Federal Ministry
of Economics
and Technology

Innovation policy, information society, telecommunications

E-Energy

ICT-based Energy System of the Future

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Preface

Climate change, growing demand for energy and depleting fossil-based resources are emerging as a huge challenge for our society. They demand a change in the mindset and a new direction. In particular, every link in the energy supply chain – from generation and distribution through to energy consumption – must be optimized in such a way that energy efficiency is increased, renewable energies are developed and greenhouse gas emissions are reduced. New technologies, in particular modern information and communication technologies (ICT), can help us achieve this goal. They provide the information networks and intelligent systems needed to analyze and process data. If we put these technologies to work, we can better meet the major challenges we are facing.

The growing importance of ICT in solving energy and climate-specific issues was recently underlined at the world's biggest computer trade exhibition, CeBIT. With its motto “Green IT”, it clearly illustrated that while ICT was part of the problem, accounting for approximately 2 percent of global CO_2 emissions, it could also be part of the solution to a far greater extent.

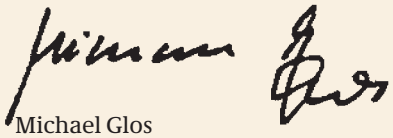
This is precisely the area where my ministry will be directing its efforts. At the trade exhibition, the “E-Energy: ICT-based Energy System of the Future” technology competition was very well received. With this new support measure as part of our technology policy, my ministry is focusing on the interface between the energy industry and the ICT industry.

Due to its importance both in terms of innovation and the national economy, E-Energy was declared a beacon project at the National IT Summit of the Federal Chancellor in December 2006 and 2007. As part of this effort, new ICT products, processes and services are developed which can be applied to reduce energy costs, increase the security of energy supply and mitigate the impact of climate change.

This brochure provides the reader with an initial overview of the twelve nominees and the six E-Energy projects finally selected for funding. Their implementation paves the way towards an "Internet of Energy" which intelligently monitors, controls and regulates the electricity system. In particular, the activities of the E-Energy projects strike a balance for the first time between volatile (weather-dependent) power generation and fluctuating power consumption. This is essential to integrate renewable energies. "Smart meters", which act as a power center and perform important control functions for distributed producers and consumers, play a pivotal role here. In conjunction with this type of smart power measuring technology, E-Energy solutions can automatically ensure that power is primarily used (in households, machines, plants, commercial and industrial equipment etc.) when it is available at a low cost and in sufficient amounts (e.g. when winds are high or sunshine is intensive) without having to compromise on convenience, energy supply security or quality. The new E-Energy solutions will be tested in selected model regions.

The E-Energy beacon project thus aims at takkling climate change and ensuring the secure and reliable supply of energy at competitive prices. Furthermore, it presents a good opportunity for the development of new jobs and markets. This is clearly demonstrated by the diversity of those participating in the E-Energy projects, including ICT vendors, power companies, providers of measuring, control and regulation technology, research institutes, mechanical, plant and equipment engineers, system operators, electrical technicians and facility management companies. There is a real chance that the new jobs will be created and remain in Germany since the E-Energy solutions are tied to model regions and fixed energy infrastructures (power plants and power grids) in the country.

This brochure intends to clearly outline the specific goals of the E-Energy beacon project. I am confident this will boost innovation and make Germany the leading ICT and energy center in an area which is critical for global competition. Even though our country is poor in raw materials, it is well positioned on account of its system expertise and its strong tradition in energy science and business software.



Michael Glos
Federal Minister of Economics and Technology

Content

What is E-Energy?

With E-Energy, an "Internet of Energy" is developed that intelligently monitors, controls and regulates the electricity system.

"E-Energy: ICT-based Energy System of the Future" is a new support and funding priority undertaken by the Federal Ministry of Economics and Technology (BMWi) as part of the technology policy of the Federal Government. Due to its utmost importance both in terms of innovation and the national economy, it was declared a beacon project at the National IT Summit of the Federal Chancellor. Just like the terms "E-Commerce" or "E-Government", the abbreviation "E-Energy" stands for the comprehensive digital interconnection and computer-based control and monitoring of the entire energy supply system. It was decided that the electricity sector would be the first area addressed by the project, as the challenges with regard to real-time interaction and computer intelligence are particularly high due to electricity's limited ability to be stored.

The primary goal of E-Energy is to create E-Energy model regions that demonstrate how the tremendous potential for optimization presented by information and communication technologies (ICT) can best be tapped to achieve greater efficiency, supply security and environmental compatibility (cornerstones of energy and climate policy) in power supply, and how, in turn, new jobs and markets can be developed. What is particularly innovative about this project is that integrative ICT system concepts, which optimize the efficiency, supply security and environmental compatibility of the entire electricity supply system all along the chain – from generation and transport to distribution and consumption – are developed and tested in real-time in regional E-Energy model projects.

To force the pace on the innovative development needed and to broaden the impact of the results, in April 2007 the BMWi held the E-Energy Technology Competition that focused on the following three aspects:

1. Creation of an E-Energy marketplace that facilitates electronic legal transactions and business dealings between all market participants.

2. Digital interconnection and computerization of the technical systems and components, and the process control and maintenance activities based on these systems and components, such that the largely independent monitoring, analysis, control and regulation of the overall technical system is ensured.

3. Online linking of the electronic energy marketplace and overall technical system so that real-time digital interaction of business and technology operations is guaranteed.

Servers for controlling the flow of information which will also increasingly regulate the flow of energy.

With these three focal topics, for the first time the Ministry called for the development of integral ideas and system concepts for an "Internet of Energy" which considerably eases and speeds up the information, communication and transaction processes on the electricity markets, intelligently monitors, controls and regulates the technical energy infrastructure on the basis of end-to-end digital networking, and links this infrastructure to electronic marketplaces such that the efficient, prompt and transparent coordination of energy supply, (end) energy demand and complementary services is possible in all areas of the power supply system. In the E-Energy competition spec, it was made clear this would not only necessitate technological progress but also the adjustment of organizational structures and general frameworks.

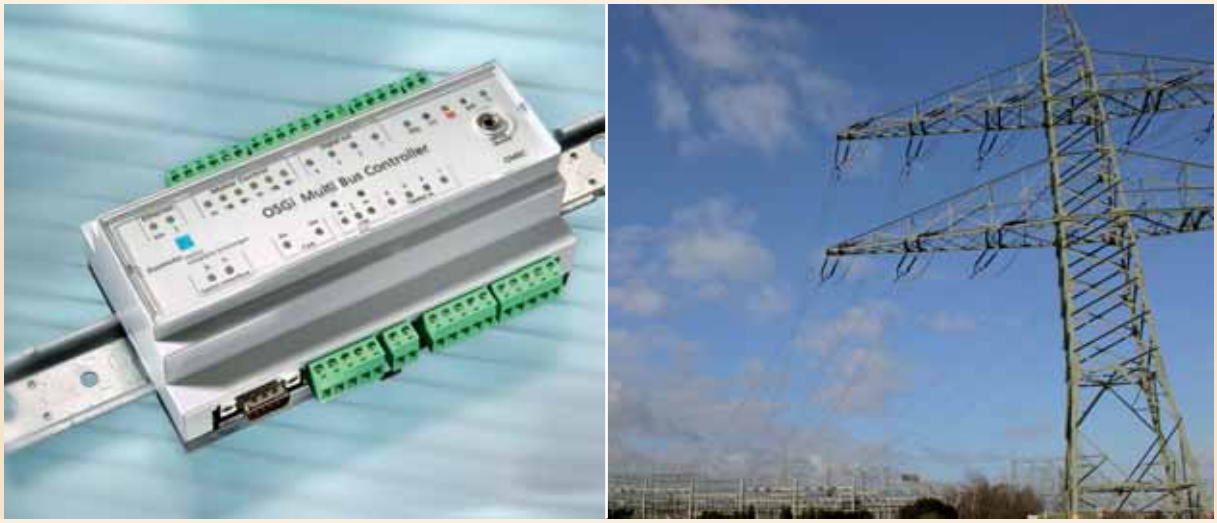
In view of the important role E-Energy plays in the development of renewable energy and the increase in energy efficiency, the prize-winning projects are supported and funded in an interdepartmental partnership with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). Through the collaboration of both ministries, more projects can be supported, which further enhances the reach and impact of E-Energy. The BMWi will appropriate up to €40 million for four model regions and the BMU will make up to €20 million in funding available to two additional model regions. Together with the equity capital of the participating companies, some €140 million will be mobilized for the development of six E-Energy model regions.

The E-Energy scenario: Intelligent networking of energy generation, distribution and consumption.

Apart from the activities in the individual models, the acquisition of transferable skills and expertise, the formation of networks for the rapid exchange of new E-Energy know-how and the initiation of effective overarching collaborative structures to solve critical horizontal issues (e.g. interoperability and standardization, security and data protection, development of the regulatory framework, business models for new services, EU collaboration and further internationalization etc.) is vital. To this end, the BMWi will drive ancillary research in addition to project funding and directly link this to the support of the E-Energy model regions. The specific tasks of the ancillary research will include the evaluation of progress made in the model regions, the derivation of success factors, the identification of new areas where action has to be taken, the organization of the exchange of knowledge and cooperative activities and the initiation of new E-Energy networks of excellence throughout the Federal Republic. Thus, the E-Energy beacon project will extend beyond the model regions to make an important economic and technological contribution to solving energy and environmental problems and developing new products, business fields and services. In this way, the BMWi also addresses its principal responsibility for energy and technology policy.

