bmvit

Federal Ministry
for Transport,
Innovation and Technology




Intelligent Energy Systems of Tomorrow
Smart Grid Pioneers in Austria

Strategies – Projects – Pioneer Regions
Vienna, 2010

ENERGY SYSTEMS of Tomorrow

Preface

Finding a solution to the energy issue is one of the main challenges we are facing today. What we have to provide is a secure, eco-friendly and cost-efficient energy system that also meets people's social needs. A key requirement for doing so is to develop comprehensive, consistent and long-term strategies. Our energy research and technology policy, which is one of my responsibilities, therefore focuses on further developing these strategies and concepts and adjusting them continuously.

The development of smart grids is an important basis for a modern, intelligent energy system in the future and is one of the major economic and technological challenges in the world today. At the same time it also creates opportunities for new technologies, such as electric mobility.

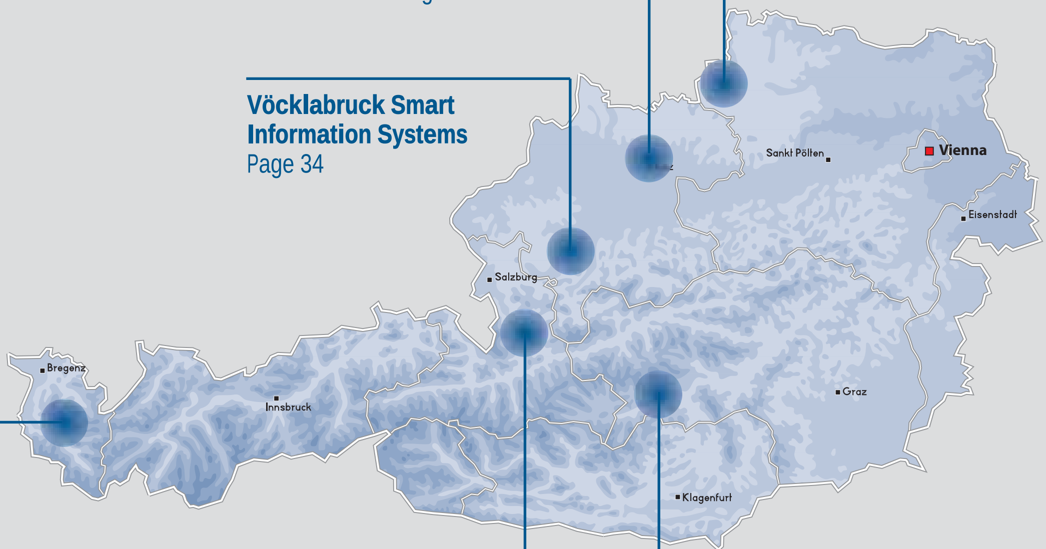
It is therefore gratifying that Austrian utilities – that can draw on decades of experience in distributed power generation –, industrial companies as well as small and medium-sized enterprises together with research institutes and universities have taken an interest in the subject and are playing an active role in finding solutions. To strengthen the capacity for innovation they require, the Federal Ministry for Transport, Innovation and Technology (BMVIT) is supporting these developments in its key areas and programs.

Doris Bures
Federal Minister for Transport,
Innovation and Technology

Contents

This brochure describes a selection of the current research and development projects in the field of smart grids in Austria. In addition, the brochure also shows the regions in Austria where such questions are being examined with concrete examples of the energy system being used. The specific approaches as well as the different interests and motivations of these pioneer regions and their stakeholders are described.

PIONEER REGIONS



RESEARCH PROJECTS

DG DemoNetz

Customers and markets

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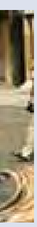
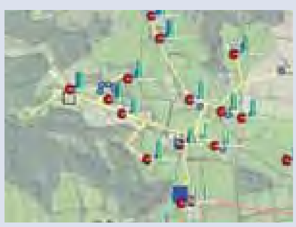


Iron concept

Smart metering pilot project



Power snapshot analysis by meters

€CO_2 – Energy and climate protection management

Smart Energy Systems
A key issue for the low-emission society




Our economic system will have to overcome great challenges in the medium and long term. We are being confronted with increasingly scarce resources in terms of energy and space as well as climate change and the CO_2 problem. At the same time our energy and mobility needs are steadily growing. We are undergoing a demographic change towards an ageing society and are part of a globalized economy where competitiveness and employment have to be upheld.

In view of these developments we will soon be seeing radical changes in our economic system. The new vision for the future is creating a low carbon economy and we are therefore faced with the task of developing adequate innovation strategies that will enable the transition to take place rapidly and in a structured manner. It will, however, require tremendous effort on the part of society as a whole. If we are to avert climate change even to a limited extent, we will have to reduce global CO_2 emissions by no less than half the 2005 levels, as we know from the assessment reports published by the Intergovernmental Panel on Climate Change (IPCC). It will primarily be up to industrialized countries to tackle the challenge. In its communication in October 2009 on the Strategic Energy Technology Plan (SET Plan), the European Commission therefore proposed aiming for an 80 percent cut in greenhouse gas emissions by 2050 compared to 1990 levels. In addition, the European economic region will need to take urgent action to become less dependent on energy imports and the risks involved. The International Energy Agency (IEA) warns that there could be serious shortages in oil and gas supplies with a drastic impact on prices. In fact, the availability of affordable energy services is one of the more important conditions for social stability.

To achieve the said targets, we will have to substantially increase energy efficiency and the percentage of renewable energies in our power systems. In the area of private transport, solutions are also urgently required. (The opportunities inherent in the widespread introduction of electric mobility are currently giving rise to great hope.) Discussions at international level started the ball rolling with strategies being developed and targets proposed. At a European level, the 20-20-20 targets were set and the member states undertook to develop and implement appropriate plans of action.

Powerful, efficient, reliable and adaptable infrastructure systems – the backbone of a modern society – play a key role as enablers. In order to develop the smart infrastructure required, not only will a great deal of research and innovation be needed but also huge sums will have to be invested.

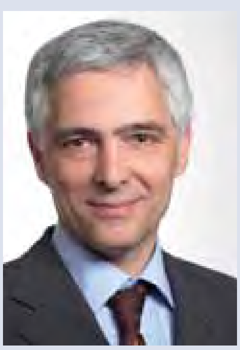
Research and technology development geared towards an interconnected system are important tools for creating an infrastructure and technology policy that is oriented to innovation and meets the demands of the times. Furthermore, we also require comprehensive innovation strategies spanning the individual development stages of new technologies to the implementation of model systems. Last but not least, increased cooperation – also international – between the relevant players will have to be a key concern.

Ingolf Schädler
Deputy Director General, Innovation and Telecommunications
Federal Ministry for Transport, Innovation and Technology

If we are to meet the objectives and targets set for Austria, a number of measures at various different levels and in various different policy areas will be required. This in turn calls for a proactive and strategically aligned approach. Against this background, the Federal Ministry for Transport, Innovation and Technology (BMVIT) is working on medium- and long-term research strategies and supported a large number of projects concerned with technological and strategic questions with a view to creating the basis for developing a reliable, eco-friendly and cost-efficient energy supply. However, we can only make the necessary changes at reasonable cost within the specified time if we manage to integrate our energy and environmental policy as well as research and technology policy in a comprehensive overall strategy.

Innovations for energy systems, grids and consumers – smart system technologies as the key to efficiency and sustainability in energy supply

One of the most important keys to the energy systems of tomorrow therefore lies in developing technologies and solutions that will enable a high percentage of renewable energy sources to be integrated in the system while increasing efficiency in energy distribution and consumption. Superior technologies, overall concepts tailored to the system and innovative ICT developments will help us increase system efficiency considerably and at the same time improve the quality of the energy services. Given the fact that electrical energy is difficult to store and both frequency and voltage have to be stabilized in the power grids, but also because existing trends would indicate that electrical energy will become more significant as an energy source in the future, there is a growing need for research in this area.



The purpose of research and technology development is not only to create the basis for us to explore new paths and solutions, but also to provide the means for evaluating various different technologies and strategies. A strategy process initiated by the BMVIT, ENERGIE 2050, has been examining these questions since 2004. As a result, the relevant levels of action have been identified and recommendations made for an Austrian energy research strategy. Developing smart energy systems and grids is one of the main tasks in this area.

Michael Paula
Head of the Energy and Environmental Technologies Department
Federal Ministry for Transport, Innovation and Technology

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Smart Energy Systems
A key issue for the low-emission society

Why smart grids?

The smart grid solutions to be developed are aimed at achieving the following objectives:

> Further development of the electricity infrastructure as the basis for meeting the political targets in terms of sustainability

> Best possible integration of renewable energies and distributed generation

> Increase the energy system's efficiency and improve the infrastructure

> Greater flexibility and supply-orientation of in energy service demand

> Enable new services to be provided – metering, smart services, electric mobility, ...

> Development of energy regions of the future that are themselves responsible to a great extent for a sustainable energy supply

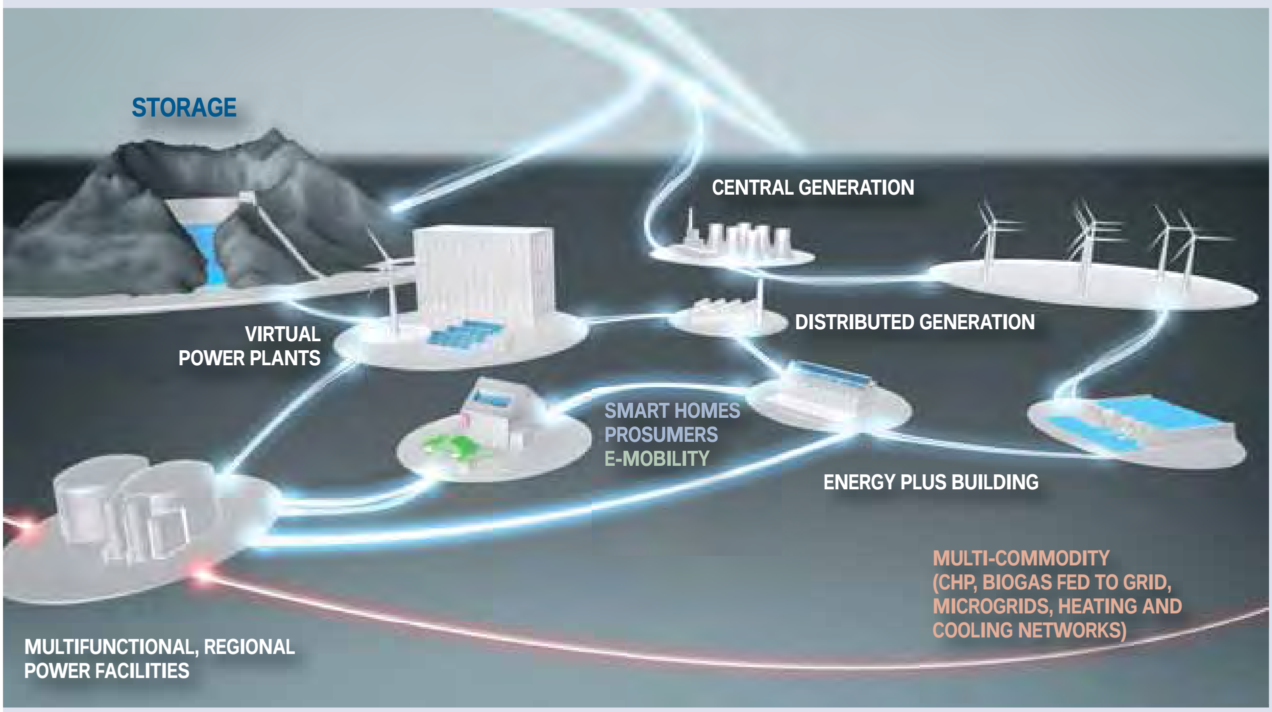
This will require three things in particular:

> Firstly, researching the options and creating the conditions required for optimum integration of renewable energy sources including energy storage facilities and taking the development of massive distributed generation into consideration

