

Preventing blackouts

Power generation and consumption must be in balance at all times at a grid frequency of 50 hertz – even with a steadily increasing share of renewable energies. Otherwise there is a risk of widespread power outages, see Spain.

VDE Policy Brief

Edition 2/2025

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Preventing future blackouts

April 2025, the Iberian Peninsula is dark. The electricity system has collapsed. BLACKOUT – the damage runs into the billions. What needs to be done to ensure that the power supply is as stable as possible? In a background paper, VDE identifies important aspects of how to integrate the 6,000 or so large power plants, hundreds of thousands of wind turbines and millions of photovoltaic systems that feed Europe's interconnected grid.

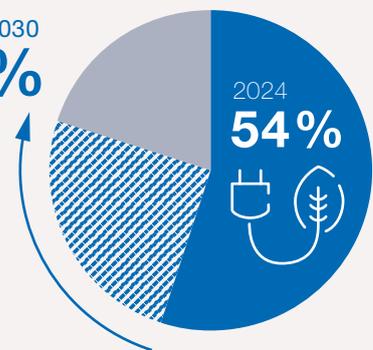
First of all: Europe's grid operators have reserves available and operate additional systems. This means that they can guarantee security of supply even if individual power lines or power plants fail. As a result, the probability of a blackout in Germany is extremely low. Nevertheless, in the course of the energy transition, the electricity system is reacting more sensitively to frequency fluctuations – which were recently recorded across Europe in the run-up to the blackout in Spain and Portugal. In order to ensure grid stability in the future, the following applies in particular:

- **Optimally coordinate decentralized players:** Photovoltaic systems feed a lot of electricity into the grids, electric cars draw a particularly large amount of electricity – information of this kind is extremely valuable for grid stability. It must be recorded and forwarded in real time.
- **Create resilience:** The higher the level of digitalization in the electricity system, the more important it is to have resilient communication systems that function even during power outages and offer the highest level of cyber security.
- **Expand grid reserves:** Renewables are often generated far away from industrialized regions. The large distances limit the load capacity of the grids. Planning and grid operation must therefore rely on additional reserves.
- **Drive forward research:** Wind turbines, photovoltaic systems and battery storage systems feed electricity into the grids via so-called converters. As the number of converters increases, so does the risk of additional frequency oscillations. This is a phenomenon that has only been discovered in recent years and can lead to overloading or even damage to the equipment. Research projects are working on technical solutions.

Share of renewables in gross electricity consumption in Germany

Electricity from renewable energy sources is covering an ever-increasing share of electricity consumption. VDE shows how security and stability in the electricity system can be guaranteed.

Target 2030
80%



Source: BMWF

Roadmap points the way

The work on the Federal Ministry of Economics' System Stability Roadmap is pointing the way for the future. The initiative aims to introduce and implement measures by the end of 2035 to ensure that the electricity grid remains stable even with 100 percent renewables. Of the 51 processes listed in the roadmap, 22 are being carried out under the leadership or with the participation of the Network Technology/Network Operation Forum (VDE FNN) and four by the standardization organization DKE – which is supported by VDE. VDE's Energy Technology Society (VDE ETG) is also heavily involved. VDE is therefore a key player in the System Stability Roadmap.

- 📄 **VDE Background**
Security and stability in the European electricity system
- 📎 **DKE website**
Energy field of activity
- 📎 **Federal Ministry for Economic Affairs and Energy**
System Stability Roadmap
- 📄 **Article from VDE Policy Brief 1/2024**
System sustainability roadmap
- 📄 **Article from VDE Policy Brief 4/2023**
Energy system: Promoting flexibility now

Sustainable thermal energy transition

Finally making full use of renewable electricity

The heating sector consumes more than half of final energy in Germany.

