4/2016

# energy innovation austria

Current developments and examples of sustainable energy technologies

## Innovations for the city of tomorrow

### Smart strategies, technologies and system solutions from Austria

In future more and more people will live in urban areas. As the most important living environment and economic framework, cities are responsible for the greater part of global energy consumption. To minimize impact on the climate, conserve resources and ensure that the city of the future provides true quality of life and remains an attractive location for business in the long-term, new strategies and pioneering solutions are necessary. Austrian research and technology development in the Smart City sector is embedded in a range of international activities. In Austrian cities and communities new technologies and strategies for the Smart City are being developed further and showcased in real life.

*Photo: Projektfabrik Waldhör KG*

Photo: Climate & Energy Fund/Hans Ringhofer

# Innovations for the Smart City
## National and international activities

According to UN forecasts we can expect a world population of nine billion people in 2050, 70 % of them in cities. Urban growth, globalization, demographic shifts and climate change present real challenges to the city of the future. Sustainable cities must combine climate protection and resource efficiency with quality of life and attractive conditions of work. However, urban areas also provide opportunities of implementing new approaches and strategies for a sustainable managing of energy and material resources. The concept "Smart City" stands for comprehensive development strategies that include a wide range of technical, economic and social innovations for cities. A Smart City is characterized by intelligent system design, bringing together new technologies and services for buildings and infrastructure, producing and distributing energy, transport, industrial production and small-scale manufacturing.

The hallmark of the Smart City is the way in which the sectors energy, buildings, transport, urban planning and governance are linked together, so as to realize the potential available for ecological, economic and social improvement. Modern information and communication technologies with which the city's technical systems and infrastructures can be controlled intelligently provide the basis for this. Here it is vital to integrate social aspects comprehensively and to provide ways for residents to participate.

Since late 2010 the Federal Ministry of Transport, Innovation and Technology (bmvit) and the Climate & Energy Fund have shared responsibility for developing new strategies, technologies and system solutions for sustainable cities – intended to enable people to live and work in energy-efficient, climate-friendly ways and to improve the quality of the location in question.

### City of Tomorrow (bmvit)

The research and technology programme "City of Tomorrow" builds on the results of the earlier programmes "Building of Tomorrow" and "Energy (systems) of Tomorrow", and promotes research into and development of new technologies, technological subsystems and urban services for the city of the future. The focus is on buildings and urban energy systems, neighbourhoods, districts and the city in relation to its environs. Energy is the central issue here. New energy services, boosting energy efficiency and increasing the share of renewable sources of energy in urban areas are key topics. The process of transformation to a sustainable city is to be promoted by means of pioneering, intelligent energy solutions for buildings and districts.

### Smart Cities Demo (Climate & Energy Fund)

The Climate and Energy Fund's Smart-Cities-Initiative is intended to set up large-scale pilot projects in which mature technologies and strategies are applied and combined in interactive complete systems for the first time. The aim is to showcase the "Zero Emission City" or "Zero Emission Urban Region" by linking technical and social innovations and measures together in real life. Smart urban development depends on intelligent, interconnected, integrated answers to generating, distributing and consuming energy sustainably in urban areas. The city (urban region) is used as a testbed in which pioneering approaches can be tried out and evaluated in an exemplary way. When technical and social systems are treated as complementary, individual components and technologies can be improved by means of interaction and crosslinking.

Educational campus in Gnigl, Salzburg, Source: City of Salzburg

## International activities

In recent years research and technological development in the field of Smart Cities have been forced internationally – as part of the **EU's Strategic Energy Technology Plan (SET-Plan)**, for instance, or the **European Innovation Partnership for smart cities and communities**, and within the framework of the **International Energy Agency's technology programme**. Here Austrian experts are actively involved in the IEA's Energy in Buildings and Communities (EBC) Annex 63: "Implementation of Energy Strategies in Communities", for example.

In 2010 coordinated by Austria the **Joint Programming Initiative (JPI) Urban Europe**, a transnational research programme which is currently uniting more than 20 countries, was launched to tackle fundamental systemic issues relevant to urban development. The aim here is to intensify transnational cooperation in the field of urban research and development, so as to generate attractive, sustainable, economically strong cities. The programme **ERA-NET COFUND "Smart Cities and Communities"**, which is supported by the EU Commission as part of Horizon 2020, is an initiative of JPI Urban Europe, linking 18 national and regional funding programmes for research and technology development together so as to carry out a transnational call for Smart Cities implementation projects (to run from 2016 to 2019). The focal points of the programme include tools and services for intelligent urban energy and transport systems, and developments in the field of big data/smart data. In this context a process has recently been started to initiate a joint call with China in the field of Smart Cities.

## Building blocks for the Smart City

The topics "Active buildings", "Heating and cooling grids", "Intelligent power grids", "Urban planning", "Energy production and storage technologies" and "Smart services" are among the building blocks for the Smart City. In Austria a number of research and technology development projects are currently in progress in this field. In this issue we present some of the projects that are being carried out with support of the bmvit and Climate & Energy Fund programmes. ◘

Stadtwerk Lehen in Salzburg, Photo: PRISMA

PV equipment on a supermarket building in Neusiedl am See, Photo: IEV AG

Photo: Jürgen Fälchle/Photolia.de

# GrünPlusSchule
## Plants on buildings and PV modules

Photo: Institute of Building Construction and Technology, Vienna University of Technology

Photo: Institute of Building Construction and Technology, Vienna University of Technology

Quality of life in cities requires multifunctional system solutions with which energy can be captured, heating and cooling energy consumption reduced, air quality improved and noise abated. As cities are packed with buildings, they are short on green spaces. Façades, roof surfaces and indoor spaces can be used for plants. This will have various positive effects on the quality of buildings and the city will permanently become more livable.

