Themen dieser Ausgabe

A smart energy platform for the energy supply of the future
In the Smart Energy Platform (SEP), ACS is currently developing a cloud-based, service-oriented platform for intelligent energy solutions. This platform is to act as a communication hub where different players in the future smart energy world communicate with each other and coordinate their actions.

RoadMap for sustainable supply to heterogeneous buildings
In the “EnEff-Campus – RoadMap RWTH Aachen" project, EBC and two other institutes are studying new ways to reduce the primary energy consumption of the heterogeneous RWTH Aachen University buildings by half. After the research is complete, the group’s findings and methods will also be made available to interested operators of similar properties.

Geothermal energy: site optimization with MeProRisk

International rebound experts meet in Aachen
New test bench for power electronic components
Spin-off: Gridhound UG develops monitoring systems for grid operators
E.ON ERC Ticker I
E.ON ERC Ticker II
Colloquium I: Are Rebound Effects Played Up or Down?
Colloquium II: Superconducting DC transmission and distribution
Events & dates

E.ON ERC | Annual Meeting 2015

New concepts and building blocks for climate-friendly urban infrastructure
Researchers from all over the world and different disciplines meet in Aachen to share their experiences

“Future Urban Energy Systems” – was the heading for this year’s E.ON ERC Annual Meeting held in late March. The meeting, the eighth of its kind, brought numerous representatives of the science, business and government sectors to the E.ON Energy Research Center at RWTH Aachen University to learn about and discuss the status of research in this field and what it means for Germany’s energy transition.

Modifying the energy supply system to move toward a low CO₂ energy and electricity supply is at the forefront of the R&D work.

Experts from all over the world and different disciplines attended the annual meeting once again this year, taking advantage of the excellent opportunity it offers to catch up with existing contacts, forge new ties, and discuss the latest research findings and projects.
performed at E.ON ERC and the German and international research institutions that cooperate with it. According to statistics of United Nations, cities have been home to more than half of the world’s population since 2007. The presentations given at this year’s annual meeting focused on supplying energy to these densely populated areas and on ways to cope with the associated challenges. Integrated concepts for a sustainable urban infrastructure were discussed at the event, as was the creation of platforms for the fast sharing of information between consumers and suppliers so that supply and demand can be balanced automatically right at the local and regional level.

Optimizing decentralized energy systems in connection with use of waste heat was discussed in detail. The development and implementation of a sustainability strategy to supply the Hyllie urban district in Malmö, Sweden, was also an important subject. “Virtual power plants” and their integration into supply and trading systems are very important against this background. The possible role of local clusters, with some households consuming energy and some producing energy, in a future supply system was also presented and discussed. Geothermal energy can also make an important contribution to ensure that the cities of the future will have a sustainable and climate-friendly supply of power and heat, as the results of several studies show exemplarily.

Many of the developments and scenarios discussed at the meeting will require that transmission and distribution networks be upgraded. Grids have to become smarter. One approach calling for the sweeping modification of distribution networks to accommodate direct current technology met with great interest. Sample studies of DC systems at the low- and medium-voltage level have shown not only technological benefits, but also cost advantages over the AC systems that are currently in common use.

The research findings presented during the meeting (see box) are available as PowerPoint presentations and can be requested as PDF documents by e-mailing newsletter@eonerc.rwth-aachen.de.

### ACS Smart Energy Platform

A communication hub for the energy supply of the future

The ACS institute at E.ON ERC, headed by Professor Antonello Monti, is currently developing the first building blocks in moving toward a cloud-based and service-oriented platform for intelligent energy solutions (the Smart Energy Platform, or SEP). The goal is for various players in the future smart energy world to use the new platform to communicate with each other and coordinate their actions. The phrase “smart energy world” encompasses smart grids, smart cities, and smart buildings – the grids, cities, and buildings of the future, where information and communication technology (ICT) will play a major role. The SEP allows players to offer their services and utilize the offerings of others, including suppliers, operators of transmission and distribution networks, energy service providers, private households with their own generation systems (“prosumers”), building managers or ICT and communication firms. Ultimately, the SEP can be envisioned as a hub of energy transactions of all kinds. That means it has to be designed and configured for the levels of performance, reliability and safety that this role demands.
The Smart Energy Platform being developed at ACS is based on several essential technical fundamentals:

- Use of open-source software to advance the dynamic development of the system;
- Cloud-based development to ensure that adjustments to meet new requirements (with regard to both the scope of the tasks and geographic distribution) can be realized at any time at reasonable cost;
- Development of a service-oriented architecture permits simple, adaptable application programming interfaces (APIs); and
- The planned three-layer platform model allows the SEP services to address numerous different data sources.

At present, the existing laboratory equipment at ACS is being connected to form what is being called a FIWARE cloud platform. This opens up the possibility of performing the first cloud-based tests of software and hardware components as well as power hardware-in-the-loop tests. In the latter type of testing, real-world connection elements and control units of smart homes are integrated so it can be analyzed how the relevant hardware interacts with the cloud. The next step is to develop a kind of “smart home” test bench that can be used for detailed testing of all associated systems, from the heat pump and measurement and control equipment to cloud-based services. Ultimately, a completely new lab infrastructure encompassing computers, workstations for development of hardware components, and visualization and demonstration options will be developed and realized for the new Smart Energy Platform at ACS.

