klima+ energie fonds

INNOVATIONS FOR THE FUTURE OF ENERGY

Energy research and technological development in Austria

www.energieforschung.at

TABLE OF CONTENTS

Photo: bmvit

Our climate and energy strategy #mission2030 marks an important starting signal for the end of the fossil fuel age. The task now is to continue along Austria's path towards sustainability and bring it to life with concrete measures. The Climate and Energy Fund is an important partner to the Austrian federal government in this process. Our very close partnership over the last few years has already made numerous innovations possible and advanced the transformation of domestic energy and mobility systems further towards achieving sustainability and climate neutrality.

The Climate and Energy Fund acts as a driving force in the area of innovative energy technologies. Its activities strengthen Austria as a business location. The energy research programme allows groundbreaking innovations to be developed and showcased. Together with the Climate and Energy Fund, our task will be to guide the energy and mobility transformation towards success, both ecologically as well as economically. The productivity of the Austrian economy and the huge innovative potential shown by Austrian researchers fill me with confidence for the future.

Norbert Hofer
Federal Minister for Transport, Innovation and Technology

Photo: Climate and Energy Fund/
Andreas Scheiblecker

The energy system is in a state of transition. These far-reaching global changes will not be feasible based on the technologies of today. The innovative potential of Austrian companies is a huge opportunity to modernise the energy system and move towards sector coupling using new key technologies. Green jobs already account for 195,000 jobs in Austrian industry today. We support forward-looking Austrian companies in the development and market launch of innovative technologies and procedures – a win-win situation, since these are put to use in Austrian manufacturing companies and are also deployed globally in export-oriented Austrian plant construction.

With the energy research programme we are providing the right mix of funding instruments for science and industry, from basic research to product implementation along the entire innovation and value chain. We are a one-stop-shop for the energy transition that is unrivalled both nationally and internationally.

Theresia Vogel
Managing Director of the Climate and Energy Fund

Photo: Climate and Energy Fund/Ringhofer

Test series print.PV at crystalsol
Photo: crystalsol GmbH

Research and technology development made in Austria

INNOVATIVE SOLUTIONS FOR THE ENERGY TRANSITION

The energy world is undergoing a fundamental change. This requires a radical transformation of our energy system in the direction of decarbonisation, and a switch to the wide-scale use of renewable resources in order to guarantee safer, cleaner and more affordable energy in the future.

All around the world, demand is increasing for green products, procedures and services that can help accomplish the energy transition. Energy and environmental technology has become a significant economic sector offering high opportunities for growth. Total revenues of EUR 3,214 billion were generated worldwide in 2016 in this dynamic cross-sector industry. (Source: http://www.green-tech-made-in-germany.de/en)

The European Strategic Energy Technology Plan (SET-Plan) defines important objectives aimed at stimulating energy-related research and industrial activities in the Member States. The SET-Plan provides the framework for developing and implementing cost-effective low-carbon energy technologies. By 2030, the EU is seeking to achieve 40% fewer greenhouse gas emissions (compared with 1990), 27% higher energy efficiency (compared with the business as usual scenario) and a 27% share of renewable energies as a percentage of total energy consumption.* By 2050 the SET-Plan aims to ensure continued development and implementation of energy technologies in such a way that the EU's greenhouse gas emissions can be reduced by 80-95%, helping to limit global warming to 2°C.

Using the opportunities of energy transition

The global upheaval in energy supply and usage is opening up major opportunities for the Austrian economy. New smart technologies and concepts are required in order to implement the change both technically and economically and to enable social acceptance. In the area of innovative energy solutions in the electricity, heat and mobility sectors, Austria has been able to score points internationally and successfully position itself on the global market with innovative technologies for the future of energy. This knowledge and expertise now need to be extended even further.

#mission2030 – the Austrian Climate and Energy Strategy (Ministry of Sustainability and Tourism and Ministry for Transport, Innovation and Technology, 2018) follows a guiding principle: to position Austria as a "country of energy innovation" with respect to research and the development of future technologies. It focuses on areas in which the economic opportunities associated with reorganisation of the energy system can best be exploited by innovative Austrian companies.

In addition to the on-going development of new technologies and components, one of the key challenges is finding ways to embed existing technologies and solutions into an overall integrated system. Research, development and innovation will play a crucial role here in analysing complex interdependencies and deriving potential solutions.

* European Commission (2014): 2030 climate & energy framework [https://ec.europa.eu/clima/policies/strategies/2030_en; retrieved on September 23, 2018]

In this brochure, we present some of the outstanding and pioneering showcase projects in Austrian energy research that have been implemented or are currently being implemented with support from the Climate and Energy Fund.

High pressure heat storage facility, Simmering power plant
Photo: Wien Energie/Ian Ehm

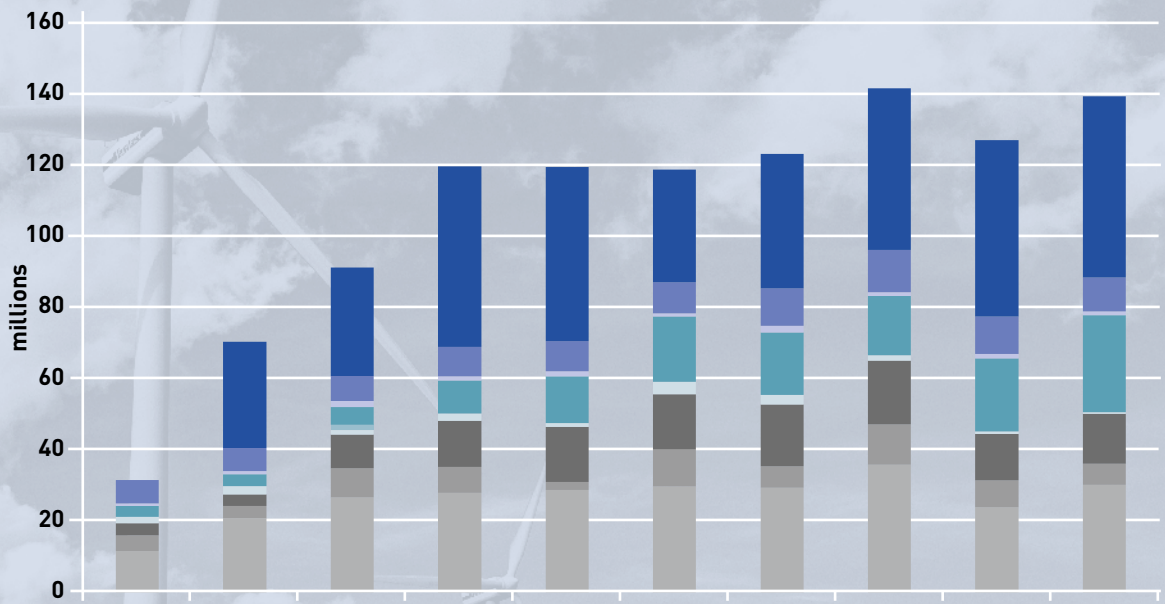
Expanding Austria's strengths

With its energy and mobility programmes, the Climate and Energy Fund supports innovations in areas where Austria features strengths and high levels of expertise compared internationally. Research and development pertain to the entire energy value chain and focus on research topics and activities that can make a particularly effective contribution towards boosting Austria as a location for innovation.

The Climate and Energy Fund's expenditure on energy-related R&D within the scope of its energy and mobility research programmes amounted to EUR 379 million between 2007 and 2016. This accounted for a significant share of the general increase in energy research spending in this period. Funding by the Climate and Energy Fund made up 36% of total spending on average between 2008 and 2016.

ENERGY RESEARCH IN AUSTRIA – CURRENT DRIVERS AND TRENDS:

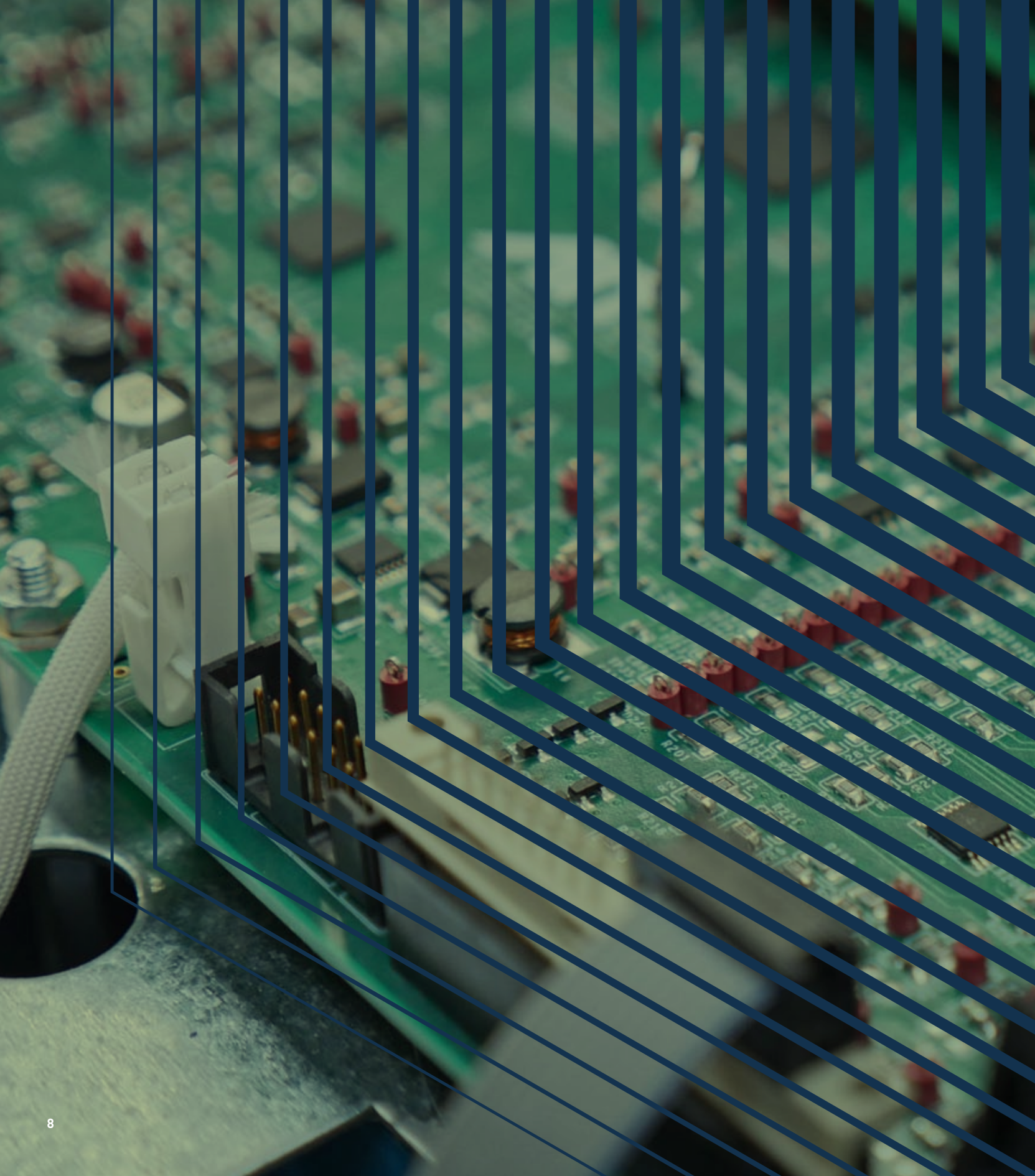
- Extensive decarbonisation of industry
- Future dominance of renewable, generally volatile energy sources
- Expected increase in the importance of electricity due to shifts in the use of energy sources
- Sector coupling, i.e. inter-connecting electricity, heat and mobility in order to enable optimum integration of renewable energy sources into the energy system
- Extensive digitalisation



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Climate and Energy Fund	0	30,191,351	30,836,148	51,210,247	49,484,424	31,998,188	38,226,899	45,824,462	50,049,465	51,491,365
TOTAL (euros)	31,886,023	71,166,956	92,268,114	120,979,645	120,821,607	120,098,940	124,545,848	143,100,718	128,415,085	140,891,866

- Climate and Energy Fund
- Universities
- Universities of Applied Sciences
- Non-university research
- Austria Wirtschaftsservice (AWS)
- Austrian Science Fund (FWF)
- Austrian Research Promotion Agency (FFG) general programmes
- Federal states
- Federal ministries

Energy research survey,
Climate and Energy Fund 2007 to 2016
Source: Austrian Energy Agency



ENERGY SYSTEMS & NETWORKS

Energy infrastructures are in a state of upheaval. The growing proportion of renewable energy sources (solar energy, hydropower, wind power and biomass) and increased decentralisation mean that energy networks need to be adapted. In the future we will need to integrate additional consumers (such as electric vehicles and heat pumps) as well as storage systems into our energy systems. One of the biggest challenges will be the balance between generating and consuming the energy supply, as the relationship between energy suppliers and consumers is changing fundamentally. Energy customers are increasingly becoming active participants in the energy system.

The energy networks of the future will require smart components that communicate with each other in order to enable secure and stable network operations despite fluctuating supplies. The intention is to use smart grid technologies in order to exploit potentials for increased flexibility among smart consumers, storage systems and producers. Concepts are required for integrated systems that can operate under realistic, economic, legal and social conditions.

One important focal point is sector coupling, i.e. ensuring that electricity, heat and mobility are interlocked so that renewable energies can be used and integrated into the energy system to optimum effect. Digitalisation is becoming a key skill here, enabling links to be created within the infrastructure, across multiple sectors between networks and with all energy stakeholders. ICT technologies form the basis for mastering complex control processes, as well as for data management and development of new business models.

Research has been carried out for years across multiple sectors in Austria (R&D institutions, e-economy and industry) aimed at finding smart solutions for further development of a sustainable energy system. Numerous technologies and components have already been developed into solutions ready for the market. Innovations provide opportunities for manufacturers of "enabling technologies", such as power electronics, communications technology and electro-technical components, to position Austrian knowledge and expertise on the rapidly growing smart grids market and thereby create highly qualified R&D and production jobs in Austria.