ICT is playing an increasingly important role worldwide in solving energy and climate-specific problems. This was clearly underlined, for example, at the world's biggest computer trade exhibition – CeBIT – in March this year. For the first time ever, the motto of the exhibition was "Green IT" and the trade show clearly demonstrated that the ICT industry is making more and more efforts to dramatically cut ICT-based energy consumption and harness the huge potential offered by ICT to optimize energy systems. The President of the European Commission, José Barroso, highlighted the need for ancillary support measures in his opening speech at CeBIT. In addition to the Smart Grid Initiative of the European Commission, internationally we are also witnessing initial efforts to push this issue forward on a country-specific level, as seen in Austria or the USA.

Why E-Energy?



E-Energy harnesses the potential for optimization of ICT in the energy industry.

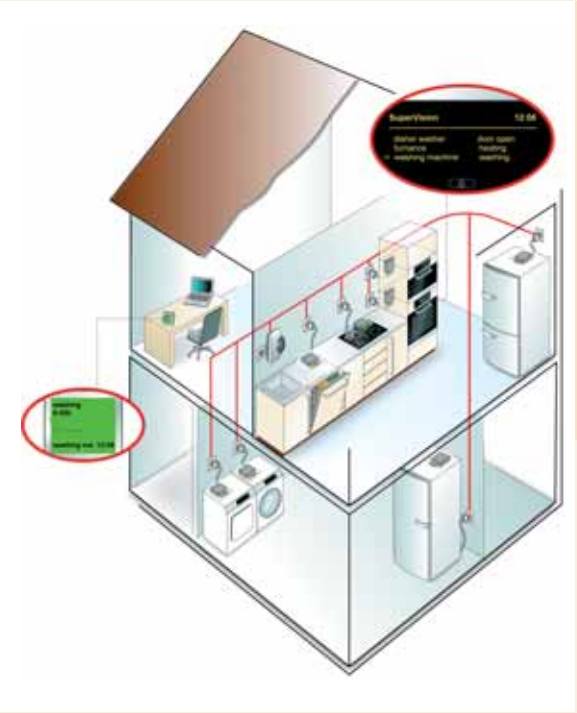
Latest studies and expert opinions (e.g. BMWi Study in December 2006 on the "Potential of Information and Communication Technologies to Optimize Energy Supply and Energy Consumption (E-Energy)") make it increasingly clear that any further development of the energy industry will not be possible without fully drawing on the potential of digital intelligence and networking. In contrast, the general consensus is that the use of ICT in the supply of energy has not played an important role up until now. Both the ICT and the energy industry see that considerable action needs to be taken in terms of technology policy before the enormous potential ICT presents for optimizing the energy industry can be tapped.

In the area of electricity, in particular, progress in modernization gives rise to new tasks that can only be solved by end-to-end digital interconnection and computer integration. The generation and retail markets are opening up with progressive market liberalization, for example. This results in greater competition and more complex market relations. The gradual decentralization of power generation also plays a part in increasing the complexity of the energy systems, as it not only causes further diversification of the markets but also leads to many new technical and organizational issues. These include the shift from central, large power stations to dispersed, weather-dependent power producers of different sizes and with different functions, the transition from a network monopoly with a one-way system – going from a large-scale power station to the consumer – to cross-border integrated networks with two-way power traffic and volatile, dispersed power feed-in, or the move to international, competition-oriented service markets with tailored products for customers.

All this underlines how the complexity of energy systems is increasing with progressive liberalization and decentralization measures. What is more, electrical energy can only be stored for a limited period so power supply and power demand have to be constantly matched. On the other hand, the enormous problems we are currently facing in terms of climate change, increasing demand for energy and depleting supplies of fossil fuels mean new solutions are urgently needed. New optimization efforts to increase energy efficiency, develop renewable energy and reduce greenhouse gas emissions, in particular, are called for.

This is where the "E-Energy: ICT-based Energy System of the Future" beacon project comes into play since tackling the increasing complexity associated with gradual modernization efforts, and solving the new energy and climate-specific optimization tasks, primarily requires communication and intelligence, i.e. networks for the exchange of information and smart systems for analyzing and processing data. ICT furnishes the main tools needed to make this happen. The E-Energy support initiative is aimed at providing an effective incentive to speed up the development of the necessary ICT products, processes and services, and apply them on a broad scale. In particular, it encourages the ICT and energy sector to define goals and tasks together, and form interdisciplinary and cross-industry partnership projects to create sample solutions for ICT-based energy systems of the future which are so convincing that they are copied and trigger follow-up investment on a large scale.

The focus is on research and development activities (R&D activities) for creating and trialling an integrated data and energy network with completely new structures and functions. Using sample solutions, it should be clearly demonstrated how such an innovative "Internet of Energy" can guarantee the utmost security and efficiency of electronic business and legal communication between marketers, and how the technical components and infrastructures of the overall electricity system can be intelligently monitored, controlled and regulated, and directly linked to electronic market activities:
On the supply side, it will be possible to even out the fluctuations in renewable energy caused by weather conditions through the intelligent blend and complex coordination of sources of energy. In the area of electricity grids, control systems that are linked online guarantee the optimum control of the flow of electricity. On the demand side, the intelligent online coordination and control of power consumption reduces load peaks and results in completely new services. It is particularly significant that the activities of the E-Energy projects enable bi-directional real-time interaction for the first time, thereby striking an accurate time-balance between volatile (weather-dependent) power generation and fluctuating power consumption.



The integrated, networked house allows economical energy management.

A critical role will be played by intelligent power meters, known as smart meters, which will increasingly replace mechanical models even in private households in the near future, and assume important control functions as an energy control center for dispersed producers and consumers. The new meter technologies boast a wide range of features and capabilities that can open up new services and business fields. Individual rate storage, load profiling, easy remote reading and control or connection to in-house software are just a few of the possibilities these new technologies offer. The smart meters act as an important interface between the end customers, who have not been integrated into the appropriate processes until now, and the grid network operators, suppliers and measuring point operators.

E-Energy aims at progressing the wide range of uses of this new smart measuring technology and making it more widespread. For example, in conjunction with smart meters the new E-Energy solutions will create two-way interactions which make the

E-Energy is central to the efficient integration of renewable energy sources.

Electric vehicles for short and long distances.

management of the grid easier for grid operators, as they have a clearer overview of the processes taking place in the network and of the power downloaded or uploaded. Furthermore, suppliers can offer their customers more flexible rates, and customers can be alerted to price signals so they can shift their consumption of energy to low-load times and thus enjoy the lower tariffs. Ultimately, E-Energy solutions will independently ensure that power is used (in households, machines, plants, commercial and industrial equipment etc.) when it is available at a low cost and in sufficient amounts (e.g. when winds are high or sunshine is intensive) without having to compromise on convenience, energy supply security or quality. On the whole, this will lead to a wide variety of new service offerings, such as comprehensive advice on potential ways to save energy based on measured values recorded. Interesting business models could also take shape for new players, particularly providers that are independent of the energy industry.

All this clearly demonstrates that E-Energy reduces transaction costs and increases transparency in business processes, facilitates the necessary significant development of renewable sources of energy, makes better use of existing grid capacity, evens out load curves and reduces costly control energy needs.

Examples of how this works are illustrated in the following E-Energy project profiles. The projects described provide evidence that the greater transparency afforded by E-Energy can also motivate consumers to become actively involved with regard to pricing, providers, the quality of the power on offer and associated services. This not only encourages power saving but also stimulates competition across a far broader range of products, and promotes better comparability and more advertising and marketing on the Internet.

The government's interest in the promotion of E-Energy projects is rooted in the enormous impact expected in terms of the national economy and the energy industry. The projects will play a role in promoting greater competition along the value-added chain in Germany - from power stations and network operators to other players in retail, housing and services. At the same time, innovative growth fields and employment opportunities will be developed at the interface between ICT and energy technology. One important aspect is that the new employment and growth prospects are largely location-specific since the E-Energy solutions created are tied to model regions and fixed energy structures (power stations and power networks) in Germany and are thus not

Solar parabolic trough power plant for high-yield sunshine regions.

exposed to the effects of globalization like other business sectors. Furthermore, the E-Energy activities guarantee new solutions for energy efficiency, supply security and climate compatibility (e.g. reducing control energy needs and primary energy consumption) which are top-priority objectives in the interests of the community and would not be developed to the same extent or at the same rate without additional support and funding. Thus, the E-Energy projects are central in underpinning Germany's leading international position in implementing integrated measures for solving energy and climate issues.

The winners of the E-Energy beacon project

State Secretary Dagmar Wöhrl with representatives from the six winning projects at the award ceremony at CeBIT.

Assisted by an independent jury, the BMWi nominated twelve finalists from the 28 entries for the E-Energy technology competition. Following an in-depth project presentation, the jury chose six projects for funding which were officially announced and granted awards on March 4, 2008 at CeBIT. According to the jury, the winning projects will tap the enormous potential for optimization offered by ICT to achieve greater efficiency, security of supply and environmental compatibility in power supply.

Over the course of the following pages, the projects of the finalists and prizewinners will be presented. The projects complement one another such that they provide a representative range of different generation concepts and supply areas, and duplication is avoided to a large extent. As such, the model regions can be split into different categories such as “urban conurbation with a high supply density”, “rural region with a low supply density” and a “regional network with a heterogeneous supply density”.

