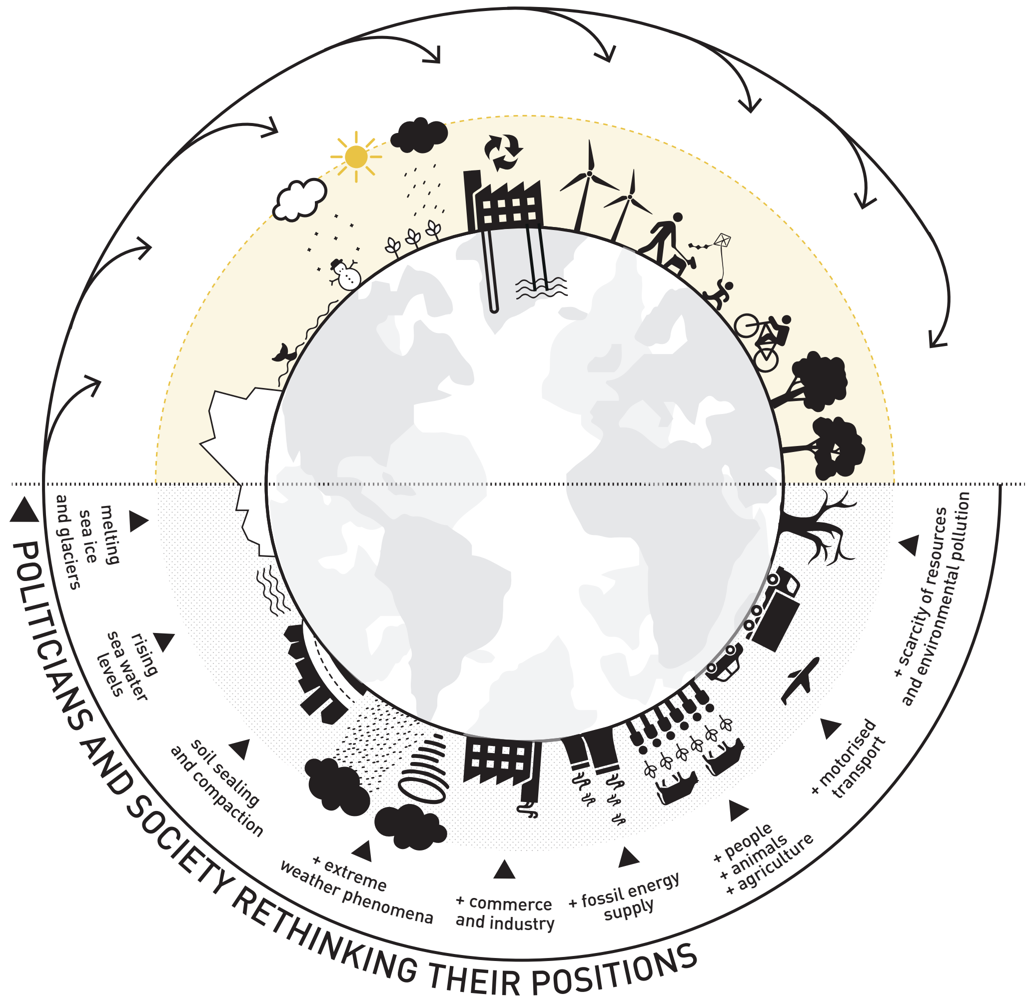
Due to massive carbon dioxide (CO_2 (►)) emissions, the human race is on the verge of a major climate catastrophe, which is to be averted by the ground-breaking Paris Agreement now (see Chapter A.1., page 20). At the same time, cities are growing all over the world; already now, they account for most CO_2 emissions. If the climate crisis is indeed to be averted, it is thus necessary to develop solutions based on the use of low-CO_2 technologies for the energy supply of cities. This is a major challenge for cities around the world. However, change in this field is potentially supported by many interesting new technologies. In Vienna, too, there are examples to show what sustainable solutions might look like. Taking energy issues into consideration in urban planning can be an important driver for change. Energy zoning planning can create the right and efficient framework conditions for ecological and affordable cities in the long term.

The following chapter will explain and present global trends, challenges to local infrastructure and Vienna's path to designing an appropriate response.

CLIMATE CHANGE - INDICATOR OF A GLOBAL CRISIS

Climate change is primarily defined as the drastic warming of the Earth's system due to anthropogenic influences. The increased concentration of greenhouse gases in the atmosphere, driven mainly by the global increase in motorised traffic, the use of fossil fuels for heat and power generation, and advancing industrialisation, is leading to the melting of polar ice caps and glaciers and, as a consequence, to rising sea levels. There is also an increased risk of extreme weather phenomena.

Coupled with steady population growth, increasing urbanisation, global pollution and global scarcity of resources, the consequences of climate change are a call on society and political decision-makers to rethink their positions. With strategies such as the Kyoto Protocol and the Paris Climate Protection Agreement, countries around the world are committing themselves to reducing greenhouse gas emissions (►) and mitigating global warming.



Ill. 6: Climate change - indicators and targets

UN Climate Change Conference in Paris 2015 (COP 21)[2]

At the 21st UN Climate Change Conference in Paris in 2015, almost all UN member states were able to agree on common targets to combat climate change for the first time. The top priority is to limit the rise in global warming to well below 2 °C, ideally 1.5 °C, in comparison with the pre-industrial age. The EU had already set targets for 2030 in the run-up to the negotiation (see “European Union targets“). The climate agreement was ratified by the EU Parliament on 4 October 2016 and entered into force at the beginning of November 2016. It is now a question **of establishing drastic measures for decarbonisation** (►), which are reviewed every five years and tightened up if necessary.

UN Plan of Action “Agenda 2030 for Sustainable Development“[3]

Sustainability is defined as a principle for action which, among other things, involves preserving the natural regenerative capacity of a system. Climate protection is considered an essential component for the preservation of our ecosystem. The 17 Sustainable Development Goals listed below, with their 169 sub-targets (see Ill. 7) form the heartpiece of Agenda 2030. They consider the balance between the economic, social and environmental dimensions of sustainable development and, for the first time, bring poverty reduction and sustainable development together in a single agenda. This also makes the **energy issue an integral part of a holistic strategy.**

European Union targets

In the autumn of 2014, the European Council set itself a much more ambitious agenda than the 20-20-20 targets for 2020, i.e. the triad of targets for energy and climate protection for 2030 (the strategy “A framework for climate and energy policy for the period 2020-2030“), which is currently being renegotiated (with the aim of further increasing the share of renewable energy and energy efficiency):

Ill. 7: The thematic concept addresses 4 out of 17 sustainable development goals in the UN Action Plan

- **Greenhouse gas emissions** (►) are to be reduced by at least 40 percent compared with 1990 levels.
- The share of **renewable energy** is to rise to at least 32 percent.
- By **increasing energy efficiency**, primary energy consumption (►) is to be reduced by 32.5 percent in comparison with the trend.

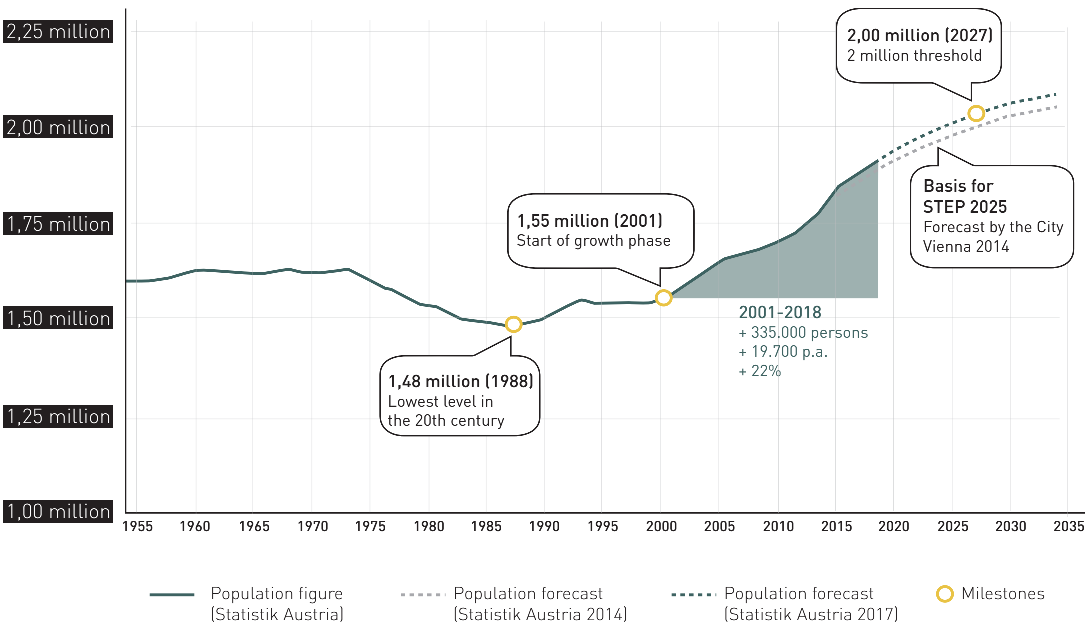
In February 2017, the EU Parliament also agreed on a **reduction path in EU emissions trading** for the period 2021 to 2030, according to which the volume of certificates is to be reduced more than before, i.e. by 2.2 percent per year. The price of CO_2 certificates is currently rising.

[2] Energieraumplanung in Wien, Aufbereitung rechtlicher Aspekte (Energy zoning planning in Vienna - Identification of legal aspects), 2016, p. 9
[3] https://www.bundeskanzleramt.gv.at/nachhaltige-entwicklung-agenda-2030, accessed on 06 July 2018

GROWING CITIES – GLOBAL RISE IN URBANISATION

According to forecasts, almost two thirds of the world's population will live in cities in 2050.[4] This trend is also apparent in Austria. Vienna is already the sixth largest city in the EU. According to current projections, Vienna will probably reach the two million inhabitant mark again in the course of the next ten years.[5] However, after a phase of demographic rejuvenation, the Viennese population is likely to age again in the future.[6] These developments lead to new demands for social and technical infrastructure, such as nursing, care and educational facilities, public transport, housing and energy supply. In this, the aim is to manage growth without increasing the consumption of fossil energy.

[4] https://population.un.org/wup/Publications/Files/WUP2018-KeyFacts.pdf, accessed on 15 April 2019
[5] https://www.wien.gv.at/statistik/bevoelkerung/prognose, accessed on 23 November 2018
[6] Bauer, Fendt, Haydn, Remmel, Seibold MA 23 (ed.) (2018): Kleinräumige Bevölkerungsprognose Wien 2018 (Local Population Development Projection Vienna 2018), Statistik Journal Wien 1/2018.



Ill. 8: Growth forecasts for Vienna

NEW TECHNOLOGICAL DEVELOPMENTS - ENERGY SYSTEM TRANSFORMATION (ENERGIEWENDE)

Seen globally, the entire energy system is facing profound change. The gradual and complete phase-out of fossil energy is being accelerated worldwide in order to meet the requirements of the Paris Climate Convention. Urban areas play a particularly crucial role here. Due to increasing urbanisation, urban energy demand will continue to rise in the coming years. The ecological sustainability of urban areas thus determines the future of global climate.

Cities offer the best conditions for sustainable energy solutions. It is especially the dense development of urban structures that allows for low energy consumption in buildings and the ability to cover short distances by public and environmentally friendly transport. This is one of the reasons why the per capita energy consumption (►) in cities is usually lower than in rural regions: At approx. 20,000 kWh/year, Vienna has by far the lowest per capita final energy consumption (►) in comparison with the other federal provinces of Austria. The City of Vienna owes this circumstance not least to the dense building stock, its high standards in new construction, the area-wide public transport network and forward-looking urban planning. Ultimately, energy consumption depends heavily on how the city is designed.

Almost 40 percent of final energy use is for heating and hot water; as a result, this sector is the largest energy consumer in the city, followed by transport, the sector requiring around one third of the energy and associated with even higher CO_2 emissions (►).

Vienna's future-oriented energy policy must thus develop a sustainable energy system which consistently follows the decarbonisation path, is characterised by a high degree of supply security, stable and socially equitable energy prices and a significantly lower level of environmental pollution.

In order to better make use of the potential of urban structures, appropriate framework conditions are needed, supported by forward-looking energy zoning planning. The foundation for the implementation of sustainable energy solutions can already be laid at the planning stage. By integrating energy issues in urban planning early on, sustainable and, above all, competitive energy solutions can be implemented.

A TECHNICAL REVOLUTION

Transformation of the energy system is more than just changing the energy source - it can therefore only be achieved through considerable technological innovations. The energy system of the future will be characterised by greater flexibility, more extensive use of renewables, increasingly decentralised energy generation, new infrastructure requirements, consumer involvement and new business models for suppliers and service providers. This is why the transformation of the system needs integrated solutions for the generation, distribution, storage and consumption of energy. Central drivers include digitalisation, but also social trends such as sharing economies or changes in the behaviour of energy users, who will increasingly assume the role of energy producers. It is important to ensure that all social groups are considered and that new user-friendly solutions must be designed in line with the smart city objectives.

The energy supply of the future will increasingly use decentralised and renewable energy sources (renewables and waste heat (►)). Distribution systems using electricity from renewable energy sources and storage facilities, both short-term and seasonal, as well as centralised and decentralised heat pumps, are key technologies for the efficient use of these energy sources. The integration of storage systems makes it possible to adjust supply and demand over time. Electricity and gas grids have to be considered in combination with heating and cooling networks. Energy zoning planning which is based on an integrated approach and implemented consistently can support the development of optimised heating and cooling concepts.

CONTINUING THE COURSE OF EFFICIENCY

A reduction of energy consumption and more energy efficiency are indispensable prerequisites for the transformation of the energy system (►) and for decarbonisation (►).

In this context, the extensive renovation (►) of the building stock through quality improvements in building envelopes and heating systems as well as the avoidance of rebound effects is essential. Vienna has a large number of old buildings: about 25 percent of the buildings date from the post-war period (1945-1970) and about 20 percent were built before 1900. Only 10 percent of all buildings are new (erected from 2001 onwards). The focus is on improving building envelopes by using insulating materials, which are highly efficient and, ideally, ecological, in combination with efficient, cost-effective building technology systems based on renewable energy and waste heat (►). Cross-property and neighbourhood-oriented solutions lead to significantly better results than the renovation of individual buildings. In addition to the need for heating, the need for cooling is becoming increasingly important in view of more heat periods in the summer months.

Vienna is already pursuing high efficiency standards in the construction of new buildings; the city is also an international leader in the implementation of passive, low-energy (►) and plus-energy buildings. Early and intelligent energy planning also promotes the optimum use of locally available renewable energy sources and waste heat (►).

USING THE CITY'S ENERGY SOURCES TO THE FULL

Scarce generation areas in the city require the extensive use of existing diverse waste heat (►) and renewable energy sources. The aim is to use all potentials for sustainable energy generation, be it from solar or geothermal energy, waste heat (►), ambient heat (►) or waste.

The emission-free production of solar energy is particularly well suited for urban areas with many sealed surfaces and roofs. Vienna has an enormous potential for this: theoretically, many roof areas in Vienna could be used to generate solar energy and over 2,200 hours of sunshine per year would ensure good yields. Solutions integrated into buildings also make the panels blend in with the architecture and allow for simultaneous multiple uses, such as the application of photovoltaic modules as shading devices to prevent overheating. Furthermore, the Vienna area offers particularly favourable conditions for the use of groundwater and near-surface geothermal energy for heating purposes. Moreover, operational and industrial processes supply waste heat from numerous sources which can above all be integrated in neighbourhood solutions in an optimum way. Usually, heat pumps are used to raise the temperature level. Heat pumps are a promising technology in many respects: they can be used to provide all of the heat required for room heating and hot water preparation, as well as cool a building - in a resource-saving and environmentally friendly way.

USING THE CITY FOR ENERGY STORAGE AND AS AN ENERGY SPONGE

Energy storage technologies, which include electrical as well as thermal, mechanical, chemical and electrochemical storages, are important building blocks for a sustainable energy system.

Moreover, cities have many energy applications (e.g. cold stores, etc.) which react flexibly to the current energy supply and can therefore absorb excess energy like a sponge for later release (for example, a concrete ceiling heated with excess electricity from a wind turbine can release heat for several days without having to be reheated).

In view of the fact that the availability of renewable energies fluctuates, intelligent storage systems will be needed in the future, to respond flexibly to energy supply and demand. Energy storage systems not only make it possible to bridge gaps independent of time, but also allow for the conversion of energy forms across the boundaries of the electricity, heat and mobility sectors. Furthermore, storage systems can improve the cost-effectiveness of technologies and thus significantly increase the share of renewable energies in energy generation and consumption. Energy zoning planning solves the challenging problem of coordination, thus supporting economic efficiency and security of supply in the energy system.

Promising storage technologies include building component activation for building temperature control (= heating and cooling); concrete is the energy storage medium used to adapt heating energy requirements to the supply of renewable energies; buildings themselves may likewise be used for storage as smart, energy-flexible buildings that can adapt to fluctuating energy supplies and, for example, heat up water when there is excess electricity from wind or the sun. Moreover, the ground is an important thermal storage medium which, in combination with heat pumps and geothermal probes, allows for seasonal heating and cooling applications. In addition, electric vehicles can be operated with renewable electricity; they play an important role in the intelligent power system of the future as flexible storage devices.

DIVERSE ACTORS SHAPING ENERGY IN THE FUTURE

More and more committed people and companies are helping to shape the energy transformation(►), operating energy plants or implementing innovative energy projects. This results in attractive synergies which need to be identified and used to the full. One challenge is to bring about optimum networking between the actors concerned and involved.

In this context, small, local heating and cooling networks which supply households and businesses


Ill. 9: Boutique Hotel Stadthalle

with energy and can be controlled individually represent an important line of development. This way, system efficiency is increased, losses are reduced and the integration of renewable energy sources is improved.

Moreover, energy projects open up new potentials for citizen participation. They combine planning and civil society commitment, offering an ideal framework for local involvement in the change in energy supply. In addition, the level of acceptance of new energy projects will rise due to the participation of private individuals and the inclusion of other partners from society and business.

ENERGY REGIONS STRENGTHEN URBAN-RURAL RELATIONS

Sustainable energy supply cannot exclusively cover the area of a city alone, it requires cross-sectoral and intermunicipal efforts. Functionally, the city and its environs are closely linked and they benefit from mutual exchange.

The region around the city can be an important producer of renewable energies; above all, it can generate electricity from wind and hydropower as is the case in the area around Vienna. In a densely built-up city, the generation of renewable energies is more difficult. As a supplier of electricity from renewable sources, however, the countryside will benefit from the fact that the share of electricity in the energy mix will continue to increase in the future; thus it will also play an increasingly important role in the mobility and heat supply of the urban area.

Factbox

Green Energy Lab and regional cooperation

The newly created “Green Energy Lab“ is the largest innovation project ever approved for the development and demonstration of green energy technologies on the way to 100 percent renewable electricity and heat in Austria. This energy flagship region of the Climate and Energy Fund is expected to bring together a total of over 100 business and research partners in 31 sub-projects worth 150 million euro. The Green Energy Lab is supported by Wien Energie, Energie Steiermark, EVN and Energie Burgenland as well as by the Energy and Environment Agency of Lower Austria and the Styrian Green Tech Cluster.

In order to reach energy policy objectives, cooperation with various actors at different levels is required. In order to be able to not only reap the benefits in one’s own area but also to exert influence on overarching framework conditions, (supra-)regional cooperation with other cities, federal provinces and research partners is promoted. Within the framework of technical exchange on energy zoning planning, a common regional and supra-regional perspective is sought. By participating in national and international research projects as well as in the Planning Association East (PGO, working group on climate and energy), the City of Vienna fosters both intra-city cooperation with companies and (supra-)regional exchange.

https://www.greenenergylab.at/en/

CHALLENGES AND SOLUTIONS IN THE HEAT SUPPLY SECTOR

These new technologies and changing spatial structures give rise to a number of challenges in the future supply of energy and heat.

CHALLENGES

Future heat densities (▸) will develop differently locally

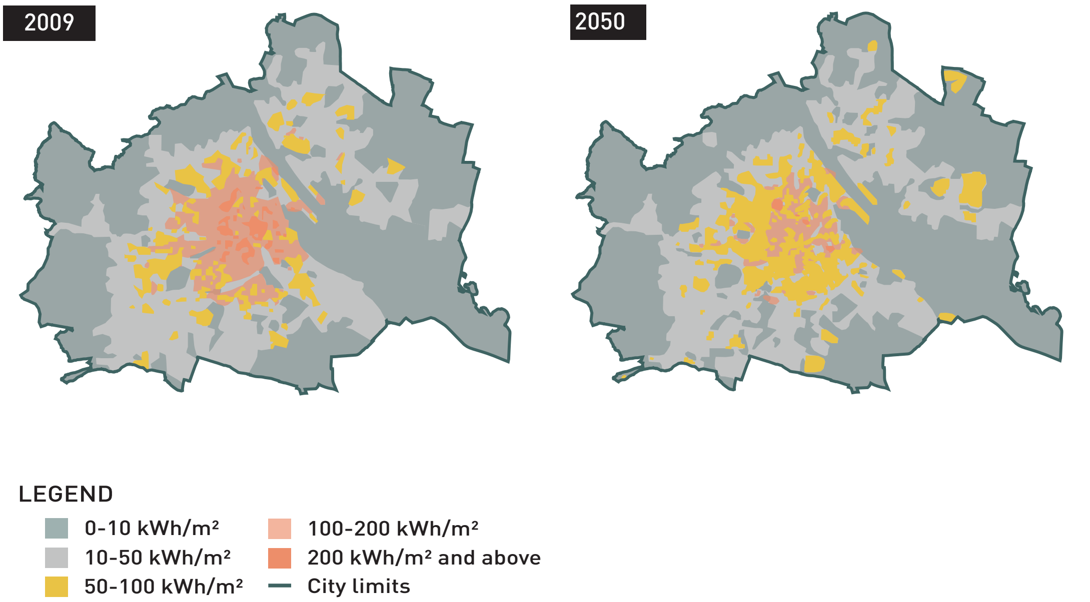
In areas where conditions for refurbishment are good or in new building construction areas, heat density (▸) will decrease significantly. At the same time, greater building density and refurbishment-inhibiting factors, such as architectural heritage protection in the city, will tend to lead to greater heat density (▸) (see also Ill. 10).

Increased pressure to unbundle parallel grid-bound infrastructures

Measures to increase energy efficiency will reduce sales volumes and thus the revenues of energy suppliers working with grid-bound infrastructure (district heating (▸) and natural gas). At the same time, the fixed costs for operating the existing grid can hardly be reduced. This will increase the pressure to unbundle duplicate grid-bound infrastructures – in varying degrees, depending on locations – in order to keep grids economically sustainable in the long run.

Demand for cooling to increase significantly

Rising temperatures in the summer and, above all, prolonged periods of heat will cause the demand



Ill. 10: Simulation of heat demand density for the years 2009 and 2050 (based on STEP 2005)

for energy used for cooling to grow. Coordinated measures on buildings as well as in building services and existing/planned infrastructure are to help minimise additional expenditure for energy and investments.

The best possible use of waste heat (▸) and renewable energy on site

Only when existing renewable energies and waste heat sources are used intensively and in an optimum manner on site will it be possible to dispense with fossil fuels.

INNOVATIVE SOLUTIONS FOR ENERGY-EFFICIENT HEAT AND ENERGY SUPPLY

Vienna already boasts many examples of innovative, energy-efficient solutions for heat and energy supply. Municipal Department (MA) 20 - Energy Planning compiles and publishes a collection of showcase projects from Austria and Europe on an ongoing basis. Particularly noteworthy examples are those which are **designed to reach beyond individual buildings**, i.e. which also take social, ecological and economic criteria into account. It is important to consider the **life-cycle costs** of energy supply solutions. Through the broader application of energy zoning planning, it will be possible to implement these solutions in larger numbers and specially enhance their economic viability in the future.

Further examples can be found here: https://www.wien.gv.at/stadtentwicklung/energie/beispiele/

Energy solutions fit for cities on the way to decarbonisation

What a sustainable energy system in an urban context needs:

- Energy-efficient buildings and neighbourhoods
- The optimum use of renewable sources and waste heat (▸) on site
- Flexibility to ensure that additional energy can be used when excess energy from renewables (e.g. solar and wind energy) is available
- Solutions which are entirely emission-free or at least low-emission
- Solutions which cover several neighbourhoods or building-integrated solutions – allowing for the optimum use of simultaneous energy supply and demand
- Optimum use of existing infrastructures
- Planning for potential imports of renewable energies (“green electricity“ and “green gas“ being the buzzwords)
- Energy concepts which include aspects of mobility

Based on the above-mentioned necessities of energy solutions suitable for cities, some examples will be presented below.

Energy-efficient buildings

OFFICE HIGH-RISE OF VIENNA UNIVERSITY OF TECHNOLOGY (TU)

KEY DATA

Building data:
Year of construction/refurbishment: 2014
Main use: Office building
Gross floor area: 7,322 m²

Energy efficiency class:
Energy required for heating: 3.4 kWh/m²a
Energy required for cooling: 2.5 kWh/m²a
Energy required for lighting: 5.6 kWh/m²a
Energy required for air conveyance: 1.0 kWh/m²a
Total primary energy required: 82.0 kWh/m²a

INNOVATION

- The annual average energy required on the eleven floors is generated and covered directly through the building.
- The facades have been optimised for heat, sun shading and lighting technology
- Austria's largest facade with an integrated PV system
- Innumerable components were fine-tuned for optimum interaction

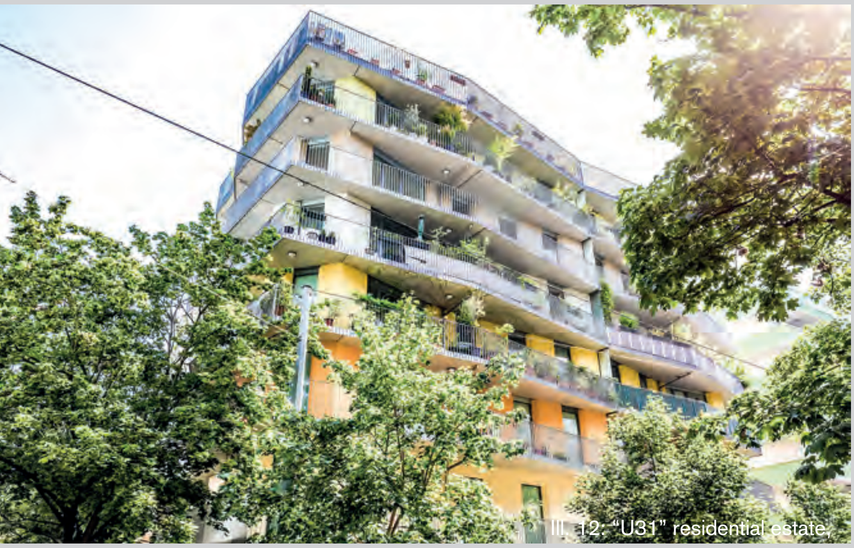

Ill. 11: Office high-rise of TU Vienna

The high rise of Vienna University of Technology on Getreidemarkt, which used to be named after the Department of Chemistry, was refurbished in the course of a research project to become a showcase project which is unique worldwide. The pioneering "Plus Energy Standard" stipulates that a building must generate at least as much energy as it needs over the course of a year.

