ASCR
Aspern Smart City Research
WORLD SMART CITY PROJECT AWARD
WINNER 2016

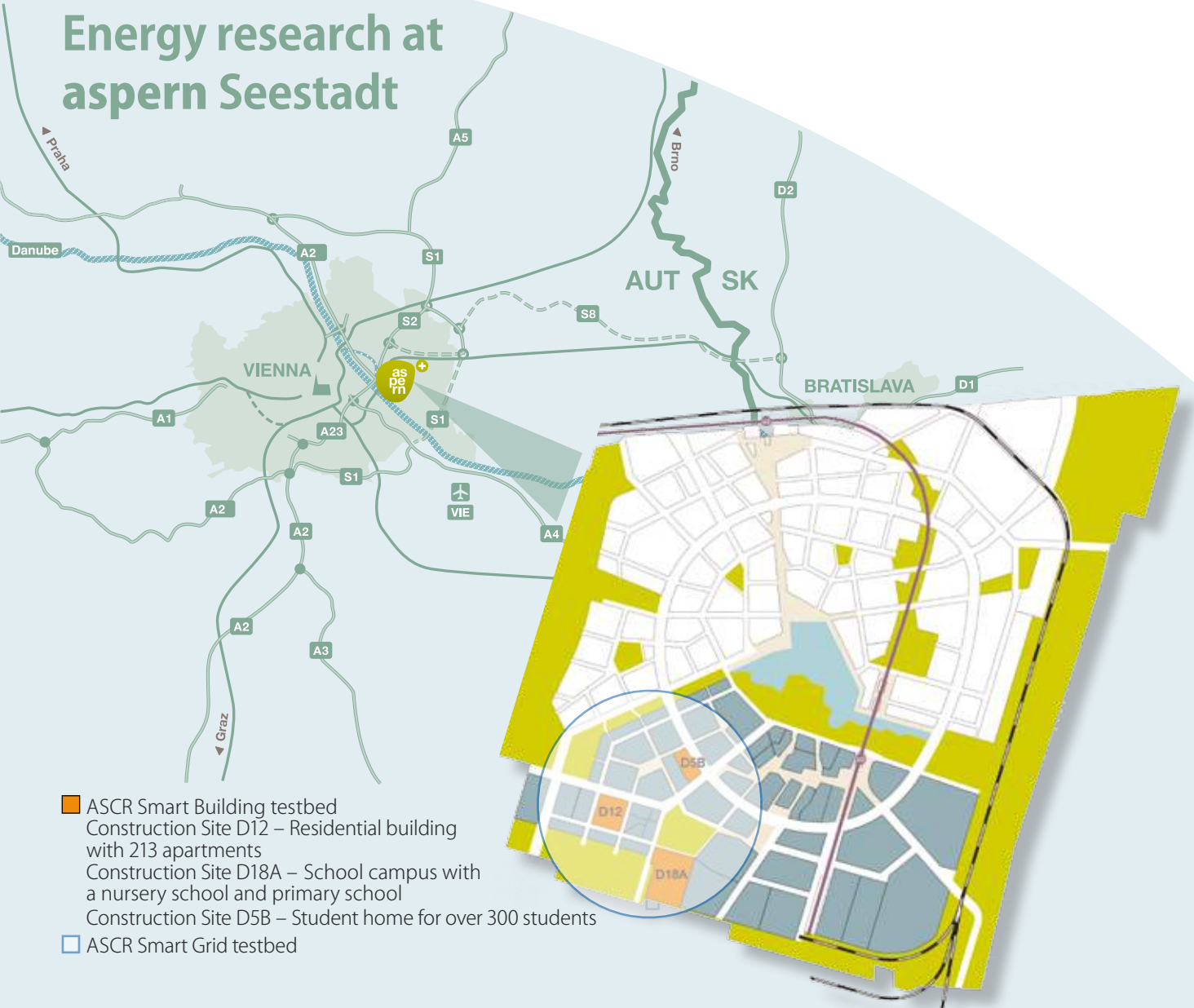
Aspern Smart City Research

Energy research shaping the future of energy

Photo credit: ASCR/Walter Schaub-Walzer

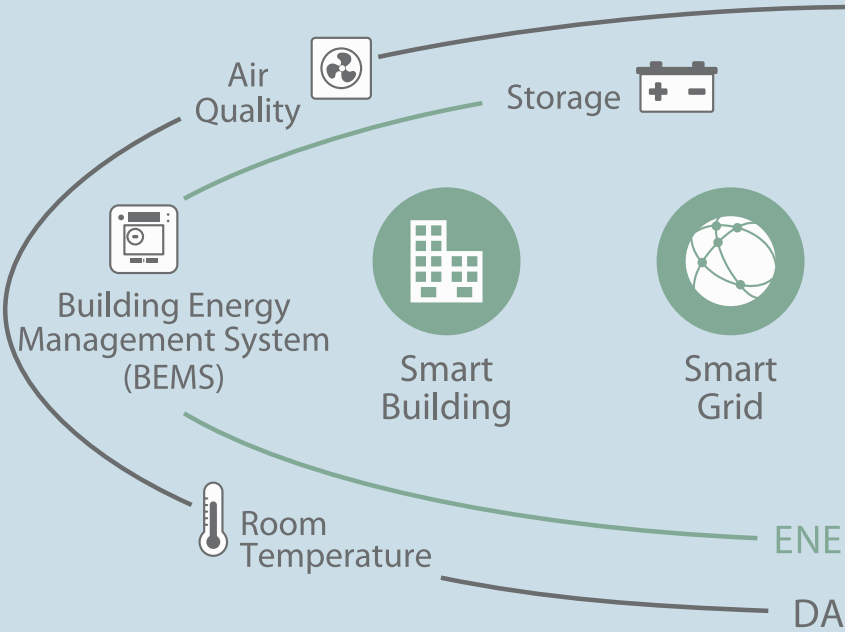
An initiative of: SIEMENS WIEN ENERGIE WIENER NETZE wirtschaftsagentur wien Ein Fonds der Stadt Wien wien3420 aspern development AG

Energy research at aspern Seestadt



- ASCR Smart Building testbed
  Construction Site D12 – Residential building with 213 apartments
  Construction Site D18A – School campus with a nursery school and primary school
  Construction Site D5B – Student home for over 300 students
- ASCR Smart Grid testbed

ASCR research



OPTIMAL HARMONISATION OF:

GENERATION ✓

DISTRIBUTION ✓

ENERGY EFFICI

Photo credit: ASCR/APA-Auftragsgrafik

Photocredit: Daniel Hawelka / wien 3420

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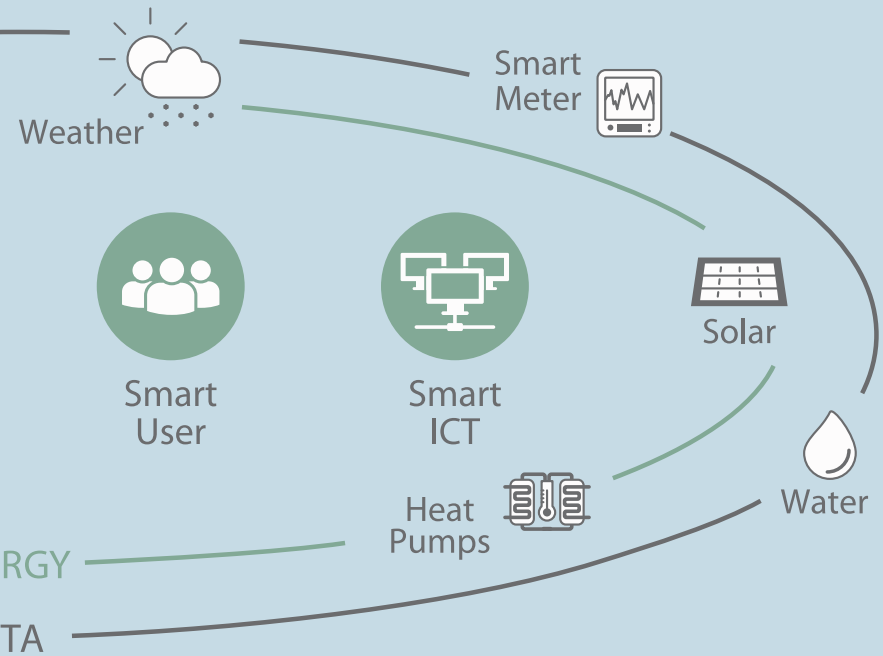

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Energy efficiency as a research field

Aspern Smart City Research cooperation project

Photo credit: ASCR/David Sailer

»The goal of this project at **aspern** Seestadt, which is unique in Europe, is to optimise urban energy production and consumption in such a way that the users of smart buildings can participate in the future of urban energy.«

Robert Grüneis
ASCR General Manager

»We conduct research at the building, grid, ICT and energy user levels. We develop new technologies so as to optimally connect buildings and energy distribution grids.«

Georg Pammer
ASCR General Manager

Shaping the future of energy over the long term means reducing CO_2 emissions whilst at the same time guaranteeing security of supply. The principle focus is on an ever-growing number of decentralised energy producers, integrating active prosumers (consumers that produce) and making use of new storage technologies. There are challenges, working business models and integrated technical solutions still need to be finalised.

However, the research company Aspern Smart City Research GmbH & Co KG (ASCR) has been tackling these challenges by focusing on solutions for the future of energy in urbanised areas since 2013. Real data from the new **aspern** Seestadt district in Vienna are being used for research purposes involving all the components of the energy system – the grid (Smart Grid), the buildings (Smart Building), information and communication technology (Smart ICT) and the users (Smart Users).