In a project carried out by Vienna University of Technology at a school in Kandlgasse, in Vienna's 7th district, ultra-efficient systems to kit buildings out with plants are being tested, involving various kinds of plants and substrate in conjunction with photovoltaic modules (PV). The project team analyses how greenery influences the building's temperature and humidity, the potential for saving energy, indoor air quality and humidity, noise reduction, water retention and urban heat-island effects. Planting the building with greenery is expected to improve its microclimate, lower concentrations of carbon dioxide and particulates, absorb noise and boost the efficiency of the PV modules (inter alia).

### Measuring system in school building

In 2015 the school was equipped with various arrangements of plants, substrates etc., indoors and outdoors. Combining PV modules with plants on a building is a novel approach. On hot summer days the modules are cooled by evaporation from the plants, making the modules more efficient. The plants are shielded by the modules, so they grow well. Numerous sensors record the most significant data inside and outside the building; these data are used to compare the performance of structures with and without greenery and the effect of the plants is assessed quantitively.

A key aspect is that the pupils are involved in the project, for example in searching for the most suitable kinds of plant, evaluating data or plotting the amount of energy provided by PV modules. The project will continue until 2018; the initial findings are positive. The U-value has been lowered by 20 % on average. Carbon dioxide concentrations above 2000 ppm have been detected much less often, and the plants have also reduced the noise level.

The experience gathered is being used to work out an effective and low-cost combination from a variety of plants, substrate thicknesses and ways of installing PV modules. The system selecting should be scalable, and suitable both for new starts and for renovating existing buildings. ◘

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*„The GrünPlusSchule project is concerned with greening built structures in conjunction with energy management and the hydrological balance in cities, and with improving quality of life indoors and outdoors. It reveals how buildings and cities can be made fit for the future and worth living in. A key aspect of this research project is the immediate involvement of the pupils; today's children and young people are tomorrow's residents and policymakers."*

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Photo: TU Wien

Eco-Suite Hotel Salzburg, Photo: Robert Freund

# Kolpinghaus Salzburg
## In transit to an energy-surplus building

In 2016 the Eco-Suite Hotel, an extension to the Salzburg Kolpinghaus, was opened. The existing building, which functions as a hostel for young people and as a seminar facility, has been supplemented with a sustainable-design new building with 44 hotel rooms. The extension features a pioneering energy strategy intended to make use of the energy available on the spot in running the entire complex. The building envelope has been implemented to passive-house standard, a convenience ventilation system with heat and moisture recovery has been installed, and energy-efficient LED luminaires and energy-saving appliances have been employed. PV modules with a total capacity of 29.5 kWp are mounted on the roof of the new extension.

### Heat recovery from sewage

In the energy system a facility to recover heat from sewage plays a key part; this is sufficient to cover the extension‘s entire thermal energy consumption (heating and hot water), and surplus energy can be delivered to the existing building. The average sewage temperature in a hotel is around 22 to 23°C. Heat is extracted from the sewage in the evaporator section of a brine/water heat pump, cooling the sewage down to around 5°C; heat is then available in the condenser section at a temperature of more than 50°C all year round. The heat recovery system also uses the sewage from the existing building as a source of heat. The heat is routed through a central layered-storage tank and distributed throughout the entire complex for space heating and supplying hot water. The heat recovery system extracts roughly 270,000 kWh of heat per annum from sewage; about one-third of this is used in the extension, two-thirds in the existing building.

### Step by step to energy surplus

As part of this project various options for developing the complex toward achieving an energy surplus have been investigated. A step-by-step plan spanning twenty years envisages using more efficient lighting and appliances to save electricity, for instance, or generating more electricity by installing PV modules on the façade of the existing building as and when it is upgraded at some future date. The idea of placing a floating hydroelectric mini-generator downstream was also given consideration, as were the economic advantages of storing electricity. ◘

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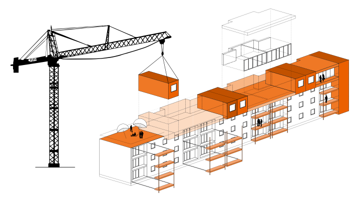
Photo: Dietmar Stampfer

Photo: Robert Freund

**ROOFBOX**

**Increasing density with energy-self-sufficient units**



Source: Nussmüller Architekten ZT GmbH

„Roofbox" has been developed as a way of providing high-grade housing with a built-in energy supply system rapidly and making better use of existing urban infrastructure to accommodate more residents efficiently, both energy and cost-wise. The system was developed by AEE INTEC in collaboration with the Salzburger Institut für Raumordnung und Wohnen/SIR, Nussmüller Architekten ZT GmbH, Haas Fertigbau and TBH Ingenieur GmbH, and is intended for use as part of renovation projects. Prefabricated timber units are implemented to passive-house and energy-surplus standard, and are especially suitable for upgrading existing buildings erected between 1945 and 1980.

Roofbox comprises the three basic modules ROOFBOX LIVING (living-space module), ROOFBOX ENERGY (building-services module) and ROOFBOX ACCESS (access module). Standardized modules can be lined up and module depth as well as two-dimensional elements varied to accommodate specific user requirements flexibly. Facilities for generating, storing and distributing energy are located in the building-services modules. Active solar systems (PV, solar collectors) can be installed on the roof of the unit. The Roofbox approach has been simulated for the GSWB (Gemeinnützige Salzburger Wohnbaugesellschaft) housing complex at Billrothstrasse in Salzburg, and a detailed project has been drawn up jointly with GSWB; it has a good chance to be implemented.