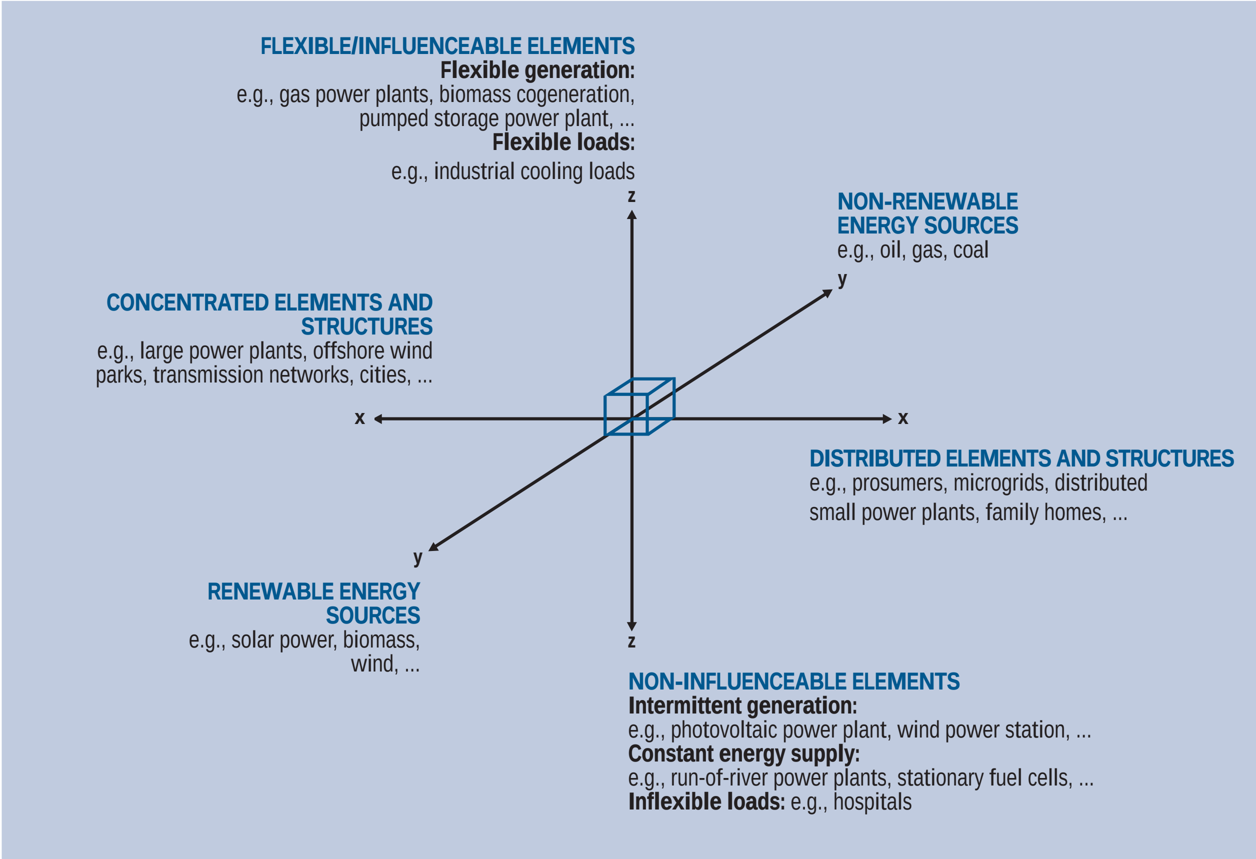
> Secondly, developing efficient technologies and concepts for energy distribution and consumption, and systematically integrating the existing energy infrastructure and the new elements in a smart energy system

> Thirdly, designing appropriate man-machine interfaces to enable people to use the valuable resource of energy economically and taking the financial aspects into consideration for using energy efficiently in the overall system

The first step is to examine the overall system, taking into account everyone involved along the entire energy value chain. In particular, developing the transition processes and defining the roles of the individual players and their business relations in the energy system will be an important part of this step.



DIMENSIONS OF THE ENERGY SYSTEM STRUCTURE



Information and communication technologies (ICT) play a key role as the enabling technology in many areas.

An ICT infrastructure will, for example, be added to the electricity distribution network, enabling information to be exchanged between generation systems, grid components and consumers and therefore the opportunities for control and regulation to be extended. As a result, more distributed power plants can be connected to the electricity distribution network, which is increasingly becoming a bottleneck. In addition, power generation can be timed better to meet demand.

On the load side, various different measures can play an active role, such as storage batteries for electric vehicles (vehicle-to-grid), heating and cooling systems for buildings, community infrastructures, individual households and appliances, or interconnected power networks (e.g., gas, electricity, heating). The existing storage or buffer facilities enable the demand for power from the grid to be controlled timewise to a certain extent. A smart grid thus connects generators, consumers and storage facilities to form a smart supply system.

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Developing smart grids – particularly in the area of electricity supply – is one of the most important steps we will have to take next on the road to developing the energy systems of tomorrow.

Michael Hübner
Strategy Development and Program Management
Energy and Environmental Technologies Department
Federal Ministry for Transport, Innovation and Technology

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Smart Energy Systems
A key issue for the low-emission society

The new system

Our energy system is therefore facing radical changes. It will also have to meet the demands of the new roles being played on the deregulated energy market in the future where the participants will not only be smart prosumers with photovoltaic systems or new regional distributors of megawatts and negawatts but also individual households, wind parks, operators of small hydropower plants, electric mobility customers and industrial companies.

Future energy systems cannot therefore be described or depicted in simple terms as an energy chain with a classic linear structure from generation to distribution and consumption. In the new system structure there is more energy flowing in both directions, i.e., also from the consumption level back to the energy distribution level up to the transmission networks. Information on the various system elements is linked to a much greater degree than previously. The participants in the energy system will exchange more information than previously and the interface between users and the technical systems in particular is specifically designed to enable consumers to become more actively involved. This will, however, give rise to new questions. Not only will new technologies and concepts have to be developed but also new business models created and new roles anticipated. A new culture in dealing with energy is becoming established. Appropriate market models and regulatory measures will have to ensure that the relevant requirements are met.

Key system parameters for future energy systems can be shown in three dimensions: "renewable/non-renewable energy sources", "concentrated (central)/distributed elements and structures" and "flexible/inflexible elements". Within this overall structure there is a whole array of solutions that have to be analyzed, evaluated and developed. In the process, questions of the optimum resource use, advantages and disadvantages for supply security, contribution to achieving the political objectives, technology aspects and economic effects of the relevant solution will also have to be taken into consideration.

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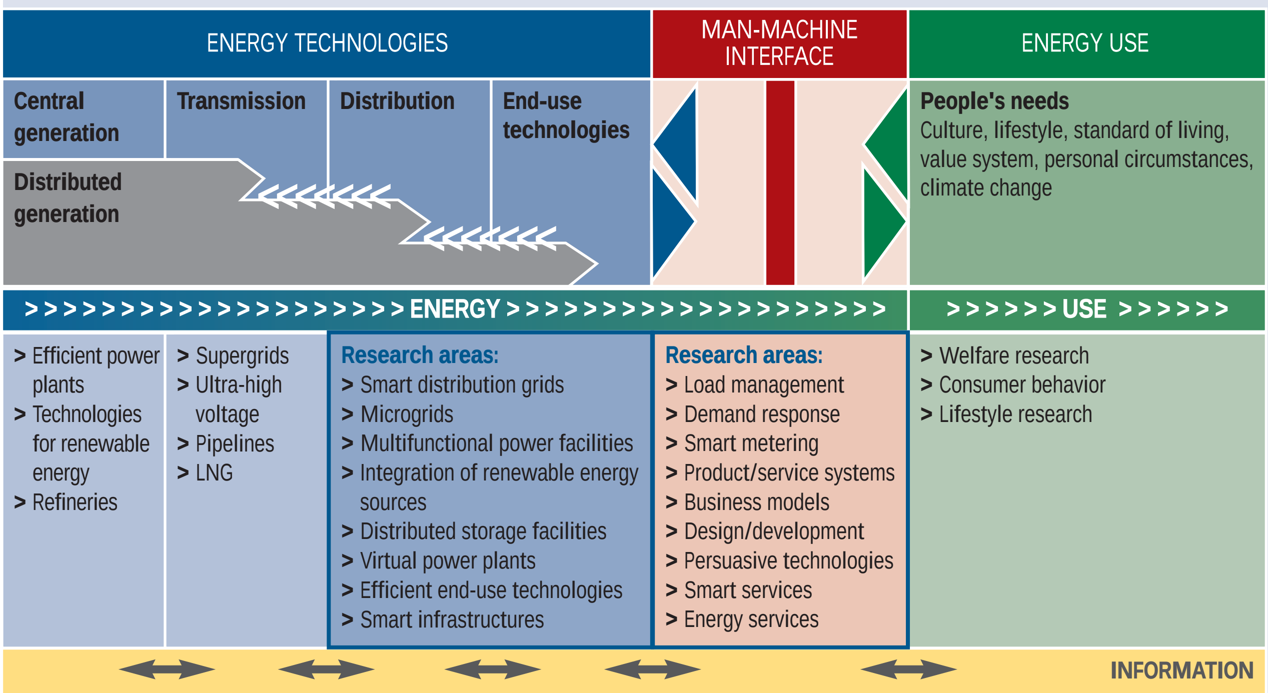
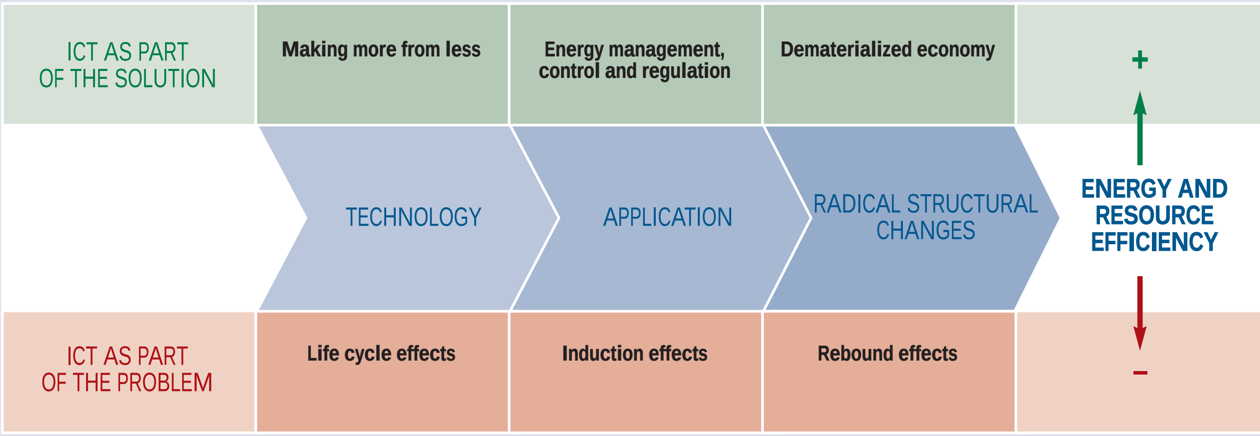




Green ICT

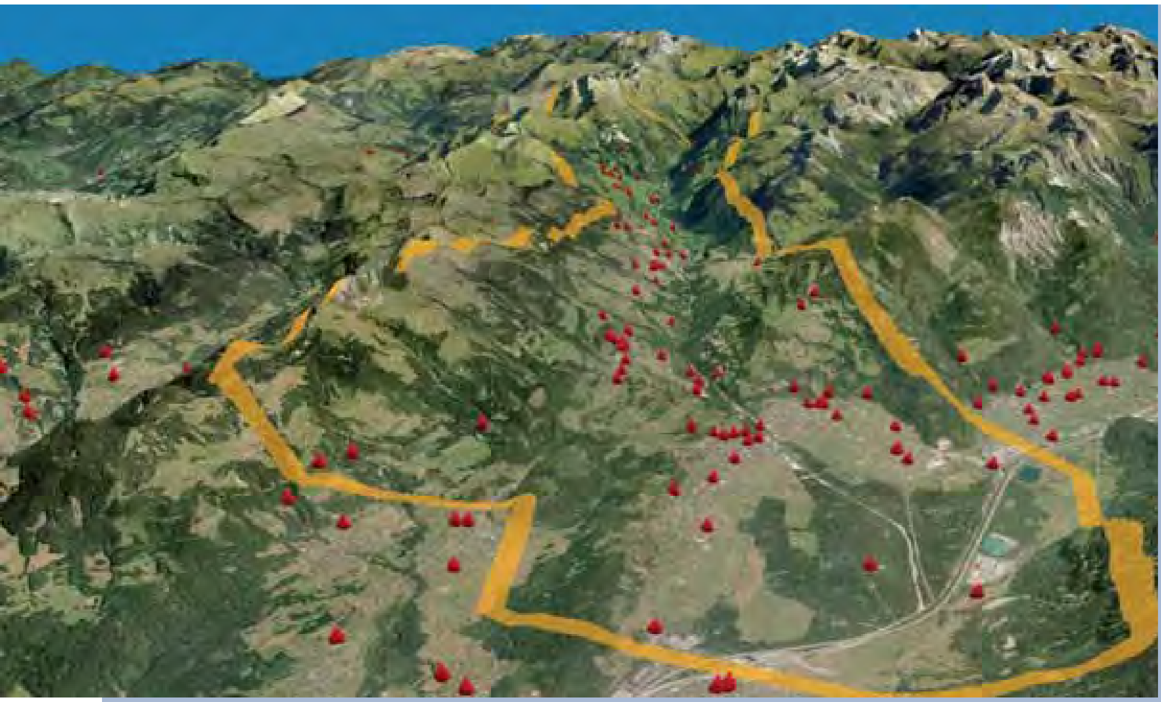
Information and communication technologies (ICT) can play a decisive role as enablers for new, efficient energy systems. Contributions are possible at several levels. At the technology level, increased efficiency is to be expected due to progressive miniaturization and improvements in the basic technologies. Life cycle and environmental effects must, however, be taken into account. As the example of smart grids clearly shows, there is also great potential for increasing efficiency by improving energy management. Other examples include engine control and air conditioning for buildings. Inductive effects, however, have a negative impact resulting in higher consumption in other sectors by creating new opportunities.

In addition, there is good reason to hope that ICT will make a contribution to far-reaching structural changes towards a dematerialized economy, for example, video conferencing instead of air travel. As with all efforts to increase efficiency, rebound effects from the resources becoming available, such as time and capital, have to be factored in. The social significance of the steadily increasing dependence on critical infrastructures must be pointed out and taken into account in system design and decision processes.

The development of smart grid solutions is a crucial next step on the road to the energy systems of tomorrow. Austrian experts and companies are already working on this development in various research projects. The concepts, technologies and integral approaches to the solutions they develop are to be tested and demonstrated in model regions firstly so that the practical experience can be incorporated in further developments and secondly so that concrete, multipliable best practice examples can be created. Key factors in the chance of putting such projects into practice in the long term are the real problems in regional energy systems – such as reaching the system limits when more small hydropower plants are built – or motivating the stakeholders – such as defining their area as an eco-energy region. This brochure shows some of the approaches taken and research work carried out as examples of what is being done in Austria.