ASCR is a test bed for the future of energy provision in urban areas, where research results will help to shape the development of solutions to the challenges posed by grid operations.

At Seestadt, research is being carried out in real life situations, with real users providing actual data, data that will be used to shape the future of grid planning and energy efficiency in urban areas.

Ownership structure

Pooling know-how at ASCR

Photo credit: PID/Jobst

»ASCR shows that innovative spirit is at home in Vienna. The City of Vienna is proud of the fact that it was possible to establish this unique research project and thereby make a meaningful contribution to the future of energy.«

Ulli Sima
City Councillor for Environment and Wiener Stadtwerke

»Energy efficiency and sustainable urban development are among the most important topics of the future for Siemens. We are happy to be the exclusive technology partner in ASCR.«

Wolfgang Hesoun
General Manager of Siemens Austria

Photo credit: Siemens/Andi Bruckner

The ASCR research company was established by Siemens AG Austria, Wien Energie GmbH, Wiener Netze GmbH and the City of Vienna (Vienna Business Agency, Wien 3420 Holding GmbH) and is the largest model of cooperation of its kind.

ASCR
Aspern Smart City Research

Siemens AG Austria (44.1%)

Siemens Austria is one of the country's leading technology companies. Its business activity is focused on areas of electrification, automation and digitalisation. Siemens is one of the largest global manufacturers of resource-efficient technologies. The company is a leading provider of energy transmission solutions and a pioneer of infrastructure services as well as automation and software solutions for industry.

Wien Energie GmbH (29.95%):

Wien Energie supplies more than two million people, 230,000 businesses, industrial facilities and public buildings as well as 4,500 agricultural businesses in and around Vienna with electricity, natural gas and heating. The production of electricity and heat stems from waste recycling, cogeneration plants and renewable energies such as wind, water, solar power and biomass. Wien Energie focuses on the decentralised generation of energy and on energy services.

Wiener Netze GmbH (20%)

Wiener Netze provides Austria's largest distribution network which combines the planning, operation and maintenance of all energy networks under one roof. Roughly two million customers in Vienna and the surrounding area are connected to the electricity, natural gas, district heating and telecommunication network. Wiener Netze offers 24/7 support. In order to ensure constant security of supply, Wiener Netze are investing over one billion Euro in an innovative expansion of its network until 2020.

Vienna Business Agency (4.66%)

Vienna Business Agency is the first point of contact for Vienna's companies, international firms and start-ups, offering subsidies, business locations, real estate and free advice. The aim is to provide support to companies in Vienna and to boost their innovative power. In this way, the business agency improves the ability of the location to compete at an international level.

Wien 3420 Holding GmbH (1.29%)

Wien 3420 was established to develop the new district of **aspern** Seestadt in Vienna. Together with partners, it is responsible for space utilisation, urban planning, zoning support and infrastructure development.

Facts & Figures

Information about ASCR at a glance

ASCR's core team, from left to right:
Nicole Kreuzer (Communications), Elisabeth Widdeck (Finance), Robert Hammerling (Research), Gerhild Kircher (Finance/Authorised Signatory), Martin Svaricek (Research), Georg Pammer (General Manager), Robert Grüneis (General Manager), Ines Weigl (Research), Roman A. Tobler (Research/Authorised Signatory), Oliver Juli (Funding), Melisa Kis-Juhasz (Assistant), Andreas Schuster (Research)

Photo credit: ASCR/David Saller

The collaboration between a network operator, energy supplier and technology company with property developers, technical manufacturers, administrators and residents in one research project is what makes ASCR unique. It is one of the most innovative and sustainable energy efficiency showcase projects anywhere in the world, and one which is particularly notable for its exclusivity. Complex connections, rather than individual elements, are researched using real data.
Over 100 people from various scientific fields are directly involved in this research project.

Scientific disciplines involved:
Automation technology, building engineering, energy technology, information technology, communication technology, mechanical engineering, mathematics, motivation and market research, psychology, spatial planning, legal sciences, sociology, engineering physics, environmental technology and economics.

Duration

Aspern Smart City Research GmbH & Co KG (ASCR) launched its activities on 1 October 2013.
The project will run until 2018.

Location

The head office of ASCR is the Seestadt Technology Center, Seestadtstrasse 27, 1220 Vienna.

Budget

The project, which runs to 2018 in its first phase, has an available budget of some EUR 38.5 million.

→ 2013 ---------- 2014/2015 ---------- Q4 2015–Q4 2016 ---------- 2016/2017 ---------- 2018 ←

Kick-off phase:

Establishment of ASCR

Preparatory phase:

Planning and construction of the technical infrastructure

Research phase 1 – Baseline phase:

Occupation of buildings, data collection without intervention, model calculations, initial user surveys, initial network analysis

Research phase 2 – Management phase:

Data collection including the management of individual building components, further network analysis, user interaction

Closing phase:

Completion of current research element, preparation and interpretation of results

aspern Seestadt

Vienna's new district as a research hotspot

The Seestadt Technology Center is the head office of ASCR.

Photo credit: Kurt Kuball

aspern Seestadt is one of the largest urban development areas in Europe. By 2028, apartments for over 20,000 people and thousands of jobs will have been created on an area the size of some 340 football pitches. The area, which lies in the north of Vienna, is being developed in three phases and in accordance with the master plan by Swedish architect Johannes Tovatt – the investment volume is around EUR 5 billion. As of 2017, approximately one quarter of **aspern** Seestadt has been completed. At the time of writing, Vienna's new district has some 6,100 residents and more than 1,500 people employed there.

Photo credit: Peter Rigaud

» ASCR provides a major impetus to Vienna as a hub of technology. Only if we continue focusing intently on collaborations between business and research will we be able to hold our own in the face of international competition.«

Gerhard Hirczi

General Manager of the Vienna Business Agency

The importance of Seestadt as an economic hub is growing. 120 companies – from sole traders to Vienna's largest co-operative training company and a multinational company – have already put down roots in **aspern** Seestadt. The new Lake Park quarter is due to be completed by 2020 and will provide additional impetus to the business location.

Major research projects are being undertaken in the Seestadt Technology Center of the Vienna Business Agency. Some of ASCR's neighbours include the first digital pilot factory in Austria. Together with 20 companies, experts from the Vienna University of Technology (TU Wien) are researching and developing new methods and production processes here for Industry 4.0.

Furthermore, various start-ups such as SCL-Sensor. Tech and Theobroma Systems have moved to the Seestadt Technology Center in recent years. SCL-Sensor Tech works in the field of ICT and develops measuring devices to research nanostructures. Theobroma Systems is an IT company which focuses on home networking and energy efficiency.

The Technology Center is expanding to meet the ever growing needs associated with Industry 4.0. An additional 10,000 square metres of production, laboratory and office floor space is being added in the form of two new buildings. The objective is to offer tech-savvy companies space and the right infrastructure to be able to forge new paths in production-related research, energy and environmental technology, as well as automation and production technology.

Photo credit: Schedl_aspern

» If you want to be fit for the future, you have to be actively involved. **aspern** Seestadt is a site that is open to innovations and creates the perfect conditions for those looking to develop technologies for the future.«

Gerhard Schuster

CEO of wien 3420 aspern development AG

The future of energy begins today

Research with real energy data at aspern Seestadt

Photo credit: ASCR/Walter Schaub-Walzer

A change in the weather is forecast for tomorrow. The smart buildings act with foresight, storing energy for use later. Some of this energy can be traded on the energy market. The smart grid interacts with the buildings, distributes energy and functions as a communications platform. Users control their energy consumption remotely and conveniently using a smartphone or tablet. This is how the energy of tomorrow is already at work in the ASCR testbed at the **aspern** Seestadt.

The guiding principle of ASCR is "the whole is more than the sum of its parts" – as the research company examines how all these components interact. The focus here is on forward-looking building automation and using a building's energy flexibility. Users are proactively involved in the development work with the aim of designing customised products and services that improve their quality of life. Furthermore, optimum methods are determined to record the grid status in order to improve network planning. All these solutions are based on comprehensive information and communication technology for which suitable models are being tested and developed in order to process large amounts of data. The research findings are intended to make a key contribution to developing scalable solutions for the future energy needs of whole cities.

