The Oldenburg way

The University's researchers were among the first to start investigating renewable energies back in the 1970s. Unusual for a university without an engineering faculty, energy research is still one of Oldenburg's flagships. On a tour of various locations on campus and around the city, we follow the unconventional path of the University's energy research from its beginnings to the present day.

By Ute Kehse

The Energy Lab is one of the few architectural testimonies to the early days of the energy transition. The building went into operation in 1982 and was exceptionally energy-efficient for those times. Power was supplied by photovoltaic modules originally manufactured for space travel, which still feed electricity into the grid today, and a wind turbine (not pictured).

It was a pretty crazy idea back then, and people called us crazy, too," recalls Prof. Dr Joachim Luther. "Energy nutcase" was one of the names he and fellow Oldenburg researchers got used to in the 1970s and 80s when people found out they were researching ways to create a national energy system based on renewables. But as he points out: "Our research was a precursor to today's energy transition."

Luther, now 82 and Professor Emeritus of Physics, was one of the first professors appointed to the newly established University of Oldenburg in 1974. And he founded a field of research that still plays a key role today.

The impetus came from the project-based courses offered by the University of Oldenburg as a "reform university" where new methods of higher education were introduced. In these courses, students acquired specialised knowledge by working on socially relevant projects – also in the field of physics. "Those were turbulent times," the researcher recalls. In 1972 the Club of Rome predicted that many raw materials were finite, and the oil crisis of 1973 led to the expansion of nuclear power. "These developments raised the question: Are there alternatives to the current energy system, and to nuclear power in particular?" explains Luther, who had originally specialised in laser physics.

In the study project "Alternative Technologies for the Use of Energy and Raw Materials", which continued into the 1980s, researchers and students soon began to look for answers. "We found the topic so exciting and important that we made it part of our scientific work," Luther explains. The team of physicists, chemists and biologists worked together with the economics department from the outset. "When you move between different faculties, something truly innovative can emerge," he says.

In the following decades energy remained a major focus of research at the University – and it still is.

The Energy Lab:

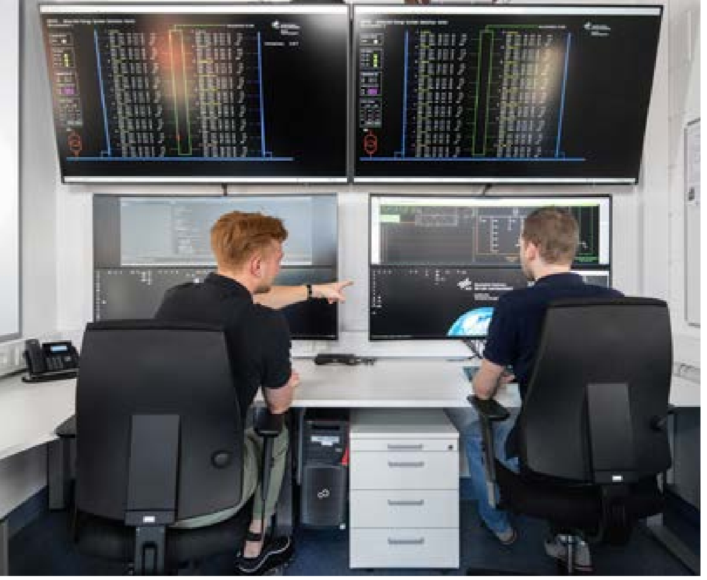
Almost entirely self-powered since 1982

"Luckily, they didn't end up on the scrap metal heap," says Michael Köritz, pointing to three large control cabinets standing in the corridor of building W0, the Energy Lab. The control panels feature an array of electrical symbols, a row of black rotary switches, and analogue current and voltage meters.

For Köritz, who was a research associate at the Energy Lab in the 2010s, these control cabinets dating from the early 1980s are a slice of history. "Today, you could control everything that goes on in here with a smartphone," he notes. But in 1982, when the building was first commissioned, the concept behind it was nothing short of revolutionary. Instead of being connected to the public electricity or gas grids, the octagonal Energy Lab, with its 250 square metres of offices, seminar rooms, laboratories and a light-filled inner courtyard, was designed to be completely self-sufficient energy-wise. The three control cabinets were the linchpin: power came from a 25-metre wind turbine and 336 photovoltaic modules originally manufactured for space travel which still feed electricity into the grid today.