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Source: ecop Technologies GmbH

# P2H-Pot
## Potentials for power-to-heat in urban areas

As the share of electricity generated from renewables increases, while inevitably fluctuating, there is a growing need to make the demand for electricity more flexible. Surveys in several countries reveal that, in conjunction with heat storage facilities, there is considerable potential for electricity in space heating (power-to-heat, P2H), with the aim of making the overall electricity/heat/gas energy system more flexible at low cost. Up to now power-to-heat has employed electrode boilers to convert surplus electricity into heat, which is then stored. At Vienna University of Technology's Institute for Energy Systems and Thermodynamics the potential of power-to-heat approaches involving heat pumps in urban areas is being investigated in collaboration with partners in Austria and abroad.

### Innovative power-to-heat systems

Thermodynamic simulation is used to analyse how suitable various P2H system configurations are. The comparison involves resistance heating-element boilers, compression heat pumps with various refrigerants, and rotation heat pumps supplied by the company ECOP with an inert gas mixture as refrigerant. The ECOP Rotation Heat Pump, which uses a special process that makes high temperature bandwidths feasible in conjunction with a high coefficient of performance (COP), appears particularly promising in the field of district heating. Whereas the temperature ceiling for the heat supplied from conventional heat pumps (employing the two-phase process) is limited to around 100°C, the ECOP heat pump using the so-called Joule Process achieves temperatures up to 150°C.

### Comparing cost-effectiveness

Inter alia this research project is intended to identify the economic potential for these pioneering system configurations in urban areas for 2020, 2030 and 2050 timeframes. With the HiREPS simulation programme developed by the Energy Economics Group (EEG) at Vienna University of Technology 20 different district heating grids are being compared. This shows how cost-effective resistance heating-element boilers, heat pumps and expanding heat storage facilities to cope with surplus electricity from renewable sources of energy are.

The legal, fiscal and regulatory frameworks are also being investigated. ENERGIEANALYSE.DK, the Danish partner in this project, provides practical P2H experience from Scandinavia, while Energie AG contributes practical experience with district heating. ◘

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# Open Heat Grid
## Using waste heat from industry in hybrid grids

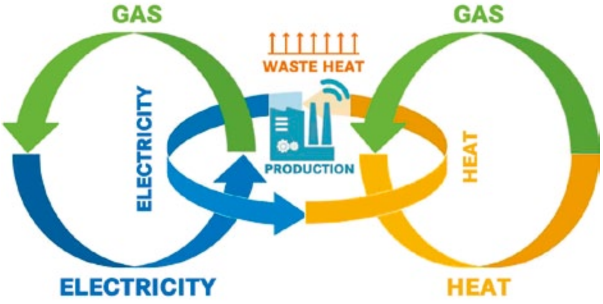
To date, grids for heat, electricity and gas are almost entirely separate; however, new technological developments make it possible to link these grids up closely bidirectionally. Hybrid grids could well play a key part in future energy supply systems in urban areas, making a major contribution to resource efficiency and energy conservation. In the OPEN HEAT GRID project, headed by the Energy Institute at Johannes Kepler University (JKU) Linz, various approaches to setting up an open heat grid were investigated and policy recommendations for open heat grids in urban energy systems drawn up. Hybrid grids need a new market and regulatory design, reflecting the upcoming interaction in previously independent grids.

### Waste heat as a source of energy

Industrial firms could act as two-directional nodes between the grids for heat, electricity and gas, realizing storage and transfer potential. One main issue in this project is integrating waste heat from industry – available in large quantities, but at differing temperatures (which affects how it can be used); it can in principle be put to work in existing district heating systems. Technical barriers concern the temperature of the waste heat in relation to that of the district heating grid, and the heat extraction and its continuity. Technologies for processing and storing heat are often available, but in many cases not cost-effective.

## Feeding into district heating networks

As things stand in Austria, there is no regulation on feeding heat into an existing heat grid; whoever operates a district heating grid is automatically the owner of the grid and in availability of a source of heat. This complicates negotiations about feeding in, as a number of interacting technical variables (such as flowrates, pressures, temperatures, etc.) must be taken into account. At the moment feeding in is handled by means of private contracts. For constructive negotiations and cost/benefit analyses, though, appropriate guidelines need to be developed. While the marginal cost of providing waste heat tends toward zero (since it can be made available without significant additional use energy), customizing this heat involves fixed costs, which must be redeemed by cost savings in the grid operator's heat production. In Vienna and Linz such savings are feasible only in winter and in the transitional periods of spring and autumn, since in summer the energy for district heating is provided mainly by incineration. A seasonal thermal storage facility could make summer waste heat available in winter, and thus make diverting heat more cost-effective.




Source: Energy Institute at Johannes Kepler University (JKU) Linz

Further investigation is planned in follow-up projects headed by the Energy Institute, such as "Future District Heating System Linz", in partnership with AIT Austrian Institute of Technology and Linz AG. ◘

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**SMART CITY RHEINTAL**
**Energy from Lake Constance**

As part of the Smart City Rheintal project the urban quarter SEESTADT Bregenz will be realized: a pioneering, diversified neighbourhood, closely linked to the existing town. To meet the energy demand of the offices, flats and shops in this new neighbourhood, the local utility Stadtwerke Bregenz GmbH plans to tap Lake Constance as a source of heat by means of heat pumps. As its temperature is virtually constant, lake water is an ideal source of heat.

