



LEBENSZYKLUS BAU

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# BENEFITS & OPPORTUNITIES OF MULTI-BUILDING ENERGY SYSTEMS

with local, renewable energy sources



Guide for urban planners, regional planners, project developers and energy suppliers

# IMPRESSUM

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**Version:** Oktober 2018

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# 1. BACKGROUND AND OBJECTIVE

In order to stop climate change, it will be an important step in the coming years to significantly reduce fossil fuels for heat, electricity and cooling. Political ambitions to advance these changes already exist. As can be seen in the "Mission 2030", the climate and energy strategy of the Austrian federal government, Austria is aiming for an exit from the fossil energy economy by 2050. In the near future, a renouncement of fossil fuels in new buildings, as well as a conversion to renewable energy sources in building stock can be foreseen. These specifications serve to achieve the goal of the Paris Climate Agreement - to reduce emissions of climate-damaging gases to zero by 2050.

Among other things, this guide should serve as a support for decision-makers in future projects in order to involve all stakeholders at an early stage.

Due to the above-mentioned points, cities will have to change or develop in the future. Of course, these future developments will have a positive impact on the climate in the long term and thus on the quality of life in cities.

Which sustainable factors characterize a sustainable city?

Ecology	Social culture	Economy
Careful use of resources	Quality of life	Supply guarantee
Use of renewable resources	Social compatibility	Synergies are used
CO2 neutrality	Innovation	Promotion of local economy

The goal is a city with a high quality of life that is powered solely by renewable energy sources. And even these resources are used sparingly, e.g. by exploiting synergies within smaller zones in a city. For instance, waste heat from a bakery can be used to support heating systems in the immediate vicinity. However, in all these future scenarios, it is important not to forget the social compatibility of upgrading to new innovative/renewable systems. The security of supply must of course not suffer after such a conversion. Therefore, it makes sense to engage qualified energy operators for small sections of the district, who not only ensure that neighbourhood synergies are found and used, but also ensure cost stability and comfort for users.



*Illustration 1: A liveable city without fossil fuels*

## 2. THE MULTI-BUILDING ENERGY SYSTEM WITH LOCAL, RENEWABLE ENERGY SOURCES

### 2.1 Delimitation

This guide looks at multi-building energy systems from locally available, renewable energy resources in the areas of electricity, heat and cooling. The spatial delimitation takes place in the areas of heating and cooling in the multi-building hydraulic network. For the electricity grid, a spatial delimitation is not appropriate, since consumers must be able to choose the electricity provider individually. For this reason, this publication focuses on local, renewable heating and cooling networks in order not to increase the already high level of complexity.

Nonetheless, electricity - including its local supply - is also taken into consideration, as electricity is an important source of energy for the heating and cooling network and on the other hand the heating and cooling network is interwoven with many interfaces with the power grid (e.g. e-mobility as power storage).

### 2.2 Framework

The current climate protection policy is driving forward building concepts that manage with low energy consumption and require a low temperature level to heat the buildings. In addition, the share of renewable energy resources will be expanded. This also means that systems integrated into buildings will increasingly produce renewable energy, which ideally will be used right on the spot.

### 2.3 Characteristics

These are ideal conditions for new heating and cooling networks with low system temperatures which can be operated with fluctuating temperature levels. Advantages of this concept are lower heating and cooling losses in the distribution lines and the increased use of renewable energy sources. Supra-regional renewable energies can also be used, e.g. the renewable surplus energy in electricity production from wind energy, solar energy or others. Therefore, these networks are interesting for many energy producers and consumers, also called "prosumers", a mixture from the words producer and consumer.

The goals of a local heating network are to optimize the energy demand of individual buildings and users and to exploit synergy effects. A local heating and cooling network should enable the exchange of energy resources, so that the share of additional energy input can be low. For example, the ratio of heating and cooling over the year should be as balanced as possible. Thus, the waste heat from the cooling in the summer can be used for the heating of hot water or for space heating in winter.

The seasonal storage can be achieved for example by geothermal probes or large water storage systems. In addition, heat pumps are required to ensure the required flow temperatures in the building. This means that renewable electricity can also be used. In the case of an imbalance in the ratio between heating and cooling, for example, solar thermal systems or waste heat from production processes can be used to even out the energy balance.