The project is unique worldwide because this standard was implemented in an existing high-rise building and because the ambitious goal behind the project is not only to generate the energy for the building, i.e. for ventilation, lighting, heating and cooling, directly on site, but to also supply the energy needed by users, approximately 800 employees and students, for everything from computer to coffeemaker.

The positive energy balance of the eleven-storey building, which houses offices and teaching facilities, is achieved through the optimisation of building envelope and electricity consumption to a degree which goes far beyond the passive house standard, using Austria's largest building-integrated photovoltaic system. Thanks to the optimisation of over 9,300 individual components in total, the energy required was reduced by up to 93 percent – without loss of comfort – and energy needs can now be fully covered by the roof- and facade-integrated photovoltaic system and energy recovery from the elevators.

"U31" RESIDENTIAL BUILDING COMPLEX



Ill. 12: "U31" residential estate.

The passive house with 46 apartments and office spaces at Universumstrasse 31 in the 20th district of Vienna, which was awarded the Austrian State Prize for Architecture and Sustainability in 2012, is known as "U31". Its jagged facade is a special exterior feature of the compact building; the most impressive qualities of the interior are maximum energy efficiency and comfortable living.

The building is equipped with highly efficient insulation and comfort ventilation provided by a central ventilation unit with an energy recovery rate of more than 90 percent. The required residual heat is provided by groundwater wells via water/water heat pumps and a large buffer tank as well as a district heating connection shared with the neighbouring building.

In the summer, the groundwater can also be used to cool the apartments via individually adjustable underfloor cooling. With a heating-related energy requirement of only 15 kilowatt hours per square metre and year (kWh/m²a), the energy-saving comfort house known as "U31" makes an important contribution to climate protection and achieves the highest "Climate: active" quality rating, i.e. Gold (918 points out of 1,000).

KEY DATA

Building data:
Year of construction: 2010
Main use: Residential building
Number of apartments: 46
Gross floor area: 6,427 m²

Energy efficiency class:
A++
Energy required for heating: 14.2 kWh/m²a

INNOVATION

- Comfort ventilation with a central ventilation unit for more than 90 percent energy recovery
- Highly efficient building insulation
- Residual heat required is covered from groundwater wells via water/water heat pumps and buffer storage
- District heating connection shared with the neighbouring building
- Ground water use for cooling via individually adjustable underfloor heating

REFURBISHMENT OF SCHLAGERGASSE ADMINISTRATION BUILDING

KEY DATA

Building data:
Year of construction/refurbishment: 2011
Main use: Office building
Gross floor area: 1,500 m²

Energy efficiency class:
Energy required for heating: 28.8 kWh/m²a
Energy required for heating before refurbishment: 144.0 kWh/m²a


Ill. 13: Schlagergasse Administration Building

INNOVATION

- The improvements led to a 75 percent reduction of the final energy required
- Green Building Award 2013

The administration building at Schlagergasse 8 in Vienna‘s Alsergrund district, built in 1918, was comprehensively refurbished and turned into a modern office building in 2010/2011. Apart from extensive thermal refurbishment (facade insulation, replacement of windows and doors) and loft conversion, a lift and exterior sunshading were installed, the room structures were optimised and a ventilation system was fitted. Ecological building materials were used specifically for this purpose. As a result of the comprehensive measures, the final energy required was reduced by 75 percent. Vienna’s Municipal Department 34 - Building and Facility Management, which is responsible for the refurbishment, received the GreenBuilding Award 2013 for the successful project. The GreenBuilding Programme is an initiative of the European Commission aimed at reducing energy consumption in private and public service buildings.

Energy-flexible buildings and imports of renewable energy

MÜHLGRUNDGASSE MGG 22 RESIDENTIAL ESTATE

Ill. 14: Visualisation Mühlgrundgasse

At Mühlgrundgasse in the 22nd district a residential estate with 160 units is being erected on the basis of a highly innovative energy concept; despite the urban surroundings of the estate, it is supplied with renewable energy exclusively. The thermal component activation (►) turns the entire building into a thermal storage facility. The object is air-conditioned year-round via the storage masses (concrete ceilings). In the winter, heat is extracted from the ground; in the summer, this energy is returned to the ground by dissipation of heat from the apartments. The key technology is a heat pump with reversible (►) operation.

The heat pump is mainly run when there is excess wind power in wind farms outside the city. Due to this flexible mode of operation, the use of renewable energy sources is optimised, the electricity grid load is reduced and the electricity costs for the residents are reduced. This is an example of how to use “green electricity“ in an optimum way.

KEY DATA

Building data:
Year of construction: 2019
Main use: Residential buildings
Number of apartments: 160
3 building sites with apartments from 30 m² to 150 m²
Gross floor area: 10,000 m²

Energy efficiency class:
Low energy standard
Energy required for heating: 24-28 kWh/m²a
CO_2 emissions: 12.0 kg/m²a

INNOVATION

- Heat pump with geothermal probes (total length approx. 5,500 m)
- Thermal component activation (ceilings for heating and cooling)
- Use of excess wind power to drive the heat pumps
- 500 m² community garden
- Public spaces with fruit trees
- Gardens and terraces on all levels
- Community kitchen

The optimum use of renewable sources and on-site waste heat

CAMPUS OF VIENNA'S UNIVERSITY OF ECONOMICS AND BUSINESS ADMINISTRATION (WU)

KEY DATA

Building data:
Year of construction: 2013
Main use: University
Gross floor area: 41,000 m²

Energy efficiency class:
Energy required for heating: 32.5 kWh/m²a
Energy required for cooling: 14.3 kWh/m²a
Energy required for lighting: 20.9 kWh/m²a
Energy required for air conveyance: 6.9 kWh/m²a
Primary energy required (►) in total:
108.0 kWh/m²a
Well depth: approx. 12 m

INNOVATION

- Binding specifications based on the "Green Building" concept
- Heat recovery system with 75 percent efficiency
- 70 percent of the heat and cooling energy required is generated from geothermal energy.
- Groundwater is extracted and conducted into ceilings and walls through a pipe system.
- Direct cooling by groundwater via the pipe system in the summer, pre-heating by waste heat (►) from the computer centres in the winter
- Lighting controlled via presence and daylight sensors
- Heating, ventilation and cooling are adapted to the respective load.
- Life-cycle costs are minimised through the use of durable materials
- Emissions from materials, energy generation and infrastructure are kept as low as possible

Ill. 15: University of Economics and Business Administration Vienna (WU Wien)

One of the largest thermal groundwater plants in Austria is the heartpiece of WU Wien's energy supply system. Most of the energy required by the campus for heating and cooling is generated from geothermal energy. For this purpose, groundwater is extracted and the ceilings and walls are "activated", i.e. heated or cooled, via a pipe system. In the summer, the water is used for direct cooling, in the winter, it is preheated by means of waste heat (►) from the computer centres. A district heating connection is available to cover peak loads and as a back-up. In order to save energy, all buildings are equipped with presence and daylight sensors for lighting control, which is in line with "Green IT" standards; heating, ventilation and cooling are also adapted to the respective occupancy rate.

PLUS ENERGY BUILDINGS - SEESTADT TECHNOLOGY CENTRE

Ill. 16: Technologiezentrum Seestadt (Seestadt Technology Centre)

KEY DATA

Building data:
Year of construction: 2012 (Wing 1)
Main use: Office building
Gross floor area: 12.000 m²

Energy efficiency class:
A++
Energy required for heating: 8 kWh/m²a, corresponds to the total primary energy requirement (►) for indoor air-conditioning
Energy required for cooling: 12.9 kWh/m²a
Energy required for lighting: 15.1 kWh/m²a
Energy required for air conveyance: 1.0 kWh/m²a

INNOVATION

- Designed as a plus energy house
- 140 kWp photovoltaic system
- Small heat pumps to recover waste heat (►) from the servers, which is then used to heat the rented office spaces by means of building component activation
- District heating connection
- Use of cold well water for cooling or re-cooling via the roof (free cooling)
- Heat recovery rate of over 90 percent

The Technology Centre is a commercial real property for R&D-oriented companies and university-associated facilities for sustainable technology development, it is located at Seestadt Aspern. The Technology Centre was the first building to be erected at Seestadt Aspern; it is designed in accordance with the Plus Energy standard. Office heating and cooling is provided via a thermal component activation system (►) in which the use of groundwater, waste heat (►) from server rooms, highly efficient recovery of heat from the ventilation system and - in transitional periods - a recooler on the roof for free cooling are combined with each other. The plus energy standard is attained through power generation by way of a photovoltaic system on the building facade. In the summer, the facade-integrated parts of the photovoltaic system serve as solar protection to avoid overheating of the building.

Vienna Business Agency is currently erecting Wing 2 of the Seestadt Technology Centre. The energy-saving measures pursued in Wing 1 will be continued and supplemented with new elements. With 932 out of a maximum of 1,000 points, the new wing achieves Gold certification status from ÖGNB (Austrian Sustainable Building Council). In the energy concept, only resources that are available on site (groundwater, waste heat (►), electricity from photovoltaics) are used as far as possible and these are adapted to particular conditions. In addition, automated sunlight collectors (rotating with the sun) are mounted on the roof. They are used to capture sunlight and provide lighting for the common areas.

Neighbourhood-wide solutions

VIERTEL ZWEI+

KEY DATA

Building data:
Year of construction: 2015
Use: office and residential buildings, student dormitory
Number of apartments: 306
Gross floor area 40,000 m²


Ill. 17: Overview of Viertel Zwei+

INNOVATION

- Use of geothermal energy in the form of 24,000 linear metres of geothermal probes (165 probes in three geothermal probe clusters)
- Two extraction wells and two absorption wells each for thermal groundwater utilisation
- two sewage water heat exchangers as additional heat sources
- 168 kWp sunlight collectors, feeding into the local network of the complex
- Two gas boilers for peak load coverage and as a redundant heating system

The neighbourhood known as Viertel Zwei+ consists of two office buildings, one student dormitory and seven residential buildings. In this complex, geothermal energy is used extensively, through 24,000 linear metres of geothermal probes (165 probes of approx. 145 metres each) and two thermal groundwater systems. In addition to the geothermal probes and the thermal use of groundwater heat, heat energy is also extracted from sewage water by means of heat exchangers. Through the mix of uses and the connection of the various parts of the building in a so-called anergy network (▸), the simultaneity of energy supply and demand (e.g. waste heat (▸) and hot water demand) can be utilised.

Utilising existing infrastructure

THE MANNER FACTORY: WASTE HEAT USE

Ill. 18: Waste heat utilisation at the Manner factory

KEY DATA

Key plant data:
Year of construction: 2016

Capacity: 1 MW
Waste heat feed-in: approx. 5,600 MWh
CO_2 savings: 1,000 tonnes per year
Length of decentralised grid: 3.5 kilometres
Number of households supplied: 600

The waste heat (►) from the baking process at the Manner wafer factory in Hernals is fed into the district heating grid to supply 600 households and businesses in the area with hot water and heat. By feeding waste heat (►) into the grid, large quantities of waste heat (►) can be used to replace heat generation. In addition, a significant contribution is made to the decarbonisation (►) of heat supply in the city.

INNOVATION

- Waste heat (►) from the baking process is used to supply the neighbourhood with district heating (►).
- The project combines an energy-efficient manufacturing process with energy-efficient heat supply.
- Excess process heat (►) is fed into the local district heating grid over 3.5 kilometres.
- 600 households and businesses in the immediate vicinity are supplied with heating and hot water
- In the summer the waste heat (►) can be converted and used in production for cooling purposes.

Buildings "fit for the future": Some educational campus projects

EDUCATIONAL CAMPUS SEESTADT ASPERN NORD

KEY DATA

Building data:
Start of construction: Summer of 2019
Main use: Educational institution
Occupancy: approx. 1,630 persons
Gross floor area: 19,974 m²

Energy efficiency class:
A++
Energy required for heating: 19.7 kWh/m²a
Energy required for cooling: 15.9 kWh/m2a
Energy required for lighting: 8.8 kWh/m²a
Total primary energy required (►): 71.5 kWh/m²a
CO_2 emissions: 10.3 kg/m²a

Ill. 19: Visualisation of Educational Campus Seestadt Aspern Nord

By September 2021, construction of an innovative educational campus for approx. 1,400 children will be completed at Seestadt Aspern. Due to the highest degree of efficiency, the energy demand of the campus can be fully covered by renewable energy and cost-effectively. A geothermal heat pump, a building envelope which meets the passive house standard, solar power generated on the building, thermal component activation (►) and controlled ventilation with highly efficient heat recovery are used.

INNOVATION

- Source ventilation with heat recovery, CO_2-controlled
- Combined air supply and exhaust systems with highly efficient heat recovery at a rate of up to 80 percent, including moisture recovery
- Slight reheating or after-cooling of supply air via the heat pump system
- Night ventilation
- The brine-to-water heat pumps with a total output of 200 kW intended for heating purposes are also used for hot water preparation.
- 36 depth probes with a final depth of 150 m
- Heating by means of brine-to-water heat pumps via thermal component activation (ceiling heating)
- Cooling by means of free cooling passive module via thermal component activation (ceiling cooling)
- Use of wind power peak loads in the heat pump system for heating or in the free cooling system for cooling purposes
- Photovoltaic system with an output of approx. 200 kWp on the roof
- East-west orientation of the photovoltaic system

The City of Vienna is already making sure that its buildings meet the needs of the future. Therefore emission-free energy supply and adaptation to climate change were already considered in the planning process of two new teaching facilities. In addition to the positive ecological aspects, new technologies will continue to ensure comfort in the buildings and long-term affordable energy in the future.

EDUCATIONAL CAMPUS ATZGERSDORF

Ill. 20: Visualisation of the educational campus Atzgersdorf

By September 2022, an education campus for around 1,200 children and adolescents will be completed in Atzgersdorf. The complex will be characterised by the highest degree of building efficiency, renewable energy supply on site and a reduction of building services to the required level. Key technologies include a heat pump, thermal component activation (►) and a passive house-quality building envelope.

KEY DATA

Building data:
Start of construction: Summer of 2020
Main use: Educational institution
Occupancy: approx. 1,350 persons
Gross floor area: 19,210 m²

Energy efficiency class:
Energy required for heating: 28.5 kWh/m²a
Energy required for cooling: 23.2 kWh/m2a
Energy required for lighting: 24.8 kWh/m²a
Total primary energy required (►): 111.6 kWh/m²a
CO_2 emissions: 16.1 kg/m²a

INNOVATION

- Comfort ventilation with heat recovery, CO_2-controlled
- The complex is supplied with thermal energy via 70 depth probes, 200 linear metres each, with heat pump.
- A separate heat pump is provided for hot water production.
- The depth probes, in combination with the heat pumps, are also used to cool the building.
- The building is heated via thermal component activation and is equipped with underfloor heating in some areas.
- For room cooling, building component activation is used; it is likewise employed for heating purposes - change-over operation
- Photovoltaic system with approx. 405 PV modules on the roof
- Given a module output of 270 Wp, this results in a total system output of approx. 109.4 kWp
- East-West orientation of the photovoltaic system

Factbox

Aspern Smart City Research (ASCR)

ASCR
Aspern Smart City Research

"Aspern Smart City Research" is a research company which has been running one of the most innovative energy efficiency demonstration projects in Europe since 2013. The consortium run by Siemens, Wien Energie, Wiener Netze and the City of Vienna (Vienna Business Agency and Wien 3420) is developing technical solutions for the energy of the future in the real-life circumstances of a newly built neighbourhood with real-life end-users. This involves forward-looking building automation and combining energy flexibility in the buildings with the energy market whilst involving "smart users". In January 2018, the ASCR project was extended by another five years to 2023. In addition to deepening research in the area of smart buildings and smart grids, the digitalisation of the entire energy system, including e-mobility, will become even more important. Three buildings - a residential building, a student dormitory and an educational campus (nursery school and primary school) – are in the centre of ASCR smart building research. Equipped with photovoltaic, solar thermal and hybrid systems, heat pumps and various thermal and electrical storage systems, intelligent materials, building services and IT, these buildings function as flexible prosumers. They not only consume energy, but also produce and store it. Complex ICT systems allow for the automated optimum control of distribution, use, storage and transmission of energy. Moreover, smart buildings can be players on the electricity market.

https://www.ascr.at/en/

Ill. 21: "Eurogate - Site 2"

ENERGY ZONING PLANNING - AN OVERVIEW

A2

This chapter presents the developments which delineate the framework of energy zoning planning in terms of content and are essential for its understanding, all against the backdrop of the three global developments mentioned above - climate change, urbanisation and new technologies. A stringent definition of the "energy zoning planning" agenda can be found in the volume compiling materials on energy zoning planning which was published as No. 192 of the ÖROK (Austrian Conference on Spatial Planning) series:

"In order to be able to effectively implement climate protection and energy system transformation (►), energy zoning planning deals with the spatial dimensions of energy consumption and production, thus combining urban and energy planning"[7]

ENERGY ZONING PLANNING – PART OF THE SOLUTION

As already expressed in the mission statement, energy zoning planning is characterised by the skilful dovetailing of zoning and energy-related questions, which makes synergies between zoning and energy planning possible. Energy zoning planning significantly contributes to an approach whereby global developments can be mastered in the long run, at the level of specific urban development: The growing complexity of planning tasks (interaction of different scales, conflicting goals, availability of resources, economic possibilities, steering techniques, ...) as well as more extensive technological possibilities, which give planners a broader intervention spectrum, require such comprehensive approaches.

"When defining the tasks of zoning planning in the implementation of energy system transformation and climate protection, one must therefore take into account that spatial structures should not only be seen in the context of planning decisions but also in an overall societal context. Accordingly, (energy) zoning planning is a starting point for energy system transformation and climate protection, which are interlinked with other influences and factors (see Ill. 23): fundamental social values, various policies (e.g. the promotion of housing construction, economic and agricultural funding), management approaches, resource potentials as well as individual lifestyles and availability of technologies. At the same time, these aspects have a profound impact on land use development and zoning planning decisions." [8]

Ill. 22: Campus WU - Teaching Center and Departments

[7] ÖROK/Austrian Conference on Spatial Planning (ed.): Energieraum-planung, Materialienband (Energy Zoning Planning Materials, ÖROK-Schriftenreihe Nr. 192), 2015, p. 17

[8] Ministerium für ein lebenswertes Österreich, Impulse für eine kommunale Energieraumplanung (Ministry for a liveable Austria, Impulses for municipal energy zoning planning), 2017, p. 29

GOALS AND TASKS OF ENERGY ZONING PLANNING

Energy zoning planning places energy issues in the focus of urban and zoning planning, thus lending the topic more relevance with a view to considering and planning the energy supply of buildings and neighbourhoods from the outset.

In an urban context, energy zoning planning primarily focuses on “heat supply“ because buildings require the greatest amount of energy for this and because the transport of such energy to heat or cool buildings requires expensive infrastructure (district heating (►) and cooling), for electricity or gaseous energy sources in gas pipelines.

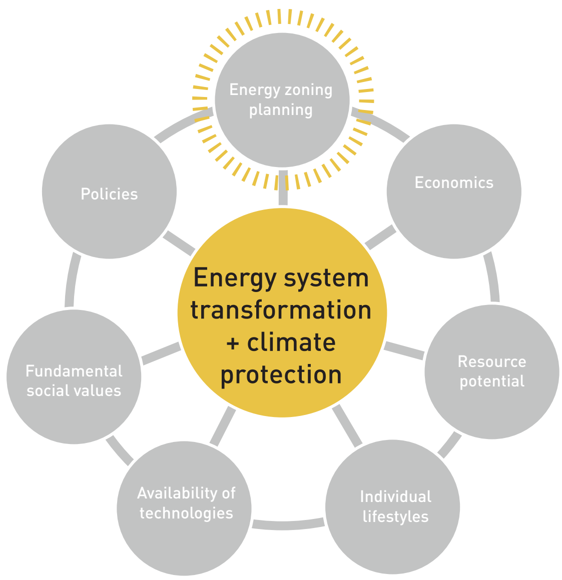
Through forward-looking energy zoning planning, renewable energies, waste heat (►) and efficient solutions can be implemented much more easily and cost-effectively, making them more competitive in comparison with fossil fuels. The infrastructure needed for low-CO_2 heat supply can thus be developed and built more economically. The following essential tasks of energy zoning planning are derived from this:

- It shows how existing structures (such as district heating grids (►) and gas grids, as well as transport routes) can be integrated efficiently, and how this contributes to ecologically and economically sustainable energy solutions > **Efficient use of district and local heating grids and networks**

- It brings together supply and demand: Knowing which energy sources are available locally and throughout the city, it is used to draw up maps to collect information on potentials of renewable energy sources and waste heat (►), to maintain energy databases so as to monitor developments, etc. > **Optimum use of waste heat (►) and renewable energy sources**

- It looks at energy consumption, the associated urban structure and its development (existing buildings, new buildings, traffic routes etc.) and way to optimise these from an energy-related point of view > **Suggestions for urban densification and development from an energy-related point of view, focusing on refurbishment measures**

- It provides planning guidelines for energy concepts in close coordination with urban planning. It thus gives instructions for concrete implementation to relevant actors involved in planning and construction projects, such as property developers, architects, etc. > **Proposals for optimised energy solutions from the point of view of energy planning, support for planners**



Ill.23: Determinants of energy system transformation and climate

WHERE ENERGY ZONING PLANNING AND URBAN PLANNING INTERSECT

Based on the above definition of energy zoning planning as the part of zoning planning which deals with the zoning dimensions of energy consumption and generation, one can find intersections with objectives known from zoning planning. For this reason, STEP 2025 also includes energy zoning planning as a planning parameter to be integrated into urban planning. These are the areas of intersection:

A contribution to determining the right extent of building density

Preference to compact structures and the way in which buildings are arranged and aligned – these are also factors closely related to issues of energy zoning planning: The more compact the structures, the lower the heat losses. Building density has a significant effect on energy supply and the choice of energy sources. For example, urban density is a factor in assessing whether grid-bound energy supply can be operated economically. The choice of energy supply solution as suitable for a certain urban area is thus determined to a great extent by zoning planning.[9] The orientation and design of structures may, for example, decide whether the decentralised use of solar energy is possible or made more difficult by shading effects.[10] It is essential to ensure moderate density with high-quality open spaces in order to achieve the good quality of life expected by residents.

Identifying and using specific advantages of mixed urban use

The design of spatial structures has a major impact on the energy requirements of a city. A city of short distances, in which the functions of living, working, local supply and leisure are mixed and thus close to one another, can minimize the distances to be covered. On the one hand, this improves the quality of life whilst on the other hand, it reduces mobility-induced energy demand. Moreover, the proximity of different uses allows for the optimum distribution across energy demand, storage and generation, for example through the use of process waste heat (►) to heat apartments (load balancing). This can also have a positive effect on the local economy or value added.

Ill. 24: Aerial view of In der Wiesen

Securing resources for renewable energy

In the current day-to-day planning routine, securing energy-relevant locations is only a marginal issue. Due to the changing spatial requirements for renewable energy sources and other new technologies in the context of the energy system transformation (►), it is to be expected that new resource areas will have to be secured in the future (e.g. corridors for higher-ranking energy infrastructure), and that this will lead to an increase in conflicts of objectives and use. Spatial planning can be used here as an organising intervention, helping to achieve the strategic goals of the energy system transformation from a long-term perspective.[11]

Establishing life cycles as planning parameters

In essence, energy zoning planning is a holistic approach to energy flows, at the right time and on the right scale. The long-term economic, ecological and social impacts must be taken into account when choosing energy supply options. Systems should be assessed on a long-term basis, or better, in terms of life-cycle costs (consideration of production, use and disposal of a product) and life-cycle emissions.

This is also essential for developers/the construction industry and it enables a rethinking process away from short-term solutions which seem to be more favorable due to lower investment costs and towards a long-term assessment which includes potential refurbishment costs resulting from the short lifecycles of the used building materials and components and their demolition and disposal costs. Moreover, lower running costs of energy due to the use of renewables must be factored in.[12] The enormous economic dimension of this approach is evident in the urban context as a whole.

Further thematic concepts of the City of Vienna

Energy zoning planning should not only to be seen and applied in combination with STEP 2025, but also with its numerous thematic concepts. Energy consumption, heat harvesting and heat production overlap with numerous urban planning issues, such as open space planning, mobility, the production sector and much more. The planning parameters of energy zoning planning can therefore be found in many measures and objectives of the thematic concepts under the urban development plan STEP 2025:

- STEP 2025 - Thematic concept Green and Open Spaces
- STEP 2025 - Thematic concept High-Rise Buildings
- STEP 2025 - Thematic concept Mobility
- STEP 2025 - Thematic concept Public Space
- STEP 2025 - Thematic concept Productive City

[9] Energieraumplanung in Wien, Aufbereitung rechtlicher Aspekte, 2016, p. 16
[10] Energieraumplanung in Wien, Aufbereitung rechtlicher Aspekte, 2016, p. 16
[11] Ministerium für ein lebenswertes Österreich (Hrsg.), Impulse für eine kommunale Energieraumplanung, 2017, p. 21
[12] Vgl. https://www.donau-uni.ac.at/imperia/md/content/department/bauenumwelt/forumbs/2.4_lebenszykluskosten_bei_hochbauten.pdf, accessed on 06 May 2019

ENERGY ZONING PLANNING IN NEIGHBOURING COUNTRIES

The interest in energy zoning planning has developed in different ways in the German-speaking countries. This is primarily due to major differences in energy-relevant governing approaches and in the distribution of competences across levels (policy-making and administration) and in content-related orientation. In particular, Germany and Switzerland are pioneers in the field. In these two countries regional planning is governed by national legislation. In comparison with Austria, this makes for a major institutional difference.

GERMANY

The Federal Office for Building and Regional Planning has strong competences in setting a framework, which leads to the regular drafting of guiding principles and action strategies for regional planning. These include numerous issues of energy zoning planning.[13] Climate protection is interpreted as an urban development task, linking urban development contracts directly with the higher level.

