effzett

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FORSCHUNGSZENTRUM JÜLICH'S MAGAZINE

Energy in reserve

Sun and wind do not provide a constant supply: to satisfy our hunger for energy at all times, we will need more storage facilities in future

OPEN APPROACH
Avoiding malpractice through open science

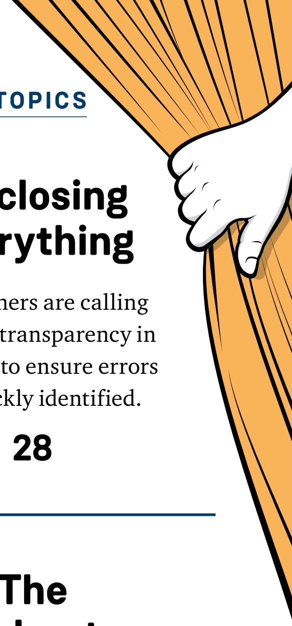
BETTER SAFETY
Simulation of visitor flows at EURO 2024

COLOURFUL MIX
No brain is typically male or female

↑

Bursting into the clouds

A weather balloon is waiting to be released in the Chilean Andes. Its sensors are designed to detect trace gases, aerosols, and cloud particles up to an altitude of around 30 kilometres. The measurements in Chile and South Africa are part of a campaign by atmospheric researchers from Jülich, Universidad Técnica Federico Santa Maria in Chile, and the South African Weather Service (SAWS). The partners thus aim to find out more about atmospheric processes in the southern hemisphere, in particular the transport of air with high ozone concentrations from the stratosphere into the troposphere. This transport influences the air quality in the atmosphere near the ground.



Built on sand!

It's holiday season! Will you be heading to the sea? Are you looking forward to the warm sand on the beach? A resourceful company from Finland is now using this ability of sand to store energy. Their "sand battery" is heated to up to 500 °C and, according to the company, keeps the energy available for several months. The first commercial sand battery is located in southwestern Finland. Moreover, a research team from Austria currently has an idea, the theory of which involves using the weight of sand. If energy is required, sand is lowered into an unused mine shaft, which powers a turbine in the process. If there is surplus energy, the sand is transported back up again – in principle like a pumped-storage power plant.

These are clever ideas, but at most they represent just small contributions to the energy transition. We need much more and, above all, different types of storage, such as those that keep the electricity grid stable in fractions of a second in the event of fluctuations, or large-scale storage systems that can bridge a period of weeks during which little to no energy is produced. Read about the types of electricity storage systems that Jülich scientists are researching and why there won't be one single super battery.

In addition, quantum researcher Vincent Mourik looks at how errors are dealt with in science, Jette Schumann uses computer simulations to help safety experts at the European football championship, and Susanne Weis studies the brain for gender-specific characteristics.

We hope you enjoy reading!
Your effzett editorial team

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PHOTOVOLTAICS

Solar panels as fire alarms

Clouds of smoke darken the sky – forest and bush fires, some of them devastating, occur time and again, such as those in Canada and Hawaii in 2023 or in Australia in 2019/20. In future, solar panels could help to detect and monitor the sources of fire at an early stage. An analysis by Australian and German researchers has shown that the panels react sensitively to smoke. Using data from 160 private solar panels in the Australian state of New South Wales, they investigated how particulate matter from fires affects the performance of solar panels.

– HELMHOLTZ INSTITUTE ERLANGEN-NÜRNBERG FOR RENEWABLE ENERGY PRODUCTION –

ALZHEIMER'S RESEARCH

Drug candidate reaches next phase

PRI-002, an Alzheimer's drug candidate developed in Jülich and Düsseldorf, can now be tested to see how effective it is in patients. The European Medicines Agency (EMA) has approved a phase II clinical trial. The results of the tests on 270 patients at an early stage of the disease should be available by 2026. The third and final study phase is expected to begin thereafter. The phase II study is being carried out by the Jülich spin-off Priavoid and the company PRInnovation, and is being funded by the Federal Agency for Disruptive Innovation SPRIND.

– INSTITUTE OF BIOLOGICAL INFORMATION PROCESSING –

“In light of the challenges facing energy grids, quantum computing and quantum communication can become a real game changer.”

Prof. Andrea Benigni, director at the Institute for Climate and Energy Systems (ICE-1), expects the planning and operation of energy grids to become increasingly complex. This is due to the ever-increasing computing requirements, since, for example, the electricity grid is becoming more complex and flexible due to the expansion of renewable energy or there is an increased need for cyber security. The recently launched NRW project QuGrids, which is coordinated by Jülich, brings together energy and quantum research as well as industry to find suitable solutions.

38

million euros

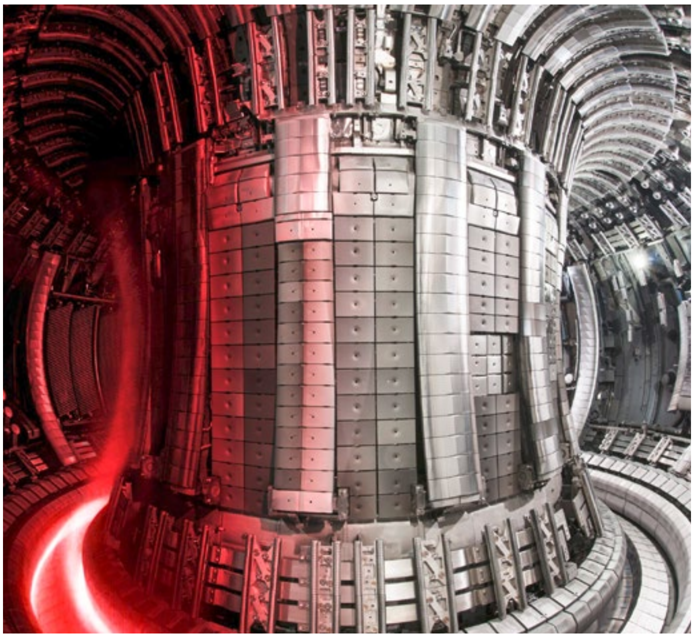
in funding will be provided by the European Commission to the EBRAINS research infrastructure over the next two years. The aim is to further expand the neuroscience platform developed in the Human Brain Project (HBP). Within EBRAINS (European Brain Research Infrastructures), 59 partners are cooperating to research the complexity of the brain using digital methods and analysis tools and to translate new knowledge into medical and technological applications.

– INSTITUTE OF NEUROSCIENCE AND MEDICINE –

ACCOLADES

Two new members

The German National Academy of Sciences Leopoldina has appointed two Jülich scientists as new members. Prof. Astrid Lambrecht, a quantum physicist and Chair of the Board of Directors of Forschungszentrum Jülich, has been assigned to the Physics section. Prof. Katrin Amunts, a brain researcher who works at Jülich and Heinrich Heine University Düsseldorf, will be active in the Psychology and Cognitive Sciences section. Leopoldina selects its members among scientists who have distinguished themselves through their outstanding scientific achievements.



World record for nuclear fusion

With an energy pulse of 69 megajoules, the Joint European Torus (JET) experimental facility for nuclear fusion reactors has generated the largest amount of fusion energy to date. This could power a television for several hours. The energy pulse lasted six seconds. Researchers from the European consortium EUROfusion, which includes Jülich scientists, produced the pulse from 0.2 milligrams of fuel. A power plant would need two kilograms of coal to produce the same amount of energy. The experiment findings are being incorporated into the successor to JET (which has since been decommissioned): the international fusion experiment ITER, which is currently being built in southern France and aims to generate 500 megawatts of fusion power in its plasma for several hundred seconds.

– INSTITUTE OF FUSION ENERGY AND NUCLEAR WASTE MANAGEMENT –

ENERGY RESEARCH

Hydrogen supply launched

The future of climate-smart energy supply at the Hermann-Josef-Krankenhaus hospital in Erkelenz has begun. The decentralized fuel cell system from Robert Bosch GmbH has been running since March 2024, marking the first stage of the Multi-SOFC Erkelenz demonstration project. By 2026, a fifth of the hospital's electricity and heating requirements is expected to be covered by a combination of different hydrogen technologies. The project is coordinated by the Helmholtz hydrogen cluster (HC-H2), the core of which forms Forschungszentrum Jülich's Institute for a Sustainable Hydrogen Economy.