Grosses Walsertal Biosphere Reserve – Smart Distribution Grid

Grid integration of distributed generation using smart grids

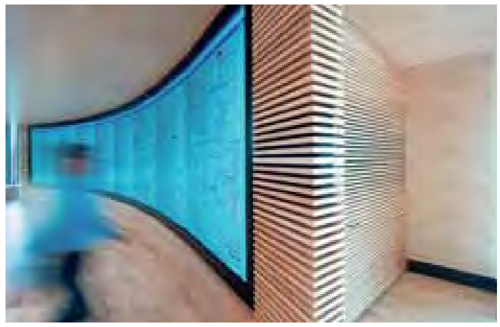


Austria's westernmost province – Vorarlberg – has set itself the goal of becoming energy self-sufficient in the long term and therefore free of price increases and supply bottlenecks in oil and gas. The focus is on energy efficiency, continuing to expand renewable energies and changing mobility, such as promoting the use of electric vehicles (www.vlotte.at). Even today nearly 30 percent of the province's energy demand is met with renewables. It comes from 18 large hydropower plants, some 240 small hydropower plants, around 12,900 solar thermal power stations, 910 photovoltaic systems, 5,000 heat pumps and 37 biogas plants.

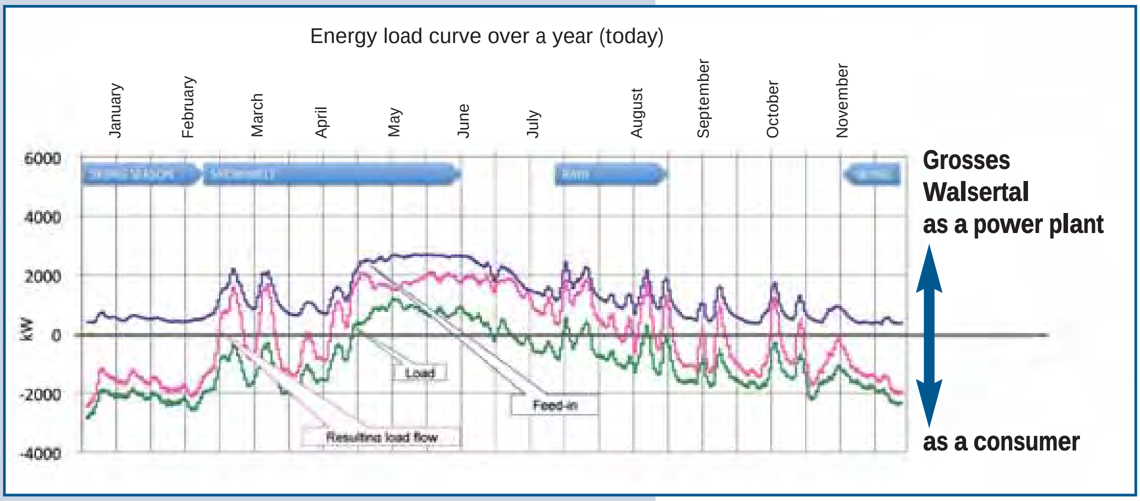
To ensure that further expansion is possible from an economic point of view – particularly small-scale hydropower where development is still feasible – some new concepts will be required for connecting them to the electricity grid. The costs of increasing the grids and especially building new lines should be kept as low as possible. A solution is developing bidirectional, smart distribution grids. In the future, the lowest grid level where consumers are connected will therefore get more energy supplied from distributed generation systems and pass on the excess to higher grid levels.

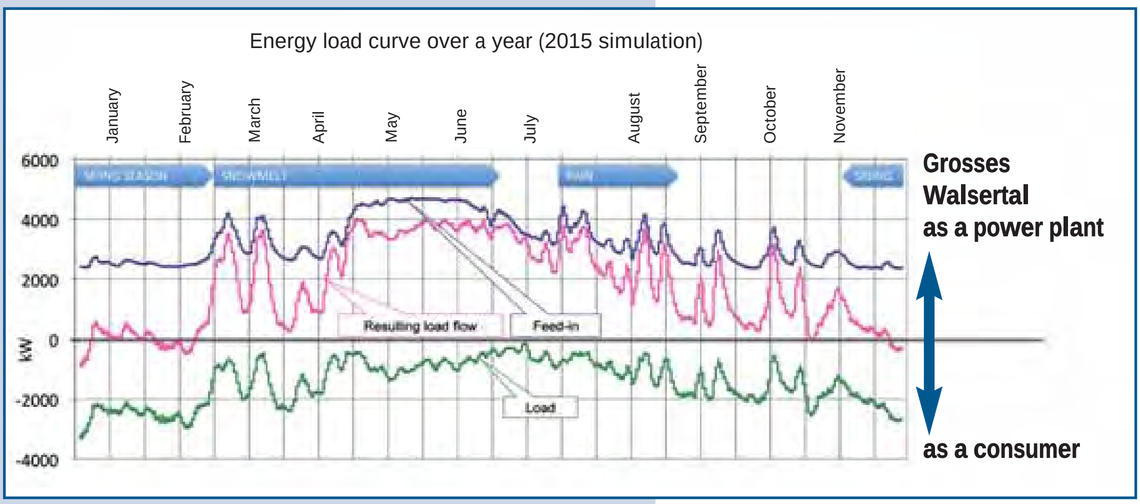
In particular in rural areas that are sparsely populated and without any large-scale consumers, conventional distribution grids are increasingly reaching their limits when a great number of distributed power plants are connected. Examples in the area served by VKW, Vorarlberg's utility, are the Grosses Walsertal and Montafon valleys and parts of the mountainous Arlberg region where the grid cannot accommodate any more power plants without additional measures.

Characteristic for the region are the considerable fluctuations throughout the year – for example in the 20-km-long Grosses Walsertal biosphere reserve. In the colder months, energy consumption in the valley is relatively high because of winter tourism combined with hotels and ski lifts. As little water can flow, the energy generated by the hydropower plants tends to be low during this period. The valley is therefore a large-scale consumer and energy has to be transmitted from the entrance to the furthest point. However, in spring when the snow melts and in summer when it rains, the hydropower plants supply a great deal of energy with current installed capacity totaling around 3 MW, which cannot be consumed by the few homes and small businesses in the valley. At the end of the valley, two hydropower stations each with a capacity of 800 kW and a number of smaller power plants supply energy to the grid. The valley then becomes an energy supplier and the energy has to be transmitted away from the furthest point.



”Computers instead of excavators! The smart grid is like a new spanner in the distribution grid operators' tool box. It makes new approaches to a solution possible in critical sections of the grid.” Reinhard Nenning, VKW-Netz AG





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Smart Distribution Grid

Smart grid in the Grosses Walsertal biosphere reserve

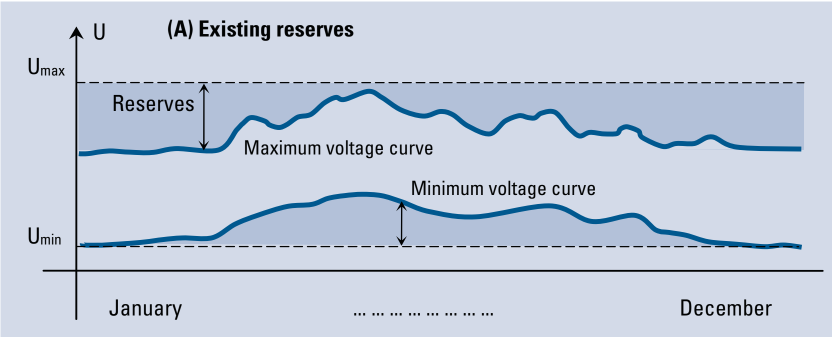
A great challenge for the future distribution grid is that it has to be capable of transmitting energy in both directions. The grid must be regulated in such a way that the specified minimum and maximum levels for voltage can be maintained at every point, although the power plants with their fluctuating supplies feed in energy at various different points in the grid and the individual consumers' demand for energy also varies. Only when this is achieved can the electrical systems and appliances connected be guaranteed to function properly. The situation becomes increasingly complex whenever a new power plant is added and the difference between summer and winter grows. If it remains the same as it is today, no more small hydropower plants can be connected to the grid in the Grosses Walsertal. The local capacity for more small hydropower plants where development is feasible and currently unused is another 10 MW and parties have already shown interest. New regulation concepts and controllers therefore have to be developed in order to handle this complex situation and feed the renewable energies into the distribution grid with as little effort as possible.

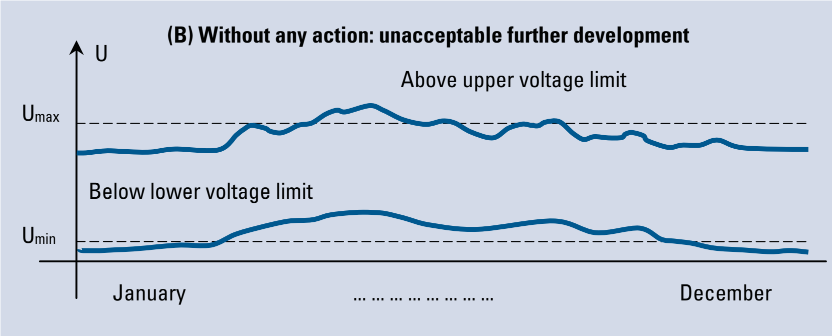
Building on the promising results of the DG DemoNetz project, the concept of a smart distribution grid is now to be implemented and tested in a demonstration project. The new technology can then also be used in other regions.

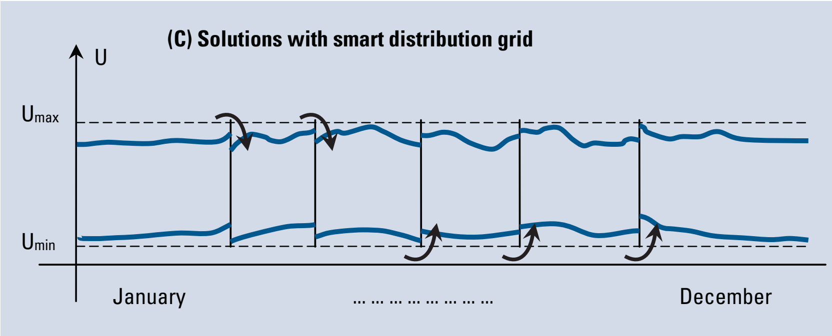
"If we as grid operators bear the economic benefits in mind, it goes without saying that we have to make an effort. Our tasks as the province's utility include supporting the energy targets and providing the region with as cost-efficient and secure a supply of electricity as possible."
Werner Friesenecker, VKW-Netz AG

Voltage range management
The curves show the minimum and maximum voltages in a grid over the year. Graph A shows the state of a grid with good reserves for future increases in both load and generation. If no action is taken, the voltage limits could be exceeded, e.g., if distributed generation is further expanded or consumption increases – graph B.

There are two options in this case:
> Shifting the maximum and minimum levels into the permissible range (by reinforcing the power lines or actively altering the voltage curves, e.g., by shutting down generation or consumption systems).
> Shifting the range demand for each time period (only possible by actively altering the voltage curves, see graph C). Such active intervention in the voltage curves during grid operation – which are generally balancing concepts – is known as smart distribution grid operation. Potential technical solutions were developed in the DG DemoNetz project concept.







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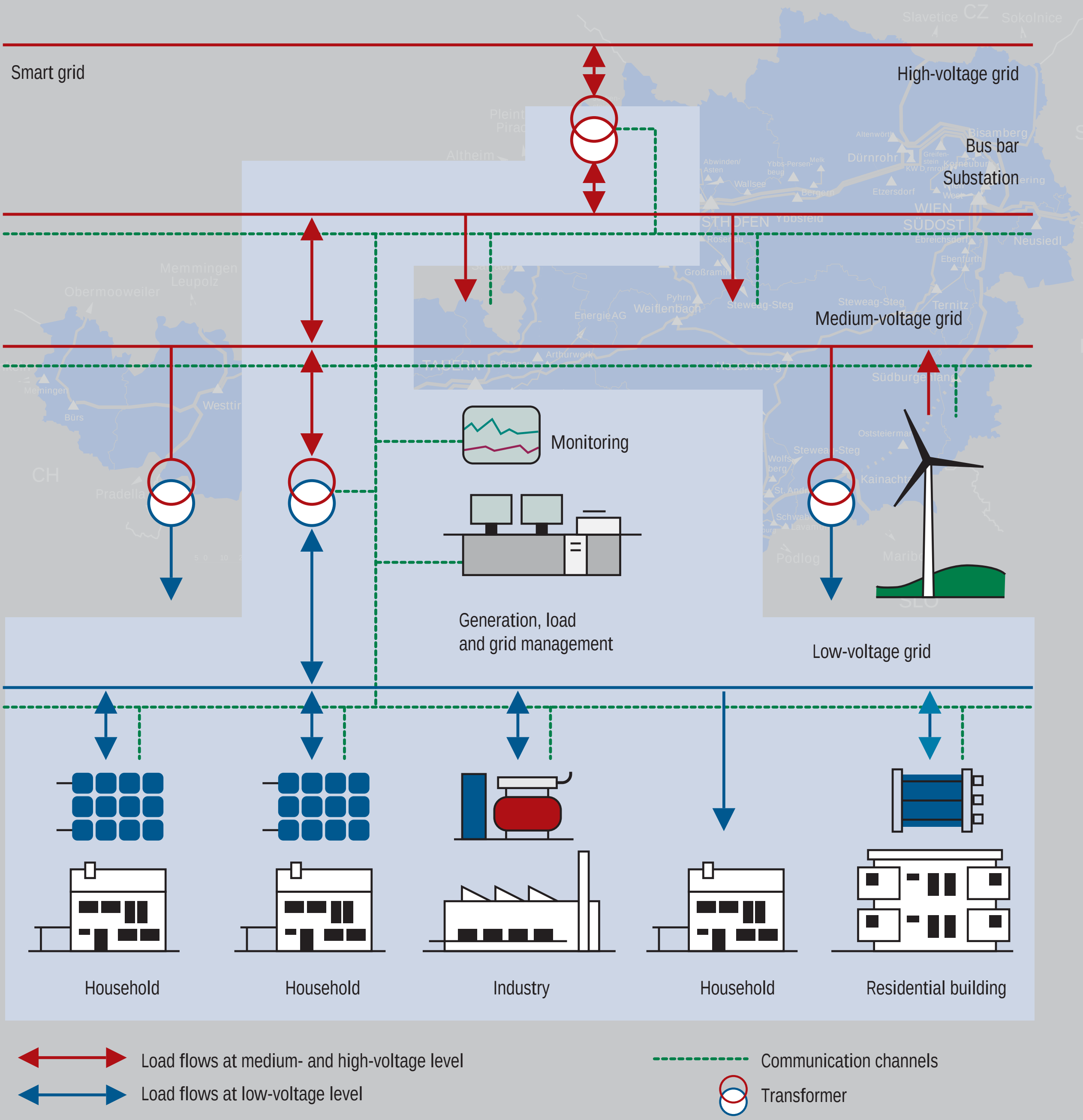
DG DemoNetz
Demonstration grids with high percentage of distributed generation



Publication:
Leitfaden für den Weg zum aktiven Verteilernetz
(guide to developing a smart grid)
Intelligente Stromnetze der Zukunft
(smart grids of tomorrow)
A. Lugmaier, H. Brunner
Reports from Energie- und Umweltforschung 13a/2008

DG DEMONETZ CONCEPT AND BAVIS PROJECT CHAIN

Smart operation of electricity distribution grids with a high percentage of distributed generation using innovative voltage regulation concepts

The primary aim of the project chain focusing on smart distribution grid operation is to develop concepts in order to integrate as high a density as possible of distributed generation systems based on renewable energy sources in electricity distribution grids without reinforcing the lines. This will involve evaluating the concepts developed in technical and economic terms.