Regional planning regulations are supported by more recent, effective measures in the context of the energy system transformation (▸), such as the levy under the Renewables Energy Act (EEG-Umlage[14]), which is now included in the electricity price, the national climate protection initiative, and the German government's energy concept. At the state level, the Berlin act on energy system change should, for example, be mentioned; under this law, the Berlin Senate intends to work towards stopping energy generation from hard coal by the end of 2030.

As for an example from the municipal level, the city of Freiburg adopted building policy principles for new buildings and new development areas. The guidelines defined in these principles define energy criteria which are applied to purchase contracts or urban development contracts; specific requirements for land owners depend on the planning benefit achievable.

In general, according to Sec. 11 of the German Building Code, several municipalities in Germany use the instrument of land purchase contracts to achieve higher energy standards in construction and sustainable heat supply:

"(1) The municipality may conclude urban development contracts. The subject matter of an urban development contract may include, without being limited to: [...] 4. the construction and use of installations and facilities for the decentralised and centralised generation, distribution, use or storage of electricity, heat or cooling from renewable energy sources or combined heat and power generation [...] in accordance with the objectives and purposes pursued by the urban development plans and measures."

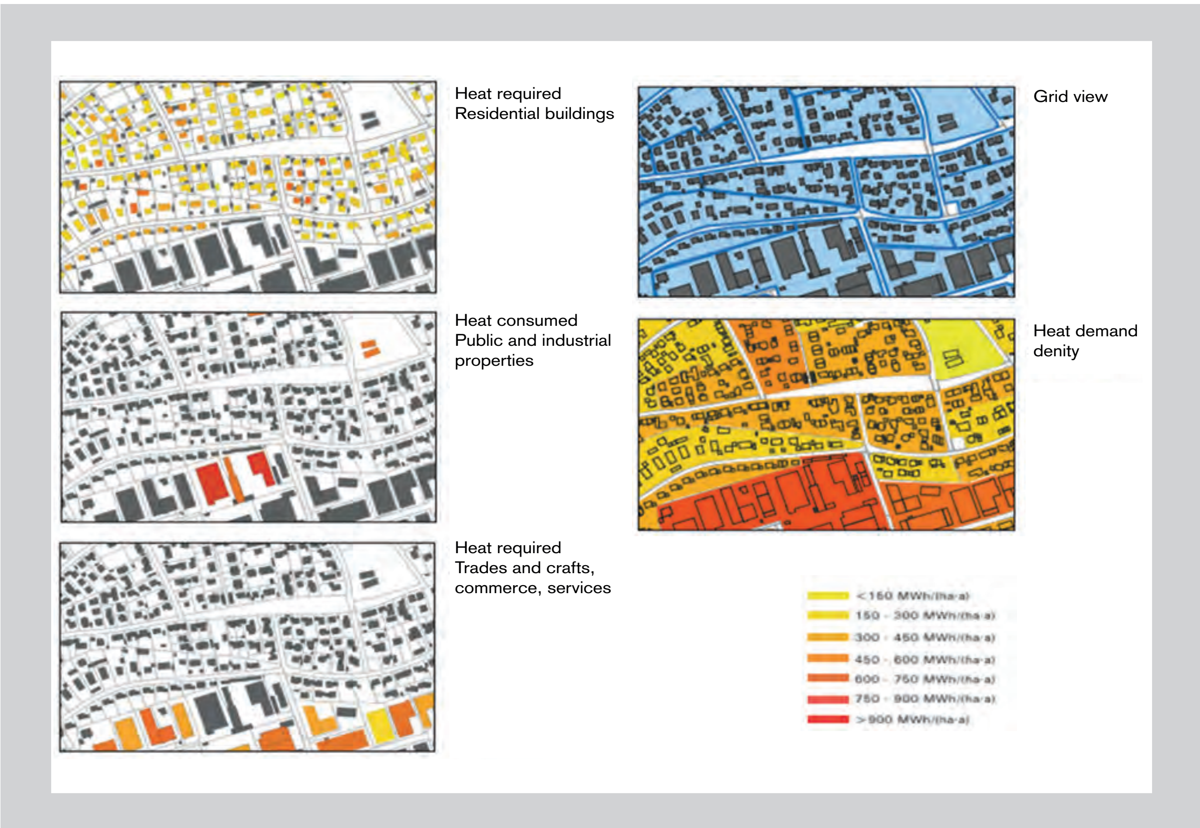
In practice, for example, the following energy requirements were agreed on in urban planning contracts:[15]

- creating an energy supply concept,
- connection to an existing heating network,
- the installation and use of heat supply systems based on renewable energies or combined heat and power (▸),
- higher energy building standards than those required by law.

A different approach was chosen in Hamburg: Creating an energy supply solution for an urban development area owned by the city or a redevelopment company was put out for tender. The tender was open to all technologies and a CO_2 limit per kWh was set. In order to achieve a high degree of connection to the heat supply solution, corresponding provisions were included in the purchase contracts.[16]

In Bavaria, energy use planning is intended to establish a link between urban planning and climate protection. The understanding here is largely the same as in Austrian energy zoning planning. The Land of Bavaria provides technical and financial support to the municipalities in setting up such planning - the guidelines for drawing up the energy use plan, made available by the Land of Bavaria is a case in point.[17]

The **energy use plan** is a central planning instrument. Some Bavarian municipalities and cities already have such a plan. Outside of Bavaria, the expression “heat plans“ is also used The plan is based on an energy data model. For this purpose, data on energy requirements and consumption, the potential of renewable energy sources, the capacity of existing infrastructure and future development are combined. From this, possible energy supply options can be determined. The City of Munich is currently working on such an energy data model (also referred to as an energy use plan system). A non-binding energy use plan is developed in a coordination process with various actors. In this context, it is essential to store all energy-relevant information in a central municipal database. The latter represents an indispensable basis for planning future land use and preparing development plans as well as a basis of information for the public. Content is to be concretised in “energy concepts for neighbourhoods“ (existing buildings) and “energy concepts“ (new buildings).



Ill. 25: Density of heat demand in Bavaria

SWITZERLAND

In comparison with Austria, Switzerland is also characterised by stronger and more binding **steering responsibility for energy and climate-relevant targets** at a national level. For instance, this is manifested in the **"2,000-watt society"** strategy which is practiced and strategically discussed across all areas of competence (state, cantons, municipalities). The ambitious **3-zone structure of energy supply** in the 2050 scenario of the city of Zurich is a case in point; it is shown in Ill. 26 below.

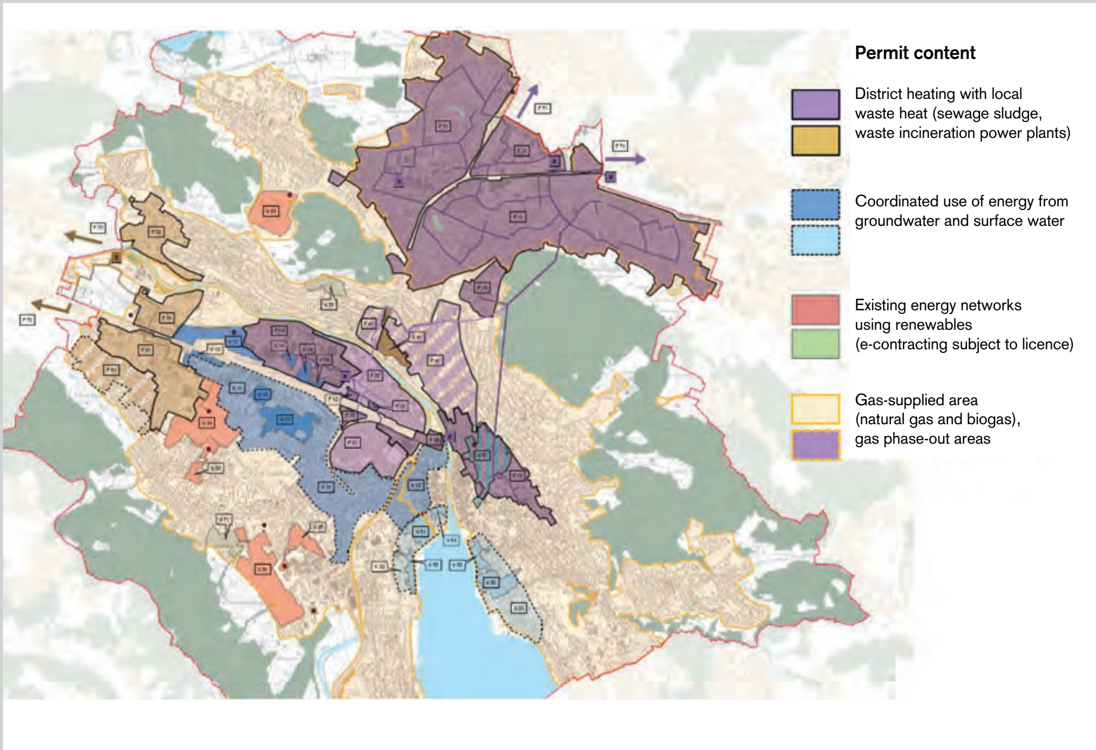
The zones are defined as follows:

- **Zone 1:** Classic public district heating, share in residential area: approx. 25 percent

- **Zone 2:** Low-temperature energy networks with sewage water, lake water, groundwater. Share in residential area: approx. 15 percent

- **Zone 3:** Decentralised supply with renewable energies and gas (natural gas/biogas); individual solutions and small energy networks. Share in residential area: approx. 60 percent

Such zonings are also recorded, broken down, maintained and made publicly available in WebGIS applications in the so-called **"energy reorientation**



Ill. 26: Excerpt from the energy planning map of the City of Zurich

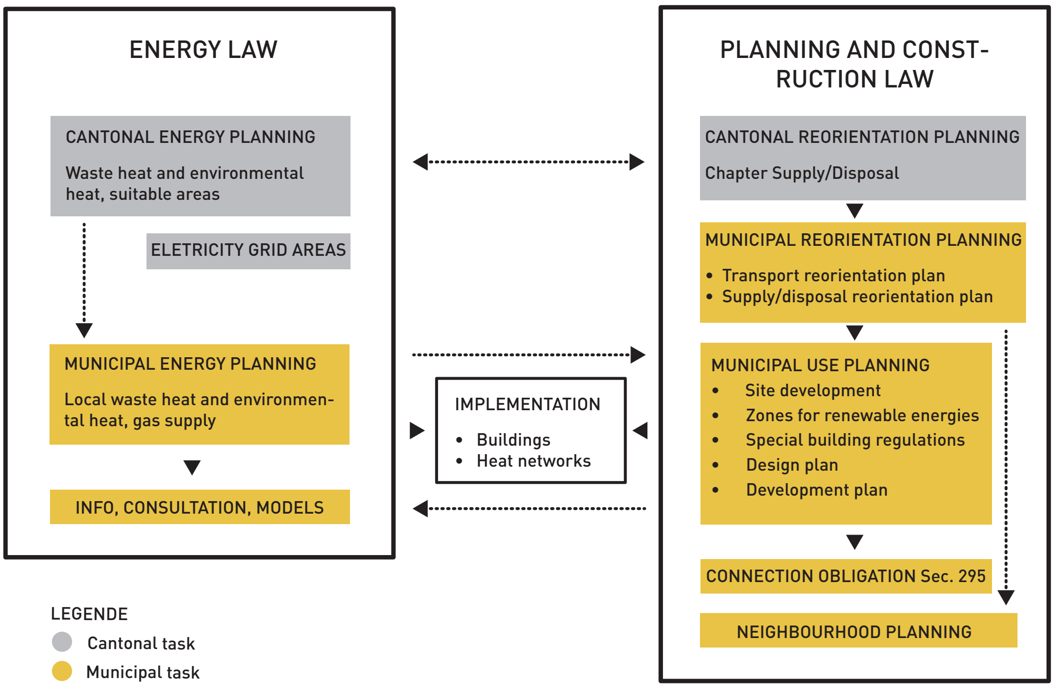
plans" according to their ACTUAL and TARGET status. At the level of buildings, **the binding nature of the plan specifications** is also high because the contents are set forth in the "Utilization planning: Zone planning and superstructure regulations" (comparable to our zoning and development plan).

As for the way in which municipal energy planning is embedded overall, reference is made to Ill. 27.

As an example of "municipal energy zoning planning", a basic map of Zurich was produced, showing energy supply classes including the classification for densification/zoning. (See Ill. 28)

The core contents of the **Swiss energy reorientation planning** are the supply areas for district heating (▸) and waste heat utilisation (including waste incineration), the allocation of supply to energy sources and suitable supply areas[18] (including future area, within the meaning of future ability to supply!), the delineation of refurbishment areas within neighbourhoods, measures for public-sector facilities and buildings, and the presentation of areas primarily suitable for new utilisation zones.

Due to the special features of the political-administrative system of the City of Vienna, which is both a municipality and a Land [19], the model of Swiss communal energy master planning offers particularly **interesting points to tie in with**, as well as attractive and reproducible process mechanisms.



Ill. 27: Instruments in Swiss energy, reorientation and land use planning

[13] The “steering power“ in Germany is a much stronger and more binding “top down“ force than is possible in Austria although in Austria, concepts exist at federal level, of course (cf. e.g. Österreichische Energieagentur - Austrian Energy Agency (AEA) et al. 2010)

[14] EEG = Renewable Energies Act, as amended in 2012. The average electricity price in Germany (i.a. due to this levy) is € 0.29, in Austria it is € 0.20.

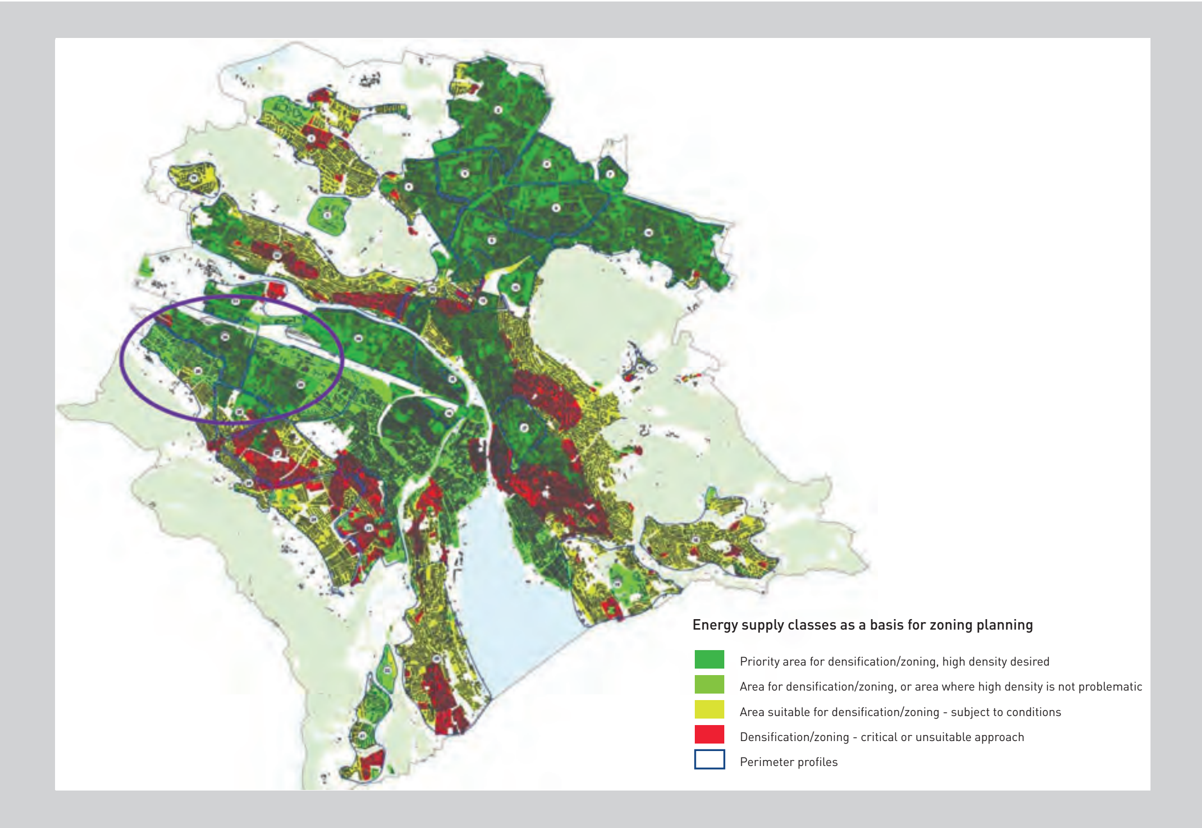
[15] Energieraumplanung in Wien, Aufbereitung rechtlicher Aspekte, 2016, p. 64

[16] Energieraumplanung in Wien, Aufbereitung rechtlicher Aspekte, 2016, p. 45ff.

[17] https://www.energieatlas.bayern.de/kommunen/energienutzungs-plan. html, accessed on 26 July2018

[18] Prioritisation according to Art 4 of the Cantonal Energy Ordinance: 1.) Local high-quality waste heat, 2.) local low-grade waste heat and environmental heat, existing grid-bound energy from renewables, 3.) existing grid-bound energy from renewables, 4.) regionally available renewable energy sources, 5.) locally independent environmental heat.

[19] Vienna thus has a unique position in Austria!



Ill. 28: Energy supply classes as a basis for settlement planning, Zurich

Ill. 29: Campus WU - Library & Learning Centre

VIENNA INITIATES FIRST STEPS

A3

Building on the objectives of energy zoning planning at a national level, including the Austrian Spatial Development Concept (ÖREK) partnership, the Climate Protection Act and the climate strategy titled "#mission 2030", the objectives pursued at urban level will be presented in this chapter. Energy zoning planning in Vienna is currently under construction, but numerous aspects have already been part of the daily planning routine of urban planners. Building on KliP II and the Smart City Vienna framework strategy, strategy papers were developed in the past and can now be used as a basis for the present thematic concept.

ENERGY ZONING PLANNING AT THE NATIONAL LEVEL

As far as energy zoning planning is concerned, various guidelines and key objectives exist at federal level; these will be described below. Based on the requirements of the "Spatial Energy Planning Partnership" of the Austrian Spatial Planning Conference, the programme of measures of the federal government and the federal provinces according to the Climate Protection Act and last but not least, the energy and climate strategy known as "#mission2030", measures in the field of energy zoning planning are being addressed.

ÖREK Energy Zoning Planning Partnership

Following the Austrian Spatial Development Concept 2011 (ÖREK), the Austrian Conference on Spatial Planning (ÖROK) established an **"energy zoning planning" partnership in 2011**, with the City of Vienna being one of the participants. The aims of this partnership are to develop and disseminate know-how on the subject of energy zoning planning, to raise awareness of the climate relevance of zoning planning measures and to design framework conditions.[20]

Programme of measures by the Federal government and the federal provinces

The programme of measures by the federal government and the federal provinces under the Climate Protection Act to attain the greenhouse gas target by 2020 (second implementation stage for the years 2015 to 2018) contains the following wording:
Supersectoral field of action "zoning planning": Within the framework of zoning planning, the federal government and the federal provinces agree to discuss and adopt measures which contribute to the reduction of greenhouse gas emissions on the basis of results of the "ÖREK Spatial Energy Planning Partnership".

Topics to be dealt with as a matter of urgency:

- Legal framework for energy zoning planning
- Standardised methods for establishing measurability and transparency
- Financial incentive systems for implementing energy zoning planning objectives
- Identification of best practices
- Awareness-raising and advice on energy zoning planning measures

#mission2030

In 2018, the federal government published an energy and climate strategy titled "#mission2030".[21] It introduces energy zoning planning as a tool for reducing conflict potential, especially with regard to large infrastructure projects. The aim is the *"implementation of innovative energy concepts with a focus on locally available, cheap and modern renewable energy, the use of waste heat (▸) and integrated mobility systems".* Integrated energy concepts can be used for decision-making in land use planning, investment in infrastructure and the allocation of grants, such as housing subsidies. A working group will be set up to follow up these objectives. These groups should

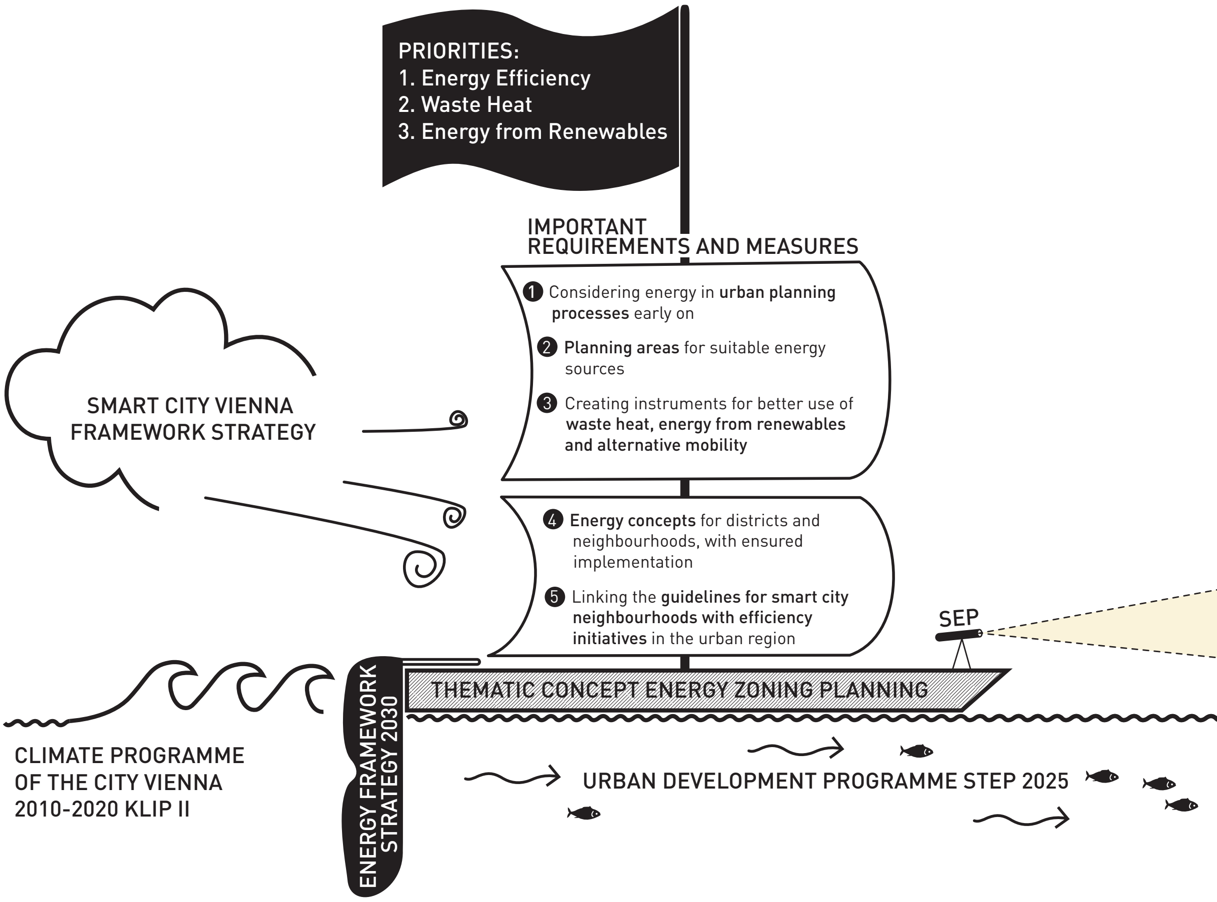
- develop a uniform definition for energy zoning planning,
- develop a strategy and common guidelines and
- achieve better coordination between actors in zoning planning, energy industry and regional development.

It is important to note that the distribution of competences alone means that the objectives cannot be achieved without cooperation between the federal government and the federal provinces.

[20] ÖREK (Austrian Spatial Development Concept), https://www.oerok.gv.at/raum-region/oesterreichischesraumentwicklungskonzept/oerek-2011/oerek-partnersen/ abgeschlossene-partnerschaften/energieraumplanung.html, accessed on 26 July 2018

[21] Federal Ministry of Sustainability and Tourism (BMNT) and Federal Ministry of Transport, Innovation and Technology (BMVIT), #mission2030: Die Klima- und Energiestrategie der Österreichischen Bundesregierung (The Climate and Energy Strategy of the Austrian Federal Government), 2018

ENERGY ZONING PLANNING: STRATEGIES AND GUIDELINES OF THE CITY OF VIENNA

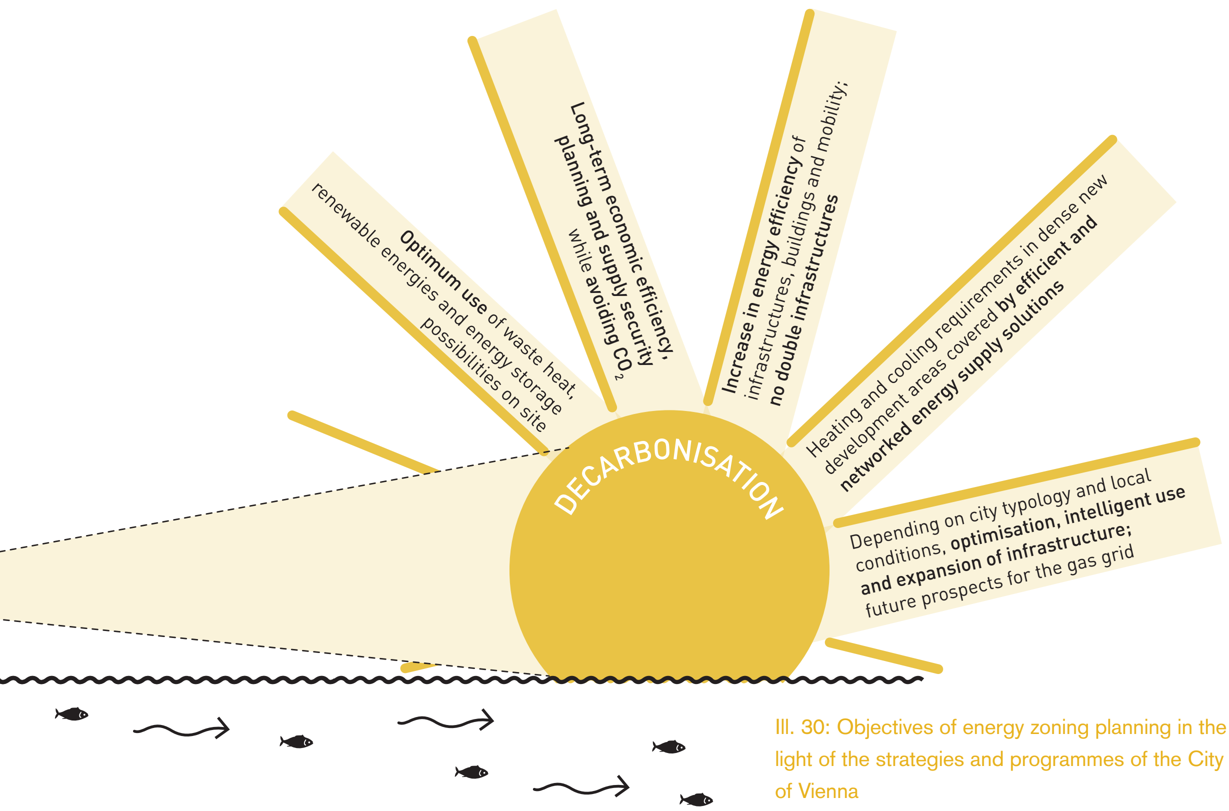


Compared with Germany or Switzerland, energy zoning planning in Vienna is still in its infancy. It should be mentioned that the model of Swiss municipal energy planning offers particularly **interesting points to tie in with** due to the special features of the political-administrative system of the City of Vienna.