Many of the new technologies and concepts are currently being tested and evaluated under real operating conditions in internationally respected demonstration projects in the Austrian smart grids model regions.

THE INIGRID DEMONSTRATOR

The specially developed iniGrid demonstrator models a virtual power grid in which energy demand and generation from renewables are defined via performance profiles. A simulation shows how infrastructure capacity utilisation varies with the time of year and time of day selected. Visitors to the "Sonnenwelt Großschönau" exhibition can test the range of functionalities provided by the new technology and intervene interactively in generation and consumption so as to create or avoid problem situations, or deal with them automatically by means of the newly developed Smart Breaker and iniGrid algorithms.

iniGrid-Demonstrator @ Sonnenwelt Großschönau
Photo: AIT Austrian Institute of Technology GmbH

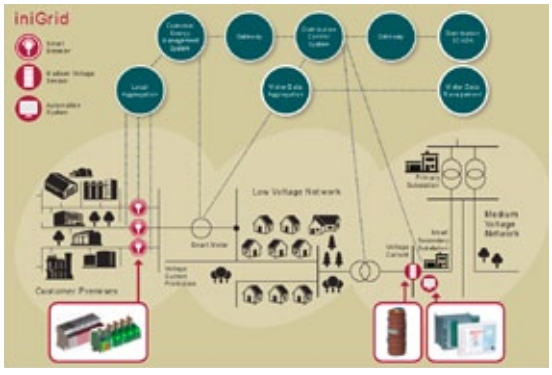


Fig. right:
Protection, monitoring and control across domains by integrating new smart components
Fig.: AIT Austrian Institute of Technology GmbH

Photo left:
diyanadimitrova/fotolia.de

iniGrid

SMART COMPONENTS FOR ACTIVE DISTRIBUTION NETWORKS

Smart control of energy flows increases energy efficiency in industry and small-scale manufacturing.

Digital display cabinet with Smart Breaker
@ Ars Electronica Festival 2016
Photo: Ars Electronica Solutions / Garamantis

To integrate renewable sources of energy into our power grids, we need smart, flexible components for efficient network management. In the iniGrid project (Integration of Innovative Distributed Sensors and Actors in Smart Grids) AIT Austrian Institute of Technology developed pioneering sensor and actuator technology for smart distribution networks, in collaboration with partners in industry and research institutes.

Low-cost all-in-one solution

A key innovation here is the "Smart Breaker", a semiconductor switch for low-voltage applications that is particularly suited to industry and small-scale manufacturing. Every manufacturing plant has separate circuits, e.g. for machines, lighting or ventilation. If the MCBs (Miniature Circuit Breakers) are replaced by a Smart Breaker, various monitoring and control functions are obtained in addition to circuit-breaking.

All the power flows within the company can be made visible by means of the Smart Breaker. An energy management system collects the data profiles and controls producers and consumers to meet given power and voltage limits as well as to minimise energy costs. With semiconductor technology this new-generation device can be built compactly and produced at low cost.

Field test with smart components

The consortium has also developed a new voltage sensor for air-insulated medium-voltage facilities. In conjunction with other technologies already on hand, such as smart metering and other existing sensor technology, the new components have been integrated into a secure, comprehensive automation infrastructure supported by intelligent algorithms in the energy management system.

From summer 2017 to spring 2018 the concept was tested successfully in a fieldtest at parts of the "Sonnenwelt Großschönau" exhibition in Lower Austria. Here the ventilation system, the lighting and the screens were automatically controlled, depending on the air quality and the movement of the visitors.

The iniGrid approach was presented at the Ars Electronica Festival in Linz and in the Welios Science Center in Wels (Upper Austria) in 2017.

www.inigrid.at

CONSORTIUM
AIT Austrian Institute of Technology GmbH (project management), Eaton Industries (Austria) GmbH, Infineon Technologies Austria AG, Zelisko GmbH, Sprecher Automation GmbH, TU Wien – Institute of Computer Engineering, FH OÖ Forschungs & Entwicklungs GmbH, Linz Strom Netz GmbH, MOOSMOAR Energies OG

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LEAFS

LOCAL STORAGE SYSTEMS AND FLEXIBLE LOADING IN THE LOW-VOLTAGE NETWORK

Photo: Climate and Energy Fund/Ringhofer

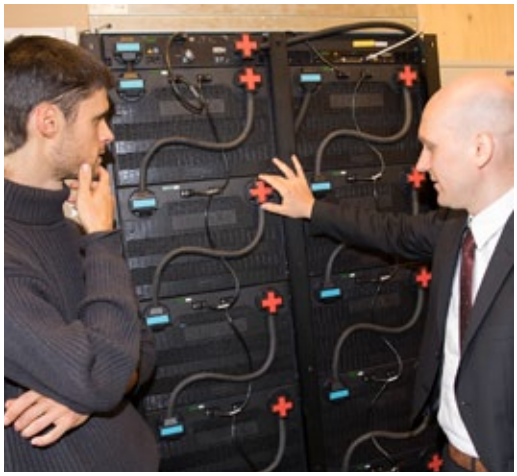
Central storage system Heimschuh
Photo: Energie Steiermark/Symbol

New concepts for storing energy from local production are being tested in three Austrian municipalities.

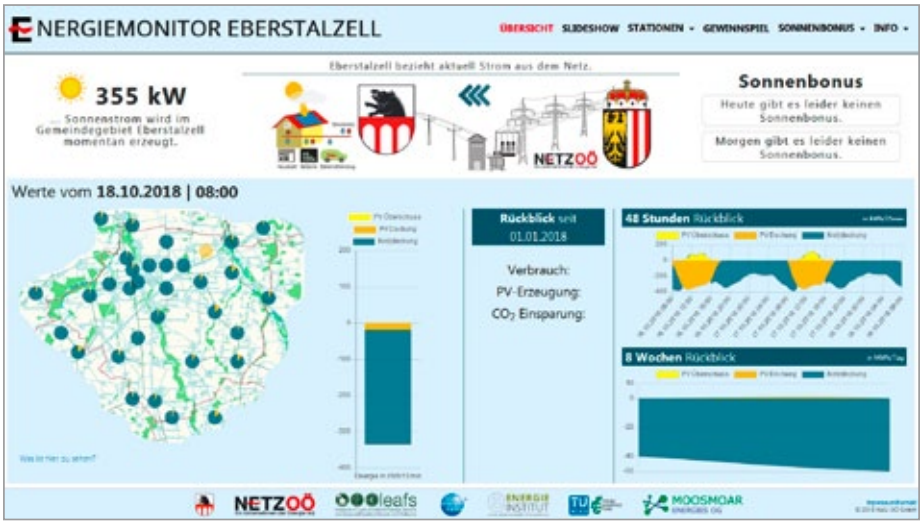
In Austria, there are currently around 125,000 photovoltaic systems that generate 1,096 GWh of electricity. Compact electrochemical battery storage systems that households can use to store the electricity they generate for their own later consumption have been available on the market for some time. In the same way as other flexible consumers (heat pumps, hot water boilers, electric vehicles) these can also be used for additional applications (e.g.: participation on the spot market). This additional usage can lead to thermal overload and voltage problems in distribution networks due to increased simultaneous use.

In LEAFS (Integration of Loads and Electric Storage Systems into Advanced Flexibility Schemes for LV Networks), technologies and operating strategies for active, network- and market-driven control of local storage systems and flexible loads are being developed and tested in field trials. The energy research flagship project is being implemented by the AIT Austrian Institute of Technology in collaboration with corporate and research partners.

The possible effects of increased market-driven storage utilisation and load variability in distribution networks were



Storage unit of the central storage system
Photo: Energie Steiermark/Symbol



Energy monitor Eberstalzell
Photo: Netz Oberösterreich GmbH

simulated using representative model networks. The project team then developed new control strategies for various requirements: direct control of central (e.g. large-scale power storage) and local elements (e.g. household storage systems) as well as indirect control of local elements such as heat pumps or local storage systems on customers' premises via an energy management system.

Field trials in Salzburg, Upper Austria and Styria

The innovative storage and control concepts are currently being investigated in three field trials and analysed in terms of their legal, economic and regulatory feasibility.

In the **Smart Grid Model Community Köstendorf** (Salzburg Netz GmbH), household storage systems have been installed in five households with PV facilities and integrated into a local energy management system, i.e. linked with the building energy agent (BEA), the onload tap changing transformer and the local electric vehicles. The elements are controlled indirectly via the BEA. The grid operator acts as an aggregator, transmitting market signals. He does not act as a market participant but instead provides the communication and control infrastructure.

Three household storage systems were installed in **Eberstalzell / Littring** (Energie AG/Netz Oberösterreich GmbH). Based on weather forecasts, the grid operator transmits network constraints that the storage system must comply with each day via power line. As the need arises, an aggregator (in this case FRONIUS International GmbH) transmits a market signal directly to the device via the internet. With the "Sun bonus", i.e. a second field trial involving participation by more than 200 households in this region, financial incentives are being tested in relation to the rate of local PV generation. The aim is to motivate these households to consume the electricity generated on the spot in specific time frames.

In **Heimschuh** (Energienetze Steiermark GmbH), a community in the south of Styria, nine households supply green power from their PV facilities to a central storage system, and withdraw it as the need arises. A battery with a storage capacity of 100 kWh has been installed for the field trial. This is roughly equivalent to the capacity of 20 household storage systems. Because the battery has 100 kW capacity the new central storage system can be used by several households simultaneously. The trial, which will run till March of 2019, is intended to show how this central power storage unit can benefit the local power network, the customers, and the market. The expectation is that costs for the network customers will go down, while power consumption will be reduced and the power grid will be relieved and negative impact is avoided.

CONSORTIUM
AIT Austrian Institute of Technology GmbH (project management), FRONIUS International GmbH, Siemens AG Austria, Salzburg Netz GmbH, Netz Oberösterreich GmbH, Energienetze Steiermark GmbH, TU Wien – Energy Economics Group, Energy Institute at the Johannes Kepler University Linz, MOOSMOAR Energies OG

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AIT SmartEST Laboratory
Photo: AIT Austrian Institute of Technology GmbH/Harry Krischanz

AIT SmartEST Laboratory

RESEARCH INFRASTRUCTURE FOR SMART POWER SYSTEMS

The AIT Austrian Institute of Technology provides a unique testing and research infrastructure for the smart energy networks of the future.

The SmartEST laboratory offers an ideal experimental environment to researchers, grid operators and manufacturers of components for electric power systems.

The interactions between components and the grid can be analysed, and products like inverters, storage systems and smart meters as well as control strategies can be tested and further developed. Test objects range from photovoltaic inverters to electrical storage systems such as accumulators or fuel cells, all the way to combined heat and power units and charging points for electric vehicles.

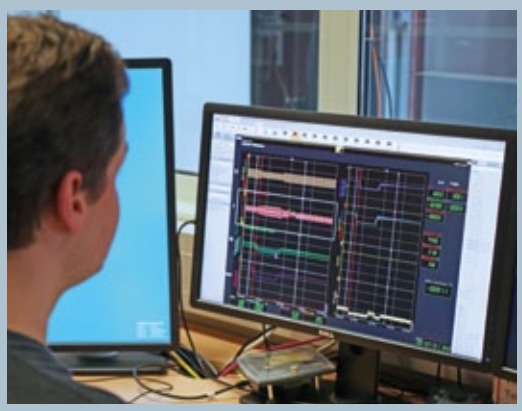
With 400 m² of floor space, the laboratory has indoor and outdoor testing areas with many different functions. The infrastructure features three configurable laboratory networks that can be operated at a constant output of up to 1000 kW. The equipment includes network simulators, PV simulators, a facility for setting up islanding systems, facilities for "power-hardware-in-the-loop" simulation, plus an environmental test chamber for testing under defined temperature and humidity conditions.

In the "power-hardware-in-the-loop" (P-HIL) simulations, a node is simulated in real time and the components to be tested are tied into the virtual network environment as hardware. The simulations are indicating if the components are compatible with the network structure and with other devices on hand.

Smart Meter, AIT SmartEST Laboratory

FUNCTIONS of the SmartEST Laboratory

- Accredited testing for components and systems for decentralised generation with simulated networks and primary energy sources (e.g. PV inverters)
- Electrical, functional and performance tests according to standards
- Simultaneous testing of power and communication interfaces of components
- Performance and durability tests under controlled environment conditions
- Simulation and testing of individual components and entire systems and facilities
- P-HIL tests using real-time simulation and multi-domain-co-simulation
- Simulation of smart grid scenarios



AIT SmartEST Laboratory

Smart Meter test rig, AIT SmartEST Laboratory
All photos: Nick Waldhör/Projektfabrik

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Barbara Schmidt
Secretary General of Österreichs Energie
Photo: Österreichs Energie/Regina Hügli

ENERGY SYSTEMS & NETWORKS

Barbara Schmidt, Secretary General of Österreichs Energie

Electricity is the energy source of the future – how will we be able to cover our energy demands in Austria over the long term (i.e. beyond 2030 and 2050)?

We know what our development policy looks like until 2030 as a result of the integrated Climate and Energy Strategy adopted on 28 May 2018. If we manage to cover the annual average domestic electricity demands by using 100 % electricity from renewable sources by then, we will have increased electricity production from non-fossil resources by around 30 billion kilowatt hours as compared with today, based on the specifications in the integrated Climate and Energy Strategy. Electricity will then be covering a much larger part of our energy demands far more efficiently than today. Yet we still need much more extensive efficiency measures if we are potentially going to be able to cover our entire energy demand with renewable electricity by 2050 or beyond. This will require major technological and social changes, for example in user behaviour. So we shouldn't confuse objectives with forecasts; instead we need to work harder on implementing the individual stages in our goals.

