The SOGNO (Service Oriented Grid for the Network of the Future) project, co-developed by ACS and supported by the European Union as part of its Horizon 2020 initiative, has been identified and recognized by the Linux Foundation branch LF Energy (LFE) as a suitable candidate for a worldwide standard in the grid automation segment.

LF Energy was founded in mid-2018 with support from the Euro- pean Network of Transmission System Operators for Electricity (ENTSO-E) and French transmission system operator RTE, among others. Through LF Energy, the Linux Foundation aims to achieve successes in the further development and automation of distribution networks like those that have already been achieved through the open-source principle in other sectors, such as networking, the automotive industry, financial services, and cloud computing. Under the LF Energy umbrella, plans call for forging ahead with

New research projects at ACS
- Solid-state transformer simplifies expansion of charging infrastructure
- A fun way to raise awareness of paths to a CO₂-free future
- FCN: Three studies of the economic benefits of a greater diversification of wind turbines
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- Science for Industry strengthens cooperation between the business and research sectors
- Fifth-generation heat networks use renewables and minimize CO₂ emissions

Editorial

Dear Readers,

E.ON ERC is growing steadily. New chairs are being added and new teams formed. And our interdisciplinary, outside-the-box thinking, a key element of the vision with which we were first founded, is now more than ever an essential element of our day-to-day work. That is just one of the many reasons our institutes and chairs and their highly qualified researchers have earned worldwide recognition. One excellent example is the SOGNO project, which ACS was instrumental in helping to develop under the leadership of my colleague Antonello Monti. LF Energy, a branch of the Linux Foundation, has identified SOGNO as a promising candidate for a worldwide standard in the grid automation segment. And the business magazine Forbes has also called this project a key innovation for automated electrical grids of the future.

I wish you happy reading!
Rik W. De Doncker

Fundamentals for the next generation of PV power plants

As part of the PV-Kraftwerk2025 project, the PGS Institute studied the requirements that apply to photovoltaic power plants of the future and developed potential approaches to achieve solutions with regard to converter topologies and farm structures and to incorporate suitable energy storage systems. To this end, various power plant concepts were considered, and grid connection points were optimized.

New team focuses on refrigerant cycles

The EBC Institute established the new Refrigerant Cycles team at the start of this year. The researchers, who comprise the new team, have a shared aim: to optimize the refrigerant cycle of the future, from fluid selection and component dimensioning to development of efficient control strategies.

Linux Foundation Energy believes SOGNO has potential for a global standard

Success draws attention from the international business press

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In this Horizon 2020 project, ACS will play an increasingly important role in the energy sector of the future. Since the start of this year, ACS has been working with partners from seven other European countries within this project, which is part of the EU’s Horizon 2020 initiative, to develop a modular set of “building blocks” that allow small- and medium-sized enterprises, in particular, to easily harness artificial intelligence in line with demand, all at low cost. The focus here is on managing renewable energies in the generation and distribution and on developing offerings that can be used to tap into synergies between different sectors, such as local and district heating, building energy supply, and/or electric mobility.

**New research projects at ACS**

**I-NERGY:** Artificial intelligence will play an increasingly important role in the energy sector of the future. Since the start of this year, ACS has been working with partners from seven other European countries within this project, which is part of the EU’s Horizon 2020 initiative, to develop a modular set of “building blocks” that allow small- and medium-sized enterprises, in particular, to easily harness artificial intelligence in line with demand, all at low cost. The focus here is on managing renewable energies in the generation and distribution and on developing offerings that can be used to tap into synergies between different sectors, such as local and district heating, building energy supply, and/or electric mobility.

**BD4NRG:** In this Horizon 2020 project, ACS has teamed up with partners from 14 European countries to develop solutions that can help to overcome the challenges in the energy sector of the future that are expected to arise in conjunction with the management of large volumes of data. The goal here is twofold: to simplify decision-making processes while opening up new market opportunities. Ultimately, the researchers plan to identify and leverage new economic potential with an eye to ongoing shifts in existing energy supply systems. For energy sector stakeholders, BD4NRG aims to create a framework that offers demand-driven possibilities for developing innovative energy services.

