ENERGY IS US

HIGHLIGHTS 2022

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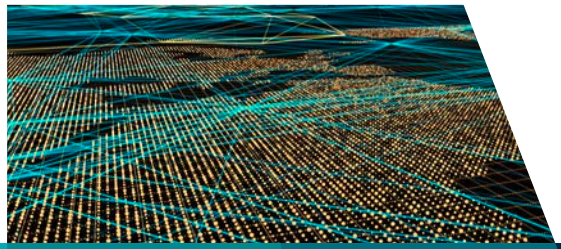
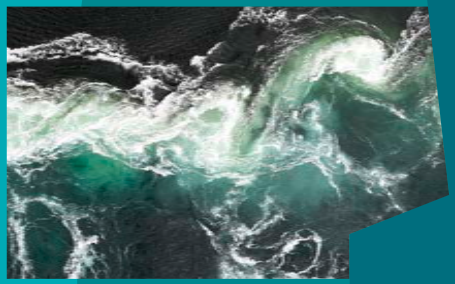
vgbe Highlights 2022



be informed



Foreword

Dear members, dear readers,

We are pleased to present the second issue of the vgbe Highlights in a visually enhanced, more appealing layout. As in the previous year, we would like to provide an overview of particularly noteworthy events and activities of your association in 2022.

2022 was a year that was undoubtedly marked by significant geopolitical and economic challenges, not only for the energy sector. In addition to the existing immense challenges resulting from the ongoing transformation and decarbonisation of our energy system, our sector was confronted with a situation of resource scarcity and very high commodity prices. It was not an easy task to break free from the overdependence on Russian energy imports in the short term after Russia's invasion of Ukraine and still ensure security of supply in a European power system that has been in a challenging phase due to the ongoing nuclear and coal phase-out in Germany, the loss of major nuclear generation capacity in France and the bottlenecks in hydropower due to severe drought.

In an unprecedented show of strength by politicians, the energy sector, industry and consumers, this unique situation was successfully mastered for the time being, supported by quick political decisions, creative and pragmatic solutions and committed and tireless action by all parties involved. Our association has also made a contribution with its network of experts and its services; find out more about this on the following pages.

Despite all the efforts of the past year, one positive aspect at least has emerged: the issue of security of supply, which has been more than neglected in recent years, has regained its place in the target triangle of energy supply, on an equal footing with the aspects of environmental compatibility/sustainability and affordability. This opens up the opportunity to now provide the framework conditions that will enable investments in a climate-neutral electricity supply system of the future, in the expansion of renewable generation, grids and storage facilities and the development of new secure generation capacities. In this regard vgbe will support the industry and thus make a valuable contribution to solving the tasks ahead.

We hope you enjoy reading this year's vgbe Highlights.

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With energetic regards

Dr Georg Stamatelopoulos
Chairman of the Board
vgbe energy e. V.

Dr Oliver Then
Executive Managing Director
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vgbe Impulse

by Dr Oliver Then
Executive Managing Director vgbe energy e.V.

Security of supply –
The dominating issue in 2022

In addition to the immense challenges resulting from the ongoing transformation and decarbonisation of our energy system, the year 2022 was undoubtedly marked by significant geopolitical and economic challenges for the energy sector. Accordingly, our industry is confronted with further tasks and issues.

Supply chain problems and rising energy prices in the course of the recovering economy had already become apparent as the Corona pandemic began to subside. Russia's invasion of Ukraine in February 2022 made it abundantly clear that secure, affordable and sustainable energy supply is one of the central pillars of our society and economy.

In recent years, sustainability and climate protection have been the dominating factors in energy policy for understandable reasons, while affordability seemed within reach and security of supply was postulated as a given. In many countries without significant access to hydropower or nuclear energy, natural gas was considered as the energy resource of the future to balance fluctuating supply of renewables and pave the way for a green hydrogen economy. The increasing European and especially German energy dependence on Russia had been accepted by politicians and also by the business community because the availability of low-cost natural gas from Russia and the reliability of supply based on decades of good experience had not been questioned. By February 2022 at the latest, we had to realise that we had made the wrong assumptions.

Consequently, security of supply became the dominant issue of the past year in many respects. It was not only about the availability of necessary (import) energy sources, lack of gas and availability of necessary power generation capacities, but also about issues such as shortage of skilled workers, logistics and procurement of auxiliary and operating materials.

With regard to the availability of necessary (import) energy sources, the main focus was on the procurement of coal and gas. The discussion about the EU's import dependency on fossil fuels has being intense, and major decisions have been taken to diversify energy supply in general and to achieve independence from Russia in particular. In this context, the expansion of domestic natural gas production and LNG import capacities as well as the development of future European hydrogen production capacities and international hydrogen partnerships are worth mentioning.

Concerning generation capacities, the term "secure generation" has become common parlance, especially in connection with the expansion of volatile renewable generation from wind and solar power.

Europe's CO_2-free dispatchable power plant fleet experienced a historic period of stress. Nuclear power generation fell by more than 30 TWh last year, as at times more than half of France's nuclear reactors were out of service for maintenance and repairs. Hydropower generation also fell significantly last year as extreme drought lowered water levels in reservoirs. Europe found itself in a dilemma: All generation capacities had to be used, including those based on coal and natural gas, in order to guarantee reliable and continuous supply of electricity. To this end, especially in Germany, coal-fired power plants were brought back into the market from reserve at very short notice and already decided decommissionings were suspended, albeit for a limited period of time; the same applied to the three remaining nuclear power plants.

However, due to the loss of Russian coal, new options had to be found to procure sufficient fuel. Although coal is available in sufficient quantities on the world market, the question of conditions and transport routes arose. The planned coal phase-out was particularly noticeable in Germany, as logistics had already adjusted to declining freight volumes with limited inland waterway freight capacities. Moreover, the situation of inland navigation was further aggravated by low water levels of rivers, so that transport from the European seaports to the power plant sites developed into one of the most challenging problems.

There was also a lack of coal wagons for rail transport and a shortage of train drivers due to the high number of sick leaves. This sometimes meant that coal had to be transported over hundreds of kilometres by lorry in order to ensure unit operation.

As a result, fossil-fuelled power plants made a significant contribution and secured supply, albeit at the price of significantly increased CO_2 emissions.

In this context, other aspects of supply security became apparent, such as the personnel situation at the power plant sites – here, too, adjustments had already been made to the planned coal phase-out. Some shift personnel were brought back from early retirement in order to be able to start up the plants again. The situation was similar when it came to carrying out urgently needed maintenance measures for the recommissioning of power plant units that had already been decommissioned . There was also a lack of experienced personnel to carry out maintenance work needed.

The shortage of skilled staff was also felt on the part of industrial plant operators. vgbe Technical Services of vgbe energy service GmbH were able to provide valuable assistance: Due to a shortage of personnel at the production site of the chemical industry, vgbe energy service GmbH prepared the tender documents for the remanufacture of a superheater at the site's coal-fired power plant in order to be able to operate the units for a longer period of time.

Power plant operators were confronted with similar procurement problems for auxiliary and operating materials. Among other things, there were shortages of hydrochloric acid and flocculants for water treatment and of ammonia for denitrification of flue gases, due to production restrictions caused by a shortage of raw materials and high energy costs.