Aspects such as the creation of mixed-function, compact urban structures or the creation of a city of short distances have already been part of daily planning practice while other aspects such as the energy supply of urban areas have mostly been treated as subordinate in terms of procedures. Energy (mostly fossil) was available in sufficient quantities and cheap, there was hardly any need to examine possible alternatives to conventional supply or to develop an appropriate basis for decision-making.

Given Vienna's objectives,[22] the aim for the future is to integrate energy planning into zoning planning and combine these in a coordinated process in order to find optimum infrastructure and energy system solutions adapted to the needs of the location. Energy planning thus becomes a parameter relevant to design, and it must be incorporated systematically in all urban planning processes. Specifically, a high degree of energy efficiency, the use of waste heat (►), the expansion of renewable energy supply and the evaluation of grey energy (►) should already be taken into consideration during the development of urban development qualities.

The most relevant specifications for the energy zoning planning concept can be found in four **overarching strategies of the city**, which will briefly be explained on the following pages:



Ill. 30: Objectives of energy zoning planning in the light of the strategies and programmes of the City of Vienna

- **Smart City Vienna Framework Strategy**
- **Urban Development Plan STEP 2025**
- **Energy Framework Strategy 2030 for Vienna**
- **Climate Protection Programme of the City of Vienna KliP II**

Apart from these central strategies, there are **other basic documents and instruments** on which energy zoning planning in Vienna is based or relates to:

- the **Strategic Plan for the Vienna Urban Heat Islands**, which identifies possible ways to reduce heat islands in the city
- the **Urban Energy Efficiency Programme** (SEP)
- the **Vienna Building Code** as a sovereign control instrument with energy relevance other
- steering instruments, in particular **housing subsidies**

Summary of priorities, objectives and requirements set in energy zoning planning

The following subchapters provide a detailed description of the objectives and requirements arising from the above-mentioned strategies and targets of the City of Vienna. Looking at the two strategies which are essential for energy zoning planning, STEP 2025 and the Energy Framework Strategy 2030, the most important statements are summarised in the box. Ill. 30 shows these in consolidated form: The essential specifications and measures which drive energy zoning planning are found in the sail, the central targets can be seen through the telescope.

SMART CITY VIENNA FRAMEWORK STRATEGY

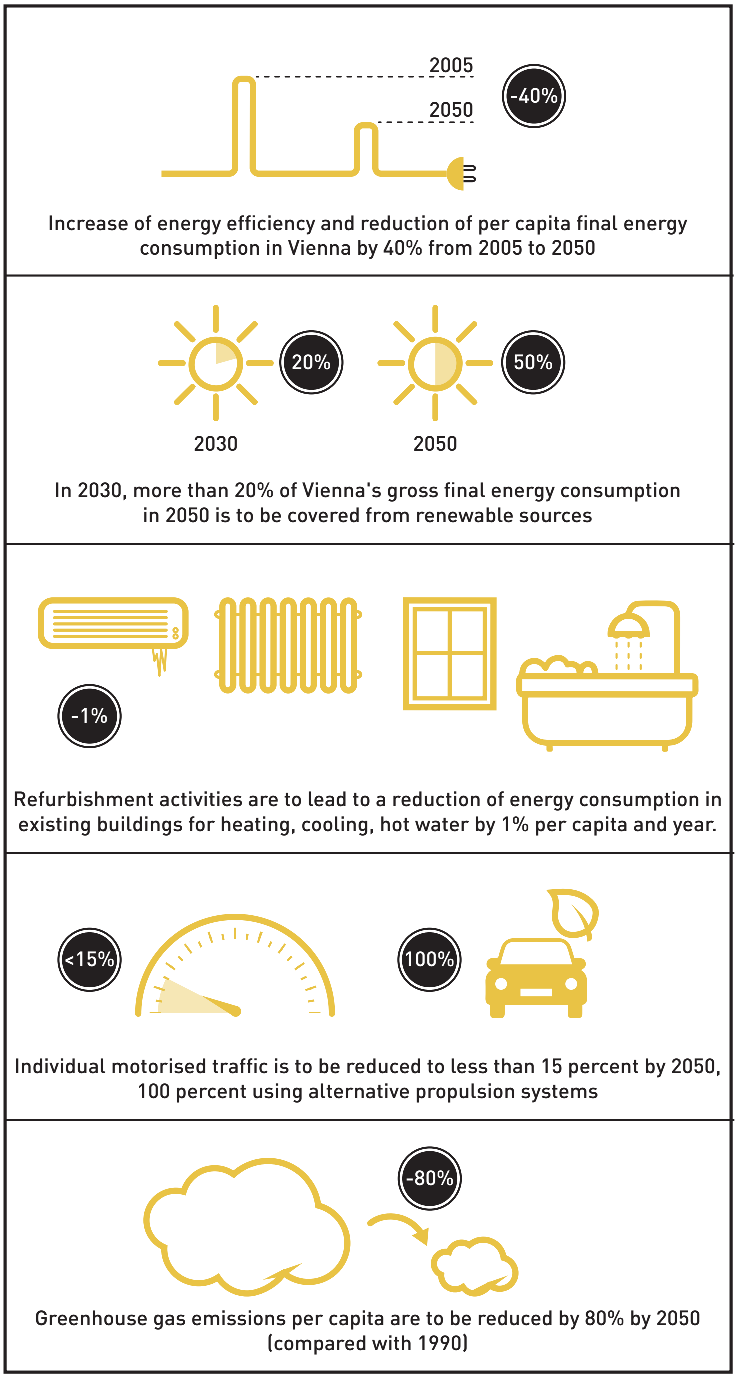
The Smart City Vienna framework strategy is a long-term umbrella strategy aiming to guarantee the best quality of life for all residents of Vienna by 2050 while conserving resources to the greatest possible extent. Apart from CO_2 reduction, the reduction of motorised private transport, new goals and strategies for innovation and research, social issues, health and environment, energy is an issue of particular importance. In the interest of conserving resources, energy consumption should also be reduced and renewable energy sources should be promoted. Fossil fuels are to be replaced by more sustainable forms of energy, conversion technologies and services.[23] The Smart City Vienna framework strategy functions as the overarching and content-providing framework for the medium-term goal of creating forward-looking and networked zoning as well as mobility and energy planning.

At the same time, the guidelines and objectives formulated here form the basis for the individual thematic concepts of the city, including the present thematic concept “Energy zoning planning“.

Specifically, the objectives and guidelines of the Smart City Vienna framework strategy relevant to energy zoning planning are as follows:

- Reduction of greenhouse gas emissions (►) per capita by 35 percent by 2030 and by 80 percent by 2050 (compared with 1990).
- Increase in energy efficiency and reduction in final energy consumption (►) per capita by 40 percent by 2050 (compared with 2005).
- Increase in the share of energy from renewables: In 2030, more than 20 percent and 50 percent of the gross final energy consumption (►) of Vienna are to be covered by renewables.
- A standard for cost-optimised near zero-energy construction (►) for all new buildings, additions and conversions
- Further development of heat supply systems
- Reduction of individual motorised traffic to less than 15 percent by 2050, 100 percent using alternative propulsion systems
- Reduction of energy consumption in existing buildings for heating/cooling/hot water by 1 percent per capita/year through refurbishment activities[24]

Since April 2018, following a monitoring process, an update of the Smart City Vienna framework strategy (SCWR) has been taking place, which is to be adopted by the municipal council. It is becoming apparent that some of the energy and climate-related targets will be given a new foundation in terms of underlying data and that the quantitative targets will be changed as a result.[25] Furthermore, during the ongoing interdisciplinary discussions on updating the SCWR, it became clear that the targets in the building and heating sector will only be achievable if the overarching framework conditions, and in particular the energy zoning plans (see Chapter B.3 “Development of Energy Spatial Plans”) support the further development of district heating (►), waste heat (►) and renewable energies in Vienna.



Ill. 31: Energy targets of the Smart City Vienna framework strategy

Priorities, objectives and requirements set for energy zoning planning under STEP 2025 and the Energy Framework Strategy 2030 for Vienna

Priorities

1. Energy efficiency
2. Waste heat (►)
3. Renewable energies

Objectives

- Avoidance of CO_2 emissions (►)
- Economy and security of supply
- Increase in the energy efficiency of infrastructures, buildings and mobility
- The most sustainable and efficient way possible of providing energy required. Use of waste heat (►) and renewables on site, provision of services and storage facilities to optimise their use
- Covering heating and cooling energy required in dense new development areas with efficient and networked energy supply solutions
- Optimisation, intelligent use and expansion of infrastructure; no duplication of infrastructures; future perspectives for the gas grid
- Differentiating use of energy sources depending on city typology and local conditions

Requirements set

- Development of foundations: thematic concept; data model; definition of processes
- Energy concepts for new districts and neighbourhoods
- Development of a model for the contractual implementation of the concepts
- Guidelines for Smart City neighbourhoods – with a section on energy
- Early consideration of energy in urban planning processes
- Linking efficiency initiatives in the urban region
- Planning areas for district heating (►), natural gas and decentralised heat supply
- Implementation of legal instruments which reduce the direct use of CO_2-intensive energy sources and promotion of alternative mobility solutions
- Creation of suitable instruments to support long-term investments, decarbonisation (►) and planning security in the construction of energy supply systems
- adaptation of legislation in order to make better use of waste heat (►) and renewable energy

STEP 2025 - URBAN DEVELOPMENT PLAN VIENNA "Mothership" for the energy zoning planning concept

The greater part of the Urban Development Plan 2025 is strategic in nature, defining the direction of urban development at the level of society as a whole up to the year 2025. STEP 2025 thus provides orientation regarding our own basic attitude as well as the direction of development which administration and policy-makers should strive for. It forms the basis of thematic concepts, master plans, programmes and much more.

In the field of energy zoning planning, STEP demands systemic solutions for energy and infrastructure adapted to the needs of the respective location. STEP 2025 already specifies the **development of a thematic concept for "integrated energy zoning planning"** in order to concretize the strategic objectives.[26]

In this context, the following objectives are relevant:

- Avoidance of CO_2 emissions
- Increase of energy and economic efficiency and security of supply
- Use of renewable energies on site
- Intelligent and optimised use of grid-bound energy sources (e.g. decentralised heating networks, waste heat (►) etc.)
- The implementation of energy storage options to optimise the use of local potentials

The combination of zoning and energy planning in an integrated process at neighbourhood level is crucial. The scope for action and planning must be defined for this purpose, and a comparison must be made between the city's technical objectives and plans. This is also to be implemented in processes which are already ongoing.

Ill. 32: The Urban Development Plan for Vienna (STEP) 2025 as a strategic framework

ENERGY FRAMEWORK STRATEGY 2030 FOR VIENNA

A bridge between the Smart City Vienna Framework Strategy and the short-term objectives of the city

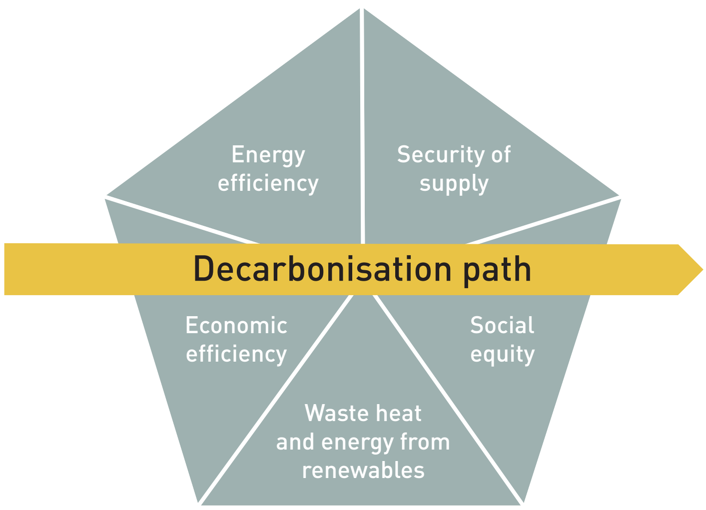
The Energy Framework Strategy 2030 for Vienna forms the basis for the detailed implementation programmes in the energy sector and builds a bridge between the objectives of the Smart City Vienna Framework Strategy and the measures and concepts of the city which can be implemented in the short run. The objectives of urban energy policy up to 2030 are defined, with waste heat recovery and the use of renewable energies being central factors.

Energy zoning planning is one of the six strategic fields of the energy framework strategy; it is oriented towards the following overarching objectives:

- Reducing energy demand in the context of infrastructures, mobility and in the construction and refurbishment of buildings
- Covering energy demand sustainably and efficiently, also using locally available energy sources and waste heat (▸), adapting the supply of energy services to the resources and technologies available and optimising such services
- Optimising and expanding infrastructure including a future perspective for the gas grid.

Specifically, that means:

- the avoidance and continuous unbundling of duplicate infrastructures,
- the definition of planning areas for district heating (▸), natural gas, decentralised or individual heat supply, taking into account criteria such as economic efficiency and local conditions, and
- differentiating use of energy sources depending on the city typology (existing buildings, development areas, densified or more dispersed developments).



Ill. 33: Energy policy target pentagon of the City of Vienna

The following requirements need to be considered in energy zoning planning:

- Energy needs to be considered at an early stage in urban planning processes (e.g. zoning) and dense, functionally mixed development structures need to be fostered.
- The heating and cooling requirements in dense new development areas are to be taken into account jointly in efficient and networked energy supply solutions.
- The implementation of legal instruments (e.g. the building code) which reduce the direct use of CO_2-intensive energy sources and promote alternative mobility, such as an obligation to provide conduits for later installation of electricity charging stations in the indoor carparks of urban development areas.
- The creation of suitable instruments to support long-term investments, decarbonisation (▸) and planning security in the construction of energy supply systems.
- Setting the following priorities on the basis of the energy policy target pentagon:
    1. efficiency,
    2. waste heat (▸),
    3. renewable energy.
- The coordination and adaptation of other legislation to support the use of waste heat (▸) and renewable energy on site, such as water law, mining law.
- The application of the cost-optimised near-zero energy building standard (▸) for all new buildings, additions and conversions from 2018/2020 and the further development of heat supply systems towards even more climate protection.

Integrated neighbourhood energy concepts as a result of energy zoning planning are to be implemented in land use planning, investment in infrastructure and in the granting of subsidies.[27]

CLIMATE PROTECTION PROGRAMME OF THE CITY OF VIENNA 2010-2020 - KLIP II
Strategic measures to reduce greenhouse gases

For years, the City of Vienna has given high priority to effective climate protection. Building on the climate protection programme of the City of Vienna (KliP I), which was adopted in 1999, the Vienna Municipal Council decided in 2009 to update the climate protection programme of the City of Vienna for the years 2010-2020 (KliP II). KliP II lists essential measures which are important for energy zoning planning in Vienna. Aiming at an integration of energy-relevant aspects in zoning and urban planning, 28 measures also include energy aspects in urban planning competitions, the systematic development of the city along the high-ranking public transport network and the district heating network as well as the definition of waste heat (▸) ,thermal energy from tunnels and district heating areas. In the case of urban planning competitions or similar procedures, coordination is also foreseen with regard to energy-relevant aspects.[29]

The declared goal of KliP II is to reduce per capita emissions of greenhouse gases (GHG) by 21 percent by 2020 (relative to 1990 levels). By the end of 2015, the savings achieved were already at around 35 percent per capita. An update of KliP II for the years 2020-2030 (KliP II) is in the pipeline.

A climate protection coordination unit has been set up to implement and bring the energy and climate protection objectives in line with the overall objectives and actions of urban development. It aims at cooperation with the authorities of the City of Vienna concerned when it comes to the activation, planning, coordination and implementation of climate protection measures.

FURTHER PRINCIPLES AND INSTRUMENTS

Urban Energy Efficiency Programme - SEP 2030

The Urban Energy Efficiency Programme 2030 (SEP 2030) is the successor programme to the SEP adopted in 2006.[30] Based on the objectives of the Energy Framework Strategy 2030, it consistently continues the efforts to increase efficiency and describes the measures and instruments which guide action to achieve these objectives. With SEP 2030, the transport sector will for the first time be included as a central element. Around 78 percent of Vienna's final energy consumption (►) is used in transport and buildings. Therefore, attention is focused on these two sectors and on the measures within their purviews as can sustainably reduce energy consumption. Many points in SEP 2030 for increasing energy efficiency and saving energy are not new, they have been pursued for years. They continue to require consistent implementation with sufficient financial resources and - due to changing framework conditions - regular re-honing. The measures and instruments concentrate on the remit of Vienna as a city and province. Moreover, the role of the City of Vienna Administration as a role model is emphasized by measures within its own sphere of influence.

Urban Heat Islands - Strategic Plan Vienna (UHI-STRAT Vienna) - energy efficiency and local climate conditions

The aim of UHI-STRAT Vienna is to identify measures which reduce the heat load during the summer months and to implement these.[31] These strategies and measures also have a significant impact on energy zoning planning, which is linked to the important issue of climate change adaptation. Accordingly, **measures** were defined which **connect with energy zoning planning** since they implicitly or explicitly affect energy demand. While some of the planned objectives and measures will result in synergies with energy zoning planning, conflicting goals need to be resolved in some contexts. The following measures are particularly relevant for energy zoning planning:

Open space networking with connection with cold air production areas promotes air circulation and must therefore be included in planning but can also contradict competing objectives - e.g. corresponding (consumer) densities; the same applies to the requirement to keep certain areas free.

In particular, the call for urban structures adapted to the heat load - such as sufficient shading or optimised building structures and the orientation of a building to avoid overheating or facade and roof greening – comes with possible conflicting goals – after all, the orientation of buildings and parts of buildings also plays a role in the optimum use of solar energy.

In order to bring the objectives of UHI-STRAT Vienna into line with the objectives and measures of energy zoning planning, an integrating overall planning approach is necessary, one which produces technical solutions adapted to the season and avoids conflicting goals. The early involvement of experts, the joint definition of objectives and an interdisciplinary and multidisciplinary approach to energy efficiency are necessary when dealing with heat loads in Vienna.[32]

Factbox
URBAN LEARNING

The EU project URBAN LEARNING played a central role in the preparatory work mentioned above. With Vienna leading the way, eight European cities took up the challenge of making energy a part of urban planning. The focus was on the process of urban planning and the identification of which elements are needed at which points in the process when it came to considering energy. This included the definition of energy criteria, the use of various instruments and tools and the integration of different actors and their roles.

Moreover, the framework for such an integrative urban planning process was also examined, including the legal and organisational basis required. In particular, the importance of a sufficient quantity of underlying data was stressed by all cities.

The results of the project include the presentation of an energy-related urban planning procedure for each city and the preparation of an implementation plan for the integration of energy issues into urban planning. This made it possible to develop recommendations for cities wishing to initiate energy zoning planning. The different perspectives of each city stimulated impulses and new approaches. The working groups that were set up in each city massively promoted the topic within the city. In the case of Vienna, this process was a precursor for the coordination between the actors of the thematic concept.

Videos on URBAN LEARNING:

http://www.urbanlearning.eu/

PREPARATORY WORK LEADING TO THE THEMATIC CONCEPT

The integration of energy zoning planning into STEP 2025 is linked to the assignment for the preparation of a thematic concept. The Municipal Department for Energy Planning (MA 20) has been building the foundations for future energy zoning planning in Vienna for several years with the support of other relevant departments. Apart from participation in the EU Horizon 2020 projects URBAN LEARNING (2015 to 2017) and SMARTER TOGETHER[33] (2016 to 2019) as well as the ongoing City of the Future project ENERSPIRED CITIES[34] (2017 to 2019), these preparations include the following:

- Preliminary draft of the thematic concept and compilation of a volume of materials by the TU Vienna
- Preliminary study for the thematic concept "Integrated energy zoning planning"
- Options study for the energy supply of the urban development area Donaufeld
- Studies and investigations on the legal aspects of energy zoning planning, in particular Werkstattbericht 169: Energieraumplanung in Wien – Aufbereitung rechtlicher Aspekte (Workshop Report 169: Energy zoning planning in Vienna - Identification of legal aspects)
- Studies and investigations to process and present relevant data, such as heat required for heating purposes and refurbishment potentials at the level of buildings
- Preparation of guidelines for actions and communication in energy zoning planning

A work and coordination structure, a core team and a steering group bringing in the relevant departments, stakeholders from the energy and planning sector and the Energy Center Wien[35] were set up to support the project. The related results were coordinated and further developed, serving as starting points for other processes, such as the preparation of the amendment of the Building Code for Vienna.

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[22] Cf. STEP 2025

[23] Smart City Vienna Framework Strategy, 2014, p. 12.

[24] Smart City Vienna Framework Strategy, 2014, p. 32ff.

[25] https://www.wien.gv.at/stadtentwicklung/projekte/smartcity/smart-monitor/ rahmenstrategie-monitoring.html, accessed on 27 September 2018

[26] STEP 2025, p. 57

[27] Energy Framework Strategy 2030 for Vienna, 2017, p. 20

[28] KliP II, p. 93

[29] KliP II, p. 98

[30] Municipal Energy Efficiency Programme (SEP), https://www.wien.cv.at/stadtentwicklung/energie/pdf/sep-endbericht.pdf, accessed on 15 April 2019

[31] Urban Heat Island - Strategic Plan Vienna, 2015, p. 9

[32] Urban Heat Island - Strategic Plan Vienna, 2015, p. 29ff.

[33] See info box Chapter B2, page 93, http://www.smartertogether.at/, accessed on 6 July 2018

[34] Enerspired Cities: The national research project (2017-2019) aims at the automated processing of information for energy-oriented urban planning. Together with the cities of Salzburg and Innsbruck as well as research actors, Vienna is developing a concept which will be imple-mented in a pilot application. (http:// www.enerspired.city/, accessed 6 July 2018)

[35] With the Energy Center, Urban Innovation Vienna (UIV) offers an independent competence centre that supports the City of Vienna and its companies in achieving their ambitious energy and climate protection goals. At the same time, the Energy Center fulfils the function of a regional energy agency, as it also exists in other cities and countries in Austria and Europe. (http://www.urbaninnovation. at/de/Energy-Center, accessed on 4 September 2018)

Ill. 34: Building Services Campus of Vienna University of Economics and Business Administration

B

STRATEGIES AND INSTRUMENTS

While the first section of the thematic concept (Part A) reflected the framework conditions of energy zoning planning and the necessity of implementing it, Part B contains the strategy of the City of Vienna with regard to energy zoning planning and the instruments and measures necessary for this purpose.

Chapter B.1 will introduce the **current energy consumption broken down by energy sources in Vienna** and explains the focus on heat supply.

Chapter B.2 will provide an overview of **energy supply and demand, the existing infrastructure and the options for action resulting from these**. It shows how these factors can be combined to achieve decarbonisation (▸).

As an introduction the energy sources, the suppliers of waste heat (▸), heat from renewable energy sources, energy infrastructure and energy imports and their respective potentials that are available in Vienna are described.

By linking this information, potential future courses of action for energy zoning planning are defined: What can coordinated processes involving urban planning, energy zoning planning and infrastructure development look like and how can a CO_2-free future be achieved for Vienna? In addition, **heat supply scenarios** will be developed.

Energy zoning planning distinguishes between existing and new development areas as they come with completely different prerequisites from the perspective of energy zoning planning. The related questions and potential solutions will be outlined below. **Finally, the contribution which energy zoning planning can make to decarbonisation (▸) will be presented.**

Chapter B.3 will define the **most important instruments** to be used or developed for the concrete integration of energy zoning planning into urban planning and the implementation phase and for reaching the objectives of energy zoning planning.

Ill. 35: Simmering power plant

Ill. 36: Seestadt Aspern D12

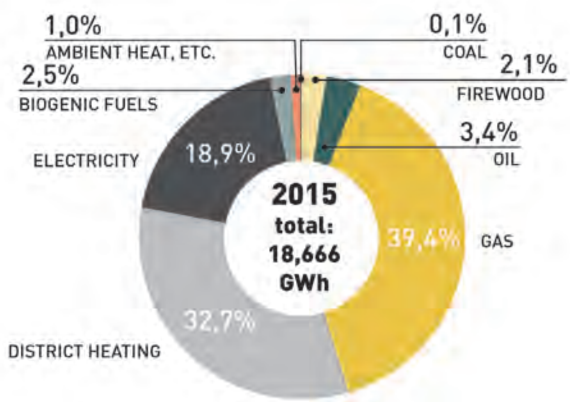
INITIAL SITUATION

B1

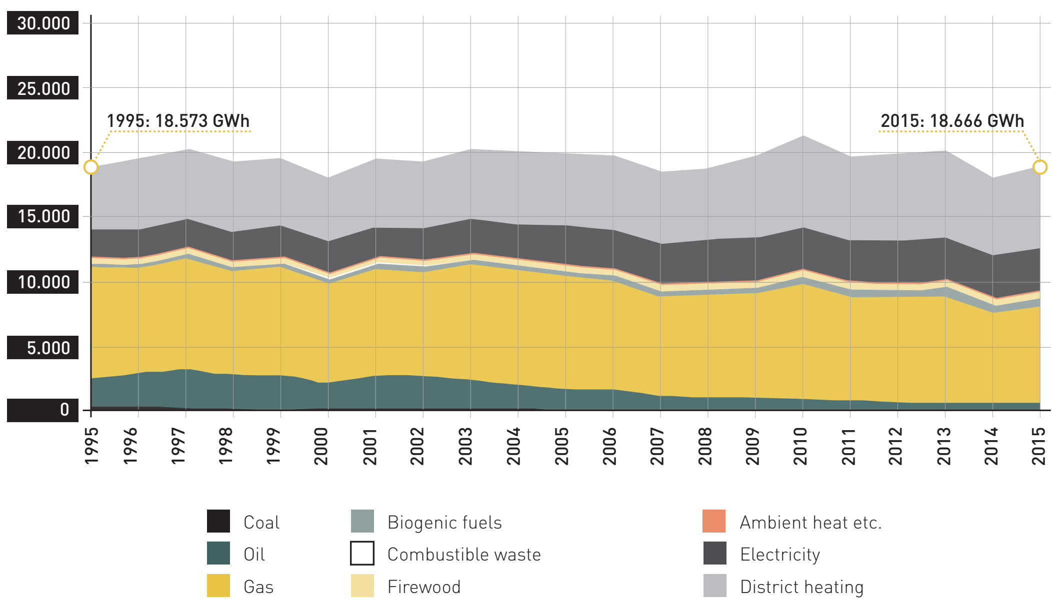
THE (ENERGY) SITUATION IN VIENNA

Looking at heat consumption by energy sources in Vienna, we can firstly see that heat consumption has remained almost constant since 1995 and that, secondly, there has been a trend towards renewable energy sources. Especially in the electricity sector, however, new technological developments in the areas of heat and cold production, e-mobility, digitisation, etc. are expected to lead to an increase in demand as many of these applications will rely on electric solutions in the future.