It is important that there is a central information on the energy demand, as well as an automatic control of the energy exchange and the energy supply. The heating networks must have control and automatization to optimize operation. The new Buildings Directive also steers in that direction. With the term "smart readiness indicator," the Building Directive aims to increase the "intelligence" of building operation. In new heating networks, this "intelligence" is indispensable to be able to offer a sustainable heating and cooling supply.

### 2.4 Approach

The approach for a supply with locally available and renewable energy resources is usually step by step.

#### **Step 1: Determine energy demand**

At the beginning, it is necessary to determine the quantities of the energy demand and the energy loads for building use that are to be expected in the area. The amount of energy depends essentially on the types of use in the buildings. Apartments, office space, sales outlets or even production facilities. Dependent on this, the amount of energy and the energy loads for space heating, hot water, cooling and other power uses can be outlined. The result of this step is an energy demand model for heat, cold and electricity, in the annual, seasonal and daily balance. Here, it should also be ascertained to what extent an energy exchange can take place under the uses (e.g. waste heat from a cooling process for hot water preparation).

#### **Step 2: Identify local energy resources**

Decisive for the development of suitable solutions for energy supply are the energy resources in the area and in the immediate surroundings. These are on the one hand existing grid-bound energy sources such as gas, district heating, district cooling or electricity, on the other hand local renewable energy resources such as waste heat, groundwater, geothermal or solar energy.

### Step 3: Development of possible solutions for energy supply

On the basis of the energy demand and the possible energy resources on-site, possible solutions for the heating and cooling supply can be shown. This can best be done with the involvement of stakeholders for the developed area in order to bundle know-how for the site. In addition, stakeholder participation provides greater acceptance in determining an energy supply solution.

The crucial challenges in the implementation of local, renewable heating and cooling networks are the organizational and legal framework conditions. Since heating and cooling is in many cases generated both centrally in the area and decentral in the individual buildings (which may be built gradually), the organizational and legal implementation is the main hurdle to implement such systems.