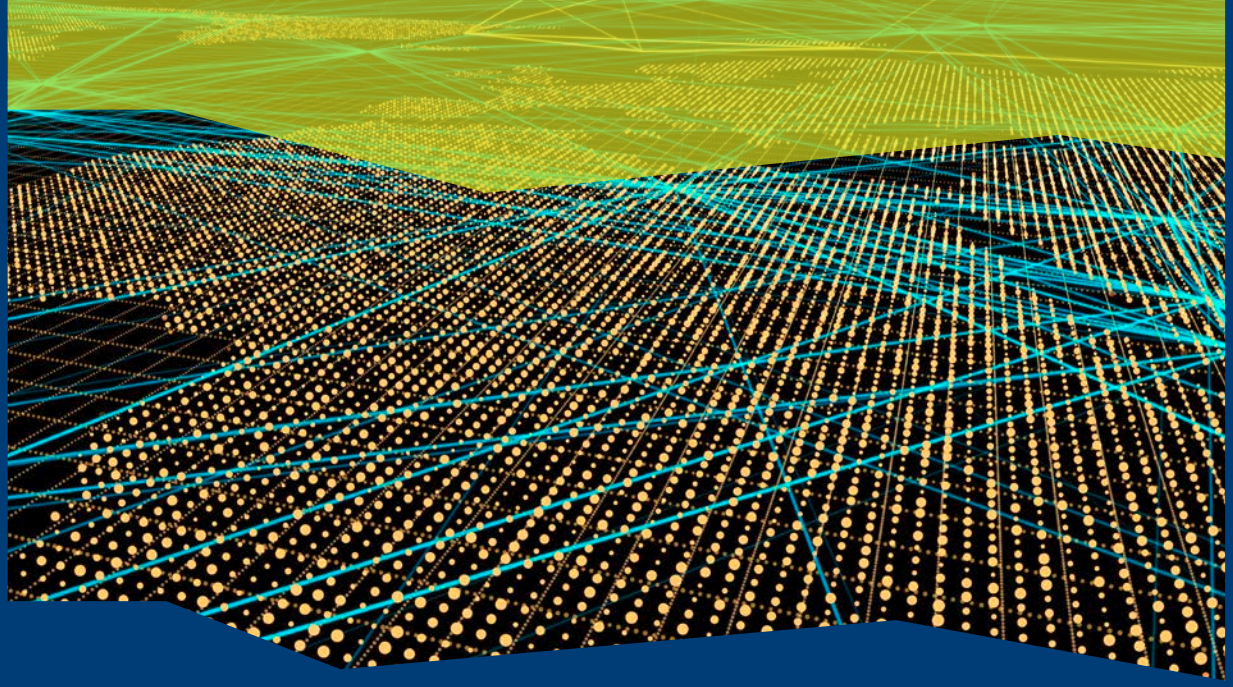
However, security of supply in 2022 required reactivation of coal-fired plants and resulting higher CO_2 emissions. If the energy system is to be further decarbonised, substantial investments in CO_2-free capacities are needed. Especially in the case of controllable energies such as hydropower, nuclear power and gas (natural gas as a bridge to decarbonised gases and hydrogen), considerable efforts are to be made to balance out the fluctuating feed-in from solar and wind power and to be able to guarantee supply and grid stability.

European policy-makers and national governments are called upon to create the right framework conditions to enable the necessary investments in the energy system of the future. The challenges are enormous. An increased expansion of renewable energies in electricity generation is necessary, whereby existing barriers in the area of licensing procedures have to reduced and the market design optimised. Furthermore, additional infrastructure in the area of energy storage and grids for gas, hydrogen and electricity have to be expanded.

Until the energy system of the future is in place and can guarantee secure and independent supply of electricity and heat, we have to provide dispatchable power and balance the generation of renewable energies. We still have several options, but we have to choose the right mix of options. We cannot pretend as if we were already in the future disposing of sufficient green gas and other deployable renewable technologies. In this context, complex issues of technology, affordability, climate protection and permitting need to be addressed. It is up to politicians to set the necessary framework.

Parallel to the expansion of renewables, digitalisation is also an important aspect of security of supply. Digitalisation is essential for the transformation of the energy system. The critical infrastructure has to be protected and sufficiently available grids are a must so that optimised processes such as demand side management, smart metering, intelligent maintenance strategies, etc. can be realised.

The topic of digitalisation is high on vgbe's agenda. In November 2022, we held our second **specialist conference on "IT security for energy plants"**, where topics such as resilience to cyber attacks, attack detection, guidance, SIEM solutions (Security Information and Event Management) and auditing according to the IT security catalogue were covered.



The network of vgbe experts discussed intensively all these aspects and challenges at committee and event level and opportunities have been created to find bilateral or multilateral solutions.

The diverse and very different tasks of the past year have once again highlighted the value of a strong vgbe community. Our members have succeeded in optimising plant operation without neglecting climate protection and occupational safety.

As an operators' association, vgbe energy e.V. is called upon to evaluate the technical options in an open-minded manner and to support our member companies in the implementation of these options. In addition, we use our findings to make our members, together with our partners such as BDEW and Eurelectric, heard by political decision-makers in order to support a fact-based discourse.

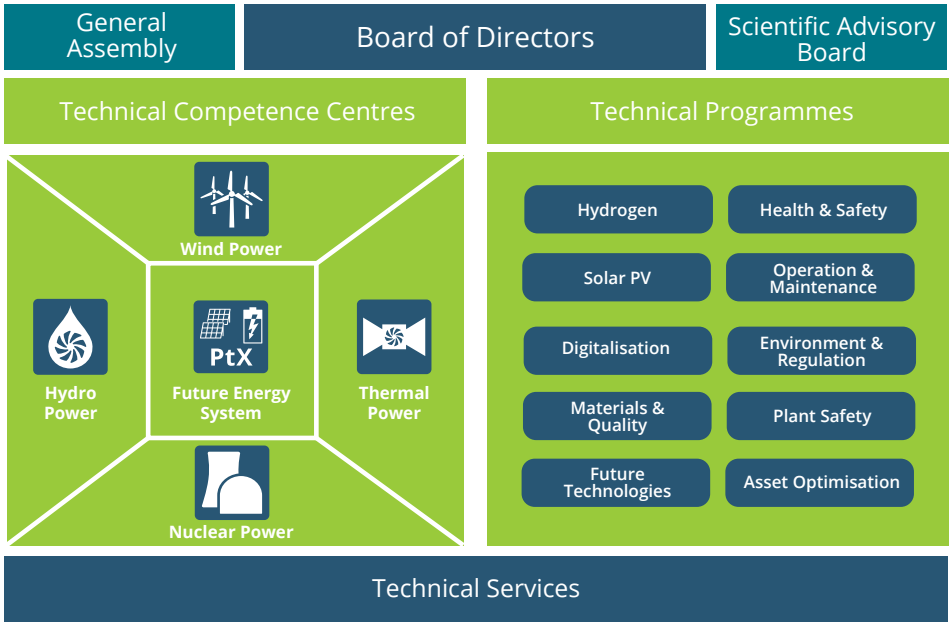
Status **VGB2025**

After the strategic realignment of the association and the successful rebranding and renaming, we were also able to complete the fundamental structural and operational restructuring within the framework of the "VGB2025" project. The basic structures and, in part, already details of the working bodies of the five "Technical Competence Centres" were adopted by the vgbe Board in the autumn meeting 2022. At the same time, the General Assembly, which was held in the framework of the vgbe Congress 2022, approved of the new membership fee regulations, which will provide our association with an adjusted business model. On the one hand, this ensures sustainable financing for vgbe against the background of the transformation of the energy industry and the development of new generation and storage technologies. On the other hand, we are also increasing the attractiveness for existing and potential member companies through a more transparent, modular and flexible participation model.

vgbe
Technical Competence Centres, Technical Programmes and Technical Services

In future, the main activities of the association will be grouped into two areas: Firstly, our five Technical Competence Centres, in which the classic working committees and activities and services assigned to them are organised. Secondly, our "Technical Programmes", which cover or develop overarching or completely new topics. These form the basis for the exchange of experience and cooperation, both between members and with other interest groups in the sector. These two areas are complemented by technical services, which are mainly provided by vgbe energy service GmbH.

vgbe organisation chart as of July 1, 2022



The Technical Competence Centres initially comprise the technologies

- Wind Power,
- Hydro Power,
- Nuclear Power,
- Thermal Power and
- FES (Future Energy System).