What will smart technologies, especially "intelligent" networks do for the energy system?

It's impossible to say today how the networks of the future will work, because many of the technologies and systems are only in the research stage right now. Yet there will certainly be highly automated, high performance and highly complex units based on smart systems that are capable of learning.

What role does sector coupling play, i.e. connecting electricity, heat and cooling supplies, industry and mobility into one integrated system?

Sector coupling and flexibility are the major challenges in terms of secure electricity supplies for the future. With the phase-out of fossil energy sources the power system loses much of its existing controllability. This must be regained by ensuring once again that sectors are integrated that have been separated until now. In the future, each potential energy source must make its contribution to the overall system. Industry will play a significant role here in particular, on the one hand as a consumer and on the other as a counterbalancing factor.

INDUSTRIAL ENERGY SYSTEMS

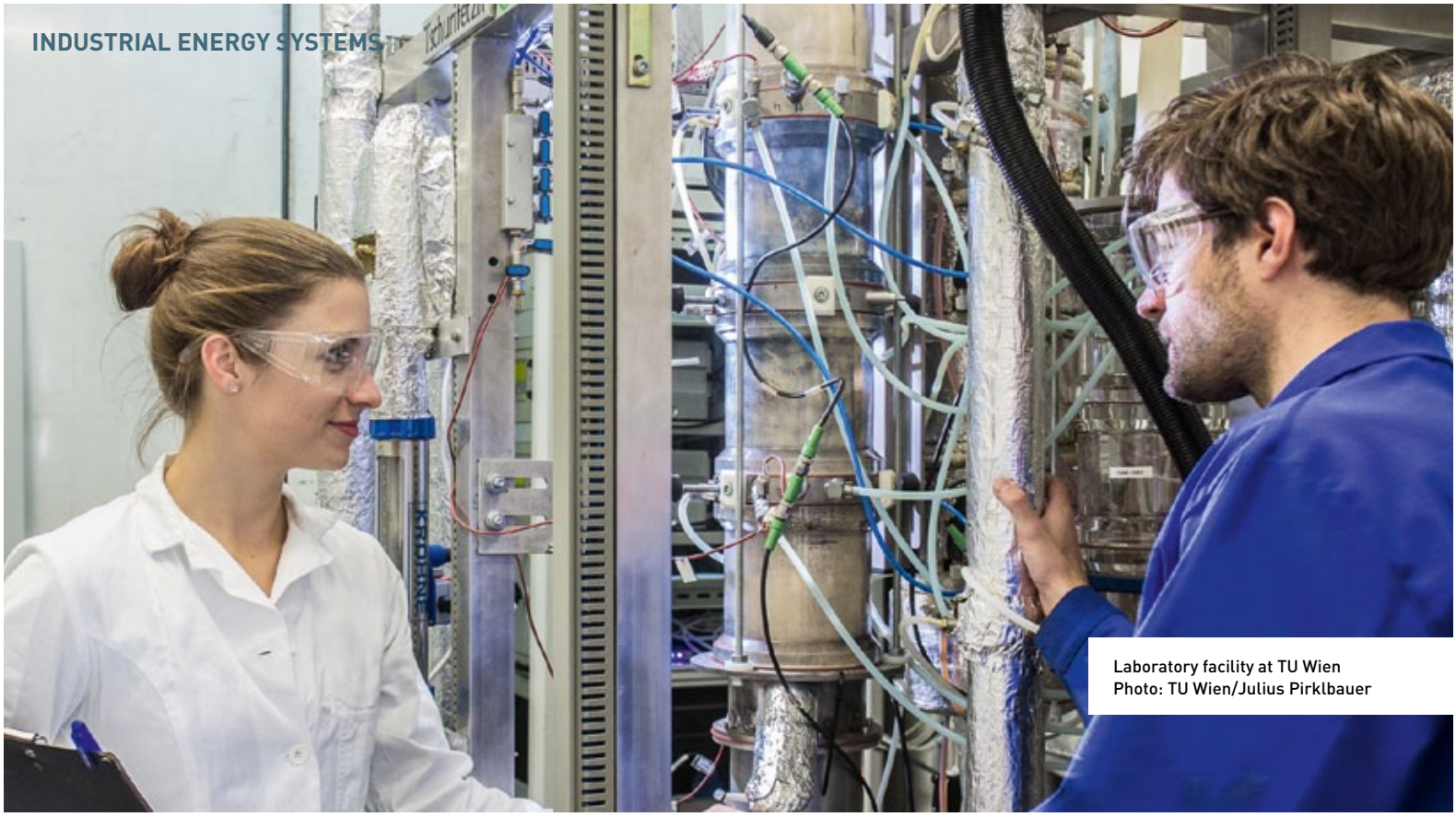
Austrian industry is an important economic factor with high productivity. It plays an important role in ensuring growth and securing jobs. Industrial production is also an energy-intensive sector. Final energy consumption in Austrian industry accounts for around 30% of total energy consumption in Austria. Energy-intensive sectors of industry include iron and steel production, chemicals and petrochemicals, the stone, earth and glass industries, and the paper and printing industries.

For many years Austrian companies have been cooperating with the research sector to develop new technologies and processes aimed at increasing energy and resource efficiency in industrial production. The efficient use of energy in industrial production processes helps to reduce costs and achieve competitive advantages. In some fields of industry, Austrian companies have managed to play a pioneering role by developing forward-looking solutions.

Research and technology development focuses on the production processes, where process optimisation can lead to increased energy efficiency for each unit produced.

One pioneering area of research is the cascading use of energy and raw materials in industrial production. Examples of this include the use of secondary raw materials and secondary fuels, energy storage and its reuse, and the use of waste heat for internal purposes and across multiple operations.

In many industrial processes the potential for energy efficiency has already largely been exhausted, and in some cases the thermodynamic limits have been reached. Further reductions in consumption can often only be achieved through breakthrough technologies, i.e. entirely new production processes. This is why intensive research is being carried out into these innovative technologies. Innovation is the central focus in order to be able to gain and extend a technological advantage and maintain industry competitiveness in the future.



Laboratory facility at TU Wien
Photo: TU Wien/Julius Pirklbauer

Fluidised bed layer of the absorber
Photo: TU Wien/Julius Pirklbauer

ViennaGreenCO_2

NEW SEPARATION PROCESS TO CAPTURE CO_2 FROM EXHAUST GASES

A cost-effective technology for separating CO_2 from exhaust gases is being tested in Vienna.

In an energy research flagship project researchers from the TU Wien (Vienna University of Technology) and the University of Natural Resources and Life Sciences are developing a cost-effective and energy-efficient procedure aimed at filtering, concentrating and utilising CO_2 from the exhaust gases from power stations or industrial processes in collaboration with Shell. The new technology is being tested under real operating conditions in a pilot plant at the Wien Energie biomass power plant in Simmering (Vienna).

Saving energy and money

Until now the process for separating CO_2 from exhaust gases has been based on a highly energy-intensive process using aqueous amine solutions. The energy consumption is around 4 GJ per tonne of CO_2 for a separation efficiency rate of 90%. The procedure is estimated to cost up to EUR 100 per tonne of CO_2. Energy consumption could be lowered by up to 40% using the fluid bed procedure developed at the TU Wien. The newly developed process also works with amines, although these are not in aqueous form. A fluid bed procedure is used whereby solid particles are put into contact with the flue gas. The tests at the TU Wien were very successful, establishing that the basic principle works. More than 90% of the carbon dioxide was separated in the test facility. Fluidised-bed systems can be built more compactly and thus potentially at lower costs than conventional separation facilities. The researchers therefore expect that the separation costs per tonne of CO_2 will be up to 25% lower than those for the conventional method.

Pilot plant in Simmering (Vienna)

The test facility at the TU Wien can separate roughly 50 kg of CO_2 per day. The pilot plant in Simmering should capture around one tonne of CO_2 per day. Long-term trials are intended to establish how cost-effective the concept is. In addition to separating CO_2 from industrial processes, other pioneering solutions could include combining the newly developed technology with biomass plants (BECCS technology) or providing CO_2 for further use in synthesis processes (e.g. for energy storage using surplus power). As well as further development of the CO_2 separation technology, trials are also taking place in the ViennaGreenCO_2 project aimed at examining whether the CO_2 that has been separated out can be used as a fertiliser in the neighbouring greenhouses belonging to the LGV Frischgemüse cooperative.

Pilot plant
Photo: Shell

Gas analysis area at the pilot plant
Photo: Shell

CONSORTIUM
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BaMa

BALANCED MANUFACTURING

Innovative software solutions for energy and resource optimisation in industrial processes.

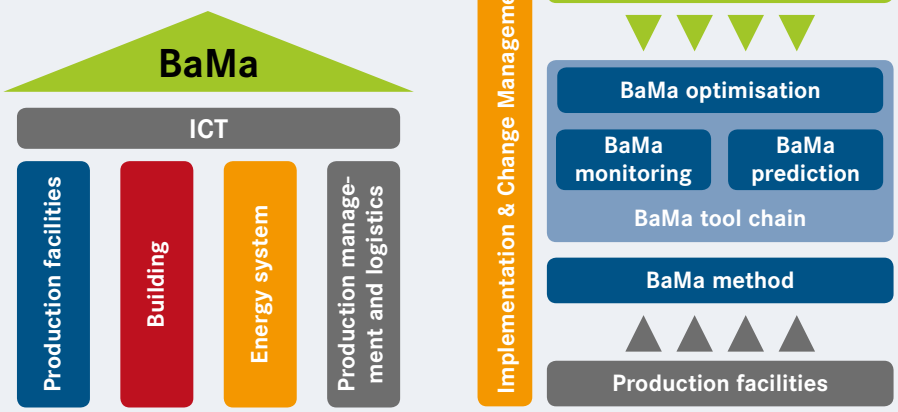

Chart: TU Wien – Institute of Production Engineering and Laser Technology

A simulation-based methodology has been developed for planning and controlling energy demand in industrial production as part of the BaMa project led by the Institute for Production Engineering and Laser Technology (IFT) at the TU Wien (Vienna University of Technology).

Application-oriented software tools make it possible to optimise the energy used in production processes, taking the economic success factors of time, cost and quality into account. 18 partners from research and industry collaborated in the lead project of energy research.

The BaMa System

The Balanced Manufacturing System enables manufacturers to analyse and forecast energy demand in production processes and to reduce it by means of adaptive operating strategies. All the relevant modules of a production unit (production, buildings, energy, logistics) are modelled, taking management aspects into account.

The method involves a modular approach. The production facility is divided into individual segments with defined system boundaries (known as "cubes") that are identified by clearly specified interfaces. This makes it possible to identify subsystems that have a particularly high impact on levels of energy consumption. Broad assessments of energy consumption at the product level are derived from energy and resource flow analyses, and a product footprint (time, costs, energy, CO_2 emissions, etc.) is also presented.

Demonstration

The methods and software tools developed are being tested in production facilities owned by MPREIS and Infineon Technologies Austria, two of the project partners. Energy savings in the range of 10 to 20% are expected for both companies.

Refrigeration machine
Photo: Infineon Technologies Austria

The software tool chain comprises the following core modules:

- Monitoring function: information is gathered, processed and displayed regarding resource consumption
- Forecasting function: starting from the product footprint and the production plan, the factory's energy consumption is forecasted
- Optimising function: on the basis of data from and numerical simulation models of the fabrication subsystems, the operational management for the production facility are adapted to approximate the targets (reducing energy consumption, processing time and cost and improving product quality)

bama.ift.tuwien.ac.at/en/

MPREIS manufacturing plant
Photo: Thomas Jantscher

CONSORTIUM
TU Wien – Institute for Production Engineering and Laser Technology (project management) / Institute for Energy Systems and Thermodynamics / Institute of Computer Aided Automation / Institute of Interdisciplinary Construction Process Management / Institute of Management Science, researchTUb GmbH, AutomationX GmbH, Siemens AG Austria, ATP sustain GmbH, Daubner Consulting GmbH, dwh GmbH – Simulation Services & Technical Solutions, Wien Energie GmbH, GW St. Pölten Integrative GmbH, Berndorf Band GmbH, Infineon Technologies Austria AG, Franz Haas Waffel- und Keksanlagen-Industrie GmbH, Metall- und Kunststoffwaren Erzeugungs GmbH, MPREIS Warenvertriebs GmbH

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Georg Kapsch
President of the Federation of Austrian Industries
Photo: Federation of Austrian Industries/Kurt Prinz

INDUSTRIAL ENERGY SYSTEMS

Georg Kapsch, President of the Federation of Austrian Industries

Austrian industry has spent years investing in decarbonisation of manufacturing processes and the development of energy-efficient products. Is the industrial sector a driver of innovation with respect to climate protection?

Industry is part of the solution to the task of the century, i.e. creating an energy system that is globally compatible with the climate. All sectors of the national economy are required to play their part in enabling this large-scale decarbonisation of our civilisation, since this is ultimately required in order to effectively end climate change. This huge task requires new technical as well as organisational solutions. It is industry, and it will be even more so in the future, that will develop and provide these solutions with its innovations in all areas, including in particular in housing and mobility as well as in its own industrial production processes.

What opportunities does the digital transformation of the energy sector create for the energy-intensive industry – in particular through "Energy 4.0"?

The new digital energy world offers not only general opportunities in the sense of a climate-friendly energy future, but also concrete opportunities for the energy-intensive industry. On the one hand, it is the opportunity to link and control countless local energy producers that provides the prospect of decarbonisation to the energy-intensive industry overall while ensuring that supplies remain secure. On the other hand, it is precisely these digital options that allow energy-intensive companies to become part of an interconnected and integrated energy system themselves by contributing towards stabilisation of the power grids via smart control of their energy procurement in the event of volatile renewable energy provision.

What do research and innovation mean in terms of the success of Austrian companies on the international markets?