» The aim is to transfer ASCR's research results to other cities in the future, and to contribute to a more efficient energy system that conserves even more resources.«

Andreas Schuster
Research

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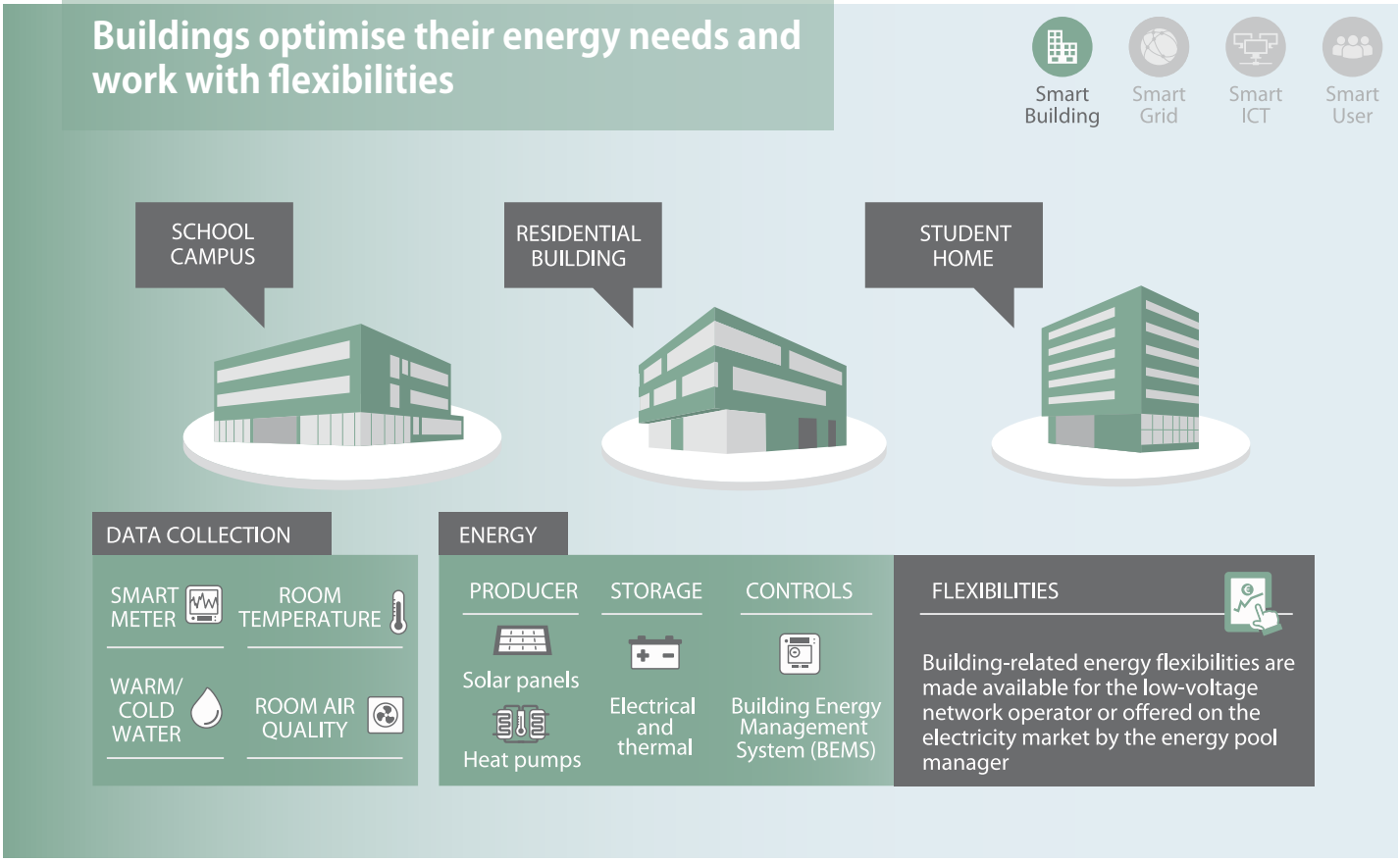
Smart Building

Buildings optimise their energy needs and work with flexibilities



Credit: ASCR/APA

Three buildings – a residential building, a student home and a school campus (currently a nursery school and primary school) – constitute the smart building research objects of ASCR. Equipped with photovoltaic panels, solar thermal panels, hybrid panels, heat pumps and various thermal as well as electrical storage facilities, smart materials, building technology and IT, the buildings of tomorrow act as flexible prosumers. They not only use energy, they also produce and store it. Complex ICT systems facilitate the optimum, automated management of energy distribution, consumption, storage and transmission. Furthermore, smart buildings can also participate in the electricity market.

Optimised own consumption

Around 40 percent of total final energy in Europe is consumed in buildings. As such, a key focus of ASCR is on optimising a building's own consumption in the building. Future building optimisation systems offer a clear advantage – they can see into the future. They are designed in such a way as to calculate expected energy needs, taking into account user habits, energy-saving behaviour, energy production, weather forecasts and other data. They can also provide information about the condition of specific building units and for planning maintenance work.

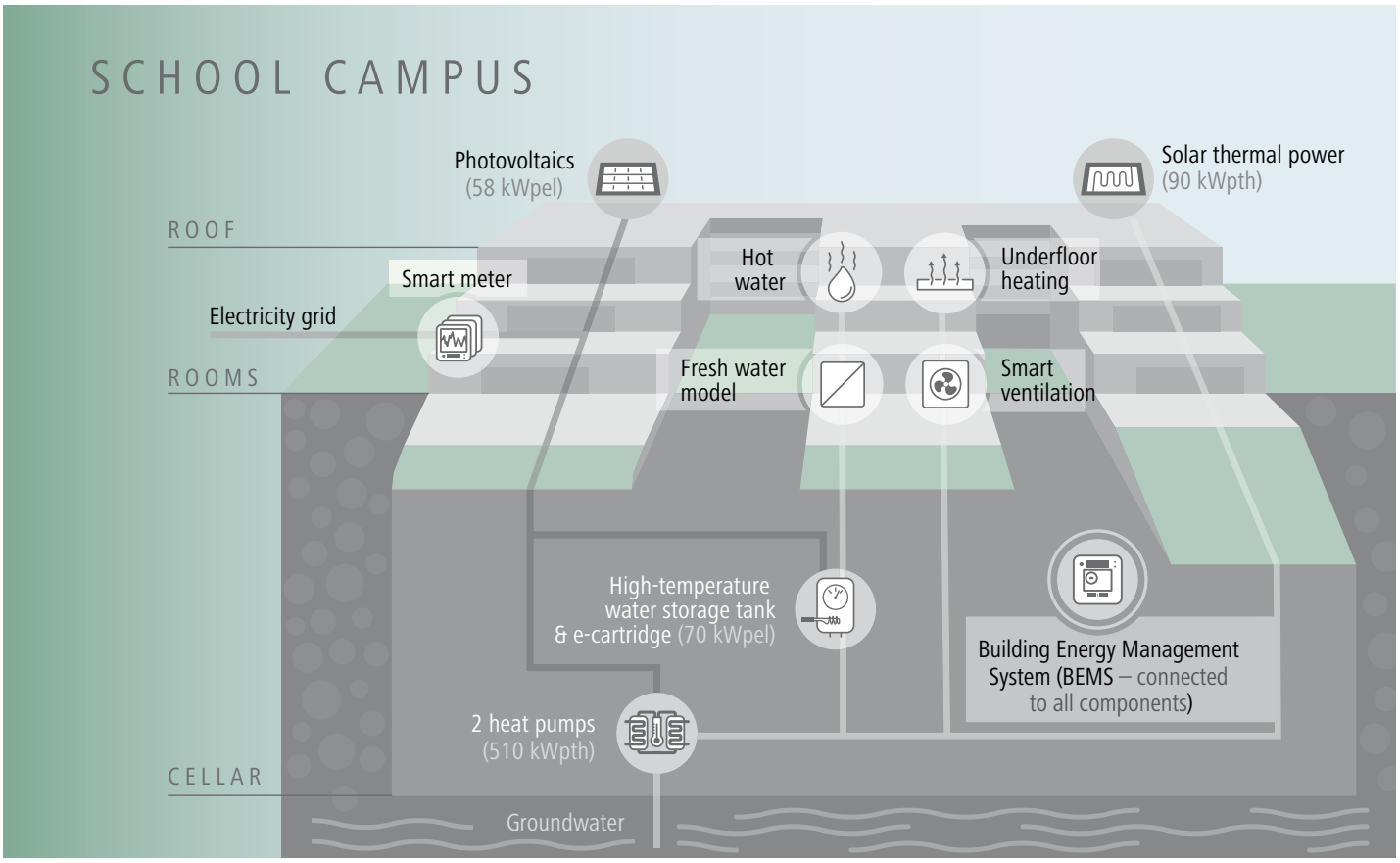
Building flexibility

Aside from optimising own energy consumption, ASCR is primarily interested in the potential of buildings to make energy flexibility available externally. Consequently, one of the most important questions is how buildings can exploit their flexibility in the future to support local medium and low-voltage networks or, alternatively, participate as an active player in the electricity market?

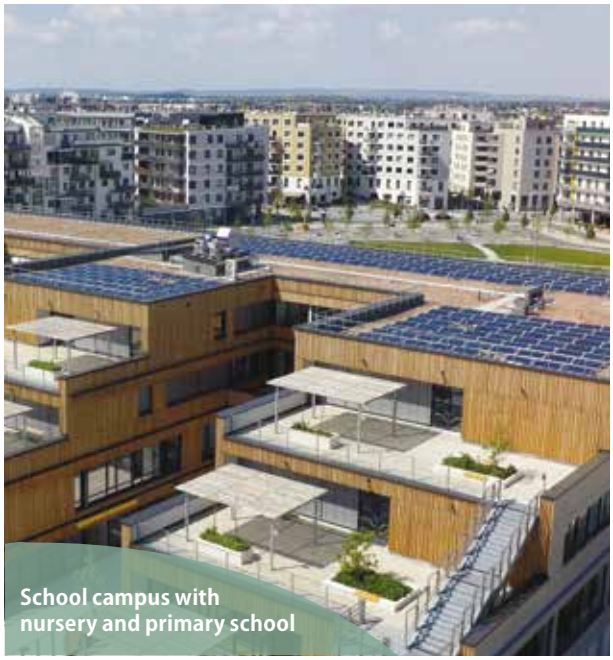
Flexibility pooling

To master these challenges, several buildings (and, in the future, as many as several thousand buildings) must be observed together. This requires a building energy management system (BEMS), which calculates the electricity consumption of the building and any flexibility at regular intervals. This makes it possible to forecast when and how much of a surplus will be produced and thus be available to feed into the grid. An energy pool manager acts as an interface between the individual buildings and the electricity exchange.