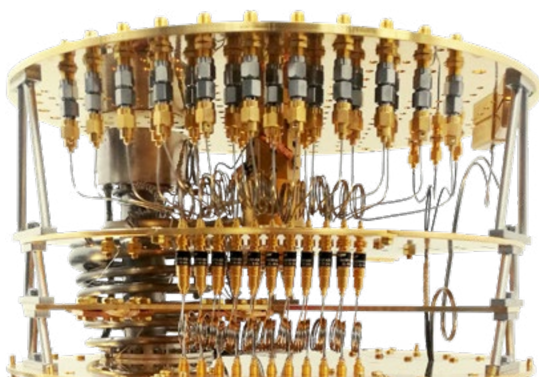
– INSTITUTE FOR A SUSTAINABLE HYDROGEN ECONOMY –

QUANTUM RESEARCH

More stable quantum bits

Superconducting quantum bits could become up to 7 times more stable in future. Jülich and Karlsruhe physicists have discovered that Josephson junctions, which are the fundamental building blocks of superconducting quantum computers, behave in a more complex way than previously assumed. Harmonics occur in a similar way to a musical instrument in which the simple fundamental oscillation is overlaid by overtones. This changes the mathematical equation that has been used to describe Josephson junctions for around 50 years. As a result, it will be possible to better understand and reduce errors in superconducting quantum bits in future.

– JÜLICH SUPER COMPUTING CENTRE/ PETER GRÜNBERG INSTITUTE –



Build up more energy reserves

With each percent more electricity generated from wind and solar power, it is becoming increasingly clear: more storage is required for the energy transition. In particular, different storage systems are needed – not just different types of batteries, but also hydrogen. This is the only way to offset fluctuations, cope with periods in which little to no energy is generated, and keep the network stable.

Make hay while the sun shines." People have heeded this wisdom for many years. For example, around 11,000 years ago, our ancestors started to preserve grain and meat and to build up reserves for the winter and hard times. The first storage containers were made of ceramic; we now use granaries, cooling appliances, and canned goods. Today, we need to apply this wisdom to another important commodity: energy. Here, too, the aim is to store surpluses in order to compensate for subsequent bottlenecks.

We will have to contend with such bottlenecks in future, as our energy supply is changing. Until now, power plants have always generated enough energy to keep supply and demand in balance. However, we have primarily burned fossil fuels to achieve this and emitted harmful greenhouse gases into the atmosphere. To keep global warming below 2 °C, as outlined in the Paris Agreement, Germany is expanding its renewable energy supply. The aim is for renewable energy to account for 80 % of electricity consumption by 2030. In 2023, renewables accounted for more than half (52 %) of electricity consumption for the first time.

But wind and solar energy are volatile. They can neither supply energy at the push of a button nor constantly. "We have to be prepared for the fact that electricity generation will in future be less controllable and plannable than it is today. But with wind and solar power, we will always generate more energy than is actually needed at the time. We need to store this surplus to get through the night and periods where there is a lack of wind or sun as well as to keep the power grid stable in the short term. We therefore need more and different types of storage," says Prof. Dirk Witthaut from the Institute for Climate and Energy Systems (ICE-1).

Battery storage systems are seen as the best technological and economic means of storing electricity generated from renewable sources efficiently and with as little loss as possible. During storage and subsequent reconversion into electricity, 80–90 % of the original energy is recovered. Battery storage systems already compensate for fluctuations in the power grid, thus ensuring a steady and stable electricity supply. This involves fluctuations in the seconds range as well as in the minutes and hours range. "These fluctuations also exist without renewables, but

METAL–AIR BATTERIES

Not yet so durable

The metal–air battery theoretically promises a high energy density, as it uses oxygen from the air. This makes the battery type lighter and leaves more space for the metal anode, which can therefore be larger. The metal anode consists of sodium, iron, aluminum, or zinc, and the metalloid silicon is also used. "We are investigating nearly all members of the metal–air battery family. It is important that the metals for the anode have a high energy density and that the raw materials are available in large quantities and are harmless to humans and the environment," says Dr. Emre Durmus from the Institute of Energy Technologies (IET-1). However, the metal–air batteries still deliver significantly less energy than expected and the number of charge–discharge cycles is still far from sufficient for commercial use. The researchers are working on finding out the fundamental causes of this. "We use, for instance, in operando techniques that allow us to observe the battery components in operation on a microscopic level," explains Durmus. "Gaining a better understanding of the complex charging and discharging processes is an important step on the path to harnessing the theoretical potential of this type of battery."

> **"We need storage systems to get through the night and periods where there is a lack of wind or sun."**
>
> Dirk Witthaut

↑ Emre Durmus is working on improving metal-air batteries.

they may occur more frequently in future as a result of the renewable energy expansion, as there will be fewer conventional power plants that can provide energy at short notice with their generators and flywheels," explains the grid stability expert.

However, Germany needs large capacities in order to achieve greenhouse gas neutrality by 2045 as planned. According to an analysis by the Institute of Climate and Energy Systems (ICE-2), around 156 gigawatt hours of electricity storage capacity is needed for short and medium-term electricity storage alone, i.e. for storing electricity in the seconds range right up to several days. Battery storage accounts for around 97 gigawatt hours of this, with the rest being provided by pumped-storage plants.

We are still a long way from achieving these figures. At the end of 2023, the capacity of the roughly 1.1 million stationary battery storage systems amounted to 11.6 gigawatt hours. Although in 2023 the number of newly installed systems in Germany doubled for the sixth time in a row, these are mainly smaller home storage systems with a maximum of 20 kilowatt hours that are being connected to the grid, i.e. storage systems for private photovoltaic systems. Large battery storage systems with over 1,000 kilowatt hours, such as those used by companies to secure their own energy supply and charge their own electric vehicles, have rarely been installed to date. Power grid operators require systems in the range of several megawatt hours. This can be used to compensate for major fluctuations, for example when a wind farm briefly generates significantly more electricity during strong gusts or the output of a large photovoltaic field drops because the sun is obscured by clouds.

REDUCE DEPENDENCIES

Lithium-ion batteries are currently the dominant battery type on the market in all sizes – from small mobile electronic devices such as smartphones and batteries for electric cars to stationary electricity storage systems. Lithium-ion batteries are considered to be very efficient, have a high energy density, and a long service life. For Prof. Martin Winter, founding director of the

↑ Dirk Witthaut focuses on storage systems, particularly with regard to the stability of power grids.

Helmholtz Institute Münster (IMD-4, HI MS) and the MEET Battery Research Center of the University of Münster, this type of battery sets the benchmark. “And this relatively new technology is still a long way from reaching its optimum level,” emphasizes the battery expert.

Nevertheless, he believes it is wrong to focus only on this battery type: “Some requirements for stationary and mobile storage systems may be better met by other battery types that are not yet as technologically mature.” Competition also helps to keep prices low, Winter adds. “After a rapid price increase in 2021/22, the price of lithium has fallen again significantly. This is because sodium-ion batteries have now been declared ready for the market and are already being used in small electric car prototypes,” he explains.

However, sodium-ion batteries have a lower energy density. To store the same amount of energy as a lithium-ion battery, they have to be heavier and larger than the latter. But they have a further advantage: sodium is readily available, inexpensive, and is relatively environmentally friendly to extract by comparison. This is often not the case with lithium. There are fewer areas with large deposits of lithium and its extraction is viewed critically in many cases due to the associated environmental damage. This also applies to two other components that are used in both lithium-ion and sodium-ion batteries: nickel and cobalt.

Researchers at the Institute of Energy Technologies (IET-1) are therefore looking for new or improved active materials for the cathode of sodium-ion batteries, for example, which should use as little cobalt and nickel as possible. Such work fits in perfectly with the Federal Ministry of Education and Research’s umbrella concept for battery research. The concepts outlines that Germany must reduce its dependence on regions of the world, some of which are politically unstable, and achieve greater technological sovereignty when it comes to battery technologies. In order to achieve these goals, Prof. Winter believes that application-inspired basic research is essential. He is therefore critical of current cuts to battery research (see interview on page 17).

SOLID-STATE BATTERIES

At a lower temperature

In batteries, an electrolyte enables ions to move between the two electrodes. In current lithium-ion batteries, the electrolyte is liquid. But it does not necessarily have to be. Batteries with a solid electrolyte are considered to be particularly safe, since nothing can leak and there is an extremely low risk of fire. However, ions sometimes migrate more slowly in solids than in liquids.

Jülich scientists are therefore working on improving the ionic conductivity of solid materials. They are also developing construction concepts that fully exploit the potential advantages of solid-state batteries. For example, a team led by Dr. Frank Tietz from the Institute of Energy Materials and Devices (IMD-2) has found a way for ions in sodium–sulphur solid-state batteries to migrate quickly enough between the electrodes at room temperature. This type of battery, which has been known about for decades, has so far only exhibited a satisfactory performance at temperatures above 250 °C. This severely restricts its potential application. The team led by Dr. Tietz has produced a ceramic electrolyte which is so thin that its area-specific resistance is about ten times lower than usual.