The current heat consumption in Vienna is mainly covered by district heating (▶), gas and electrical energy. While oil and gas are declining as energy sources in heat generation, the consumption of biogenic fuels (▶), district heating (▶) and ambient heat (▶) is rising rapidly. In the future, however, the cooling of cities heated up by climate change will also become an increasingly important factor for energy demand in the building sector.



Ill. 37: Current heat consumption by energy sources 2015



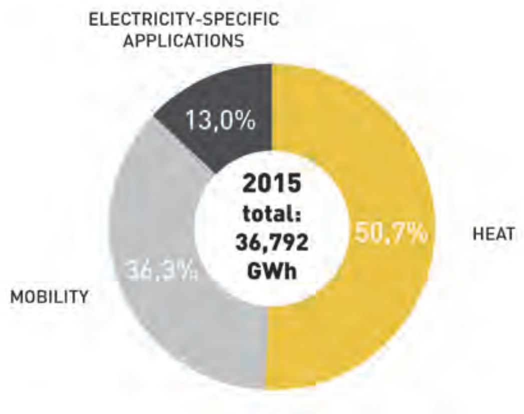
Ill. 38: Change in heat consumption by energy source between 1995 and 2015

FOCUS ON HEAT SUPPLY

Looking at final energy consumption (►) by application, one can see that the heating sector accounts for the largest share in Vienna: Around 50 percent of the total final energy consumption in Vienna is used to generate heat! Almost three quarters of this is accounted for by room heating and hot water, only one quarter goes to process heat (►).

Due to the high share of the heat sector in final energy consumption (►), this thematic concept focuses on the steering and coordination of heat supply in Vienna. In addition, this sector offers a wide range of optimisation options, such as the best possible use or unbundling of grid-bound energy infrastructures and the exploitation of locally available waste heat (►) and renewable energy potentials.

The other major final energy consumers - mobility and other, more heterogeneously structured consumption patterns in the service and production sectors - are dealt with in STEP 2025 Mobility and in the context of the Urban Energy Efficiency Programme 2030, which is currently being drawn up.



Ill. 39: Final energy consumption (►) by application[36]

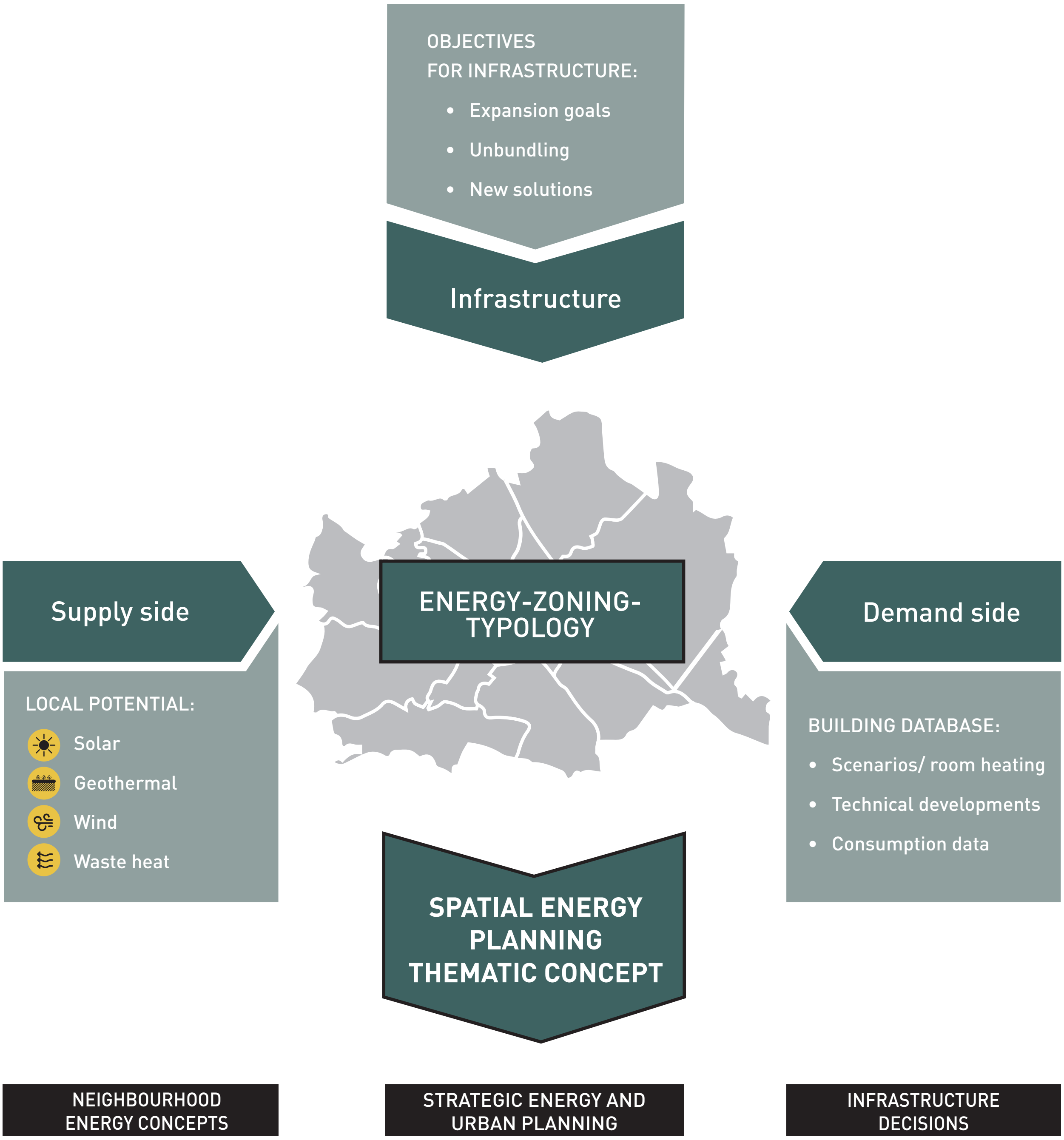
[36] 87 percent of Vienna's energy consumption is consumed for the purposes of heat and mobility. The remaining 13 percent of Vienna's final energy consumption is accounted for by other users in the service and production sectors. These include, for example, power consumption for equipment in offices and retail outlets or the consumption of process gas for high-temperature applications in production plants.

Ill. 40: "silo" passive office building

THE BASICS OF ENERGY ZONING PLANNING IN VIENNA

B2

From a legal point of view, spatially differentiated steering, planning or funding instruments require sound objective justification. The underlying basis for this is the comparison of various energy demands (see Chapter B.2. "Energy demand: Urban structures in Vienna") with supply (see Chapter B.2. "Supply of waste heat and heat from renewable sources"), infrastructure and imports (see Chapter B.2. "Infrastructure and imports"). This results in options for action in future energy zoning planning, which are outlined in Chapter B.2 "Options for action in future energy zoning planning".



Ill. 41: Analysis approach in energy zoning planning Vienna

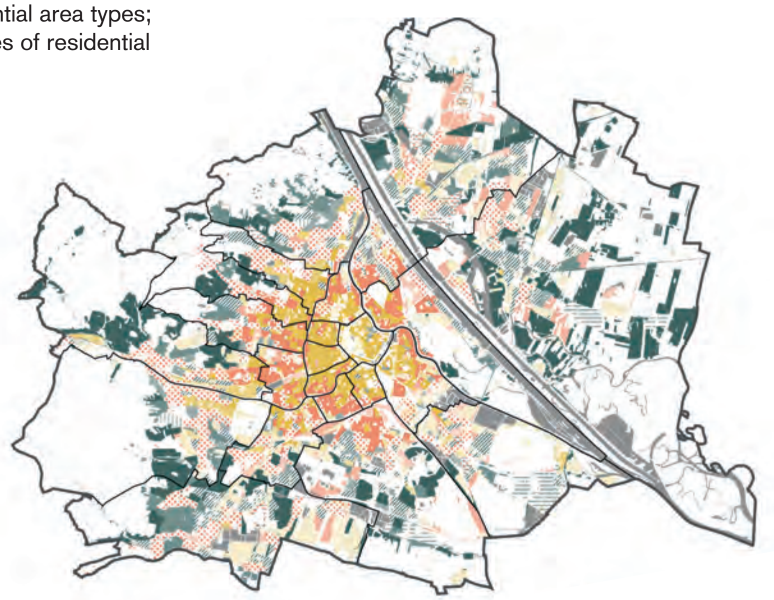
ENERGY DEMAND: URBAN STRUCTURES IN VIENNA

The demand for energy, in particular for heating, is distributed unequally across the city. New development areas have a different heating demand than old building areas or industrial areas. The characteristics of the urban structures are thus a central and decisive factor for determining heating demand and thus for planning and improving the supply of energy and heat.

Consequently, there is a need to take a differentiating look at structures in Vienna as a fundamental building block for energy zoning planning, based on the following information:

- **Status of construction:** existing / new
- **Density and typology of buildings:** dense / dispersed (multi-storey housing, terraced housing, single-family housing)
- **Use:** residential / commercial / industrial
- **Characteristics of buildings:** volume, type, age and state of refurbishment
- **Characteristics of area:** Nature and open spaces, spatial infrastructure (transport infrastructure) and residential units, inhabitants and size of the area[37]

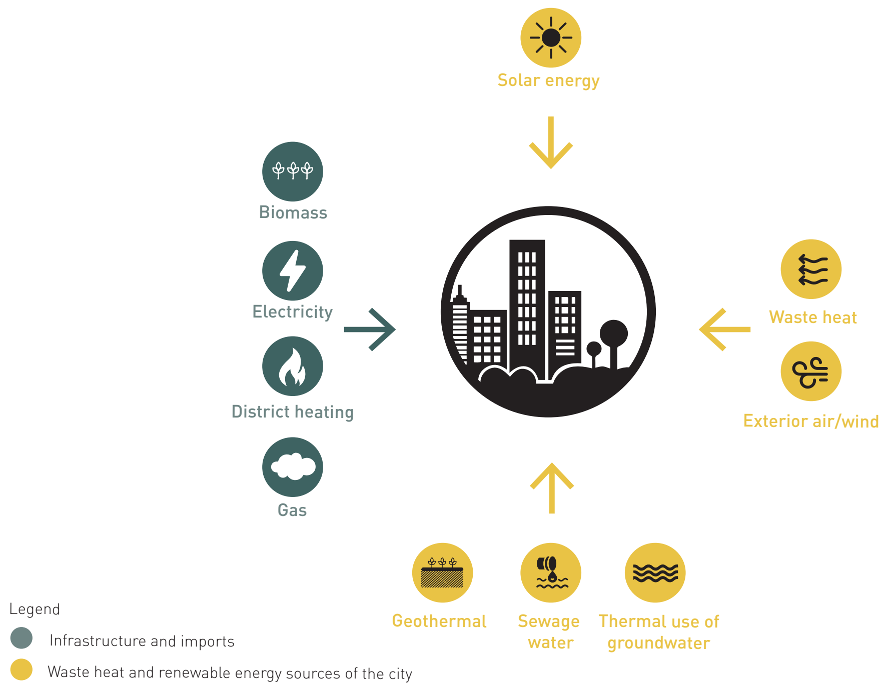
A first classification of Vienna was carried out in the following Ill. 42 according to residential area types; several of the above-mentioned types of residential areas are already listed.



[37] http://enur.project.tuwien.ac.at/index.php/typologie-im-raum.html, accessed on 18 July 2018.

Ill. 42: Residential area types 2016

SUPPLY OF WASTE HEAT AND HEAT FROM RENEWABLE SOURCES



Ill. 43: Energy sources of a city - from above, below and the surrounding area

As described in Chapter A.3. "Energy zoning planning: Strategies and guidelines of the City of Vienna", the City of Vienna is striving to meet its energy needs by making greater use of the potential of waste heat (►) and renewable energy sources. The following section describes what they can offer to the city and which opportunities they come with.

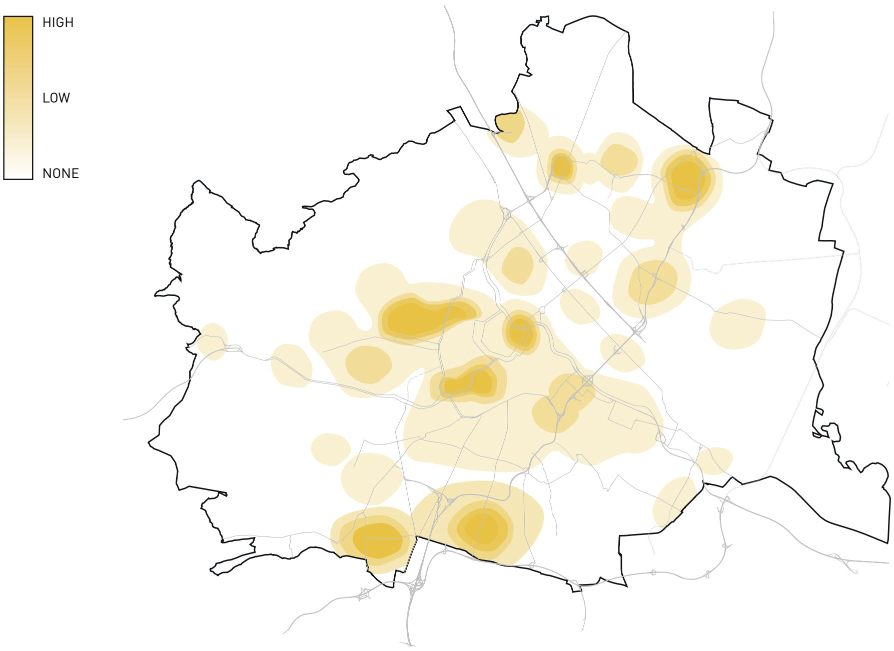
WASTE HEAT

>> An efficient heat source

Waste heat (►) from industry, tunnels and canals as well as sewage water is only available locally, but has the advantage that it is located close to large residential areas and that transport routes are short. At present, waste heat (►) often remains unused, which means that a high technical potential for room heating and hot water preparation is lost. According to the waste heat potential map of the City of Vienna, several large industrial and commercial waste heat sources have already been identified. These are currently located mainly in centres of work such as the 1st, 6th and 16th districts of Vienna, along the Wienzeile street and in large commercial and industrial areas in Liesing, Inzersdorf, Kagran and Floridsdorf (cf. Ill. 44). From an energy planning point of view, dependencies on individual companies (risk of relocation) are to be avoided by the formation of networks of several companies or waste heat sources.

- **Sewage water**

Sewage water is already being used effectively for heat generation in the first pilot plants. Using heat pumps, heat can be extracted from sewage water, which usually has a higher temperature level than air, groundwater or geothermal energy.[38]

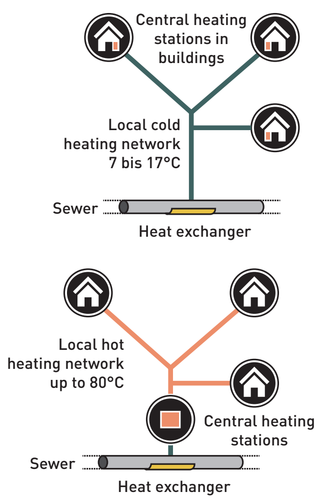


Ill. 44 Potential of waste heat

Heat from sewage water can be obtained and used as follows:

- Heat from sewage water can be reused inside buildings for heating and hot water preparation (a particularly inexpensive solution in hospitals, homes, indoor swimming pools, industrial plants).
- Heat from purified sewage water in sewage water treatment plants can be applied in the energy self-sufficient operation of the sewage water treatment plant itself or, if necessary, for the supply of adjoining residential areas.[39]
- Heat extraction from water sewers can supply entire residential units, as larger water sewers are also available in these areas.[40] In the summer months, sewers also offer the advantage of absorbing excess heat.[41]

In order to be able to use the heat (▸) from sewage water effectively, good demand density in the surrounding area must already be considered during planning.[42] Moreover, heat exchangers in the sewers should be designed in such a way that no impairment of normal operation is to be expected and maintenance is easily possible (e.g. through bypass solutions).



Ill. 45: Heat from sewage water

AMBIENT HEAT

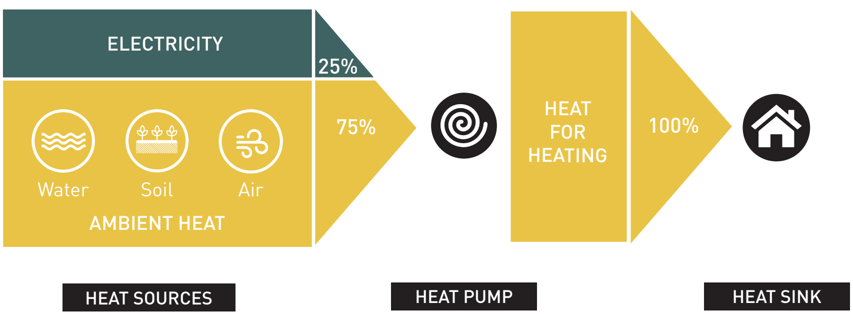
>> A possible renewable energy source

Ambient heat (▸) currently accounts for almost 1 percent of gross domestic consumption (▸) in Vienna, and this sector is growing strongly.[43] By means of heat pumps, heat from the environment (outside air, geothermal heat, groundwater) is raised to a higher temperature level for heating and hot water preparation. Hot water storage tanks ensure heat storage.[44] The heat generated this way is mainly used for room heating in residential buildings as well as for office and commercial buildings. It is also possible to use it for hot water preparation, room cooling and dehumidification.[45]

Heat pumps can also be combined with photovoltaic and solar thermal systems. In the first case, the electricity produced by the photovoltaic system is used to drive the heat pump. Solar thermal energy can support heat pumps in the preparation of hot water in the summer.[46]

The generation of heat from various heat sources is explained in more detail below:

Ill. 46: How efficiency and availability of heat sources are linked



Ill. 47: Energy flow of a heat pump

- **Outdoor air**

Outdoor air, which in principle is available without restriction, is brought to a higher temperature level by a heat pump so that it can also be used for heating in the winter. Outdoor air can often also be used to cool rooms.[47] However, especially in the winter months, outdoor air temperature drops, making the heat pump less efficient.[48]

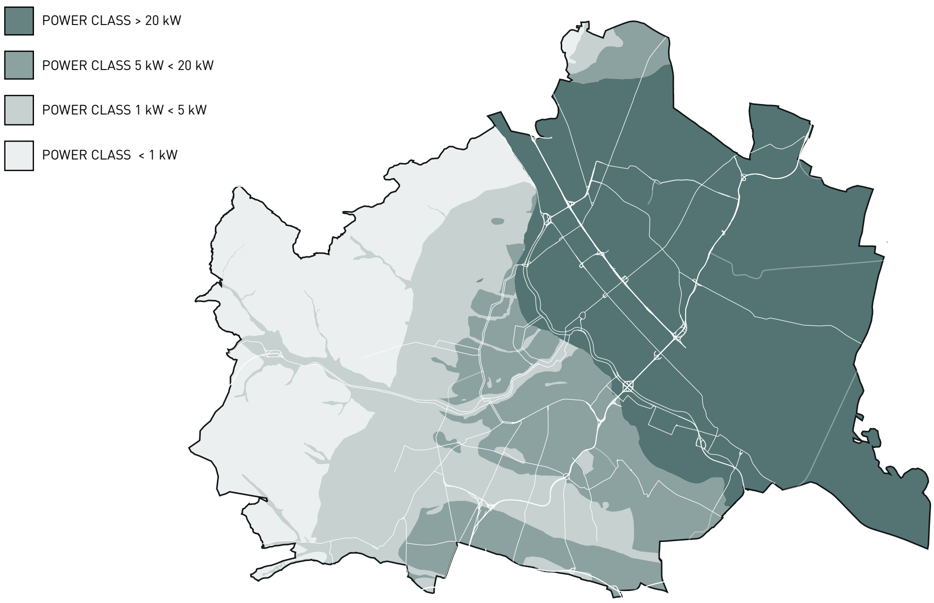
- **Near-surface geothermal energy – soil**

The use of geothermal heat from the soil for heat generation comes with a special advantage, i.e. the fact that this changes only little in the course of the year. “The heat in the near-surface soil comes predominantly from the sun, which, through irradiation, warm air and rain, is stored in the uppermost layer; heat from the earth‘s core can also be accessed through deep geothermal probes.“[49] The potential for using geothermal heat is very high, especially in western Vienna (very good suitability for geothermal probes with a length of between 30-200 metres).

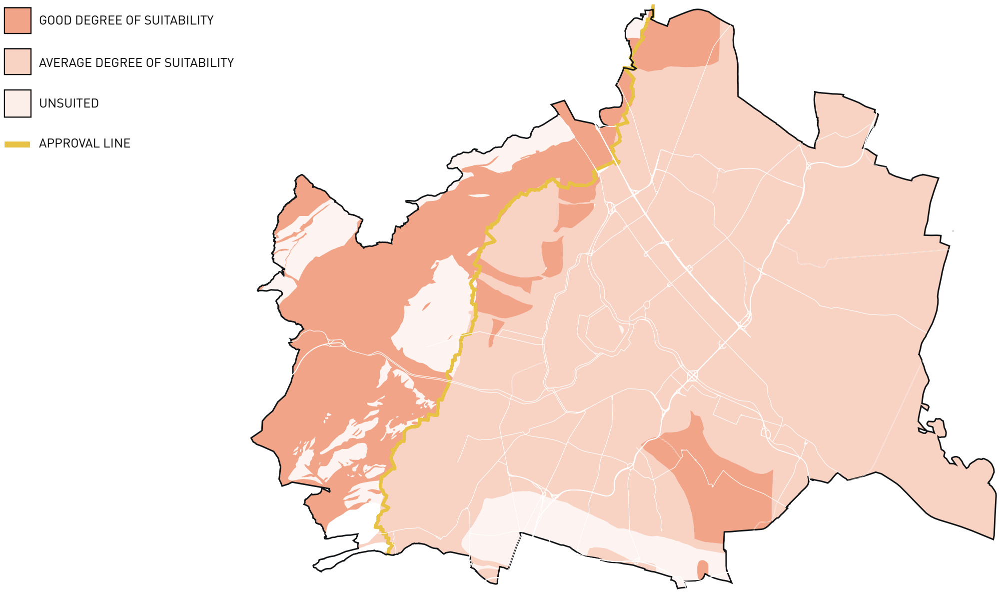
- **Near-surface geothermal energy - groundwater**

Near-surface geothermal energy is mainly used for heating purposes; groundwater is utilised through heat pumps.[50] In Vienna, near-surface geothermal energy is frequently processed by means of groundwater heat pumps and used for air-conditioning buildings and infrastructure facilities.[51]

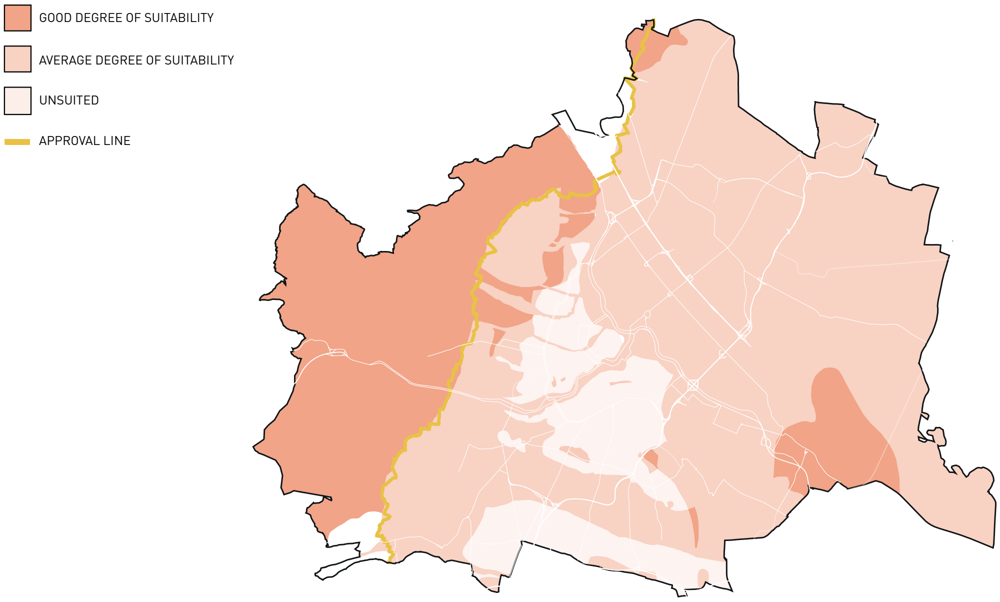
According to the geothermal potential map, Vienna (especially in the districts northeast of the Danube, Floridsdorf and Donaustadt) has considerable potential for near-surface geothermal energy generated through the processing of groundwater. (Cf. Ill. 48)



Ill. 48: Geothermal potential map - thermal utilisation of groundwater



Ill. 49: Potential for geothermal probes of up to 30 metres length



Ill. 50: Potential for geothermal probes of up to 200 metres length

HEAT FROM DEEP GEOTHERMAL ENERGY

>> A renewable energy source

Geothermal energy refers to the heat stored in the ground, which is constant seasonally (starting from a depth of approx. ten metres). Deep geothermal energy uses heat potential from depths of up to several thousand metres. The temperature levels that can be reached there usually allow for direct feeding into heating networks, even without heat pumps. On a global average, one can expect a temperature increase of about 1 degree per 33 metres depth (so-called "geothermal depth stage").[52] Deep geothermal energy is currently not used in Vienna. However, within the framework of "GeoTief Wien", a research project run by the Vienna utility company Wien Energie in cooperation with numerous research institutions, the eastern part of Vienna is being surveyed for the use of deep geothermal energy.