In order for buildings to participate in balancing energy markets, they require smart electricity networks, which not only need to know about the network status at any given time, they also have to be able to forecast it. New legal framework conditions are also needed for this.



Credit: ASCR/APA

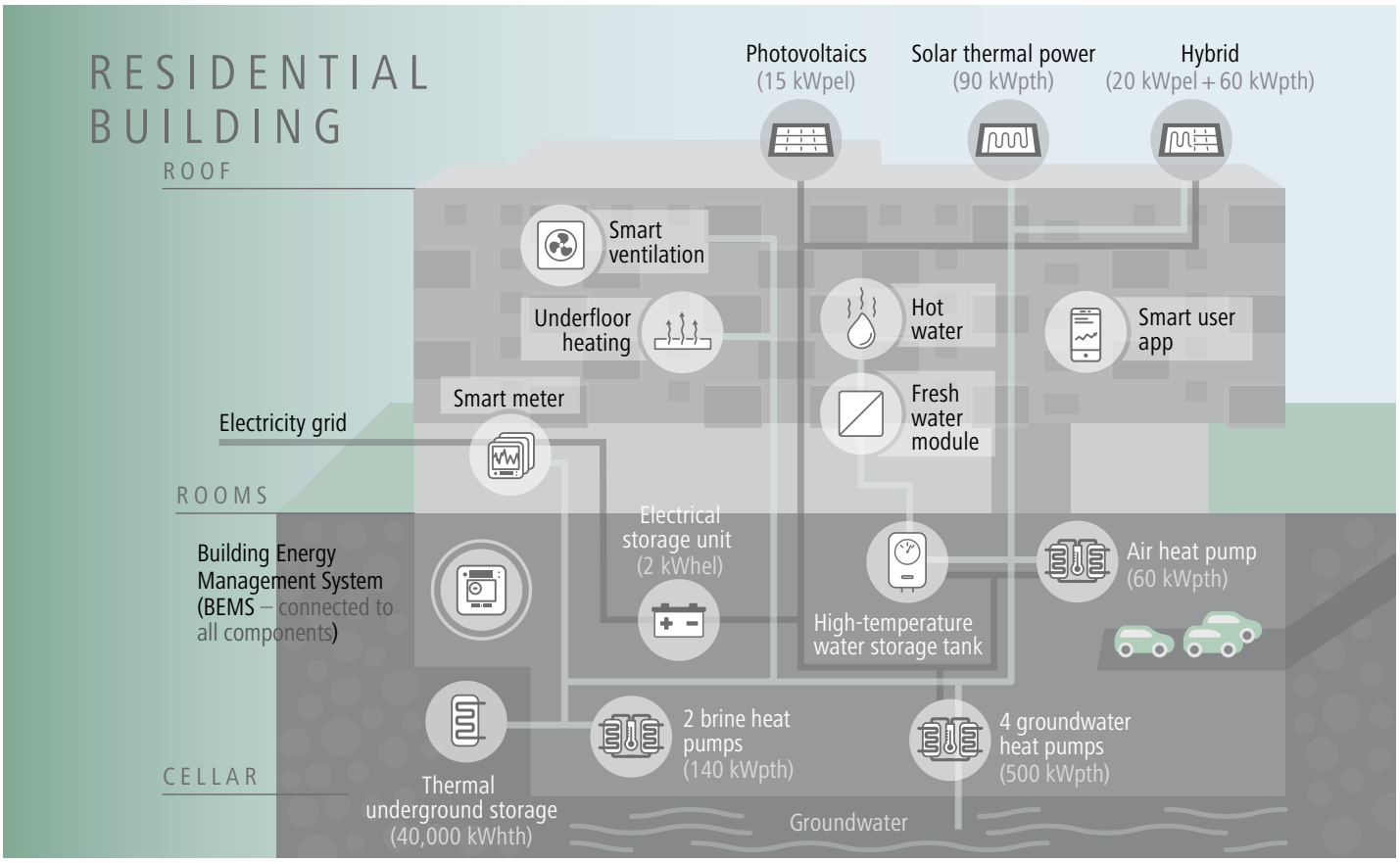


School campus with nursery and primary school

Photo credit: ASCR/Walter Schaub-Walzer

At Vienna's largest school campus, Campus Seestadt, there have been eleven nursery groups for over 200 children since 2015, as well as a full-day primary school with 17 classes and eight classes designed for children with special educational needs.

The school is self-sufficient in terms of its heating requirements thanks to the technical infrastructure of ASCR. Energy is produced using solar thermal and photovoltaic panels as well as heat pumps. A special feature of this building is that heat is extracted from the exhaust air produced by people and technical equipment. There are major potential savings to be tapped by recovering energy in this way.



Credit: ASCR/APA

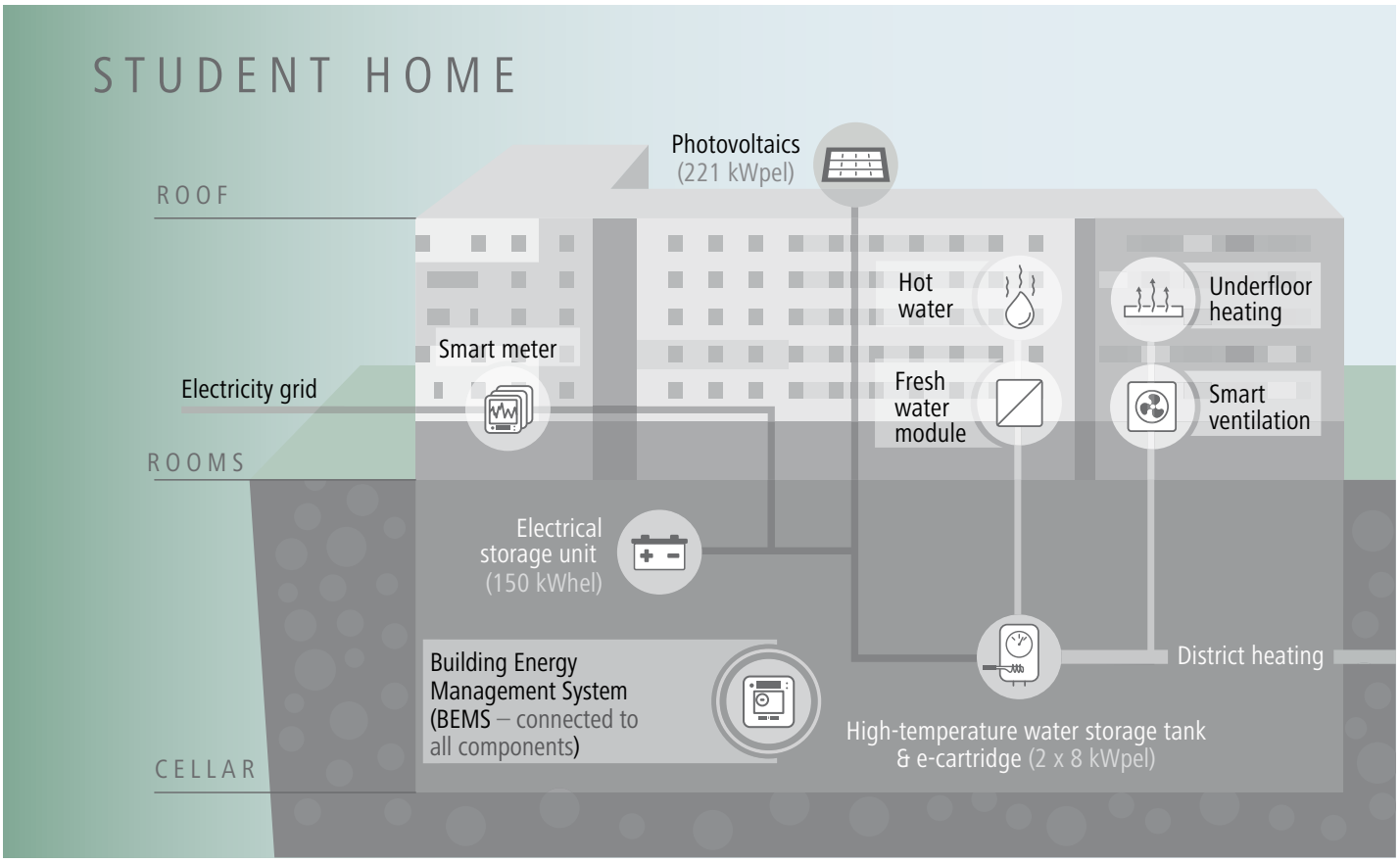
Photo credit: wien3420/Amelie Chapalain

Residential building on Maria-Tusch-Straße

The residential building on Maria-Tusch-Strasse comprises 213 subsidised rental apartments in six complexes with a total floorspace of some 16,000 square metres. Commercial floorspace is located on the ground floor and beneath the commercial space two levels of underground car parking have been constructed. What is special about this building is that its façade is made of timber.

Energy is produced using solar thermal panels, photovoltaic panels and hybrid systems (mix of photovoltaic and solar thermal systems), as well as heat pumps.

Interaction with residents in this building is of particular interest to ASCR. 111 households decided to actively participate in the research project. They are able to monitor and actively manage their energy consumption by means of a smart home control app developed in-house. ASCR was also able to harness the waste heat from the car park to produce hot water and heating using an air heating pump. Additionally, a new concept of thermal underground storage was successfully installed.