Prof. Dina Fattakhova-Rohlfing from IMD-2 is improving ceramic lithium and sodium batteries, or more precisely the manufacturing process for them. “These solid-state batteries are robust and safe, but manufacturing them using conventional methods is still energy-intensive,” says the scientist. To produce the cell components of these batteries, ceramic powder is typically heated for hours at high temperatures in a sintering process to compact and solidify it. “In addition to high energy consumption, this leads to high production costs and undesirable material degradation, which has an adverse effect on battery performance,” says Fattakhova-Rohlfing. Researchers in her department have therefore developed advanced processing and sintering techniques that allow ceramic batteries and battery components to be manufactured at lower temperatures and in shorter production times. “This is crucial for the future market development of this type of battery,” Fattakhova-Rohlfing stresses.

DIVERSITY REQUIRED

According to Winter, six criteria are crucial when selecting battery types: sustainability, cost, energy content, performance, service life, and safety. "The type of battery we should use is dependent on the criteria that a battery storage system needs to fulfil. With electric cars, for example, the focus is more on the volume and weight of the battery; with stationary batteries there is a greater focus on cost," Winter explains. Scientists at the Helmholtz Institute Münster and at the institutes on the Jülich campus are therefore researching various types of batteries. These include lithium-ion and sodium-ion batteries, solid-state batteries, metal–air batteries, and redox flow batteries (see infoboxes).

However, new battery storage systems alone will not be sufficient for the energy transition. "Batteries are needed to compensate for fluctuations in electricity consumption throughout the day or to be used in reserve for hours, or perhaps even a few days, but not for seasonal storage over weeks or even months. Other solutions have to be used in such cases," Prof. Winter emphasizes.

Prof. Andreas Peschel, director at the Institute for a Sustainable Hydrogen Economy (INW-4), agrees: "We need batteries, but they are not suitable for bridging periods of several days in which little or no energy can be generated. They are also not suited to replacing current winter storage facilities for natural gas in a climate-friendly way." Hydrogen-based solutions are particularly recommended for long-term energy storage. The electrical energy is converted into chemical

"Batteries are not suitable for seasonal storage. Other solutions have to be found."

Martin Winter

↑ Dina Fattakhova-Rohlfing optimizes the manufacturing process of solid-state batteries.

“Like fossil fuels, hydrogen carriers can be easily transported from overseas by ship.”

Andreas Peschel

energy by using it to produce hydrogen from water in electrolysis plants. The stored energy can be released again in fuel cells.

Hydrogen can be used directly as an energy carrier as well as a reaction partner in power-to-X technologies. These technologies convert electricity from renewable sources into fuels or raw materials for industry. Synthesis products such as methanol, ammonia, and special liquid organic compounds known as liquid organic hydrogen carriers (LOHCs) are particularly important here. They can be used to store energy at normal temperature and pressure, or at only slightly increased pressure, and their energy density per volume is significantly higher than that of pure hydrogen. “Such hydrogen carriers can be handled in a similar way to traditional fossil fuels and can be easily transported from overseas by ship, for example,” explains Peschel.

↑ Andreas Peschel’s work is focused on hydrogen as an energy source: how it can be stored and which solutions are suitable for existing infrastructure.

However, a lot of research and development work is still needed when it comes to hydrogen. Peschel and his colleagues at INW are working together with partners on innovative technologies that should enable the switch to hydrogen as an energy carrier. This should make it easier to transport, store, and use hydrogen. The aim is to develop hydrogen-based solutions that are compatible with existing infrastructure. The researchers are also investigating how hydrogen can be recovered from chemical hydrogen storage and integrated into various applications, for example as a fuel or in the chemical industry. This research forms part of the Helmholtz Cluster for a Sustainable and Infrastructure-Compatible Hydrogen Economy (HC-H2). In the cluster, INW and its partners seek to transform the Rhenish mining area into a hydrogen model region. At the beginning of March 2024, the first of several planned demonstration projects was put into operation: a fuel cell system from Robert Bosch GmbH at the Hermann-Josef-Krankenhaus (HJK) in Erkelenz. In combination with an LOHC storage technology that has yet to be installed, the system is expected to cover 20 % of the hospital’s electricity and heating requirements. “This is an order of magnitude that allows us to scale the technology for larger requirements and other applications, for example for industry and commerce,” explains Peschel.

Other Jülich institutes are also working on hydrogen and power-to-X technologies. Jülich experts are even putting the energy transition to the test on a small scale on their own campus. The findings of the Living Lab Energy Campus (LLEC) project are to be used as a blueprint for residential and industrial areas. Various storage technologies such as large batteries and hydrogen are used to combine electricity, heat, and chemical energy, for example. The mobility sector is also involved by using batteries from electric cars as intermediate storage. If many people succeed in making their electric cars available as energy storage for the public grids in future, it is likely that significantly fewer new stationary battery storage systems would need to be installed. Jülich researchers from ICE-2 estimate that electric cars could cover almost two thirds of the 97 GWh of battery storage capacity that is required by 2045. For this to be possible, however, regulatory hurdles for feeding electricity from the vehicle battery into the grid first need to be removed and attractive business models developed. There are still many unanswered questions here.

In principle, however, Jülich experts are clear on the fact that we need different storage technologies and more storage for a climate-neutral energy system. This can help to keep the power grid stable and nobody has to worry about being left in the dark during periods of little energy. And who knows, perhaps the electricity reserves in the cellar will become just as common for future generations as the freezer filled with peas, pizza, and bread rolls is for us today.

FRANK FRICK/CHRISTIAN HOHLFELD

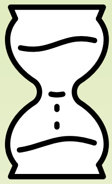
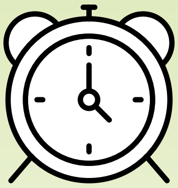
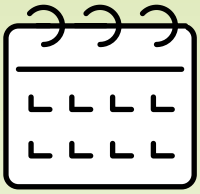
REDOX FLOW SYSTEMS

A question of cost

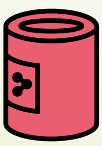
Redox flow systems occupy a special position among batteries. They feature two tanks, each with a liquid electrolyte, as well as two reaction chambers with one electrode each. The chambers are separated by a membrane. If required, the electrolyte solutions are pumped in two separate circuits through the reaction chambers where they then absorb or release electrons at the electrodes while consuming or producing electricity.

The advantage of this construction method is that in order to expand the storage capacity of redox flow batteries, it is only necessary to increase the volume of the tanks. Redox flow technology therefore promises cost benefits for large storage systems. It has not yet been able to fulfil this promise, however, in part because the electrolyte solution of commercially available redox flow systems is based on expensive vanadium compounds. A team led by Mariano Grünebaum at the Helmholtz Institute Münster (IMD-4, HI MS) is therefore looking for easily accessible, environmentally friendly electrolytes. The team recently published a digital blueprint that any research group can use to produce small redox flow batteries themselves using 3D printing. The costs involved amount to € 230 – commercially available redox flow systems are at least ten times more expensive.

Electricity storage: the right type for each time frame

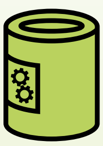
	 **Short-term storage**	 **Medium-term storage**	 **Long-term storage**
Duration	Seconds to minutes	Hours to days	Days to months/years
Task	• Keep the grid stable in the event of acute voltage fluctuations • Compensate for differences between electricity consumption and generation	• Compensate for daily fluctuations in wind and solar energy • Compensate for periods lasting several days in which little or no energy is generated	• Bridging long periods where little to no energy is generated • Securing supplies in winter
Special requirements	• Energy has to be available very quickly • Storage systems often need to be rechargeable • Only a small amount of energy may be lost during charging/discharging	• Varies depending on the area of application, sometimes electricity must be available quickly, sometimes not • Typically only a few charging cycles per day	• Storage systems require very high capacities • Less frequent charging/discharging • Efficiency level can be lower
Examples of electricity storage systems	• Flywheel energy storage • Capacitors • Batteries	• Batteries • Pumped-storage power plants • Compressed air energy storage • Hydrogen	• Hydrogen • Power-to-gas

Storage types

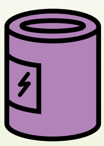


Chemical storage
chemically converts low-energy substances into high-energy substances, for example water into hydrogen (and oxygen) by electrolysis

Electrochemical storage
stores energy in the form of electrical charge carriers



Mechanical storage
converts electrical energy mechanically into another form of energy, for example into potential energy in a pumped-storage power plant (water is pumped into a higher basin, with the water then powering the turbines when it is released back)



Electrical storage
stores energy using an electric field

Danger for Germany as a research hub

The German Federal Government has cut funding for battery research by around 75 % as of 2024. This decision was taken on the basis of a ruling by the Federal Constitutional Court, which prohibited the government from using coronavirus funds for the Climate and Transformation Fund (KTF). Battery expert Prof. Martin Winter assesses the consequences of this decision.