Geothermal energy in itself is a very environmentally friendly heat source enabling emission-free energy supply. In principle, geothermal energy is available everywhere and thus ideally suited for local energy supply.[53] The integration of geothermal energy into district heating (▸) can contribute to long-term security of supply, sustainability and a certain price stability for end customers in Vienna.[54]

Ill. 51: Citizens' solar power plant Wien Mitte

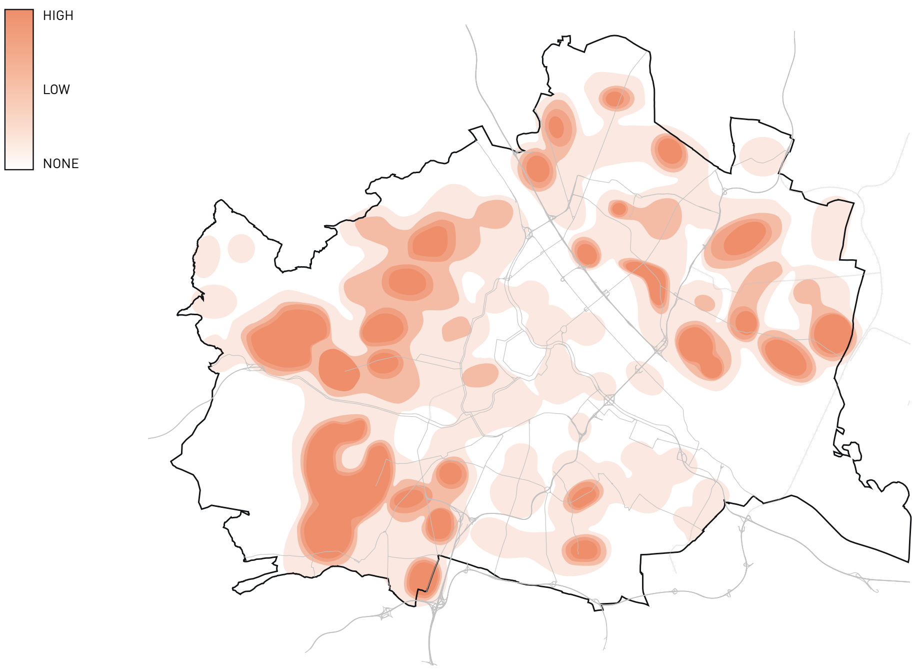
HEAT FROM SOLAR ENERGY

>> A renewable energy source

Currently, almost 0.2 percent of the total final heating energy consumption (►) is generated from solar energy, so there is still great potential for expansion, especially with regard to climate protection targets.[55]

Most solar heat is generated from flat-plate collectors in small systems; it is used for domestic hot water generation and auxiliary heating. By now, photovoltaics has become so affordable that photovoltaic systems are also used for hot water preparation.[56] One disadvantage of generating heat from solar energy are the daily and weather-related fluctuations. However, these can be compensated for at least for several days by means of buffer storage.[57]

[38] Information about energy from sewage water, p. 1ff.
[39] http://www.abwasserenergie.at/, accessed on 12 July 2018.
[40] Information about energy from sewage water, p. 1ff.
[41] Bundesverband WärmePumpe (BWP) e. V: Heizen und Kühlen mit Abwasser (Heating and cooling with sewage water) 2005, p. 27.
[42] http://www.abwasserenergie.at/, accessed on 12 July 2018.
[43] Energie! voraus, Energiebericht der Stadt Wien (Energy ahead! Energy Report of the City of Vienna), 2017, p. 41.
[44] Institute of Building Research & Innovation ZT-GmbH: Handlungs- und Kommunikationsleitfaden für die Wiener Energieraumplanung (Guidelines for Action and Communication for Vienna's Energy Zoning Planning), 2015, Anhang Technologieprofil Wärme aus tiefer Geothermie (Annex: Technology Profile Deep Geothermal Heat).
[45] Wärme! pumpen zur effizienten Energieversorgung, Technologieleitfaden Wärmepumpen, 2014, p. 22ff.
[46] Ibid., p. 28.
[47] https://www.strom-magazin.de/info/waermepumpe/, accessed on 18 July 2018.
[48] Wärme! pumpen zur effizienten Energieversorgung, Technologieleitfaden Wärmepumpen, 2014, p. 20.
[49] Ibid., p. 19.
[50] Institute of Building Research & Innovation ZT-GmbH: Handlungs- und Kommunikationsleitfaden für die Wiener Energieraumplanung, 2015, Anhang Technologieprofil Wärme aus tiefer Geothermie.
[51] https://www.wien.gv.at/stadtentwicklung/energie/wissen/erneuerbar/geothermie.html, accessed on 09 July 2018.
[52] https://www.wien.gv.at/stadtentwicklung/energie/themenstadtplan/erdwaerme/fakten.html, accessed on 09 July 2018.
[53] https://www.wien.gv.at/stadtentwicklung/energie/wissen/erneuerbar/geothermie.html, accessed on 09 July 2018
[54] Institute of Building Research & Innovation ZT-GmbH: Handlungs- und Kommunikationsleitfaden für die Wiener Energieraumplanung, 2015, Anhang Technologieprofil Wärme aus tiefer Geothermie
[55] Annex: Technology Profile Heat from Solar Energy
[56] Annex: Technology Profile Heat directly from Electricity.
[57] Anex: Technology Profile Heat from Solar Energy



Ill. 52: Density of subsidised solar thermal systems

INFRASTRUCTURE AND IMPORTS

DISTRICT HEATING (►)

>> A largely renewable and efficient energy source

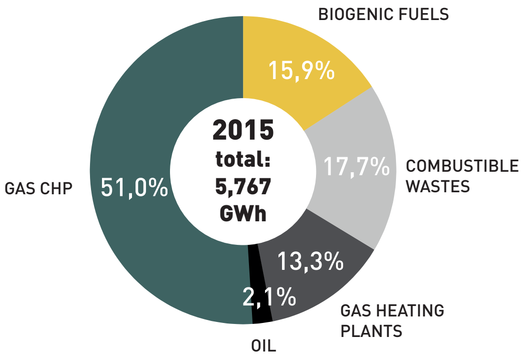
Wien Energie (►) supplies one third of Vienna's households (32.7 percent in 2015) with district heating.[58] 51 percent of the district heating (►) in Vienna is generated from waste heat (►) from natural gas CHP plants, 18 percent from combustible waste, 16 percent from biogenic fuels, 2 percent from oil and 13 percent from gas heating plants (►) (cf. Ill. 54). Due to the heat supply from various sources and energy carriers, district heating (►) is continuously available throughout the year.[59]

In 2015, a total of **18 percent of district heating**(►) **was** generated **from renewable energy sources** (mainly waste, wood, biogas and liquid and solid biogenic materials).

The tapping of renewable energy sources such as geothermal energy, ambient heat from surface water or solar energy as well as waste heat (►) from sewage water, industry and commerce would in any case guarantee an ecological expansion of district heating.

Other cities are also pursuing the strategy of partial decarbonisation (►) through district heating (►). Amsterdam wants to phase out natural gas by 2050 and has presented a strategy to that end.[60] It is based on a detailed analysis of the building ensembles, which can require very different quantities of energy depending on their composition. These data must be compared with the supply potential of district heating (►).

Ill. 53: Energy atlas of Amsterdam, district heating network supply, waste heat and waste potential



Ill. 54: District heating generation by energy source

NATURAL GAS

>> A fossil fuel

Nearly 40 percent of the heat demand in Vienna is covered by decentralised natural gas heating systems (gas-powered heating systems, central heating systems) although this trend is declining slightly.[61]

Natural gas is available all year round and can be stored for long periods of time. The production of heat from natural gas results in small local added value only: In Vienna 100 percent of the natural gas has to be imported, the figure for all of Austria is approx. 85 percent.[62]

In the long run, natural gas should be replaced by renewable energy sources. The existing natural gas network can be used as a bridge technology to switch to renewable energy sources.[63] At present, there are also plans to produce large quantities of green gas; primarily, these considerations concern biogas and hydrogen from renewable surplus electricity.

HEAT FROM BIOMASS

>> A renewable energy source

As explained in Chapter B.1 “The energy (situation) in Vienna“, about 5 percent of Vienna‘s heat consumption is currently covered from biomass. Energy sources such as wood pellets, wood chips, straw, grain, waste wood, vegetable flotsam, biodiesel and biogas are combusted. Combustion can take place in large central systems with or without combined heat and power (►) or in small decentralised systems in detached houses and apartment blocks.[64] The advantage of biomass is that it is available locally in Austria and that it is easy to store. Thus, it is available continuously and all year round. In urban areas, space for storage can become a problem, and particularly efficient exhaust gas cleaning is also necessary for reasons of clean air.[65]

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[58] Institute of Building Research & Innovation ZT-GmbH: Handlungs- und Kommunikationsleitfaden für die Wiener Energieraumplanung (Guidelines for Action and Communication for Vienna's Energy Zoning Planning) for the City of Vienna, Municipal Department 20 - Energy Planning, 2015, Anhang Technologieprofil Fernwärme (Annex: Technology Profile District Heating).

[59] Handlungs- und Kommunikationsleitfaden für die Wiener Energieraumplanung, 2015, Anhang Technologieprofil Fernwärme.

[60] http://www.cityzen-smartcity.eu/amsterdam-2050-a-gas-free-city/, accessed on 18 October 2018; Naar een stad zonder aardgas. Strategie voor de verduurzaming van de warmtevoorziening in de gebouwde omgeving, Amsterdam, 2016.

[61] Energie! voraus, Energiebericht der Stadt Wien, 2017, p. 88.

[62] Handlungs- und Kommunikationsleitfaden für die Wiener Energieraumplanung, 2015, Anhang Technologieprofil Wärme aus Erdgas (Annex: Technology Profile Heat from Natural Gas).

[63] Handlungs- und Kommunikationsleitfaden für die Wiener Energieraumplanung, 2015, Anhang Technologieprofil Wärme aus Erdgas

[64] Ibid., Anhang Technologieprofil Biomasse (Annex: Technology Profile Biomass)

[65] Ibid., Anhang Technologieprofil Biomasse

OPTIONS FOR ACTION IN FUTURE ENERGY ZONING PLANNING

MATCHING SUPPLY, DEMAND AND INFRASTRUCTURE FOR POSSIBLY CO_2-FREE REGIONAL SUPPLY

Integrated processes of urban development and urban planning, energy zoning planning and infrastructure development

In order to give energy zoning planning in Vienna the position it deserves in everyday implementation beyond the strategic framework, integrated processes bringing together urban planning, energy zoning planning and infrastructure development are necessary. This means that a new perspective has to be opened up on urban planning, which can thus significantly deepen its claim for sustainability in the areas of energy and climate protection. The basis for this will be made available in the future: on the one hand, there will be data on the energy potentials and energy infrastructures for the entire area of the city, on the other hand, demand profiles - e.g. building databases (►) – will exist.

The aim will be to match supply and demand, each optimised for the specific, space-related task. This can be associated with the development of new neighbourhoods or the sustainable refurbishment of old buildings or existing areas. From the first planning step onwards, special attention will be given to considering grid-bound infrastructure capabilities and the use of waste heat (►) and renewable energies. In this context, the aim is to find optimum solutions from both an economic and an ecological point of view. Through the instruments described in Chapter B.3., the outcome of this optimisation process will then come to bear with an effect that is as binding as possible.

This way, optimum use can be made of the city's existing energy potential and, as a result, urban and infrastructure development in terms of energy can be optimised overall; in this development process, densification will, as it were, enter into a dialogue with sustainable resource use, involving e.g. large renewable sources and waste heat (►).

Vienna is preparing for a CO_2-free future

Within its remit, the City of Vienna is seeking to create the framework conditions required to make it easier for residents to change their everyday habits towards energy and climate awareness. Both are essential steps towards what is desired and urgently needed: a strongly CO_2-reduced future for Vienna.

It is crucial to gradually convert the city into structures enabling the supply of sustainable energy. Other European cities are also gaining experience in this field. International exchange has proven to be essential in the context of the following:

- The presentation of **clear goals and requirements** to be reached for the city as a whole. They should be drafted in such a way that, building on them, implementation roadmaps supported by policy-makers can be drawn up.
- **Commitments and responsibilities** are to be clarified and defined in cooperation with the relevant stakeholders for a wide variety of cases.
- Implementation will need instruments and should follow **standardised processes**. This has to bank on existing processes to be extended or redefined so as to include aspects of energy zoning planning and infrastructure optimisation.
- The sum total of new approaches is based on **uniform and coordinated data models** providing information on the energy supply side and demand side. In particular, information on regionally available renewable energy sources, local waste heat (►) and ambient heat, existing grid-bound energy sources etc. as well as the distribution of heat demand and the structure of energy supply are collected and illustrated on the basis of a related demand model.

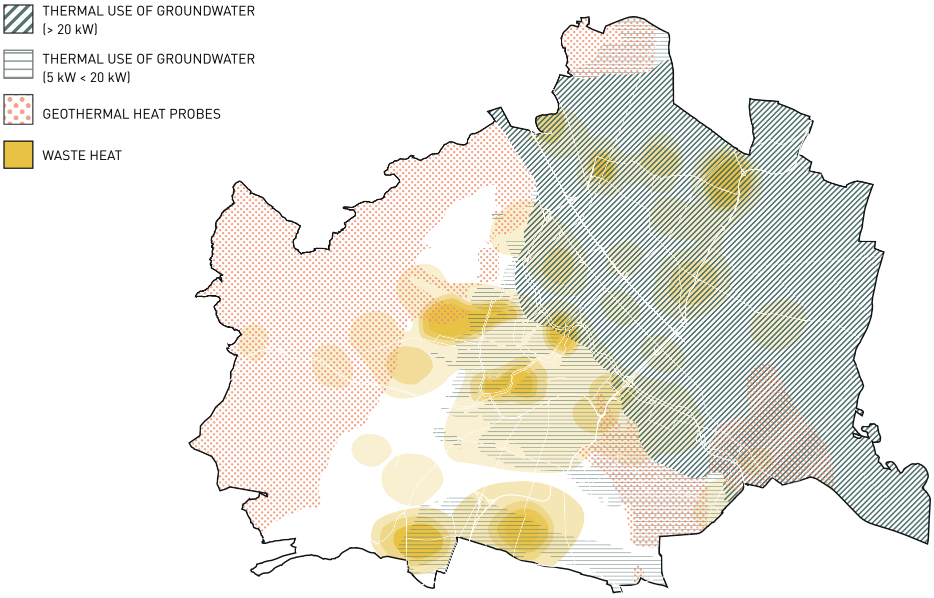
Factbox

Area screening as part of the EU HORIZON 2020 project SMARTER TOGETHER (2016 to 2021)

Within the framework of the EU project SMARTER TOGETHER, innovative measures in the areas of refurbishment, mobility, participation and energy were implemented in a so-called "Lighthouse District" in Simmering (in the neighbourhoods of Geiselberg and Enkplatz). However, when the project took off, it became clear that data about energy-related aspects for the area were scarce. Therefore, an area screening was carried out on behalf of MA 20 in order to create an initial database as a basis for discussion. The mapping of basic information (e.g. age of buildings), the demand side (e.g. heating energy required) and the supply side (potentials for renewable energies at the level of blocks as well as refurbishment potentials) attracted great interest. Building on this, the possible coverage of demand by existing supply and the quantitative assessment of Smart City targets were also identified. The analysis of such data proved to be helpful in communication. However, the underlying information is based on many assumptions, which is why it is considered essential to improve the database. Only when this is the case can these analyses be used as a basis for coordinating energy-relevant decisions and the use of potentials (e.g. geothermal energy, solar energy). The methodology developed in this project is continuously updated and extended across the whole of Vienna in order to generate an appropriate collection of data. Data are stored on a platform generated with Open Source. Moreover, the findings from refurbishment completed as part of the EU project make it possible to estimate the change in heat density (►) with existing buildings.

Ill. 55: Analysis of solar energy potential at the level of blocks as part of area

www.smartertogether.at



Ill. 56 Overview of potentials for renewable energy source in Vienna

- Once the plans and framework conditions to be defined as binding have subsequently been drawn up, it is important to involve stakeholders and affected parties, especially business and civil society, in **the process with as much transparency as possible** in order to ensure the required degree of acceptance.

- The **economic added value** which can thus be achieved will, among other things, lie in the fact that, on the one hand, there is improved planning security for investors and property developers with regard to energy supply and, on the other hand, the provision of regionally generated energy represents a clearly positive contribution to regional added value.

SCENARIOS OF FUTURE HEAT SUPPLY

The **representation** of an area **in maps** with suitable spatial resolution (e.g. block of buildings, neighbourhoods) translates the data into clear demand models which visualise the connection between the distribution of heat demand and the energy supply structure in a new way. On this basis, **demand scenarios** coordinated with the objectives of the City of Vienna can be created, and on this basis, **heat supply scenarios** can be drawn up. Taking into account the possibilities and effects of new technologies, this will finally enable the identification of economically and technically feasible **energy supply solutions**.

Referring to the Zurich energy map shown in Chapter A.2 “Energy zoning planning in neighbouring countries“ (cf. Ill. 26), the above presentation of how various energy sources in Vienna overlap sketches out the potential of this planning method (cf. Ill. 56).

QUESTIONS AND SOLUTIONS FOR NEW DEVELOPMENT AREAS

New development areas enable an optimisation of urban planning from the point of view of energy. Apart from relevant building standards, an optimum energy supply concept can be developed at the very beginning of the planning process with the help of coordination by the City of Vienna, energy suppliers and property developers, thus guaranteeing maximum energy efficiency as possible use of renewable energies and waste heat (►) are sounded out.[66]

If district heating lines (►) are available, it makes sense to use them. On the other hand, local energy potentials must be factored into energy concepts, measures against overheating in the summer must be provided for and peak loads must be avoided as far as possible through the integration of storage facilities. Lowest-temperature heating networks, so-called “anergy networks“ (►), which work with heat pumps and possibly with geothermal probes, can help to use regional waste heat sources (e.g. sewage water) and provide heating and cooling in an energy-efficient way (see the example of Viertel2+). Where possible, these anergy networks (►) can also be linked to the districtheating grid. Anergy networks (►) in different forms are to be pushed in the future, particularly in mixed-use areas. For pure residential areas which, for technical and economic reasons, cannot be supplied by district heating lines (►) both now and in the future, decentralised alternatives such as heat pumps, geothermal probes, groundwater wells and solar systems would be conceivable solutions.[67]

Furthermore, through the interaction of densification, green space development and infrastructure measures at the beginning of planning, new development areas offer responses to increasingly important microclimatic questions, such as increasing summertime overheating.

QUESTIONS AND SOLUTIONS FOR EXISTING AREAS

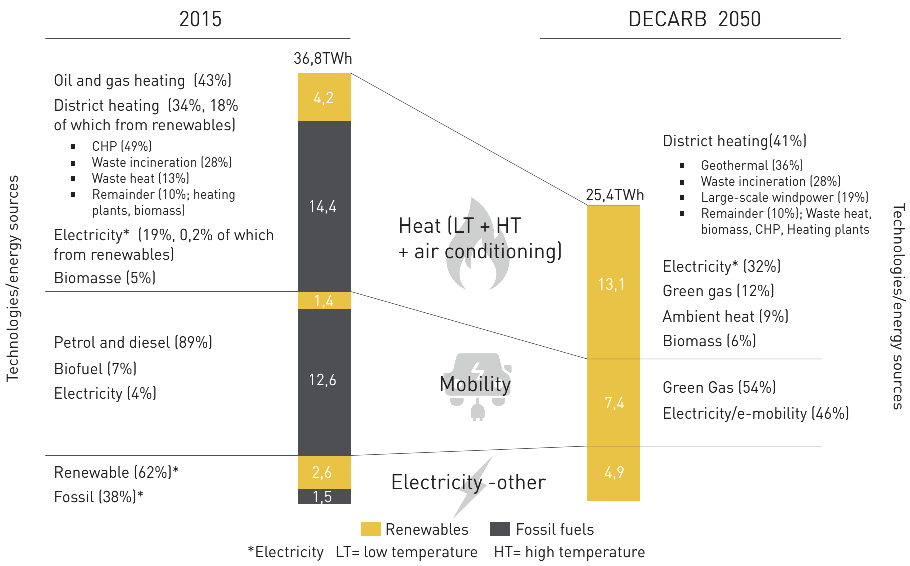
Existing neighbourhoods, which as a rule cannot be operated anywhere near the energy-efficiency as new ones, usually have a grid-bound heat infrastructure (district heating (►) and/or gas) with high heat density (►). Due to the high level of investment in such infrastructure, long-term coordination is needed to avoid competing duplicate infrastructures.

Due to the building density, which can partly be rather high, the use of the existing grid-bound heat infrastructure should be aimed for. In this context, supply by means of district heating (►) will not only come with economic but also environmental advantages[68] and a high expansion potential.[69] The replacement of natural gas by district heating (►) should be pursued where possible. The use of waste heat sources must be taken into consideration.

In any case, priorities in terms of location, and thus a focus on refurbishment measures should be considered; one example is the designation of zones which are particularly favourable for the use of renewable energy (e.g. use of Danube water) or the classification of areas by blocks of buildings and stand-alone buildings so as to create a basis for the refurbishment of existing buildings to minimise heat demand.

DECARBONISATION - CO_2 SAVINGS THROUGH ENERGY ZONING PLANNING

In order to decarbonise urban structures to a large extent, the integration of energy planning into urban development is necessary (see Chapter B.3.). What are the savings potentials that can be addressed? In Zurich, analyses have shown that a complete decarbonisation (►) of heat supply would be possible with a high proportion of renewable



Ill. 57: Comparison of energy sources and technologies

sources being used locally and through importing green electricity and gas from the surrounding countryside. For the situation in Vienna, a first decarbonisation scenario for 2050 was designed on behalf of Wien Energie; it also includes a variant of decarbonisation (►) in heat supply (cf. Ill. 57). This is an initial picture, to serve as a basis for further discussions on the implementation of the Energy Framework Strategy 2030.

Complete decarbonisation (►) in heat supply by 2050 will enable the **CO_2 emissions of the City of Vienna to be reduced by a total of around 18 per cent[70] if a comprehensive package of instruments going beyond energy zoning planning is implemented.** The energy potentials of waste heat (►) and renewables in Vienna are to be analysed in detail as the thematic concept is implemented; in this context, essential improvements in energy zoning planning can be summarised as follows: Buildings account for 17.9 percent of total CO_2 emissions.[71]

1. New buildings will only use renewable energy sources, waste heat or district heating

As the technologies for using alternative energy sources are available (see Section A.1.“New technological developments - energy system transformation“), new decarbonised neighbourhoods can be developed with support of energy zoning planning when heat sources are available, both technically and economically speaking.

2. District heating becomes denser and is decarbonised

New sources of energy (renewable geothermal energy and large heat pumps, new waste heat sources and CHP plants, which are then operated with green gas[72]) can be developed for district heating (►). This means that in one scenario, district heating (►) can be fully decarbonised in the long run (cf. Ill. 57).

3. Existing building: refurbishment, district heating, densification and green gas for selected buildings

Energy can be saved in existing buildings by well coordinated refurbishment measures. Where possible, supply will be converted to district heating (►) and infrastructure will slowly be unbundled. Energy conversion needs to be considered carefully as green gas supply will be preferable in certain areas of the city and for certain categories of buildings.

Based on the above-mentioned global and local framework conditions, major changes will be made in the city‘s energy systems. These changes will require an appropriate mix of intelligent instruments and reliable guidelines from the city administration. This is the only way to come up with new solutions.

[66] Urban Development Plan Vienna, STEP 2025, 2014, p. 49

[67] Energieversorgungsoptionen für das Stadtentwicklungsgebiet Donaufeld (Energy Supply Options for the Urban Development Area Donaufeld), 2016, p. 87ff.

[68] Ibid., p. 87

[69] Institute of Building Research & Innovation ZT-GmbH: Handlungs- und Kommunikationsleitfaden für die Wiener Energieraumplanung, 2015, Anhang Technologieprofil Fernwärme

[70] Federal Environment Agency: Bundesländer Luftschadstoff-Inventur 1990-2015 (Airborne Pollutants List for the Federal Provinces), 2017

[71] Ibid.

[72] The appropriate framework conditions created on the part of the EU and the federal government are indispensable for this.