In addition to the classic fossil fuels coal and gas, the thermal sector also includes biomass and thermal waste utilisation, including sewage sludge incineration. The FES serves as a think tank for new technologies, such as hydrogen, power-to-X, sector coupling, biomethane, energy storage and photovoltaics, as well as for systemic issues in the future energy system.

The Technical Competence Centres with their working bodies concentrate on the important focal points relevant to all member companies in the areas of plant and operational safety, technical exchange of experience, expertise for external communication, development of standards and organisation and coordination of joint research projects as well as events.

By replacing the TAB with the five Steering Forums, we are adding great value for the vgbe community. Due to their focus and specialisation, the forums can react in more detail to the respective challenges in connection with the technologies they oversee, or anticipate them pro-actively and thus initiate the necessary association activities in good time.

Particularly in the area of thermal plants, we are facing major tasks, even after 2030, because until the market ramp-up of hydrogen and sufficient storage options, we will certainly continue to need controllable thermal plants in Europe, i.e. in particular gas-fired power plants, for a stable and secure energy supply.

Dr Frank Neumann (RWE Power)
Chairman of the vgbe SF "Thermal Power"

The following flat hierarchy applies for the working bodies:

- Steering Forum (SF)
- Technical Committee (TC)
- Working Group (WG)

The Steering Forums (SF) are to serve as platform for the exchange of experience between industry executives for their respective technology areas, focussing on general and overarching generation and storage topics, on strategic technical and ecological aspects and on medium to long-term research and development priorities. To this end, they advise the vgbe Board on all issues relating to power and heat generation as well as energy storage and sector coupling, and provide strategic orientation and additional suggestions on the vgbe's range of work and on the development of its portfolio of products and services. Additionally, the Steering Forums are responsible for the further development of their portfolio, committee structure and projects/programmes. In this way, they provide vgbe Offices with essential input parameters for preparing of the association's budgets and medium-term planning as well as membership fees. They also supervise the technical activities of the assigned vgbe Working Committees and Technical Programmes. Participation in the committees of the Technical Competence Centres still requires membership in the association.

Technical Programmes

Technical Programmes represent a project-oriented approach to the implementation of one or more combined activities of cross-cutting or innovative nature in accordance with the objectives set out in the vgbe Statutes. Technical Programmes provide more flexible implementation conditions in terms of participation, funding and structuring compared to the contributory committee approach in the vgbe Technical Competence Centres.

A Technical Programme is time-limited and has a clear focus on the objectives to be achieved and the deliverables. For example, a Technical Programme may consist of:

1. Developing and coordinating studies on topics of common interest
2. Initiation, coordination and/or implementation of joint research projects
3. Development of databases or other tools and services
4. Structured exchange of experience on cross-cutting issues which more than one technology and which can serve as a starting point for further activities and coordination

A Technical Programme can also be carried out in cooperation with other associations, research institutes, laboratories, industry partners or universities in order to achieve a broader exchange.

The newly launched Technical Programmes in the Competence Centres Hydropower, Nuclear Power and FES underline the range of implementation options outlined above. It has become apparent that there is a great deal of interest in the separately funded, project-oriented work. Moreover, it was perceived as a great enrichment in the vgbe community that now also non-vgbe members can participate in goal-oriented project work. On the association side, we have succeeded in arousing interest in our activities and convincing of the value of association membership in a number of places.

The new membership fee regulations reflect the modular and more transparent financing approach. In future, the membership fee will be divided into a basic fee and technology-specific fees for the selected Competence Centres. The basic fee for financing the basic structures of the association will be determined by the Board on the proposal of vgbe Offices. The Steering Forums are given extensive autonomy in the design of the committee structures and the associated expenses. In this way, they create the basis for vgbe Offices to develop proposals on the amount and allocation modalities of the technology-related membership fees. All fee components are finally approved by the General Assembly. Financing of a Technical Programme is determined individually and apportioned to the partners involved.

vgbe Technical Advisory Board (TAB) replaced by vgbe Steering Forums

For many decades, the vgbe Technical Advisory Board, as the highest working body of the association, was the link between expert committees and Board and was responsible for monitoring and steering the work of the association. High-ranked representatives of member companies have headed the TAB in recent years. Due to the introduction of the Steering Forums as the highest bodies of the Technical Competence Centres, the Technical Advisory Board, under the leadership of its last chairman, Prof Nikolaus Elze (EnBW), held its last meeting at EnBW in Hamburg on November 24, 2022. Fortunately, the majority of the TAB members will continue their voluntary commitment to the association in one of the Steering Forums.

It was only logical that the constituent meeting of the SF "Thermal Power" also took place following the last TAB meeting. As before, a large part of the working committees will be located in this SF, including some higher-level topics such as environmental protection or occupational health and safety. Dr Frank Neumann (RWE Power) was elected chairman of the SF "Thermal Power". The constituent meeting of the Steering Forum "Future Energy Systems" is scheduled for the end of March 2023.

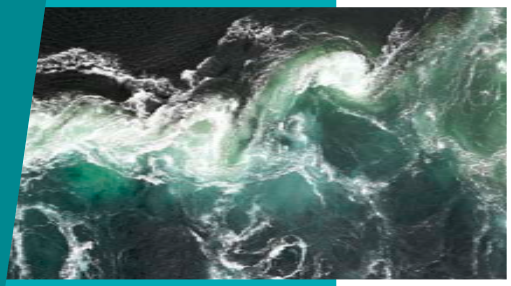
The Steering Forums "Hydropower", "Wind Power" and "Nuclear Power" already met in autumn and elected the following chairpersons:

- SF Hydropower — Dr Karl Heinz Gruber (VERBUND hydropower companies)
- SF-Wind Energy — Stefan Bogenberger (SW München)
- SF Nuclear Power — Jörg Michels (EnBW Kernkraft)

TAB members

By participating in the various Steering Forums, member companies will have much greater influence in shaping committee structures, work content and technology-related membership fees in the future. Thus, the association will respond even more strongly to members´ needs and the requirements related to the transformation of a new energy system. This will strengthen the entire vgbe community and as community of solidarity in the energy sector, we can make our contribution to climate-neutral and secure future energy supply.

RENEWABLE ENERGIES



2022: Wind and solar energy – For the first time the most important energy sources for European electricity generation

The year 2022 was very successful for renewable energies in Europe. For the first time, wind and solar power provided more electricity than gas, coal, nuclear energy or hydropower. More than one fifth, exactly 22.3 %, of the electricity generated in the EU was based on these renewables[1]. Compared to the previous years' results, the increase amounted to 24 % for solar energy – another record value – and 8.6 % for wind energy.

The record growth also helped Europe overcome a "triple crisis":
1. The constraints on natural gas supply due to the loss or withdrawal of supplies from Russia
2. A significant drop in hydropower generation due to prolonged periods of severe drought across Europe
3. Unplanned unavailability of nuclear power plants

The balance of trade and the independence of energy supply from imports, which is to be further expanded, are also noteworthy: In 2022, solar power generation replaced imports of natural gas amounting to around 35 billion cubic metres, corresponding to around 49 billion Euros in costs based on the average trading price in 2022 for natural gas in Europe of 121 Euros/MWh.

Nevertheless, much remains to be done. These individual successes have to be consolidated in both technical and regulatory terms. This is the only way to achieve the ambitious expansion targets for renewable energies and the decarbonisation of the energy sector in the EU in 2030 and beyond.