Mr. Winter, what's your assessment of the current situation?
In the last 15 years, Germany has invested well over € 1 billion in battery research. We have succeeded in establishing an internationally competitive research infrastructure. While other countries continue to step up their efforts, we are basically abandoning our billion-euro investments. We have to expect that we will lose touch with international competition. This is particularly fatal for a country with a strong automotive industry.

What are the concrete consequences?
Without the necessary funds, systems and equipment cannot be adequately maintained and operated. We will lose top scientific personnel and, as a result, know-how. For example, a large proportion of the 500 or so people here in Münster are financed by project funding from the Federal Ministry of Education and Research. We won't be able to retain many of them and we will be unable to replace those who leave. However, the cuts are also having an impact on young scientists and companies.

In what way?
Master's and doctoral theses are also written with the help of research funding. If young people see that there are fewer opportunities in battery research in future, they will turn to other areas. And yet the industry is already experiencing a severe shortage of skilled workers. And, of course, companies go wherever they can find skilled workers. The question remains whether this should be outside of Germany, according to the current plan. We hope that the federal government will make the necessary funding available again in a new budget. Germany would then suffer a severe slump, but at least it would not be the end of German battery research.

QUESTIONS WERE POSED BY FRANK FRICK.

← Martin Winter, founding director of the Helmholtz Institute Münster (IMD-4, HI MS) and the MEET Battery Research Center at the University of Münster, has received more than 60 scientific awards for his work.

When the fans start to flock

The football will kick off in Germany this summer. But security experts have many things to clarify for the European football championship, such as how best to manage the flow of visitors. In Düsseldorf, computer simulations are helping with these efforts.

> **“We then press ‘play’, so to speak, and see how the whole situation develops.”**
>
> JETTE SCHUMANN

Three years ago at London’s Wembley Stadium: England and Italy face each other in the final of the European football championship. Hours before kick-off, fans descend on the overcrowded entrances. And more and more people keep coming. Many come despite not having a ticket. Some manage to break through the barriers and charge into the stadium. Tumultuous scenes ensue. The police eventually arrest around 50 people.

A repeat of these scenes needs to be avoided at UEFA EURO 2024 in Germany this summer. Five matches will take place in Düsseldorf’s main stadium. Hauke Schmidt is Executive Director Safety Management for stadium operator D.LIVE, where he is responsible for visitor safety. He can look back on many years of professional experience, which is why he knows that the EURO 2024 matches cannot be compared with the usual encounters in the Bundesliga.

For example, an additional, external security area needs to be set up around the stadium during the tournament. This area is intended to prevent people from gaining uncontrolled access to the stadium. This creates a problem in Düsseldorf: “The underground train station right next to our stadium is situated within this security ring and therefore cannot be used for arrivals – only for departures,” explains the security expert. To bring spectators to the stadium, the Rheinbahn will therefore stop on the opposite side of the arena. This changes how the travelling fans are distributed along the various routes to the stadium.

← Dr. Jette Schumann analyses how football fans get to and from the stadium. Her computer simulations help with planning for the European football championship.

For Schmidt, the question is how and when the visitor flows will be distributed around the stadium under these unusual conditions – particularly at the various entrances. “There is no blueprint for this and we are unable to do a test run. Despite this, everything will have to run smoothly right from the very first game,” says the security expert.

Fan walks are another challenge. “This is an organized march of a team’s supporters from an agreed location to the stadium,” explains Hauke Schmidt. “And this could involve a very, very large number of people – potentially tens of thousands.” This mass of people can interfere with the arrival of other fans, for example when the thousands of football fans cross an intersection and bring traffic to a standstill. Level crossings along the route of fan walks are also critical points.

In order to predict the flow of visitors and identify potential risk zones, Schmidt is supported by complex computer simulations from the interdisciplinary research project CroMa-PRO (see infobox). “Our simulations provide various scenarios for the temporal and spatial development of visitor flows. These scenarios facilitate on-site planning,” explains Jette Schumann, one of the project managers from Jülich’s Institute for Advanced Simulation (IAS-7).

CONSIDER ALL PATHWAYS

The simulations take account of travel to Düsseldorf by car, bus, train, and other means of transportation. This part of the simulations is developed by project partner DLR. At IAS-7, an agent-based model is used to simulate how a large number of individual people move to the stadium on foot. The model is based on findings concerning the behaviour of people in large crowds.

↑ Hauke Schmidt from stadium operator D.LIVE is responsible for visitor safety at the Düsseldorf stadium.

“We give each virtual person a goal at the beginning: You want to get to this specific stadium entrance. You have several routes to choose from. We then press ‘play’, so to speak, and see how the whole situation develops,” explains Schumann. “We also take influencing factors into account, such as the weather, which has an impact on travel behaviour.” The researcher can display the results on a map on the computer screen: Small dots move like ants along the streets and footpaths towards the stadium. Sometimes individually, but often in groups.

ZOOM INTO HOT SPOTS

This makes it possible to understand which route a crowd of people will take through the city, how long it takes, and what happens if the crowd is interrupted by other road users in between. “We can always see how many people are in which place at which time. You can then zoom in and say: I’m more interested in this place at this time,” says Schumann.

For example, one group game in the Düsseldorf stadium kicks off at 15:00. “When rush-hour traffic is flowing through the city at the same time as the fans, this naturally has a significant impact on the duration of the walk to the stadium and the traffic situation. Our simulations show exactly how this plays out,” explains the expert.

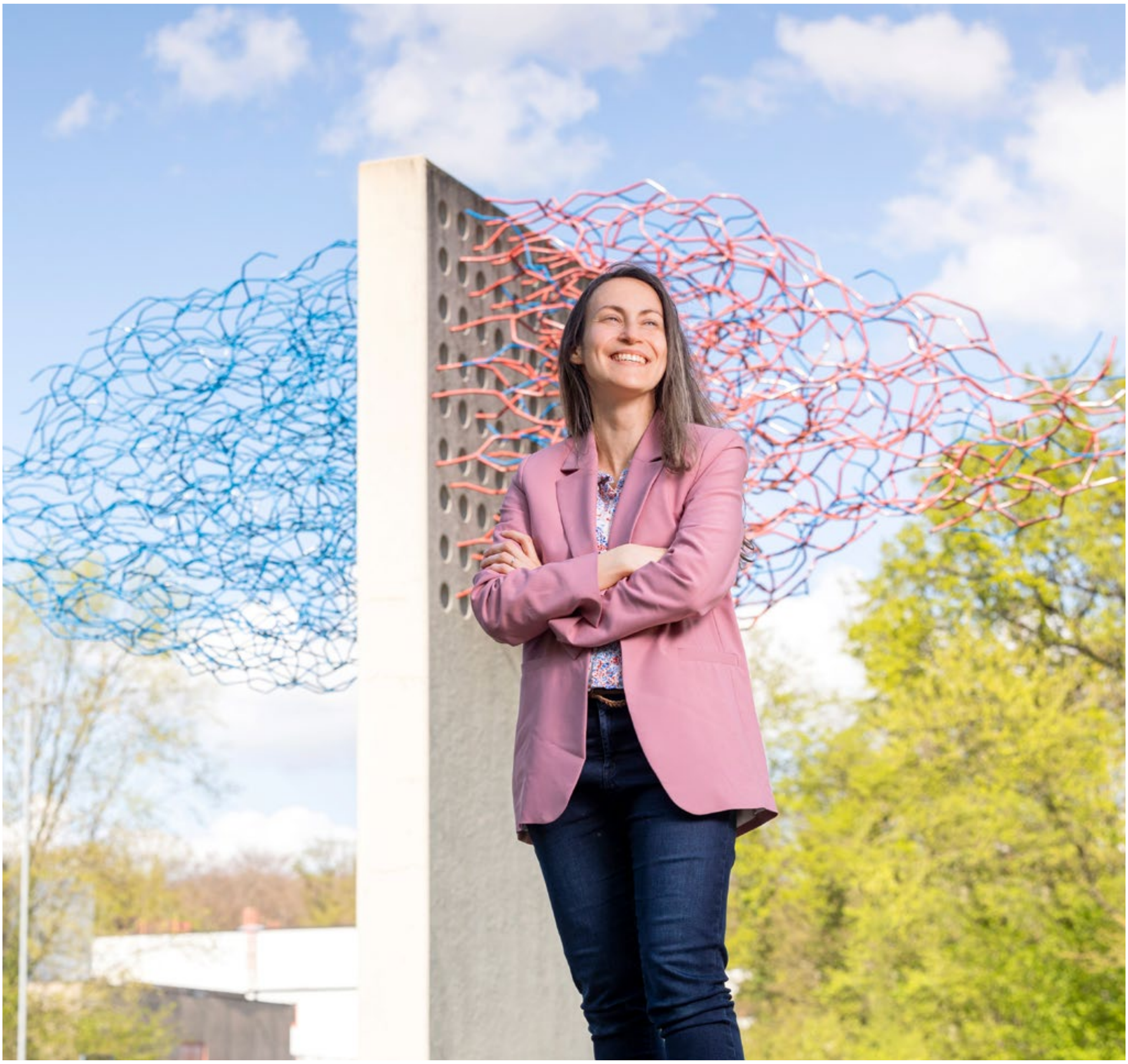
This is a great help to Hauke Schmidt and the other planners: “If the fan walk proceeds along one of the main traffic routes, for example, we need to calculate in advance how much space we should give it. Do we give it access to the whole road or do two lanes have to remain free for other road users?” says Schmidt. The project partners will pass on their findings, for instance regarding the utilization of individual entrance areas, to other organizers such as EURO 2024 GmbH, which is responsible for admissions.