One focus of the projects is to develop and test the standardized E-Energy architectures and E-Energy platforms needed for business processes and automation. They make it possible to bring all the market participants together online (e.g. households, industrial and commercial customers, retailers, grid operators and large and small generators), guarantee the necessary information, communication and transaction processes, and ensure such processes are secure. Following from this, the E-Energy projects should give rise to a multitude of new kinds of products and services. These could help energy supply systems become more self-regulating through the supply-dependent control of the demand pattern of end consumers, or could make effective incentive programs available to save costs and energy (e.g. with online power consumption analysis, online pricing information, supply conditions and current energy mix or online invoicing and payment systems).

In view of the highly complex nature of E-Energy technologies, applications and services, the use and development of practical standards to safeguard the necessary interoperability across the board is a particularly important part of the E-Energy projects, and key to being able to translate the new E-Energy solutions from the model regions to other supply systems. Ultimately, the E-Energy project activities should also scrutinize the legal framework, and make recommendations on how this framework could be improved and developed.

Accordingly, a wide variety of utility companies are involved in the projects, ranging from municipal facilities and regional providers to large corporations. The cross-section of the companies participating from the ICT and systems engineering sectors, as well as from equipment engineering and plant construction, is just as diverse with strong representation from the midmarket. Furthermore, close collaboration with universities and Fraunhofer Institutes is also planned in both the ICT and energy sector to pool the many R&D resources and form a critical mass. Overall,

The three goals of energy policy.

the unusually broad participant structure clearly highlights the tougher-than-average requirements in creating the cross-industry and interdisciplinary framework needed.

The six award-winning projects are now to be implemented and will be supported by ancillary research. This will take place as part of an inter-ministerial partnership with the BMU. Under the umbrella of the E-Energy beacon project, the BMWi will provide some €40 million in funding and the BMU will make approximately €20 million available. The participating companies will raise another €80 million so that a total of approx. €140 million in research funds can be mobilized to give the new E-Energy area of innovation the impetus it needs.

The six prizewinners are:

- E-DeMa, Ruhr area model region
- eTelligence, Cuxhaven model region
- MEREGIO, Baden model region
- Mannheim model city, Rhine-Neckar model region
- RegModHarz, Harz model region
- SmartW@TTS, Aachen model region

E-DeMa, Ruhr area model region – prizewinner

The Ruhr area is far nicer than its reputation; the region around Essen boasts forests, fields and a large reservoir lake, the Baldeneysee. But that is not what makes the Ruhr so interesting as a model region for the E-Energy project, says Michael Laskowski, coordinator for the E-DeMa project. The abbreviation stands for "development and demonstration of decentralized integrated energy systems on the way towards the E-Energy marketplace of the future". The Ruhr area is the perfect fit for this project "as it offers an excellent mix of buildings, single-family homes and multifamily residences with different social standards, providing us with a more or less representative cross-section of the entire population structure. Added to that, we have hospitals, small-scale industries, SMEs etc."

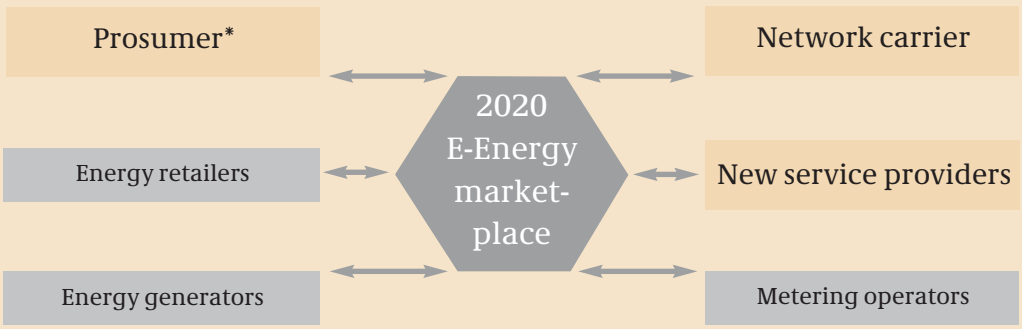
To all intents and purposes, the region is already relatively an old hand in E-Energy-related issues. For example, RWE has been exploring the area of smart metering for quite some time.

"Smart metering is nothing more than the process of recording power consumption data intelligently. However, what we have proposed in our project plan is the system integration of smart meters into an intelligent gateway. This type of gateway is a function unit which is part of the customer's sub-distribution system, reading out and controlling smart meters on the one hand and processing pricing signals from the power provider on the other. Customers are able to control their household appliances – mainly white goods but also dispersed power supply units, such as power-generating heaters, in the future – in such a way that it makes the most financial sense for them."

In the future, washing machines will be able to provide customers with pricing signals so customers can choose the cheapest rate and be more efficient in their use of energy. This pricing information will be made available to customers through an incentive system and will thus help improve energy efficiency in every household.

The customer can specify certain time brackets, explains Michael Laskowski: "If you live in an apartment block, the washing machine cannot run at two in the morning as you'll have the neighbors knocking on your door otherwise. So essentially you're telling the machine to wash ecologically but only during these specific periods."

If new heating appliances with Stirling units or fuel cells simultaneously generate heat and electricity in the future in such a way they can be controlled, the new ICT control technology will become increasingly important: "To ensure the power generated is uploaded at a time that is financially attractive from the customer's perspective, the intelligent gateway controls both energy consumption and energy supply – on the basis of price signals from the market!"



*) **Prosumer:** Customer from the private and commercial customer segment who can actively participate in the E-Energy marketplace and both **pro**duce energy (producer) and consume energy (con**sumer**).

The E-Energy marketplace is the centre of interest of different stakeholders.

The control and regulation of consumers and generators in households takes place through a "smart" gateway on the basis of pricing signals from the E-Energy marketplace.

Customers will be able to set all this up on their laptops: "The gateway has a wireless interface and customers can configure the system so it's tailored to meet their specific needs. One approach would be the direct control of appliances, which is why we've also brought a large equipment manufacturer on board. The appliances would then have appropriate receivers so they can react to incoming price signals. We want to encourage customers to actively save and give them the tools they need to make more efficient use of their energy."

Praise for the "E-DeMa" project

In general, a distinction is made between those who produce energy and those who consume it, the customers. In the "E-DeMa" project – development and demonstration of decentralized integrated energy systems on the way towards the E-Energy marketplace of the future – the concept of a customer does not exist. Instead we refer to "prosumers", which are active customers who both generate energy and upload it to the distribution grid (producers) and also consume energy (consumers). And precisely this fact is an important objective of the project, as the scheme promotes the active integration and participation of the end customer in the energy market. The 2020 E-Energy marketplace to be developed as part of the project thus not only links the distribution grids of RWE Rhine-Ruhr to the distribution network of Krefeld municipal utilities, but also focuses on integrating prosumers through ICT gateways which can be used for managing loads, controlling household appliances, smart metering and controlling distributed generators. The benefits are numerous, not only in the form of displaying energy consumption or pricing signals for the prosumer, or in the form of online information for better network management on the part of the grid operator. What we will have is a holistic infrastructure for controlling power consumption into which consumers are actively integrated and which can be used as the basis to set up additional energy services.

eTelligence, Cuxhaven model region – prizewinner

"... where the sea gulls cry/shrill in the blustery winds/that is my dear homeland / that's where I call home..." go the lyrics of a traditional north-German song. The words still ring true today since one thing the coastal town of Cuxhaven on the Elbe estuary certainly does have is wind – and plenty of it! Directly across the way, behind the northeast bank of the Elbe, you can find the cradle of wind energy - the Kaiser-Wilhelm Polder - one of the most windswept corners of Germany.

"Cuxhaven has a population of just 52,000 but some 3 million people overnight at Cuxhaven every year – no better way of broadcasting the message of E-Energy," says Wolfram Krause from EWE AG and project manager of eTelligence, the E-Energy project in the region. He went on to explain how the region was perfectly suited to the project, highlighting the wide range of renewable energy available, namely wind, photovoltaic, biogas etc. "50 percent of the electricity needs are covered by renewable energy sources in the district. That is tremendous."

There are also many flexible consumers in the region: "The fishing industry with its refrigerated warehouses, two large swimming pools with heat power co-generation systems etc. The clever use of these pools is at the crux of our idea to generate electricity precisely when we urgently need it, considering the heat as an inert system and using the swimming pools as storage units. Visitors to the spa won't notice whether the water is sometimes a half degree colder or warmer."

As envisaged in the E-Energy scenario, control energy and network services are traded on a transparent electronic marketplace. Wolfram Krause explains that he "imagines the refrigerated warehouse of the future simply having an Internet interface which I can use to integrate it into the market. If this takes place automatically and is not overly complex or time-consuming, customers can generate extra earnings using new products which are to be developed." He went on to say that private end customers must be given the opportunity to perceive energy as a valuable product. "We want to make this happen through smart metering which uses visualization systems to show customers how they can reduce their electricity consumption."

Wind power plants in the offshore test field in Cuxhaven. The "wind harvest" is to be on offer on the eTelligence marketplace in the future.