Credit: ASCR/APA-

Photo credit: Rupert Steiner for aap.architekten/WBV-GPA/OeAD-WV

GreenHouse:
a home for students

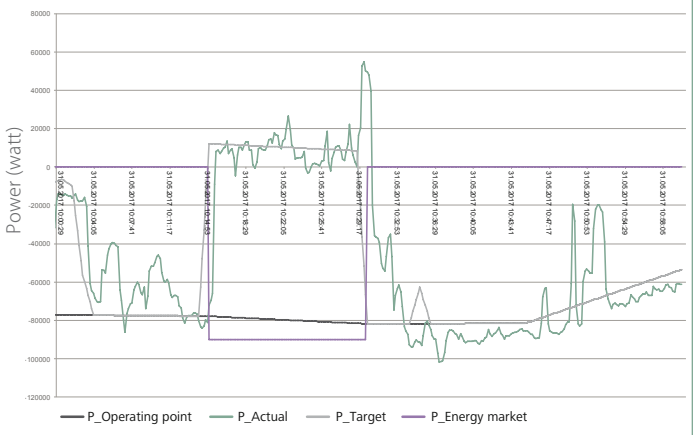
The GreenHouse student home offers 313 living units over 7,000 square metres. The student home has been built to passive house standards. The Austrian Association for Sustainable Building (ÖGNB) recognised GreenHouse for its sustainability back in February 2014. The electricity for the building is produced using photovoltaic panels on the roof. Heating and hot water are provided by means of district heating.

ASCR has implemented an intelligent building energy management system (BEMS) in the student home, which actively controls the supply of energy to the building and optimises energy consumption. In addition, BEMS looks for what is economically ideal by trading energy flexibilities at various energy markets.

Heating center in the student home

Photo credit: Siemens/Markus Rössle

Providing negative balancing power from the building to the energy market



A sample calculation based on a calendar week in May 2017 produced potential savings for the whole building of 18 percent thanks to the BEMS – assuming variable electricity prices (based on current daily energy prices according to Energy Exchange Austria and actual grid and power prices). The rate of the building's own consumption was 40 percent. Energy flexibility (30 kW positive and 90 kW negative) was actually tested in practice.

Interim results in the Smart Buildings research area

Building results – energy optimisation:

- The smart residential building saves over 71 percent or nearly 240 tonnes of CO_2 emissions every year compared to a gas-fired heating system. A 100 percent green electricity tariff further increases the potential savings.
- By overcharging the thermal buffer storage during the day with solar power, night-time heating requirements in the residential building can be met, particularly during transition times. This means that the heat pumps have shorter operating times, thereby saving energy and cutting costs.
- Heat recovery at the school campus saves 195 MWh/year, which corresponds to financial savings of around EUR 10,000 every year.
- A reduction in peak grid demand was achieved at the student home by using battery storage units, meaning a saving of up to EUR 5,000 every year.

Findings from infrastructure and planning:

- Solar thermal panels on the roofs supplied much greater yields than conventional systems despite the significantly higher requirements in terms of operational management.
- The air heat pump in the car park exhaust air system in the residential building successfully harnesses the car park's exhaust air and increases the thermal energy by a factor of one.

Results in respect of the building energy management system (BEMS):

- In terms of energy optimisation, the BEMS integrated into the student home is operating successfully. Moreover, the building already communicates with the electrical grid, through which valuable information, such as forecast energy consumption, is exchanged.
- Sample calculations have shown that it is possible to achieve cost savings of around 18 percent with the BEMS.

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ASCR Demo Center

Insights into the energy world of tomorrow

Photo credit: ASCR/Philipp Lipiarski

ASCR Demo Center at the Seestadt Technology Center

Since June 2016, the ASCR Demo Center at the Seestadt Technology Center has been open and providing an insight into tomorrow's energy world.

In an interactive showroom covering more than 60 square metres, visitors are given the opportunity to get to know the complex research programme and all its facets. A tour through the Demo Center demonstrates all about how the production, storage, distribution and consumption of energy can be efficiently designed in an urban context. Presentations are tailored to the interests and prior knowledge of the visitors. The content of interactive installations and animations can be controlled by a tablet, and additional information displayed on demand. This way, the tour can be just as informative and interesting for a group of energy experts as for interested laymen.

In order to present information in a comprehensible and clear way, ASCR's research areas in the Demo Center are spread over two levels. The first level focuses on components of energy research visible from outside, smart buildings, and the smart users interacting with these. The second floor of the Demo Center looks at the technical equipment, data flows and control elements that work in the background, i.e. the smart grid and smart ICT.

Where is it located?

The Demo Center is located on the first floor of the Seestadt Technology Center, Seestadtstrasse 27, 1220 Vienna. Tours can be booked by writing to office@ascr.at or calling 01 908 93 69. There are no fixed opening times.

WINNER

World Smart City Award

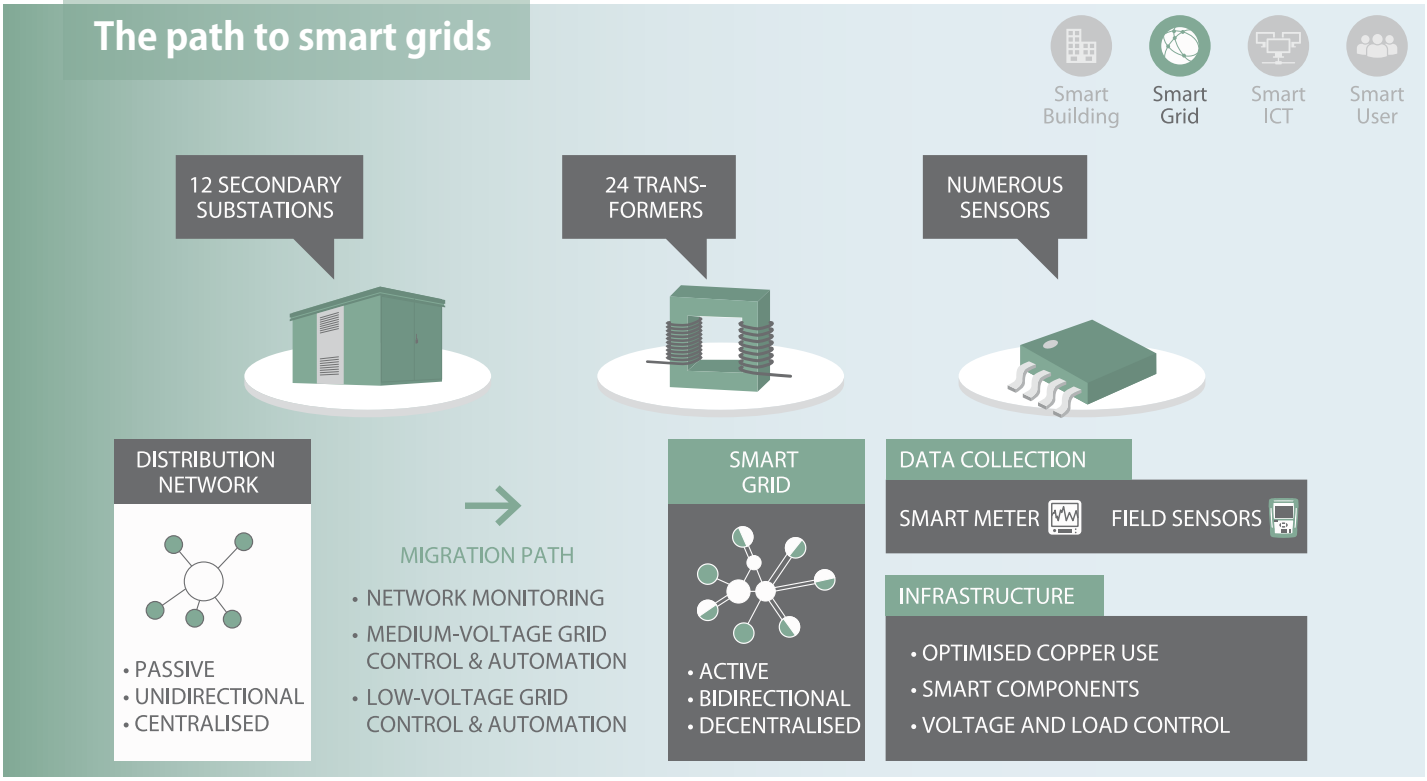
ASCR was identified as the world's best Smart Project 2016. It prevailed against more than 250 projects from 45 countries at the Smart City Expo World Congress in Barcelona, the world's largest event on the subject of smart cities.

The international jury was won over by the approach to combine all components in the energy system – i.e. building, grid, user, and information and communication technologies – and thereby work on an efficient and low CO_2 energy future.

SMARTCITY
EXPO WORLD CONGRESS

Smart Grid

The path to smart grids



Credit: ASCR/APA-Auftragsgrafik

12 secondary substations, 24 transformers of different types (including one variable), numerous sensors in the substations and supply lines with different measurement accuracy (including power quality measurements) as well as smart meters make up the basic infrastructure of the ASCR Smart Grid testbed. Furthermore, there are five grid storage systems in the substations with important functions both for the grid and the energy market. ASCR is investigating how to turn passive distribution network operations into actively managed smart grid operations.

Smart grids connect every player in the energy system via a communication network, thereby enabling prompt, bidirectional and cost-efficient communication between grid components, producers, storage facilities and consumers.