Surplus energy was fed into 104 batteries, and later on into an electrolyser to produce hydrogen for a fuel cell. The building was heated using thermal solar collectors, geothermal probes, a hot water tank and heat exchangers. There was a minor flaw in the system: a backup combined heat and power generator that was supposed to run on biogas had to run on propane gas from bottles instead, because the logistics of ensuring a safe supply of biomass at the University were too complicated. Apart from that, the Energy Lab was completely self-sufficient. "All the technologies we are discussing today already existed back then," says Köritz.

The driving force behind this unique experiment was the research group 'Physics of Renewable Energies'



In the NESTEC Emulation Centre at the DLR's Institute of Networked Energy Systems in Oldenburg, scientists can create accurate simulations of complex power grids.

The 30-metre long wind tunnel, with its 3m x 3m active grid, is the scientific centrepiece of the Oldenburg WindLab.

which formed around Luther in the early 1980s. The researchers wanted to demonstrate the feasibility of their concept in a very practical way. This proved more difficult than expected. "We totally underestimated the problems," Luther admits. "On paper, it all looked easy, but even when the system was up and running we still had a lot of work to do." Sometimes physicists have more faith in feasibility than engineers, the researcher quips dryly.

But despite the experiment's teething problems, the Oldenburg scientists were years ahead of their time: it wasn't until 1992 that the Fraunhofer Institute for Solar Energy Systems in Freiburg (of which Luther later became director) completed a solar house which is now regarded as one of the world's first truly self-sufficient buildings.

However, self-sufficiency was not the Oldenburg team's ultimate objective. Behind the demonstration project was a larger question: Could Germany be reliably powered by energy from non-fossil and non-nuclear sources in the long term? "We collected more and more data and made more and more detailed calculations," Luther recalls. Finally, they arrived at a conclusion: "Technically, physically and systemically, it is possible."

The researchers began to look more closely at energy storage systems and energy converters – specifically, solar cells and wind turbines – with the goal of improving their performance. Another focus was energy meteorology. The aim was to collect accurate data on the fluctuating output of solar and wind energy sources to improve forecasting. The topic was way outside the mainstream back then: at the end of the 1980s, the prevailing opinion was that renewable sources could meet only two to three percent of total energy needs.

Germany now covers about a fifth of its primary energy demand and almost half of its electricity requirements with energy from renewable sources.

Meanwhile the Energy Lab is somewhat past its prime. "You could say it's in a deep slumber," says Köritz, who along with Luther and several others is campaigning for the now vacant building – one of the few architectural testimonies to the early days of the energy transition – to be put back into use.

The WindLab:

A storm in a wind tunnel

The visitors from South Africa are impressed. The delegation from Oldenburg's twin town Buffalo City has just listened to a lecture at the WindLab about the problems of Germany's energy transition. But Princess Faku, Mayor of Buffalo City, sees things rather differently: "Germany is addressing its problems." In South Africa, she explains, blackouts are common and wind energy is rarely used even though there's plenty of it.

In Oldenburg's Research Laboratory for Turbulence and Wind Energy Systems, or WindLab for short, visitors can get an idea of the progress that has been made in harnessing the power of the wind. The scientific centrepiece of the elegant research building is a 30-metre-long wind tunnel through which air is propelled at speeds of up to 150 km/h – as strong as a hurricane, and just as turbulent.

This is made possible by a grid of almost a thousand diamond-shaped metal blades whose configuration can change from one elaborate geometric pattern to another in a matter of moments to generate different degrees of turbulence, similar to what happens in natural wind fields. "It's like cutting a piece out of a storm," is how a team led by turbulence researcher Prof. Dr Joachim Peinke described the process in a well-received paper published in the journal Physical Review Letters.

The ForWind Center for Wind Energy Research of the Universities of Oldenburg, Hanover and Bremen, of which Oldenburg wind research is a member, recently began studying real wind fields and their turbulence dynamics at a large-scale, globally unique research facility: the German Aerospace Center's (DLR) new WiValdi research wind farm offers researchers five measurement masts, each over a hundred metres tall, and two wind turbines fitted with around 1,500 sensors for their experiments.

A third methodological pillar of Oldenburg's wind research, alongside the lab experiments in the wind tunnel and the free field experiments at the wind farm, are the complex simulations carried out on ForWind's two supercomputers. The Energy Meteorology Group – established in the 1990s as a separate research group by Dr Detlev Heinemann – also remains active in the University's wind research.