Krause explained that even though electricity is generated locally, the model region will remain connected to interregional grids to be able to export the sometimes enormous amounts of wind power: "Over 2.5 GW of wind power is available in the grid area of EWE NETZ GmbH. If we have high winds here and the load on the system is low – for example during the night when people consume less electricity – then we feed up to 1.5 gigawatt, which is 1.5 times the output of a nuclear power station, into the higher-order grid. This was not thought to be possible years ago and there are still some people out there who still think it's impossible. But we prove it can be done - time and again!"

Kaemmererplatz in Cuxhaven's city center was formerly a marketplace for fish. On the eTelligence marketplace, electricity is traded which is also used to cool Cuxhaven's fish catch.

Krause went on to say that they can only give a real figure for the savings that are possible with ICT once the project has been installed since "we can't do magic. The refrigerated warehouse will need just as much electricity each year as it does now since it will refrigerate just as much fish. But the overall system will become more efficient since you won't have to reduce the wind turbine performance if a surplus is produced and then switch on a gas turbine an hour later. You'll just simply convert the wind energy peak into more cold and instead of switching on the gas turbine later on, you'll shave the peak load by cutting back on refrigeration for the refrigerated warehouse."

Praise for the "eTelligence" project

It is not possible for customers and distributed generators to actively participate on the market today due to proprietary or nonexistent interfaces, as well as on account of obsolete market mechanisms. With the development of a new marketplace and the definition of products for small, medium-size and large producers and consumers, the Cuxhaven model region makes an innovative contribution which will create the primary framework for automated business processes, particularly for small market players. The Cuxhaven model region is in an excellent position to guarantee the energy blend of the future, an optimum consumer mix and a secure and economic infrastructure. By combining the project with tourism, there are good possibilities for the interregional development of the solutions to create marketable and licensable products. Great importance is attached to standardizing the reference solution so that the final result is an end-to-end, interoperable information platform – from the generation and transportation/distribution of power to the use of electrical energy – which can be easily mapped to other regions. This helps create the framework to also economically integrate small producers of renewable energy into the energy market without jeopardizing the security, safety and reliability of the system.

MEREGIO, Baden model region – prizewinner

Not only is the region of Baden famous for its wines, it has also inspired numerous creative minds, including Carl Friedrich Freiherr Drais von Sauerbronn, the inventor of the most environmentally friendly mode of transport of all time – the bicycle. Given such a tradition, it must be possible to make E-Energy a success here, says Hellmuth Frey, coordinator of the MEREGIO project.

It has not yet been decided where exactly the MEREGIO E-Energy project should be implemented in the Karlsruhe/Stuttgart region but the bottom line should be to achieve as many positive results as possible. "As a large energy provider, of course we have all kinds of customers so we'll be able to find a good mix that can be integrated into the project." Regional self-sufficiency is a desirable goal albeit a goal that is "difficult to achieve".

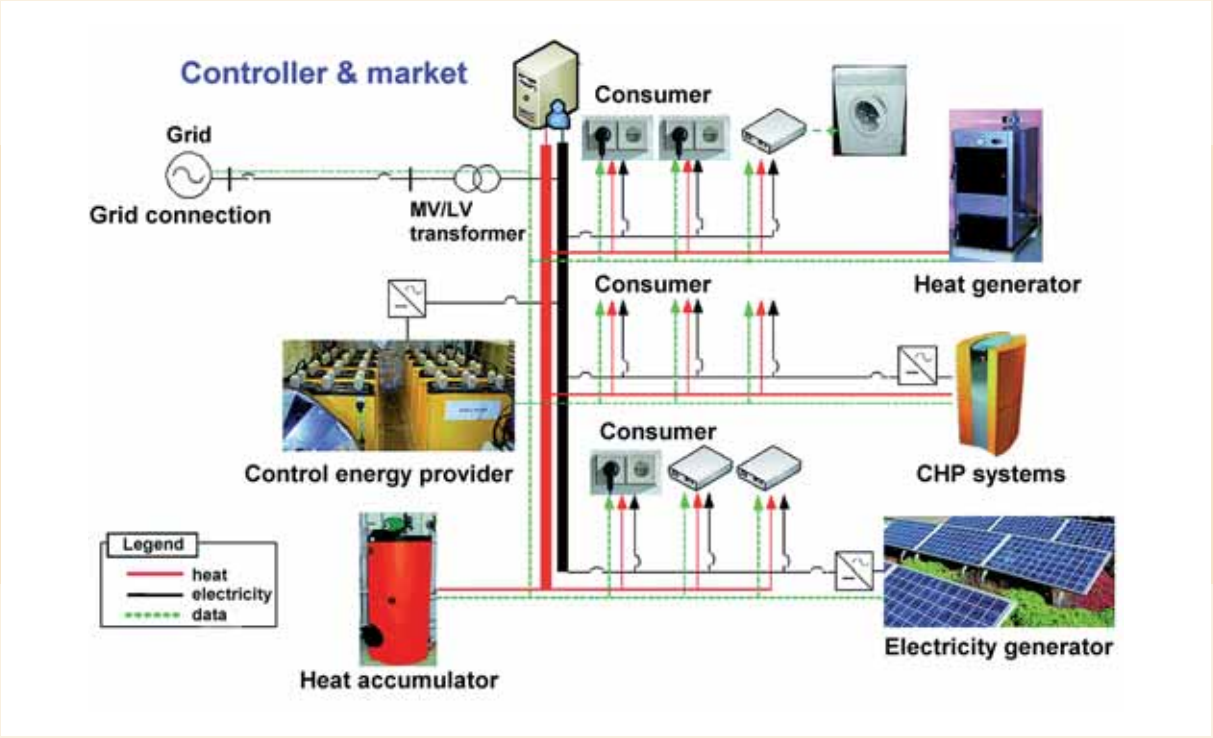
"For reasons of safety and security," the area will not be disconnected from the national grid since "we don't want to leave our customers in the dark. That's for sure."

"Smart metering" is a key element of the project: "We've put in a lot of groundwork here and initiated a pilot project which can act as a catalyst for the E-Energy region where 1000 customers are already equipped with meters that can be read remotely," Frey explains. These meters allow greater flexibility in accounting and invoicing as well as in terms of product design. Customers are thus able to plan the use of their appliances and equipment at times when electricity is cheaper. The electricity is more expensive when it is in shorter supply and this helps the customer avoid making expensive losses.

Display unit for previewing the price of electricity.

Praise for the "MEREGIO" project

Many ideas and concepts have been proposed to achieve the goal of reducing CO_2 emissions by 2020 by 20 percent compared to 1990 levels. "MEREGIO – Minimum Emission Region" is one such scheme and applies a holistic concept. The objective is to develop regions with power supply systems that are optimized with regard to their greenhouse gas emissions. This is based on three specific components, namely an E-Energy marketplace for producers of electricity, end customers and intermediaries for coordinating the supply and demand of energy and complementary services; a sophisticated and innovative energy infrastructure; and a powerful information and communication infrastructure that links the infrastructure to the marketplace and controls it depending on the specific market situation at hand. The project focuses on developing technically economic concepts to implement the three components and put them to work in a pilot project with some 1000 participants in the Karlsruhe/Stuttgart area. However, the project also goes one step further and plans to develop minimum emission certification for regions where concrete specifications and standards are developed on the basis of the experience gathered to motivate regions to actively reduce their greenhouse gas emissions and promote specific measures to cut CO_2 production.



Schematic illustration of the MEREGIO project.

The University of Karlsruhe, renowned for energy sciences and information and communication technology, is helping to optimally integrate the many power producers, including operators of renewable energy systems like wind and solar energy, hydropower and biomass. The Internet acts as the main control and regulation instrument "so we won't have a lot of installation expense. Our primary task is to generate and distribute pricing signals that encourage customers to adapt their use of electricity in such a way that optimum power supply and demand conditions take place."

Frey explained it will be possible to guarantee the stability of the grid through the improved quality of acquiring information; some things will have to be decided based on practical experience: "Do I really have to get control energy from outside? Or will I include biomass plants, for example, in the system, which can be switched on or off as required, or perhaps a hydroelectric power station where I can open or close the cock one little bit?"

Some of Hellmuth Frey's customers can already log into an Internet portal which has been recently set up and call up their data completely from there; a small display unit is also available where customers can at least view the prices of electricity for the present day and in days ahead. It has to be easy and convenient since "the whole thing will lose its attraction very quickly otherwise".

By switching off useless loads – such as avoiding having equipment like printers or monitors on stand-by mode – and applying smart load management, "roughly speaking" savings of around 10 percent can be made, Hellmuth Frey estimates.

Mannheim model city, Rhine-Neckar model region – prizewinner

The electricity-generating heater called "WhisperGen" consists of a Stirling motor and heat exchangers. These components are integrated into the heat and power supply system in a house, and monitored remotely using cutting-edge technology.

The area around Mannheim between Pfälzer Wald and Odenwald is one of the warmest regions in Germany. The city at the confluence of the Rhine and Neckar rivers has a population of approx. 300,000 and was the birthplace of famous people like Carl Benz who sent the first car rumbling across the streets of Mannheim in 1886. But the city also has a romantic element since it was here that Mozart met his first love Aloysia, and locals meet up with visitors from all around the world at the historical water tower and in the neighboring Rosengarten conference center.

"There are plenty of good reasons to have an E-Energy marketplace here", says Dr. Britta Buchholz, coordinator of the Mannheim model city E-Energy project. "As the regional provider, we at MVV Energie know the region very well. We know where the technical sticking points of power supply are and where we can carry out representative trials to improve energy efficiency and the quality of the grid."