[1] Source: European Electricity Review 2023. Ember's analysis of the EU electricity transition in 2022: what happened in 2022, what can we expect for 2023? www.ember-climate.org

Interview

with Dr Thomas Eck and Sebastian Zimmerling
on the vgbe Position Paper "H2-Ready"

Hydrogen – An important topic in the association's work **vgbe publishes its Position Paper "H2-Ready"**

Climate neutrality and security of supply are the core issues of our industry. In this context, hydrogen (H_2), which is preferably produced on the basis of renewable energies, plays a central role. The Russian war of aggression on Ukraine has brought the importance of hydrogen and thus the stability and independence of our energy supply even more to the fore. Renewable energies and green hydrogen will replace the fossil age and make their contribution to an energy supply that is as climate-neutral and independent as possible. The vgbe member companies are aware of their responsibility and are actively taking up the challenges. In doing so, the association supports its members and, together with the vgbe community, works out those technical facts that contribute to bringing about solutions that meet with the broadest possible consensus and take equal account of economic and socio-political interests.

In the previous "vgbe Highlights 2021" we already reported in detail on the activities of the association with regard to a rapid market ramp-up of hydrogen. These intensive activities and related projects were vigorously pursued during the reporting period. In September 2022, the vgbe Position Paper "H2-Ready" was published as a contribution to the current debate on the definition of "H2-Ready" in the energy sector.

The position paper explains the technical, economic and regulatory challenges for the use of hydrogen in the energy sector and brings the perspective of the vgbe member companies into the discussion on the use of hydrogen for energy.

The following points were identified as the core statements of the position paper:

1. A plant is considered to be H2-ready if it can be operated with 100 % hydrogen during its service life – if necessary, in various retrofitting steps.
2. The use of hydrogen is technically possible in gas turbines, engines and industrial boilers as well as fuel cells. The economic viability of such plants is not yet clear.
3. Higher NO_x emissions are to be expected with hydrogen combustion compared to natural gas combustion. This circumstance should be taken into account with practicable specifications for the approval and promotion of plants.
4. The requirements to be met by materials have to be transferred to German regulations and defined. Any data gaps have to be filled accordingly.

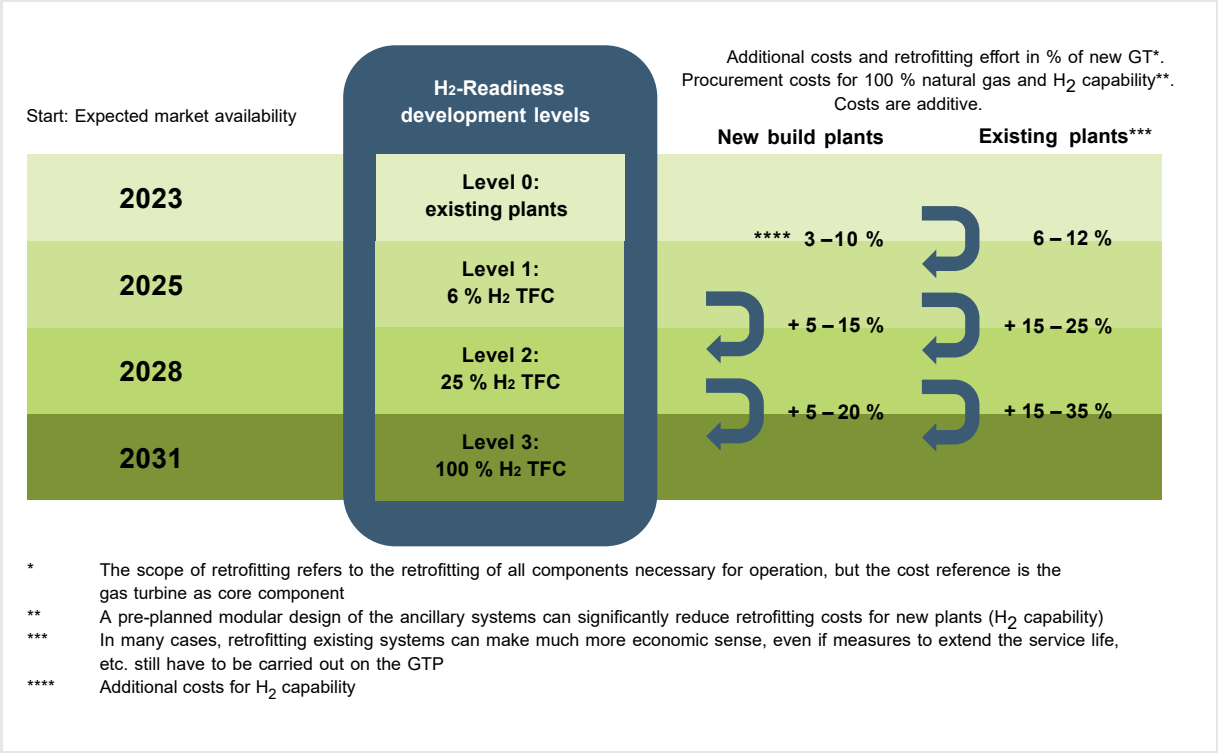
The editor of this Highlights interviewed the two contact persons at vgbe, Dr Thomas Eck, Head of Power Plant and Environmental Technology, and Dipl.-Ing. Sebastian Zimmerling, expert on hydrogen, fire and explosion protection, about the intention and development of this **position paper** and subsequent further activities.

> What was the impetus to define the term "H2-Ready" from vgbe's point of view, or to describe what is meant by "H2-Readiness" from the operator's point of view?

Thomas Eck: In the earlier discussions around the topic of "Carbon Capture and Storage" (CCS), which is about the capture and storage of CO_2, the term "CCS-ready" found its way more and more into the discussion, without having a definition or a common understanding about the actual definition behind this term. We have also observed a similar development with the topic of hydrogen and "H2-readiness" – this term is also increasingly used in current discussions, especially political ones. However, there is also a lack of common understanding as to which requirements must be fulfilled in order to be "H2-ready". vgbe naturally sees itself as the "voice of operators" on this topic as well, so it went without saying that the association would act and draw up a joint position paper in order to avoid overly stringent requirements or requirements that are imposed on operators too early. In addition, there were numerous individual considerations and opinions on the topic, which we have now bundled in order to put communication with legislators, politicians and social groups on a solid basis, i. e. with clear definitions, because the conversion to hydrogen is not trivial in terms of technology and engineering.

Dr Thomas Eck (l.) and Dipl.-Ing. Sebastian Zimmerling (r.)

Sebastian Zimmerling: Our position paper is also the first operator paper with a clear technical focus. The position papers of e. g. plant manufacturers and gas grid operators, which also exist on this topic, do not comprehensively take into account the aspects that we, as a technical association, illuminate from the operators' perspective. In addition, current political developments have accelerated the need for a definition, because in the case of complete decarbonisation, hydrogen and hydrogen derivatives, which we have deliberately not dealt with in the paper because issues related to these are still not settled, will remain the "only fuel" alongside biomass, biogas and waste in Germany in order to ensure security of supply and grid stability in the face of fluctuating feed-in from renewables.



* The scope of retrofitting refers to the retrofitting of all components necessary for operation, but the cost reference is the gas turbine as core component

** A pre-planned modular design of the ancillary systems can significantly reduce retrofitting costs for new plants (H_2 capability)

*** In many cases, retrofitting existing systems can make much more economic sense, even if measures to extend the service life, etc. still have to be carried out on the GTP

**** Additional costs for H_2 capability

> How did the association determine the perspective of its member companies?