Smart grid migration path

The approach that has been adopted is based on the optimal use of existing copper reserves and the integration of smart ancillary technologies – not overnight, but continuously, along the smart grid migration path.

Photo credit: Wiener Netze/Ian Ehm

» As part of ASCR, we focus on the requirements of tomorrow's energy grid.
In this way, we safeguard reliable security of supply, today and in the future.«

Thomas Maderbacher
General Manager of Wiener Netze GmbH

Phase 1 of the migration path is monitoring which sensors and which data are needed in which resolution. Phase 2 uses the sensors and pushes the equipment to its limits. Phase 3 is characterised by the efficiency gains from automation and active management.

Phase 1 – Measuring and monitoring the low-voltage network

While there are already suitable sensors and control systems at the level of high-voltage networks, these are still lacking in low-voltage grids. However, these make up the largest part of the electricity network and are the most active areas in terms of grid dynamics and fluctuating voltage. Now, for the first time, ASCR is recording comprehensive data in the urban low-voltage network on a large scale so as to make the grid status and utilisation at the low-voltage level transparent. Data capturing is carried out via smart meters and self configuring field sensors – including power quality meters (P855) or grid monitoring devices (GMDs).

How many sensors are needed?

A key issue for the ASCR research programme is to determine the minimum number of sensors required to provide a sufficiently detailed picture of how efficiently the network is operating and to aid network planning, whilst being mindful of the costs. The general rule is to use as many sensors as necessary and as few as possible.

Phase 2 – Low-voltage management with no active intervention

Further down the smart grid migration path, the data can be used to make management decisions that do not require any physical network expansion for the time being. They represent an efficient alternative to vague worst-case planning. Without active network intervention, specific network data enable infrastructure to be used closer to its physical limits and provides early warnings when thresholds or set KPIs (key performance indicators) are approached. In addition, the collected data/time series can be used to plan accurate expansion measures by means of relevant evaluations, extrapolations and simulations.

Phase 3 – Active grid management and automation

Active grid intervention can help to raise the efficiency of electricity network infrastructure. This, however, requires that the components are as fault-tolerant as possible and that they do not add significantly to overall cost during roll-out or operation.

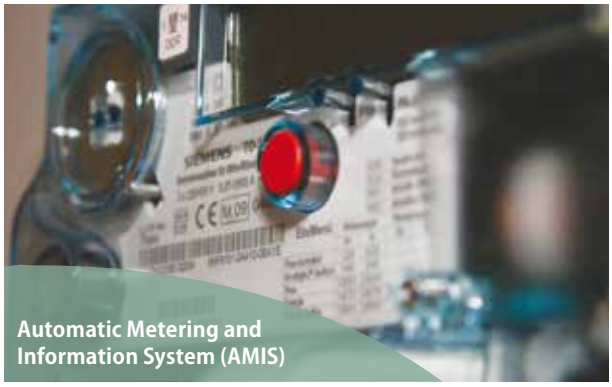
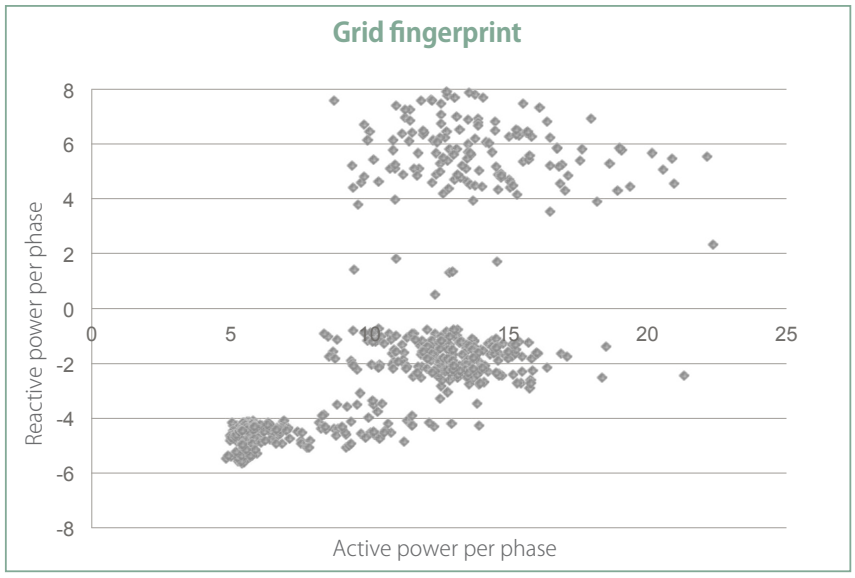


Photo credit: Siemens

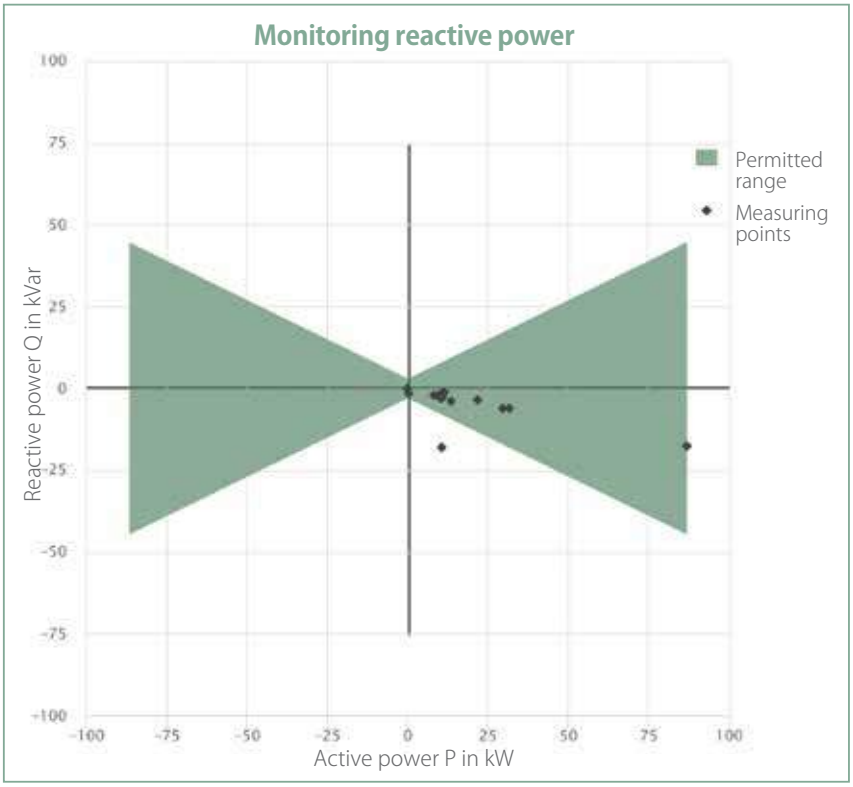
Smart Grid testbed

The main components comprise:

- Twelve prototypes of a smart grid station
- 24 transformers of different types (incl. one variable)
- Five grid storage systems in the substations (120 kWh)
- Fully equipped with grid monitoring devices (around 90 units)
- Two construction fields with smart meters (over 500 units)
- 15 power quality measurements at the substation



To simplify the visual processing of the network status, vectors of different grid parameters are calculated and presented in the 'grid fingerprint'. Just as with a fingerprint, every network status and all network behaviour have a different pattern. Time and local differences, and the interplay between the battery storage system and grid activities, are very easy to see.



The monitoring of critical thresholds (shown in the figure to the left as reactive power) is a key factor of network operations. In the future, there will be an increased number of smart meters and other sensor technology in order to identify and handle critical consumption data. By comparing different time periods, ASCR is exploring whether thresholds are breached in the grid so as to optimise network operations. Major deviations are immediately visible.

Interim results in the Smart Grid research area

- Existing battery storage systems are not yet compatible with grid technology. Questions are being asked of producers.
- For much of the analysis, the 15-minute effective averages offer a sufficient insight into the distribution network. However, minimum and maximum values need to be stored.
- The economically important factor driving the implementation of a smart grid is avoiding power outages (already at around one minute every year).
- Vienna's network has shown itself to be very robust, meaning that a flexibility operator is only needed in exceptional cases.
- Early results show that, at individual connection points, reactive power breaches thresholds.
- A distinction can already be made between consumption curves for normal operations and exceptional situations.
- Characteristic failure patterns in smart meters can be read from the data flows.

INFOBOX

Smart City Vienna

The Smart City Vienna Framework Strategy, which runs until 2050, is a long term umbrella strategy that aims to raise the quality of life for all residents of Vienna, whilst ensuring that natural resources are conserved.
Vienna rightly wants to be seen as an international pioneer and is therefore working not only on carbon dioxide (CO_2) targets, but also on the whole smart city concept.
The ASCR research programme is making a valuable contribution to the framework strategy given that, through this project, every aspect of smart city living is being considered with particular attention being paid to energy, traffic, healthcare, buildings and communications.

More information on Smart City Vienna can be found here: www.smartcity.wien.at

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Funded projects

Intensive research through collaborations

Photo credit: Thomas Preiss/APA

Presentation of the flagship project SCDA 2014, from the left: **Oliver Juli (ASCR project management), Theresia Vogel (General Manager of the Climate and Energy Fund), Reinhard Brehmer (former General Manager of ASCR) and Silke Mader (Transition Partners)**

Smart Cities Demo Aspern (SCDA)

The showcase project Smart Cities Demo Aspern (SCDA) has been running since 2014 and has a budget of EUR 8 million. The Austrian Climate and Energy Fund is supporting the SCDA project with grants totalling EUR 3.7 million. The three-year project involves around 120 people, with research being conducted primarily on the usage of energy flexibilities, the active management of the low-voltage grid and the intelligent interlinking of buildings and the low-voltage network through ICT. The involvement of users is also a key component of the project.