**I-Greta:** In this multinational alliance project focusing on energy storage solutions, partners from Austria, Sweden, Romania, and Germany – ACS and EBC among them – are jointly working to better integrate energy consumers, who are increasingly also generating energy themselves, into the increasingly complex energy supply system. Ultimately, I-Greta is intended to promote active consumer participation, which has been limited thus far for lack of appropriate technical solutions. One of the core innovations of I-Greta is the way it optimizes the interaction among automation, cloud-based IT and communication platforms, as well as dynamic storage integration. Professor Antonello Monti of ACS is the coordinator of the overall project.
PGS Photovoltaics

Fundamentals for the next generation of PV power plants

The use of solar energy to generate electricity – photovoltaics (PV) – is crucial to ensuring a CO₂-free supply of electrical energy. A look out at the roofs in any neighborhood is enough to see a steady increase in the number of small, private solar panels, which are used primarily to supply individual households. Beyond that, the expansion of photovoltaics through large facilities is essential to ensuring a safe, clean, and reliable supply of energy in the future. And that, along with the expansion of wind power, means tougher requirements for the grid infrastructure. This is where power electronics converters come into play, as only their use enables a stable interaction between volatile generation, fluctuating demand, and intelligent supply networks of the future.

In the PV-Kraftwerk2025 project funded by the German Federal Ministry for Economic Affairs and Energy (BMWi), PGS worked closely with SMA Technology, Infineon Technologies, Danfoss Silicon Power, the University of Kassel, and Kiel University of Applied Sciences to study the requirements that apply to photovoltaic power plants of the future and developed potential approaches to achieve solutions with regard to converter topologies and farm structures and to incorporate suitable energy storage systems. To this end, various power plant concepts were considered, and grid connection points were optimized. Innovative technologies were used in tandem with battery storage systems to make operating these kinds of systems more efficient and more reliable as well.

In light of the transient behavior of these kinds of large-scale PV power plants, dynamic models for individual power plant components were developed, the interaction between these kinds of components was studied in detail, and measures to improve stability were mapped out.

The PV-Kraftwerk2025 project had a number of key tasks:
- comparing different power plant concepts,
- devising a methodology for optimization,
- studying the interactions between individual power plant components in depth with an eye to cause and effect, and
- developing suitable measures to counteract undesired interactions between power plant components.

In the course of the project, which has now been brought to a successful conclusion, various concepts for large photovoltaic power plants with integrated battery storage systems were designed and optimized for both direct current (DC) and alternating current (AC) grid connection points. Simulation methods were used to develop innovative valuation models and optimization procedures. The causes of undesired interactions were identified using dynamic models, and appropriate countermeasures were devised and validated through experiments.

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E.ON ERC Ticker

Sonja Happ, Antonello Monti, and Stefan Dähling (all from ACS) have received a best paper award from IET Cyber-Physical Systems: Theory & Applications for their publication titled “Swarm-based automation of electrical power distribution and transmission system support.” The IET (Institution of Engineering and Technology) is an association of engineering and technology professionals.

* * *

The ACS and EBC institutes of E.ON ERC have been selected by RWTH Aachen University for the pilot phase of the Azure project. The goals is to fully integrate Microsoft Azure into the university’s organizational processes by September 2021. Once the pilot phase is complete, all processes, such as account statements, billing, and linking to identity management, will be implemented by the University’s IT Center. Ultimately, the goal is for all institutions at RWTH Aachen University to be able to use Azure to get all kinds of services quickly and easily without having to develop their own solutions for each use case.