The platform is based on the FINESCE project (which is receiving support from the EU as part of the FP7 program) and the SCoOP project, which is supported by E.ON ERC GmbH.

**EBC | Research project**

RWTH Aachen University is looking for ways to reduce its own primary energy consumption by half over the next ten years, thereby taking on a pioneering role in the German energy transition. Achieving the target reduction at minimal cost is the overarching goal of the project “EnEff:Campus – RoadMap RWTH Aachen,” which is receiving funding from the German Federal Ministry for Economic Affairs and Energy (BMWi). In addition, the project’s findings and methods will be made available to operators of properties faced with similar challenges.

Analyzing and optimizing the supply of energy to the many widespread and heterogeneous buildings of the university in Aachen requires a comprehensive approach that tackles the issue from different perspectives. To take account of as many aspects as possible that play a role in this case, cooperation across disciplinary and departmental lines is essential. Architects are a key part of the process, as are civil engineers and mechanical engineers. For that reason, not only the Facility Management unit of RWTH Aachen University, but also the Department of Building Technology (GBT), the Chair for Energy Efficient and Sustainable Building (E3D), and the Institute for Energy Efficient Buildings and Indoor Climate (EBC) at E.ON ERC are participating in the interdisciplinary project team.

To arrive at a holistic consideration of the building and supply systems, it is necessary to study not only the structure of the systems, but also real-world behavior in operation. With this in mind, the project will be accompanied by extensive analysis of measurement data, with existing measurements of energy consumption and dynamic operation of building services being supplemented by
mobile individual measurements. All data regarding buildings and supply systems at RWTH Aachen University will be compiled in a database and made accessible to all concerned via a website.

The data that are collected will be used to set parameters for models depicting the dynamic behavior of energy flows at the university's properties. Software solutions developed specifically for this purpose will be used to this end. To predict the effects of rehabilitation measures and identify (undesirable) interactions between individual measures in advance, these models will be used to simulate different improvement variants. Finally, a dynamic three-dimensional visualization of energy flows will be prepared.

A roadmap generated at the end of this project will show RWTH Aachen University ways to reduce primary energy consumption at its properties as cost-effectively and sustainably as possible. Operators of other properties will have the chance to learn from this example and design their own energy supply to be more efficient as well.

**E.ON ERC Ticker I**

In late February, Professor Rik W. De Doncker, Marco Stieneker, and Nils Soltau participated in the SMART GRID WORKSHOP at the University of Alberta. The workshop encompassed brief talks on topics including decentralized generation, integrated grid concepts, and smart grids in general as well as their possible future uses. Alongside the abovementioned participants from PGS, Dr. Christopher Breuer and Dr. Andreas Schäfer of the Institute of Power Systems and Power Economics (IAEW) at RWTH Aachen University, and Dr. Christian Haag, of FEN GmbH, had traveled to the event. The experts from the University of Alberta and RWTH Aachen University meet regularly with the dual aim of firming up their existing work together and launching new cooperative initiatives for joint research projects. During the workshop, Professor De Doncker gave a lecture on the topic “Flexible Electric Networks of the Future – Power Electronics as a Key Factor.”

In early March, Aachen’s Center for Wind Drives hosted the CWD Conference, with approximately 400 participants from the industrial and research sectors. The 4-MW test bench was presented in action to a broader audience for the first time as part of the conference. PGS played a substantial role in connecting the tested commercial wind turbine to the artificially established electrical grid.

**GGE I Geothermal energy**

Site optimization with MeProRisk

Exploration and tapping into underground geothermal resources involve serious technical and financial risks in comparison to hydrocarbon exploration. The reasons for this include the need for deep drilling and extensive geophysical studies. In the MeProRisk project, new methods and strategies have been developed for interdisciplinary cooperation with an eye to improving reservoir assessment and reducing risk across all phases of managing a geothermal resource.

MeProRisk is a joint project among four German universities (RWTH Aachen University, Free University of Berlin, the University of Kiel, and Freiberg University of Mining and Technology), a geothermal energy consulting firm, and several international firms focusing on geothermal reservoir exploration. The first phase of the project, which ran from 2007 to 2011, was financed by the German Federal Ministry of Education and Research (BMBF). The second phase of the project, under way since 2012, is now being funded by the German Federal Ministry for Economic Affairs and Energy (BMWi) for 3.5 years.

The basic idea is to understand the development of a geothermal reservoir in an iterative process. Starting with existing geological information and geophysical data, the team is developing initial conceptual models for which the physical heat transportation processes that take place underground are calculated through numerical simulation. These models are refined in stages, taking into account fine geological structures based on advanced seismic interpretation and statistically verified rock properties.

Use of inverse simulation techniques as an approach not only yields an optimum model, but also allows for an estimate of uncertainty with regard to temperature, flow rate, and the resolution of the model. This information can be used as a basis for optimizing the selection of sites for new exploratory drilling activities.