Research, development and innovation play an essential role in maintaining and increasing competitiveness against economic powers such as the US and China. Differentiation on the world market is only possible through innovative and high-quality products and services. R&D-intensive companies grow more rapidly, create more jobs and are more resilient in times of crises. In addition to securing up-and-coming innovation talent, effective funding instruments – including in particular the research premium or direct R&D product funding – are therefore essential along the entire innovation chain up until market launch and must feature adequate planning certainty in order to continue strengthening our successful companies in relation to the international competition.

FORWÄRTS 2.0

DRY GRANULATION OF BLAST-FURNACE SLAG

A new granulation process including heat recovery is utilizing the energetic potential of the slag.

For each tonne of pig-iron produced in a blast furnace, the process results in roughly 300 kg of hot, molten slag as a by-product, the heat content of which is no longer used during subsequent processing. Slow cooling in the air forms crystalline blast-furnace slag, while rapid cooling in water results in glassy slag sand, a raw material that is used primarily in the cement industry. The standard process for obtaining slag sand is wet granulation. The energy potential of the blast-furnace slag amounting to around 1.8 GJ per tonne of slag is wasted in this process.

An innovative concept for dry granulation of blast-furnace slag has been developed by Primetals Technologies Austria GmbH, and is currently being tested in a pilot plant facility directly linked to the blast furnace at voestalpine Stahl GmbH in Linz. This innovative process makes it possible to recover the heat transferred to the air and use it in further processes.

Top: Granulation process
Bottom: Pilot facility for dry-slag granulation at the furnace of voestalpine Stahl GmbH
Photos: Primetals Technologies Austria GmbH

Flow of slag to the granulator
Photo: Primetals Technologies Austria GmbH

Fireproof refractory lining for the air discharge duct
Photo: voestalpine Stahl GmbH

Innovative procedure

The facility is based on the rotating-cup principle. Molten slag is poured into a rapidly rotating cup. The forces acting on the slag atomise it and eject it radially against a water-cooled wall. During this process, which takes milliseconds, the particles are cooled in air and the hot exhaust air is dissipated. The granulation process is currently being tested at the plant. At this stage of the project the target is to produce high-grade slag sand. If the current project phase is completed successfully, with the engineering approach adopted and the slag sand's quality both confirmed, an overall strategy on an industrial scale, including heat recovery, can be worked out.

Saving energy and water

With the newly developed dry slag granulation process water consumption can be cut by up to 95%. In addition, no energy is needed to dry the slag sand. With wet granulation subsequent drying consumes about 130 kWh of energy per tonne. Around the world about 400 million tonnes of blast-furnace slag are produced each year, at temperatures up to 1,500°C. Thus, starting from current practice, roughly 280 PJ of thermal energy could be saved per year. With the option of transferring the recovered heat into electrical energy, this is equivalent to a possible reduction in global CO_2 emissions of around 17 million tonnes per year.

Granulator at the pilot plant
Photo: Primetals Technologies Austria GmbH

CONSORTIUM
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Solar system at Fleischwaren Berger,
Sieghartskirchen, Lower Austria
Photo: Fleischwaren Berger GmbH & Co KG

InSun

SOLAR COLLECTORS FOR PROCESS HEAT IN INDUSTRY

A company from Lower Austria showcases
a process for utilising process heat from a large solar system.

Energy storage unit
Photo: Fleischwaren Berger GmbH & Co KG

Fleischwaren Berger turns fresh meat into ham and sausages at its location in Sieghartskirchen, in Lower Austria. Every day around 100 tonnes of meat products are produced. The company installed a solar thermal system in 2014 with 1,067 m² of collector area and a 60 m³ energy storage tank. The system features Gluatmugl HT flat-plate collectors supplied by the Austrian manufacturer S.O.L.I.D.

The system was installed and evaluated as part of the EU project "InSun – Industrial Process Heat by Solar Collectors" (which has received funding from the EU's Seventh Research Framework Programme). Six partners from Austria, Italy, Spain and Germany collaborated with the objective of testing the quality and reliability of large solar thermal systems for use in industrial processes. The system installed at Fleischwaren Berger has been providing detailed operating data since June 2013; AEE INTEC monitored its performance from 2013 to 2015.

Solar heat in the production process

The solar heat is supplied at two points in the production process. One involves use in the production of process water. Process water at 40 to 60°C for cleaning purposes is required at a rate of 7 m³/h. The water is required for rinsing the sausage products, for the drying processes as well as for cleaning the crates and machinery. The other use involves hot water at a higher temperature (> 60°C) for preheating the additional water required for two steam boilers.

Results of the monitoring

In the period under consideration the system performed reliably and delivered satisfactory solar yields. The total yield came to 408 kWh/m² per year, covering around 3.5% of requirements in line with forecasts. Roughly 83% (314 MWh) of the total solar yield were used to heat process water in the period under consideration. The system supplies 11% of annual energy consumption for providing process water; this share rose to around 60% in summer. 64 MWh were used to preheat additional water for boilers. This represents around 0.7% of total energy demand for steam generation. A parabolic trough collector array with an area of 122 m² and a maximum capacity of 60 kW was added in 2015 to act as a temperature booster for the flat-plate collectors in order to increase this proportion.

Using heat from the sun enables Fleischwaren Berger to save up to 46,500 litres of fuel oil each year, thereby cutting CO_2 emissions by 150 tonnes per year. This represents a saving of 4 to 5% on the company's total fuel oil consumption.

CONSORTIUM
Fleischwaren Berger GmbH & Co KG (project management), S.O.L.I.D. Gesellschaft für Solarinstallation und Design mbH, AEE INTEC, Stuttgart Technology University of Applied Sciences – Hochschule für Technik, EURAC research, Laterizi Gambettola SRL / Soltigua, SOLERA GmbH

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CONVERSION TECHNOLOGIES

Renewable energy sources form the basis for sustainable energy supplies that are fit for the future. European climate targets provide for a 40% reduction in greenhouse emissions by 2030 compared with 1990. The plan is also to increase the percentage of renewable energies as a share of energy supplies by at least 27%. According to a proposal of the European Commission, Austria is required to reduce greenhouse gas emissions from sources not covered by emissions trading by 36% compared with 2005.

Decarbonisation is only possible from today's point of view through a rapid migration to technologies for the use of renewable energy sources. Research and development strive for a consistent further development and optimisation of conversion technologies. They examine the entire value chain from production to operation through to recycling.

New, efficient and cost-effective technologies are developed continuously in the areas of bioenergy, fuel cells, geothermal energy, photovoltaics, solar thermal energy, heat pumps and refrigeration systems, hydropower and wind power. Through further consistent technological development, the costs for the production and use of these energy sources are to be continuously reduced, thus helping to increase the share of renewable energies in total energy consumption.

All available individual technologies and energy efficient measures need to be smart and connected with the application-adapted systems in future in order to ensure sustainable, environmentally-friendly energy provision.

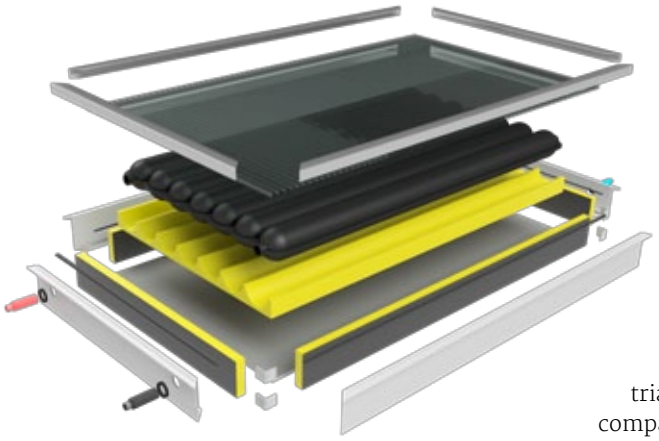
Key elements for this are sector coupling concepts. The goal is to create solutions for an integrated system based on renewable resources by merging different technologies in hybrid systems in buildings, industry, the grid, as well as in traffic and mobility systems.

New approaches to integrated system solutions also open up new target markets for export-oriented Austrian companies and industries, and play a role in increasing their competitiveness.

SolPol

POLYMER MATERIALS FOR SOLAR TECHNOLOGIES

Sunlumo solar system
Photo: Sunlumo Technology GmbH



GREENoneTEC solar collector
Photo: GREENoneTEC Solarindustrie GmbH

SolPol is the world's largest research initiative dedicated to polymer-based innovations for solar technology.

The major research project combines the expertise of leading Austrian polymer and solar research institutes with the expertise of Austrian plastics and solar technology companies. A total of 10 scientific and 19 company partners have been working on the development of new plastics-based thermal collector systems and PV modules since 2010 under the leadership of the Johannes Kepler University (JKU) Linz – Institute of Polymeric Materials and Testing.

The objective is to reduce the manufacturing costs of solar thermal collectors and PV modules while retaining the same or achieving a higher level of performance. In the area of PV modules the cost reduction is achieved using new encapsulation materials with improved processability. In the case of solar thermal collectors these are being fully re-designed as all-plastic constructions. The new developments seek to boost and expand the position of Austrian solar and plastics companies in the solar technology markets that are growing worldwide.
The technical solar solutions designed as all-plastic constructions or with a high proportion of plastic feature the following characteristics:

> Extensive prefabrication and optimised integration of functions
> Reduction in weight and straightforward installation (plug & function)
> Reliability and long service life
> More attractive design
> Reduced cost/price and improved cost/benefit ratio

Pioneering new products

Some of the SolPol developments are already being used successfully on the market. These include the high-temperature plastic sealing strips from AGRU Kunststofftechnik GmbH which are not used solely for high-volume thermal solar energy storage units combined with local and district heating networks, but also in geothermal energy. High-performance plastics from Borealis AG are used in plastic collector systems as well as in vehicle engineering and plant construction. Optimised plastic laminates and composite

SolPol-1 JKU Linz
Photo: Climate and Energy Fund/Ringhofer

SolPol collector
on the solar testbed
Photo: AEE INTEC

films from Lenzing Plastics GmbH & Co KG are suitable for PV and solar thermal applications as well as for heat insulation systems, facade elements and construction foils.

Improved life-cycle assessment

Polymer-based collector systems feature much better life-cycle assessments as compared with conventional collector systems (LCA/EcoFootPrint values). An examination of different scenarios has shown that, compared with the status quo, around 70–84% of CO_2 emissions in the low-temperature heat sector in Austria can be spared by 2050.

The energy-related payback periods for photovoltaics are now around 1.5–2 years with the encapsulation materials and module production technologies developed. A guaranteed service lifetime of 20 years means that savings of at least 80% can be derived with CO_2 emissions as compared with fossil power plants.

One World Solar Collector

The One World Solar Collector from Sunlumo Technology GmbH produced entirely from plastic is an outstanding development within the scope of the project. The system is used for process water heating and as backup heating. It is very easy to install and can be connected to storage systems all over the world.

Manufacturing costs halved, 50% weight reductions, and a 60% improvement in carbon footprint as compared with collectors made from metal and glass are the benefits of this innovative product. The energy demands for a fully polymer One World Solar System with a four square metre collector surface and 150 litres of heat storage are 5,000 MJ with a CO_2 footprint of 250 kg.

www.solpol.at

CONSORTIUM
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Ulrike Rabmer-Koller
Vice President of the Austrian Economic Chambers
Photo: WKO

CONVERSION TECHNOLOGIES

OPPORTUNITIES FOR AUSTRIAN COMPANIES

Ulrike Rabmer-Koller, Vice President of the Austrian Economic Chambers (WKO)

Average growth of 6.9% is forecast globally for energy and environmental technology*. What are the growth opportunities like for Austrian companies?

The growth opportunities are very good – we have some competitive businesses that are on the front line in many areas. Austrian environmental technology is among the most innovative in the world and enjoys an excellent reputation internationally. The study "Austrian environmental technology – engine for growth, employment and export", created in 2016 and commissioned in part by the Austrian Economic Chambers (WKO) contains information on growth. According to the study, turnover in the industry rose by 18% between 2011 and 2015, with employment rising by around 9%. Since surveys of the environmental technology industry started in Austria in 1993, the sector has recorded a 3-fold increase in the number of jobs and a 6.5-fold increase in turnover. And there's room for even more improvement if the Paris Climate Agreement is given a new lease of life globally.

In which segments of energy innovation are Austrian companies particularly strong? Where will new jobs be created?

There are a broad range of issues involved, and the study also reveals this: when asked whether the company has launched an innovation on the market over the last three years that has had a positive impact on the environment, almost two-thirds stated that their R&D activities had been focused on developing products or services aimed at increasing energy efficiency. 51% were working on processes for replacing fossil energy sources with renewables.

What role do research and innovation play in growth and job developments in energy and environmental technology companies?

They play a very important role – because standing still actually means falling behind. Advances need to be championed through innovation – this is why we need an ambitious research and technology policy. Because good ideas and innovation in the form of operating R&D form the basis for successful business. The propensity for innovation has traditionally been high in environmental technology, and this has also been supported by a welcome increase in public energy research over the last few years.

* Source: GreenTech made in Germany 2018, published by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), text: Roland Berger GmbH

At Wienerberger, the heat pump technology is used for drying bricks. Photos: Zinner/Wienerberger AG

DryPump

COMPRESSION HEAT PUMPS FOR INDUSTRIAL DRYING PROCESSES

Illustration of innovative technology for drying processes in Austrian manufacturing companies.

Photo: Zinner/Wienerberger AG

The compression heat pump is an established technology for the dehumidification of air flows in air conditioning technology and the removal of building moisture. In the DryPump project, the AIT Austrian Institute of Technology investigated whether this innovative technology is also suitable for use in industrial drying processes. Dewatering and drying are among the most energy-intensive industrial processes, accounting for up to 25% of total energy consumption in industry around the world. Roughly 85% of all drying processes involve fossil-fuelled convective driers. In 99% of these systems the water vapour produced in drying is simply expelled with the exhaust air and no use is made of its energy content.

