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Researchers connect simulators for a transatlantic real-time simulation

Scientists from the USA and Europe are bringing their high-performance, real-time simulators together in the Global Real-Time Super Lab project to make global electricity supply grids fit for the challenges of the future. Six research institutions from the USA are participating. The European side is being overseen by the Politecnico di Torino and the institute ACS.

Editorial

Dear Readers,

For the first time, a JARA-ENERGY Talks event took place this November. With this new series, the Jülich Aachen Research Alliance (JARA), the institute ISEA, the FEN Research CAMPUS, and E.ON ERC have set the goal of informing scientists, as well as interested members of the public, about the current state of research of the energy systems of the future, with the help of renowned speakers who cover fascinating topics. Both we – and particularly the speakers – have undoubtedly succeeded in doing so with the first talk of the series.

I also hope that this issue of Research & News, which features some unusual research topics, will also interest you.

I wish you happy reading!

Rik W. De Doncker

Merry Christmas & Happy New Year

The entire team of E.ON Energy Research Center wishes all readers a peaceful and merry Christmas and all the best for a healthy, successful and happy New Year!
**PGS Workshop**

**Electromobility is learning to fly**

PGS Professor Rik W. De Doncker is certain that electric-powered flight is no longer a utopian dream: “Electrically- propelled airplanes have existed for several years and I am convinced that the developers’ work will soon no longer be classified as prototypes. If there was no chance of success, companies such as Airbus or Siemens would not be as intensively occupied with this issue as they actually are.”

If electric cars are only gaining momentum slowly, it has less to do with technology and more so with the costs, explains the engineer from Aachen. “We have technical solutions and we are working, both intensively and with good prospects, to improve the power density of all components. But for price-sensitive products such as cars, these solutions are only of interest if they can be built and sold in large quantities. Weight and volume play a much larger role in aircrafts; financial aspects are certainly important as well, but not as significant within the scope of the overall costs.”

The positive assessment by Professor De Doncker and many of his colleagues was reason enough for the Research Association for Power Electronics and Electrical Drives (FGLA e.V.) to organize a workshop on the subject of “All-Electric Aircraft” for the first time. Although about 20 participants were expected, more than 125 international experts from the most varied fields in economics, science and management came to Aachen in November.

With his opening address for this one-day event, Professor De Doncker made it clear that he, alongside his colleague Professor They agree that electromobility for flying has a big, long-term future (from left): Peter Rostek, Product Leader Novel Energy at Airbus Defence and Space GmbH, Prof. Rik W. De Doncker, PGS, Dr. Claus Müller, Leader of Center of Competence “Aircraft Drives and Controls” at Siemens AG, Prof. Rudolf Mathar, Prorector for research and structure at RWTH Aachen and Prof. Dirk Uwe Sauer, PGS.

**E.ON ERC Ticker**

This year, the E.ON ERC was represented at the RWTH Science Night, which took place in the new C.A.R.L. auditorium center for the first time (see image), with numerous contributions. Why can’t I cool my kitchen down in summer with an open fridge? Electrical power from the Earth - how does this work? What requires the most energy in the home? How does power get from a turning wind turbine to a socket? Why does my mobile phone battery last for fewer hours over time? Such questions roused considerable interest.

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Premiere in Aachen: The FEN Research Campus will host the Aachen DC Grid Summit (ADCGS) conference for the first time on 19 and 20 April 2018. The two-day event, which brings international experts from research and industry together, is designed to be an R&D platform in the field of direct current (DC) grids. Parallel lecture sessions deal with issues including the automation, planning, operation and social acceptance of direct current grids. The event is particularly conducive for exchanging new trends and developments. It is hard to find better opportunities to enter into direct dialogue with one another, to network with each other, and to exchange knowledge across disciplines in the comparatively young modern DC community. Ideally, new collaboration partners can be found, with whose support the potential of direct current technology can be used even better on a national and international level than was previously possible. You can find more information here.
Dirk Uwe Sauer of RWTH PGS and ISEA institutes, have substantial expertise in the field of electromobility. With numerous highly qualified contributors, the fields of power electronics, electronic drives, and mobile and stationary battery storage cover an impressive range of important research topics for the development of electrically-driven vehicles and airplanes.