In summer the lake water's temperature (essentially at a defined extraction depth of around 40 m) is to be used to air-condition the buildings by means of free cooling; the secondary cooling circuit operates with an inlet temperature of around 10°C and a return temperature of around 16°C, using a heat exchanger. This method of air-conditioning needs neither chillers nor a recooling system (e.g. via the roof). The water returned is cooled down in the primary circuit in Lake Constance. In winter the energy in the secondary circuit is used in electric heat pumps for low-temperature space heating.

The initial assessment as per Austrian law indicates that this use of lake water can be authorized, and thus be implemented in the course of realizing the construction projects.

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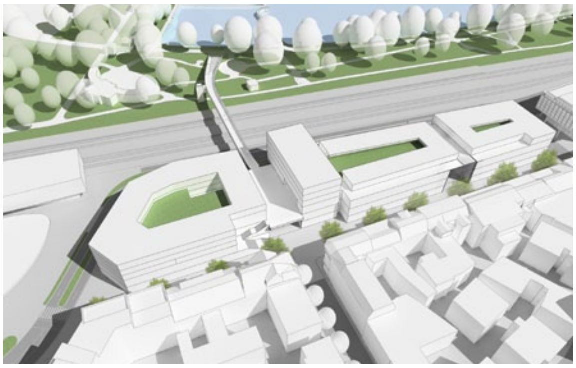
Source: PRISMA



Source: Smart City Rheintal

Video Smart City Rheintal: **http://bit.ly/2dNeejf**

Photo: Salzburg AG

# Rosa Zukunft
## Buildings as interactive participants in a Smart Grid

The share of electricity generated from renewables is constantly increasing, with many small-scale local suppliers and a fluctuating total supply level. Buildings of the future will not only consume electricity but also generate it themselves. Tying these local supplies of electricity into the grid while maintaining the quality of electricity supply is a major challenge in grid operation. By means of load management (i.e. intelligent regulation of consumer devices in buildings and households) the squeeze on the low-voltage grid can be relieved and the feeding in from local, fluctuating sources of electricity are favored.

As part of the HiT project “Houses as interactive participants in a Smart Grid“, the Smart-Grid-oriented housing development ROSA ZUKUNFT has been erected in Salzburg. The demonstration facility provides a very useful degree of flexibility by means of a combination of heat and electricity suppliers, storage and consumers with an automatic control system for the buildings. The aim here is to tie both the buildings and their residents into the energy system as interactive participants.

### Full integration into the grid

The housing development’s power centre has been designed so that the buildings can react appropriately to the state of the power grid and the availability of renewable sources of energy. A CHP unit (Combined Heat and Power generation), a buffer storage facility, a heat pump, a PV facility and a link to the district heating grid have all been implemented. All these systems are coordinated via an automatic control system. At times when grid supply exceeds demand, the housing development is meant to charge the storage systems; when grid demand exceeds supply, it is meant to reduce consumption or feed into the grid. To aid in this a price plot has been constructed, made up of a grid element and a power element. The plot is transmitted to the buildings one day ahead where it is processed. The Building Energy Agent (BEA) generates a time schedule for the control system and a forecast

Photo: Salzburg AG


Photo: Salzburg AG

of relative load for trading electricity. Load management of electricity suppliers and consumers is taken care of without residents being bothered in any way.

### Evaluation

From April 2014 to March 2015 the housing development was assessed in a field trial covering both technical aspects and user behaviour. Out of a total of 129 flats, 34 were equipped with indoor air sensors, room-temperature controllers etc. for monitoring purposes. The most important facility for residents to interact with the system was the web application “Smart Centre“, which provided various services such as energy feedback, home automation, car-sharing and a forecasting clock for information about a dynamic (time-variable) power tariff. Among other findings it turned out that the residents in the flats monitored consumed almost 15 % less electricity over the trial period. ◻

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Photo: Projektfabrik Waldhör KG

# Flagship project
## Smart City Demo Aspern

The urban development project aspern – Vienna's Urban Lakeside is a large-scale implementation of the Smart City approach in Austria. The development is meant to show how tomorrow's cities can function in an energy-efficient and climate-friendly way. As part of a flagship project a system-tuned strategy is being worked out, covering buildings, the power grid, users and ICT facilities.

The results are being integrated in a testbed made up of blocks of flats, a student hostel, a kindergarten and a school building. Findings from the project will be used to improve methods of managing and controlling buildings and power grids, while new facilities for user interaction are developed. The research results are applicable not only to individual buildings or Vienna's power grid, but to entire urban districts all over the world. In the testbed buildings smart meters will record electricity consumption in detail, and other data, such as room temperature and indoor air quality, will also be collected; on this basis it should be possible to identify various "energy types" as the Smart Users of the future.

The aim is to permanently improve user behaviour and limit power consumption by means of goal-directed information, new services and structured incentives. Dynamic tariff models from the electricity suppliers, for example, are one possible technical element in this. The project is intended to reveal which system solutions customers will accept.

Integrating intelligent buildings in a Smart Grid is another area of interest. Real-life data are used to investigate how buildings and clusters of buildings can bring their power surpluses to the electricity market profitably. For this a Building Energy Management System (BEMS) is needed in the building, communicating with a so-called Energy Pool Manager. For example a power supplier could act as an interface between buildings and the electricity exchange.

Photo: Projektfabrik Waldhör KG

For buildings to take part in the electricity market Smart Grids and dynamic (time-variable) tariffs will be needed, to make selling surplus power commercially viable.