* * *

A team of authors headed by Panos Kotsampopoulos with significant participation by Prof. Ponci and Prof. Monti of ACS has received a best paper award from the editors of the IEEE Open Access Journal of Power and Energy for their article titled “A benchmark system for hardware-in-the-loop testing of distributed energy resources.” The publication appeared in the journal’s predecessor, the IEEE Power and Energy Technology Systems Journal (PETS-J). It is an especially noteworthy distinction because only two teams of authors received this kind of award during the entire publication period running from October 2017 to September 2020.
**PGS I Electric mobility**

Aachen needs cleaner air. Various approaches are being taken to get there, from expanding bicycle infrastructure to supporting electric mobility. One of them is ALigN (named for its German title, Ausbau von Ladeinfrastruktur durch gezielte Netzunterstützung, which means “expansion of charging infrastructure through targeted grid support”), in which PGS is also playing an instrumental role. Plans for this project include installing 550 charging stations for electric vehicles. (For information on the overall concept and participating partners, please click here.) This measure to reduce NO\(_x\) and CO\(_2\) emissions is receiving funding from the Federal Ministry for Economic Affairs and Energy (BMWi).

The goals of ALigN include improving capacity utilization in the supply network through intelligent load management on the grid side for the charging infrastructure and targeted transmission of energy at the distribution network level using solid-state transformers (SSTs). An SST is an active power electronic transformer with a DC intermediate circuit that can influence voltage and power flow, thereby alleviating problems in the distribution network. This type of transformer can be used to link neighboring low-voltage networks together. Most of the expansion of charging infrastructure occurs in low-voltage networks, which can quickly become overloaded as a result. Linking them via an SST prevents this kind of overloading and minimizes the costly expansion of distribution networks.

In this project, PGS is tasked with developing and building a bidirectional power electronic transformer (SST) for the intelligent meshing of low-voltage networks and testing this transformer to ensure reliable operation within a distribution network. In the meantime, PGS researchers have specified and configured the innovative transformer for this specific application. Alongside hardware components, a control and regulation architecture was also developed. The SST was set up at AixControl, another project partner based in Aachen. The new transformer is currently located at the PGS lab for an extended commissioning process. For the near future, plans call for establishing additional charging stations next to the main E.ON ERC building. These stations are to be supplied with energy via a solid-state transformer that links two grid connections present at the center together for test purposes.

![Solid-state transformer diagram]

**FCN I Gamification**

A fun way to raise awareness of paths to a CO\(_2\)-free future

In cooperation with E.ON, Professor Madlener and his team are currently working to develop a “serious game” to help future users better understand the energy transition in Germany and Europe. “Gamification” – the deliberate use of elements of game design in a non-gaming context – is being utilized here as a fun way to initiate three continuous processes to modify environmental behaviors:

- knowledge acquisition,
- formation of firmly held beliefs, and
- adoption of certain behaviors.

Gamification is increasingly in use as a way to fill information gaps, enhance learning, and motivate people to make behavioral changes. The topics of sustainability and energy are among the most popular areas.

Apart from this specific project, games like these can be used to enhance awareness that transitioning to a carbon-free future is crucial, and that as many people as possible should be aware of the full ramifications of their actions in this context. Beyond that, various
providers offer a wide range of games to initiate and foster a kind of competition between neighbors, cities, or co-workers in the fields of energy and resource conservation.

The target audience defined for the current FCN project is the 16+ age group. The game is geared toward older teens and young students, but by all means also to older people who are familiar with using apps and interested in the German energy transition. In the game, players take on the role of political decision makers tasked with leading a country into a carbon-neutral future. The object of the game is to balance the many complex and interrelated factors that are part of this process. Ultimately, the idea is to “play out” real-world situations and highlight the consequences of individual actions in a highly complex environment through game play.

The content developed for the game includes the areas of budget, public opinion, and sustainability. Additional information is provided to improve the players’ chances of success, but also, and chiefly, to impart knowledge about the energy transition.

In the next phase of the project, which should be complete by mid-2021, the FCN project team is using an initial version of the learning game in practice as part of a workshop. The insights gleaned in this workshop should create a better understanding of the gamification concepts used and improve their suitability for real-world use and their attractiveness. The game’s effectiveness in terms of imparting knowledge and spurring behavioral change will also be studied in detail, along with aspects relating to fatigue.