Sebastian Zimmerling: First, we internally considered potentially affected circles. Here it was again very helpful that we had already established our vgbe-internal, interdisciplinary working group H2@vgbe. In this topic, too, colleagues from the fields of gas turbines, industrial and combined heat and power plants, gas engines, materials and quality assurance as well as steam generators cooperated very closely and brought their working groups together through our internal vgbe group. In addition, we asked interested parties, who proactively got involved, what their expectations were and worked out the issues in a joint kick-off workshop with prioritisation of the topics. The individual chapters were largely written by the vgbe committees and groups themselves. The input was then bundled at vgbe Offices and finalised in several harmonisation rounds.

> What activities are the vgbe members developing to upgrade their plants to H_2 (co-)combustion and what support does the association offer in this process?

Thomas Eck: Numerous members are in the process or considering retrofitting their plants or planning and building new plants. The position paper provides a clear statement on the definition, field of application and feasibility in economic, regulatory and material-technical terms. In addition, the exchange of experience takes place in our committees, which is one of the core tasks of our association and a pillar of our vgbe community. vgbe also responds to specific enquiries and is developing further assistance. In the area of regulations, material issues/materials, there are various projects and applications, such as the research project "HyPower" funded by the 7th Energy Research Programme of the BMWK (German Federal Ministry for Economic Affairs and Climate Action) or the AiF project "Surface Influence on Hydrogen Embrittlement", as well as the direct exchange with member companies on the available experience and material qualification.

In addition, a new committee was created as part of the restructuring of vgbe, i. e. the Technical Committee "Hydrogen", which is based in the Technical Competence Centre "Future Energy System" and which deals with all matters relating to the topic of "hydrogen production".

> Are there any further activities after publication of the position paper?

Sebastian Zimmerling: As already mentioned, the topic of "hydrogen" plays an important role at vgbe, because the climate-neutral and sustainable development of the economy and society are part of our vision and this goal is no longer conceivable without hydrogen. We have complemented the Position Paper "H2-Ready" with the "Factsheet: H2-Readiness for Gas Turbine Plants". The factsheet was finalised in the last quarter of the reporting period and published at the beginning of 2023. The factsheet describes in detail the requirements for gas turbine plants in the different scenarios of H_2 (co-)combustion, i. e. from 6 % H_2 share of the thermal firing capacity to 100 % H_2 use.

In addition, the association also provides input via Technical Programmes, research projects, committee work, databases and our vgbe Standards. At vgbe, the topic of "hydrogen" is understood and lived as an interdisciplinary and cross-sectoral issue. The practical relevance, the application reference and our standardisation make a rapid market ramp-up possible in the first place. Experience from other areas (thermal power plants, renewable energies) can be quickly and easily incorporated into the market ramp-up, thus minimising errors and dead ends in the development process.

Thomas Eck: Besides all these activities that Sebastian has mentioned, the exchange of experience and transfer of knowledge naturally also takes place in the vgbe events. At this point I would like to point to the **Hydrogen Industry Day**, the first edition of which we held very successfully with our partners at the Deilbachtal Energy Campus in March 2022. The focus of the 1st Industry Day was on the topic of "H2 readiness & security of supply". The continuation with the **2nd Hydrogen Industry Day** in February 2023 in Wismar had the guiding theme "Lessons learnt!?" and also the 3rd edition at the end of March 2023, again in the Ruhr area, describes the further progress under the motto "Paths to success". These activities with a focus on the exchange of practical projects are rounded off with more regional reference by the quarterly "Essener Wasserstoffstammtisch" (regular meeting of hydrogen experts).

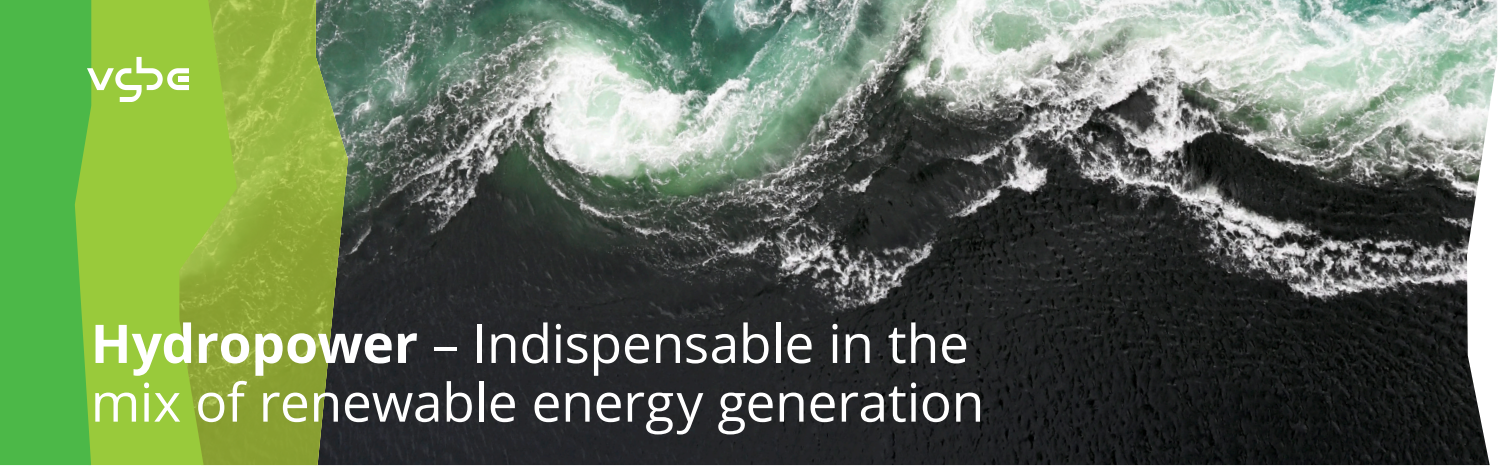
The strength and versatility of vgbe is also particularly evident in the range of activities from the regional meeting to international exchange, e. g. within the framework of the "Materials & Quality Assurance" workshop or the joint TENPES-vgbe workshop 2023 in Japan. In addition, the laboratories of vgbe energy service GmbH are also involved with their expertise.

The results of our position paper are also incorporated into a joint BDEW-vgbe document "Process Guideline: electricity and heat generation based on renewable and decarbonised gases for the transformation of gas-based generation plants".

> What is the benefit of such a joint BDEW-vgbe “Process Guideline”?

Sebastian Zimmerling: The Process Guideline takes a “cross-sectoral” approach that combines policy, environmental protection (limit values), security of supply, economic viability and technical feasibility and thus presents a more holistic view than just the vgbe Position Paper alone, which, as already mentioned at the beginning, focuses on technical aspects.

Thomas Eck: Next to the technical aspects, the Process Guideline will address other aspects such as the importance of hydrogen for electricity and heat generation, technical challenges for the switch to hydrogen, which roughly corresponds to the vgbe Position Paper, regulatory challenges for H2-ready gas power plants and gas power plants as part of a hydrogen economy. This broader positioning and a corresponding abridged version will also achieve a greater reach and perception, also in the (political) discussion. In any case, the association has placed the position of its members in the appropriate places in this enormously important, current topic of the energy industry.



Hydropower – Indispensable in the mix of renewable energy generation

The expansion of renewable energies is one of the most urgent tasks and challenges in designing and implementing the energy transition in order to decarbonise industry and society to the necessary extent while at the same time ensuring affordable security of supply. The past year has shown very clearly that work on these issues has to be done at full speed.

On the one hand, anthropogenic climate change must be curbed and, on the other, dependence on energy imports must be reduced. Both problems can only be solved through the massive and rapid expansion of renewable energies. In the future, it will be necessary to make optimal use of all renewable energies in order to meet the increasing demand for electricity in industry and society, for mobility and, above all, for the market ramp-up of green hydrogen in order to be able to cover this demand.