Project content and results

The voltage regulation concepts developed in the DG DemoNetz project concept show that smart grid operation using regulation and control measures in the distribution grid enables greater reserves in the existing grid infrastructure to be used. Business analyses indicate that these measures can compete with conventional solutions in economic terms (e.g., line reinforcement). The aim of the follow-up BAVIS project is to develop the portfolio of voltage regulation concepts that was created during the DG DemoNetz project concept. Key sub-goals of the BAVIS project are:

> Toolbox of mature measures for smart voltage regulation
The portfolio consists of various different mature voltage regulation concepts for distribution grid operation. On the basis of these concepts, it should be possible for distribution grid operators to avoid voltage problems and therefore make best use of the available voltage range. The voltage regulation solutions will take all the relevant operating issues into consideration, thus enabling the distribution grid operators to use them in day-to-day system operation.

> Easy check method for planning smart voltage regulation
The aim of this method developed as part of the BAVIS project is to simplify planning of smart distribution grid operation for distribution grid operators with the focus on voltage regulation strategies. With this method it should be possible to make the following estimates with a minimum of effort:

- Estimate of the urgency of the voltage problem in a particular grid
- Estimate of the suitability of various different voltage regulation methods from the toolbox for solving voltage problems in a particular grid

Outlook

The regulation concepts should be implemented in the grid sections examined in order to validate the technical and economic results of the DG DemoNetz concept and BAVIS in a field test, and put the concepts to the test in practice.

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Vienna University of Technology
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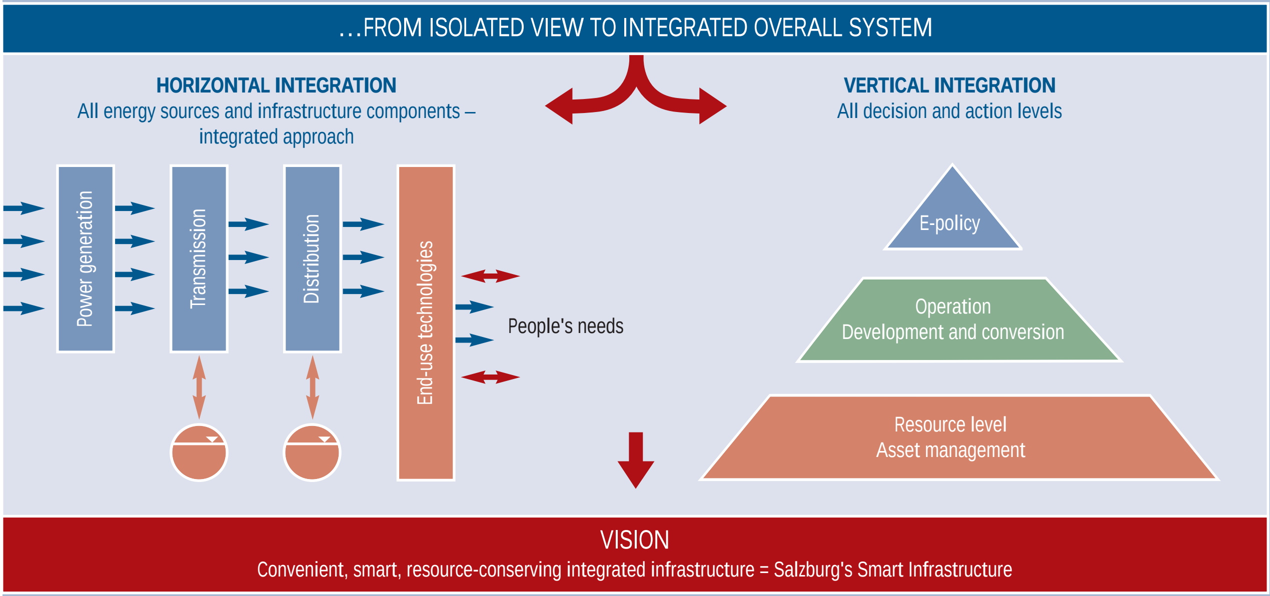
Salzburg's Smart Infrastructure
Integrated infrastructure planning

The Province of Salzburg features a wide variety of geographical regions – from urban centers to wide sweeping plains and high mountains. The demands placed on a forward-looking energy system but also the opportunities it presents are therefore correspondingly broad. Salzburg AG provides multi-utility services including electricity, gas, district heating, water, telecommunications and public transport. As the province's utility, it operates 26 hydropower plants, two cogeneration plants and a large number of photovoltaic and biomass plants and at the same time is one of the largest broadband cable network operators in Austria.

Salzburg has now set itself the goal of becoming a model region for developing and operating smart grids in the future. The company is not, however, examining energy supply in isolation, but planning cooperation across the various divisions in relation to the sources of energy and infrastructure components. This will enable synergies to be exploited and coordination between the various divisions regarding development and cutback plans to be improved. For this purpose a Roadmap 2025 for developing the grid-bound energy supply in the city of Salzburg will be worked out, taking the urban planning measures and regional planning development into consideration. Integrated planning should combine the various levels of action from the climate and energy policy to strategic grid development planning, operation and maintenance of the resources.

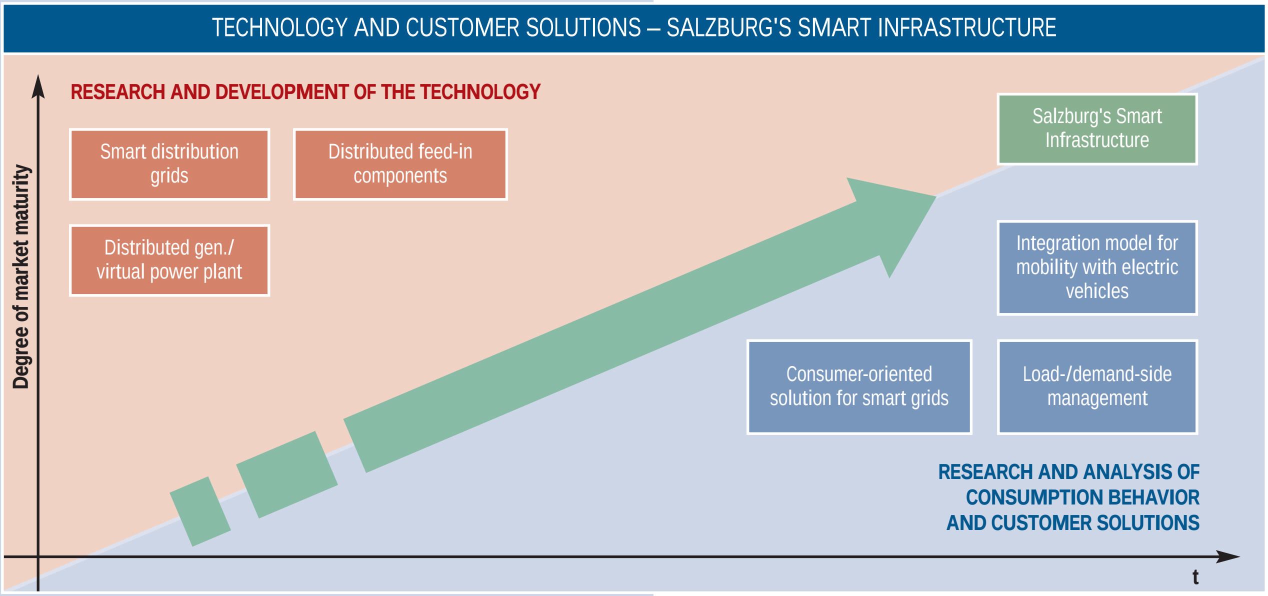
The common vision is a convenient, smart, resource-conserving integrated infrastructure that can be used to provide modern energy and information services. The customer benefits achieved, the design and management of the interfaces to the customers are seen as major assets for the future.



"Our energy system will simply have to undergo a complete conversion over the coming decades. Salzburg intends to play an active role in this development and aims to be the first model region for smart grids in Austria."
Michael Strebl, General Manager of Salzburg Netz GmbH

Salzburg: a model region – 2009 Smart Grids Week

Roland Wernik, General Manager of Salzburg Wohnbau
Ingolf Schädler, Head of Innovation at the BMVIT
Gabriele Burgstaller, Governor of Salzburg
Arno Gasteiger, Director of Salzburg AG
(from left to right)



THE FOLLOWING DEVELOPMENT LINES WILL BE PURSUED TO ESTABLISH SALZBURG AS A MODEL REGION:

Smart distribution in medium- and low-voltage grids. To enable many different distributed generation units using renewable energy to be integrated in the grid – particularly small-scale hydropower but also wind, photovoltaics and biomass – new and improved regulation and optimization concepts will be required in the distribution grid. Such questions are currently being posed in individual sections of the grid, such as in Salzburg's Lungau region. To develop new solutions, a central and a regional concept for smart regulation of medium-voltage grids should be implemented, tested in practice and compared. The next step planned is to develop concepts for smart grid system integration in low-voltage networks.

Consumer2Grid and Building2Grid – load- and demand-side management. This project investigates the role of consumers as active participants (human in the loop) and buildings as active components in a smart energy system. The aim in particular is to determine how customer information has to be presented and what technologies can be used in buildings in order to enable customers to play an active part in a smart energy system and optimize energy efficiency. In addition, the opportunities involved and the benefits of smart metering are also being examined.

Vehicle2Grid – integration of electric mobility. Based on the experience gained from the ElectroDrive initiative launched in April 2009 to offer the public complete e-mobility packages, interfaces and concepts are being developed for interaction portals for electric mobility customers in the Salzburg model region. They focus on concepts for smart grid integration and new business models.

Virtual power plants, CHP and micro-CHP. The options for operating combined heat and power (CHP) plants and using storage facilities including business models have already been tested in practice and the results extrapolated for high penetration in the grid. Distributed electricity and heat generation with fuel cell heating appliances has also been examined.

Smart heat networks. To reduce peak loads, smart network management is being developed for district heating networks. As a result, the number of full load hours for the systems feeding the network can also be increased and investment costs reduced by adjusting the dimensions. The overall efficiency of the district heating supply can thus be increased and the use of fossil fuel-fired peak-load units minimized to a large extent.

ICT synergy potential. A wide range of data and information has to be collected from the entire area and distributed for various different smart grid and e-mobility applications. The applications differ with regard to the demands, e.g., on data volume, real time capability and data security. This has a significant effect on the costs of the ICT infrastructure to be installed. Concepts are being developed for cost-efficient installation of the ICT infrastructure by exploiting synergies and using it for several applications.

”From the perspective of a multi-utility company, completely new concepts and services can be created for urban mobility. There is a total of 300,000 cars in Salzburg. If 25 percent of them change over to electric mobility in the long term, there will be a completely new potential for improving grid operation. It will be a challenge and an opportunity at the same time.”
Michael Strebl, General Manager of Salzburg Netz GmbH

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Institute of Computer Technology, Vienna University of Technology
Center for Usability Research & Engineering (CURE)

The developments are aimed at achieving the following results in particular:

> A convenient, flexible and efficient infrastructure tailored to customer interests and acceptance

> The widespread use of renewable energies and reduction in peak loads

> Gaining in-depth field experience and consequently securing innovation leadership for Austria with the export opportunities it would bring

> Reduction in CO_2 emissions and resource consumption

Customers and Markets
Current research work

Motivation and goals

The steadily growing demand for energy services calls for increased use of renewable (volatile) energy sources, more efficient use of fossil fuels and restructuring of today's energy supply chains – to ensure that Austria's climate targets are met as well as possible. It is also important to include the customer's view in the design of the solutions developed. Designing economically affordable and technically feasible integration models of energy consumers, generation and storage facilities in increasingly smart system operation is the motivation behind the research work on the subject of customers and markets. The work primarily focuses on finding and examining new business and market models as well as viable options for efficient provision of convenient energy services for consumers that could be used in Austria in the long term. Based on detailed technical analyses (e.g., load flow analyses in low- and medium-voltage grids) and financial cost/benefit analyses – both from a business management and an economic point of view – are being used to identify the decisive system parameters. What is ultimately being aimed at are contributions to an overall evaluation of the new technologies and concepts in economic, ecological and energetic terms.