Ill. 58:
Citizens' solar power plant Wien Mitte

Ill. 59: "Eurogate – Site 2"

INSTRUMENTS OF ENERGY ZONING PLANNING

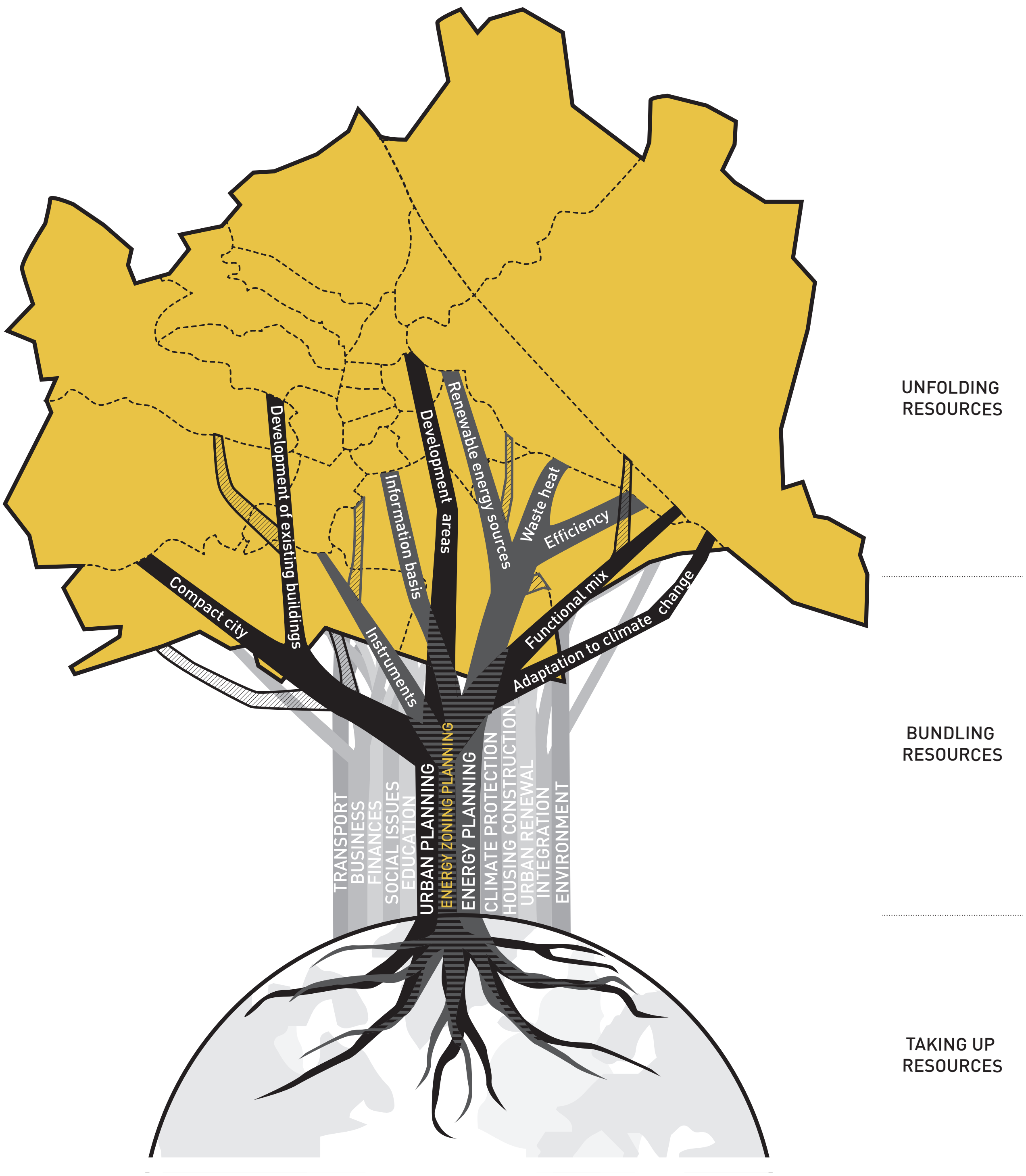
B3

As described in detail in Part A of the present thematic concept, area-specific energy and climate protection targets are to be achieved (e.g. connection to district or local heating networks, climate-friendly heat and energy supply, exclusion of certain fuels for space heating, minimum share of renewable energies for heat supply, setting of CO_2 limit values). The following chapter presents and exemplifies these key instruments that the City of Vienna implements:

- definition of energy zoning plans (mandatory regulations)
- climate-friendly energy concepts for neighbourhoods and assessment tools
- agreements and contractual solutions
- (spatially differentiated) subsidies
- steering and monitoring of energy zoning planning in Vienna
- examples

These instruments, which will be explained in detail below, are intended to enable or support the implementation of spatially differentiated heat and energy planning in Vienna. While the first step is aimed at influencing the construction of new buildings and the associated initial installation of heating and hot water systems, the intentions in the medium term include the development of **instruments for existing buildings and heating systems** in order to achieve the energy and climate policy goals.

For more than five years, MA 20 – Energy Planning has been working together with the urban planning departments in order to encourage appropriate energy solutions, especially in the new urban development areas. The first innovative solutions (see also Chapter A.1. "Challenges and solutions in the field of heat supply") have been initiated but so far there has been a lack of effective instruments for implementation. This was the trigger for considering energy in the current STEP 2025 and the commission to draw up the energy zoning planning concept. A decisive step forward towards implementing the objectives of energy zoning planning in Vienna is embodied in the amendment to the Building Code for Vienna (Law Gazette of the Land no. 37/2018). Among other things, more concrete energy and climate protection policy objectives are added to the existing planning objectives; this has significantly expanded the options for action with regard to energy-oriented specifications in the field of urban planning.



Ill. 60: Energy and climate protection as integral components of urban planning in Vienna

LEGALLY BINDING ARRANGEMENTS FOR ENERGY ZONING PLANS

The strongest instrument for implementing heat zoning planning in Vienna is the building code, which is also the planning act of the federal province of Vienna. The amendment of the Vienna Building Code 2018 (Law Gazette of the Province no. 37/2018) made it possible to define energy zoning plans (Wiener Bauordnung/WrBO § 2b).

The regulation of energy zoning plans is also based on the new objectives of the building code (cf. Factbox), with the focus being on climate protection and the avoidance of duplicate infrastructures. The regulation of energy zoning plans requires a particularly sound technical basis. From today's perspective, the basis for the definition of related areas is in any case available; it can be:

- the existence of appropriate infrastructure enabling the use of climate-friendly energy resources
- relevant, regionally available sources of renewable energies and/or waste heat (►)

In Vienna, district heating (►) is mainly generated from waste heat, waste incineration and renewable sources. Moreover, in a medium to long-term perspective, work is underway on tapping into renewables and integrating additional waste heat sources. District heating (►) can thus make an important contribution to the decarbonisation (►) of heat supply. Furthermore, the creation of related infrastructure is associated with high investments and thus efficient use and further development which will be of great importance for Vienna as a business location.

As a first step in the regulation of energy zoning plans, areas should therefore be designated where new buildings can be efficiently connected to district heating (►) or comparable local heating networks. In these areas, only the use of highly efficient alternative systems will be possible as an alternative to district or local heating (in accordance with § 118 para. 3 of the Vienna Building Code). For new buildings in these areas, this means that the combustion of fossil fuels for the sole purpose of heat production is excluded.

Appropriate areas must be designated in coordination with the companies wishing to offer or develop district heating in Vienna (►) or similarly high-quality heating networks. These areas have to be reviewed by experts and related orders must be issued in a proceeding oriented on zoning (Vienna Building Code § 2b(5)). Especially in new development areas, particular attention must be paid to the integration of waste heat sources,

Effects which can be created in favour of a sustainable energy system:

- Adaptation of subsidies for climate-friendly energy sources in line with the energy zoning plans
- Support of densified connections in the district heating network in areas in which both a district heating and a gas grid are available, taking into account the economic feasibility of this conversion
- Heightened planning security for developers and energy supply companies
- Enabling a shift away from heat supply using natural gas to district heating (►) and non-fossil energy sources (use of waste heat, renewable energies etc.)

New Objectives in the Vienna Building Code

The objectives set out in Section 1 (2) of the Vienna Building Code form a legal basis of energy zoning planning instruments. In the course of the last amendment to the building code, these objectives were expanded to also include climate protection and energy.

It is now necessary to take the following into account:

- the **climate-friendly use of energy resources**;
- a green infrastructure that serves the microclimate;
- environmentally friendly and **resource-saving forms of mobility** and the **reduction of energy consumption** for mobility;
- **climate-friendly** and modern **facilities for supply and disposal**, with special consideration of the **efficient use of waste heat** (▸) **and renewables potentials**;
- and the **avoidance** of an unreasonable burden due to **infrastructure duplication**.

renewables, energy storage and the possibility of an optimum interaction with the higher-ranking energy markets - in particular electricity and gas from renewable sources. In a possible next stage, the 2018 amendment to the building code will also make it possible to prescribe future area specifications via CO_2 limit values.

Zoning in accordance with the Infrastructure Utilisation Levy Act (Gebrauchsabgabegesetz/ GAG)

There is yet another way to decree energy-relevant requirements for certain areas through the Vienna Infrastructure Utilisation Levy Act. This instrument can in the future be used to support or supplement the provisions of the Vienna Building Code, especially in areas where no energy infrastructure is yet available.

For example, under the Infrastructure Utilisation Levy Act, "zoning plans" could be enacted to restrict the use of public property to purposes specified in the Act. One of the objectives mentioned in the Infrastructure Utilisation Levy Act (§ 1b (2) GAG) concerns the "guarantee of modern energy supply facilities".[73] In principle, it would thus be possible to exclude gas lines for the supply of new developments by means of zoning decrees under the Infrastructure Utilisation Levy Act. This is particularly relevant for large urban development areas where no such infrastructure is yet available and where gas line construction would take place above or below the "public property".

[73] Law Gazette of the Province (LGBl.) no. 20/1966 as amended by LGBl. no. 61/2016: Infrastructure Utilisation Levy Act/Gebrauchsabgabegesetz 1966 (GAG)

CLIMATE-FRIENDLY ENERGY CONCEPTS FOR NEIGHBOURHOODS

In larger, contiguous new development areas, the chances of implementing climate-friendly energy supply concepts are particularly favourable as the entire infrastructure is newly built anyway and structures can be equipped accordingly – both efficiently and cost-effectively. With little additional investment, solutions can already be applied as allow for significantly lower operating costs and greater comfort, making them very economical over their service life. These investments are also important because they determine the climate impact of heat supply for the coming decades. New development areas should therefore be built and operated as climate-friendly as possible in accordance with the overarching strategies (see A.3. “Energy zoning planning: Strategies and guidelines of the City of Vienna“).

GUIDELINES AND ADVANTAGES OF ENERGY CONCEPTS FOR NEIGHBOURHOODS

Guidelines for urban energy planning for new residential areas

When it comes to the transformation of the energy system towards decarbonisation (►), energy concepts for new urban districts should be based on the **“Guidelines for urban energy planning for new residential areas“** listed below. The focal points of work may differ depending on the characteristics, size and local conditions of the planning areas but as many points as possible should be included.

A climate-friendly energy supply system

- can absorb or store **energy surpluses and peak loads** and be operated with local energy storage for a certain period of time,
- thus allows for operation in **the service of the energy grid** (electricity or district heating (►)) which is thus **economical**,
- also uses **market or weather forecasts** for the purpose of steering,
- considers **summer suitability/climate change adaptation** (temperature control, greening, ventilation),
- makes it possible to **use** or **store heat and cold in the area** at the same time,
- is rated for realistic values for heating and cooling loads (no accumulation of safety factors),
- reduces the losses in hot water distribution
- **uses CO_2-free local resources and waste heat** (►) in an optimum way.

Advantages of energy concepts for neighbourhoods

Orientation for planners

Clear specifications and goals regarding energy supply provided by an existing energy concept can serve the orientation of all those involved in a project. It leads to clarity about the objectives from the early planning phases through to final implementation. Therefore, it can also essentially support approval processes, such as the granting of building permits or housing subsidies. By considering energy issues at an early stage, building permit applicants and developers will have more planning certainty with regard to energy supply.

The required guidelines are intended to ensure that buildings erected today are “fit for the future“ and thus meet the requirements of future generations.

Saving space and investment costs

Synergies can be used in one building or across building sites. In particular, cross-estate planning of supply solutions helps to save space and costs.

<u>Reducing operating costs and increasing comfort for residents</u>

Issues of heat supply as well as building temperature control in the summer can be thought of as interlinked - photovoltaic systems cover the electricity requirements of heat pumps, geothermal probe clusters supply heating energy in the winter and are regenerated with waste heat (►) from cooling in the summer, local waste heat (►) can be integrated into heating systems, internal load shifts minimise the required installed capacity and increase operating efficiency, and much more. The use of low-temperature heating systems, such as concrete core activation (►), will not only increase overall efficiency, but also user comfort.

WHEN DOES A NEIGHBOURHOOD ENERGY CONCEPT HAVE TO BE DEVELOPED

In areas in which **energy zoning plans** (see Chapter B.3. "Definition of energy zoning plans") have been identified for the future, these will serve the orientation of planners further down the line and **replace the neighbourhood energy concept**. The installation of local or district heating (►) and highly efficient alternative heating systems will only be possible. In the case of contiguous new developments with a gross floor area exceeding 30,000 m^2, the subjects addressed in the **"Guidelines for Urban Energy Planning for New Construction Areas"** are to be applied to the greatest extent possible.

If there are contiguous new developments with a gross floor area exceeding 30,000 m^2 which are **not included in the energy zoning plans**, the subjects addressed in the **"Guidelines for Urban Energy Planning for New Construction Areas"** are to be taken into account and the relevant focal points must be developed and defined in cooperation with the City of Vienna.

Ill. 61: Urban development area Nordwestbahnhof

CONTENT OF AND PROCEDURES FOR NEIGHBOURHOOD ENERGY CONCEPTS

Climate-friendly supply options

Neighbourhood energy concepts examine potential supply options and compare them in a life cycle cost analysis. This allows for the economic and environmental optimisation of building projects across their life cycles as early as in the planning phase.

Expected energy consumption is recorded in qualitative and quantitative terms. The type of energy supply system and the yields on site are described and compared. Moreover, a description of the power distribution system and its main components is included.

Ecological assessment criteria of special relevance include primary energy demand and greenhouse gas emissions.

From an economic point of view, the following criteria are relevant: construction costs, energy supply costs, energy distribution costs, energy storage costs and operating costs, if any.

Uses requiring connection to the gas grid are to be avoided as much as possible in new development areas; if this cannot be avoided, they should at least be located in peripheral areas adjacent to existing gas lines.

Depending on the characteristics, size and local conditions of planning areas, neighbourhood energy concepts can vary considerably.

Energy criteria in the relevant planning and approval processes

The achievement of climate targets and compliance with the relevant specifications is of decisive importance at all levels and in all planning phases, from overarching concepts and strategies to individual planning phases and approval procedures, as well as the construction and operation of the buildings. In order to make this materialise, comprehensible and transparent, **energy criteria** will be developed in line with the **respective planning phases** and applied in the neighbourhood energy concepts. The following energy criteria may, for example, be used, depending on the requirements and timing of the procedures:

- Share of renewable energies in energy consumption or generation
- Use of waste heat (►)
- Temperature level of heating and cooling systems
- Use of existing infrastructure
- Specifications regarding storage capacity
- CO_2 limits
- Installation of a monitoring system
- Specifications for the use of local potentials

Recommended procedure for the preparation of a neighbourhood energy concept

1. **Assessment of demand**
2. **Analysis of potential**
3. **Interim stock-taking: What is the energy coverage rate for renewables and waste heat?**
4. **Coverage of remaining demand with renewable energy sources to the extent this is possible, use of surpluses**
5. **Development of supply options according to the guidelines**
6. **Comparison of options (ecology, investment, life cycle costs)**
7. **Determination of the variant to be implemented and definition of planning specifications**

Energy compass for construction projects

For the development of neighbourhood energy concepts guidelines are made available by Municipal Department 20 - Energy Planning; under the title “Energy compass for construction projects“ content is defined for the individual planning phases and further information is provided.

The energy compass for construction projects covers the following topics:

- recommendations and practical tips for the drafting of neighbourhood energy concepts for urban planning projects
- information on energy-relevant building regulations and subsidy conditions
- practical examples of projects supported by MA 20 (see the options study for Donaufeld, Nordwestbahnhof mission statement)
- energy from above - use of solar energy
- energy from below - use of geothermal energy and groundwater
- energy from next door - use of waste heat (►)
- energy concepts for high-rise buildings- see STEP 2025 Thematic Concept High-Rise Buildings
- insights into the strategies and programmes of the City of Vienna from which specifications for energy generation and supply are derived

https://www.wien.gv.at/stadtentwicklung/energie/kompass/

SUPPORTING AND SECURING THE RESULTS OF NEIGHBOURHOOD ENERGY CONCEPTS

When the planning requirements from the energy concepts are ensured throughout the individual planning phases, a high degree of orientation can be achieved for all parties involved. Not only do energy objectives have to be taken into account in urban planning processes, it may also be necessary to use other instruments (e.g. quality assurance instruments) for the purpose of safeguarding results.

In early planning phases, fundamental decisions can be made, e.g. about the building structure configuration and use distribution, and these can be underpinned by the framework of the individual planning processes, e.g. through competitions or in the land use planning process. Other results, e.g. those concerning the type and quality of buildings or their heating systems, can be prescribed in the terms of competitions or contractual instruments. It is crucial for the neighbourhood energy concepts concerned that the appropriate instruments are selected jointly by all participants in order to put them on a sound basis from the early planning phases through to implementation.

The following is an exemplary list of the effects which an energy concept can have on urban development and which other issues may need to be considered in other planning phases:

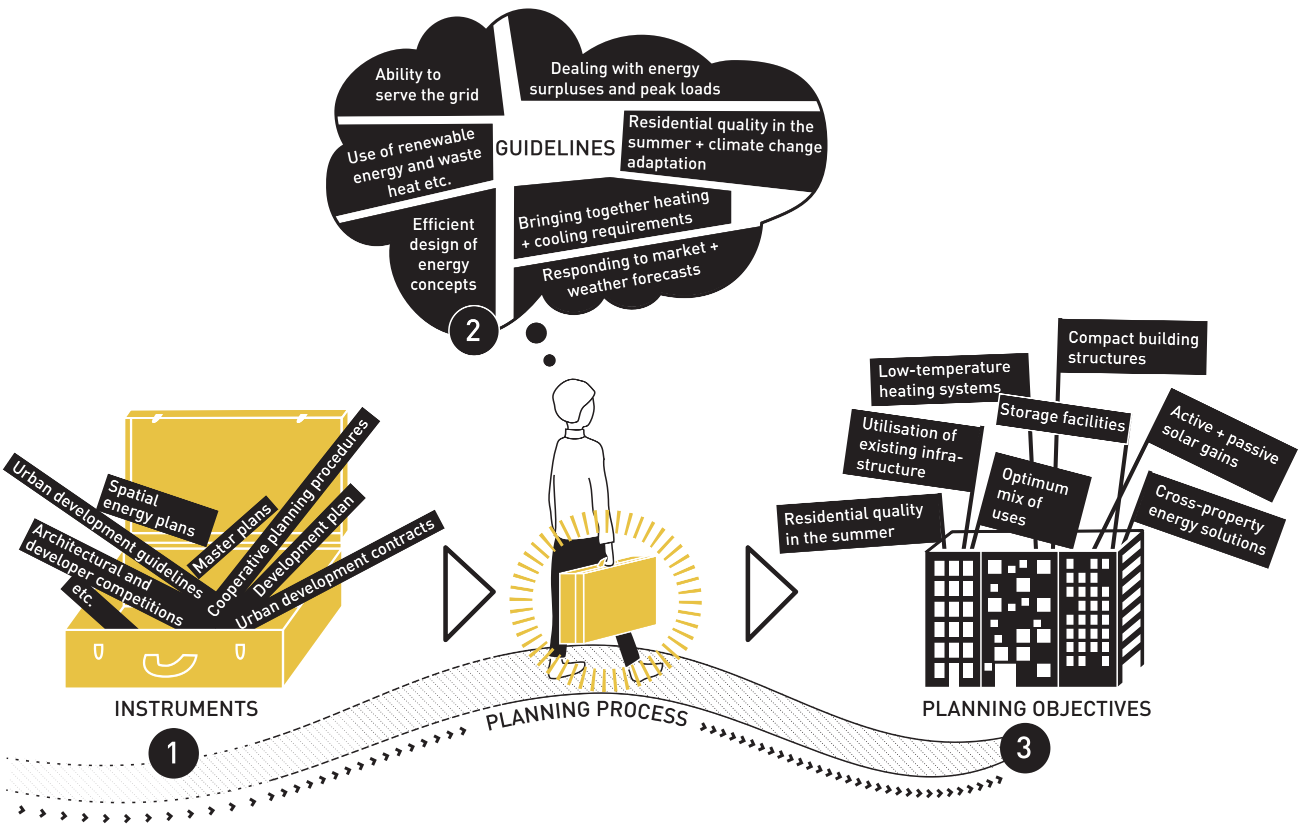
- The building structure should be compact, yet allow for natural lighting and the desired passive solar gains while at the same time ensuring that sufficient space is available for the production of solar energy. Roof and facade surfaces intended for active solar gains should not be shaded.

- Particularly in areas where the temperature load is high in the summer (urban heat islands), attention must be paid to strike a balance between solar gains and avoiding overheating in order to ensure residential quality in the summer. Moreover, optimised structural configurations can ensure sufficient ventilation of the planning area. Furthermore, greening, shading and the use of water as a design element can help against summer overheating.

- For an energy concept, a balanced mix of uses makes it possible to use heat and cold (e.g. hot water and cooling) simultaneously. This is not only ecologically and economically advantageous, but it also reduces summer overheating and infrastructure costs due to the use of the waste heat (►). Early optimisation of uses in an area will facilitate the use of these synergies.

- Potential agreements for cross-property (cross-site or cross-complex) energy solutions:
  > Type and extent of on-site potential utilisation
  > Conditions for the use of waste heat (►)
  > Agreements on heating networks

- Specifications for building energy concepts:
  > Use of low-temperature heating systems or building component activation
  > Use of storage facilities or the storage capacity of buildings



Ill. 62: Integration of energy issues in urban development planning processes

ASSESSMENT TOOLS FOR URBAN PLANNING

Standardised assessment tools are to be used to evaluate projects with regard to whether they will achieve the overarching energy criteria and the Vienna Smart City objectives[74] at an early planning stage. Furthermore, they should also identify potential energy supply solutions, make them comparable, optimising them up until the time when the final design is created. These tools support the urban planning process and could produce synergies as other issues such as microclimate and mobility are also addressed. Apart from open source tools, the creation of an assessment system for neighbourhoods and urban development projects would also be conceivable.

The focus is on finding out which available tools or assessment systems are suitable for Vienna and can be used here. Using such tools can help better assess the impact of measures and the development of energy criteria can be supported. The climate-active assessment tool for residential neighbourhoods is one of the most comprehensive tools; it is to be tested in Vienna on the basis of pilot areas.

[74] In the course of updating the Smart City Vienna Framework Strategy, a comprehensive guideline for Smart City neighbourhoods is to be drawn up. As already required in STEP 2025 (page 57), MA 20 – Energy Planning is working on the energy-related part of the guideline.

[75] https://nachhaltigwirtschaften.at/de/sdz/projekte/kennwertesiedlungsbewertung-fuer-errichtung-betrieb-und-mobilitaet-in-klimavertraeglichen-siedlungen.php, accessed on 14 June 2018

Factbox

Climate-active – Neigbourhood assessment tool

klimaaktiv

Following the Swiss example of the 2,000-watt area certification, the **climate-active** initiative created an Austrian variant for “residential area assessment“. From 2019 onwards, a tool will be available to check urban development projects for their climate friendliness and energy efficiency. Apart from energy demand, grey energy (▸) and mobility are also considered. The characteristics and reference values required for this purpose have already been determined in the course of the Urban Area Parameters project.[75] The assessment consists of a qualitative and a quantitative part. It allows for the analysis and optimisation of urban development projects at various stages. Continuous assessment after completion of the construction project serves the purpose of quality assurance. A service office which works Austria-wide conducts the audit and makes recommendations.

https://nachhaltigwirtschaften.at/en/sdz/projects/Indicators-for-urban-areas-for-construction-operation-and-mobility-in-climate-friendly-areas.php

AGREEMENTS AND CONTRACTUAL SOLUTIONS

The city has various options to enter into private-law agreements for the transfer of obligations regarding relevant energy projects:

Aspects relevant to energy are included in urban development contracts due to new legal foundations and building code goals

Since the amendment of the Vienna Building Code (Wiener Bauordnung, WrBO) in 2014, a legal basis was created for so-called urban development contracts (agreements under private law pursuant to § 1a of the Building Code for Vienna); these can be concluded between the City of Vienna and private owners or developers in the course of a change in the zoning and land use plan. As a result, a number of such agreements have already been concluded in recent years, among other things to support the materialisation of the planning objectives set forth in § 1, par. 2 of the Vienna Building Code. Prior to that, there were legal limits to applying the Building Code so as to pursue energy objectives. The existence of the technical basis described in Chapter B.2. and the successful extension of the planning objectives in the Vienna Building Code (see introduction to Chapter B.3.) will in the future facilitate the application of this instrument in the definition of energy-relevant aspects under a consensual energy concept.[76]

The City of Vienna as an owner/subsidised housing construction

Apart from the instruments already mentioned, the anchoring of project-specific energy-relevant criteria in the context of the sale of properties owned by the City of Vienna or facilities owned by the City of Vienna is an understandable and already well-established approach. The sale of properties for subsidised housing construction by way of so-called "developer competitions" (►) via the Vienna Housing Fund (Wohnfonds Wien) is a case in point. The projects submitted for construction jointly by property developers and planners are assessed by an interdisciplinary jury of experts based on a "4-pillar model" in which climate- and resource-friendly construction (including energy-relevant aspects) is included as one of the criteria, also considering the economic framework in subsidised housing construction. When the "building sites" are sold to the winners, these are obliged to make the projects materialise with the qualities presented to the jury. Examples of energy-relevant specifications set forth in the past include the connection of the project to district heating, the achievement of certain building standards ("passive house"), e-charging stations, etc.

This procedure is mainly used when Vienna sells its own land to housing developers or grants them building rights, and when these subsequently build housing (which is also subsidised by the City of Vienna) on such land.

[76] Several such agreements were concluded in recent years.

LOCATION-SPECIFIC SUBSIDIES

Ill. 63: Aerial photograph Helmut-Zilk-Park

The technical basis for energy and heat planning (see Chapter B.2.) also serves as an orientation framework for the subsidy lines within Vienna's remit, above all housing and refurbishment subsidies.

New building regulation

By linking the Neubauverordnung (New Building Regulation) to the energy zoning plans in accordance with the Building Code (see B.3.), it is possible to promote renewable heat supply in a differentiated location-specific way. Thus, scarce subsidies could be used more efficiently to implement the goals of energy zoning planning.

With the amendment of this regulation governing new buildings (Law Gazette of the Province no. 32/2018), subsidised housing construction will be carried out largely without fossil energy supply in the future. Only the use of gas-fired condensing boilers in combination with solar energy can still be approved where no district heating (▸) is available and where it can be shown that, from a technical point of view, no highly efficient alternative solutions can be implemented.

Amendment of other relevant subsidisation guidelines for existing buildings

However, in order to achieve the goals of the Smart City Vienna Framework Strategy and the Energy Framework Strategy 2030, it will also be necessary to introduce similar instruments for subsidies in the area of building refurbishment and heating conversion in the future. The agreed information basis for energy and heat zoning planning can be used for the drafting of the subsidy guidelines concerning the type of heating system which will be subsidisable. Energy zoning in respect of heat supply is to be taken into account in a future revision of the refurbishment target areas to complement the choice of heating system.

STEERING AND MONITORING OF ENERGY ZONING PLANNING IN VIENNA

In order to steer the further development of energy zoning planning in a targeted manner and coordinate it with other strategies of the City of Vienna, Vienna's energy zoning planning system needs a monitoring process. The implementation programme, consisting of concrete and in-depth instruments from the energy zoning planning concept, is used as the basis of monitoring.

In coordination with the **Energy Report** of the City of Vienna, a set of suitable **indicators** will be developed (e.g. implementation status of the development of an information basis for decision-making and the designation of energy zones, the share of district heating (▸) or renewable energy sources in new buildings) and Vienna's energy zoning planning will be reviewed and improved on this basis.

Steering energy zoning planning in Vienna

Energy policy objectives can only be achieved through cross-city steering of energy zoning planning in Vienna.

Steering Group for the Energy Framework Strategy 2030

The Steering Group for the Energy Framework Strategy 2030 will steer the implementation and further development of energy and heat zoning planning in Vienna under the leadership of the Staff Office for Strategic Affairs and MA20 - Energy Planning, which is responsible for energy planning.