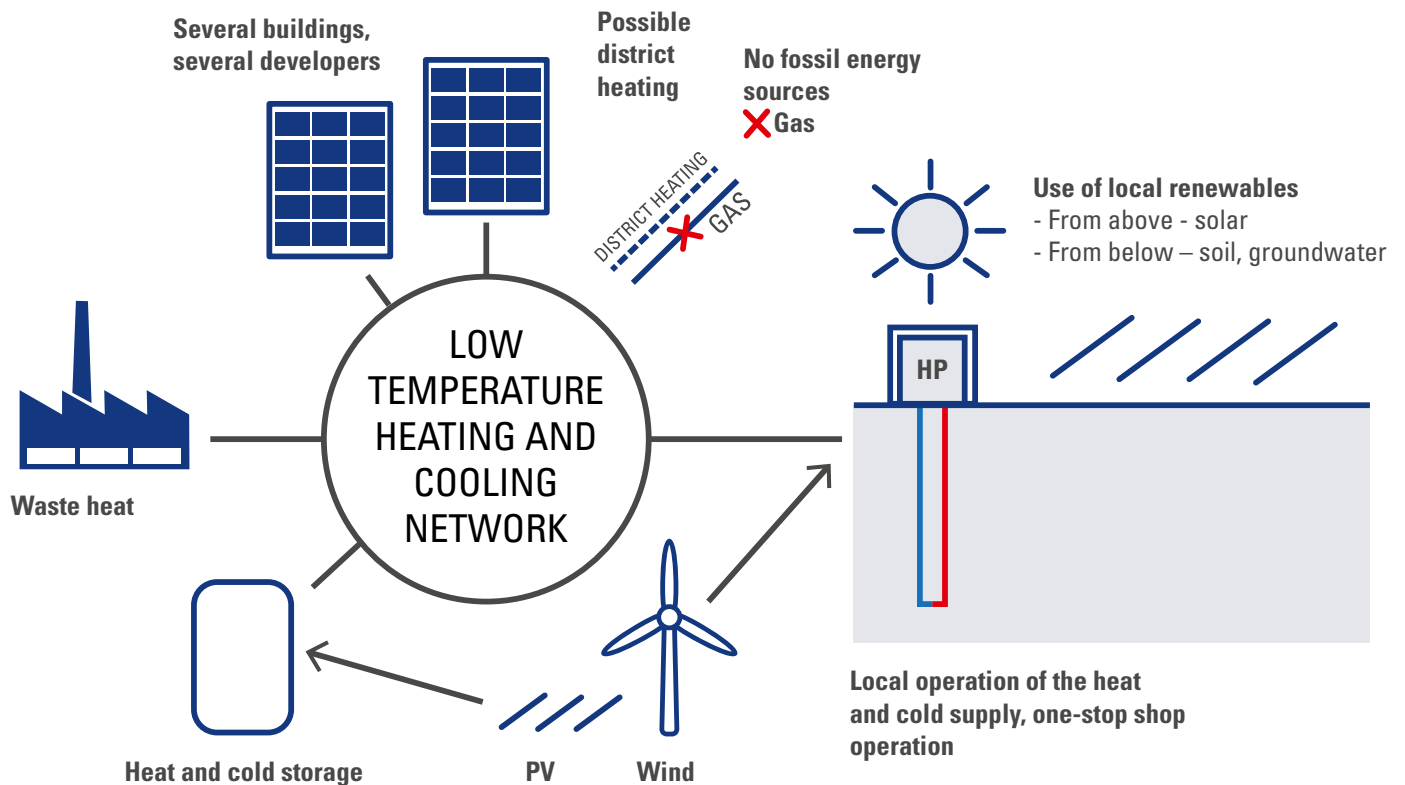


Illustration 2: Elements of a heating and cooling network

### 3. PROBLEM STATEMENT

With the transformation of the energy supply from a central concept with large power plants to decentralized concepts with many small power plants, increasingly decentralized supply structures are becoming the focus of the energy industry. Modern neighbourhoods and buildings equipped with smart meters communicate with the energy supplier via information and communication technologies and thus become active participants in the energy supply network. This relieves the load on the central power plants, avoids long transport routes and increases supply security overall, but results in new challenges.

#### 3.1 Concepts with local, renewable energy sources are more complex - technical

The approach of the individual technical solutions in the individual subprojects requires a new methodology of planning.

- Holistic energetic approach
- Each project/building has individual framework conditions
- Competent planners for energy supply and building design for customized, overarching and innovative solutions which bring together individual decentralized energy resources
- Flexible data and energy networks for the exchange of information (compatibility for further expansion)

#### 3.2 Concepts with local, renewable energy sources are more complex - organizational

The coordination and organization are ideally managed by a central coordinator.

- Find a central professional coordinator who will coordinate the developers and who collects and coordinates individual customer needs - ideally supported by the municipalities
- High organizational effort to bring together all stakeholders
- Creation of new methods and tools for the cooperation and communication of the individual stakeholders (energy supplier - coordinator - property developer - end customer)
- Development of new business models from which new business fields can be derived
- Organization and awarding to an operator who is qualified to operate complex energy system in an optimized way

#### 3.3 Concepts with local, renewable energy sources are more complex - economic

For the energy system, there is a trade-off between investment and follow-up costs. The investment costs of several renewable energy systems, such as geothermal probes, are significantly higher than, for example, a heating plant for district heating. In contrast, the energy consumption during operation is significantly reduced, since no energy costs must be paid for the environmental heat from the soil or the sun. The energy costs for heat pumps or circulating pumps are only a fraction of the total final energy.

Over the life cycle of the plants, the costs are equal to or slightly higher than the conventional energy supply. Optimized operation can result in high cost efficiency.

In addition, the investment costs for local energy production and for storage are shifting from the central energy suppliers to their customers (for example: local renewable systems such as photovoltaic or heat pumps instead of a supra-regional heating plant). From an overall energy-economic perspective, the customer thus takes over the tasks and expenses that the energy provider previously had.

If the usual energy supplier recognizes the advantages for himself and invests in the decentralized, energy-efficient infrastructure, new business models emerge for him and little or no additional costs for the decentralized energy model arise. As far as possible, a co-operation between local energy networks and the energy provider, who would normally offer central solutions, should therefore be strived for.