With these research strategies, the Oldenburg researchers follow in the tradition of the Energy Lab. "We study the wind and its interactions with the turbines not as engineers but from a physics perspective," explains Prof. Dr Martin Kühn, head of the Wind Energy Systems research group and board member of ForWind.

In Kühn's view, the main task now is to increase the "social and ecological value" of wind energy. "As an industry, we have been very successful in recent years in reducing the cost of generating a kilowatt hour of electricity. In future, the focus will be on making wind power more consistently available and ensuring that it maintains the stability of the grid and replaces fossil fuels."

The DLR Institute:

From materials research to systems

The roof terrace of the DLR Institute of Networked Energy Systems provides a fantastic view of the University's sports ground – and of the Energy Lab, whose grey wooden façade dotted with blue solar panels peeks out between the trees. The path joining the two buildings is not a long one, and they have many other things in common. "The Oldenburg site started with energy systems research, then switched its focus to energy-related materials research, and has now gone back to energy systems research," explains Prof. Dr Carsten Agert, Director of the institute.

After Luther left the University in the mid-1990s, his successor, physicist Prof. Dr Jürgen Parisi, focused on the search for new materials that could efficiently convert solar energy into electricity. He was very successful: "The timing was perfect, the photovoltaics research in Wechloy got off to a flying start, expanded and made a name for itself," Agert recounts. This success contributed to the establishment of a new affiliated institute at the University in 2008, the NEXT ENERGY – EWE Research Centre for Energy Technology, which, with its focus on photovoltaics, fuel cells and energy storage, was the forerunner of today's DLR Institute. "Back then, materials and components were a key topic in the discussion about the energy transition, because photovoltaics, fuel cells and batteries were still very expensive," explains Agert, who has headed the Oldenburg DLR Institute since its founding.

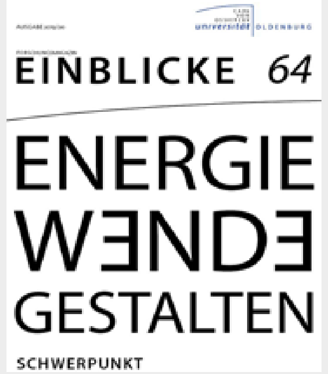
In 2017, when NEXT ENERGY found a new home at the German Aerospace Center (DLR), the photovoltaics industry was in crisis and it had become clear that the main challenge would be to find ways to properly integrate renewables, with their fluctuating energy outputs, into the energy grid. "Consequently, the institute focused entirely on systems research," says Agert. Today, its ten research groups investigate topics such as energy management in smart power grids, integration of energy sectors and the modelling of power grids and energy systems.

The Future Laboratory Energy:

Energy systems go digital

Information technology plays a key role in the energy transition, says Prof. Dr Astrid Nieße, head of the Digitalised Energy Systems Group at the University of Oldenburg and Executive Board Member of the R&D Division Energy at the OFFIS Institute for Information Technology, one of the University's affiliated institutes. "New IT-based approaches are a game changer in the transition to a sustainable energy system," she emphasises. With four en-

Energy research has been EINBLICKE's cover story five times since the magazine was launched. The cover of the first issue published in April 1985 shows the hot water collectors on the outside wall of the Energy Lab.



ergy informatics professorships and a junior research group focused on energy, Oldenburg's Department of Computing Science is well positioned in this field, she notes.

As head of the Future Laboratory Energy, a large collaborative project funded by the state of Lower Saxony, Nieße is working hard to advance smart energy management systems, simulation models and energy scenarios, and to streamline collaboration between the various players in energy systems research. The goal is to integrate millions of photovoltaic systems, battery storage units, heat pumps and electric cars as well as thousands of wind turbines without destabilising the power grid. Easier access to data and software is essential, says the IT expert. Under her leadership, the NFDI4Energy consortium works across Germany to make energy systems research more transparent and – thanks to digitalisation – more efficient.

Nieße and her research group at the University study how artificial intelligence (AI) and the principle of so-called controlled self-organisation can be used to stabilise energy systems. "Controlled self-organisation means that the individual components of the system are equipped with autonomous software that controls their operation – but in a safe mode," she explains.