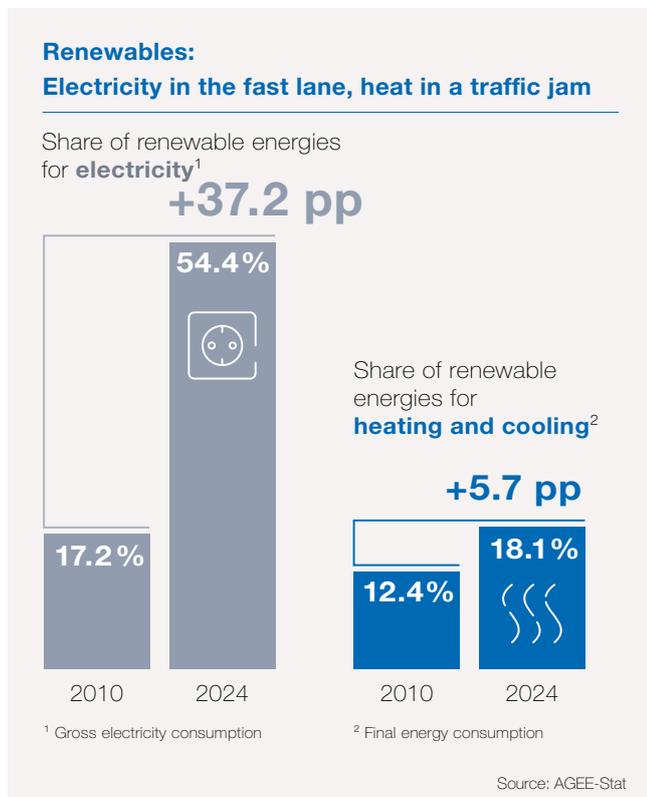
The problem is that gas and oil dominate in boiler rooms. In order to finally make progress with the overdue heating transition, electricity from renewables must finally be utilized comprehensively. VDE shows what is needed.

The share of renewable energies in gross electricity consumption has more than tripled in recent years, reaching 54.4 percent last year. In future, this energy must also be increasingly used to decarbonize the heating sector, especially as alternative energy sources such as wood pellets are only available to a limited extent.

The good news is that established technologies are available to utilize sustainably generated electricity for the heating transition. This is already happening in some areas, such as the increased use of heat pumps in new builds. Numerous efficient options for existing buildings have yet to be utilized.

The main recommendations for action for the heating transition are as follows:

- **Expand renewable electricity generation:** Germany needs more green energy, preferably produced decentrally and close to consumption. The focus should be on wind energy, as the heating sector requires additional electricity, particularly in the relatively dark winter months.
- **Prioritize use:** Renewable electricity should be used where it achieves the highest CO₂ savings. Electricity-heat applications offer the highest efficiency alongside charging electric vehicles and should be prioritized accordingly.
- **CO₂ emissions are more expensive:** Due to the current tax and levy system, heating with oil and gas is in many cases significantly cheaper than using renewable electricity. In order to create real competition, the costs must converge – in particular through a rising CO₂ price.
- **Optimize electricity market design:** To date, private households have generally only been offered a standardized electricity price. Increased consumption therefore leads to an almost linear increase in costs – even if low or even negative prices are charged on the exchange. Electricity market design and tariff structures must be adapted in order to be able to make attractive offers. The smart meter rollout must be driven forward.
- **Facilitate financing:** Heat pumps should become standard in new buildings, and local heating networks may also make sense in larger neighborhoods. Suitable financing models should also be developed.
- **Promote solutions for existing buildings:** In existing buildings, cost-effective electric heating systems in conjunction with heat storage systems can already support conventional heating systems. This applies in particular to domestic hot water heating.



 **VDE Impulse**
Embrace the sustainable thermal energy transition!

 **Website**
VDE ETG

Lack of young talent

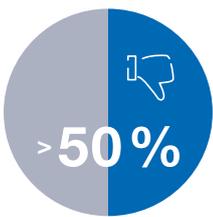
Electrical engineering degree program needs reform

Despite the weakening economy, the annual demand for electrical engineers will not be met. With very low numbers of first-year students and a drop-out rate of 50 percent, there is no improvement in sight. Two new volumes of a VDE study series show: In addition to hurdles in studying, the low participation of women is a central problem.

Dropping out instead of graduating: why electrical engineering students fail

Electrical engineering studies are seen as the key to future technologies and digitalization – yet more than one in two people drop out before completing them. The reasons are clear: firstly, a theory-heavy curriculum without a recognizable link to later practical experience. Secondly, an introductory phase that builds on prior knowledge in maths and physics but does not systematically promote this. Thirdly, a university culture that leaves students to their own devices and makes 'perseverance' a key skill. Universities and students need support:

Drop-out rate



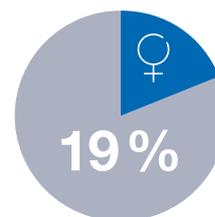
- **Reform the curriculum:** Project-based, practical study formats must be integrated into the degree program on a mandatory basis.
- **Strengthen the introductory phase of studies:** Universities should offer preparatory courses, guided learning opportunities and low-threshold counseling formats across the board.
- **Improve supervision:** Teaching must be quality-assured through binding standards for didactics, supervision and accessibility.