#### 3.4 Concepts with local, renewable energy sources are more complex - legal

Currently, legal framework conditions prevent viable technical and economic feasibilities of ecologically sound concepts.

- Legal framework is designed for central power generation and distribution

## 4. OPPORTUNITIES & BENEFITS OF LOCAL, RENEWABLE ENERGY NETWORKS

The use of local, renewable energy and its exchange between buildings entails more effort, which must be justified by the creation of an enhanced value during operation. The opportunities in the energetic interlinking of buildings must be recognized and considered and they have to show a verifiable impact.

### Security of supply

- No dependence on fossil fuels.
- The storage of a surplus supply of electricity and (waste) heat is possible and thus contributes to a more stable power grid (shifting of peak load).
- It is important to have clear organizational and legal framework conditions to guarantee perfect operation.

### Mixing the city, livable city

- Local, renewable energy systems need a mix of building uses to balance the heat and cold reservoirs over the year. This results in a good mixing and thus a vibrant city.

### Ecology

- No or reduced greenhouse gas emissions.
- Significant contribution to climate protection.

### Comfort

- Due to the necessary heat and cooling compensation in the soil, cooling energy for residential buildings is available, which brings a significant increase in comfort with increasing temperatures.

### Economics

- Over the lifecycle, local heat and cooling networks are competitive with conventional heat networks - with local added value and high environmental benefits.
- There are hardly any market price fluctuations, as energy resources do not need to be purchased or only to a limited extent.

### New business and professional models

- **For energy providers:**  
In addition to the existing energy networks, local, renewable energy systems can open new supply areas with new business models.
- **For private operators:**  
In addition to public operators, private operators can also act as energy suppliers.
- **For companies/organisations with high energy demand:**  
In case of own energy production, the environment can be supplied with overcapacities. This results in new business models as energy suppliers.
- **For property developers /housing cooperatives:**  
In addition to the provision of buildings, new business models as energy service providers can also open opportunities.
- **For property managers:**  
In addition to the usual property management activities, the operation of energy systems may also create a new business area.
- **For consultants:**  
Due to the organizational, technical and legal complexity of the networks, know-how is required on many sides. New business areas open for consultants in the areas of technology (planning and design of facilities), organization (development of business models), law (contracts between owners, users, and operators), coordination and organization of projects, etc.

### Transparent energy usage

- Good control is needed for local, renewable energy systems. This requires data on energy demand and energy supply. These data can be made available to users to monitor their consumption (operators do not receive individual profiles).

## 5. WHO ARE THE RELEVANT ACTORS?

### Creation of framework conditions

Stakeholders	Tasks
<b>EU</b>	<ul style="list-style-type: none"> <li>■ Setting climate targets, requirements for member states (e.g.: Energy Efficiency Directive, Directive on the Energy Performance of Buildings, Eco-design, Public Procurement)</li> <li>■ Research initiatives</li> </ul>
<b>Federal government</b>	<ul style="list-style-type: none"> <li>■ Adaptation of relevant laws [e.g.: climate strategy, green electricity, construction, tenancy, housing law, ElWOG (Austrian Electricity Industry and Organization Act)]</li> <li>■ Granting of funding (research funding, advisory and investment support, support for innovation-promoting, public procurement)</li> <li>■ Promotion of information campaigns</li> </ul>
<b>State government</b>	<ul style="list-style-type: none"> <li>■ Climate Change Programme</li> <li>■ Adaptation/nationwide standardization of relevant laws (e.g.: building regulations, ElWOG, subsidies)</li> <li>■ Promotion of information campaigns</li> </ul>
<b>Municipalities</b>	<ul style="list-style-type: none"> <li>■ Energy planning</li> <li>■ Establish a coordination office for local, renewable energy systems</li> <li>■ Adaptation of planning and approval procedures</li> <li>■ Investment grants</li> <li>■ Promotion of information campaigns</li> </ul>