Energy efficiency and CO_2 reduction

This new technology is used to recover the energy content of the water vapour from the exhaust air and feed it back into the drying process. Industrial drying requires very high temperatures of up to 170 °C. The waste heat is vaporised with a refrigerant in compression heat pumps and heated to a higher temperature through compression.

Technically feasible approaches have been developed and assessed for cost-effectiveness in selected processes in cooperation with project partners Wienerberger, AGRANA and Bitzer Kühlmaschinen Bau GmbH. Energy-intensive drying processes are particularly common in the paper industry, but also occur in the timber, sugar, paint, textile and brick industries. The researchers expect that in the mid term the new technology will enable energy savings of up to 80% and CO_2 emission savings of up to 68%. The results will provide a basis for follow-up demonstration projects.

Demonstration in EU project DryFiciency

Industrial heat pumps are the focus of the DryFiciency project funded by the EU programme Horizon 2020 (EC Grant Agreement No. 723576). The innovative heat pump technology for industrial drying is being demonstrated as part of this project among Austrian industrial enterprises.

In AGRANA's sugar and starch production the heat-pump system is incorporated into the processes for producing and drying starch from potatoes, wheat and maize. This is intended to provide around 25% of the heat recovery potential on site.

The heat pump technology is used for drying bricks at Wienerberger.

www.dryficiency.eu

CONSORTIUM
AIT Austrian Institute of Technology GmbH (project management), Wienerberger AG, AGRANA Beteiligungs-AG, Bitzer Kühlmaschinen Bau GmbH, TU Wien – Institute for Energy Systems and Thermodynamics, Institut für Ziegelforschung Essen e.V., AMT Kältetechnik GmbH

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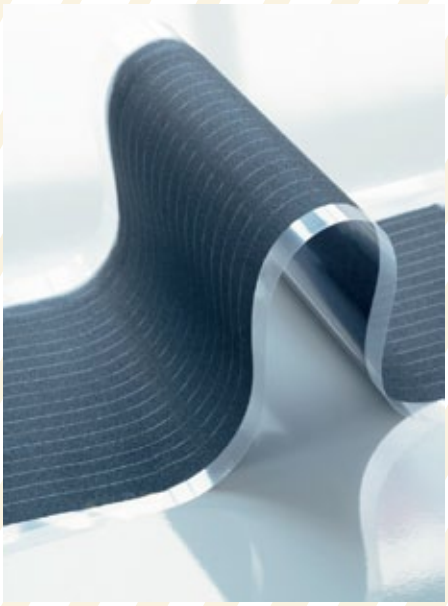
print.PV

NEW PRODUCTION PROCEDURE FOR FLEXIBLE PV FILMS

Flexible PV films
Photos: crystalsol GmbH, Helmut Mitter, www.helmut-mitter.com

Cost and resource savings through next-generation technology.



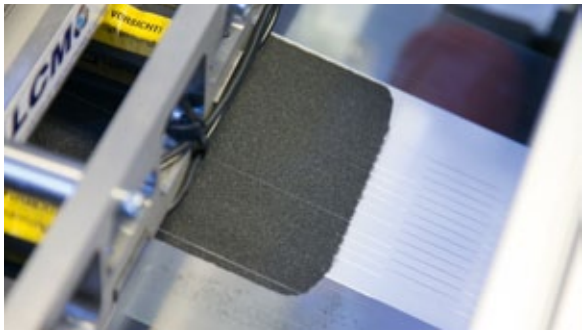
The virtually unlimited availability of free solar power makes photovoltaic technology one of the most attractive forms of renewable energy production. The rapid growth in the market for PV modules over the last few years has resulted in a huge drop in prices and a marked rise in production quantities (100 GW in 2017). The current situation is characterised by competition between existing technologies (crystalline silicon vs. emerging technologies) and global production locations (Europe and United States vs. Asia).

With "print.PV" the two Austrian companies crystalsol GmbH and Forster Werbetechnik GmbH worked with partners in science to develop next-generation technology aimed at producing flexible PV films. The concept is based on employing low-cost materials and ultra-efficient manufacturing technologies from the printing industry. The medium-term aim is to be able to produce solar modules at a globally competitive price of 0.3 Euro/Wp in Austria.

Roll-to-roll printing process

The new technology uses the patented PV film produced by crystalsol. It has attractive product features, particularly in terms of building and equipment integration. These include flexibility, low weight and easy assembly of the photovoltaic sheets. Dramatic savings can be achieved in the cost of fabricating the film using fully integrated, ultra-productive roll-to-roll printing technology such as flexographic printing.

Test series print.PV at crystalsol
Photos: crystalsol GmbH, Helmut Mitter, www.helmut-mitter.com



The printing process has been adapted accordingly:

> Replacing different process steps in roll-to-roll printing by new innovative processes
> Reduction in the amount of absorber materials in use
> Development of a contacting process with no vacuum which plays a significant role in reducing system and production costs
> Reducing quality fluctuations in production through an innovative laser process

In the course of the project they demonstrated

> how to achieve 40 m/min band speed when manufacturing solar modules
> how to eliminate precious metals such as silver entirely

The new innovative materials and processes were developed in realistic environments from the first proof-of-concept to validation. Test runs under real-life conditions were successfully completed on printing presses at Forster Werbetechnik GmbH in Waidhofen an der Ybbs (Lower Austria).

CONSORTIUM
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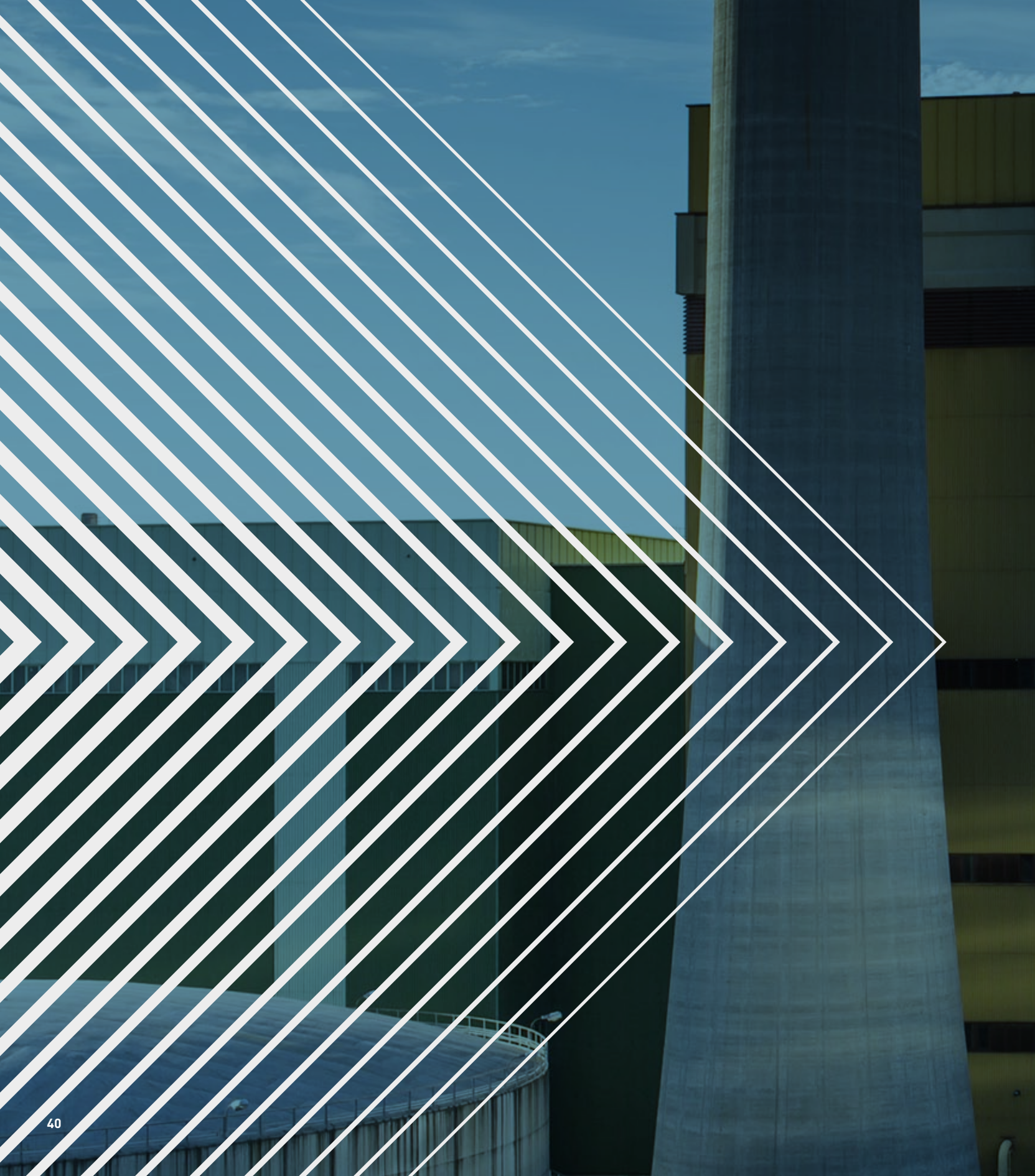

STORAGE TECHNOLOGIES

Energy storage systems for electricity and heat are becoming key components in the energy system as a result of the increasing amounts of renewable energies in the energy supply. These storage technologies enable production and consumption to be uncoupled in terms of time, and clearly help to improve the use and system compatibility of renewable fluctuating energy sources.

Power requirements increasingly need to be covered by renewable energies (hydropower, solar, wind and biomass) in order to achieve a low CO_2 economy. The growing amounts of solar and wind power also have to be saved for periods with low wind and for night-time.

When the electricity is converted before being stored, e.g. into hydrogen or other chemical energy sources then, in addition to re-generation, the energy can also be used in other energy sectors. Power-to-Heat, Power-to-Gas and Power-to-Chemicals technologies form the basis for coupling the various sectors to form one integrated energy system.

Heat and refrigeration storage systems will also have an important role to play in the energy system of the future. It is expected that heat requirements will continue to constitute a high proportion of overall final energy needs. Storing heat is considerably more cost-effective than storing electricity. Heat and refrigeration storage units are already being used in many areas today – from the building sector to heat supply plants connected to the grid through to industrial applications. The objectives here are to improve energy efficiency, the cost-effectiveness and increase the proportion of renewable heat.

The development of innovative technologies and concepts for storing energy is a pioneering field of research in Austria. The focus in future must be on selecting and coupling the different systems and solutions to form one integrated overall system.

AVERAGE FIGURES FOR THE HEAT STORAGE FACILITY:
(evaluation of operating data between 1 January 2014 and 31 December 2017)

Amount of water stored / delivered:
Loading 944,736 t / 1,022,376 m³
Discharge 934,983 t / 1,010,237 m³

Operating hours:
Loading 2,015 hours
Discharge 1,909 hours

Amount of heat stored / delivered:
Loading 90,104 MWh
Discharge 89,072 MWh

Maximum loading and discharge performance:
Loading 110 MW
Discharge 147 MW

Content of storage unit:
Average value 370 MWh
Maximum 981 MWh

Total CO_2 emissions saved:
53,810 t

High pressure heat storage facility at Simmering power plant
Photo: Wien Energie/Ian Ehm

ProWäSpe

HIGH PRESSURE HEAT STORAGE FACILITY IN THE VIENNA DISTRICT HEATING NETWORK

A reduction in energy demands and CO_2 savings can be seen in the operation of Wien Energie's large heat storage facility.

High pressure heat storage facility at Simmering power plant
Photo: Wien Energie/Ian Ehm

More than 380,000 households in Vienna and more than 6,800 major consumers are supplied with heat and hot water via the Vienna district heating network. In 2013 the world's first high-pressure, high-temperature storage facility started operation in Vienna Simmering. Integration of the new storage facility into the Vienna district heating system has made it possible to uncouple energy production and consumption from each other. When demand for heat is low, hot inflow water is pumped from various production facilities, such as a plant that runs on wood chips (Wald-Biomassekraftwerk Wien), the CHP plant in Simmering and primarily from waste-processing plants, into the storage facility and gets stored for peaks in demand.

Optimising operation through scientific support

Scientific support for planning and constructing the innovative facility was provided by the Institute for Energy Systems and Thermodynamics at the TU Wien (Vienna University of Technology) as part of the research project "ProWäSpe", in collaboration with Wien Energie. Dynamic simulation calculations were used to identify potential improvements in the overall process, which were then implemented directly at the planning, erection and commissioning stages. Based on simulations and analyses of operational states, it was possible to reduce the storage facility's own electrical energy requirements and accelerate loading and discharge times. Dynamic calculations have not only made the heat storage facility more reliable in operation, but have also saved fossil fuels and reduced CO_2 emissions.

Storing heat at high pressure

The core of the facility consists of two identical storage tanks with a total capacity of 11,000 m³. The heat storage facility uses thermally stratified storage: the tank is always full of water, hot at the top, cold down below. Due to the difference in density, a so-called separating layer is formed between the water layers. If demand for heat increases, hot water from the tank is pumped directly into the district heating network. The quantity of water withdrawn is replenished at the same time with cold water, thereby retaining the pressure conditions within the storage unit.

Energy efficient and environmentally friendly

The maximum storage capacity for the facility has settled down to around 980 MWh on average following an operating phase of more than four years. Loading time for both tanks amounts to an average of 2,000 hours per year, the same applies for discharge time. As surplus heat is stored from the power plants, the peak-load boilers are needed less often when demand for heat is high, meaning that less primary energy is consumed. This ensures that Vienna's district heating system will become even more energy-efficient and environmentally-friendly: around 54,000 tonnes of CO_2 emissions have been saved since the high-pressure heat storage facility came into service.