The Mannheim-based company has already dabbled in E-Energy. In 2007, 25 families in Mannheim took part in a field test where they used washing machines and dryers when particularly large quantities of solar power were generated in the housing estate on sunny days. "These families now know that it is best to immediately use electricity locally as soon as it has been generated. Extensive areas of Mannheim are equipped with a broadband power-line infrastructure which allows real-time access for smart electricity grids. As a result, the development of the communication structures that are needed for the E-Energy marketplace is manageable and thus also affordable."

In the energy supply system of the Mannheim model city, a new "service oriented architecture" is set up. Customers can select the quantity, price and origin of their energy at their own discretion in real time, and drive energy efficiency and the energy market through their own behavioral patterns. According to Britta Buchholz, it is particularly important that "our concepts can also be translated to other cities and regions – to Dresden, for example, but also to the Rhine-Neckar metropolis region, and to our munici-

pal utilities grid for the towns of Kiel, Ingolstadt, Offenbach, Solingen and Köthen."

She went on to say that the new E-Energy marketplace will, above all, facilitate the efficient supply and use of renewable energy and efficient domestic power systems with combined heat and power generation. "Currently, the efficiency balance is out of kilter if power plants randomly produce electricity without taking consumption into consideration and if consumers don't even know when cheap electricity is available. In our forecasts, we predict that the penetration of distributed energy generation and renewable energy will greatly increase in the coming years and we are already preparing for the fact that this will help us constantly improve energy efficiency." According to Buchholz, this could be achieved in this E-Energy project by evening out the consumption curve for the regional and local grid by controlling demand. MVV Energie is already an accredited provider of control energy in the southwest of Germany. As part of the E-Energy project, the company is also considering controlling refrigerators and air conditioning systems such that it will be easier to stick to the power consumption schedules. "The many small cooling systems work together like a large virtual energy reservoir. This allows new leeway for the optimum consumption of electrical energy."

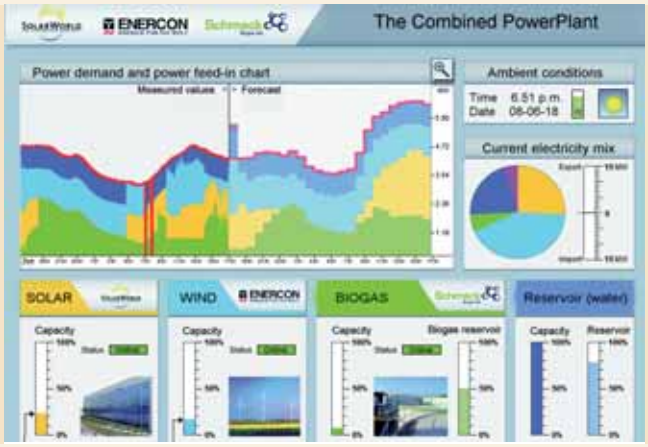
With the Energiebutler system, customers can either use their computers to automatically adapt power consumption in their homes to a variable electricity price or manually specify when a particular consumer can be connected to the power grid.

Praise for the "Mannheim model city" project

We can only counteract climate change and achieve climate compatibility if every single one of us increases his/her energy efficiency and thus plays an active role in reducing CO_2 emissions. This is what the "Mannheim model city" aims at with a representative, large-scale trial project to improve energy efficiency, particularly where consumers are concerned. A large number of consumers in the high-density region of Mannheim are provided with "Energiebutler" systems which furnish consumers with real-time information on consumption, prices and rates, for example. Consumers can then use this information to control and optimize their individual consumption of energy by deciding what time to use their electrical appliances, or by organizing the use of their electrical equipment around a variable price. The focus is on developing an open platform with a broadband powerline infrastructure on the basis of which renewable and distributed energy, above all, is fed into the main supply grid and this energy can be directly assigned to customers' current power needs in the network. The result is an E-Energy marketplace that is important particularly from the point of view of environmental protection: Consumers are encouraged to be more efficient with power usage, operators of distributed power plants can connect up to the system easily and the operator of the distribution grid can optimize technical grid operation and minimize transmission loss.

RegModHarz, Harz model region – prizewinner

Dardesheim – town of renewable energy.



The renewable-energy combined cycle power station.

"The Harz district is definitely one of the most popular holiday destinations in Germany. A vacation makes you feel like new, and renewable energy is the perfect complement," says Heinrich Bartelt, wind farm operator and coordinator of the RegModHarz project – renewable energy model region of the Harz district. "Clean air, clean water and clean electricity."

Heinrich Bartelt's wind farm is located in Dardesheim, a small village with a population of 1000 at the foot of the Druiberg hill in Harz, Saxony-Anhalt. Boasting a height of 125 m, its biggest windmill is also the most powerful series system in the world. Its top output of 6 MW can provide clean power to 4000 households on average every year. Obviously it cannot do this during slack periods but then other producers or storage technology take over, such as a pump-fed power station with an output of 80 MW. If the wind farm also produces excess power with an output of up to 80 MW, water is pumped into a reservoir lake in the hills 30 km away. Where necessary, the water flows back to the valley, driving electricity production by means of two 40-MW turbines to balance the system.

In the future, many other producers and consumers will help iron out peaks and troughs in power needs. Many solar power plants are installed in the village of Dardesheim and the region itself has numerous biogas systems. "A large 5-MW co-generation unit is also nearby that has started operation with vegetable oil." The area thus has plenty of sources to ensure a safe and secure supply of electricity.

In addition to the many different systems and the pump-fed Vattenfall power station, Bartelt also cites a second intangible but important plus point of the region: "The people want renewable energy. Acceptance among the public is high. The local citizens, groups and associations, local government and policymakers have all been pulling together for many years to make it work."

As a third factor, Heinrich Bartelt mentions the quality and quantity of the partners on board, and both are certainly impressive. Big players in the industry are actively involved but so too are innovative small businesses, universities and affiliated institutes, a Fraunhofer Institute and also the municipal utilities of Halberstadt, Quedlinburg and Blankenburg. "The entire district of Harz is behind the project and, with a population of some 250,000, this is the biggest and most economically powerful district in Saxony-Anhalt."

Following the model of the "renewable-energy combined cycle power station", the Harz renewable-energy model region is to digitally integrate suppliers and consumers via a control station – a completely new idea. For this purpose, the Kassel Institute for Solar Energy Supply Technology (ISET) has developed an instrument which can be used to switch on freez-

Wendefurth pump-fed power station.

ers, refrigerators, washing machines, dishwashers and dryers in the households of the end customers at times to suit the actual supply of electricity. This control system is called BEMI - Bidirectional Energy Management Interface – costs about €100 and will find its buyers, Heinrich Bartelt is sure because "with a power consumption of between €600 and €800 a year, it will have paid for itself in just a few years." A potential flexible current sink here could be a rolling mill for wind turbine towers with a power consumption of 60 MW near Wernigerode, which was capable of variable operation even during the times of the GDR.

As regards the percentage of renewable energy in the "Harz renewable energy model region," Bartelt says "Some 800 million kWh of power are used every year in the whole district and over 500 million kWh are generated from renewable sources in the region. That makes up two thirds of the power even today, which is fantastic!" When asked about possible cash savings Bartelt says "as a conservative estimate I would say 10 percent on the medium term and maybe 20 to 30 percent on the long term, and all that with regional added value."

Praise for the "RegMod Harz" project

In line with the specifications of the E-Energy funding regulations, a sustainable and efficient power supply system is implemented in regional markets through coordinated renewable power production and altered consumption. In this way, climate protection desired by policymakers is sustainably supported through the development of renewable energy sources, while the project also further improves the ongoing process of liberalizing energy markets. Making renewable energy competitive, and ensuring supply reliability in the process, is a challenging goal but the Harz model region is well positioned to achieve it. Taking electrical mobility into account in the efficient integration of heat and electricity opens up enormous new potential for distributed energy management where the regulation of consumers is ensured via pricing signals, as is their connection to pricing forecasts in an end-to-end, electronic market platform. The exploitation plan also envisages marketing new energy products and energy services and developing urgently needed concepts to increase the efficiency of electrical power supply. Critical factors for the success of the project are the group's long-standing experience in the operation and management of renewable sources of energy and the active support of the project by the population and policymakers in the Harz model region.

SmartW@TTS, Aachen model region – prizewinner

"Aachen has been the birthplace of so many large-scale projects. One that first springs to mind is that of Charlemagne and his marvelous Aachen Cathedral," says André Quadt, who is responsible at Trianel for SmartW@TTS, the regional E-Energy project. Most people also know Aachen for its gingerbread cookies, the International Charlemagne Prize, the CHIO show-jumping tournament and for the "Medal for Combating Deadly Seriousness" awarded during Carnival. However, the region is also the headquarters of numerous world-renowned energy companies and research institutes that have recently joined forces to form the "Energy Hills" energy association.