Examples of current questions

> What could future business models look like? What can, for example, be offered to biomass power plant operators as an incentive to reduce generation or perhaps temporarily store biogas when the wind energy supply is currently high? How can the relationship with grid operators become smarter and how can adequate compensation be provided for the contribution to grid operation made by virtual power plants?

> Positive contributions to grid operation from renewables and distributed generation systems and consumers create benefits for the entire system. How can it be applied to grid operators in such a way that providing the necessary infrastructure can be funded?

> How can incentives be created for customers so that they participate in balancing? What larger loads apart from commercial cooling loads are suitable? Do the concepts for introducing smart meters, displaying energy consumption promptly, offering time-of-use tariffs and showing real load profiles on the Internet actually reflect the motivation situation and information required by household customers?

> What increases in efficiency, load shifts and reductions in consumption can actually be expected from measures on the customer side?

> What are the new marketplaces and market rules like that will support the innovations in the energy system and the creation of new services and enable cooperation between the stakeholders with a view to achieving the joint optimum in the future?

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Energy-Efficient Refrigeration of Food in Supermarkets

Peak-load shifting in food chains

Food shops and supermarkets use a considerable amount of energy in ensuring that the cold chain for food products is maintained. Refrigeration of food accounts for around 50 to 60 percent of total electricity consumption and therefore ranks among the largest load consumers in a supermarket. This segment thus also has considerable potential for savings and storage. An Energy Systems of Tomorrow project is examining in detail what options are available for shifting peak electricity demand and saving money in supermarkets and how this potential can be used. What plays a key role in the basic idea of electricity load leveling is the consideration that peak loads have a significant effect on the electricity price and that peak-load shifting reduces grid overloads and improves supply security.

The aim was to develop a concept for successful interaction between load management and energy storage that would improve matching of electricity supply and demand and simplify integration of renewable energies. Researchers examined whether integrating standard latent storage units in existing refrigeration systems resulted in substantial improvements in load behavior, whether they can be loaded to an adequate extent with already installed off-peak refrigeration units and whether these systems can display economically attractive effects.

The symbiosis of load management and energy storage is created with a smart control strategy that stores cooling energy at off-peak times and uses it at peak times. As a result, no or only very little electricity is required for the refrigerators at peak times. This means that consumption characteristics can be leveled with load management and energy storage. In the future, such thermo-electrical systems could act like a kind of battery in the existing power grid. Using cooling energy as a “battery” integrated in the electricity grid provides great potential for improving integration of fluctuating renewable energy sources, such as wind power and photovoltaics. Supermarkets can therefore become active components of a smart grid scenario.

The analyses presented were carried out using the supermarkets operated by MPREIS Warenvertriebs GmbH as an example – with various load shift scenarios modeled for a selected shop. In addition, further ways of saving power were determined using technical and administrative measures to increase energy efficiency. The analyses show that taking appropriate action can result in savings of 3 to 10 percent and the potential for load shifting is up to 20 percent in the food trade. A demonstration project is currently being planned.

Before strategies for reducing peak-load electricity can be implemented over a large area, electricity suppliers have to provide incentives for reducing peak-loads. As part of the project, possible billing scenarios and bonus models were therefore derived from the analysis of the current electricity procurement methods and the market potential.

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Murau Smart Microgrid

Regional, fail-safe electricity supply in the Murau region

The Murau district in the province of Styria has been working on a common energy vision since 2003. While consistently implementing a broad participation process, the goal defined was making the region self-sufficient in supplying heat and electricity by 2015.

In addition to the local biomass heat networks, the number of green electricity plants in the region has continuously increased in recent years. Murau is a sunny, wooded region. Which is why future investment will not only be in more small hydropower plants as planned but also in biomass combined heat and power generation and photovoltaics. In the area supplied by the Murau utilities, the annual balance sheet now shows that excess energy amounting to 40 percent of its own needs is generated. The degree of self-supply for the entire region is just under two thirds.

The Murau region can look back on a long tradition of striving for an independent electricity supply. The first hydropower plant in the region with a capacity of 100 kW was built in 1906 – at that time primarily to supply electricity to the Murau brewery. Up until the early 1970s, Murau operated an isolated network and was one of the last regions in Austria to be integrated in the national grid. This was why the utility ensured that the machinery for the River Mur power plant was also capable of isolated operation when it set about increasing generation capacity in 1974. In addition, Murau also started installing and operating a ripple control system in 1970, which not only included industrial facilities but also households and naturally the brewery.

The following factors have to be taken into consideration for further developments:

> Self-sufficiency is not currently possible all year round and also not in the whole region. The region's problem lies in the nature of hydroelectric power, i.e., less power is generated in winter. Biomass CHP and photovoltaics could make a significant contribution here towards covering the daily peaks.

> Without further action being taken, the current grid structures are no longer capable of absorbing the growing distributed generation. Transmitting energy from the regional grid to the provincial utility is becoming more of a problem and increasingly involving costs.

> New concepts for regional energy management will, however, be required if the synergies from the individual energy sources are to be used to full effect in line with the energy vision.

> The secure regional electricity task force formed to achieve the energy vision is now setting itself the goal of developing a smart energy system in order to use the electricity generated regionally in the region where possible, thus increasing local value added. At the same time, this is aimed at taking the strain off the higher grid levels. The system is to be designed in such a way that even if the higher-level grid fails, grid operation can be maintained in the region and power supplied for the most important applications. Such concepts of temporarily creating microgrids could help to improve quality and supply security in future grids. The customers' many years of experience with the ripple control system and the common Murau energy vision create an excellent basis for integrating consumers effectively with the smart technologies available today and using special tariff models.

"The most important feature of the Murau energy vision is that it will help us together with the other players to strengthen the region without being dependent on individual isolated plants. Here we are creating something truly sustainable and that is extremely important, particularly in a region with a weak infrastructure."
Sepp Bärnthaler, Upper Styria Energy Agency

"I see myself in a plane flying over the province at night. A power cut plunges all of Styria into darkness – only Murau stays light. That is the image of the strong, independent and secure regional energy supply that we are dedicated to providing. As a local company, the Murau utilities are committed to the region and its development and wish to be a partner in the energy region that delivers greater value than national suppliers."
Kurt Woitischek, Murau Utilities

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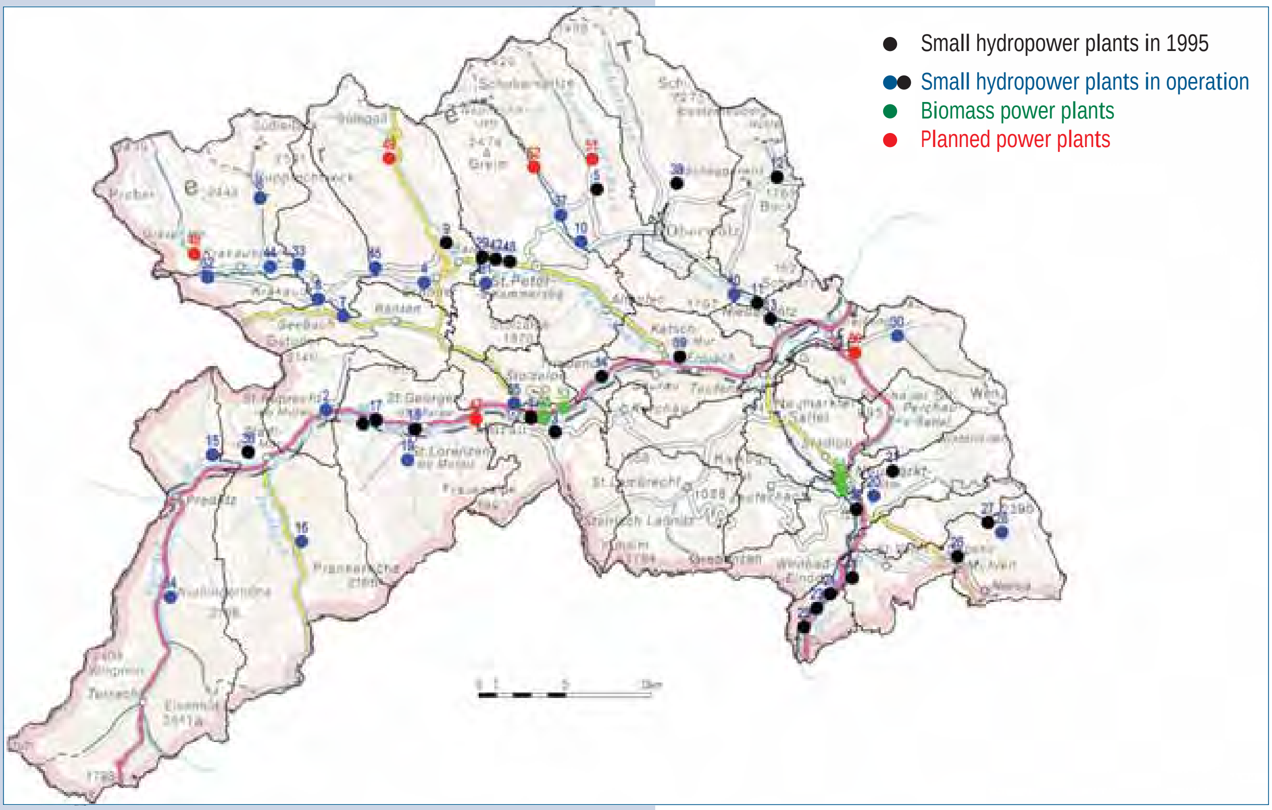
Building the weir in 1907/1908

Power plants in the Murau region



Rethinking Energy

How can smart grid customers become part of an active, interconnected community?

The energy sculpture is the visual result of a creative process following discussions on the smart grids of the future that took place between energy experts, researchers and designers during the 2008 conference on rethinking energy – innovations for energy systems, grids and consumers. Symbolizing the connection between energy consumption and the renewable energy available in the region, the sculpture could be installed in the town center as a visible sign and indicator encouraging the population to support a forward-looking, smart energy system.

Background

The aim of a workshop attended by 112 experts and decision-makers in trade, industry, research and planning was to develop creative solutions for energy applications in the consumer field together with designers from the Vienna University of Applied Arts (Prof. Hartmut Esslinger). What they primarily discussed were questions of how to motivate consumers to play an active part in a smart grid community. Can smart meters providing improved information on power consumption be sufficient incentive for people to question their own energy consumption? Do time-of-use tariffs actually lead to efficient control of power consumption on the part of the consumers? How can emotions and associations be connected to the renewable energy generated in the region? How can utilities make consumers understand the impact of their personal actions in the smart energy system? How can communication on the subject be stimulated and each individual become visible as a participant in the smart grid community? During discussion of these questions, various different creative approaches to the solutions emerged, enabling people to visualize or experience the rethinking of the subject of energy.

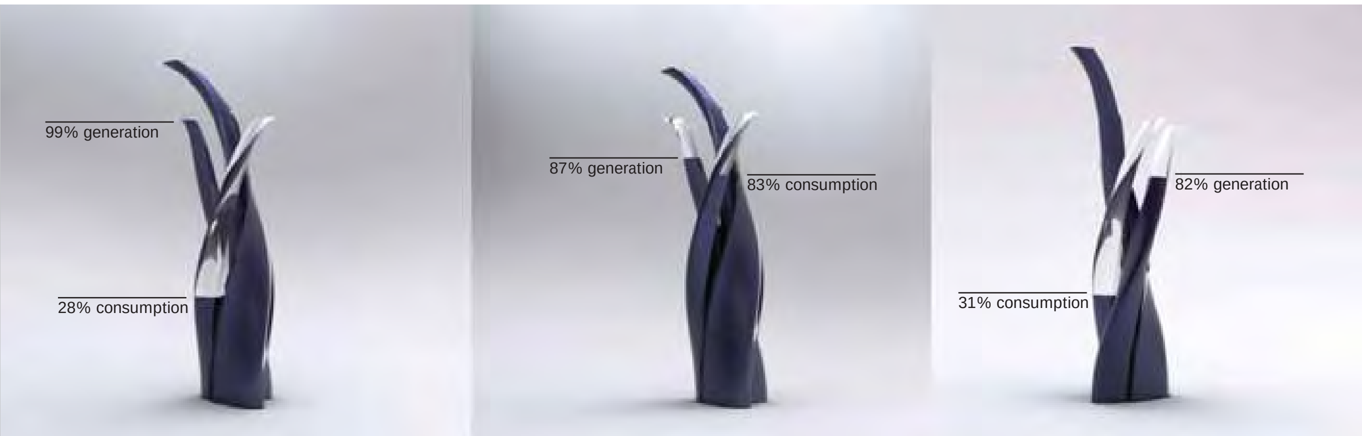
Results

The Smart Energy Sculpture designed during the workshop visualizes the connections and relationships in an intelligent energy system where communities primarily use renewable energy generated regionally and make it available to other networked communities when excess is generated. Three columns forming the sculpture act as the control system and digital data display for the smart grid, indicating the source of the renewable resources (e.g., wind, water, solar), generation and consumption in the region.

The sculpture could therefore include the following features:

> Smart energy manager
> Control center
> Distributed grid infrastructure regulation
> Information & communication site for consumers
The new church/energy as religion
> Consumption/generation display
Energy made visible
> Energy storage

Another interesting way of integrating the user in a smart grid community is designing smart controllers and indicators capable of showing that the user is a member of the community (like various mobile phone models).