In addition to wind and solar power, hydropower has an important function in maintaining security of supply, as already described in detail in the vgbe Highlights 2021. In contrast to the fluctuating feed-in from solar power and wind energy, hydropower is the only controllable, flexible renewable energy and thus indispensable in the mix of renewable energy generation.

vgbe Technical Programme **“The Value of Hydropower”**

In the present vgbe Highlights 2022, the problems in connection with the expansion of renewables have already been pointed out elsewhere. Political will and social consensus are often not enough to realise concrete projects. The past has shown that, above all, an open and constructive discourse with all stakeholders, transparency and conviction are needed to implement the necessary expansion targets.

The hydropower industry in Europe is increasingly facing resistance that not only jeopardises the sustainable development of hydropower but also hinders the energy transition in line with energy, climate and biodiversity goals. In order to improve a wide acceptance of hydropower, vgbe has implemented the Technical Programme “Value of Hydropower” during the reporting period. The programme is open to hydropower operators and producers to reinforce the importance of the positive impact of hydropower on the sustainable energy future in Europe.

In addition to providing flexibility to the European electricity system, the hydropower industry in Europe also delivers various economic and societal values such as security of supply, local employment and prosperity, protection against floods and droughts, drinking water supply, irrigation, navigation, recreation and tourism, which need to be taken into account in order to recognise hydropower as an essential contribution to the energy transition and as an important European industry.

The Technical Programme "The Value of Hydropower" was to bring together the individual measures that have already been implemented in recent years to raise awareness of the positive impact of hydropower on a sustainable European energy future.

The aim of the programme was to establish a long-term structured campaign to significantly increase the importance of hydropower generation for a sustainable energy future in Europe. The campaign was carried out under the umbrella of vgbe with the support of VUM, Verfahren Umwelt Management GmbH and a consortium around AFRY.

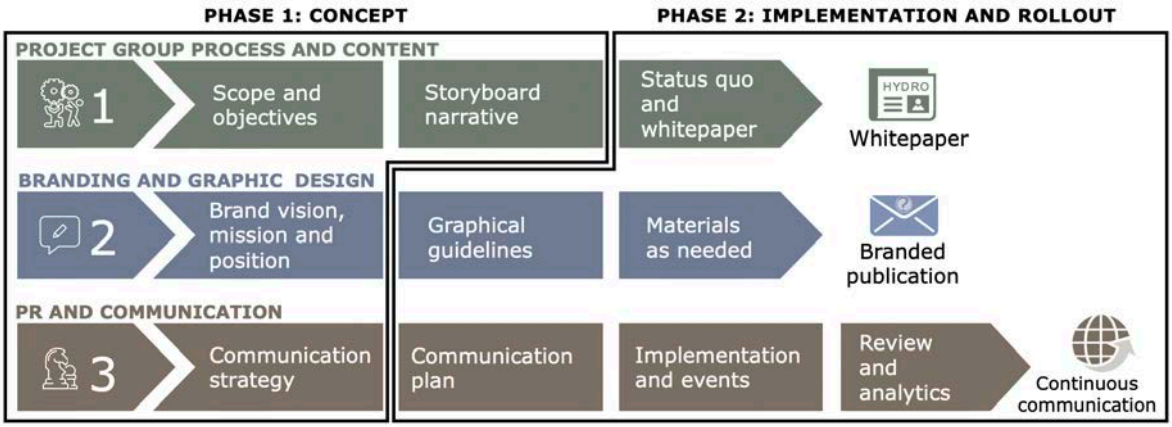
The programme, in which 18 companies from the European water sector participated, was divided into a Concept Phase (phase 1) and an Implementation and Rollout Phase (phase 2).

After a kick-off event in April 2022, vision and mission were developed, target groups were defined, narratives for different target groups were drafted and a future communication strategy was discussed in order to subsequently achieve

- a higher brand value for hydropower in Europe,
- increased visibility among different stakeholders,
- a dedicated target audience (e. g. EU decision-makers) and
- greater influence on future EU framework.

The project was concluded in September 2022 with the presentation of the results to the 18 project partners. In the course of this presentation, possible further steps for the implementation of phase 2 were also discussed.

The two phases of the vgbe Technical Programme "The Value of Hydropower"



Wind Power – Central pillar of decarbonisation

The year 2022 was a special year for the energy sector in many respects. The Russian war of aggression on Ukraine clearly showed the effects of depending on just one energy source. In Germany, the share of electricity generated from renewable energies in consumption was 48.3 % (2021: 42.7 %). Wind power plants made the largest contribution – especially offshore plants. On- and offshore plants together accounted for a share of 25.9 %[1].

The expansion of renewables and the market ramp-up of green hydrogen are currently among the most pressing challenges facing the energy sector, without losing sight of the energy industry's triangle of goals – climate protection, security of supply and affordability/economy. *"The importance of wind energy and the expansion of renewable energies as a whole is more urgent and important today than ever before,"* said the German Economics Minister Robert Habeck at the opening of the world's leading trade fair WindEnergy Hamburg in September 2022, if the ambitious targets of the German Government for renewable energies are to be met, i. e. at least 80 % of gross electricity consumption is to be covered by renewable energies by 2030. However, ambitious expansion targets alone are not enough – there is a lack of capacity in the approval process, of necessary skilled staff and of corresponding material supplies. In addition, the expansion plans repeatedly meet with resistance from society. Although the expansion of renewables is a social consensus, the "not-in-my-backyard mentality" often dominates when it comes to implementing concrete expansion plans.

In this conflict of interests, it is all the more important that existing plants are optimally operated and upgraded. Here, vgbe energy does valuable work for its members and the energy sector by providing the necessary platform for wind turbine operators to discuss technical, operational and environmental issues at expert level.

Besides the professional exchange, the joint development of vgbe Standards, the continuation of the WiPPeX database for benchmarking of wind turbines, research projects are another pillar at vgbe to drive innovation in the field of wind energy. vgbe actively initiates and accompanies research projects that provide added value for our members and lead to the optimised operation of existing and new wind turbines.

[1] Source: https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2023/20230104_smard.html

Development of a smart algorithm for optimised control of **ice protection systems (IPS)**

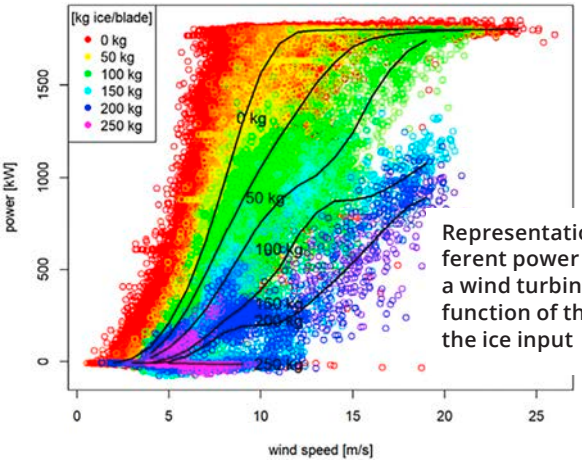
Continuation of the vgbe Research Project SOPWICO "Smart Operation of Wind Power Plants in Cold Climate (Ice detection II)" in cooperation with Meteotest AG from Switzerland. During the reporting period, the third part of the vgbe Research Project 451 "Smart Operation of Wind Power Plants in Cold Climate (Ice detection III)" was started.