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Video Smart Cities Demo Aspern: **http://bit.ly/2dNd8F1**

***ERA NET***
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*www.eranet-smartgridsplus.eu*

As part of this research initiative, which is funded by the EU Commission, a permanent cooperation structure linking national and regional Smart Grid programmes in Europe is to be set up and coordination with the relevant initiatives at European level made possible, with the aim of boosting the integration and commercial launching of Smart Grid system technologies in Europe long-term. Austrian experts are involved in the DeCAS project ("Demonstration of coordinated ancillary services covering different voltage levels and integration in future markets"), for instance, and are researching into system services such as demand response, control strategies for reactive power across voltage levels, and how to integrate these technologies in the market.

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Salzburg district Schallmoos, Photo; SIR

# Smart City Salzburg
## Pioneering strategies and projects

In recent years the city of Salzburg has acted as a pioneer in several energy relevant policy areas. With numerous climate protection projects to its credit, and as a showcase region for Smart Grids and electric mobility, Salzburg has a wide range of emission-reducing initiatives. Since 2008 the city's Spatial Development Strategy includes national and international targets for climate protection. It is official policy to lower energy consumption significantly and to increase the share of renewables. Various different scenarios have been drawn up for the city's energy future; lowering per capita energy consumption by 30 % between 2010 and 2050, and increasing the share of energy produced locally from renewables from 8.8 % in 2010 to 32.3 % in 2050, are regarded as realistic.

In 2012 a Master Plan for 2025 with which to achieve these aims was developed in collaboration with stakeholders; it contains numerous detailed projects. An interdisciplinary, multi-technology approach is employed, linking up the fields of buildings (new construction and renovation), energy production and distribution, transport, the planning of open spaces, social aspects and involving the general public to arrive at a comprehensive strategy. The development process is supervised by SIR (Salzburger Institut für Raumordnung und Wohnen). In 2013, as part of a building structure analysis, urban districts and clusters of buildings suitable for large-scale renovation were identified.

### Smart City pilot projects

The most important project is the pioneering project **Stadtwerk Lehen** with almost 300 flats, shop premises, a kindergarten, a student hostel and the Life Science office complex. Here a sustainable energy strategy for an urban district has been implemented in real life for the first time. The EU Green Solar City project, part of the CONCERTO programme, had a decisive influence here.

Funds were provided for (inter alia) 2,000 m² of solar collectors, a 200,000 l buffer storage tank, more than 250 m² of PV modules and a low-temperature microgrid, through which the nearby residential buildings in Strubergasse are also supplied with heat. The neighbouring "Strubergassensiedlung", an old residential complex, has been renovated with state-of-the-art technologies.

Stadtwerk Lehen - Solar storage tank, Photo: SIR

Stadtwerk Lehen, Photo: Stadt Salzburg

When the building structure analysis was carried out, one of the areas identified was the **Goethesiedlung** in the Itzling district – it may turn out to be a new pioneering pilot project. A feasibility study is currently in progress for a very ambitious energy supply system (almost carbon-dioxide-neutral), and the social aspects of renovating this 1970s settlement sustainably are being investigated.

The starting-point for the **Smart District Gnigl** project was the plan to build a new primary school in the Gnigl district; at the same time the kindergarten and the clubhouse next door were to be integrated in a new building complex. The Gnigl educational campus has been planned as a flagship energy project, and may well provide stimuli for the entire district. The basic principles for implementation have been worked out in an exploratory survey; they include a cost/benefit analysis for the district heating grid, and estimates of the surrounding buildings' energy-saving potential. Ideas for transport arrangements and for involving the residents have also been developed. ◘

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Solar storage tank, Photo: SIR

### Current projects for Smart City Salzburg

- **EnergyCityConcept** – energy modelling to achieve zero-carbon-dioxide space heating as part of an energy strategy for the Salzburg district Schallmoos
- **ZeCaRe** – exploring/preparing for renovating a neighbourhood in F. Inhauserstraße (one of the settlements identified in the building structure analysis)
- **ItzSmart** – working out principles for smart development in Salzburg district Itzling
- **HeatSwap** – developing a comprehensive space-heating plan for Greater Salzburg as a starting-point for further steps in energy oriented spatial planning

### TRANSFORM+
### Strategies for Smart City Vienna

Photo: Projektfabrik Waldhör KG

Smart City Vienna is all about a sustainable energy system, intelligent transport services and efficient urban and building structures to make the city worth living in. With the aid of integrated energy and urban planning approaches, pioneering techniques to save energy and carbon dioxide are being developed in Vienna. The research project Transform+ (headed by ÖIR – the Austrian Institute for Spatial Planning - in collaboration with MA 18, the city department of urban development and urban planning) augments Austria's activities within the EU initiative TRANSFORM with a concrete, comprehensive Smart City development strategy for Vienna. In the course of the project a transformation plan for the post-fossil city has been drawn up, stakeholder fora and a Smart City Working Group put in place and energy-specific datasets as well as quantitative analytic tools for energy-oriented spatial planning constructed.

Planning activities focussed on implementation in the districts of Liesing-Groß-Erlaa and Aspern – Vienna's Urban Lakeside are intended to push sustainable development ahead at the local level. Consistent energy supply strategies and concrete pilot applications have been worked out for both districts. The Smart Citizen Assistant provides the residents of the Urban Lakeside with data in user-friendly formats to simplify saving energy, and makes vital information from the district available. The potential for setting up a pool of electric-powered delivery vans on a trading estate has been investigated in the project e-delivery.

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Photo: Franz Neumayr

### Interview with Helmut Strasser SIR Salzburger Institut für Raumordnung und Wohnen

**Salzburg is on a development path leading to the Smart City. What are the main challenges involved?**

It's partly a matter of comprehensively upgrading the existing stock of buildings; residential areas are to be turned into really attractive parts of town by means of integrated planning, with the residents involved throughout. We also need a space-heating turnaround, i.e. reliable long-term heating free of carbon dioxide. The third great challenge is adapting the transport system, as regards both funding and public acceptance during the transition phase.