For the Jülich researchers, however, the European football championship only marks half-time for the CroMa-PRO project. “The European football championship is the first example of our simulation software in use. We will then work on transferring the concept to other events and locations,” says Schumann.

ARNDT REUNING

CroMa-PRO

The interdisciplinary CroMa-PRO research project is developing solutions to optimize visitor flows at major events. Computer simulations, which can be used to examine the arrival and departure of visitors in advance, are a key component of the project. The simulations allow the researchers to run through possible scenarios. These scenarios in turn help event organizers and security personnel to prepare, come up with security measures, and suggest efficient arrival routes. Forschungszentrum Jülich, the German Aerospace Center, event and mobility planner Eventbande GmbH, and stadium operator D.LIVE are involved in the project, which is funded by the Federal Ministry of Education and Research.



↑

What are you researching right now, Dr. Pizzoccaro-Zilamy?

Dr. Marie-Alix Pizzoccaro-Zilamy, young investigator group leader at the Institute of Energy Materials and Devices (IMD-2)

"I develop ultrathin layers with uniform pores that only allow certain components of a gas mixture to pass through – a bit like in the work of art behind me. Such sieve-like membranes can be used to separate hydrogen from natural gas, for example, after both have been sent through pipelines together. Or they can remove carbon dioxide from exhaust gases. We use materials such as zeolites, which naturally contain pores. The aim is to produce perfect layers just a few atomic layers thick on more stable substrates using processes that can also be implemented on an industrial level."

go.fzj.de/effzett-pizzoccaro-zilamy

Innovative container concept

The most powerful supercomputer in Europe is being built in Jülich. An innovative building concept allows the JUPITER exascale supercomputer to be flexibly modified.

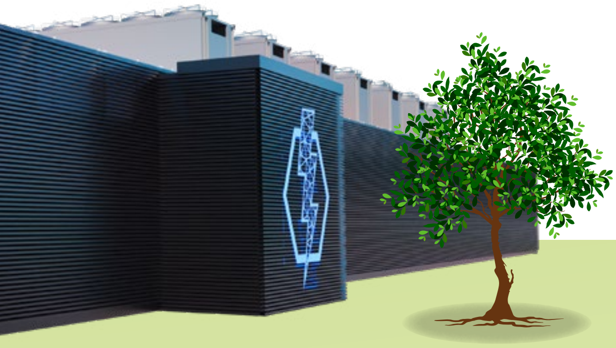
↑ A low-rise building consisting of around 50 containers will house the JUPITER exascale supercomputer on the Jülich campus.

A significant date for Forschungszentrum Jülich was 15 June 2022. On this day, the European supercomputing initiative EuroHPC JU decided that Europe's first exascale-class high-performance computer will be built in Jülich. At the Jülich Supercomputing Centre (JSC), Benedikt von St. Vieth heads the department that is responsible for setting up and operating the gigantic computing machines. The new addition, JUPITER, is set to be inaugurated this winter, explains the expert: "We're talking about an exascale computer. It can perform one quintillion floating-point operations per second. This is a 1 with eighteen zeros. You would need the equivalent of ten million notebooks for that. To date, there are only two publicly known computers in this performance class, both of which are located in the USA."

Initial planning for an exascale computer at Jülich began in 2019. However, when the decision was made three years later, conditions had changed: "As a result of the pandemic and the invasion of Ukraine, prices and, therefore, construction costs had exploded," recalls von St. Vieth. This meant that the previous concept for the data centre designed to house the new supercomputer was up for discussion.

The original plan was to erect a multi-storey building. A central infrastructure would have supplied JUPITER with electricity and cooling water. However, it was not only the costs that now spoke against such a standard solution, but also the tight time frame in which it was due to be put into operation. "That's why we decided against building a traditional data centre, instead opting for a modular building in a container design. It's quicker and less expensive," says von St. Vieth.

The basic structure of the supercomputer has not been changed as a result of the new design. The installation will cover an area that equates to roughly half a football pitch. It will consist of



around 50 containers, which will be manufactured and supplied by the IT company Eviden (Atos Group). At first glance, the containers resemble the metal boxes from cargo ships, says the expert: "But they are custom-made designs with excess lengths. Two containers are always combined to form one IT module. This dual container comprises 20 computer racks. These are the frames in which the more than 7,000 servers are housed." Each module has its own transformers for the power supply and its own cooling infrastructure – a sustainable hot water cooling system. The water heats up from 36 °C to over 40 °C. The thermal energy can be used via a heat exchanger to supply heating systems on campus, for example.

"We are now convinced that we are leading the way with the modular design of JUPITER," says von St. Vieth. "Of course, the container design might also have disadvantages in terms of exposure to nature. It could be penetrated by rainwater. But we don't think that will be a problem." The advantage of the modular design is that it enables a high degree of flexibility. Individual containers can be replaced relatively easily to optimize the overall system to meet new requirements. Von St. Vieth: "The next computer generation with significantly higher requirements could be easily integrated into the overall architecture on a module-by-module basis. Conventional data centres that were built 10 to 20 years ago, on the other hand, reach their capacity limits in terms of power supply and heat dissipation with such expansion measures."

The container design also enables the integration of modules based on completely different computing technology in future. This might be quantum computers or neuromorphic systems that are inspired by the way the human brain works, explains von St. Vieth: "At present, such alternative concepts that go beyond binary computing are not planned for JUPITER. However, if such a module were to be built, it could easily be integrated using the container design. Not bad for a concept that was originally intended as an emergency solution."

ARNDT REUNING

↑ At the Jülich Supercomputing Centre, Benedikt von St. Vieth heads the department that is responsible for setting up and operating the future exascale computer.

Particularly suitable for AI

JUPITER enables scientists to calculate simulations in greater detail than ever before, whether it be comprehensive calculations for climate research, fluid mechanics, or molecular dynamics. AI algorithms have an important role to play here, says Prof. Thomas Lippert, director of the Jülich Supercomputing Centre: "JUPITER will be ideally suited for artificial intelligence applications." At the core of JUPITER is a booster module with around 24,000 GPUs (graphics processing units) from NVIDIA, which are specially tailored to AI applications. This is supported by a cluster module that is suitable for universal tasks. Thanks to the modular system architecture, which was developed as software at Jülich several years ago, both components can also work hand in hand and thus perform particularly efficient calculations.

← The area on which the new building will stand measures almost 3,600 square metres – the equivalent of about half a football pitch.

Typical man? Typical woman? Typical ME!

Women can't park and men don't listen. Are these just prejudices or are female and male brains actually organized differently? Jülich researchers let artificial intelligence decide. The answer: it's complicated.

Detailed mapping of the brain began with the discovery of the two language centres for sound articulation and language comprehension by the French anatomist Paul Broca in 1861 and the German neurologist Carl Wernicke in 1874. We now know which areas of the brain allow us to speak, see, hear, move, understand, and feel. And yet, every brain is different in detail.

"We are interested in the individual differences in the structural and functional organization of the brain," says Privatdozentin Susanne Weis, head of the Brain Variability group at the Institute of Neuroscience and Medicine (INM-7). A very fundamental difference between individuals is their sex.* Anatomically, it is clearly male or female in most cases. Susanne Weis and her team wanted to know whether these differences are also reflected in the brain and, if so, where.