Integrated network information systems (INIS)

The INIS project runs from 2014 to 2017 and is receiving funding totalling EUR 1.8 million from the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT). INIS develops methods and processes based on smart meters and sensor data for network analysis in order to achieve improvements in system efficiency and network operations. The implementation of an ICT infrastructure suitable for the network operator is being defined and implemented. The objective is to enable the interoperability of ICT architecture with existing systems and future smart grid requirements.

Network stabilisation and optimisation of the distribution network by using flexible AC distribution systems (FACDS)

The FACDS project is due to run for 30 months (until August 2018), with some EUR 1.1 million of funding from the Climate and Energy Fund. It defines useful functions of future decentralised storage systems in electrical distribution networks through simulation validation at the system and component levels, accompanied by a laboratory validation of the inverter systems. The main focus is on the real implementation of pilot facilities in the ASCR testbed.

SCDA consortium

Consortium management and project management: ASCR

Industry partners: Siemens AG Austria, Wien Energie GmbH and Wiener Netze GmbH

Scientific partner:
Austrian Institute of Technology GmbH (AIT)

City of Vienna:
Municipal Directorate / Urban Building Directorate – Project Management Seestadt Aspern as well as Municipal Department 18: Urban Development and Urban Planning

SME partners:
Moosmoar Energies OG, Technisches Büro Käferhaus GmbH and SERA energy & resources e.U.

INIS consortium

Consortium management and project management:
Austrian Institute of Technology (AIT)

Partners: ASCR

Grid operators:
Wiener Netze GmbH, Salzburg Netz GmbH

Technology partners: Siemens AG Austria, GRINTEC Gesellschaft für graphische Informationstechnologie mbH, Teradata GmbH

Scientific partner:
Vienna University of Technology – Institute of Energy Systems and Electrical Drives

FACDS consortium

Consortium management:
Wiener Netze GmbH

Partners: ASCR, Siemens AG Austria, Wien Energie GmbH, AIT Austrian Institute of Technology GmbH, Energy Institute at the Johannes Kepler University Linz, Research Burgenland

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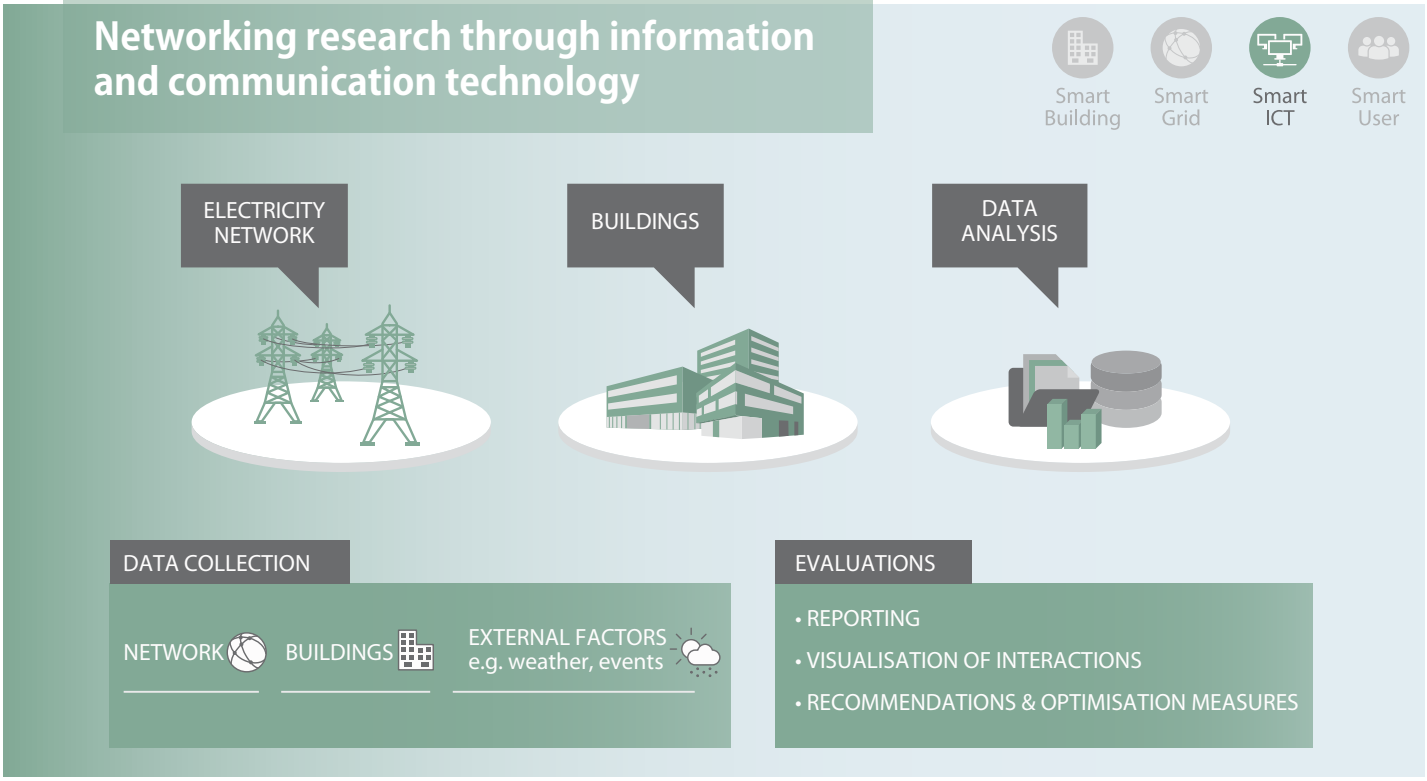
Smart ICT

Networking research through information and communication technology



Credit: ASCR/APA-Auftragsgrafik

Smart ICT uses all of the data obtained from the buildings and the network (temperature, room air quality, electricity consumption, voltage, etc.) and external data (e.g. weather or other related events), with due consideration of data protection guidelines, to analyse the interaction and the interdependencies between the network and the buildings. These important sources are providing an integrated overview of data from the various domains. ASCR's comprehensive approach is unique around the world.

Digital reproduction of reality

Using data from the test field, The ASCR research team is able to create a digital reproduction of an actual situation in order to simulate any energy concept as well as associated optimisation measures. The objective is to develop scalable and feasible solutions to deliver urban energy balance.
The Smart ICT testbed comprises a central data warehouse, Teradata DM670C, and a Hyper-V environment with 25 virtual systems.
The research questions concerning smart buildings, smart grids and smart ICT are closely interlinked. The buildings and sensors in the low-voltage network provide the readings for the ICT. The security of data transfers, data quality and the integration of various data sources play a major role here. The way in which the different components are related to each other are explored.

Examples of Smart ICT questions that could be answered through this process are: How do various strategies for optimising a building's own energy consumption influence the grid – and vice versa? What influence does active network management (integration of plug and play technology, etc.) have on buildings with regard to their flexibilities?

Self-learning systems

Since building occupancy rates and network capacity utilisation constantly change, the models on which the simulations run must be adjusted continuously. The models, and thus the internal building and network control mechanisms, must refine themselves by means of adaptive self-learning algorithms. The information obtained is particularly important for the optimum integration of renewable energy sources. ASCR explores the impact of using different energy sources – in different combinations and under changing weather conditions – on the network and the building. Potential local overloads can be forecast and bottlenecks resolved through coordination between the network and the building.

Which data models are used?

Large data methods are used to cope with the enormous data volumes from the various domains. As part of the ASCR research programme, both large centralised data models and decentralised models (Hadoop software framework) are being tested. Smart data analysis leads to optimised consumption or energy distribution, and potential problems with voltage fluctuations, for example, will be recognised early. Using data from different domains will, in the future, enable a comprehensive, comparative analysis of an urban area (whole city, district, building complex or individual building). Both predefined reports and the explorative analysis of different data are able to highlight new relationships within the complex urban system, or demonstrate the effectiveness of optimisation measures.

Photo credit: Siemens/Markus Rössle

Secondary distribution panel at the transformer station of the school campus

Apps and services

The integration or exchange of different data is the basis for the development of apps and services for various stakeholders:

- Benchmarks: Reporting, simulation and comparative analysis of buildings / building components or of the network to evaluate optimisation measures in operations and equipment.
- Operational network planning: Uncovering anomalies/ threshold breaches in the low-voltage network and digital representation to simulate appropriate measures.
- Load forecasting with ML technology (Machine Learning) based on historical information and current external factors (e.g. weather and events).
- Energy feedback and home automation: Controls for residents to make savings, on the one hand, and, on the other, to improve convenience. Every smart user should be able to retrieve relevant and personalised information from the vast data landscape at any time.

Smart ICT testbed

The main components comprise:
Central data warehouse: Teradata DM670C
(6 x dual core processor, 256 GB RAM,
12 RAID1 disks with 6 TB of storage space),
Hyper-V environment with 25 virtual systems
(556 GB RAM, 12 TB HDD)

Interim results in the Smart ICT research area

- In order to ensure data quality, different data collection intervals were tested.
- Initial findings concerning the automated servicing of the energy and ICT infrastructure were obtained.
- The ICT testbed at **aspern** Seestadt delivers valid empirical data for the smart meter rollout, which will begin from 2018.