The columns indicate regional generation using renewable energy sources and the community's consumption.

The two smaller columns show the energy generated and that consumed in the community. Like in a thermometer, a certain percentage of the column is colored. This makes the difference visible and whether energy is required by other communities or can be sold.

The large column shows from what power plants and resources the energy comes. In addition, more detailed information is displayed digitally. Making energy visible also makes the local population more aware and gives them a better understanding of the issue. Around the sculpture that should be located in the center of the town, for example, on the market square, there should be seating. This will make it a place for communication and information comparable to a church where the local population regularly meets for a chat.

"During the rethinking energy workshop, creative approaches were taken, enabling people to visualize or experience the rethinking of the subject of energy."
Lothar Rehse, initiator of the workshop

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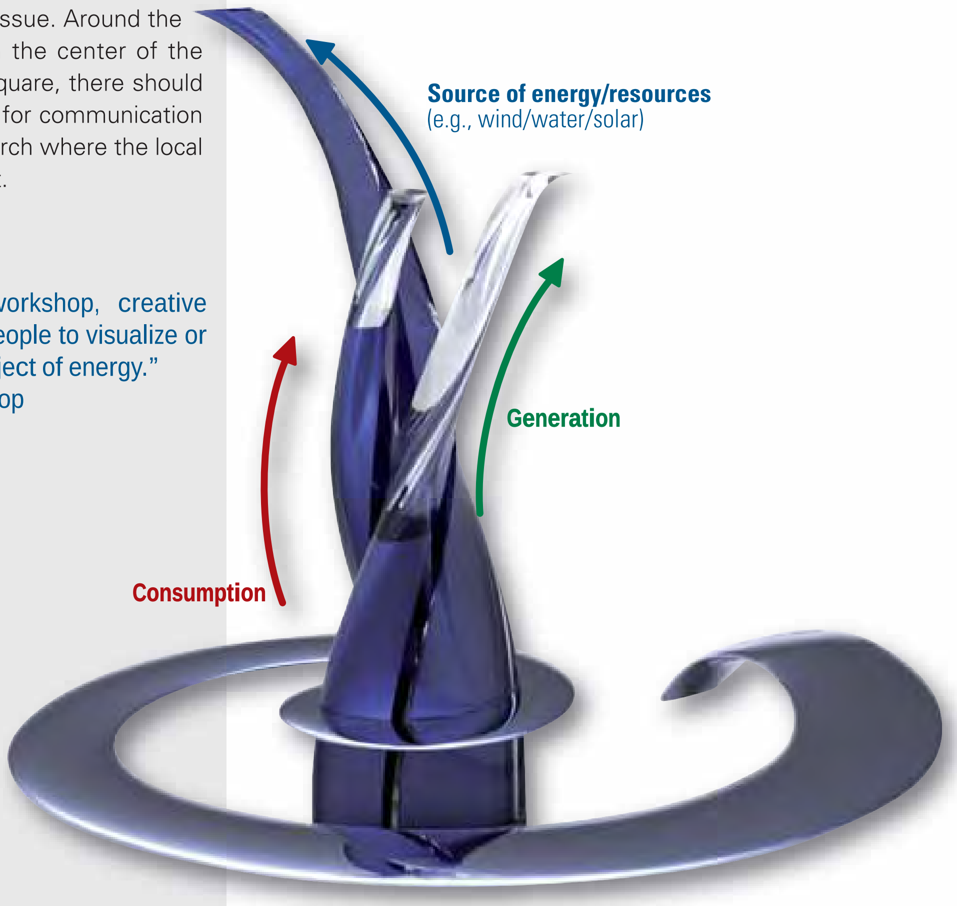

Grossschönau Smart Community

Community infrastructure and consumers as key elements of a smart energy system

Back in the 1980s, Grossschönau, a village in Lower Austria's Waldviertel region, started considering how the value added created with energy could remain in the community. The first move was to install wood chip heating systems in local homes. Later, the council built a biomass heating plant with 36 square meters of solar panels for the new community center. Today, all the public buildings, four businesses, the church center and several households in the immediate vicinity are supplied with eco and solar heat.

These initial initiatives have led to energy still being the main issue in the local council to this day. A four-day eco and eco-energy fair has been held here every year for over 20 years, attracting some 300 exhibitors and more than 30,000 visitors from all over the region and beyond. Europe's first passive house village in Grossschönau gives those interested the opportunity to have a short holiday in a passive house to see what it is like and how it works. In addition, the council has not only invested in activities in the area of energy supply and efficiency but also installed its own fiber-optic network. Close cooperation between the council, tourist office and the relevant players in the area enables common goals to be pursued. As a result, Grossschönau has bucked the trends in the neighboring villages and seen its population growing by 7.1 percent.

The council attaches particular importance to developing measures for increasing energy efficiency. In all the passive houses, for example, electricity consumption data is collected and evaluated for the individual applications. Of the 1,300 people living there, 50 have been trained as energy experts who carry out surveys of the energy used in 550 households in 13 villages governed by the local council. Based on the experience gained over the past few years, practice-oriented user training sessions have resulted in 20 to 30 percent savings in the energy consumed in five public buildings (council offices, primary school, nursery, community center and gym).

The council's latest idea is to position Grossschönau in a future smart energy system as a new player on the energy market. If the market conditions are suitable, the council as a flexible consumer could contribute towards balancing supply and demand on a broader regional basis and thus create benefits for reducing peak electricity requirements and optimizing the use of renewable energies. It would involve the individual consumers offering their flexibility through distributors as a service on the electricity market. As a result, they could save costs by using new tariff models.

In a field test, the real load shift potential of automatic electrical load management is now to be determined and experience gained regarding user convenience and acceptance. Storage processes on the consumer side will be used in particular. Heat pumps serve as shiftable loads in households. In addition, the pump system for the local district heating supply and drinking water pumps can be integrated. In the public sector, it is also possible to integrate air conditioning and ventilation systems. The sludge pump and fans in the local wastewater treatment plant offer potential for shifts in consumption as does the sludge drying plant and certain energy consuming processes required by industry in Grossschönau.

“The answer is little by little and bit by bit.”
Mayor Bruckner

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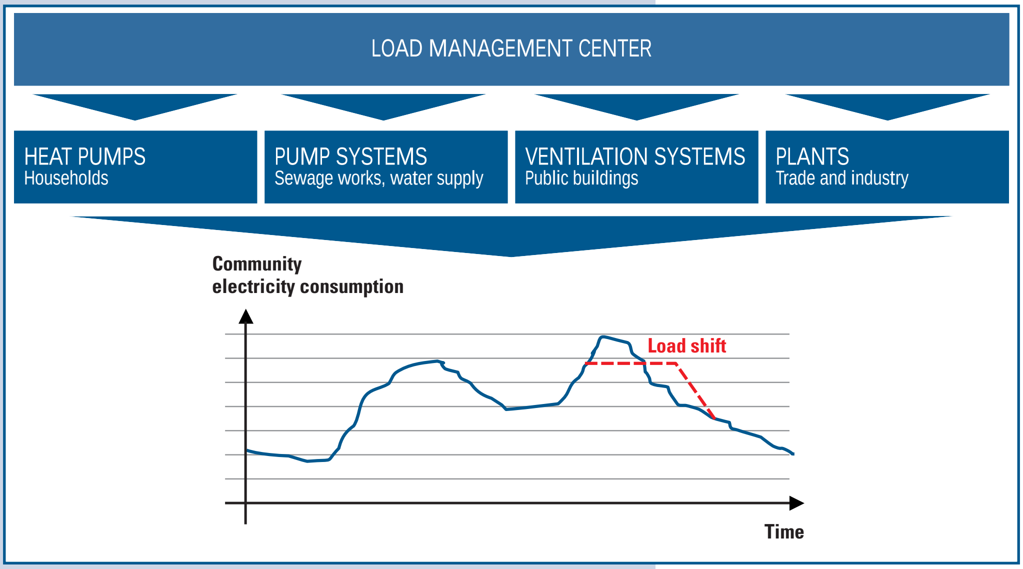

IRON Concept
Resource optimization in the power grid

The IRON (Integral Resource Optimization Network) concept project examines market-oriented opportunities for exploiting previously untapped potential for increasing efficiency by enhancing information flow in the electricity system. In the electricity grid, there is little or no communication at all with the consumer side and minor suppliers in particular. If an influence is to be exerted on the consumer side using load management, a suitable communication infrastructure with the individual consumer devices is, however, a must.

Unlike load management as practiced today – disconnecting loads in exceptional cases to maintain grid stability – the project focuses on adjusting or controlling the load in normal grid operation. Such adjustments have to be made in such a way that they do not make the energy service less convenient for the consumers affected to any great extent. In particular, such loads are therefore adjusted that convert electricity into other energy forms (e.g., potential energy, thermal energy) and can store it for a certain period of time (e.g., cooling systems, heating systems, pump systems, etc.).

In the project, four potential market models are being developed complying with current legislation or what will be in place in the medium term that could enable the economic impact of automatic load shifts to be shown. The market models are:

Transmission cost minimization: reducing the line losses and grid expansion costs with local consumption at the required time and distributed supply.

Green electricity: increased simultaneous use of locally generated eco-energy.

Time-of-use tariffs: passing on energy price fluctuations (trading prices) to the consumers who can then primarily use energy at times when costs are lower.

Balancing energy provision: pooling many small loads to create a large virtual energy storage facility that provides energy for balancing generation and consumption in the power grid.

In-depth studies have shown that only the last two market models can be implemented cost-effectively. The balancing energy model in particular is attractive, as balancing energy is traded at high prices. Given the increase in renewable energy sources used for generating electricity and the fact that their generation profiles are sometimes erratic (especially wind power), the demand for balancing energy will continue to rise, which makes this market model additionally attractive.

In the project, detailed technical implementation is being prepared for providing balancing energy from electrical loads (IRON Box). Another beneficial aspect of the balancing energy provision model is that in the case of primary balancing the balancing power is acquired when there are grid frequency deviations from the target 50 Hz, a level that can be measured locally in the entire grid at any time. No particular demands are therefore placed on communication between the individual load nodes. The algorithm developed during the project is designed to ensure that daily contact between the load nodes and the control center is sufficient. Either the Internet or the smart metering networks currently being created can be used for this.

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Smart Metering Pilot Project
Consumer motivation and general situation

In Austria, the electricity meters currently used in households and for customers with annual consumption of less than 100,000 kWh are only read once a year for billing purposes. Regarding energy consumption, consumers are therefore only notified of the amount used over the year but do not receive any detailed information of when they consumed how much electricity.

In addition to various other possible measures, the EU Directive on energy end-use efficiency and energy services (2006/32/EC) states that showing energy consumption is an incentive for changing consumption behavior and an important move for saving energy. This can be achieved by equipping energy customers in the future with meters that record “actual energy consumption and actual use time” and provide consumers with suitably presented information using various display systems. In addition, energy consumption should be billed more frequently than has previously been the case. This should encourage consumers as a whole to change their consumption behavior and ultimately save energy.

The basis for smart metering as it is called are electronic meters and modern communication systems for transmitting data between the energy consumers and energy suppliers. Electronic meters store and send daily and monthly figures to the utilities. Depending on the technical equipment selected, current energy consumption for the hour, minute or even second can be displayed at the customer's home or premises. The core question is, however, what information makes sense for the consumer and how should it be processed and displayed?

Changing the status quo for billing energy, e.g., by issuing accurate monthly invoices, has a significant impact on the processes used at the utility (i.e., billing in the accounting system, times, printing, sending, credit control, discount policy, etc.). Customers are also affected to a great extent. To enable more frequent billing, the current method of reading meters manually would have to be changed over to an automatic remote system. This would require remotely readable load profile meters to be installed and connected to a telecommunication system. In addition, the data volume for 15-minute meter readings would also have to be stored in the billing system correctly and in good time and validated accordingly. As soon as this has been done, the consumption data, any comparisons with previous time periods available and, for example, costs derived and CO_2 footprint can be shown to the customer (in-home display, web portal, etc.).

Before smart metering is implemented at EVN AG, various different systems will therefore be tested during a pilot project. Some 300 selected customers – households, service companies and public buildings – are being studied to see what a smart metering and billing system has to be like before it is accepted by consumers and could actually lead to a change in their behavior. Furthermore, the study will examine how high the potential for savings could be and how sustainable the savings are.