The approach used in the MeProRisk project for optimum use of a geothermal reservoir.
FCN  Workshop

International experts meet for a workshop in Aachen

Within the scope of the “Rebound-E.NRW” research project financed by the North Rhine-Westphalia Ministry of Science and Research (MIWF), FCN hosted an international workshop on current rebound research in early March, headed by Professor Reinhard Madlener. Alongside international scholars Dr. Kenn Gillingham (Yale University), Prof. Colin Vance (of FCN project partner RWI Essen), Lee Stapleton (University of Sussex), Sylvain Weber (University of Neuchâtel), Mona Chitnes (University of Surrey), Harry Saunders (Breakthrough Institute, California), Franco Ruzzenenti (University of Siena), and Hannah Krings (RWTH Aachen University), FCN researchers Hendrik Schmitz, Julius Frieling, and Ray Galvin also presented the results of their studies of different aspects of the rebound effect.

On the whole, the event offered impressive proof that rebound research has made numerous important new contributions recently at the theoretical, methodological, and empirical levels alike. Professor Madlener suggested that the workshop should be continued on an annual basis and proposed the publication of a special issue of the scientific journal Energy Policy (Elsevier Science) containing contributions from the workshop and further recent contributions from rebound research.

PGS  Test bench

Stress test for power electronic components

A new test bench (see photo) at PGS can be used selectively to apply very high currents in power electronic components in order to check their reliability in the case of thermal overloading due to overcurrent. The new test bench makes it possible to create overload current conditions in a controlled manner and perform reliable, comparable measurements under laboratory conditions.

The data gathered in this process can then be used to study how overload current affects component functionality. The testing current waveform can be set variably to values of up to 20 kA over a span of two seconds. The test bench focuses on medium-voltage semiconductor components.

ACS  Spin-off

Gridhound UG develops monitoring systems for grid operators

Gridhound UG was recently founded as a spin-off of the ACS institute. The new company develops cloud-based monitoring services, especially for distribution networks. These kinds of services are becoming more important as electricity is increasingly generated on a decentralized basis across many smaller units. The goal is to enable suppliers to monitor and control their grids without having to invest heavily in new measurement infrastructure.

Flexible Elektrische Netze FEN GmbH is providing consortium partners with three Renault Zoe electric cars. FEN is using these electric vehicles to test how widely accepted they are in society, and the university partners in the consortium also aim to study how electric cars can be integrated flexibly into the electricity grid.
Energy Efficiency, Consumption, and Behavior: Are Rebound Effects Played Up or Down? – under this title, Harry D. Saunders, Ph.D., of the Breakthrough Institute in California spoke as part of the FCN colloquium series in Aachen. During his presentation, the researcher and consultant–introduced by Professor Reinhard Madlener with a wink as the “Godfather of Rebound” – illustrated to impressive effect that his colleagues in the field had good reason to give him this honorary title. A former employee of the International Energy Agency (IEA), Saunders is by no means convinced that rising energy efficiency is necessarily connected with commensurate decreases in energy consumption. In his opinion, which he backs up with many facts, there is still too little research on and understanding of the rebound effect, especially in manufacturing. Saunders used statistics to demonstrate that the use of energy-saving technologies can theoretically even backfire, meaning that it can lead to rebound of over 100 percent. In this situation, cost savings can offer a perverse incentive to consume more and be less careful with energy use, even raising energy consumption above the original level. According to Saunders, one thing is certain: Greater efficiency is reflected, only in part – with that part varying on a case-by-case basis – in overall lower consumption.

The lively discussion that took place at the end of this didactically and methodologically impressive presentation also made it clear that the rebound effect is still substantially underestimated by the general public and policymakers and in some cases also by scientists.

Under the title Superconducting DC transmission and distribution: concepts and applications, Professor Antonio Morandi of the University of Bologna gave a presentation as part of the E.ON ERC colloquium series. Thanks to their outstanding electrical properties – high power capacity and no resistance in DC connections – superconductors are ideally suited to realizing DC cable connections in terms of the aspects of efficiency and transportation capacity, the Italian scientist explained. Another advantageous factor, he said, was the ability to work with lower voltages than in the case of AC connections.

In his talk, Morandi presented different cooling systems – using liquid hydrogen and liquid nitrogen – and gave a detailed explanation of their pros and cons. In the process, he demonstrated both the maximum possible distance between the necessary cooling stations and possible applications in data processing centers, on ships, and in industry. Use of superconductivity in high-voltage DC transmission was also discussed in detail over the course of the presentation.

Events & dates

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<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tr>
<td>May 12, 2015</td>
<td>Colloquium: VISION 2050: what does that mean for today? Dorothea Ernst, CEO Celviva</td>
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<tr>
<td>May 19, 2015</td>
<td>Colloquium: The economy of using high-alloy material in power station construction, Ralf Berker, Berker Impuls Co.</td>
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<tr>
<td>June 22-25, 2015</td>
<td>PEDG2015 • The 6th International Symposium on Power Electronics for Distributed Generation Systems, Quellenhof, Aachen, Germany (<a href="http://www.pedg2015.org">www.pedg2015.org</a>)</td>
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