Interest for two presentations right at the start of the event was considerable. In them, leading researchers from Airbus and Siemens spectacularly demonstrated that electrically-powered aircraft have long been a reality. Accordingly, Airbus sees the most potential in small battery-fed aircraft, but is skeptical regarding the construction of large passenger aircraft, primarily due to the excessive weight of the required battery capacity for the foreseeable future. On the other hand, in the words of Airbus employee Peter Rostek, all technology starts small.

Dr. Claus Müller from Siemens AG announced the construction of small aircrafts with hybrid power systems for the next five years. He considers passenger aircrafts for up to 100 passengers and short-haul flights a possibility by 2030. A sturdier backdrop for such optimistic predictions: Siemens’ first electric airplanes made their maiden flights three years ago.

The design of battery systems for electrically-powered aircraft was also one of the topics presented and intensely discussed at this workshop, like the development of a two-seater, hybrid-electric sports aircraft, which can take off and land on both water and land. In Norway, the first test flight of this aircraft is imminent. The electrification of hydraulic and pneumatic actuators was also explained by United Technologies. Students from RWTH presented their work on the development of an electrically powered glider.

Other presentations showed that electrically-powered aircraft can offer enormous advantages for energy efficiency and protection of the environment, but that in regard to the actual power unit, power electronics and storage technology, many improvements in terms of costs, size, weight, reliability and thermal management are still required before mass production is possible.

Professor Dirk Uwe Sauer does not just see vast improvements for “all-electric aircraft”. The battery specialist insists that the studies also have a positive effect on electromobility. “Short and medium range small aircraft and drones can already be very well built with the battery technology available today. Highly efficient batteries for hybrid powertrains, which allow electric take-offs and landings in particular, are already available. Further developments are being driven forward by the quickly growing market of electromobility for the road with the automotive industry. Flying across the Atlantic in a large passenger aircraft which runs purely electrically on batteries is, however, going to remain a dream for a long time.”

**ACS I Intercontinental Cooperation**

Researchers connect ten simulators for a transatlantic real-time simulation

“Scientists from the USA and Europe bring their knowledge, their experience and their high-performance, real-time simulators together in the Global Real-Time Super Lab project, in order to make the global electricity supply grid ready for the challenges of the future.” Professor Antonello Monti from ACS at E.ON ERC Aachen summarizes in one sentence the unprecedented transatlantic collaboration of numerous researchers. Three research institutions and three universities from the USA are participating; the European side is being overseen by Politecnico di Torino in Italy and ACS.

The project includes the investigation of how data and energy exchanges can also be used over large distances to keep energy supply and demand at the same level and how to avoid extensive blackouts, or at least how to reduce their duration and impact. Such systems currently operate at a continental level at best. The researchers finally have a shared vision: the development of a reliable and resilient global supply grid largely protected against external
influences with DC bridges between the continents and systems.

At the end of September, and with the help of their high-performance real-time simulator, the project partners successfully demonstrated whether and how such a system can operate. ACS had the highest capacity in this project with the RTDS and Opal-RT simulators at its disposal; the remaining partners were involved with similar simulators made by the same manufacturers.

The transatlantic co-simulation was made possible with the help of the VILLASframework, a software developed at ACS and tested a few years ago by JARA Energy for the networking of resources in the Aachen/Jülich area as part of a project. VILLASframework enables communication between simulators, is free to use as open source software for all involved and is constantly being developed further by them. During this demo (so far unique in scope), an intercontinental grid with a high-power, virtual high-voltage DC connection between the USA and Europe was simulated with the help of ten real-time simulators. The computing capacities in Aachen were used for simulating transmission grids, while the behavior of medium-voltage distribution grids was simulated in Turin. On the American side, the real-time simulators modeled transmission, medium-voltage and distribution grids. In addition, local electricity producers with actual photovoltaics and wind turbines were incorporated via hardware-in-the-loop simulation. Whether and to what extent temporary differences in electricity generation from renewables can be used for intercontinental grid stabilization is also being investigated.

All the researchers involved agreed on the positive assessment of the results from this initial, transcontinental demonstration in real time and want to further develop the system together. More importantly: the potential funding organizations that were invited were very impressed. Interest in continuing the work has certainly been roused.