EACH PERSON A COLOURFUL MIX

In contrast to earlier psychological tests in which women and men competed against each other in the disciplines of spatial thinking, language comprehension, or fine motor skills, the test subjects in the Jülich study did nothing. "We wanted to see what differences there are at rest, detached from any tasks," emphasizes Weis. To do so, the team used artificial intelligence (AI) to analyse over 1,600 MRI images from their own and several large brain studies.

The AI was trained to recognize patterns in 500 functional regions of the brain, classify them as typically male or typically female, and then decide whether the subject was a man or a woman. The success rate was around 70 %. "But why not 100 %?" asks Weis. A closer look at the data revealed that each of the 500 regions tends to fall into the category of male or female – or even both. This results in a colourful mix of male, female, and ambiguous areas for each person. "And that is the case with the majority of the brains tested," underlines Weis. There are, therefore, hardly any purely female or purely male brains. Instead, brains nearly always have either more female, more male, or predominantly ambiguous regions.

MORE SIMILAR IN OLDER AGE

The AI's success rate was higher in some brain regions than in others: In the regions for emotions, social understanding, spatial memory, and language, the AI discovered clear differences between men and women. So is it a case of being a typical man or a typical woman after all? "Stereotypes don't come about by chance," Weis stresses, "but the studies show that there is no such thing as the typical male or the typical female brain – we are all somewhere in between." And it has not yet been conclusively clarified where the differences in the brain regions come from: whether they are hereditary, acquired, or shaped by the environment, lifestyle, or experiences, says Weis.

The researchers also discovered a completely surprising result, as the AI identified many more regions in the brains of young people that could be categorized as typically male or typically female. So do the sexes become more and more alike in old age? Intuitively, the researchers had assumed that the differences between men and women would become more pronounced over the course of a lifetime, for example due to social conditioning. One possible interpretation of the new finding: "Each brain becomes slightly less efficient with age. To compensate for this, it has to find other ways of dealing with certain tasks. There appear to be increasingly fewer different possibilities over time, meaning that we become more and more similar," the neuroscientist assumes. However, the researchers want to take another closer look at these data.

The interpretation of the data is also complicated by the following fact: “The function and organization of the brain is constantly shifting – sometimes within the space of a month,” stresses Weis. The hemispheres of a woman’s brain sometimes work together more and sometimes less depending on the phase of a woman’s menstrual cycle. Weis and her colleagues therefore also advocate recording the hormone status of the test subjects in brain studies in order to better understand its effects.

MORE INDIVIDUAL AND MORE TOLERANT

Since there appears to be a lot of the opposite sex in each of us, Weis believes that mutual tolerance in particular has been strengthened: “The overlap between the male and female characteristics of the brain is enormous – each brain is a unique mosaic of both.”

She therefore warns against falling into the trap of selective perception: “You might categorize a man who parks badly as an exception and forget about the incident very quickly. Whereas the woman who is a good listener is simply pigeon-holed as being a female empath. Gender is one aspect that influences our brain,” says Weis, “but it is only one factor. Many other components make us who we are: a unique and typical individual.”

BRIGITTE STAHL-BUSSE

* Most brain studies conducted to date have not asked which gender someone feels they belong to. Only the biological sex is recorded. However, INM-7 also conducts research into issues of social gender, such as transgender. Social gender refers to a person’s individual identity and social role in relation to gender.

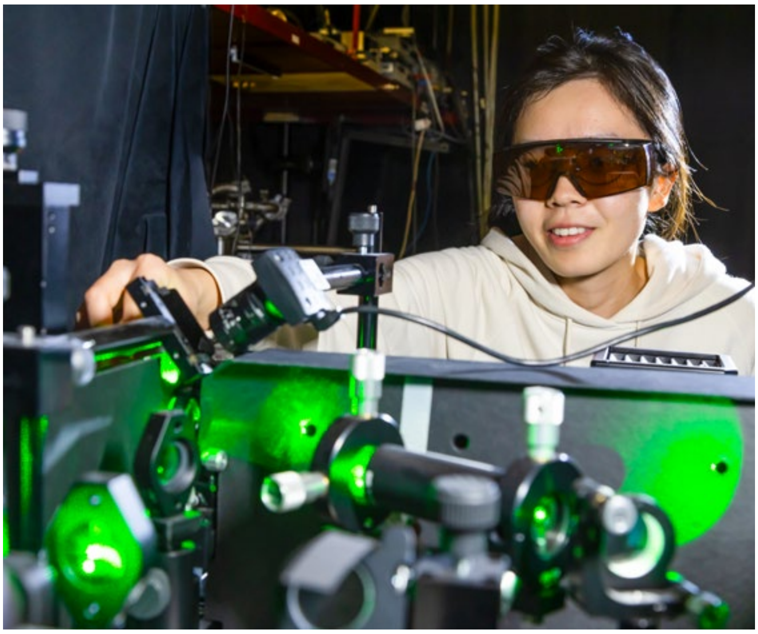
“The overlap between the male and female characteristics of the brain is enormous – each brain is a unique mosaic of both.”

SUSANNE WEIS

↑ Dr. Susanne Weis is investigating whether biological sex is also reflected in the brain.

Ray of light

Thanks to improved measurement technology, Jülich researchers have gained new insights into perovskite solar cells. The fact that their efficiency matches that of silicon solar cells appears to be due to certain defects.



↑ Photoluminescence measuring system: Dr. Genghua Yan was responsible for a large part of the measurements in the perovskite solar cells.

No solar cell is perfect – there are always small irregularities somewhere in the atomic structure of the materials. These defects cannot be avoided – an inconvenience, since they reduce the efficiency of the cells.

Using an innovative method, Jülich researchers have now been able to observe the defects in perovskite solar cells as well as their impact in more detail. They found that there are differences to other types of solar cell, which could explain the high efficiency of perovskite cells.

To understand the observations, you have to look at the energetic structure of semiconductors, the material of the solar cell. Researchers use the band model to do this. Various energy states are shown in the form of bands.

The most energetic electrons are typically located in the insulating valence band. Stimulated by light, they can jump across a gap into another band, the conduction band. Only there can they move and migrate to the electrical contact. This is how current flows. However, some excited electrons lose their energy on the way to the contact and fall back into the valence band. As a result, less current flows and the solar cell is less efficient. However, this rarely happens spontaneously; defects accelerate the rate at which the electrons fall back.

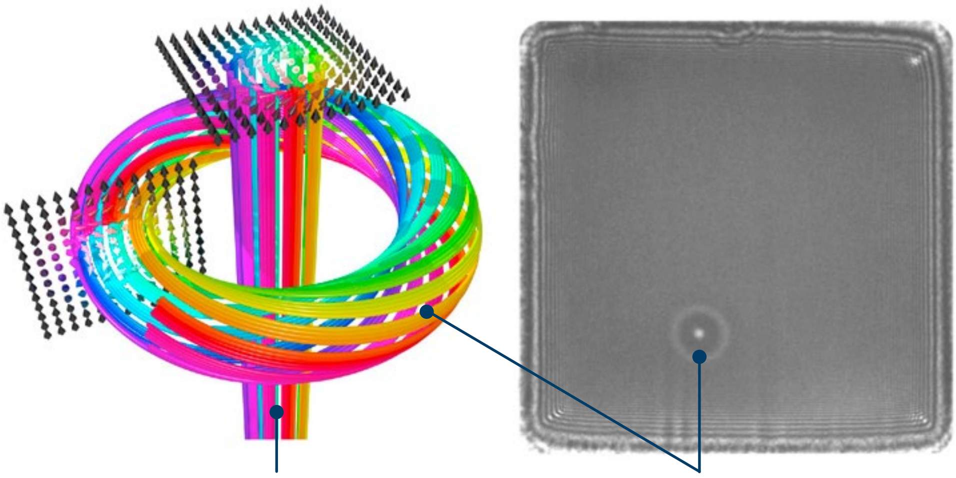
STIMULATED FOR LONGER

"It had previously been assumed that in terms of energy, the responsible defects were predominantly located in the middle between the two bands," says Prof. Thomas Kirchartz from the Institute of Energy Materials and Devices (IMD-3). "However, our investigations show that for perovskite solar cells, defects predominantly occur in the vicinity of the valence or conduction band."

This appears to result in the excited electrons not losing their energy as quickly. Further investigations must now clarify why this defect is predominant in perovskite solar cells.