CONSORTIUM
Wien Energie GmbH (project management), Bilfinger Bohr- und Rohrtechnik GmbH, Bilfinger VAM Anlagentechnik GmbH, TU Wien – Institute for Energy Systems and Thermodynamics, Integral – Montage Anlagen- und Rohrleitungstechnik GmbH, ABB AG, Porr Bau GmbH, Pöyry Energy GmbH

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Wind2Hydrogen

PRODUCTION AND STORAGE OF RENEWABLE HYDROGEN

Wind2Hydrogen pilot facility at OMV site in Auersthal, Lower Austria
Photo: OMV

The supply of green hydrogen to the natural gas grid was tested for the first time in an OMV pilot facility.

Power-to-Gas is a pioneering cross-sectoral system solution for the energy system of the future. It is mainly operated to smooth fluctuating electricity production from renewable sources to produce hydrogen and renewable liquid or gaseous hydrocarbons (e.g. methane). The renewable hydrogen or methane can be used directly or transported via gas infrastructure, stored and subsequently used in various areas of application or can also be converted back into electricity if required. Key elements in the forthcoming system are flexible, efficient, cost-effective electrolysers.

The Wind2Hydrogen project, led by OMV and in cooperation with research and corporate partners, investigated the production of "green hydrogen" using a novel high-pressure electrolyser. The project also tested the feeding of hydrogen into the natural gas grid and the filling and possible use of hydrogen (H_2) in mobility.

The primary aim of the research work was to identify how well the gas infrastructure (transit and distribution grid) copes with hydrogen, and how much "green hydrogen" can be stored in the Austrian natural-gas grid.

Wind2Hydrogen pilot facility
Photo: OMV

Hydrogen filling station
Photo: OMV

Pioneering electrolytic process

The high-pressure PEM electrolyser developed by FRONIUS International GmbH was first of its kind, generating high-purity hydrogen at 163 bar; its modular design makes it perfect for ultra-dynamic operation, with no risk of shutdowns in connection with fluctuating levels of wind or PV-generated power. The high pressure is mainly needed for feeding into the high-pressure grid, or where such units are installed at a filling station.

Successful operation of the pilot facility

A pilot facility featuring 100 kilowatts was constructed at the OMV site in Auersthal (Lower Austria) in 2015. Future business cases (from the perspective of electricity and of the natural-gas grid operator) were simulated here in experiments. Hydrogen was supplied to one of OMV's natural gas pipes here between September 2015 to May 2017. It was the first pilot plant of this type and size anywhere in the world. Part of the hydrogen produced was compressed to 200 bar and bottled in high-pressure storage tanks for potential use in motor vehicles or industry.

Tests were carried out in the sister project HylyPure aimed at recovering the renewable hydrogen following transportation in the natural gas grid using membrane technology and pressure swing adsorption.

The pilot facility was running for a total of 40,400 operating hours with 12 electrolysis modules. During this period, 4,610 kg of hydrogen were produced and either successfully supplied to the natural gas grid or bottled.

Wind2Hydrogen allowed valuable experience to be gained over the entire hydrogen value chain – from planning through to operations. Legal, economic and ecological assessments were also carried out and various business models laid out in preparation for the actual roll-out. The knowledge gained will be used by the project partners involved in numerous follow-up projects as part of the Energy Model Region WIVA Power & Gas (Energie-Vorzeigeregion WIVA P&G) hydrogen initiative.

Wind2Hydrogen pilot facility
Photo: OMV

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Martin Hackl
Head of Solar Energy Business Unit, FRONIUS International GmbH
Photo: FRONIUS

STORAGE TECHNOLOGIES

Martin Hackl, Head of Solar Energy Business Unit, FRONIUS International GmbH

What role will energy storage play in the energy system of the future?

The amount of wind and sun supplied naturally is enough to ensure a 100% renewable energy system. The challenge now is to align supply with demand. When current energy consumption levels correspond with current energy production levels we can say the electricity supply is functioning. Since the situation is somewhat different in reality, we need a buffer to bridge this gap. The solution is to use interim energy storage – and this therefore represents a major pillar of the energy system of the future.

In your opinion, which storage technologies have the greatest potential?

The different requirements for storage options, such as from day to night or over the longer term, can be met with the right technologies. In the short term, battery storage units provide maximum flexibility when managed intelligently and allow several local producers to be integrated without needing to expand the network. For the long term, gas infrastructures provide large storage volumes which can be used as intermediate storage units for renewable energy in the form of hydrogen or methane. There are also great potentials for storage and therefore flexibility which can be exploited in the area of sector integration between electricity and heat.

FRONIUS is a pioneer in the production and development of green hydrogen. As such, the company makes an essential contribution to sector integration and seasonal energy storage. FRONIUS has been researching corresponding usage options for 15 years and can be considered a reliable partner in today's energy transition.

Are there export opportunities for innovative developments by Austrian companies?

Our main goal is 24 hours of sun. At FRONIUS we work daily to make this vision of the future a reality, where we cover global energy demands using 100% renewables. To this end, we focus on solutions aimed at producing, storing, distributing and consuming solar energy cost-effectively and smartly.

This results in products and services that we export today at ratios of more than 90%. Success in the technologically complex environment of energy storage requires a great deal of experience and expertise, as well as intensive networking with partners. We have been involved in collaborative projects at the national and international levels for years. These projects sought to expand our expertise even further while working together with network operators, partners in industry and both university and non-university research partners.

Underground Sun Conversion

PRODUCING AND STORING NATURAL GAS IN AN ENVIRONMENTALLY FRIENDLY WAY

RAG's plant in Pilsbach/Upper Austria
Photo: RAG Austria AG/Karin Lohberger Photography

The existing natural gas infrastructure is used to store renewable energy and to produce natural gas from hydrogen.

RAG's plant in Pilsbach/Upper Austria
Photo: RAG Austria AG

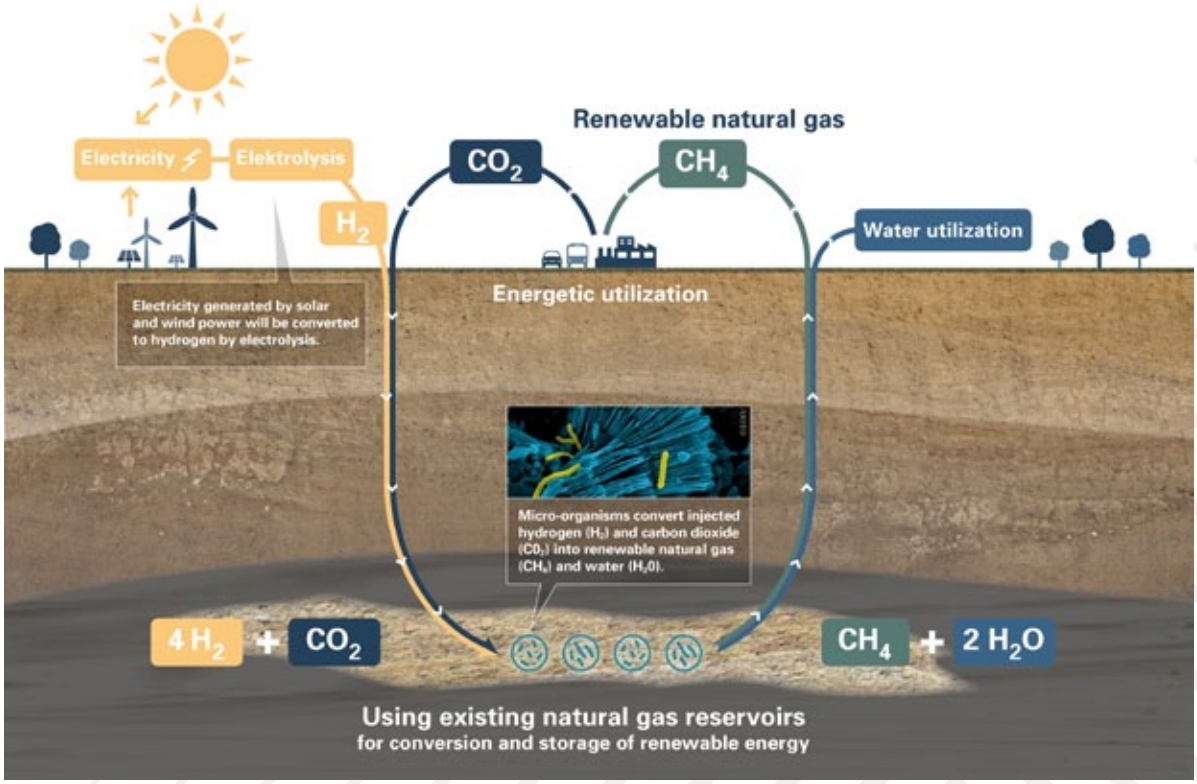
In the "Underground Sun Conversion" project which runs until 2020, an Austrian consortium headed by RAG Austria AG is investigating how to produce large quantities of renewable natural gas in a way that binds CO_2, and to store the gas in an environmentally-friendly manner in natural storage facilities to use it flexibly at any time.

Seasonal storage of wind and solar power

The research project builds on the energy research flagship project "Underground Sun Storage", which was concerned with storing wind and solar energy in natural gas storage facilities. The storage capacities in the gas network are enormous compared with the storage technologies currently available for electricity. By converting electrical energy into hydrogen, the existing natural gas infrastructure – consisting of pipelines and natural gas storage facilities – could be used as buffer storage for surplus green energy. The Underground Sun Storage project examined the hydrogen compatibility of underground gas storage facilities and, in addition to laboratory experiments and simulations, for the first time also implemented a field trial on an industrial scale at a former natural gas reservoir in Pilsbach in Upper Austria.

Renewable production of natural gas

The follow-up project "Underground Sun Conversion" is currently investigating a process (an industry first worldwide) that copies the way in which natural gas originates in nature. This should make it possible to produce natural gas in a gas storage facility directly by means of a mi-



Source: RAG Austria AG

RAG's plant in Pilsbach/Upper Austria
Photo: RAG Austria AG/Karin Lohberger Photography

crobiological process induced systematically. Here the existing pore storage space is treated as a natural reactor.

First, hydrogen is produced from solar or wind power and water above ground. Together with CO_2 (e.g. from biomass combustion) it is then pumped down to an existing gas storage facility more than 1,000 metres below ground.

In the preceding project, laboratory tests showed that the hydrogen/CO_2 mixture supplied to the storage space is converted to methane by micro-organisms in a fairly short time. Methanisation thus takes place naturally in underground rock formations, but it is accelerated by millions of years. At the same time a sustainable carbon cycle is established. The renewable natural gas produced in the depths can be stored right there, tapped into as the need arises and transported to consumers via the existing grids.

Laboratory tests, simulations and scientific field experiments – carried out in an existing RAG storage facility – are scheduled over the course of the project. The extent to which the findings obtained can be applied to many other storage spaces around the world will also be targeted by this project.

www.underground-sun-conversion.at/en

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Tes4seT

NEW THERMAL ENERGY STORAGE DEVICES FOR BUILDINGS, INDUSTRY AND TRANSPORT

Liebherr Air-Cycle-Air Conditioning Unit ICE 3
Photo: Liebherr Transportation Systems GmbH & CO KG

Sorption collector at the AEE INTEC laboratory
Photo: AEE INTEC

Partnership between research and industrial enterprises for the development of new storage technologies.

Innovative technologies to store thermal energy over the short and long term are essential for energy security and for making energy conversion, energy distribution and final consumption more efficient. In the Tes4seT energy research flagship project, pioneering technologies for a new generation of compact thermal energy storage devices were researched and concepts developed for integrating them in energy systems in buildings, industry and vehicle engineering.

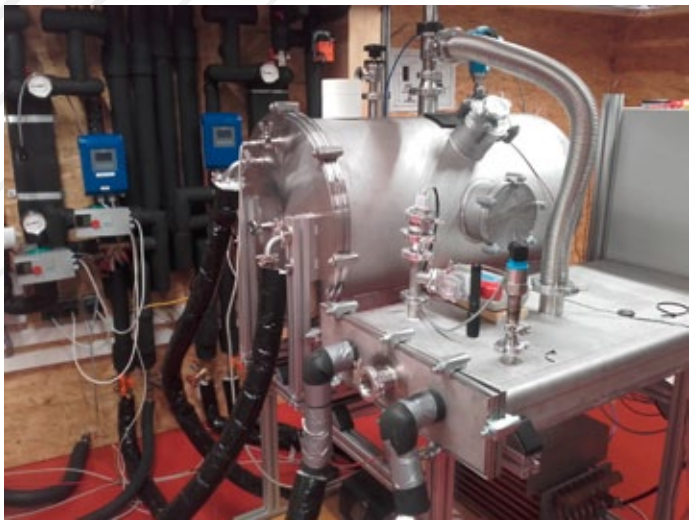
Led by AEE INTEC, the project brought together 19 research partners and industrial firms to lay the foundation for further industrial developments. They worked out new concepts and solutions in five development lines:

> Seasonal sorption storage for buildings
> Heat accumulators for temperature conditioning of electric batteries in electric and hybrid vehicles
> Storage systems for efficient energy systems in rail vehicles
> Heat recovery in industry using new thermochemical storage technologies
> New medium-temperature phase change material for thermal storage in industrial applications

Pioneering developments

The purpose of developing a seasonal storage system for buildings based on solid sorption is to store surplus heat from a solar thermal plant from summer until winter. A new sorption collector was developed as part of the Tes4set project. This allowed the efficiency of the storage system to be increased significantly for the sorption storage material Zeolith X13BF that was used. The system becomes more compact and at the same time material costs are reduced.

The use of thermal energy storage units to control the temperature of vehicle batteries was tested at a testing facility. Lithium-ion batteries can only be oper-



AEE INTEC test arrangement
Photo: AEE INTEC

DBAG ICE 3 close to Cologne's main railway station
Photo: Rolf Heinrich, Cologne, Creative Commons Attribution 3.0 Unported

ated efficiently within a narrow temperature range. They need to be cooled during a ride and during rapid charging, and pre-heated before the vehicle is started in winter. The tests revealed potential energy savings of 60% for the cooling during rapid charging as compared with conventional cooling systems.