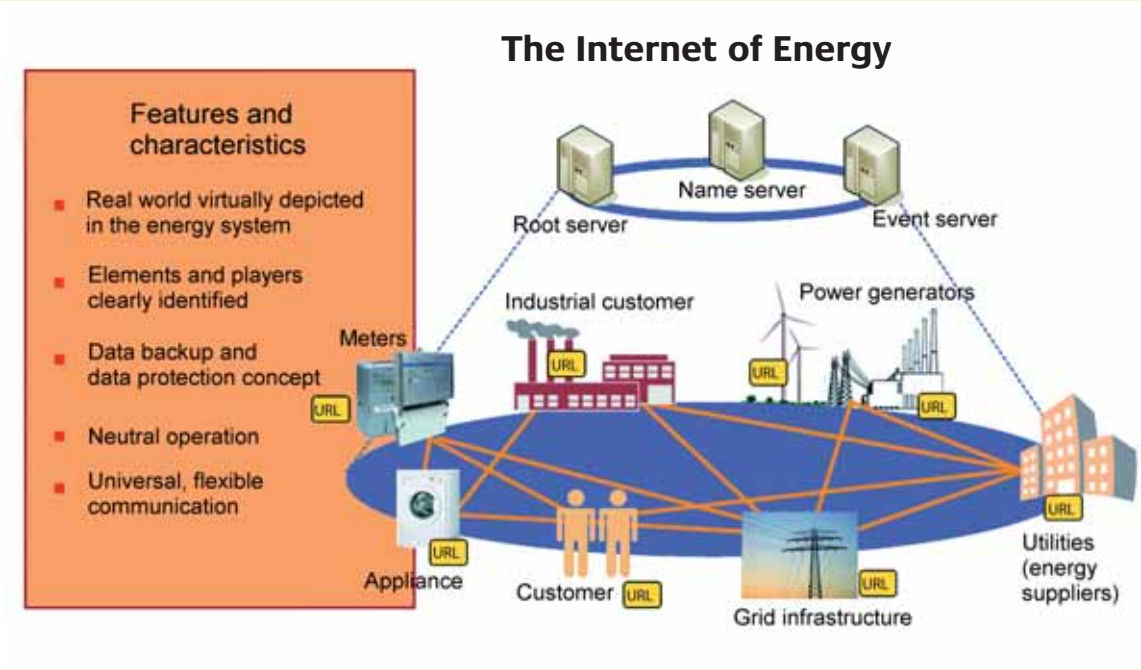
Trading floor at Trianel where all the orders for procuring and selling energy from Trainel's partners are placed. Energy trading experts conclude deals for the orders on the stock markets and marketplaces of the energy industry. Both long-term procurement orders and short-term transactions (even intra-day trading) are handled here.

The tendency of the region to form alliances and partnerships is a major advantage for projects like E-Energy: municipalities and towns cede a share of their responsibilities and official duties to form a public body – the "Aachen city region". Trianel itself, a group of over 70 municipal utilities from all over Germany, as well as the IT services provider regio iT aachen, are good examples of this type of partnership and collaboration. A similar attitude and approach is needed with E-Energy.

Collaboration and partnerships were even needed for the E-Energy subprojects, explains André Quadt: "For smaller municipal utility companies, better forecasting, more complex electricity products, smart metering, data integration etc. can only be approached and tackled as a group. They work together as a multi-utility company and provide electricity, gas, water and heat, and more and more energy is being generated through heat and power co-generation. Our plans take distributed players, in particular, into consideration – producers on the one hand and municipal utilities as our partners on the other – in an energy system of the future since these shareholders also have to live with the solutions."

The primary idea behind SmartW@TTS is that the volatile medium that is electricity is linked to the similarly volatile medium that is information in an Internet of Energy "end to end, from generation, retail and distribution to the end customer and back". This makes it possible for the system to better handle the fluctuating generation of renewable energy which will become a far more dominant feature of the grid: "Today, it is still the case that power consumption in households is not at all in line with the current supply of energy in the grid. Those who base their power consumption on the supply of energy available do not enjoy any specific benefits, nor do those who tap electricity when the market prices are at the highest have to suffer any disadvantage." This is a situation the company wants to change without forcibly imposing its will on customers. "Everyone should be able to do as he/she wishes but they just have to pay the price for it." The same applies to uploading renewable energy whose compatibility could be increased through various market incentives.

According to André Quadt, incentives are already in place in industry that reward behavior patterns that comply with market conditions. Power consumption has already been adapted to the prices, and thus the supply of power, so not a lot can be done here, Quadt explains. "If we really want to see some action, we'll have to focus on households. While they have a smaller shift potential, there are an awful lot of households out there. What could we control? Essentially, everything that produces heat or cold is interesting, so we're talking about washing machines, dry-



The Internet of Energy.

ers and dishwashers. The deep freeze is a good example, a hot water storage unit is also." He went on to say that heating and cooling with heat pumps is also an interesting, growing market, as are air-conditioning systems or charging the batteries of hybrid vehicles. "We are working on practicable and affordable solutions."

Praise for the "Smart W@tts" project

This project pursues important objectives of the current energy policy such as competition, climate protection, market mechanisms, renewable sources of energy, the active participation of all players in the energy market, as well as the safe and cheap provision of power in the Aachen model region. Modular, interoperable energy meters create the necessary gateway to the customer to be able to develop a complete market model for a more distributed energy market and an automated transaction platform for trading and managing scheduled products. Supply-controlled pricing signals that are specific to the various providers form the basis to a distributed balanced regulation system where automated household appliances are also taken into consideration via the common gateway. The primary features of the innovative solution include the requisite data security and data protection concepts, universal, flexible communication between all the market players and the clear identification of all the requirements of those participating on the energy market. This makes variable time-based rates possible that guarantee an end-to-end market platform based on standardized interfaces through distributed, closed control systems between producers, traders, distributors and customers. The new business models developed are then implemented in many municipal utilities by means of the existing Trianel network.

The other nominees

The twelve E-Energy projects nominated.

From the short list of the twelve proposals nominated, only six projects could be selected for funding. However, the remaining six nominees should remain integrated in the E-Energy network and act as catalysts. Thanks to the knowledge and skills acquired in the run-up to the final selection process, and the commitment and dedication that is reflected in the quality of the project proposals, these projects also act as valuable promoters in the network, in addition to the actual prizewinners.

The six other projects nominated are:

- deCide, Dresden model region
- EnTradeIT, Berlin model region
- EquiKom, Nuremberg model region
- OPTIFLOW, Allgäu model region
- SPREE, Cologne model region
- Uckermark virtual power plant, Uckermark model region

deCide, Dresden model region

Zwinger Palace in Dresden: In addition to culture and tradition, the city of Dresden also has plenty of high-tech on offer.

"History, art and nature floated over town and valley [...] like a chord enchanted by its own harmony", wrote Erich Kästner of pre-war Dresden whose architecture he found to be like "frozen music".

Part of the magic of Dresden can now be seen and experienced again. However, the city also has a lot to offer in terms of technology and science as it boasts ten universities, three Max-Planck Institutes, five Leibniz Institutes and eleven Fraunhofer Institutes. A host of transfer facilities, networks, skill centers and research companies can also be added to the tally.

"All told, we have the perfect parameters to meet the requirements of the E-Energy competition spec," says Holger Hänchen from Dresden's municipal utilities DREWAG whose E-Energy project is entitled "deCide". The name plays on the individual ability of the market participants to make a decision. With new technology at hand, market participants are "no longer one-sided buyers or suppliers – they are active market partners shaping the marketplace," and thus able to choose their power source such that it is optimized in terms of CO_2 emissions – the primary objective of deCide.

Against this playing field, in the deCide project, DREWAG works together with highly skilled partners, such as Vodafone, the biggest international provider of mobile phone technology; Siemens, the traditional company and global market leader in the area of electronic engineering and electronics; Görlitz AG, one of the top producers and suppliers of metering solutions in Europe and Inpower, one of the first direct marketers of electricity from renewable energy in Germany. The local university partner, the Dresden University of Technology (TU Dresden) – represented by the Schools of Energy Economics, Telecommunications and Electrical Power Systems and High-voltage Engineering - is responsible for providing scientific expertise.

"Without doubt, it is a challenge to generate energy from renewable resources in a large, devel-

oped urban area, particularly when the preservation of historical monuments is of prime importance," explains Holger Hänchen. "Wind energy would hardly be possible but photovoltaic power is becoming increasingly important, as is the recycling of urban waste for biogas plants."

Being a compact urban area also has its advantages from an energy perspective, however: Dresden has a modern gas turbine combined heat and power plant (GTCHP) that covers some 75 percent of Dresden's electricity needs. The resulting heat is directed into a district heating grid. Generally speaking, the power plant operates in line with the district heating needs. For the time being, the resulting power surpluses and deficits have to be balanced out with external sinks and sources. In the medium term, accumulator batteries in electric cars could be responsible for this balancing task. What happens, however, if the city needs electricity in the summer but does not need heat? This is not an issue for the Dresden-based project since the gas turbine combined heat and power plant uses its heat to generate more cold (around 4° C) using adsorption-type refrigeration technology, providing power to storage facilities, large cold storage centers and the beer cellars of local bars and restaurants. "The interaction between heat and cold is a critical control factor," Holger Hänchen explains "particularly during low-load periods."

This complex interaction is managed by an ICT network in such a way that the system aims at minimum CO_2 emission rates. "Consumers should notice as little as possible of the underlying system complexity." According to Hänchen, customers do not need to constantly have a display unit in front of them to tap climate-friendly electricity. The details are gathered silently from independent software agents which customers can, however, assign individual priorities. The comfort and convenience factor has to be right, as does the price. In terms of flexible rates and transparent invoicing, deCide can greatly benefit from the experience of the telecommunication and cellular phone industry thanks to the partners involved in the project.