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**FCN: Three studies of the economic benefits of a greater diversification of wind turbines**

In the first study, FCN is investigating the shutdown costs for facilities using renewable energies in Germany. Renewable energy plants can be taken off the grid temporarily to reduce the burden on the grid. When this is done, compensation is paid. Researchers working on this study are identifying and quantifying the regional variation in these kinds of shutdown costs, which can run into the billions of euros. In an econometric estimate, FCN is working to determine the likelihood of these kinds of shutdowns in a given region and quantify the resulting shutdown costs. The results show that wind turbines connected to the grid increase the renewable energy shutdown costs by 0.7 percent per MW or 0.2 percent per GWh. This applies to subregions where these kinds of facilities were shut down between 2015 and 2017. That means that political decision makers should send pricing signals for renewable energy facilities depending on regional grid overloading in order to cushion the costs imposed on consumers as a result of surplus renewable energy generation.

Second study: The market value of wind power is decreasing as market penetration rises. This trend can be countered using turbines that are optimized for the location and through targeted selection of the regions where turbines are located (geographic diversification). FCN is analyzing the potential of a hybrid approach to improve market value and reduce system costs and overall subsidy requirements in Germany. To this end, researchers are identifying suitable diversification regions and turbine configurations. Market values and costs are being forecast for Germany and for penetration levels of up to 65 percent (2030). The analysis has shown that the market values do not decline as sharply when system-friendly turbines are used in diversified regions. Beyond that, the hybrid approach also yields savings on system costs and subsidies. Using plant and equipment technology that has been optimized for the specific location has proven especially advantageous. The positive effects of geographic diversification are more muted.

In the third study, FCN is working with the German Aerospace Center (DLR) to study how alternative auction designs – regional auctions instead of national ones – affect funding for renewable energies in Germany. To do this, researchers are analyzing auctions at three different geographic levels: national, regional type I (state level), and regional type II (north/south auction). The results reveal significant unused onshore wind potential in Germany’s southern states. The team is using a newly developed auction model and FCN’s electricity market simulation model HECTOR to show that more bidders from southern states can win in auctions conducted regionally. Based on their detailed geographic analysis, the researchers have also noted that regional auctions bring perceptible potential for savings in terms of the funding to be provided, a factor that should be taken into account in long-term policies around renewables.

See FCN Working Paper 13/2018
See FCN Working Paper 1/2020
See FCN Working Paper 22/2019
FCN (Prof. Madlener) and Umlaut SE teamed up for a study of the cost-effectiveness of renewable power to hydrogen (RP2H) facilities. Using a binomial decision tree approach and taking expected future hydrogen sales prices into account, optimum times for sequential investments in modular RP2H facilities were identified.

Hydrogen is the subject of much discussion these days, both as a storage medium and as a means of sector coupling. To achieve the aim of reducing greenhouse gas emissions, however, “greener” hydrogen – hydrogen generated using renewable energies – will have to be used. Production of this hydrogen will mainly center on hydrogen electrolysis plants (electrolyzers) in the future.

Because the hydrogen sector and worldwide funding efforts are still in the early stages, the years to come are expected to bring sharp reductions in costs and changing overall regulatory conditions. Investments in hydrogen production plants and infrastructure are thus not just irreversible for the most part ("sunk costs"). Above all, they are associated with considerable uncertainty regarding ongoing costs and the expected revenues.

The sequential, real options-based investment model developed by the project partners was applied to RP2H plant locations with gas network feed-in in the Mojave Desert in California and in northern Germany. Real options models explicitly account for economic uncertainty and the “value of waiting” (for more information about the future).

To reduce hydrogen production costs, the notional electrolyzers were dimensioned for purposes of fixed cost degression in such a way that the locally available electricity from photovoltaic facilities and wind turbines can be used to reach at least 3,000 hours at full load. In addition, electrolyzers with larger capacity (> 10 megawatts) are to be installed wherever possible, as these cases permit the greatest economies of scale.