Ice protection systems (IPS) play a central role in protecting wind turbines from icing. However, IPS are only effective to a limited extent and cannot prevent blade icing under all external conditions. In Central Europe and Scandinavia, it is not uncommon for wind turbines equipped with IPS to lose several percent of their annual production due to icing. Many modern IPS are still controlled in a rather trivial way, i. e. with fixed heating duration and heating power and pre-defined icing criterion. Therefore, optimising control of the heating system by relaxing the boundary conditions, taking into account real-time turbine parameters and future atmospheric conditions, holds great potential.

As part of the research projects "Smart Operation of Wind Power Plants in Cold Climate" (SOPWICO) and "Smart Operation of Wind Turbines under Icing Conditions" (SOWINDIC), the IPS control is to be optimised to reduce losses in generation without compromising safety.

The subject of this project are wind turbines at four wind farm sites in Scandinavia and Central Europe from different manufacturers with different heating systems and different regulatory operating restrictions. To optimise turbine control based on current and future atmospheric conditions, it is important to understand the efficiency of the heating system under different atmospheric conditions. Therefore, wind turbine data and especially data from previous blade heating events need to be analysed comprehensively. This requires an integrated analysis that takes into account the expended heating energy, possible production losses due to the different atmospheric conditions, heating energy, possible production losses due to forced stops during heating and the time evolution of production losses due to disturbed blade aerodynamics caused by icing. The aim is to develop an algorithm that allows the best de-icing time to be determined based on weather and icing forecasts as well as current measurement data at the wind turbine.

Ice build-up on a rotor blade



Representation of different power curves of a wind turbine as a function of the mass of the ice input

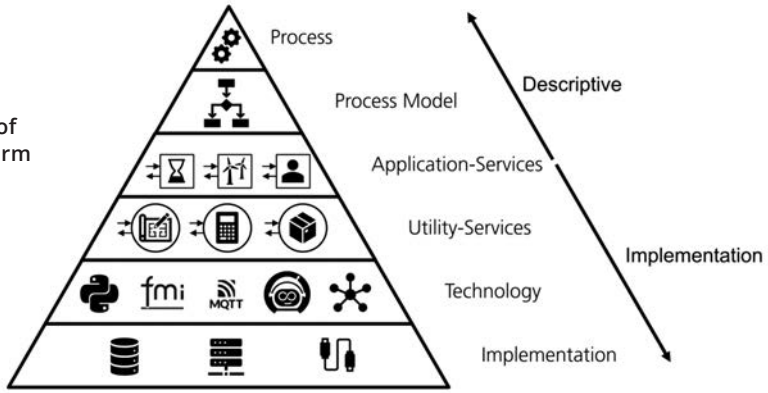
Successful completion of the **“DigiWind”** research project

The one-year research project “DigiWind – The digital twin of a wind turbine” was successfully completed in 2022. In cooperation with the Fraunhofer Institute for Wind Energy Systems (Fraunhofer IWES) based in Bremerhaven and the Vienna University of Technology (TU Wien), the architecture of a digital twin for modular structures was expanded. The members of the vgbe Technical Committee “Wind” were involved in the development right from the start of the project through internal workshops.

The project focussed on integrating information about the remaining service life into the operational planning of a wind turbine. Load cycles must be recorded and analysed in order to estimate the remaining service life. This requires continuous measurement data and models of all components involved. The model for the load cycle analysis consists of several sub-models that are interconnected for the calculations. The service life estimates flow into the operational planning of the wind turbine in order to operate it in such a way that the maximum yield is achieved without causing premature damage to the turbine. The entire (control) loop is thus mapped: From data collection to data processing to the determination of operating strategies that can be fed back into the real system.

The models used in the simulation always have to match the components of the real system in order to achieve reliable results for the service life estimation. If a part is replaced during maintenance, the corresponding model has to be adjusted. Utility services are used so that changes to the wind turbine can be taken into account.

By building these utility services, the user can apply (almost) any function on the DigiWind platform. For the demonstration of the prototype of the DigiWind platform, a Remaining Useful Lifetime (RUL) service was created as part of the project to predict the remaining lifetime of wind turbines, which can then be incorporated into the operational planning of the plant. The vgbe members thus benefit from a basic architecture of a digital twin. In the future, this architecture can be equipped with further functions and individually adapted.



Modular structure of the DigiWind platform

vgbe Standard
"Fire Protection in Offshore Wind Farms"

Work on this vgbe standard continued in cooperation with the Federal Association of Offshore Wind Farm Operators (BWO) and with the support of the Federal Maritime and Hydrographic Agency (BSH).

The new standard, which is to be published in the course of 2023, will harmonise the existing regulations on fire protection in the offshore wind industry. In addition, fire protection concepts are to be approved more quickly in accordance with BSH specifications and standardised solutions for fire protection in offshore wind farms are to be defined in order to reduce costs for planning, operation and maintenance and to ensure maximum occupational health and safety.

A structure for the standard was created in intensive discussions by a joint working group of BWO and vgbe members, first chapters were developed and issues were settled. Furthermore, a discussion was initiated with the transmission system operators in order to take current technical developments into account.

THERMAL POWER

vgbe database **KISSY** for qualified technical benchmark of power plants

EDF "translates" the parameters of six CCP plants and speaks the "language of vgbe"

Today, benchmarking is one of the most important tasks in all industries in order to be able to compare one's own performance with the help of standardised parameters. Technical benchmarks are carried out both within and across companies and serve to directly compare systems and processes. In particular, cross-company industry benchmarks provide valuable information about one's own performance and help to understand processes comprehensively, to improve process continuously, to make change an integral part of corporate culture and to determine optimal performance in order to identify "best practices" and learn from the "best in class". Robert C. Camp, a pioneer in this field, who enforced benchmarking processes at Xerox in the 1980s, describes benchmarking as *"the search for solutions based on industry best practices that lead a company to excellence"*. [1]

Without such a comparison with defined reference values, no company can make a statement about the efficiency of its processes.

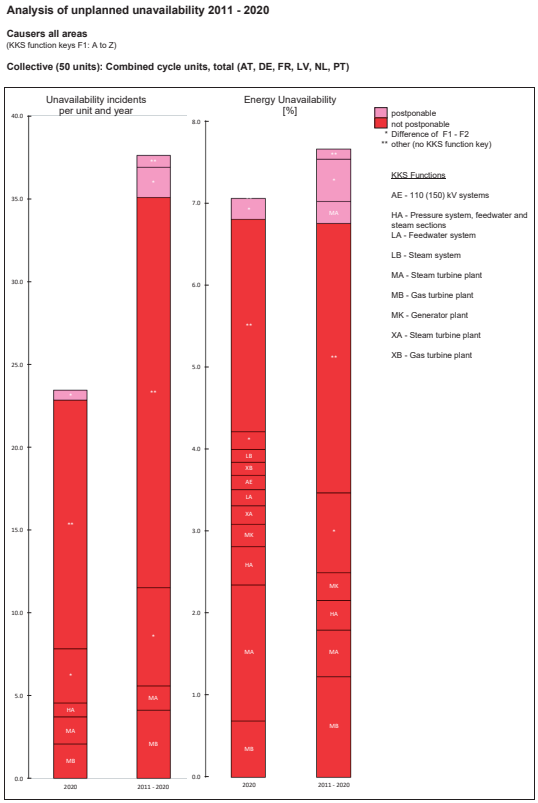
In the energy industry in particular, availability and reliability of power plants are of utmost importance in order to ensure security of supply and grid stability at any time and to use scarce resources optimally, or to operate plants perfectly in order to achieve the longest possible operating times at optimum plant performance.

These fundamental considerations are also among the main tasks of vgbe as the technical association of power plant operators. Even when the association was founded in 1920 as a result of a serious and momentous boiler explosion at the Reisholz power plant in Düsseldorf, the exchange of experience and the prevention of accidents and unavailability were high on the list of priorities for the founders of our association. Accordingly, the exchange of experience plays a major role in the association's work.