Efficient energy systems in rail vehicles were also examined. Higher efficiency levels are feasible in cooling circuits with non-controllable compressors by using heat accumulators with phase change materials (PCMs) on the low temperature side (e.g. storage evaporators or small-scale storage units in the distribution system). Simulations of system behaviour were used to show that the start/stop cycles of the compressor can be extended threefold for convenience applications on a tram or underground train without exceeding inside temperature or moisture levels.

During the project, experiments were also carried out aimed at improving the efficiency of air cycle cooling systems (ACS) such as the ones used in high speed railway vehicles. The enthalpy of process air was reduced with this by using special materials, e.g. Zeolith or silicon-aluminium-phosphate (SAPO). The process air is dehumidified and cooled at the input point using additional storage components in order to achieve a higher cooling capacity in the system's low-pressure range. Initial results show that additional cooling of the sorbent could reduce specific air humidity by 10 g/kg, which could theoretically result in efficiency levels being improved by 20%.

www.tes4set.at

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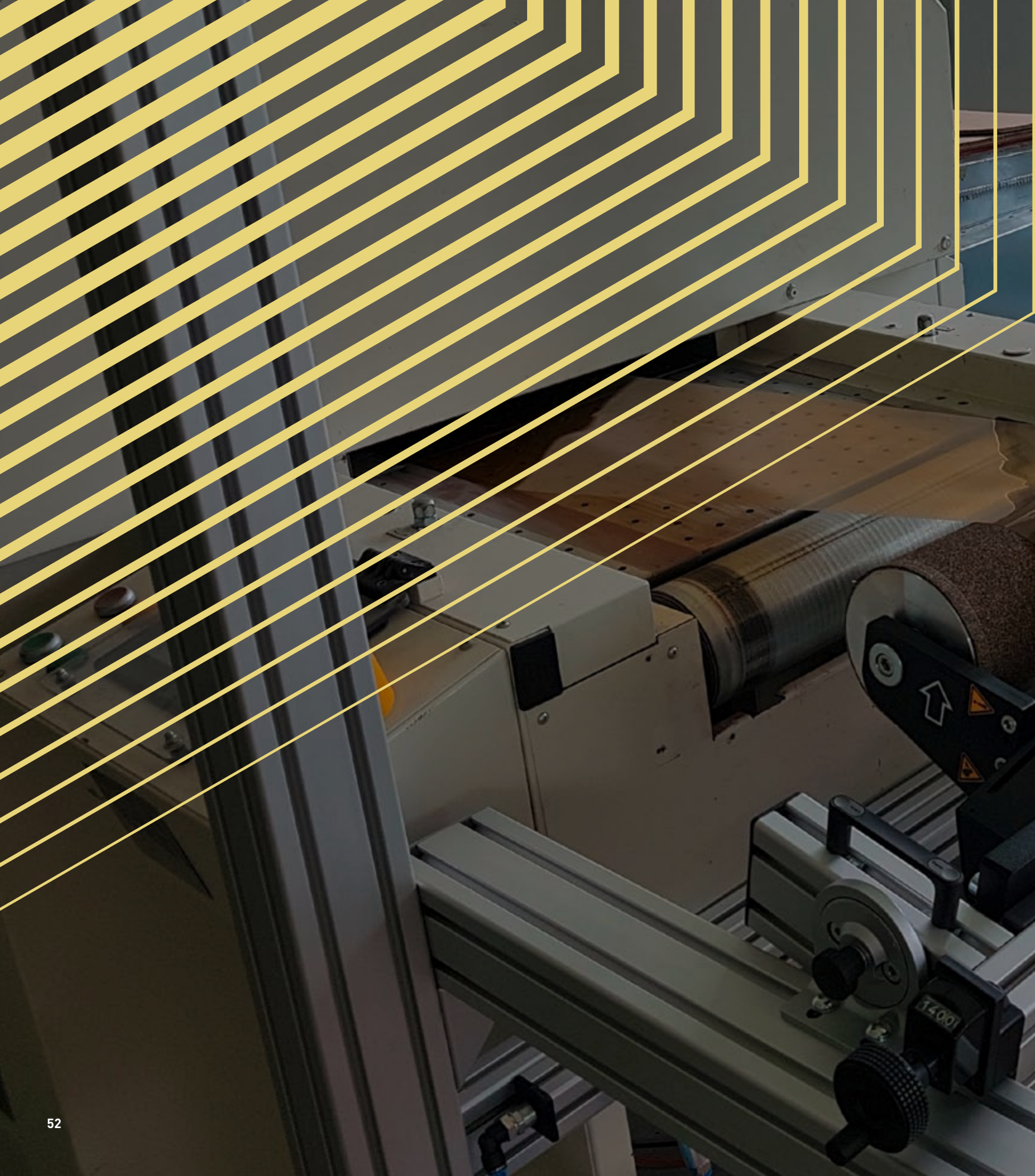

PRODUCTS AND SERVICES FOR ENERGY CONSUMERS

Aside from high-efficiency processes for converting, storing and distributing energy, the energy transition also calls for new services, products and business models. The aim is to create a smart energy system centred on the consumer in which citizens play an important role as active participants. Flexible local energy supply systems allow energy consumers to generate clean energy themselves, e.g. from small-scale PV systems, to supply networks, and adjust their energy consumption to reflect the signals from the energy market. Information and communication technologies (ICT) will play a key role in transforming the energy system. The use of smart meters and controls as well as intelligent devices and their incorporation into household networks should enable less energy to be consumed without affecting convenience or quality of life.

The SET-Plan (Strategic Energy Technology Plan) from the European Commission places citizens at the centre of a decentralised and digitised energy system, and aims to speed up the proliferation of smart energy services and applications over the next few years. The goal is to control at least 80% of electricity consumption and at least 80% of energy consumption using ICT in 80% of European households by 2030.

The EU plans to use the European Ecodesign and Energy Labelling Directives to support the distribution of energy-efficient products on the market and to promote the purchase of these types of products by consumers. New energy-related product groups and guidelines are being defined as part of the current Ecodesign Working Plan (2016 to 2019).*

A number of innovative companies in Austria are working with research partners to develop new smart components and systems for a wide range of energy-efficient consumer applications, such as components for mobile micro devices from the areas of communications, supply and medicine. Among other factors the research focuses on developing new solutions that enable the use of efficient, cost-efficient and more environmentally-friendly sources of energy. Coupling with reliable energy storage systems is another important issue.

* Source: https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:52016DC0773

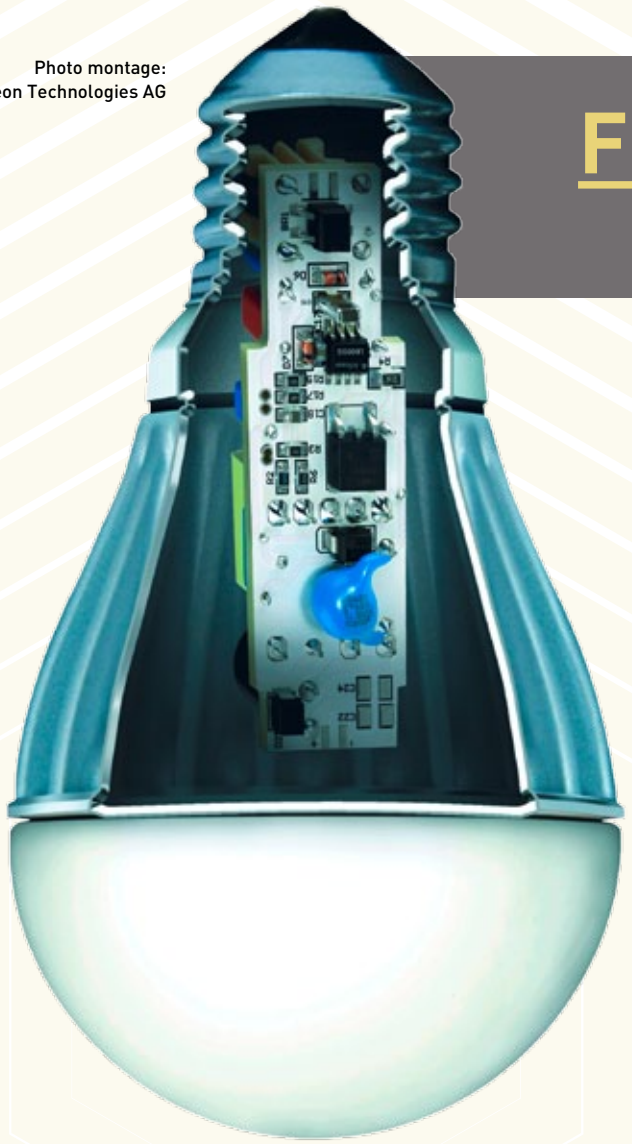

Photo montage:
Infineon Technologies AG

Future LED-Bulb

ENERGY-SAVING LIGHT TECHNOLOGY FOR THE MASS MARKET

Innovative Austrian product developments for the global LED market.

In 2007 Infineon Technologies Austria AG launched an ambitious R&D programme with the energy research flagship project "Future LED Bulb" in collaboration with Zumtobel Lighting GmbH and Tridonic Jennersdorf GmbH, aiming to develop new energy-efficient LED bulbs. These were intended to satisfy the most demanding customer requirements and be suitable replacements for conventional filament bulbs in the mass market.

The following requirements were stipulated for the LED development project:

> Top energy efficiency
> Constant, pleasant colour temperature
> Constant intensity
> Extremely long service life (approx. 50,000 hours)
> Attractive market price
> Capacity for dimming by means of existing systems

Bulbs with an exceptionally long service life were developed over the course of the project which are equipped with extremely efficient ultra-compact DC converters and low-loss LED drivers, with new control algorithms to set colour temperature and stabilise the luminous flux.

LED drivers
Photo: Infineon Technologies AG

Photo: Infineon Technologies AG

Application High-Bay-Hall
Photo: LEDON GmbH

Specific challenges in the development process involved producing an attractive design for the LEDs and a suitable distribution of light, and ensuring that no system components overheat. Thermal management, mechanics and power electronics represented additional important research areas at the time of the project.

In response to the EU's ban on filament bulbs enacted in 2009, the project partners quickly started deriving marketable products from their research. In 2009 Zumtobel launched its subsidiary LEDON to exploit the new products. Infineon brought out the ICL8001G LED driver and the corresponding demoboard. With the aid of the upstream control setup developed in the project, the number of components required was reduced from more than 50 to roughly 30.

Lighting technology has since undergone rapid development. LED lights are now the first choice for most lighting applications on account of the high potential for energy savings and their long lifetime.

The company LEDON GmbH based in Vorarlberg has specialised in the development of high-efficiency LED lighting solutions ever since. The company's products include classic retrofit products which fit conventional sockets as a substitute for filament bulbs, energy efficient light bulbs and halogen bulbs. LEDON also produces powerful louvre luminaires for offices, moisture-proof lamps for basements and garages and high bays for industrial and hall lighting.

In terms of lighting, Infineon focuses on premium energy-efficient products and solutions, and among other items produces custom-made LED driver ICs, MOSFETs (metal-oxide-semiconductor field-effect transistors) and sensors for commercial lighting and automotive lighting applications. Today Infineon's range includes 15 control ICs (integrated circuits) for industrial LED lighting systems. Tens of millions of these LED components are sold globally each year.

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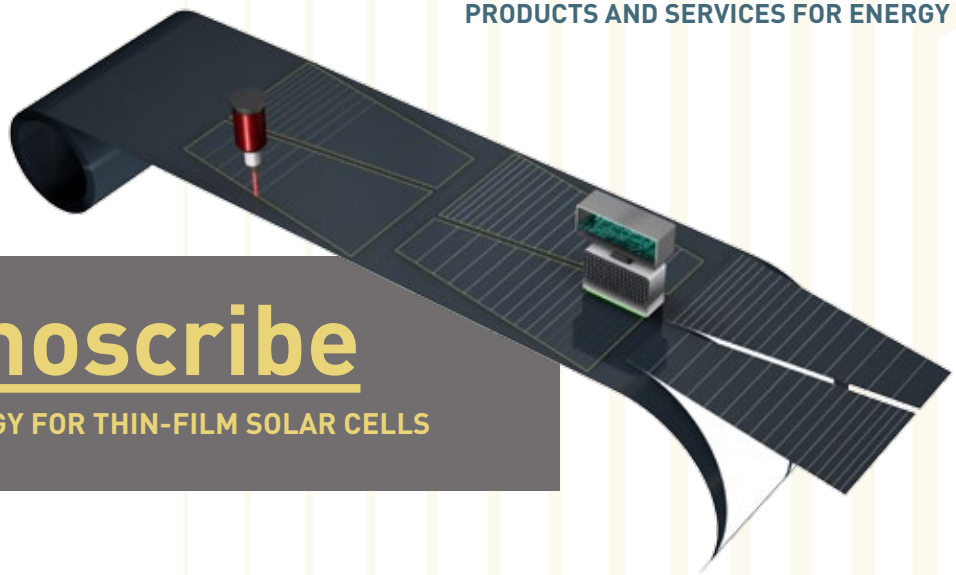
Prototype for backpack with ergonomic photovoltaic module (SUNNYBAG design)
Photo: SUNNYBAG GmbH

SIARQ solar lamp/Barcelona
Prototype with rectangular solar modules
Photo: SIARQ, Spain



Monoscribe

NEW TECHNOLOGY FOR THIN-FILM SOLAR CELLS

Basic idea for Monoscribe interconnection
Image: Sunplugged GmbH

An innovative concept for interconnecting solar cells allows PV modules to be produced with unique new geometries and voltages.

Austrian company Sunplugged – Solare Energiesysteme has been working with corporate and research partners for years to develop flexible photovoltaic films whose size, shape and voltage can be freely adjusted. The innovative technology allows customised solutions to be implemented for multiple applications in buildings, equipment and vehicles.