The study shows that given the overall conditions in place, it will not be possible to realize profitable gas network feed-in of green hydrogen in either Germany or California in the next few years. The pricing level for natural gas, which was used as a reference value for the sales price of hydrogen, is simply too low. Since external costs arising from the emissions of greenhouse gases are insufficiently internalized at present, natural gas is relatively inexpensive, especially in the United States. Measures that could enable cost-effective feed-in of green hydrogen include fixed feed-in rates, CO₂ prices that are high enough, and/or minimum admixture requirements.

A model proposed by the study’s authors currently only makes it possible to take hydrogen sales into account via the natural gas infrastructure, but it offers a good basis for further investigations in other hydrogen sales markets, such as the mobility sector.

Hydrogen generation with renewables still far from market readiness

Hydrogen is traded as a key element of the German energy transition. It has a wealth of advantages as a source of energy, both in technical terms and with an eye to systems. Hydrogen can store large amounts of energy at sites such as salt caverns. It also allows for importing of huge amounts of energy through pipelines or by ship and can be used to supply final applications for which electricity or battery power is not an option. The current discourse involves many possibilities for how and where hydrogen could be produced sustainably, what prospects there are for importing it to Germany and distributing it there, and in which applications hydrogen could be used. There has been little economic consideration of what value chains are conceivable, what the associated costs would be, and in which applications the use of hydrogen seems realistic in the first place, given the level of costs calculated.

Techno-economic prospects for hydrogen supply chains
FCN (Prof. Madlener) studied this question in tandem with industry partners. To do this, the team studied 12 cost and value creation chains for the provision of hydrogen from a technical, social, political, and economic perspective. A number of production paths were excluded for reasons relating to energy technology. For Germany, models showed that there will hardly be any green surplus energy available for electrolysis until well after 2030, and even with ambitious expansion efforts, there will still be only comparatively little in 2050. Many European countries are in a similar situation. Worldwide, there are many locations with high potential for green electricity generation with sufficient full load hours. However, it became apparent that where transportation routes are very long (especially in Australia and Argentina), supply chains are associated with considerable costs and energy losses. Scenarios for provision from Iceland, North Africa, and Saudi Arabia were modeled in greater detail. Taking the most optimistic estimates for future production costs and efficiency into account, the long-term costs were still surprisingly high, at 5 euros per kilogram or 15 euro cents per kilowatt-hour at a minimum.

One surprise was the discrepancy between these results and those of many other studies. The study uncovered several common errors made in assumptions relating to cost factors and efficiency levels in the literature. The specific design of the transportation supply chains is frequently not given adequate consideration in the literature, either. For example, hydrogen is imported either in liquid form, by ship, or as a gas traveling through a pipeline. Since changing the physical state carries significant cost and involves considerable use of energy, this difference is highly important to both distribution and final applications. For example, only the gas form will be suitable for some applications (households, for example), while others (such as aviation) will be limited to liquid hydrogen. Recent modeling of various electricity scenarios showed that the environmental impact could remain relatively unfavorable for decades to come if the development of renewable energy sources continues at its current pace.

Guarantees of origin (GoOs) create transparency regarding the manner and location of the production of green energy. These kinds of GoOs are traded independently from the electricity market itself. However, this trade is still dominated by a lack of transparency and speculative behavior.

In one research project, the two authors – Alexander Wimmers and FCN professor Reinhard Madlener – initially developed an overview of the development of the European GoO market, including an analysis of the relevant price trend. Based on the project’s findings, the team developed a model that can be used to estimate future developments in the prices of European GoOs for different renewable energy generation technologies on a country-specific basis for the present until 2040.

The model’s methodology is based on the average ability to pay (ATP) for green energy for companies in certain sectors of the economy. The ATP is calculated based on the ratio of profit to electricity costs. A special factor relating to environmental awareness is also taken into account.

The proposed model can be used by regulatory agencies, for example, to determine whether the European GoO system needs reform. Other stakeholders, such as project developers or investors in renewable power generation facilities, can use these price predictions to gauge profitability for their investments.