Modern DREWAG CHP plant.

If Dresden's 256,000 households were integrated into the deCide system to obtain their electricity in such a way that CO_2 emissions were minimized, the penetration of electricity from renewable resources, which averages 16 percent today, could grow by 10%. In addition, climate-conscious Dresden locals can also reduce their own carbon footprint.

EnTradeIT, Berlin model region

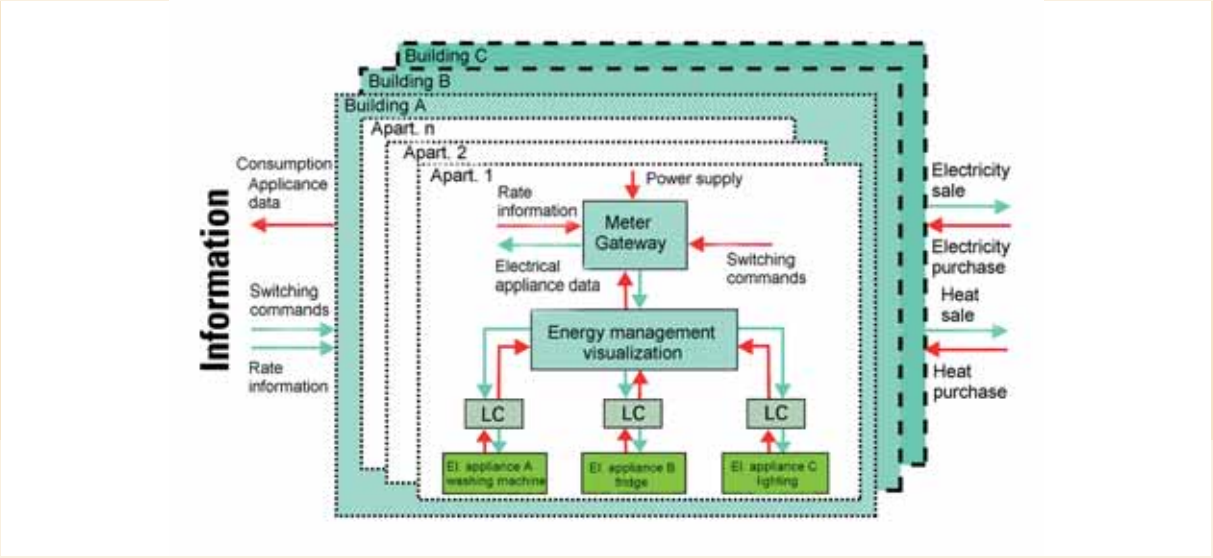
Great savings can be made through energy management in densely populated consumer areas.

Berlin is the biggest university city in Germany and boasts a wide range of research institutes of national importance. One such institute that is particularly interesting from the point of view of E-Energy is the DAI Laboratory of the Berlin Institute of Technology (TU Berlin), which focuses on research and learning with the aim of developing technologies for a new generation of services and dispersed systems as will be used in the electronic marketplaces envisaged by E-Energy.

Optimizing the power supply system appears to be particularly worthwhile for Berlin. It is a densely populated city which makes it easier to improve electricity procurement by centralizing the demand through marketplaces. Berlin has a high percentage of rented apartments, office spaces and commercial areas. On account of its history, a lot of renewal and redevelopment work has to be carried out in the city which makes it easier to test out new technologies. The capital has innovative hospitals, like the Helios Clinic, with a high IT standard that can be won over for E-Energy, and there is a large percentage of dispersed production systems.

What makes the Berlin EnTradeIT project so special? Martin Pokojski, coordinator of the project, cites the possibility of integrating a wide range of diverse consumers: housing estates, consumer markets, public buildings, hospitals and businesses. Via electronic marketplaces where software agents act, the power flow in the public grid is optimized and end consumers are integrated. The project group has expertise from the energy and telecommunications industries, such as IT companies, software developers and universities. State-of-the-art visualization systems are set up to improve the transparency of energy consumption. Controlled energy savings among end consumers also present opportunities for selling free resources.

Block-type thermal power stations and photovoltaic systems are among the power producers planned. The extent of conventional electricity generation will depend on local electricity and heating needs, and volumes purchased via electronic marketplaces.



Hierarchical energy management in the EnTradeIT project.

The grid is stabilized across the transport area, and pumped storage hydroelectric stations or gas turbines are also added. As part of the E-Energy project, it is also planned to support the control system with shutoff consumers and distributed power feed-in. The load on the grid is reduced by optimizing the power flow between providers and customers.

To cover basic needs, Martin Pokojski also envisages a high percentage of base load power stations in the future so that interregional grids will continue to play a dominant role. They will be responsible for balancing electricity production based on renewable energy across Germany. According to Pokojski, the future supply system can only be optimized through the interaction of distributed and centralized facilities in the form of smart grids.

Martin Pokojski expects a 10 percent drop in power consumption from the new smart metering technology alone.

EquiKom, Nuremberg model region

Nuremberg Christmas market: Energy optimization of urban structures also factors in special social aspects.

“Franconia, with Nuremberg as its capital, is a very scenic area,” says Gerd Schmiedehausen, coordinator of the EquiKom project. “We have “Franconian Switzerland” and the Franconian Lake District - with Brombach Lake and Roth Lake - which was partly created for drinking water supply and has since become a huge tourist magnet. In the past, the economy of the area was largely shaped by its proximity to the former GDR border but now, on account of the EU enlargement to the East, the region is becoming more central, acting as a kind of gateway between the East and West.”

“The region is the perfect fit for E-Energy,” says Rudolf Dögl from the Nuremberg tms Institute for Technology & Market Strategies, “since it has a tradition of excellent collaboration and partnerships between businesses and scientific centers that are involved in energy supply.” And it is true that the energy industry in the region is carried by no fewer than 500 businesses with 50,000 employees, ranging from global corporations like Siemens, with its PTD and PG sectors, to successful medium-sized enterprises, such as cable manufacturer LEONI AG and power electronics specialist SEMIKRON, numerous regional providers, as well as N-ERGIE AG, the eighth biggest power utility company in Germany. The economy is actively supported by the universities of Erlangen-Nuremberg, Bayreuth and Würzburg, and the Nuremberg, Ansbach and Weihenstephan-Triesdorf Universities of Applied Science, offering study courses in energy industry and technology, accompanied by research centers like the Frauenhofer IIS and IISB, as well as the Bavarian Center for Applied Energy Research. More than half of all industry export revenues come from the energy industry.

The EquiKom project aims at continuous, end-to-end optimization from the generation side right through to the consumer side, so practically from the photovoltaic plant straight through to the washing machine. This would not be possible without ICT technology, without E-Energy. “What definitely sets our project apart is that we have also integrated social components into the model projects,” says Rudolf Dögl, “and have thus also taken the particular situation of recipients of Hartz-IV social welfare into account. It's not easy for them to go out and buy a

Solar-energy house in Nuremberg.

smart meter for €200." "Thus, in addition to the technical component, a psychological and social approach should also be applied here to make economical resource management attractive," Gerd Schmiedehausen added. "The city of Nuremberg alone spends sums in the double-digit million euro range each year on electricity subsidies for basic income support households. Even if we only manage to make savings of 10 percent, the effort will have been worth it."

According to Schmiedehausen, particular attention also has to be paid to the quality of the grid as a central factor for energy efficiency. This is also interesting from an economic perspective since grids exhibiting uniform utilization are less "taxed", which means expensive grid upgrades are often superfluous or can be postponed. The project consciously focuses on medium-sized businesses both from a supplier perspective and with regard to ICT solutions.

Substantial savings can be achieved: If interference in the distribution grids can be compensated for using ICT, and transparent energy data are used in real time to control and regulate consumption, the combined positive effects could make bottom-line savings of over 10 percent possible.

OPTIFLOW, Allgäu model region

Photovoltaic plants and wind turbines in Wildpoldsried.

Mountains, lakes, peace, cows, cheese – such are the images most Germans associate with the southernmost corner of Germany, Allgäu. While this is right, says Ludwig Karg, a native of Allgäu and involved in the Allgäu E-Energy project OPTIFLOW as the managing director of B.A.U.M. Consult GmbH, the region has also morphed into a favored location for innovative high-tech companies, including global names like Bosch, Steca or Liebherr. There are many reasons behind this: “Workers identify with the company, absenteeism here is virtually non-existent, and this region is also home to a special type of person we call “Mächler”. A “Mächler” is someone who can make a lot out of very little through dexterity, ingenuity and plenty of innovation.”

It must be a legacy of the past when locals had to rely on their own abilities in the isolated Alpine valleys and could not easily call upon others for help. The resulting tendency to be more independent meant that the people in Allgäu discovered renewable energy at an early stage. Ludwig Karg tells us that when he drives through the region nowadays, he would have a tough job finding a farm that did not have a large photovoltaic system on its roof. Electronic systems that control and direct the solar power directly into the grid or into batteries are also produced and manufactured in the region. “We also have numerous biogas plants that reuse dung and liquid manure, and there are also many run-of-river power stations in rivers and streams that are currently being modernized. We're just a bit reluctant when it comes to wind power because of the tourists.”

One village – Wildpoldsried – does have nine wind turbines, however. With renewable energy, the village produces several times what it actually consumes. That is achieved with wind power, photovoltaic systems, solar thermal power, biogas systems whose thermal discharge still heats buildings, a central wood pellet heating system for public buildings and many other sophisticated ideas.