The project is divided into eight work packages/phases:

1. Concept
2. Technical clarifications
3. Customer selection
4. Meter and smart meter purchasing and installation
5. Installation of the communication infrastructure (software, installation, etc.)
6. Data processing/visualization with recommendations for action
7. Monthly billing and customer campaign
8. Scientific support and validation

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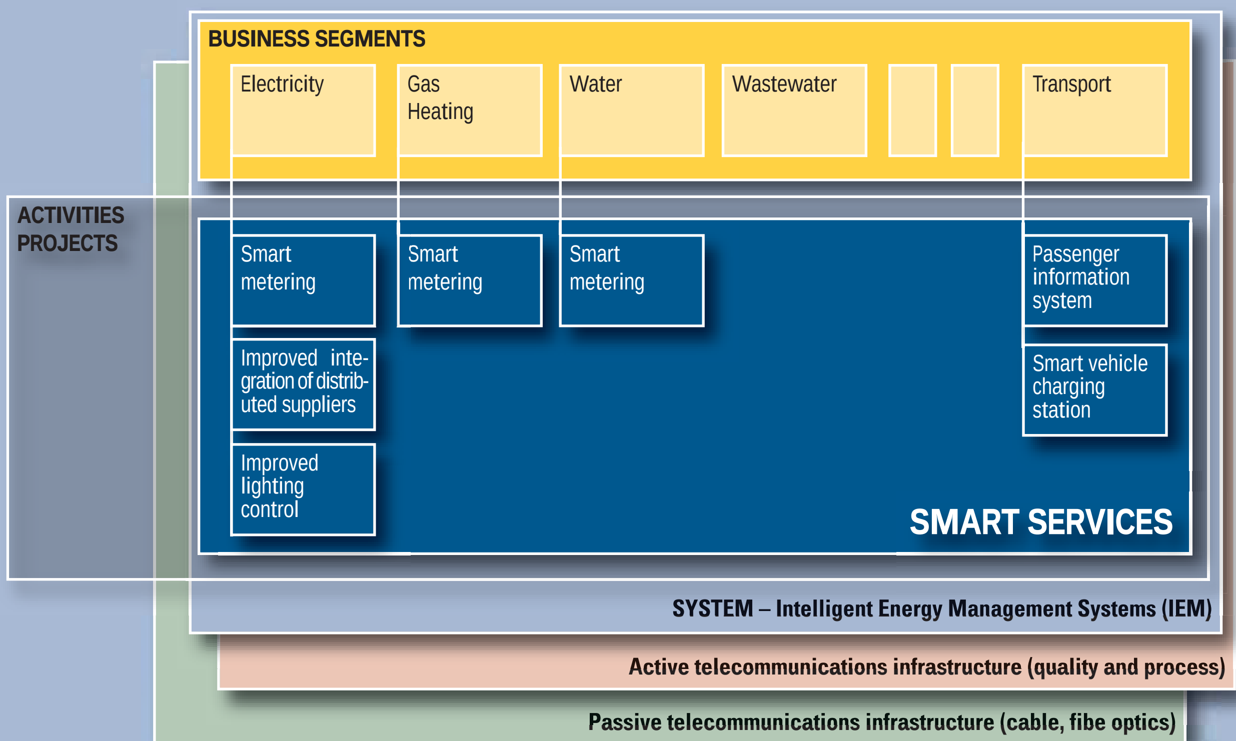
Smart Services for the Linz Area

Linz AG is a multi-utility, i.e., with several different divisions (e.g., electricity, gas, heating, water, sewage, transport, etc.). Core activities at Linz AG aimed at achieving a smart energy system focus on developing an intelligent information and communication structure used as the basis for supplying various new services to customers across all the divisions. The key to it is intelligent energy management. Only when all the divisions have access to the same system can new smart services be created over and above the traditional individual areas.

Charging stations for electric vehicles, for example, can link the areas of transport and electricity or customer information nodes can access the data from all the divisions at the same time – at consumer level. If combined heat and power (CHP) plants are to be used more intelligently for supplying power in the future, a link between heating and electricity will be required. In every area it can be seen that in the future a common information structure will be the basis for all other activities.



The reason for the comprehensive initiative is also that 250,000 mechanical meters in the area served (of which around 15,000 meters have been in the grid for longer than 35 years) will have to be replaced in the coming years (about 11,000 meters annually). Linz AG's aim in replacing the meters is to ensure that the system becomes smarter and more cost effective as a whole and that new services can be created for the customers. It will be based on a

common stable, passive telecommunications infrastructure such as cable and fiber optics. As the energy supply and traffic management systems are highly critical, the passive structure will have to function completely independently.

Once the passive structure is in place, a common active telecommunications structure will have to be developed. Here it will be important to ensure that all the divisions use compatible quality standards and the same processes right from the start. In addition, the indoor line solutions will have to be compatible with the outdoor power lines.

Only then can full use actually be made of intelligent energy management with the appropriate functions and future smart services for customers. Unified Intelligent Energy Management (Unified IEM) is a system that controls smart applications and can meter on site and import data. The new opportunities for communication and feedback connect the consumers with the various different areas of community supply. Only when these new communication channels have been created can the overall system be improved.

Examples of initial services already being provided include the smart passenger information system, remote meter reading, ripple control and controlling public lighting in the area supplied.

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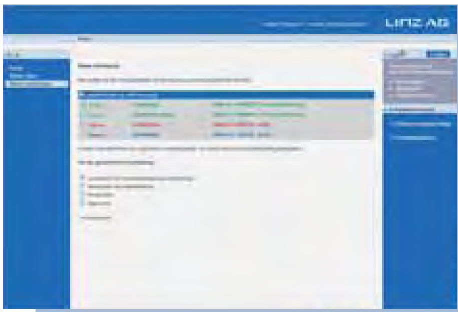
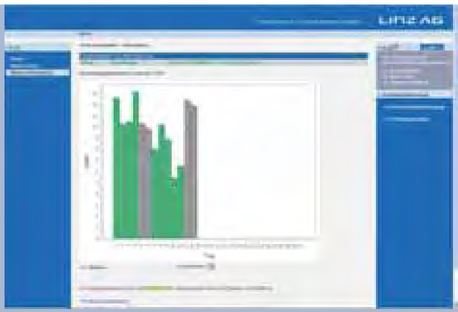




PLUS 24
LINZ AG's personalized customer service

After registering and obtaining a password, customers can access their own energy data on the Internet at any time. Viewing current energy data in the personal customer service area is just the start. Plans are underway for providing additional services:

> Comparison with previous year
> Details (quarter-hourly readings)
> Tips and tricks for saving electricity
> Notification of conspicuous trends in electricity consumption
> New tariffs available (Happy Hour – currently a test project)
> Special energy advisory services
> Smart home services (e.g., door camera and intercom system that can be controlled via the Internet)

Smart service: intelligent lighting

Lighting in public spaces is very important in communities, especially for safety reasons, but puts a considerable strain on the budget in the long term. Using intelligent lighting systems can save energy while improving the lighting quality at the same time. Intelligent systems use motion sensors that switch all the lights on or off depending on the lux levels and can also dim them depending on the time. This can easily be controlled using remote maintenance with a monitor. Changing over to modern light fittings not only improves the lighting quality but also reduces electricity consumption.

The aim of intelligent lighting is to improve energy efficiency and system maintenance as well as to increase safety and flexibility. It is again based on the common use of system and network components. Linking smart metering and street lighting enables consumption to be recorded for individual lights or whole streets and also energy monitoring/accounting and lighting control to be combined.

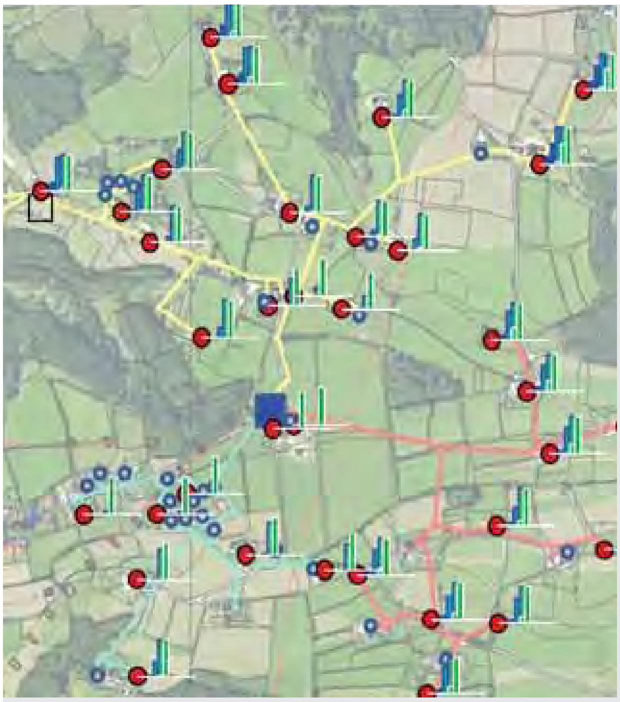
Such a control system was implemented in the Plesching energy park. It meets the multi-utility's requirements of including all the relevant information in one smart system. The system in the test project, for example, integrates meters for electricity (Echelon), gas (Flonidan), heating (Kamstrup) and water (EWT), street lighting (Siteco) and home automation (Moeller).

Examples of other smart services

> Metering – read annually/every quarter of an hour
> Online metering
> Home metering
> Customer information
> Market platforms (IRON)
> Distributed suppliers – influenceable/non influenceable
> Optimizing distributed suppliers – influenceable consumers/e-motion as special case
> Virtual power plant – isolated operation
> Simulation: grid/voltage profiles
> Grid/voltage statistics
> Grid information – asset management
> Grid information – voltage quality
> Grid automation

Power Snapshot Analysis by Meters

Development of an innovative analysis method for improving low-voltage networks



Background

The existing low-voltage networks as used today are not designed for a large number of distributed generators – usually based on renewable energy sources. Currently, the relevant decisions regarding connection of distributed generation systems to low-voltage networks have to be taken on the grounds of calculations based on estimates of load peaks in the individual line sections. As a result, additional large safety margins currently have to be factored in, which limits the connection options for distributed generation systems.

Project content

The aim of the ISOLVES:PSSA-M project is therefore to determine and develop the necessary technical basis in order to enable an increasing number of distributed suppliers to be connected to low-voltage networks. To do so, an innovative analysis method will be developed using smart meters to take snapshots of the power grid state in the relevant sections and evaluate them (power snapshot analysis by meters – PSSA-M).

The basic idea behind the method is to take simultaneous readings that reflect the current status of the entire low-voltage network (voltage parameters, resource capacity utilization, etc.) triggered by a pulse. The options for analyzing the snapshots of the physical quantities in a low-voltage network include load flow and distribution, critical voltage states, fault location, etc. The meter's time stamp where the trigger occurred is sent to an aggregator. It then requests all the meters in the low-voltage network to send the readings taken when the time stamp occurred. In order to be able to exploit the synergies (no need to install additional measuring devices, which would involve high investment and operating costs), the smart meters used in the project will first have to be adapted as measuring devices.

Analyzing the readings obtained from up to a hundred different low-voltage networks in urban and rural structures will enable the potential for implementing the smart grid approach to low-voltage network operation to be determined in depth for the first time. The results of these studies will help to represent and model low-voltage networks more accurately and thus substantially improve network planning and operation in the distribution grid. Insight gained from these results will lead to decisive improvements in network planning – especially for expansion to include new generation and consumer systems – and ensure voltage quality for end users. A particular challenge facing the low-voltage distribution grid will be integrating electric mobility.

The development of this method in the ISOLVES:PSSA-M project is a necessary step on the road to intelligent energy systems with the focus on smart distribution grids. As a result, the present project will in particular play a significant role in increasing the percentage of renewable energy generation systems on a broad basis in the medium to long term with the considerable savings in CO_2 emissions that go hand in hand.

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Vöcklabruck Smart Information Systems

Intelligent metering and information systems in the smart meter test region



An important core element and at the same time a bottleneck in smart energy systems is the information and metering system – i.e., the interface between the customer and supplier. Siemens Energy together with Energie AG therefore developed an automatic metering and information system (AMIS).

The key component of this system is a new meter family capable of being rolled out with which Upper Austria will set new standards throughout Europe. Used here for the first time, the smart electricity meters are software-controlled and therefore open for future developments and new applications, such as home automation. However, the meter is just one albeit important element for the customer. AMIS creates the basis for completely new business models and a new quality in customer relationships. In fact, the comprehensive system will make various new functions possible in the smart energy system of tomorrow.

With AMIS, the generators, grid and consumers can be intelligently connected with integrated control. A data concentrator collects the consumption data in the transformer stations that is recorded accurately to the second by the individual meters, monitors the grid, passes on the information to the control center and feeds the data into the software for billing (e.g., in SAP). Communication with the customer uses powerline technology, i.e., data transmission via the low-voltage network. No additional systems therefore have to be installed to ensure the same high security standard.

The new system is open for future interfaces and meters from other manufacturers. Gas, water and district heating meters can also be directly integrated. The consumption data for all grid-bound energy sources can therefore be metered automatically and as a result new tariff models and services provided.

Customers can use an Internet portal to access information on their current consumption and load profiles on their own computers. In view of people's increasing interest in generating electricity themselves, e.g., using photovoltaics or fuel cells, the system automatically provides the necessary facilities for control and metering.

The new AMIS electricity meters therefore offer a completely new environment for future services and new energy products with which customers can substantially improve their own energy use and power costs. Added value is generated for customers as well as for grid operators and electricity suppliers in that information is available in the entire system, i.e., up to billing (e.g., costs, load profiles) and quality assurance (e.g., voltage quality).

Vöcklabruck test region

The new functional smart meters are currently being tested for practicality in a pioneer region. In 2009, 10,000 such meters were installed in the Vöcklabruck region. Given the advance information they received, the customers were prepared for introduction of the AMIS technology and welcomed it.

Experience with the test meters has shown that the systems work well. All the installations were carried out successfully and the meters automatically logged onto the AMIS system. Mass readings for annual bills can now be carried out within 12 hours and individual readings mostly within a minute. The trial run represents the beginning of implementation and a further roll-out with 100,000 meters is being planned.

Smart grid laboratory in Gmunden

A special AMIS laboratory was set up in Gmunden. It carried out the necessary tests for developing the new devices. In addition, the entire system for customers and suppliers in the energy system can be simulated at the laboratory.

The test room holds the equipment used by the AMIS system, which means that all the main functions, such as reading, disconnecting/reconnecting, changing tariffs, payments and installation, as well as many other services and diagnostic functions, e.g., status request, log book request, voltage quality data or information/load profile data, can be simulated.

When there are system updates, all the functions are tested and errors corrected here. Only then is the live system updated in the pioneer region. The test system is also used for further developments, e.g., integrating meters from other divisions (gas, water, heating), transmitting automation data from transformer stations, testing customer displays, etc. Combining the test laboratory with the pioneer region enabled Energie AG together with Siemens AG to prepare the roll-out for 100,000 smart meters properly and ensure the new products involved were validated.

The director of Energie AG puts it into a nutshell: "There will be no smart grids without metering. Projects have proved that smart grids are just hollow words without these systems."