Women are missing: untapped potential

Only 19 percent of first-semester students in electrical engineering are women – of which only 50 percent are German students; young women from Germany are therefore a rarity. The study shows that the problem lies less in aptitude than in structural hurdles. A male-dominated occupational field, stereotypical ideas about technology and a lack of visibility of successful female engineers characterize the image. Even motivated and talented female students therefore choose other study paths.

Several points therefore need to be addressed: Successful female electrical engineers should be systematically integrated into career and study guidance as visible role

Proportion of women among first-semester students



models, for example through media presence, school events or counseling formats. At the same time, schools must provide practical technology-related experience at an early stage. Career counseling, in turn, should be consistently geared towards individual strengths and interests, regardless of traditional role attributions.

 **VDE study series**
Volume 3: Students and drop-outs in electrical engineering

 **VDE study series**
Volume 4: Women and electrical engineering

 **Article from VDE Policy Brief 3/2023**
Inspiring enthusiasm among the next generation

VDE ensures young talent

VDE has been committed to promoting young technical talent for decades – with measurable success. The [INVENT a CHIP](#) school competition, organized in cooperation with the Federal Ministry of Education and Research, brings thousands of young people into contact with microchip development every year. The university competition [COSIMA](#) promotes creative applications in microsystems technology. And VDE is also involved in the new [Skills4Chips](#) program to specifically attract the next generation to semiconductor professions.

Europe's future

It's the youth, stupid!

YES to Europe, YES to the EU! In light of the global crises – from Russia's war of terrorism and China's intention to take over the technological leadership of the world to the unpredictable US policy – it is more important than ever to focus on our own strengths. Our continent has enormous potential – and young engineers who want to shape the future.

EUREL, led by VDE, starts right here: The European umbrella organization promotes and networks students and young professionals from all over Europe.

A particular highlight is the annual [European Future Technology Summit \(EFTS\)](#) held in Brussels at the beginning of September. Over the course of three days, 50 young Europeans will work in workshops with experts from science, research and politics to develop key ideas for Europe's technological sovereignty. This year, the focus is on Europe's comeback in microelectronics, strengthening resilience and the expansion of future-oriented key technologies. Topics that are closely linked to the EU chip law. Participants also gain exclusive insights into the work of the EU Parliament and the EU Commission – knowledge transfer that takes the sting out of any EU bashing.

VDE Summer Reception

At the same time, EUREL uses the exclusive VDE Summer Reception in Brussels – which traditionally takes place at the EFTS and brings together international luminaries from industry and science as well as top politicians – as a special platform and presents the [PhD Best Paper Award](#). It honors pioneering doctoral theses in electrical engineering, electronics and information technology that offer socially and politically relevant solutions. The award puts young research in the spotlight and gives it the attention it deserves.



 [Website](#)
EUREL

 [Article from VDE Policy Brief 3/2024](#)
We. Network. Europe. Young. Technology

Strategic online business simulation game

At this year's [EUREL TOPSIM International Management Cup](#), over 100 participants from nine different countries



competed in 39 teams. The

young people take on the role of the management of a virtual company and decide on marketing, finance and personnel issues. Using realistic scenarios, they learn to analyze data, solve complex problems and work together effectively. Skills that characterize good managers. The winning teams – 2025 from Hungary, Poland and Slovenia – will receive cash prizes and be invited to the EFTS in Brussels.

2025 Field Trip



Another flagship project of the Young Engineers program is the annual [Young Engineers Field Trip](#). Here, around 20 students and young professionals come together in a European country to visit local companies, discuss regional challenges and discuss solutions in the field of electrical engineering, electronics and information technology. The EUREL member organization Association of Polish Electrical Engineers SEP from Poland will host the event in July 2025.

VDE – the technology organization



Your contact

Markus B. Jaeger

VDE Global Head of Political Affairs

VDE Verband der Elektrotechnik
Elektronik Informationstechnik e.V.
Bismarckstraße 33
10625 Berlin

Cell +49 171 7631986
markusb.jaeger@vde.com

Contact details as vCard:



Publisher

VDE Verband der Elektrotechnik
Elektronik Informationstechnik e.V.
Merianstraße 28
63069 Offenbach am Main

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Facts and figures

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 Research and funding projects	over 175
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 Product inspections per year	25.000
 Electrical products bearing VDE's certification mark	billions
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