**Which smart technologies and services have the most potential?**

We're primarily looking for measures and instruments to improve eco-sufficiency. Residential buildings have become significantly more efficient in the last few decades, but this gain has been cancelled out by increases in demand for space. A larger area does not always result in a better quality of life, though. I regard synergies by way of shared use as a good starting-point. Integrated urban planning can and must contribute a great deal here. Spatial planning and energy planning must be fused into energy-oriented spatial planning, so that we can make intelligent use of energy potential such as waste heat.

**How will Salzburg go on developing in future – what are the next milestones?**

Preparations are under way for more than one neighbourhood development project. Watching which solutions are elaborated with local residents wil be exciting. The links between energy, spatial planning and designing open spaces on the one hand, and residence and transport on the other, have a decisive influence here. I see another milestone in the phasing out of oil and gas in space heating, which we are aiming to achieve. Here I expect answers from the HeatSwap project, which has just started as part of "Showcase Region Energy". And thirdly we could develop our strength in cycling to shift Salzburg closer to the European front runners, cities like Amsterdam or Copenhagen.

Photo: Österreichische Energieagentur

# Urban pv+geotherm
# Producing energy sustainably in the city

Supplying urban districts with locally available energy from renewables is a very promising option for the city of the future. In densely built-up urban areas implementing energy strategies involving photovoltaic (PV), solar collectors, geothermal energy, heat pumps and large-scale storage is a complex task. In the Urban pv+geotherm project the Austrian Energy Agency (in collaboration with AEE INTEC, geohydrotherm and Ochsner Wärmepumpen GmbH) has worked out strategies for combining heat pumps (tapping into geothermal energy) with PV and other ways of exploiting renewables to heat and cool an urban development area, so as to maximize energy efficiency and cost-effectiveness. Pioneering storage technologies and building services are part of this approach.

## The example of "Nordwestbahnhof Wien"

The investigations were carried out for the Nordwestbahnhof urban development area in Vienna's 20th district; the experts looked at options for covering this new part of town's energy needs entirely from locally available renewable sources (independently of district heating or the gas grid). From 2020 on new buildings with a total floor area of 780,000 m² are due to be put up at Nordwestbahnhof; 68 % of the buildings will be flats, while offices, schools, shops and restaurants make up the remainder. On the basis of an evaluation of geothermal and solar potential and of other renewable sources of energy available on the spot, simulations have been performed for various scenarios.

## Results

The idea of an anergy grid with downhole heat exchangers turned out to be particularly advantageous. An anergy grid is a low-temperature grid with temperatures between 8°C and 20°C, with various heat sources and sinks tied into. It was found that all the energy needed can be provided from renewable sources available on the spot. Solar energy (e.g. PVT collectors, which combine PV and solar thermal elements), heat from sewage, outdoor air and waste heat from cooling applications were identified as suitable starting-points. Downhole heat exchangers are not an energy source; instead they bridge the gap (discrepancy) between the supply of and demand for heat.

An ecological audit was carried out to determine the levels of carbon dioxide emitted and of primary energy consumed. In comparison with a system running on natural gas, a scenario combining PVT collectors with downhole heat exchangers on the Nordwestbahnhof site could save 47 GWh of fossil primary energy and 9,500 t of emitted carbon dioxide per annum. The saving of emitted carbon dioxide involves a cost increase of Euro 580,000 per annum as against conventional natural-gas heating (annuity on full-cost basis), so the anergic grid plus PVT collectors involve unit avoidance costs of around Euro 60 per t of carbon dioxide. ◘

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**SMART CITY GRAZ**
**Sustainable energy production at district level**

West of the main rail station in Graz the first Smart City district is taking shape; here new energy technologies for intelligent cities self-sufficient in energy are to be demonstrated. The **flagship project Smart City Graz** is concerned with testing novelties such as new solar modules, solar cooling systems, solar power generation in urban contexts, integrated façade technologies, mini-CHP facilities and smart heat grids, and with implementing demonstration buildings.

The centrepiece of the project is the **Science Tower**, a research facility 60 m tall; its façade is clad with an advanced type of PV cells. It is planned to complete the building by the end of 2016. In the Science Tower pioneering enterprises and research organizations will work in the field of urban technologies and push ahead with applying these technologies.

This flagship project also includes setting up a **power centre** and a local power grid to make the district self-sufficient in power; housing complexes and trading centres with pioneering building technologies are to be realized, and sustainable transport strategies (including electric-powered vehicles) tested. These developments will be supervised by a district management team, to ensure that the new structures are integrated in the existing urban space and are accepted by the residents.


Source: markus pernthaler architekten zt gmbh

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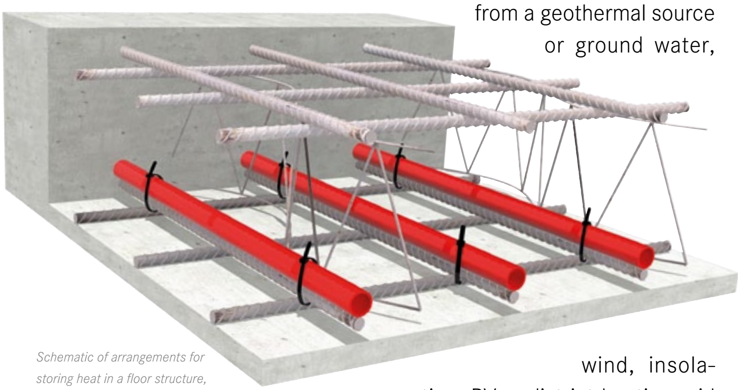
Video Smart City Graz: **http://bit.ly/2dv9yl9**