The observations were made possible by a new type of measurement using photoluminescence. This is a luminous effect in which photons excited by light are emitted. The Jülich researchers have refined the measurement method to such an extent that they were able to distinguish between the various defects for the first time.

BARBARA SCHUNK/CHRISTIAN HOHLFELD



Proven existence of an exotic structure

They are tiny and complex but stable – and they could pave the way for new types of data storage. For the first time, an international team has detected hopfions, ring-shaped 3D magnetic structures, in a solid.

The existence of hopfions was predicted decades ago, but they had previously remained just a theory. Experiments at Forschungszentrum Jülich have now shown that hopfions can actually be found in a magnetic material. The scientists from Jülich, China, and Sweden used a small piece of an iron–germanium single crystal for this purpose. They then created the hopfion rings within the piece. “These magnetic structures have a characteristic size of 10 nanometres and are possibly the most complex structure ever observed experimentally in three-dimensional magnetic crystals,” says Dr. Nikolai Kiselev from the Peter Grünberg Institute (PGI-1).

But that’s not all: “With their complex structure and three-dimensionality, they open up a new area of research and could be ground-breaking for new types of data storage and neuromorphic computers of the future,” adds Prof. Stefan Blügel, director at PGI-1.

The hopfions created by the researchers are coupled to other exotic magnetic structures known as skyrmions. These two-dimensional structures have been causing a stir among experts for around 20 years. Both skyrmions and hopfions behave similarly to ordinary particles, can be spatially localized, and can move and interact with each other under the influence of external forces.

The observed hopfion rings wrap around the skyrmion strings like a ring on a finger. The hopfion rings can easily move up and down along the strings – or together with them in any spatial direction, making them promising candidates for a wide range of future computer technologies.

Creating the hopfion rings was a challenge. The team had to find the right size and shape for the samples over the course of many tests. They then had to spend hundreds of hours at the microscope, mainly at the Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons (ER-C). “With the protocol developed through testing, we can now create the hopfions at any time,” emphasizes Prof. Blügel.

TOBIAS SCHLÖSSER

Disclo

Jan Hendrik Schön was once considered a shooting star of science and a contender for the Nobel Prize. In 2001 alone, 17 papers by the physicist appeared in the renowned journals *Science* and *Nature*. Then came the fall from grace. Two scientists discovered inconsistencies in Schön's data and the fraud was uncovered. Schön had falsified and manipulated data on a grand scale. The University of Konstanz, where Schön had completed his doctorate, spoke of the "biggest fraud in physics in the last 50 years". Schön was ultimately unable to present the raw data to prove the accuracy of his work. To this day, the physicist denies having deliberately falsified the data and figures.

THE QUANTUM PHYSICIST

"Schön's story sent shockwaves through the physics world at the time," says Jülich quantum physicist Vincent Mourik, who was still a teenager at the time. And the wake-up call continued to have an effect during his time as a student at TU Delft. "However, the problem at heart has yet to be solved; instead it has just been kicked down the line," says the 37-year-old. The Dutchman conducts research at the JARA Institute for Quantum Information at Forschungszentrum Jülich and is setting up a young investigator group for his Solid State Quantum Devices Laboratory.

"The problem in science today is not so much that data are being falsified, but rather how we interpret the flood of data: How did I select the data? How do I make the data visible? What success story do I want to tell?" explains Mourik. His own experiences have led him to become an advocate of open science.

Mistakes happen – but how do we deal with them?
A quantum physicist, a biochemist, and an open science manager describe their experiences – and what role open science can play in creating a positive error culture.

sing Everything

Mourik's story: In 2019, the physicist and a former colleague discovered inconsistencies in a *Nature* article published by the Delft working group in which Mourik once completed his doctorate. The paper was focused on the Majorana particle, which had attracted a lot of attention in the community. Mourik and his colleague were somewhat surprised at the sudden progress made by their colleagues, as they had been researching the topic themselves for many years. They asked for the primary data, recalculated everything – and discovered inconsistencies.

"The scientists had only analysed the data that supported their hypothesis," explains Mourik. They had ignored the rest of the data. This scientific malpractice is referred to as results-oriented analysis. "This shouldn't be allowed to happen," says Mourik. After some back and forth, the research group led by Mourik's former doctoral supervisor finally retracted the paper. However, the story is still ongoing: A second *Nature* article had to be withdrawn. Mourik and his colleagues are also examining other published articles for possible errors.

Mourik blames the highly competitive scientific system for the malpractice: "No one can really afford to fail these days. What counts are the publications." The more publications and success stories, the greater the chance of acquiring funding, winning research prizes, and making a career in science. And yet science in particular is a source of creativity, ideas, experiments, assumptions – and mistakes. He sees open science and the sharing of data as an opportunity to shake up the system. The Dutchman advocates open online publishing, including open peer review processes – without the rejection of submissions.

"Platforms should be non-profit and commercial scientific journals should be abolished," he urges. In a digital age, it is no longer appropriate to limit complex research questions to just a few pages in a journal.

"The problem today is not so much that data are being falsified, but rather how we interpret the flood of data."

VINCENT MOURIK

"This tunnel vision for your own data is human, but it is not scientifically correct."

MARTINA POHL

THE OMBUDSPERSON

Biochemist Prof. Martina Pohl can understand Mourik's discontent. She has been working as a researcher for more than three decades and has also been an ombudsperson for good scientific practice at Forschungszentrum Jülich for five years. Anyone who has concerns – whether it be in relation to data, superiors, or publications – is able to contact Prof. Pohl and her two other colleagues. Prof. Pohl is certain of one thing: "Mistakes happen. The main thing is how we deal with them. We should stand by our mistakes and learn from them."

She has not yet experienced a case at Forschungszentrum Jülich like the one Mourik describes, "which does not mean that such cases don't exist." The results-oriented analysis of data – as happened in the case of the retracted *Nature* paper – represents the first step towards scientific misconduct. "This tunnel vision for your own data is human, but it is not scientifically correct. It is a violation of good scientific practice," she explains.

If errors occur, you need to find out why. "For us supervisors of scientific work, however, this also means taking responsibility. We have to create the conditions to ensure that mistakes are not repeated," explains the 62-year-old.

If there are information gaps in the correct application of measurement methods or in the analysis, these must be recognized and clarified by an appropriate explanation.

And if anyone is concerned about a potential "violation of good scientific practice", Prof. Pohl and her colleagues are on hand to investigate the case in question. "If our expertise is insufficient, we would bring other experts on board to help us determine whether the suspicion is justified." In case of doubt, there would be an investigation committee, and the Board of Directors would also become involved in order to draw possible repercussions.

Pohl's view: The scientific system, its complexity, and its hierarchy lead to a situation in which young scientists in particular often find it difficult to point out the misconduct of their superiors: "You are ultimately dependent on the head of an institute or a doctoral supervisor," says Prof. Pohl. As whistle-blowers, they then run the risk of damaging their own scientific career.

Vincent Mourik was also plagued by career worries at the time when he decided to call into question the Majorana paper and, in turn, his former doctoral supervisor: "I lay awake at night and ruminated for hours." It was a difficult deci-

"It's all about producing reliable and transparent knowledge that benefits society."

MONICA GONZALEZ-MARQUEZ

sion. But he reached a moment of clarity: "If as an expert I'm unable to issue criticism, then why did I become a scientist in the first place?"

THE OPEN SCIENCE EXPERT

Like Vincent Mourik, Monica Gonzalez-Marquez from the Central Library of Forschungszentrum Jülich is convinced that open science is an opportunity to make research and errors more transparent. She works as an open science manager and "teaches" researchers in the "subject" of open science. Her message to the scientific community: "It's all about producing reliable and transparent knowledge that benefits society. It is not enough to simply share data or papers and make them publicly available," the cognitive scientist says. Instead, standardized documentation of the data and methods is needed so that scientists can still refer to them years later.

"If the data and methods are documented in a comprehensible way, not only can funding applications be written much faster, but also doctoral theses or other research projects, since users can find and access data and methods without having to perform time-consuming searches," explains the open science manager. But it is still early days: "Open science is still in its infancy. Researchers must learn to work and document in a different way." This should not be seen as additional work, but rather as a foundation from which everyone benefits.

This is also where Vincent Mourik comes in: As group leader, it is not only the success and the number of his employees' publications that count, but much more that they conduct their research in a responsible and comprehensible manner and that they share their results publicly in order to advance science as a whole. Mourik, biochemist Prof. Pohl, and open science manager Gonzalez-Marquez are convinced that open science can help to make science more transparent – and thus also achieve greater transparency in dealing with errors. Mourik's conclusion: "We can do better."

KATJA LÜERS

Open science ...