People involved in the Future Laboratory investigate how this and other energy informatics solutions can be put into practice on a small scale in three "smart neighbourhood" pilot projects in in the north German federal states of Lower Saxony and Schleswig-Holstein. "Neighbourhoods are an important part of the transition, but in Germany, for example, citizen-driven energy systems or energy cooperatives are not yet standard practice," Nieße explains. Which is one more reason for the researchers to simulate concepts like electric mobility in the three pilot neighbourhoods. One of these neighbourhoods – Helleheide – is located in Oldenburg.

Helleheide:
A climate-friendly neighbourhood

It's a Tuesday in March 2023. Two members of the ENaQ (Energetic Neighbourhood Fliegerhorst Oldenburg) project group are giving a guided tour of the former Oldenburg Air Base site. The focus of the tour is a section covering around five hectares in the northern part of the site which is currently under construction: the Helleheide neighbourhood. The whole area is still fenced off; the future living lab is still just a large hole in the ground. But it will soon be home to a climate-friendly neighbourhood where as much energy as possible is generated and consumed locally – not yet fully climate-neutral, but certainly very close to what the Oldenburg researchers led by Joachim Luther envisioned almost fifty years ago. In 2025 around 350 people will move into seven buildings on the site and make communal use not only of the energy but many other things, including a launderette and a meadow orchard.

"It's wonderful that people will actually live there and go about their normal lives," says Prof. Dr Sebastian Lehnhoff, head of the project consortium, which includes many of the stakeholders in Oldenburg's energy sector, and Chairman of the Board of the OFFIS Institute. The project is not just about researching technologies but also about the "interface with humans", he emphasises. Oldenburg citizens were invited to express their wishes and requirements for the climate-friendly residential area in a participatory process that was organised and evaluated by a team from the University led by sustainability economist Prof. Dr Bernd Siebenhüner, among others. One idea that emerged was the "energy traffic light", a small lamp that is plugged into a socket and goes green when there is plenty of green electricity in the grid. "Ideally, users will switch on their appliances during that time," explains project worker Maren Wesselow. The traffic light device offers a simple solution to avoid load peaks within the neighbourhood. A preliminary test in Oldenburg showed that many of the participants used larger electrical appliances more conscientiously thanks to this device – although this didn't save them any money because the tariff system still lacks the necessary flexibility.

A digital platform is also in the pipeline to encourage Helleheide's residents to save more energy. Users will be able to track things like how much money their solar panels are currently earning, or consumption levels in their own household, their street, or the neighbourhood as a whole. "Comparing yourself with others can be very effective," says Lehnhoff.

He stresses that the success of the energy transition hinges not only on new technologies, but on people accepting them. This means that the social sciences play a key role in the current phase of the energy transition, and the University has an important contribution to make. "Energy research at the University has always been transdisciplinary," he explains, adding that over the years an intense and unique interdisciplinary collaboration has developed between the University's energy informatics, wind research, social sciences and economics departments and the affiliated OFFIS and DLR Institutes. "We've been doing this for a long time," Lehnhoff underlines, "and we're really good at it."

Outlooks

How will healthcare change in the years to come?

Prof. Dr
Hans Gerd Nothwang

Medicine and
Health Sciences

"We are facing a major transformation in the healthcare system. Medical services will be concentrated in far fewer locations than at present, and treatments will increasingly take place on an outpatient basis. All current developments and hospital reform plans point in this direction. There is no alternative because medical professionals – already in short supply – will continue to decline in numbers, and this is the only way to meet demands for quality healthcare. What is the point of a hospital that has no staff, or where the procedure that a patient needs is not routine? Centralisation may mean that people have to travel longer distances – especially those in rural areas – but it also has advantages for patients: expertise will be concentrated at those facilities that continue to operate, and the diagnosis and treatment of even rare diseases will become routine there.

The digitalisation of the health industry will also shape this transformation. Tired of having to repeat your medical history to every doctor you go to? That will no longer be necessary once the results of all your medical examinations and information about medications and previous illnesses are stored on your health insurance card or in an app. Having this data at their disposal will give patients a new autonomy. I believe that within the next five years our smartphones will inform us in advance about what we need to bring along when we go to hospital, guide us through all the required examinations during our stay, and receive and store the results afterwards. The expectation here is that medical professionals will know far more about patients in advance, thanks to digital medical records and other innovations – and this will leave more time for actual communication."