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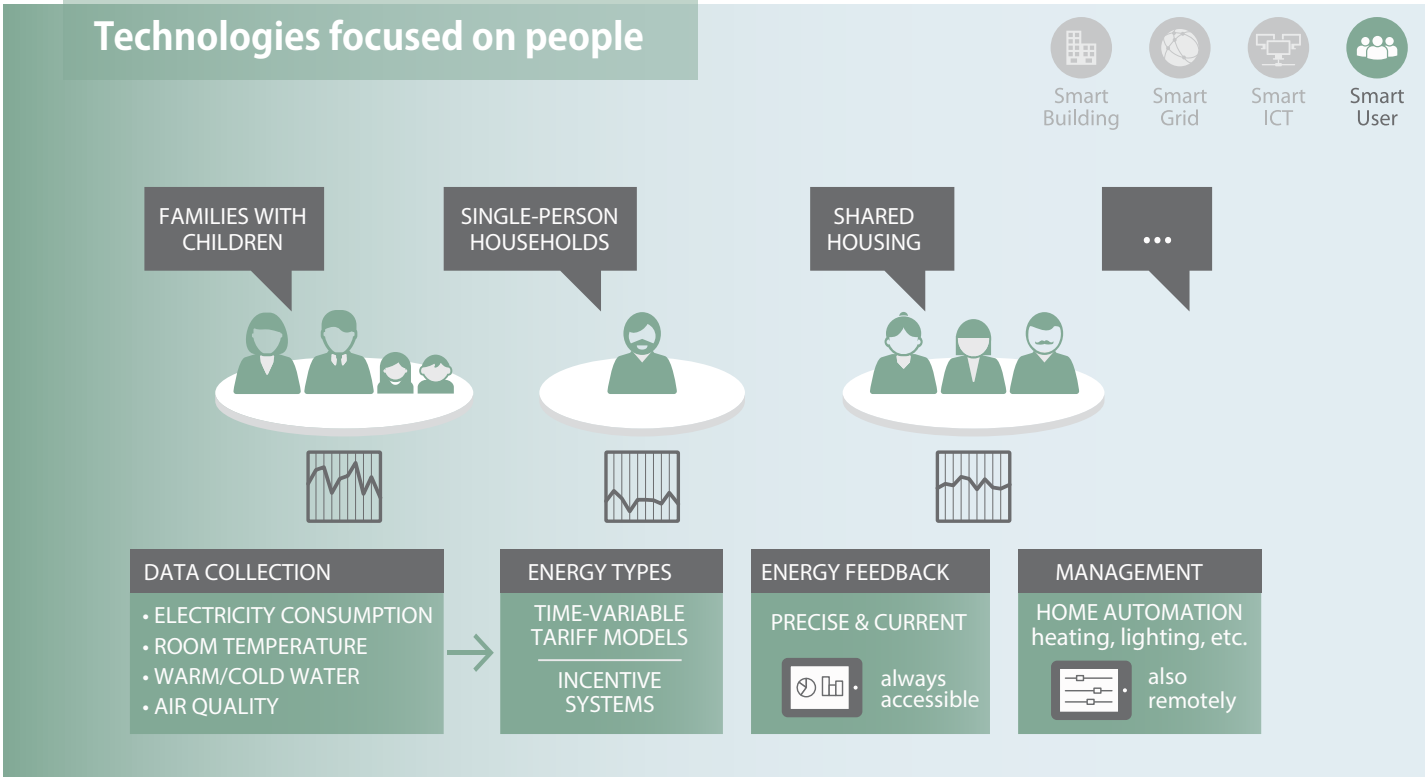
Smart User

Technologies focused on people



Credit: ASCR/APA-Auftragsgrafik

Users are a particularly important element of the ASCR research project, as ultimately they control how much energy their building requires and thus to what extent it can offer flexibilities. 111 households are participating in the research programme. They have given their written consent that their energy consumption data and ambient air control system data (electricity, hot and cold water, room temperature, room air quality, etc.) can be used for research purposes.

Why are user data vital for ASCR?

The aim is to find out how the buildings work in an optimal way. Using real time data will allow us to discover how buildings really function and thus help us to plan for the future. Accordingly, the partnership and cooperation with users will continue until 2018.

Smart MCT and innovative products and services

As the basis for home automation, smart measuring and control technology (smart MCT) is installed in the participating households. It controls the air quality and temperature of the premises with the aim to optimise the living comfort in the residence. Users can control their home automation either from home or remotely using a tablet or smartphone.

They can also test innovative products and services to control their individual energy consumption. From summer 2017, ASCR customers will be able to try out new tariffs developed on the basis of the research.

The objective is also to promote sustainable, cost-efficient and energy-efficient user behaviour by means of raising awareness and incentive systems. Up to now, the paradigm has been that generation follows consumption. It must be possible, in the future, to bring consumption more into line with renewable energies.

Photo credit: Wien Energie/Ian Ehm

» In the course of the ASCR research project, we are able to test new offerings for our customers. We are able to continuously improve our products with their feedback.«

Michael Strebl
General Manager of Wien Energie GmbH

Photo credit: APA/Ludwig Schedl

The energy consumption of an apartment can be controlled and managed using an app.

Interim results in the Smart User research area

- Over 30 percent of users regularly control their home automation using the app.
- A survey at the school campus revealed a high level of satisfaction (88 percent) with the building. The building was given an even better rating at the student home. Everybody questioned indicated that they were either satisfied or very satisfied.
- Interaction with the users and their willingness to cooperate work very well.
- In 2015, 84 households participated in a study on the subject of energy, technology and sustainability. 48 percent of participants proved to have the technical skills and to be interested in the topic of energy.
- The Smart Home Control app has been available since December 2016. Over 50 percent of the users questioned had a positive opinion about the app. Over half of everyone questioned uses the app every two or three days or more frequently. The app is used for around one hour a week, on average.

Photo credit: ASCR/Markus Rössle

An interview with Susanne Geissler (Smart User research area):

How are users involved in the research project?

User data are particularly important for ASCR in order to be able to develop energy services and offerings in a targeted fashion. We would like to better understand how residents use the smart systems in the apartments, and where there is a need for improvement. In apartment block D12, we have the possibility to test solutions to see how suitable they are for everyday use. To this end, we make use of survey and other social science methods to collect readings at the apartment level and interpret these in combination with the findings of the surveys. Ultimately, technology should not only improve energy efficiency, but above all make people's lives easier.

Is the cooperation with users successful?

Yes, for two reasons. Firstly, over half of the households in D12 agreed to make their data available and to participate in surveys and workshops This participation rate is very high and has remained constant throughout the project.
Secondly, ASCR can determine how much willingness there is to use innovative technologies, which needs exist and how the technologies provided are accepted and used.

Which findings are already available?

It became clear that only a small proportion of the users are interested in the technical details of the energy system. The topics of cost savings and internal air quality are much more interesting for them – simple instructions here are well-received. As such, we can see the importance of the (partial) automation of energy management in residences.
At the building level, it has emerged that the supply of urban, decentralised energy from renewable sources means connecting the housing sector with the energy industry. To this end, we have identified another group of smart users in the smart city, i.e. property developers.

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ASCR's Smart Home Control app

Users and research benefit equally

Resident Thomas Keil controls the energy consumption of his apartment using the smartphone app

Photo credit: APA/Ludwig Schedl

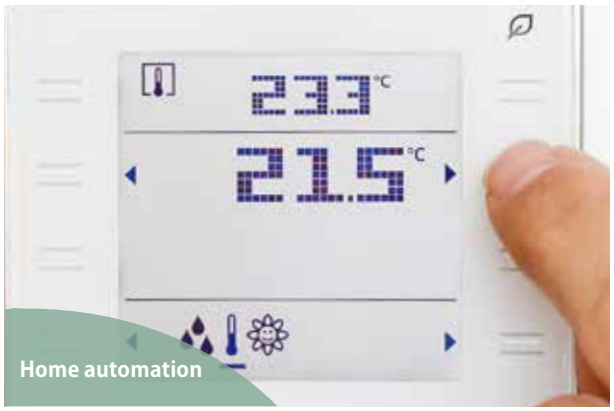
Use electricity and heating more sustainably and cost effectively with just a few clicks when sitting on the sofa or in the metro. This is possible for the 111 households at **aspern** Seestadt which are actively participating in ASCR's energy research project. Since December 2016, these residents have had a clear and simple overview of their energy consumption, along with all apartment control options, via their smartphones or tablets, thanks to the Smart Home Control app developed by ASCR and EMAKINA.

The benefit to users is that they are able to view and manage all energy settings from any location and at any time via a personalised dashboard. Energy consumption itself can be managed as required. Heating and ventilation can be switched on or off, turned up or down, as desired. Similarly, predefined plug sockets can be taken offline using the app or by activating the eco button at the front door of the apartment.

Additionally, the app has user-friendly, pre-set modes such as workday, home office, party or holiday. A time-variable electricity tariff has also been implemented with which users can activate households, e.g. running the dishwasher, ironing, charging batteries, etc., at times when electricity is cheaper.

The app has an interface with the building's technological systems, enabling the control function, and another with a database from which energy consumption data, for example, can be read. In addition to findings concerning user energy consumption, it can also be determined which app functions make sense over the long term and how often they are used.

This practical check is invaluable as real user data gives ASCR important insights into the behaviour of these users. Ultimately, the objective is to develop customer-friendly market solutions which are then applied on a large scale and to entire cities.



Home automation

Photo credit: APA/Ludwig Schedl

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