Under the direction of the Energy Planning Department (MA 20), working groups are set up, the composition of which depends on the task on hand. A few examples are listed below:

- *Information basis working group*
  This working group is responsible for providing technical information as a decision-making basis for heat zoning planning. This includes an analysis of the potential for renewables, information on existing buildings and their development as well as evaluations and proposals on energy supply options and infrastructure decisions.

- *Neighbourhood energy supply working group*
  This working group, consisting of representatives of the city and Wiener Netze, the infrastructure company, is to discuss supply options and energy concepts for districts and neighbourhoods. Innovative solutions for the decarbonisation (▸) of the heat supply of neighbourhoods as well as recommendations and proposals prepared on the basis of data (e.g. drafts of energy zoning plans) will be discussed and decided upon. The goal is to ensure timely decision-making to support the urban planning process.

FIRST NEIGHBOURHOOD ENERGY CONCEPTS FOR VIENNA

The neighbourhood energy concepts described in Chapter B.3 under "Climate-friendly neighbourhood energy concepts" should especially be called for when planning for neighbourhoods or large-scale projects is underway so that energy supply options in an area can be evaluated and optimised. The first concepts of this kind were developed for the urban development areas Donaufeld and Nordwestbahnhof.

Ill. 64: Building component activation in the construction phase, Mühlgrundgasse - Neues Leben

OPTIONS STUDY DONAUFELD[77]

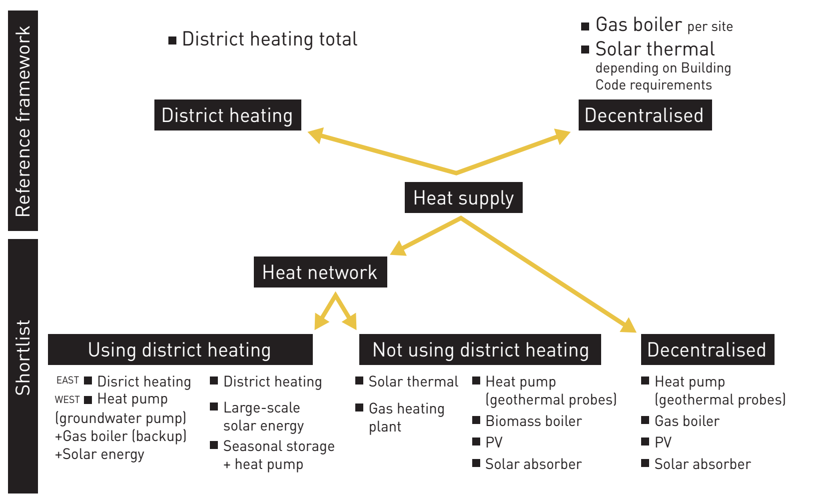
KEY DATA

Development area: 60 ha
Gross floor area of buildings: 757,000 m²
Number of apartments: 6,000 (status: 2015)

On the basis of energy-economic, economic and ecological assessment criteria, concrete technical solutions for energy supply were developed, contributions for a property developer tender were drawn up and a general method was derived from this process; this can be applied to other urban development areas and serve as an instrument for energy zoning planning.

INNOVATION

- Determination of energy demand for hot water, room heating and electricity
- Determination of energy resources - potential for renewable energy systems on site
- Development of possible energy supply solutions - comparison of energy demand and dimensioning of local renewable energy systems
- Qualitative examination of energy supply solutions
- Development of a shortlist of energy supply options
- Definition of reference scenarios
- Definition of system boundaries and calculation parameters
- Detailed examination of energy supply options
- Calculation of life cycle costs
- Interpretation of results



Ill. 65: Overview of the energy supply variants examined

The method and presentation for the assessment of energy supply options developed for the Donaufeld urban development area is a good starting point for the creation of future energy concepts for new development areas. First, different variants of energy supply were looked into. These were analysed and compared in terms of energy efficiency, environmental aspects and costs (including life cycle costs), and the underlying assumptions within the city were compared with different stakeholders.[78]

[77] https://www.wien.gv.at/stadtentwicklung/energie/pdf/energieversorgung-donaufeld.pdf, accessed on 26 March 2018
[78] Energy supply options for the Donaufeld urban development area, 2016

ENERGY CONCEPT FOR THE NORDWESTBAHNHOF AREA

Abb. 66: The energy concept for the Nordwestbahnhof area

KEY DATA

Development area: approx. 44 ha
Gross floor area of the buildings:
approx. 800,000 m²
Number of apartments: 5,700 (status: 2016)

INNOVATION

- Development of the distribution concept for energy
- A cold/cool ring network in a two-conductor system is to be installed (“anergy network“ (►)), central heating systems distributed over the planning area are investigated
- Identification of energy sources: sewage water energy, waste heat (►), solar energy, air/water heat pumps, geothermal energy, groundwater
- Presentation of the different variants
- The complex interaction of different energy sources and sinks was processed in detail; insights were developed as to how work with the anergy network (►) concept can be continued.

As part of the research project “urban pv+geothermal“,[79] energy- and cost-optimised solutions for low-temperature systems in combination with renewable energy sources were developed, using the example of the Nordwestbahnhof urban development area. The aim was to identify system solutions capable of ensuring the heating and cooling supply of the entire area.

What emerged as a result of the research project was that a concept based on an anergy network (►), i.e. a low-temperature distribution network (“cold district heating“ (►)) in combination with geothermal probe clusters for storage, was technically feasible, environmentally advantageous and economically competitive for application in urban development areas.

It also turned out that the locally available renewable energy sources were sufficient to cover 100 percent of the energy demand. The energy sources of solar energy (thermal and electrical), sewage water energy, fresh air and waste heat (►) from cooling applications were identified as relevant. Geothermal probe storage tanks proved to be the best option for load compensation storage (short- and long-term storage) to balance heat supply and demand.

MA 20 - Energy Planning supported the research project both financially and in an advisory capacity and took the recommendations to the urban planning process. Implementation planning has not been done yet.

[79] https://nachhaltigwirtschaften.at/resources/sdz_pdf/schriftenreihe-2016-19_urban-pv-geotherm.pdf, accessed on 18 June 2018

STEP 2025 – THEMATIC CONCEPT HIGH-RISE BUILDINGS

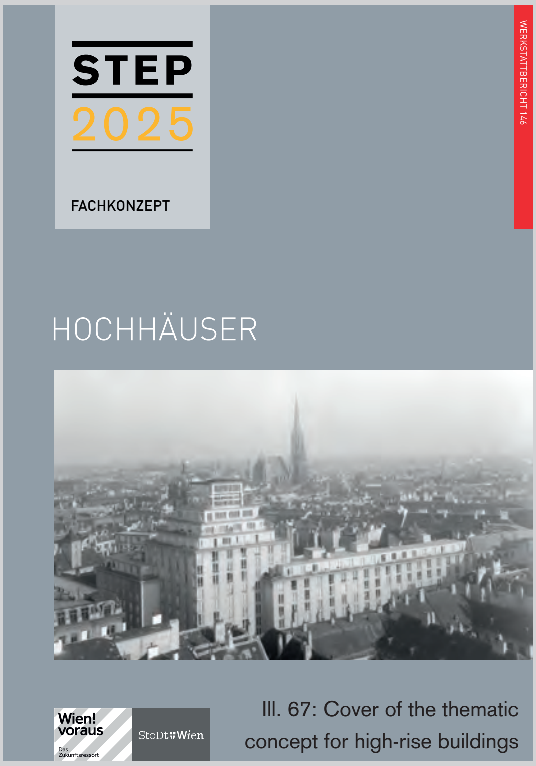
KEY DATA

Year of publication: 2014

INNOVATION

City densification with integrated energy zoning planning

- Design and construction with low ecological life-cycle costs
- High overall energy efficiency (near-zero energy house or passive house standard)
- Energy-efficient heat generation with lowest possible emissions
- Use of renewable energy sources
- Decentralised power generation and storage



Ill. 67: Cover of the thematic concept for high-rise buildings

If one defines high-rise buildings as vertical cities or neighbourhoods, new perspectives will open up. In the planning of modern neighbourhoods, individual buildings are designed with sustainability and energy-efficiency in mind, and there are overall concepts for energy supply which continue to develop towards decarbonisation (▸) along with the thematic concept.

In this context, the integration of an energy concept for sustainably usable high-rise buildings already makes sense in the first design phase; as is the case when a complete neighbourhood is planned, there are closely interlinked connections between energy flows, urban planning concepts and the actual design of the building.

In the thematic concept for high-rise buildings, which forms part of STEP 2025, it was decided that energy issues should be incorporated into the urban planning process. MA 20 specified the requirements for this in a guideline and is available to the planners and developers for coordination processes.

RENEWABLE ENERGY SUPPLY – KÄTHE-DORSCH-GASSE

KEY DATA

Development area: approx. 15,500 m^2
GFA of the buildings: approx. 45,000 m^2
Number of apartments: 450
(status 2018)

INNOVATION

- The energy stored in long-term heat storage – solar-ice storage and geothermal probe clusters - is raised to a higher temperature level by three heat pumps for heating and hot water preparation.
- Long-term storage is fed and regenerated with heat from two heat sources, solar-air collectors and heat recovery from sewage water, all year round.
- Moreover, the building has passive cooling in the summer via the activated floors and ceilings - without requiring active air conditioning.
- This cooling energy is also used for the regeneration of long-term storage (geothermal probes and solar-ice storage).

At Käthe-Dorsch-Gasse in the 14th district, a developer competition (►) was launched for the first time; it included comprehensive efficiency criteria and utilisation requirements for renewable energy sources which had been drawn up in cooperation with the Vienna Housing Fund (Wiener Wohnfonds). This was in line with the amendment to the New Building Regulation adopted in the summer, which requires the energy supply of new buildings that cannot be supplied with district heating (►) due to the location of the building to be largely fossil fuel free.

The buildings are to be equipped with surface heating systems allowing for a very efficient autonomous supply using a heat pump or, depending on the situation, a low-temperature or anergy network (►). If required, apartments equipped in this way can also be cooled in a highly sustainable way, generating regenerative heat for geothermal applications or waste heat (►), which leads to synergies with integrated grids.

EICHENSTRASSE DEVELOPMENT AREA (12TH DISTRICT)

KEY DATA

Plot size: approx. 14,600 m²
Gross floor area: approx. 54,000 m²

INNOVATION

Creation of an integrated energy concept in coordination with MA 20 - Energy Planning

- Use of on-site energy potential (waste heat(►), renewable energy sources)
- Connection to district heating (►) is prescribed, no natural gas supply must be provided
- Gas connection is only permitted for process heat (►), resulting waste heat (►) must be channelled into the energy concept and taken into account
- Consideration of building temperature control through thermal concrete core activation (►) or cooling via the soil by direct cooling or active cooling
- Monitoring for optimisation
- Certification according to climate-active standard

The area is to be developed for mixed use and primarily supplied by district heating (►). As part of a cooperative planning process, the owner WSE committed to fulfil certain requirements and ensure specific characteristics in the course of the implementation of future developments. As far as energy is concerned, this means that, in a first step, on the basis of the tender documents underlying the sales, buyers of the properties are contractually obliged to prepare an energy concept. The concept has to include supply via district heating as well as other qualities relating to energy supply which conform to the guidelines of neighbourhood energy concepts (integration of any waste heat (►) as may be available, environmentally friendly concepts for the temperature control of buildings and use of photovoltaics). Further down the line, energy criteria derived from this will be incorporated into the architectural competitions and will ultimately lead to an optimum energy solution for the area.

THE FUTURE OF EDUCATIONAL BUILDINGS

Ill. 68: Sonnwendviertel Educational campus

Based on the concept of the two flagship projects Aspern Nord and Atzgersdorf mentioned in Chapter A.1 “Innovative solutions for energy-efficient heating and energy supply“, the City of Vienna is also reviewing the exclusive supply of local, renewable resources to three other “Bildungscampus-Plus” educational campuses. These properties are to be developed in the 14th district, at Deutschordenstrasse, in the 11th district in the Gasometer area and in the 10th district in the Innerfavoriten neighbourhood.

All three educational buildings are designed for year-round use, i.e. also including the summer. This means that it is particularly important to avoid summer overheating, a factor to be taken into account in the planning stage.

KEY DATA

Buildings such as the educational campuses Seestadt Aspern Nord and Bildungscampus Atzgersdorf, which are “fit for the future”, are the models for other educational buildings.

INNOVATION

In close coordination with Municipal Department MA 20 - Energy Planning, MA 19 - Architecture and Urban Design is offering awards in competitions which are adapted and supplemented on the basis of findings from the previous projects.

The main focus is on largely self-sufficient educational institutions. Energy supply is to be based on renewable energy technologies. Technologies based on the combustion of fossil fuels are undesirable.

This is achieved through architecture-supported energy concepts and the integration of renewable energies on site, which, apart from the use of solar energy, are also examined for their technical and economic feasibility prior to implementation, e.g. the use of geothermal potentials for cooling and heating. A comprehensive energy monitoring concept will also be developed.

ANERGY NETWORK IN THE REFURBISHMENT OF EXISTING BUILDINGS AT GEBLERGASSE

KEY DATA

Smart Block II STUDY
Heat supply study

INNOVATION

Qualitative comparison of:

- Primary energy needs (►)
- CO_2 emissions (►)
- Investment costs
- Energy costs
- Space requirement
- Maintenance
- Local noise emissions and air pollution
- For the study, no hard facts are available in respect of costs, energy demand levels etc., therefore, a points-based assessment is done for the items listed above

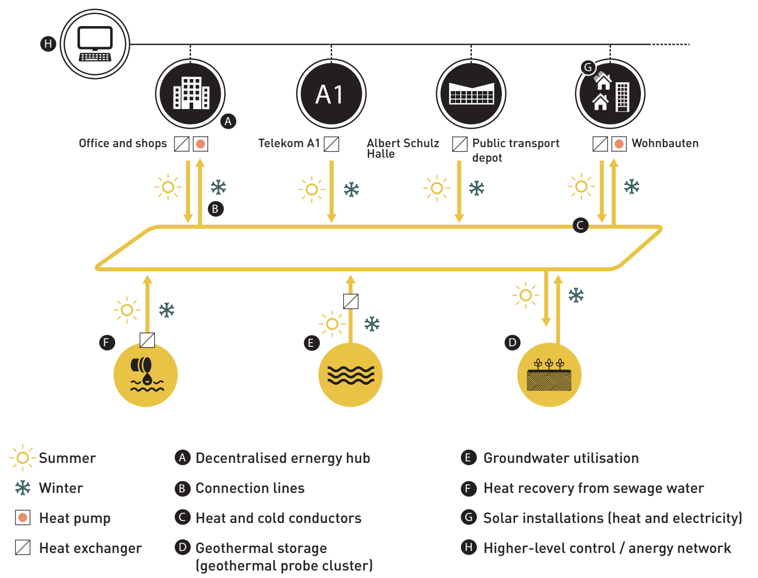
Objectives of the study:

- Achieving sustainable supply with heat energy
- Maximising the share of renewable energy sources
- Concepts can be expanded in stages

Ill. 69: Refurbishment of existing buildings at Geblergasse

In the 17th district, several old buildings in the block between Geblergasse, Veronikagasse and Ottakringer Strasse are being refurbished and some extensions are being added. The cross-property project uses an innovative energy supply system based on an anergy network (►). The network is supplied from solar excess energy (collectors on the roofs), waste heat from the apartments (by means of surface heating/cooling) and geothermal energy. More than 90 percent of the natural gas which had previously been required can be saved and replaced by climate-friendly energy.

THE ENERGY CONCEPT BEHIND THE ZENTRUM KAGRAN "ANERGY NETWORK"



Ill. 70: Schematic of the anergy network for Zentrum Kagran

An urban planning model was developed for Zentrum Kagran, which ensures a resource- and climate-friendly energy supply for this mixed-use neighbourhood. In order to achieve the goals set forth in it, the project applicants for the high-rise locations are asked to draw up integrated energy concepts in co-ordination with the MA 20 - Energy Planning. The energy concepts are deemed part of the high-rise concepts for the entire location and the individual construction sites and should present the potential supply options. In this context, the following points are given special consideration:

- Optimisation of building envelopes
- Near-zero temperature networks for the utilisation of waste heat (►) and cooling across buildings
- Low temperature heat supply systems
- Examination of options to use energy that is available on site
- Installation concept enabling the use of simultaneous heating and cooling demands by load shifting (via an anergy network (►))
- Testing of long-term storage options for the use of on-site energy

The goal and challenge for the future is the actual implementation of such concepts.

KEY DATA

Development area: approx. 100 ha
GFA of the buildings:
approx. 200,000 m² for housing
approx. 50,000 m² for offices
approx. 7,000 m² for cultural purposes
Number of apartments: approx. 2,000

INNOVATION

An anergy network (►) for the Zentrum Kagran (Kagran Centre) complex could be the first larger network of its kind to take existing use into account in addition to catering to new buildings. This way the waste heat (►) from the ice-skating rink and offices can be used for heating the residential buildings. Thus, Zentrum Kagran will become more energy-efficient and environmentally friendly in the long run and better adapted to climate change at the same time.

Factbox
"Neighbourhoods of the Future"

The aim of the project is to design a **plus-energy neighbourhood** which considers the local energy situation and stakeholder requirements.

The project seeks to develop a neighbourhood energy system which enables the energy produced to be distributed among local consumers and in doing so, optimises all energy services across the board. The focus is on technical and economic feasibility as well as user comfort.

Specifically, the following objectives are to be pursued:

- Achieving the highest possible degree of supply with heat, cooling and electricity from locally available renewable energy sources in a neighbourhood
  - > Development of various energy supply scenarios
  - > Verification of the functional capability of the system in a simulation
  - > Determination of options for flexibilisation
- Achieving the economic payback of the additional costs arising for the overall system
  - > Comparison of investment costs with standard designs
  - > Determination of life-cycle costs and environmental impact

The project is funded under the FFG tender "City of the Future" as an exploratory study.

https://nachhaltigwirtschaften.at/en/sdz/projects/futurequarter.php


Ill. 71: OeAD Guesthouse at Gasgasse

ANNEX

GLOSSAR (▸)

Ambient heat

Indicates the heat of the environment that is used for energy generation purposes, including near-surface and deep geothermal energy as well as solar heat.

Anergy network

A pipe network (cf. district or local heating) in which a heat transfer medium - usually water - circulates throughout the year at a temperature level of approx. 5 to 18 C°. Due to the low temperatures, an anergy network has significantly lower losses than a classic local heating network. Anergy networks are often used in conjunction with geothermal probe storage systems.
The temperatures in the network offer optimum source conditions for efficient heating with a heat pump but can also be used directly for free cooling. By means of an energy network, synergetic interactions between different building categories (e.g. service buildings and residential buildings) can be harnessed.
A balanced energy balance between heating and cooling must be ensured. Excessive heating in the cold season can be compensated by solar surpluses in the hot season. For peak load coverage, corresponding networks can also be coupled very efficiently with district heating (▸) (ideally return flow). Buildings supplied by anergy networks should be equipped with panel heating systems to make effective use of the low temperature level.

Biogenic fuels

Describes, among other things, the biological portion of household waste, pellets, wood briquettes, wood waste, charcoal, waste liquors, landfill gas, sewage gas, biogas, bioethanol and biodiesel.

Building database

The building database collects basic information on buildings such as area, age, geometry. The energy-relevant building data are subsequently used as a basis of (heat) planning.

Building developer competitions

Building developers and architects work together with experts to develop implementation concepts for the sites tendered. An interdisciplinary jury of experts will select the winning projects. The winners acquire the building sites with the obligation to realize the juried projects.[80]

CO_2

Is a chemical compound of carbon and oxygen with the molecular formula CO_2. As a greenhouse gas, it is a natural component of air.
(See also Greenhouse gas emissions (▸))

Combined Heat and Power (CHP)

Is the simultaneous generation of electrical energy and heat, e.g. in a thermal power plant.

Comprehensive refurbishment

Means the structural-technical restoration or modernisation of buildings including energy optimisation (e.g. insulation measures, switching from car to bicycle, installation of photovoltaic systems, etc.).

Decarbonisation

Stands for the transformation of the economy, especially the energy industry, towards a lower turnover of carbon.[81]

District heating

Is the supply of heat to consumers via a long-distance heating network to provide heating, hot water and/or process heat (▸). Thermal energy is usually transported in underground insulated pipe systems by means of a heated medium (usually water or steam).

Embodied energy

According to SIA (Schweizerischer Ingenieur- und Architektenverein) Merkblatt 2032, grey energy is defined as follows: “Grey energy refers to the cumulative expenditure of non-renewable primary energy for the production and disposal of a building material. It is calculated using standardised methods from the life-cycle inventories for all processes upstream and downstream of the use of the building material, from raw material extraction to transport, manufacturing and processing processes as well as disposal, including the necessary aids. The grey energy of a building material depends on the place (origin, transport) and the time of provision. Grey energy for the production and disposal of a building material is shown separately.“

Energy system transformation (Energiewende)

Stands for the transition from the non-sustainable use of fossil fuels and nuclear energy to sustainable energy supply by means of renewable energies.[82]

EU convergence criteria

The aim is to harmonise the performance of national economic areas and to achieve economic stability and solidarity within the EU.[83]

Final energy consumption

Is the consumption of the amount of energy which is delivered to end users, for example in the form of electricity, district heating (▸), petrol, diesel, pellets or natural gas. These can use the energy directly or after further conversion.

Greenhouse gas emissions

Greenhouse gas emissions resulting from human activities - in particular the greenhouse gas CO_2 (▸) - have an impact on the greenhouse gas effect. This effect in itself is a natural phenomenon, the balance of which is influenced by the emission of greenhouse gases by humans. An increased concentration of greenhouse gases in the earth's atmosphere reinforces this greenhouse effect and leads to global warming. The main cause of anthropogenic greenhouse gas emissions is the combustion of fossil fuels.

Gross domestic consumption

Is the amount of energy available to the city. This is made up of the difference between energy imported and exported across city boundaries (net import) and that generated in the city itself (energy generation).

Gross final energy consumption

Gross final energy consumption according to EU Directive 2009/28/EC is calculated from the final energy consumption (►), the consumption of the energy industry itself in the generation of heat and electricity as well as the transport and line losses during transmission and distribution.

Heat density

Is the amount of heat in kilowatt hours that is required in an area (e.g. building block or grid cell, e.g. 100 x 100m) per area or pipe metre.

Heating plant

Designates a system for the central generation of heat used e.g. for supplying hot water, room heating or heat for industrial processes. Combined **heat and power (CHP)** is the simultaneous generation of electrical energy and heat, for example in a combined heat and power plant.

Nearly zero-energy building

According to EU Directive 2010/31/EU, a building which has a very high energy performance as determined in Annex I is a n**early zero-energy building**. Nearly zero or very low energy demand should be met to a very significant extent by energy from renewable sources, including energy from sources produced at or near the site.

Per capita energy consumption

Stands for the final energy consumption (►) per capita, i.e. the consumption of the amount of energy that is supplied to end customers in the form of electricity, district heating (►), petrol, diesel, pellets or natural gas, for example. These can use the energy directly or after further conversion.

Primary energy

The originally available form of energy which must first be transformed into the desired final energy by various conversion steps. Wind power, sunlight or geothermal energy (organic Rankine Cycle processes) are used as primary energy for electricity generation, while fossil fuels such as coal, oil or gas are also used in obsolescent systems. Electricity is generated from these forms of energy via generators, semiconductor modules (photovoltaics) or turbines. Sunlight, geothermal energy, environmental energy or biomass can be used as primary energy for thermal applications. In analogy to electricity generation, fossil resources are also used for heat generation. The conversion of primary energy into final energy is associated with losses. In order to make different types of useable or final energy consumption comparable (►), these are converted back to the primary energy required by means of conversion factors.

Process heat

Refers to waste heat released during operating processes.

Reversible operation

Reversible operation in a heat pump means cooling operation in comparison with heating operation. The source (e.g. soil) and sink (e.g. building) are swapped, and in the process, excess heat is extracted from the building and fed to the soil as regeneration energy. Reversible operation requires the use of surface heating systems (ideally building component activation).

Thermal component activation

A system in which the thermally inert building masses are used to release heating energy to the room or to dissipate excess heat from rooms. For this purpose, the component is equipped with plastic heating pipes through which the heat transfer medium circulates, similar to underfloor heating, and at the same time the temperature of the component is controlled. As a rule, these elements are heating or cooling ceilings. Concrete walls are also occasionally activated. Concrete core activation is particularly suitable for energy supply using a heat-pump system, which can be operated very efficiently due to the low flow temperatures.

Waste heat

Waste heat is heat which is generated as a by-product of processes. This mainly includes waste heat from waste incineration plants, highly efficient CHP plants (►), industrial and commercial processes. (see also Energy Framework Strategy 2030, page 12)

[80] http://www.wohnfonds.wien.at/articles/nav/118, accessed on 06 November 2018

[81] https://de.wikipedia.org/wiki/Dekarbonisierung, accessed on 06 November 2018

[82] https://de.wikipedia.org/wiki/Energiewende#cite_note-3, accessed on 27 November 2018

[83] https://de.wikipedia.org/wiki/EU-Konvergenzkriterien, accessed on 16 July 2018

LIST OF ABBREVIATIONS

cf.	See also
CHP	Combined heat and power
CO_2	Carbon dioxide
e.g.	For example
EEG	Renewable Energies Act
EU	European Union
FFG	Research Promotion Agency
GAG	Infrastructure Utilisation Levy Act
GIS	Geographical Information System
ha	Hectare
ICT	Information and Communication Technology
Ill.	Illustration
IT	Information Technology
KliP	Climate protection programme of the City of Vienna
kWh	Kilowatt hours
kWp	Kilowatt peak
LGBl.	Law Gazette of the Province
MA	Municipal Department
MIV	Motorised individual traffic
ÖREK	Austrian Land Use Development Concept
ÖROK	Austrian Land Use Planning Conference
PHPP	Passive House Project Package
PV	Photovoltaics
SCWR	Smart City Vienna Framework strategy
SEP	Urban energy efficiency programme
STEP	Urban development plan
UIH-STRAT	Urban Heat Islands Strategic Plan
WrBO	Vienna Building Code
WStW	Wiener Stadtwerke
WU	Vienna University of Economics and Business Administration

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Legal Notice
The German version was adopted by the Vienna City Council on 30 April 2019

Owner and publisher:
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Developed with the extensive expertise of employees of the City of Vienna.

Graphics and layout: StudioVlayStreeruwitz ZT-GmbH

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Translation and English proofreading: Elisabeth Frank-Grossebner

Druck: Print Alliance HAV Produktions GmbH

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

ISBN 978-3-903003-50-7