In their study, the two researchers find that GoO prices will rise on average over the next few years, reaching levels between 1.77 and 3.36 euros per megawatt-hour in 2040. In combination with rising demand for green energy, subsidies that are being phased out, and further standardization of emissions procedures as well as the forecast development of GoO prices, the GoO trade could in fact become a useful additional tool for promoting the generation of green energy in the EU in the years to come.

The study is available to download as FCN Working Paper 17/2020.

New team focuses on refrigerant cycles

Heat pumps are always chillers as well. The only difference is how they are used. They are viewed as a key technology in the German energy transition. Sustainably supplying buildings with heat and cold without heat pumps is inconceivable these days, with ongoing advances in the electrification of provision of heat in the building sector. In response to this development, EBC established a new team focusing on refrigerant cycles at the start of this year. Under the leadership of Dr. Valerius Venzik,
the researchers on the team have a shared aim: to optimize the refrigerant cycle of the future, from fluid selection and component dimensioning to the development of efficient control strategies.

Boosting energy efficiency and reducing the direct and indirect emissions of future refrigerant cycle generations are key goals of the new team’s research work. Findings from theoretical analyses and their potential for practical implementation are being validated through experimental studies. The hardware-in-the-loop method plays an important role here. It can be used to perform both static and dynamic studies on a reproducible basis.

The team will develop simulation models and optimization algorithms in commonly used programming languages. The connection to the experimental world takes the form of an automation system that enables fully automated experiments. To ensure the quality of measurements at all times, all process variables are monitored using an integrated monitoring system.

In summary, the team focuses on the following research areas:

• identifying working fluids with a focus on “sustainable coolants,”
• optimizing the design, configuration, and operation of refrigerant cycle processes, and
• further developing individual plant and equipment components.

Best paper award

Immediately after it was first established, the Refrigerant Cycles team notched its first success. At this year’s international online conference focusing on compressors and refrigerants, Refrigerant Cycles researchers presented the results of research in their field in two different talks. The contribution submitted by EBC employees Stephan Göbel, Christian Vering, Valerius Venzik, Markus Nürenberg, and Dirk Müller received a best paper award from the scientific committee.

Under the leadership of E.ON Energy Solutions, a broad-based consortium is working within the TransUrban.NRW project to put innovations involved in the German energy transition into practice. TransUrban.NRW is one of four winning projects from the state of North Rhine-Westphalia in the nationwide idea competition titled “Living Labs for the Energy Transition,” which the Federal Ministry for Economic Affairs and Energy initiated in early 2019. The total project volume is 16.7 million euros.

Alongside regional and municipal supply companies, a number of other research institutions, and various industry partners, E.ON ERC is represented in the project by the EBC and ACS institutes and by the Chair for Energy Systems Economics (ESE) at the FCN Institute. EBC and ACS are developing new digital methods for the planning and operation of neighborhood energy systems for TransUrban.NRW, and ESE is devising new business models and studying their scalability.

The overarching goal of TransUrban.NRW is to replace the classic form of district heating in traditional mining regions, which is often operated at temperatures higher than 100 degrees Celsius, with what are known as “low-ex” networks, thereby significantly improving urban carbon footprints. The low-temperature networks needed to achieve this will either be newly established or integrated into the existing infrastructure. Ultimately, these new networks are to be designed as platforms for the exchange of energy where all of the stakeholders involved can act in concert. This is made possible by intelligent networking that balances buildings’ needs for heat and cooling, thereby enhancing the efficiency of the overall systems.

This technology does more than just reduce energy losses. It also allows the integration of geothermal heat sources and/or use of waste heat. Both are available in relatively large amounts at low temperature levels. Fifth-generation heat networks are able to incorporate renewable energies and waste heat at all temperature levels into a supply system.