Naturally, the transatlantic cooperation is limited to the exchange of experience in dealing with disturbances and to control aspects given the as yet missing connections between the continental grids. However, researchers and potential users agree that the significance of the knowledge gained here for operating large-scale, continental energy supply structures should not be underestimated.

A smaller side effect not to be underestimated is that European manufacturers of renewable power generating systems can test the suitability of their hardware components for the American market by running simulations with the real-time super lab.

### FCN Green Electricity Labelling

EEG 2017 provides new marketing opportunities for regionally produced green electricity

After the green electricity privilege from the EEG (Renewable Energy Sources Act) 2014 ended, calls for a successor system grew. EEG 2017 therefore introduced a regional green electricity disclosure. The aim of this tool is to promote the use of renewable energies in Germany and to increase the acceptance of regionally generated renewable electricity – which, if consumed nearby, could relieve grids, reduce losses, and possibly improve the acceptance of renewable power plants.

In a study, FCN and the Aachen-based consulting company BET thoroughly investigated whether and how the implementation of regional, green electricity products can contribute to strengthen the German energy suppliers’ brand essence. To do so, existing possibilities for the marketing of green electricity were first considered on a regional basis. In the second phase, they were compared to new marketing models, which would be possible with the regional green electricity disclosure according to EEG 2017. The findings of the completed analyses show that the regional green electricity disclosure introduced with EEG 2017 is suitable for systematically upgrading the pre-existing marketing options of regional and renewably generated electricity.

FCN also conducted a multi-criteria analysis, whereby decision makers from regional electricity suppliers were intensively involved in the evaluation. The results of the multi-criteria decision analysis show clearly that the regional green electricity disclosure according to EEG 2017 can significantly improve the marketing possi-
The third ENERGIEWENDEBAUEN project leaders meeting (PL) focused entirely on the subject of “Buildings and Districts of the Future” and the central question of how innovative concepts and new technologies can unify climate protection and profitability. The project leaders meeting, of which the content was planned by the accompanying scientific research (BF2016), saw just under 150 invited players from research, industry, planning, the energy sector and politics come together on 6 and 7 December at the Federal Ministry for Economic Affairs and Energy (BMWi) in Berlin. After the participants were greeted by Dr. Rodoula Tryfonidou from BMWi and Professor Dirk Müller (EBC) as consortium leaders of the accompanying research BF2016, the lecture sessions were opened by Professor Silke Langenberg with her subject of “Expensive or Valuable?” and the observation of the life cycle costs of existing buildings.

The presentation gave participants a detailed insight into new technology projects from the field of energy in buildings and districts by showing new research findings based on three joint projects. While the Urban-Factory interdisciplinary research project presented its findings on the optimization of resource efficient, urban factories, the PCM-(phase change materials)-Demo II research project (which is made up of eight subprojects) demonstrated the various uses for PCM technology in the building sector. The SpeicherLCA research team also examined new and established concepts and materials for heat and cold storage. The day ended with the award ceremony for the EnEff. Gebäude.2050 idea competition, which honors outstanding concepts. In the subsequent get together, which featured a poster exhibition of submitted competition entries, participants had the opportunity to delve into and discuss all the submitters’ concepts with them.

The high visibility of the research area was emphasized on the second day: Christine Polsfuß, representative of the newly renamed research network ENERGIEWENDEBAUEN, stressed the role of accompanying research as the “driving force of content” for the network. New developments surrounding the project map as a central and interactive tool for the BF were presented by Professor Dirk Müller and Carsten Beier. The tool should make future project information about current and completed research projects available to the public.

Some of the issues raised by the participants were subsequently discussed at eight round tables, which aim it was to enquire about the project leader’s current research themes, to promote the exchange of experience between the project leaders, and to reveal optimization potentials in the further development of technologies for attaining climate policy objectives.

In a ranking of green electricity marketing models based on the results of the analysis, the top three ranking models are those in which the regional green electricity disclosure is combined with existing options for the marketing of regionally generated electricity.

Panel discussion about the energy in buildings and districts research field with the speakers from the presented joint projects.