### Development of new business interests and models

Stakeholders	Tasks
<b>Energy supply companies</b>	<ul style="list-style-type: none"> <li>■ Building new business models for local, renewable energy systems</li> </ul>
<b>Private operators (including companies that provide energy overproduction to the environment)</b>	<ul style="list-style-type: none"> <li>■ Development of new business models for the implementation and support of local, renewable energy systems</li> </ul>
<b>Project developers, housing cooperatives</b>	<ul style="list-style-type: none"> <li>■ Find collaborations with potential operators</li> <li>■ Construction of new business areas in addition to the provision of buildings (for example, to be an energy supply company)</li> </ul>
<b>Property managers, facility managers</b>	<ul style="list-style-type: none"> <li>■ Building new business models in addition to managing and operating buildings</li> </ul>
<b>Financial institutions</b>	<ul style="list-style-type: none"> <li>■ Support for innovative projects regarding advice on the best financing models and funding opportunities</li> </ul>

## Planning and implementation

Stakeholders	Tasks
<b>Architects</b>	<ul style="list-style-type: none"> <li>■ Integration of technology in the buildings has to be planned</li> <li>■ Coordination of relevant stakeholders, if applicable</li> </ul>
<b>Energy planners</b>	<ul style="list-style-type: none"> <li>■ Planning the necessary technology</li> <li>■ Attention should be paid to the integration in the overall system</li> </ul>
<b>Energy coordinators</b>	<p><b>On the part of the municipality:</b></p> <ul style="list-style-type: none"> <li>■ Coordination that energy planning is made and implemented</li> </ul> <p><b>On the part of the developer:</b></p> <ul style="list-style-type: none"> <li>■ Coordination to implement spatial planning which has a focus on energy planning</li> <li>■ Create an interface plan and a schedule</li> <li>■ Communication and coordination of all parties involved (municipality, property developer, client, users, operators, planners, consultants, etc.)</li> <li>■ Ensuring the quality and performance of the energy system</li> </ul>
<b>Construction companies</b>	<ul style="list-style-type: none"> <li>■ Implementation of the required quality regarding structure and technology</li> </ul>

## User

Stakeholders	Tasks
<b>Building users (Tenants, owners)</b>	<ul style="list-style-type: none"> <li>■ Active demand for buildings that are sustainably supplied with renewable energy sources</li> <li>■ Acceptance of new building concepts (e.g.: low temperature systems mean slower heating and cooling systems)</li> <li>■ Acceptance of possibly low additional costs for investments to obtain more attractive operating costs in the long term</li> <li>■ Self-commitment to the careful use of energy</li> </ul>

## Additional stakeholders

Stakeholder	Tasks
<b>University and non-university research institutions</b>	<ul style="list-style-type: none"> <li>■ Research projects on technical possibilities, demand management, business models, economic feasibility studies, demonstration projects, participation processes, user information and motivation</li> </ul>
<b>Industry</b>	<ul style="list-style-type: none"> <li>■ Further development of relevant technologies</li> </ul>
<b>Press</b>	<ul style="list-style-type: none"> <li>■ Objective coverage on examples and opportunities</li> </ul>

## 6. BEST PRACTICE EXAMPLES

### DISTRICT TWO

Vienna, Austria



Illustration 3: District Two © IC Development GmbH

#### New building district with mixed use:

1,500 workplaces, 370 flats, 350 student flats, 250 hotel rooms

#### Area size:

160,000 m<sup>2</sup>

#### Energy system:

Energy is produced directly from renewable sources such as geothermal, groundwater, waste heat, wastewater and solar energy.

In an anergy grid they form an intelligent network of renewable energy sources and buildings which work together.