Wildpoldsried village heating system with wood pellets.

Web-based Emetrion IQ meter for use among industrial customers.

However, the project does have a drawback. At this stage, so much green electricity is flowing that it will be necessary to expand and develop the power grid which was ultimately designed for distribution and not for power intake. “Just imagine a farm in a remote village. Originally, cables to the farm were only meant to light a few lamps and run the milking machine and now they're supposed to transport huge quantities of electricity from photovoltaic and biogas systems. That will be difficult.” And it will cost millions to develop and extend the grid network, so the only solution for this village is E-Energy.

Ludwig Karg explains that E-Energy can best be implemented in the region with a “virtual Allgäu power station” into which the numerous small producers are integrated, controlled centrally and assisted by a load management system that distributes electricity intelligently to the consumers. Controllable generation plants or storage units would be needed for this purpose. “The generation of power can be controlled with biogas plants. Proper accumulators for photovoltaic electricity would be suitable storage units but they are expensive. However, it is also possible to convert electricity to something that is more easily stored, such as heat, or (even better) cold in the many refrigeration rooms in hotels or breweries or in the regional supermarket chain Feneberg.” This is where Allgäu milk could also do its bit, reckons Karg. Ultimately, over one million tonnes of milk are produced each year from over 8000 farms, and all this milk has to be kept refrigerated under 8° C until the collection truck arrives, which does not happen until midday for half of the farmers. To avoid having the refrigeration units running at peak load times at midday, the virtual power station would cool the milk beforehand to below the specified cooling level and then no electricity would be needed to cool the milk during midday peak times. This is just one idea of many. We could even sell peak electricity on the electricity exchange “and make a killing.” The Mächler will surely come up with something.

SPREE, Cologne model region

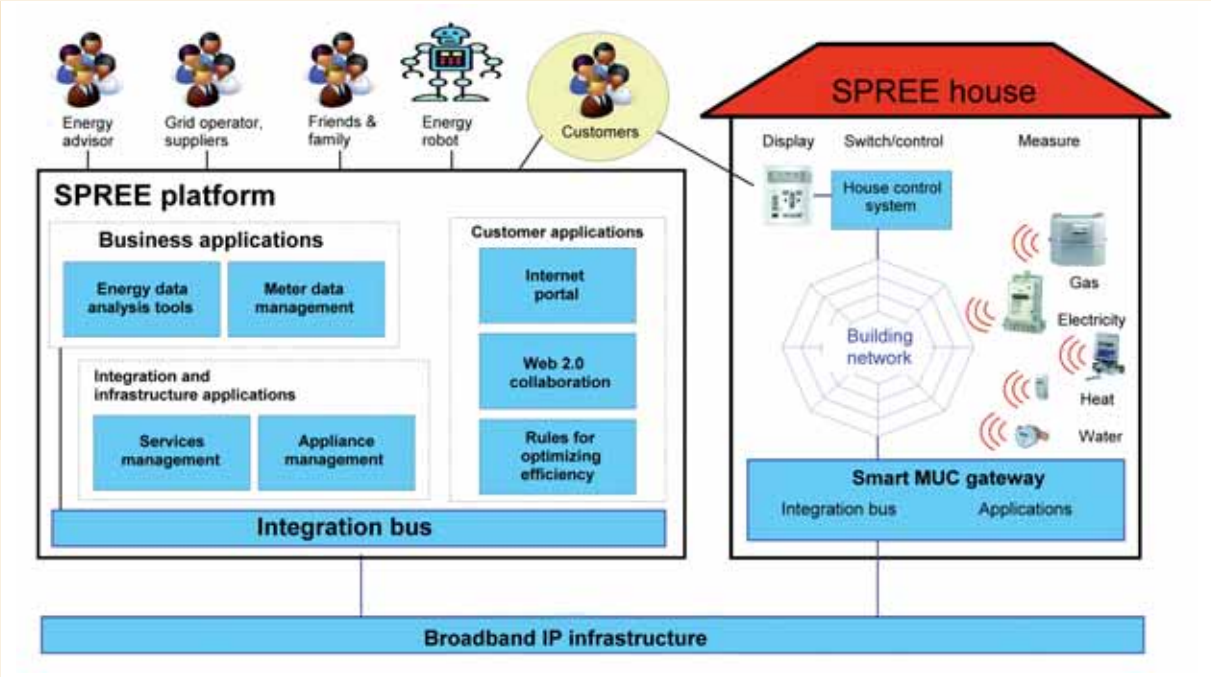
The flow of energy is optimized around the city of Cologne by a sophisticated integrated network.

Cologne has a population of just over a million and is the center of a dynamic economic region in an excellent location, making it the perfect pilot region for the SPREE E-Energy project. The project abbreviation stands for Service Platform for Rational Energy Efficiency.

In Cologne and the surrounding area, RheinEnergie – the leading consortium partner – supplies some 2 million people with electricity, gas, water and heat either directly or indirectly. With NetCologne, the company also has its own telecommunications provider which is constantly expanding and developing its own fiber-optic network in the city and the region. This link offers a tremendous, cross-industry potential for innovation for the SPREE project. "End customers are the focus of the project, and we are offering them all the intelligent options available to save energy," explains Andreas Menge from QVEDIS GmbH, the consortium partner responsible for in-building networks.

Steffen Schmidt from the automation engineering company Dr. Riedel Automatisierungstechnik GmbH, another consortium partner, adds that "the power company can offer different rates depending on the availability of energy. At cheap times, home automation systems activate controllable consumers in homes and apartments, such as washing machines, dishwashers and warm water tanks. Information on the various rates is sent online to a gateway for the object in question and from here this information is directly translated to a concrete control command. End consumers do not have to worry about anything. All they have to do is specify the times when this is permitted."

"Demand side management" is the term used to describe this, explains project coordinator Ralf Thiemann. "The power producer not only wants to estimate how much power has to be produced but also wants to be able to influence what amount of electricity is used and where. The really innovative



SPREE platform.

aspect of SPREE is that all consumer data are available transparently, but secure, on a platform which is then actively involved in the controlling process. This is a real challenge given the number of customers." The community mindset is important here. We need to develop a "solidarity community of energy savers" and connect them together using modern tools. Distributed power generators, such as solar power systems and block-type thermal power plants with natural gas, are also integrated into the system. "Everything is integrated and made transparent. In the Internet, we will create a service platform that links all the market participants together. It also facilitates the exchange of particularly clever solutions, and tips on how to save energy, from LED lighting to cold water detergents. Energy advisors – either people or intelligent software agents – help the users." Reportedly, power savings of 10 percent are possible for the average household, which would correspond to about €80 per year. If the project were introduced nationwide, savings could total €1.6 billion with a 5.6 million tonne reduction in CO_2 emissions.

Uckermark virtual power plant, Uckermark model region

Renewable energy landscape in Uckermark.

The origin of the name Uckermark – the "borderland on the border" – can be traced back to the word "Ucker" which, like "Ukraine", means "borderland" and "Mark" which also means "on the border". Here, in Germany's most expansive rural district around Berlin, Germanic and Slavic settlements have fused and merged from time immemorial.

If you launch "Google Earth" and go towards Prenzlau – one of the main hubs in the Uckermark region – you will see a vast lake district which is a relic from the last Ice Age, and expansive fields around it. "Unfortunately it's not quite an idyll," says Jörg Müller, executive chairman of ENERTRAG and involved in the "Uckermark virtual power plant" E-Energy project. "On account of structural changes since 1990, many classic industry-based jobs have broken away and the region is suffering from rural migration, particularly of qualified young people".

Prompted by this situation, policymakers have decided to focus on technologies of the future in the region which, like agriculture, are tied to the land, and thus guarantee long-term employment opportunities. The result is an important economic factor with more than 1000 jobs in the area of renewable energy.

The vast, expansive landscape offers an excellent framework for the extensive exploitation of wind power. "A good 2 percent of Germany's electricity needs could be produced in Uckermark in the future," Jörg Müller reckons. Today, 500 megawatts of wind power are already on the grid, which is the same output as a coal-fired power station. In addition, the rural region can provide renewable resources as well as solar power since the Uckermark area enjoys the second-highest number of sunshine hours in Germany.

"With the direct connection of wind and biogas in a special underground-cable feeder grid, which feeds energy directly into the European supergrid, an important technical framework for the combined use of renewable energies is already created. Furthermore, more than half of all the systems here are

Biogas plants, important balancing elements in load management.

already interconnected via fiber optics for data transmission. Only two things are missing to make it a real power plant operation, namely specially designed ICT solutions and energy reservoirs."

From a technical perspective, it is already possible to refine biogas with wind hydrogen generated from the electrolyzer and then feed it directly into the existing natural gas network where huge caverns are available as energy reservoirs. Supply security can be guaranteed through the interaction of the individual sources of energy and hydrogen as the load sink. "We will be focusing on this in the near future."

Within the context of E-Energy, the individual components of this power plant, which only uses renewable energy, can be interconnected in a new, intelligent control station that uses cutting-edge control technology and online data. For this purpose, uniform standards are being developed for a wide number of technical plants and the interaction of the market players. With the designed control station schedules, electricity traders can directly provide consumers with offers and the electricity networks can be operated at a low cost. All the steps of this process, from generation to marketing, are transparent and traceable and take place on the Internet.