An innovative procedure was developed in the Monoscribe project aimed at producing thin-layer solar cells consisting of layers just a few micrometres in thickness and that can be separated on glass or flexible films using large-scale thin-film technology.

These solar cells are cost-effective to produce and form the base material for a new interconnection concept which promises low manufacturing costs and new usage options. As part of this process, large, endlessly manufactured solar cells are divided into smaller sections and the individual functional layers of the solar cells are exposed using lasers. The electrodes in the solar cell can then be connected with conductive materials.

Both the laser process as well as the application of the conductive materials can be controlled digitally. Within the framework of the project, the innovative printing and laser technology was developed and an experimental roll-to-roll pilot production plant was set up and put into operation.

Innovative product developments

The printable solar cell circuit allows photovoltaic modules to be produced with different voltages, shapes and sizes. Combined with the flexibility of thin-film solar cells, these modules are suitable for a large number of innovative applications, from products with integrated photovoltaics such as sensors and charging devices, to PV modules for building integration.

The feasibility of the concept has been demonstrated at the industrial level using photovoltaic modules with unique new geometries. A prototype for ergonomic PV modules for bags and backpacks was developed in partnership with Austrian manufacturer SUNNYBAG. A solar streetlight from the Spanish company SIARQ is another example of usage, with PV modules designed to be used with Monscribe interconnection technology.

CONSORTIUM
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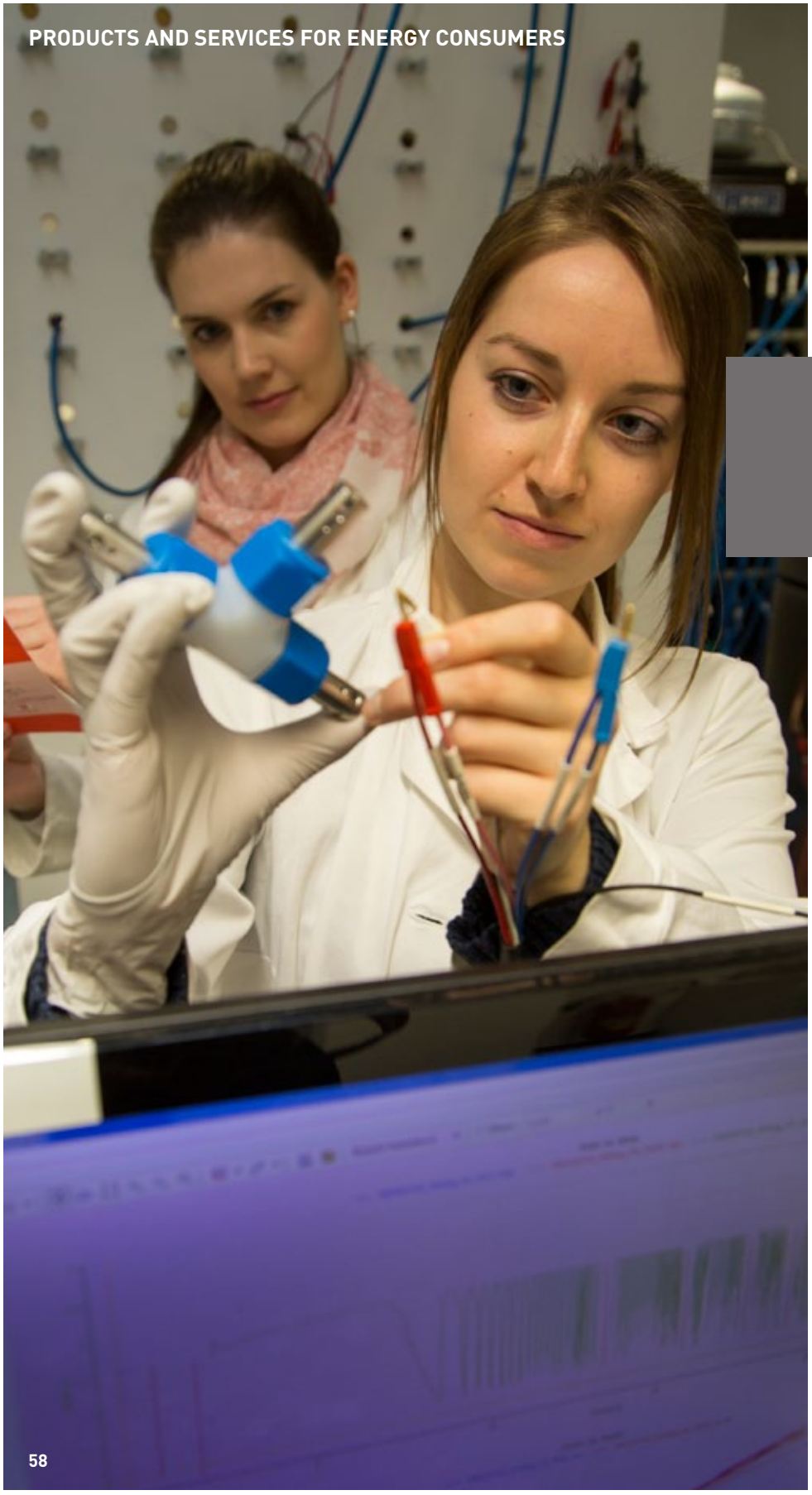


Two single systems combined into
a hybrid of battery and solar cell
Photo: Lunghammer – Graz University of Technology

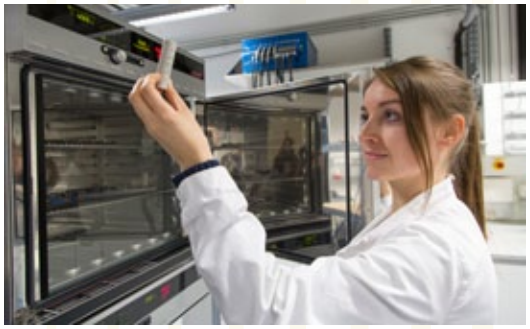
SolaBat

SOLAR CELL & BATTERY

▷ Graz University of Technology is researching a hybrid energy system that combines photovoltaic cells with electrochemical energy storage systems in one device.

The energy transition aims to have a high proportion of energy demands covered from renewable sources. Yet how is it possible to ensure sustainable energy supplies despite fluctuating levels of solar and wind power? One solution to this problem is to couple environmentally-friendly energy sources with reliable energy storage systems.

A hybrid energy system is being developed in the SolaBat research project which combines solar cells and electrochemical storage units (e.g. Li-ion batteries) in one device. The goal is to allow energy to be converted and stored in one single, intelligent system. The project is being implemented by the Institute for Chemistry and Technology of Materials



SolaBat research work at the Institute for Chemistry and Technology of Materials at the Graz University of Technology
Photos: Lunghammer – Graz University of Technology

at the Graz University of Technology, in partnership with the Centre for Electron Microscopy (ZFE) at Austrian Cooperative Research. The project involves the development of the innovative applied concept and examination of its efficiency.

Combining new materials

Powerful materials are the key to success in coupling smart energy storage units with durable conversion systems. One important focus for the research work is on the examination of suitable functional materials. On the one hand, they need to reliably complete their respective tasks in the solar cell and in the battery, and at the same time be electrochemically compatible so that they can be combined in one device. Instead of environmentally harmful, cobalt-containing electrodes, the researchers want to use environmentally-friendly titanates as active materials. Polymer-based and therefore organic solar cells could also be used.

Usage options

The fundamental bases for the new technology are being developed in the SolaBat project. The aim is to be able to present a working concept for a photovoltaic battery hybrid at the end of the project period. The system should save space, be efficient and easy to manage. Where the system will be used for the first time cannot yet be determined in the basic research. However, there are already indications of versatile potential usage options.

These areas of application range from mobile phone batteries to car batteries and larger solar plants. In battery research, different applications also involve different requirements and research topics. For instance, for batteries in micro applications or small devices such as smartphones, the space issue takes priority while the weight is secondary. With car batteries on the other hand the weight is the most important parameter.

www.tugraz.at/institute/ictm/projects/solabat

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CEO Infineon Technologies Austria AG
Photo: Infineon Technologies Austria AG

PRODUCTS AND SERVICES FOR ENERGY CONSUMERS

Sabine Herlitschka, CEO Infineon Technologies Austria AG

How will smart energy solutions change our everyday lives?

Smart energy solutions play a crucial role in making optimum use of the most important energy resource: energy efficiency. Given the impact of the climate crisis, which is increasingly being felt all over the world, energy-efficient technologies are a key part in ensuring the tangible reduction required in greenhouse gases. This means they have a direct positive impact on our future quality of life.

Smart energy solutions combined with digital technologies will be an everyday part of life in future. For instance in terms of making living safer, easier and more environmentally-friendly through the smart home and smart controls over heating, security and lighting systems. Our mobility options will also become safer as well as more sustainable and convenient through the huge increase in electric vehicles and the use of technologies for autonomous driving.

Power electronics is a key to energy efficiency.
What chances do Austrian developments have on the international markets?

Innovations are a crucial basis for success for Austria as a place for technology, but they also need to be competitive on the global market. Infineon Austria has this leading global expertise in the area of power electronics, meaning that the Infineon Group has been the global market and technological leader in power semiconductors for more than a decade. Energy-saving chips developed, produced and marketed in Villach control the propulsion systems in eight out of every ten best-selling electric cars, and ensure efficient power conversion in 50% of servers worldwide.

Digitalisation is a dynamic process that spans all sectors. What role does collaboration with partners such as universities, research institutes and start-ups play in the innovation process, in terms of companies' international competitiveness?

For the first time in a while, digitalisation once again provides a real opportunity for Europe to enjoy a competitive advantage, as knowledge and expertise have become the decisive factor. It is therefore crucial for companies to boost their innovative capabilities through strategic partnerships and research networks in Austria and abroad. Collaboration with all partners in the innovation system plays an important role in this. Infineon has for instance been playing a leading role for years in EU research initiatives aimed at boosting Europe's position in the development and production of innovative microelectronics.

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Quotes and interviews reflect the personal opinions of those questioned.
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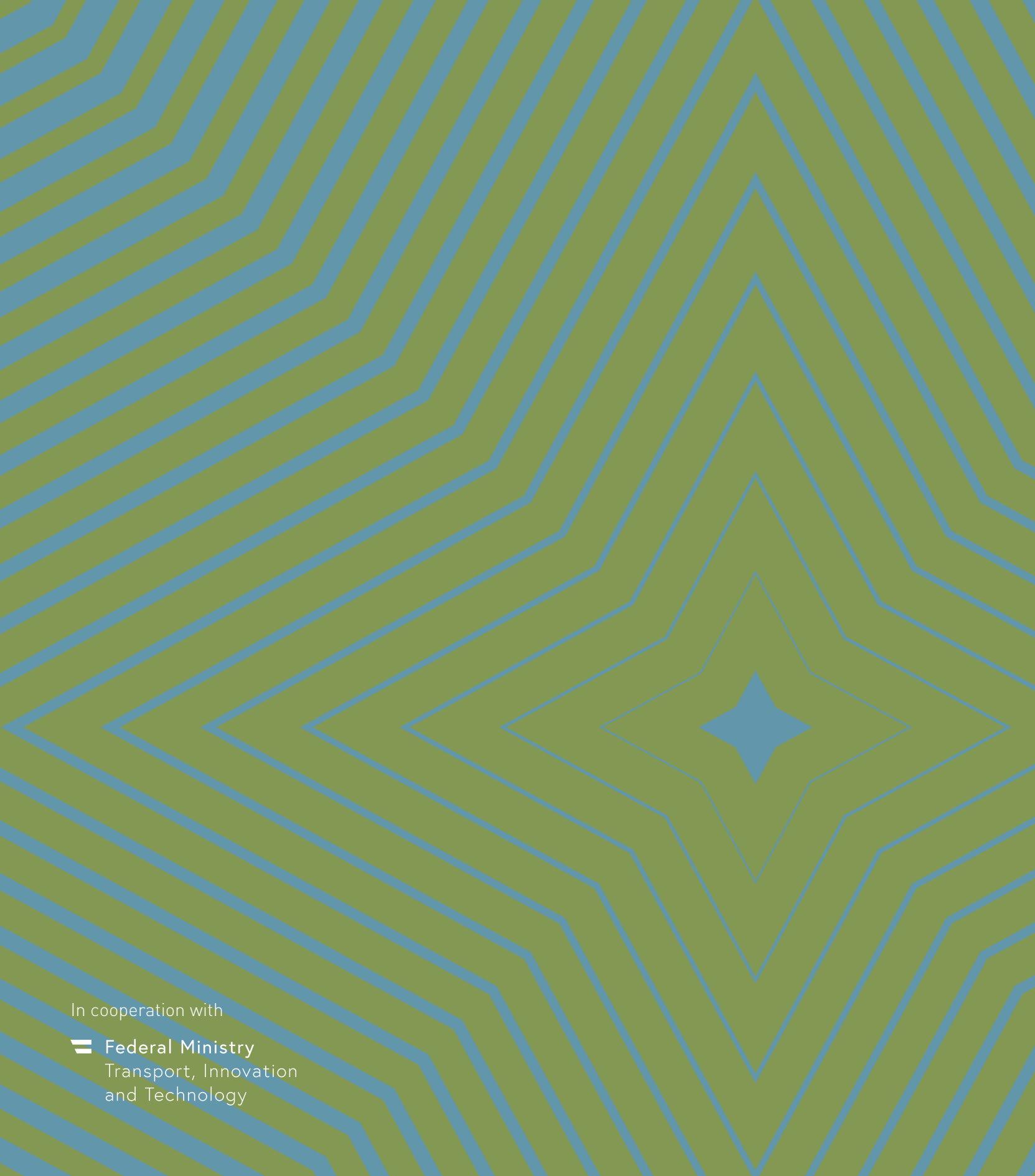

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