Energy supply using solar power, Hallwang community centre, Photo: Adrian Kuster, Millstatt

Equipping a floor structure for storing heat, Photo: Aichinger Hoch- u. Tiefbau GmbH

# Storing heat in structural elements
## Buildings as energy storage facilities

An effective way of making buildings more energy-efficient is to store heat in concrete structural elements. To do this, pipe arrays are laid in concrete structural elements with a large area; hot or cold water is then passed through the pipes. The water transfers heat or cold to the concrete, which stores it in its dense material structure and heats or cools the room uniformly. This approach can be coupled with any source of renewable energy; the modest amount of energy needed for heating or cooling can be obtained from a geothermal source or ground water, wind, insolation, PV, a district heating grid or biogenic fuels. The heat or cold obtained from renewables in this way is adjusted to the appropriate temperature level and supplied to the concrete elements. As concrete conducts heat well, heat is rapidly transferred from the pipe array to these elements (with little resistance). As concrete can store large amounts of heat, a floor slab can absorb heat on a fairly large scale without its temperature rising sharply.

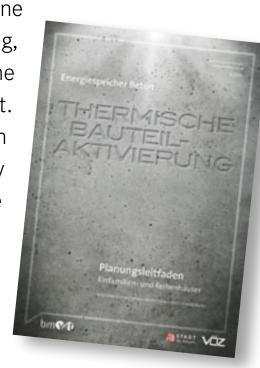


Schematic of arrangements for storing heat in a floor structure, Source: Z + B

The system can thus serve as a very efficient storage device for surplus energy from renewable sources. The structural elements can also be charged at irregular intervals with no ill effects on thermal comfort. If enough buildings are equipped to store heat in structural elements, they can blot up surplus power from renewables, thus helping to even out peaks in supply; conversely, this will reduce the demand for electricity when the supply is low.

### Planning guidelines and monitoring

The Austrian Cement Industry Association (Vereinigung der Österreichischen Zementindustrie VÖZ) has drawn up a planning guideline explaining how storing heat in structural elements can be used to heat and cool buildings. The guideline covers the physics and design of buildings, heating, ventilation and energy supply. Dimensioning the individual storage components is a key aspect. To compare the capacity of the system in different contexts, the project team is currently monitoring two similar houses, which are equipped to store heat in structural elements, one using wind power, the other solar power. The system might also have considerable potential in large-scale housing complexes; particularly in urban areas this opens up interesting resource-conserving options for supplying heat and storing energy from renewable sources.




*Download: https://nachhaltigwirtschaften.at/de/sdz/publikationen/planungsleitfaden-energiespeicher-beton.php (in German only)*

*„Today, heating and cooling buildings by making use of structural elements is virtually state-of-the-art. Previously, storing surplus energy from alternative sources involved considerable expense – but now we are on the brink of a revolution, since the storage technology employed here does not involve additional infrastructure costs.“*

*Felix Friembichler*
*Vereinigung der Österreichischen Zementindustrie VÖZ ( Austrian Cement Industry Association)*

Photo: VÖZ

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# Smart Services
## Business models for resource-optimated urban energy systems

The Graz-Reininghaus urban development area, Photo: Martin Grabner

To realize pioneering technologies and solutions for the Smart City, novel service approaches and business models, so-called "Smart Services", must be developed and tested. A project headed by e7 Energie Markt Analyse GmbH and carried out in collaboration with Energy Center Wien (tinavienna), SIR (Salzburger Institut für Raumordnung und Wohnen) and the Institute of Urbanism at Graz University of Technology is concerned with the implications of the Smart City approach for providing and using energy within delimitable urban districts.

The project team develops practical business models for supplying heat from renewable sources of energy to built-up areas as efficiently as possible. To the experts Smart Services are service packages that make it possible to integrate the demand for and supply of energy in a comprehensive strategy for the settlement or urban district in question.

*„Housing corporations play a key part in sustainable urban development. Supply systems based on renewable sources of energy need cost no more than conventional arrangements; our analyses of life-cycle cost demonstrate this."*

*Walter Hüttler*
*CEO*
*e7 Energie Markt Analyse GmbH*

Photo: e7 Energie Markt Analyse GmbH

### Sample applications

In the course of the project Smart Services will be configured for specific applications in three Austrian urban development areas, and their practicability checked in a comprehensive stakeholder process.

For a new neighbourhood with a total of 6,000 flats in **Wien Donaufeld** one option would be a low-temperature district heating grid with heat pumps and downhole heat exchangers, which could supply the entire settlement with energy from renewable sources. The strategy has been reviewed by experts from e7 from the technical and economic point of view and found to be feasible. As part of the project a funding scheme has been drafted: for this project a mix of project funding, crowd funding and contributions from property developers appears to be suitable.

In the urban development area of **Graz Reininghaus** the waste heat and cold from nearby industrial enterprises (Marienhütte, Stamag and Erber Brunnen) is to be utilized. In addition PV modules could be installed on roof and façade surfaces to supply electricity for the heat pumps and the facilities in general. As the investor here has an operating company, an all-in-one business model might be a good choice.