**Stakeholders:** IC Development GmbH, Kraftwerk Krieau GmbH

#### Additional information:

<https://energie-krieau.at/>

<https://viertel-zwei.at/de/>

### DISTRICT CENTER FRIESENBERG

Zurich, Switzerland

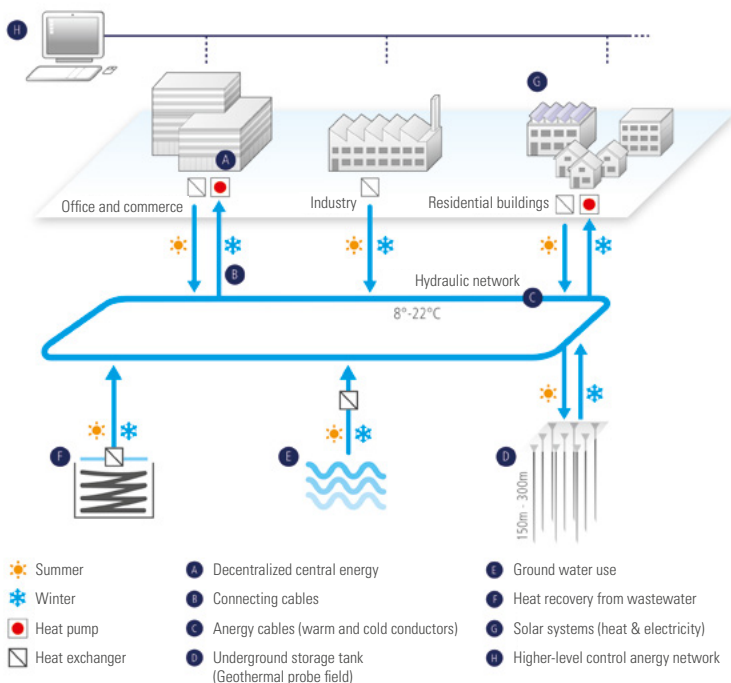


Illustration 4: Principle of anergy grid © Amstein + Walther

#### District renovation and consolidation, mixed use:

2,300 residential units, 5,700 residents, 35,000 MWh heating demand, 80,000 MWh cooling demand.

#### Energy system:

Conversion of the existing local district heating network to low temperature heating and cooling grid (anergy grid). Gradual decommissioning of central gas and oil boilers. Decentralized heat pumps (heating and cooling) draw electricity from local photovoltaic systems and primary energy from the grid. Companies feed waste heat into the power grid. Surplus heat is stored seasonally in over 500 geothermal probes and used for cooling in summer. By 2050, the requirements of the 2000 Watt Society are to be met and the annual CO<sub>2</sub> emissions will be 90 percent lower than in 2011.

#### Stakeholders:

Familienheim-Genossenschaft Zürich (Generalplaner), Amstein + Walther AG (Energieplaner), Swisscom, Credit Suisse Uetlihof, Sportzentrum Heuried, Stadtsptial Triemli, Bürger- und Mieterbeteiligung.

#### Additional information:

[www.amstein-walther.ch/fileadmin/user\\_upload/Dokumente/zB\\_Broschueren/zB\\_Nr66\\_A4.pdf](http://www.amstein-walther.ch/fileadmin/user_upload/Dokumente/zB_Broschueren/zB_Nr66_A4.pdf)

[www.fgz.ch](http://www.fgz.ch)

## 7. CONCLUSIONS

The energy industry is in transition. Due to the scarcity of resources and the efforts to achieve the climate goals, new ground must be broken regarding energy supply. Local energy systems operated with locally available renewable energy sources are therefore in demand. The technologies are available, but there are plenty of organizational, legal, economic and technical challenges that make it hard to implement them.

Politicians are called upon to create the legal framework and incentives as well as to stimulate economy, research and further education. Municipalities must become aware of their central role in energy planning and as coordinators. Suppliers and operators, developers and property managers need to recognize and seize the opportunities in new business models, and end-users should demand renewable energy supply.

There are already positive examples that are - considering the life cycle and the economy - competitive. These need to be increasingly communicated to demonstrate feasibility and to create interest. Local, renewable energy systems bring local added value and make a significant contribution to a sustainable and liveable city.

IG Lebenszyklus Bau comprises more than 70 companies and institutions in the construction and real estate industry in Austria. Founded in 2012 as IG Lebenszyklus Hochbau, the association supports builders in the planning, construction, financing and management of holistically optimized, life-cycle-oriented structures. Interdisciplinary working groups provide a common platform for project participants from all areas of the building lifecycle. The association has already developed numerous guidelines, models and performance models that help clients realize successful construction

projects based on life-cycle-oriented processes, a partnership-based project culture and a result-oriented organization. With the DBS-Club ([www.dbs-club.at](http://www.dbs-club.at)), the association runs an ongoing initiative that develops interdisciplinary solutions for digitizing the building's life cycle. All publications can be requested free of charge from the association.

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