... aims to disclose all information generated during the scientific research process. This should make it easier to track results and use them further. This openness is also intended to promote cooperation between science and society.

The accelerator

More efficient, faster, and sustainable: catalysis is Regina Palkovits' passion as well as being an important aspect of "catalaix", a project being provided with € 106 million in funding. But accelerating processes is also a crucial part of the chemist's life.

€ 106 million for "catalaix" (see infobox) – that's an incredibly high sum. How did you react to this commitment?
It definitely took us a while to fully grasp the extent of the funding. It started on a very small scale – with a call for tenders and ten pages detailing our vision in condensed form. A lot of very good scientists threw their hat into the ring; that we won in the end was a surprise in itself.

In your opinion, what tipped the scales in your favour?
We were able to showcase our strengths in the final round. This includes a locational strength of Jülich that I aim to build upon: moving quickly from a creative new idea to experimental design and subsequently to a resilient application. This is more difficult in the university sector.

What is "catalaix" about?
We want to create the conditions for recycling plastic waste. With the help of catalysis – the technology that influences the speed of chemical reactions – plastics will be broken down into molecular building blocks that can then be fed into various value chains and material cycles.

You are receiving a lot of money for this project. Does that also come with a lot of pressure?
Pressure is often associated with the belief that you are making the wrong decisions. But if you weigh up all the arguments and your own expertise to the best of your knowledge and belief beforehand, then it is not a problem to take on responsibility. Of course, it might be the case that something doesn't work. But even then, we are still learning something. I'm simply not afraid that nothing will come of it all.

Personal background

Prof. Regina Palkovits has been a director at the Institute for a Sustainable Hydrogen Economy (INW) at Forschungszentrum Jülich since 1 October 2023. She is head of the subinstitute Catalytic Materials for Chemical Hydrogen Storage (INW-2). The 43-year-old is also Chair of Heterogeneous Catalysis and Technical Chemistry at the Institute of Technical and Macromolecular Chemistry, RWTH Aachen University. As a researcher who works at the boundaries of various disciplines, she is particularly passionate about making science as comprehensible as possible – both within science and for the public. She received the popular science award back in 2008.

A project of the century

To mark its 100th anniversary in 2023, the Swiss Werner Siemens Foundation (WSS) launched an unconventional ideas competition for a "project of the century", for which the WSS would provide 100 million Swiss francs in funding over a ten-year period. A total of 123 teams from Germany, Austria, and Switzerland submitted their ideas. The 17-strong team led by Prof. Regina Palkovits and her colleague Prof. Jürgen Klankermayer from RWTH Aachen University ultimately won out. Among those involved from Jülich are Prof. Peter Wasserscheid from the Institute for a Sustainable Hydrogen Economy (INW) and Prof. Ulrich Schurr from the Institute of Bio- and Geosciences (IBG-2).

This sense of confidence that you have – has it helped you in your choice of field? Women are still underrepresented in chemical engineering.
Well, no one ever told me that science and technology are not for girls. And that was good. My favourite subjects were always maths and science. I went to a secondary school for girls – nobody there told me that boys are the better scientists. And I was lucky enough to always find fantastic mentors who encouraged me to go my own way.

Women mentors too?
Actually, I didn't have a female role model for many years. There were very, very few women in engineering. Today, women make up two thirds of my team, without me having done anything explicitly to achieve this. Clearly, a lot has happened in the past 20 years.

Passing on knowledge: for Regina Palkovits, this is just as important as her research.

Plastic waste is to be recycled in the “catalaix” project.

What advice would you give to young women scientists who want to pursue a career in science today?
I believe that women with the qualities usually mentioned as strengths have an ideal starting position – in other words, very good communication skills, empathy paired with expertise in their field, and good self-confidence. They just have to recognize this and demand space. And self-reflection is important. But women are also very good at this.

And how do you see your role in promoting early-career scientists?
I really enjoy helping young people prepare for a career, getting them “on track”. As mentors, we should be aware that – if we do it right – we are a huge accelerator and we set the course for the next 20 years or more.

And now a question that is unfortunately still rarely asked of men: You have two children and can reflect on a successful career.
How did you manage to balance everything?
With a great man (laughs). He took parental leave and brought stability to my working life. The university environment also offers a lot of flexibility – if you demand it. I used to take my children to meetings in a Maxi Cosi car seat or pram. There was always someone willing to walk up and down the corridor with them. Or their grandmother accompanied me to conferences and looked after the children. But it’s true, without this support, it would have been difficult.

You have received many accolades – including being named one of the 100 women of tomorrow. What else do you want to achieve in the future?
The same thing as 20 years ago: I don’t need a Nobel Prize, but I want to put things into practice and have an effect – and I see great opportunities here, not only in “catalaix”, but particularly through the combination of my role as a director at Jülich and holding a chair at RWTH Aachen University.

QUESTIONS WERE POSED BY KATJA LÜERS.

KNOWING-IT-ALL

LITHIUM

The chemical element lithium is a coveted material. It is used in rechargeable batteries and is considered a key material for the transformation of the energy- and transport sectors.

LITHIUM IS

the lightest of all metals. It is so soft that you can cut it with a knife and is so reactive that it is typically stored in petroleum, as it would otherwise react with the oxygen and nitrogen in the air.

TECHNICAL

74% of the lithium used can be found in rechargeble batteries, around 14% in glass and ceramics, and 3% in lubricants. *

THERAPEUTIC

Some lithium salts are used in medicine, for example to treat depression, bipolar disorders, or cluster headaches.

DEADLY

After the Second World War, lithium was used to produce tritium for hydrogen bombs.

BIG BANG

Alongside hydrogen and helium, lithium is one of the three elements that were created directly after the Big Bang.

WHAT DOES JÜLICH DO?

Jülich is continuing to develop lithium-based battery types, but is also researching alternatives.

* As of 2022 according to the U.S. Geological Survey, Mineral Commodity Summaries, January 2022, (https://pubs.usgs.gov/periodicals/mcs2022/mcs2022.pdf, p. 100)

THUMBS UP

“FORSCHUNGSQUARTETT” PODCAST

Neuromorphic computing increases efficiency

In terms of pure performance, AI is far ahead of our biological brain. But when it comes to energy efficiency, our brain is unbeatable. The brain consumes no more energy than a light bulb. Supercomputers, in contrast, require vast amounts of energy. Neuromorphic computing could be the key to making AI more energy-efficient based on the model of the human brain. Rainer Waser from Jülich’s Peter Grünberg Institute – Electronic Materials (PGI-7) spoke about this topic in the latest detektor.fm podcast “Forschungsquartett”.

– DETEKTOR.FM/WISSEN/
FORSCHUNGSQUARTETT-NEUROMORPHES-COMPUTING –

SCIENCE YEAR

Time to stand up for freedom

In 2024, democracies around the world will face a host of challenges. In addition to the threats posed by war and economic conflicts, democratic values are endangered by populist movements and attacks on tolerance and freedom of expression. Scientific institutions have sent out clear signals and made a clear commitment to liberal principles. To mark the 75th anniversary of Basic Law and the 35th anniversary of the peaceful revolution in former East Germany, the Federal Ministry of Education and Research is calling for a discussion on the subject of freedom as part of Science Year 2024.

– WISSENSCHAFTSJAHR.DE/2024 –

JUGEND FORSCHT AT FZJ

Herbal power for a better night’s sleep?

Mia and Zoe Strothmann have an ambitious goal. They aim to make insomnia a thing of the past with the help of lavender and valerian. In January, the two students gave a presentation on the effectiveness of the garden herbs during the regional “Jugend forscht” competition at Forschungszentrum Jülich. 48 talented early-career scientists from the region presented 31 exciting projects in the fields of biology, physics, chemistry, and technology. The best young researchers qualified for the North Rhine-Westphalian state competitions.

– GO.FZJ.DE/EFFZETT-JUGENDFORSCHT2024 (IN GERMAN)–

RESEARCH IN A TOOT

It's a world record! An organic solar module achieves an efficiency of over 14 % for the first time. The gap to silicon modules is shrinking.

Organic photovoltaics (OPVs) are considered an environmentally friendly alternative to silicon modules. OPV modules can also be flexible and transparent. But when it comes to efficiency, silicon has the edge, achieving efficiency levels of over 20 %. However, the record set by researchers at the Helmholtz Institute Erlangen-Nürnberg for Renewable Energy (HI ERN) and Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU) shows that OPVs have a lot of potential.

Link to press release: go.fzj.de/Worldrecord
Link to the video: go.fzj.de/effzett-OPV-Weltrekordvideo

JÜLICH Forschungszentrum
Shaping Change