As part of the TransUrban.NRW project, four different neighborhood energy systems are being planned and realized. The cities selected for the implementation of the project – Gelsenkirchen, Mönchengladbach, Herne, and Erkrath – are all located in areas in the grip of structural change, where coal and lignite are common. Each of the four

Fifth-generation heat networks use renewables and minimize CO₂ emissions

| EON ERC | A living lab for the German energy transition |

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locations stands for a different innovation focus as a living lab for the energy transition.

The static operational assumptions common to date are no longer adequate for planning and operating fifth-generation heat networks and associated neighborhood energy systems. New, dynamic methods are becoming more important. The integral consideration of these neighborhoods using different target functions such as cost or CO₂ minimization during the early phase of the project is the prerequisite for resource-conserving and cost-effective operation of the neighborhood energy system solutions. In addition, EBC and ACS are working on developing new digital tools for the planning and operation of neighborhood energy systems as part of TransUrban.NRW. These two institutes are relying on mathematical optimization and dynamic simulation methods for this and further developing these methods on a project-specific basis.

Mathematical optimization models are being used to support design decisions. The facilities are selected and dimensioned with an eye to minimizing costs and CO₂ emissions when all operating points are viewed as a whole. After that, the Aachen-based researchers use dynamic simulation models to visualize thermo-hydraulic processes and the dynamics of heat networks in detail. Dynamic effects such as reversal of the direction of flow and the network’s storage capacity are also factored in. Finally, the simulation models serve to study different operating parameters and how they affect the efficiency of the overall system.

Beyond the purely technical design of new, highly efficient and low-CO₂ neighborhood energy system solutions, TransUrban.NRW also aims to optimize the solutions identified from an economic standpoint. To this end, the ESE chair at FCN is taking a systematic approach to developing and evaluating business models that enable sustainable and cost-effective operation of the technical innovations used in the TransUrban.NRW project. The stakeholder groups involved and their interests – which may conflict – are also being studied in the process. At the macro level, system feedbacks that affect the scalability of the fifth-generation energy systems studied and the associated business models are being analyzed. The study is also looking at the extent to which the positive effects of fifth-generation energy systems that have been achieved at the neighborhood level can be transferred to other energy systems in Germany.
Heat pumps are generally viewed as crucial to a sustainable supply of heat and cooling for buildings. In the LOGIN project funded by the German Federal Ministry for Economic Affairs and Energy (BMWi), EBC is identifying key requirements for heat pumps and proposing optimum coolants for promising applications. As the next step, researchers from EBC are developing a model-based method for optimum design and configuration of heat pumps. The practical suitability of these heat pumps is being studied through experiments. The final product will be a set of guidelines for the application-related design of heat pumps and the safe handling of flammable coolants. This specific design will make it possible to use heat pumps more efficiently. At the same time, the guidelines will help to significantly shorten facility development time, thereby specifically strengthening German heating technology.

In the “Digital Twin of Heat Generation Systems as a Forerunner for the Development of Low-Emission Building Energy Technology” project funded by the BMWi, EBC’s aim is to visualize and monitor the development and operation of building energy technology systems in digital form. The goal is for the digital visualization of different conversion systems (heat pump/fuel cell) to considerably shorten R&D times. In addition, the laborious and costly process of taking measurements using prototypes can be postponed until much later than had previously been the case. Thanks to a close cooperation between the research sector and industry, digital twins that have been prepared can be tested directly on products with real-world relevance. In hardware-in-the-loop tests, fundamental parameters for heat pumps and fuel cells are determined in this way. One key element of this method, aside from measurement technology analysis, is achieving maximum accuracy in describing the dynamic and static behavior of elements such as the refrigerant cycle.

For more detailed information about both projects, please click here.

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FCN | Future Energy Consumer Needs and Behavior, Prof. Dr. rer. soc. oec. Reinhard Madiener; Chair for Energy Systems Economics, Prof. Dr.-Ing. Aaron Praktiknjo
PGS | Power Generation and Storage Systems, Prof. Dr. ir. Dr. h. c. Rik W. De Doncker; Chair for Electrochemical Energy Conversion and Storage Systems, Prof. Dr. rer. nat. Dirk Uwe Sauer

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