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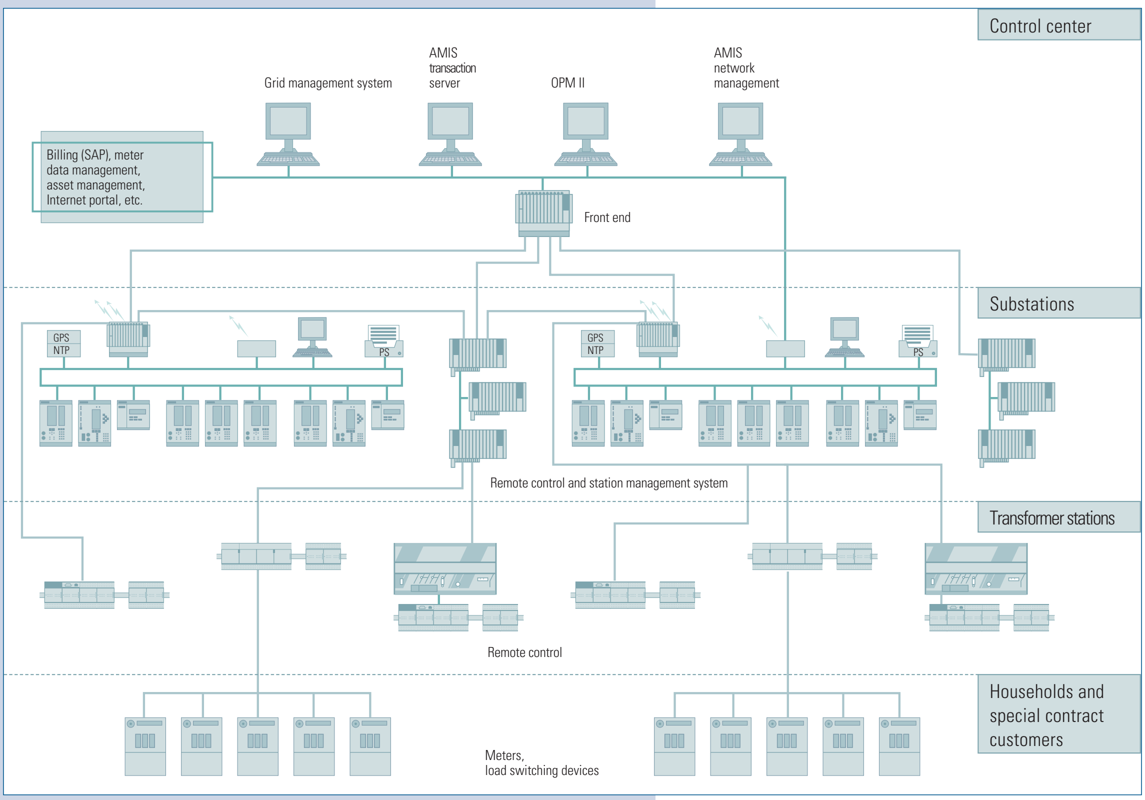
SIEMENS automatic metering and information system (AMIS)



€CO_2
Energy and climate protection management

Development and use of a smart metering and monitoring management system and a mobile application, the €CO_2 phone

In the future, information and communication technologies will increasingly be used for controlling and regulating energy consumption. Hopes are high that they will also help to make private consumers use energy more efficiently. The leading €CO_2 management project (financed by the Austrian Climate and Energy Fund) consists of three sub-projects. The first step is to create the technical basis for implementing an innovative smart metering and monitoring management system in practice.

In the second part, a field test will be run in two regions (Klagenfurt and Styria). Around 300 consumers will have smart electronic electricity meters installed enabling a wide range of fine-grained energy consumption figures to be recorded, such as electricity, gas and heating. When connected to a central collection system, this data can be used for calculating CO_2 emissions. The detailed data acquired is forwarded to a climate protection service provider that carries out the required calculations and sends the results to the test customer via the home automation system and a mobile application, the €CO_2 phone.

During the 12-month test run (until the end of 2011), customer behavior and savings effects in energy and CO_2 will be determined. Households can use a special advisory service throughout this period. Together with an energy and climate protection adviser, the savings potential will be determined (target is at least -13% CO_2) and then constantly monitored. Customers can access all the detailed data recorded at any time with their home automation system and make adjustments themselves (demand-side management).

When the tariffs are displayed, they can also shift individual consumer loads to a cheaper tariff period in order to reduce consumption peaks and save costs. The €CO_2 mobile phone gives customers a regular overview of the extent to which their consumption deviates from the target set.

The pilot test will also be combined with a micro emissions trading scheme – simulated for the 300 households. At the end of the test period, every electricity customer will receive a micro emissions permit and can “sell” the equivalent CO_2 emissions they have saved on the simulated CO_2 credit market. The plans are for the households to receive a credit note for every kilogram of CO_2 they save.

Intensive supporting socio-economic research will examine the effects and consequences of using such technologies, the user-friendliness of the devices used, the impact on user behavior, the individual motives for energy-related behavior and the reasons for decisions.

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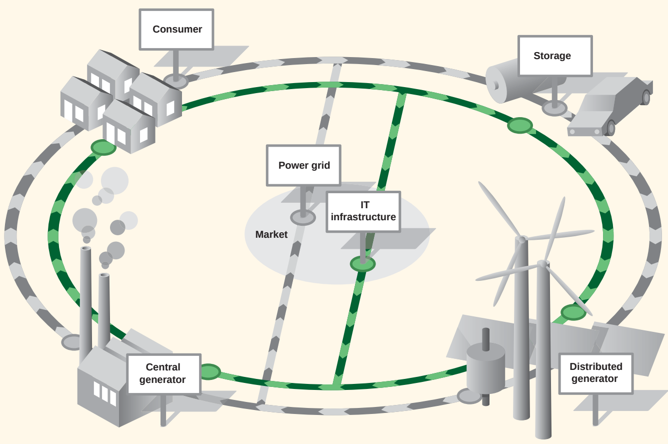
Joanneum Research, Graz (micro carbon credit model)
Inter-University Research Centre for Technology, Work and Culture (IFZ)
Grazer Energieagentur GmbH
e-Lugitsch (Styria test region)
Energie Klagenfurt GmbH (Klagenfurt test region)
Energie Graz GmbH (Graz test region)

Smart Grids Austria
National smart grid technology platform

Power grid of tomorrow



Smart Grids Austria is a national technology platform that brings together Austrian stakeholders in industry, energy economics and research in the field of electricity supply. Its aim is to pool their strengths to help develop smarter electricity grids in the future and achieve energy and cost-efficient system operation.

Sustainable development of the energy supply places considerable new demands on the electricity supply system of the future. In addition to increasing electricity efficiency, even more domestic electricity generation will be required in Austria with a rising percentage of renewable energy and highly efficient cogeneration plants in order to meet the electricity demand in the long term. Furthermore, the electricity supply structure will also have to be prepared for interactive electricity users and a large number of distributed mobile and stationary storage facilities (e.g., for electric vehicles).

Smart grids enable an energy-efficient and cost-effective balance to be struck between a large number of electricity consumers, generators and in the future also an increasing number of storage facilities. This balance is achieved with optimized management of energy generation, storage, consumption and the power grid itself. A continuous, bidirectional communication capability from the power plant to the load consumers is therefore required.

Smart grids open up an internationally relevant technology field where the Austrian energy and communications industry can position itself at an early stage due to its existing expertise, particularly in the area of smart distribution grids. The wide-ranging challenges that electricity networks are facing call for close cooperation between all the important players and a concentrated research and market preparation initiative. In 2008, the National Technology Platform Smart Grids Austria was therefore established with the support of the Ministry for Transport, Innovation and Technology (BMVIT), the Ministry of Economics and Labor (BMWA) and the Climate and Energy Fund.

The necessary development steps for the next decade are described in the **Roadmap Smart Grids Austria**. It shows a coordinated, structured and mutually agreed path to achieving smart grids.

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Excellent Research in the Area of Smart Grids
Austrian Institute of Technology – Energy Department

The Austrian Institute of Technology (AIT) originated from arsenal research and the Austrian Research Centers (ARC). It focuses on high-level research in key Austrian and European infrastructure issues. There are five specialized departments: Energy, Mobility, Health & Environment, Safety & Security and Foresight & Policy Development. The AIT's main task is to develop methods and technologies for future innovations and implement them in close cooperation with the private and public sectors.

The Energy Department researches into the entire chain from eco-friendly energy generation to sustainable end use. The key research areas are:

> Electricity infrastructure – smart grids and photovoltaics
> Sustainable energy supply for the built environment

Energy suppliers are confronted with the challenge of preventing CO_2 emissions from electricity generation, increasing energy efficiency and raising the share of renewable energy sources used. Smart grid concepts enable distributed generators and storage technologies (e.g., electric vehicles) to be integrated efficiently in the existing network infrastructure.

In the area of smart grids, the Energy Department focuses on:

> New management methods for operating power grids
> Interaction between the electricity system and grid components
> Grid components: design of development environments, validation and diagnostics

In these research activities, the Energy Department's scientific methods are based on a combination of experiments and simulations. The simulations use new multi-criteria simulation tools for smart grid concepts, coupled numerical simulations as a design tool for grid components, and model-based diagnostics for resources. For the experiments, the researchers have access to a high-level infrastructure consisting of a high voltage laboratory, power test area and inverter laboratory.

The AIT is a partner in the European Network of Excellence DER Lab (Distributed Energy Laboratory), plays a leading role in a number of European and national research projects (e.g., DISPOWER, DGFACTS, DGNET, SOLIDER, MetaPV, DG DemoNetz, BAVIS and ISOLVES) and leads certain activities in the International Energy Agency (e.g., IEA ENARD). Playing such an important role in technology strategy, the AIT is a key partner to industry, the electricity sector, university research and government in Austria and Europe.

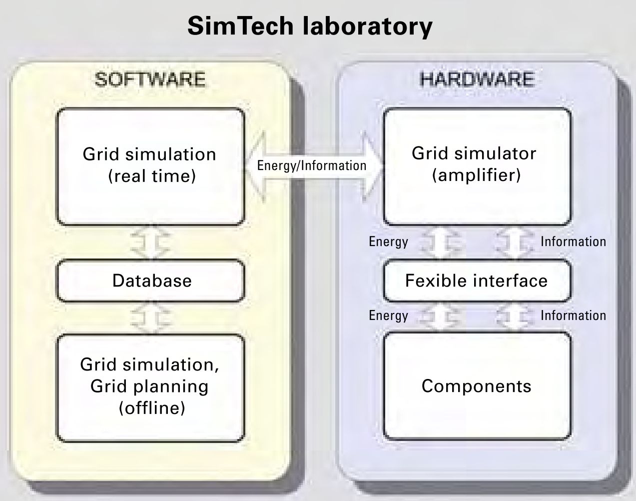
AIT'S SIMTECH LABORATORY INFRASTRUCTURE

New functionalities in the grids require innovative network components (e.g., inverters, smart meters, chargers, current limiters, etc.). These components are smart and display a high level of non-linear system behavior. It is essential when developing such components or defining, verifying and optimizing network management processes to examine the interaction between the system components and the grid. As new components' behavior cannot be modeled analytically, experimental processes are necessary. For intelligent network components, such as those in smart grids, **power hardware-in-the-loop (P-HIL)** and **controller hardware-in-the-loop (C-HIL)** processes are used as innovative approaches to the solution.

A new laboratory infrastructure is currently being developed at AIT's Energy Department where these innovative analysis processes can be carried out. Adding to the existing infrastructure, a system capable of power hardware-in-the-loop simulation will be installed primarily for analyzing electricity distribution networks. It includes a powerful real-time-capable computer cluster combined with network simulators (power amplifiers) for low-voltage direct and alternating current networks. Also required are instruments, sensors and equipment for supplying electricity.

This laboratory equipment will enable the interaction between components and the power grid as well as technological developments in the field of integrating distributed generators in the grid, demand-side management and electric mobility to be systematically explored.

In the case of power hardware-in-the-loop, the power grid is modeled in a simulation environment with real grid data, and individual nodes in the simulation are then sent to the laboratory infrastructure using power amplifiers (called grid simulators). Real components, such as inverters and cogeneration plants can also be connected to these simulators (power hardware-in-the-loop). Operating smart grids also requires new control algorithms for operating power networks with the participants being actively integrated. The controllers used can also be tested and developed in these facilities (controller hardware-in-the-loop). The real reactions of the systems and controllers to different network conditions are fed back to the simulator in real time (in the loop). This means that the systems' behavior on the real network can be modeled.



Such an infrastructure can minimize the risks involved in implementing new products in real-time operation and therefore shorten the innovation cycle for smart grid technologies. The AIT Energy Department's SimTech laboratory is helping Austria to position itself as a unique research hub for industry throughout Europe. As a result, it can play a leading role in international research projects in the area of smart grids.

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International research cooperation

Smart Grids D-A-CH
International Energy Agency (IEA ENARD, DSM, 4e, PVPS)
SmartGrids ERA-Net
European Electricity Grids Initiative (EEGI)

Publishing information

Edited, published and distributed by:
Austrian Federal Ministry for Transport, Innovation and Technology
Renngasse 5, 1010 Vienna, Austria, Europe

Responsible for content:
Energy and Environmental Technologies Department
Head of Department: Michael Paula

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Designed & produced by:
Projektfabrik Waldhör KG, www.projektfabrik.at

Photos and graphics:
Provided by the relevant regions and project partners,
Lenhard Reuter (page 8), Siemens AG, photocase,
Stella/pixelio.de, Projektfabrik Waldhör KG

We wish to thank the players mentioned for their contributions and the material supplied.
Vienna, 2010

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