In the case of the 200-flat **Sonnengarten Limberg housing complex in Zell am See**, using electricity straight from PV modules is to be reviewed. The investigation will cover several ways of consuming the power from a 900 $m^2$ PV facility (140 kWp) on the spot, if possible without buffer storage. Here the system for supplying heat is to be put out to tender, for a contractor to handle. ◘

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The city as a power station – PV facility owned by Wien Süd in Vienna's 23rd district, Photo: Wien Süd

PV modules at a Klagenfurt retail park, Photo: IEV AG

# Strombiz
## Business models for generating and distributing electricity locally

Up to now electricity generated locally with PV has either been consumed by the owner of the property himself or fed into the public power grid. No suitable business models exist for supplying tenants in flats, flat owners or commercial consumers in large buildings directly or distributing the power generated locally to nearby properties via microgrids.

The technical, economic and legal feasibility of such business models has been thoroughly investigated in a survey conducted by IIBW (Institut für Immobilien, Bauen und Wohnen GmbH) in collaboration with experts in science, law and the energy and construction industries. On the basis of specific applications a total of seven models have been developed, tested and documented. Today it is already possible to use electricity generated locally from renewables for the shared facilities in a large housing complex; however, there are legal barriers to supplying individual flats directly.

### Technical and economic feasibility
Even today systems of this kind are technically feasible. On the economic front it has been shown that, with the cost of components continually sinking, payoff periods shorter than 15 years are realistic – even without subsidized feed-in tariffs. Relatively large PV facilities (from about 25 kWp) can achieve payoff periods shorter than 10 years.

### Legal reform
The main obstacles to implementing these business models are in the legal fields concerned with energy, housing tenure and consumer rights. In the course of the survey the manifold legal constraints were analysed and recommendations drawn up. The Austrian statute governing the power supply industry (ElWOG) has to be be reformed, so that the potential of using PV electricity locally can be exploited in future. With communal facilities the promoter will become the power supplier in many cases, which in turn generates new legal issues. And there are other regulations in energy law (such as free choice of supplier, compulsory separate meter per flat, etc.) which make implementation more difficult.

### Potential
Some models, such as tenants of individual flats renting small PV facilities, or flat-rate leasing contracts (for student hostels or nursing homes), can be implemented in line with current law even today. With minor amendments to energy law it would be possible to transfer PV yields to households on a strict accounting basis; within a customer complex the grid operator would assign the yields from a communal PV facility to individual households for accounting purposes. The experts see considerable potential both in existing non-commercial housing and in future construction. Once suitable business models for this sector are available, they can be expected to come on the market very soon. ◘

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The Porsche housing complex in Wiener Neustadt, Photo: Wien Süd

PV modules on the Porsche housing complex in Wiener Neustadt, Photo: Wien Süd

Photo: AIT/Zinner

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**Head of Energy Department**
**AIT Austrian Institute of Technology**

**You are active as an expert in international research initiatives in the Smart City field. What are the objectives of the European activities in this research area?**
For radical innovations to be feasible long-term, clear strategies in research and development are essential. One key instrument is the EU's Strategic Energy Technology Plan (SET-Plan), which will shape its energy R&D policy up to 2050 and beyond. In this strategy for developing and disseminating renewable energy technologies Smart Cities are an important issue, and numerous independent initiatives and programmes are already focussed on it; Austria takes an active part in several of these, for instance in the European Innovation Partnership (EIP) for Smart Cities and Communities, the Joint Programming Initiative Urban Europe or the Joint Programme Smart Cities within the framework of the European Energy Research Alliance (EERA).
**Which are the most promising strategies for making a city more energy-efficient?**
At all infrastructure levels efficiency can be massively increased – for example by making more use of urban sources of waste heat, such as industrial processes, by renovating existing buildings thermally or by accelerating the adoption of the passive-house standard for new buildings. It is equally important to tie in energy systems based on renewables in urban areas, by integrating PV modules, solar collectors or even wind turbines in residential, office or industrial buildings much more. In the long term this will transform buildings into energy-surplus facilities which produce more energy than they consume and can feed power into the grid. In the long run they will thus develop into active players in the overall energy system. In future, though, these developments will make it necessary to control and direct two-way flows of energy in line with supply and demand.
**How can individual elements be successfully combined to yield integrated complete systems for cities?**
The Smart City of the future must be considered, much more than it is today, as an overall system in which buildings and industry must be taken into account just as much as energy supply, the heat and power grids and the transport facilities. Here e.g. electric-powered vehicles will play an ever more important part. Concrete implementation in pilot projects focussed on pioneering design and intelligent operation of the entire urban energy system will lay the foundation stone for more energy efficiency and sustainability.

***Brigitte Bach*** *is active in international research initiatives in the Smart City field. In March 2016 she was re-elected chair of the Advisory Group on Energy – this body of topflight experts advises the EU Commission on the strategic organization of energy research.*

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## Information

**National and international Smart Cities programmes**

**bmvit programme City of Tomorrow**
https://nachhaltigwirtschaften.at/en/sdz

**Climate & Energy Fund's Smart-Cities-Initiative**
www.smartcities.at/home-en-us/

**Joint Programming Initiative (JPI) Urban Europe**
http://jpi-urbaneurope.eu/about/what/
http://jpi-urbaneurope.eu/enscc/

**ERA-NET COFUND „Smart Cities and Communities“**
www.smartcities.at/europe/transnational-cooperations/era-net-cofund-smart-cities-and-communities-en-us/

**ERA-NET „Smart Grids Plus“**
www.eranet-smartgridsplus.eu

**Joint Programme Smart Cities within the European Energy Research Alliance (EERA)**
www.eera-sc.eu

**IEA research collaboration**
www.nachhaltigwirtschaften.at/iea
(in German only)

**IEA-EBC Annex 63: „Implementation of Energy Strategies in Communities“**
https://nachhaltigwirtschaften.at/de/iea/technologieprogramme/ebc/iea-ebc-annex-63.php
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