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**E.ON ERC Ticker II**

In early December, on the Day of Electrical Engineering and Information Technology, **Dr. Mohsen Ferdowsi** (in photo at right, at the side of Prof. Antonello Monti), a former doctoral candidate at ACS, received the STA Wagner Prize for his dissertation, which the jury thought was “outstanding”. Ferdowsi obtained his undergraduate and master’s degrees at the University of Tehran in his home country of Iran. He subsequently conducted research as a doctoral candidate at E.ON ERC’s ACS. His award winning dissertation is entitled “Data Driven Approaches for Monitoring of Distribution Grids”.

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**Dr. Marco Pau** received start-up funding from the RWTH Aachen for the project “SMART Placement of Measurements in distribution grids – SMART PLUS”. This consists of personal project funding, which is available as start-up funding to promote academic independence and the strengthening of an academic profile. Dr. Pau studied and earned his PhD in the Italian city of Cagliari. He has worked at ACS, where he has led the power system automation team since 2015.
The role of energy storage systems in the energy system of the future

As part of the “JARA-ENERGY Talks”, a joint series of events from the Jülich Aachen Research Alliance (JARA), E.ON Energy Research Center (E.ON ERC), the Institute for Power Electronics and Electrical Drives (ISEA) and the Flexible Electrical Networks (FEN) Research Campus, Prof. Dr. Michael Weinhold, CTO of Siemens’ Energy Management Division, gave a lecture on “The Role of Energy Storage Systems in the Energy System of the Future” in mid-November. In his lecture, the renowned scientist and manager clearly explained the challenges that transport and distribution grids face in light of increasingly volatile and decentralized power generation with wind turbines and photovoltaic systems, as well as the role energy storage systems already play today and the roles they could play in the future.

In Weinhold’s opinion, German electricity supply is characterized primarily by considerable complexity in terms of generation. This complexity is undoubtedly going to increase further. For example, generation is being relocated away from the centers of consumption to large solar and wind power stations mainly because of the large areas required, while simultaneously the number of small, decentralized generating plants, which are often operated in conjunction with local storage systems, is increasing very rapidly. Subsequently, the transmission grids – particularly from north to south – need to be expanded and the distribution grids strengthened as well. In Weinhold’s words: “The world of energy as we know it is changing massively and at great speed.”

Dr. Weinhold is convinced that storage systems of varying forms will play a prominent role in the future supply of energy. For Weinhold, four types of storage system are paramount in this regard: Pumped-storage power plants, chemical storage (particularly in the form of hydrogen), battery storage and thermal storage. The storage of electrical energy with pumped-storage power plants is indeed fully developed and plays an important role today, but Weinhold does not see noteworthy potential for any further expansion. Thermal storage is currently more significant at local levels in the decoupling of power and heat consumption. In terms of batteries, Weinhold sees lithium-ion (Li-Ion) technology remaining advantageous for a long time. The automobile industry is believed to be the primary driving force in this field. There is an impressive price trend here, which will continue further as the numbers of hybrid and fully-electric vehicles keep increasing.

For Weinhold, the future lies in “agile” supply grids, which include renewable energy generation and highly flexible, conventional power stations alongside flexible loads, smart-grid technologies and energy storage systems of varying types. Regarding grid stabilization, he thinks li-ion batteries are at an advantage over the largely exhausted potentials of pump storage, at least in the medium term. For large quantities of energy “it’s more a question of hydrogen”. 

E.ON ERC | E.ON Energy Research Center, RWTH Aachen University, Prof. Dr. ir. Dr. h. c. Rik W. De Doncker
ACS | Automation of Complex Power Systems, Prof. Antonello Monti, Ph. D.
EBC | Energy Efficient Buildings and Indoor Climate, Prof. Dr.-Ing. Dirk Müller
FCN | Future Energy Consumer Needs and Behavior, Prof. Dr. rer. soc. oec. Reinhard Madiener
GGE | Applied Geophysics and Geothermal Energy, Prof. Dr. rer. nat. Christoph Clauser
PGS | Power Generation and Storage Systems, Prof. Dr. ir. Dr. h. c. Rik W. De Doncker Prof. Dr. rer. nat. Dirk Uwe Sauer

Events

15 February 2018
6.30 pm, RWTH Super C
JARA-ENERGY Talks: Innovation – the most important energy source of the future, Talk by Dr. Johannes Teyssen, Chief Executive E.ON SE

19-20 April 2018
Aachen, Tivoli Business & Events
Aachen DC Grid Summit (ADCGS): More Info Infos at: https://adcgs.org