[1] Camp, R. C. (Benchmarking, 1994), S. IX.

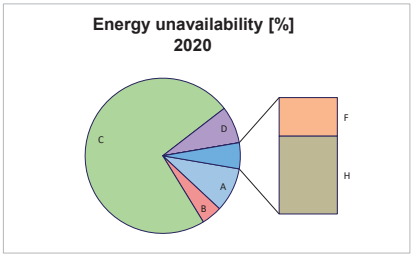
This exchange of experience becomes more quantifiable through the collection of availability data and the determination of operating parameters as well as unavailability events of individual power plant components. These data are collected with the help of the vgbe power plant statistics for operating parameters (KISSY). KISSY is thus the tool that can be used to optimise plants efficiently. The KISSY database currently contains availability data and operating parameters from international energy supply companies with a total gross capacity of around 273 GW. The data collected there, or the performance of the main plant components and systems that affect unavailability of power plants, are evaluated and incorporated into the annual vgbe Technical-scientific Reports (TSR) "Availability" and "Analysis of Unavailability" of power plants in order to identify those plant components and systems that cause unavailability, to monitor and/or upgrade such components and to improve overall plant performance. Besides, these data and the resulting analyses can also serve as basis for further research projects initiated by vgbe, the results of which are directly beneficial to the KISSY feeders.

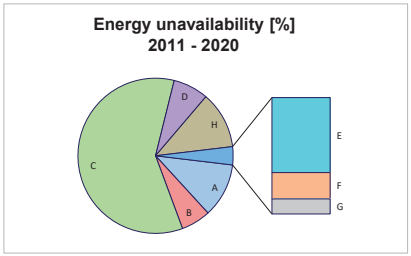
The plants and facilities are currently specified according to the vgbe Power Plant Identification System (Kraftwerk Kennzeichensystem, KKS) and the events are classified according to the vgbe Event Characteristic Key (Ereignis-Merkmal-Schlüssel, EMS). Accordingly, only those plants can participate in vgbe's power plant benchmark that have coded their plants according to KKS or rate their events according to vgbe EMS. First extensions for using other power plant coding systems, such as the vgbe RDS-PP® (Reference Designation System for Power Plants), have been developed. At present, however, the extension has not yet been fully completed.



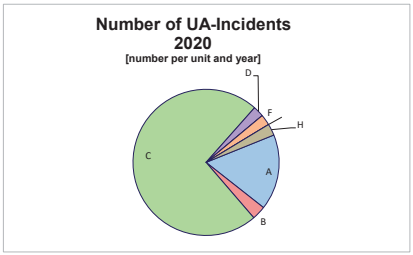
The value of vgbe´s technical benchmark is generally recognised. However, the question always arises how other vgbe members who have not coded their plants according to KKS and EMS can nevertheless feed their data into KISSY in order to benefit from the technical benchmark and also to broaden the data base for the vgbe community? This problem can only be solved by transferring a company's internal coding into KKS and EMS. In the following it is shown how the vgbe member Électricité de France (EDF) "translated" their data of six combined cycle power plants (CCP) into the "vgbe languages" KKS and EMS to feed the EDF data into the KISSY database.

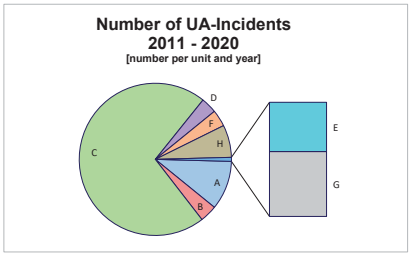
Analysis of unplanned unavailability: time frame
Collective (50 units): Combined cycle units, total (AT, DE, FR, LV, NL, PT)





	EMS 4/1	Units	A	B	C	D	E	F	G	H
Energy unavailability [%]	2020	25	0.65	0.30	5.17	0.55	0.00	0.13	0.00	0.25
	2011 - 2020	50	0.86	0.47	4.54	0.56	0.19	0.07	0.04	0.91
Unavailability incidents per unit and year	2020	25	3.92	0.72	17.08	0.56	0.00	0.56	0.00	0.60
	2011 - 2020	50	3.84	1.35	26.23	1.24	0.13	1.31	0.18	2.54





time-frame of unavailability (EMS 4/1)

A Automatic load-rejection/fast shutdown
B Manual load-rejection/fast shutdown
C Controlled shutdown within 12 hours
D Start-up or recommissioning not possible
E Exceeding planned incident-time
F Start-up-time extension
G Start-up prolongation
H Postponable more than 12 hours

The plant manufacturer and EDF jointly selected vgbe's KKS for the CCPs, i. e. for computer-aided maintenance monitoring and identification at the sites.

KISSY is primarily focused on the generation of data. For uploading such information, EDF has extracted two types of files from two different platforms:

- the technical inventory software and
- the internal database of EDF trading.

The challenge was to take into account three different standards simultaneously, i. e.:

- EDF-AM-Code (EDF internal event characteristic key)
- KKS as well as
- vgbe event characteristic keys EMS 1 and EMS 4/2,

in order to collect the following data:

- date, time of event,
- energy loss,
- coding of component and transfer to KKS,
- explanation of the problem (root cause analysis), translation from French into English,
- type of failure, transfer of the EDF-AM code to vgbe EMS.

These tasks seem so simple, but in practice there were numerous problems to be solved, as shown below.

Experience with data collection

Coding system

In the first step, the component codes had to be transferred. A simple Excel spreadsheet is usually sufficient for this task. This work takes time, but once such an Excel file has been created, it can be used again and again.

Source AM-code	Description AM-code	KKS code	KKS for using KISSY	KKS description
260	approvisionnement en gaz	EKF	EKF	gas storage system
413	tuyauteries CP bruleurs	HH+	HH	burner and burner tubes
430	divers combustion au gaz	EK+	MBM	gas combustion general
433	réchauffeurs gaz	EKC	EKC	gas pre-warming system
434	bruleurs principaux gaz	EKA-EKG	MBM	combustion chamber (gas pre-warming, combustion)
436	turbine a gaz de détente	MB+	MB	gas turbine (GT)
450	divers générateur vapeur	HA+	HA	pressure system
452	réservoir et accessoires	HAD-HAG	HAD	evaporator and live steam drum

Excerpt from the transformation table from EDF AM code to KKS

In the second step, the event codes have to be transferred, i. e. the EDF-internal AM had to be transferred to vgbe EMS 1 = event type and EMS 4/2 = main effect on unit. At this point, the transformation appears to be simpler as there are fewer codes, but great care has to be taken to ensure accuracy of translation. The vgbe EMS 1 consists of an extensive list of events the correspondences of which were found by reading the event list in the Computerised Maintenance Management System (CMMS) .

Energy and kind of event

The technical data and the trading data should usually match exactly. Experience at EDF has shown that it is advisable to collect trading data first before starting to work on the CMMS events.

The first step is to collect events and interpret the trading data. With 8,760 h time series per site, the proper “issues” have to be filtered out. For this work, the Excel tool proved its worth and the events were identified with the help of the AM code. Other events such as test times, planned maintenance etc. were not taken into account.

The root cause analyses are of high interest to improve data quality. The history is important to identify the optimal KKS code. Exact details are to be determined with the CMMS if necessary, or site personnel are to be contacted. The accuracy of the KKS code is of great importance to all stakeholders. A separate "correspondence table" was created years ago for an internal EDF benchmark. However, not all codes were checked at that time, so the KKS still had to be consulted. In addition, interpretations by the O&M engineer were necessary.

In addition, the root cause analyses originally written in French had to be translated into English.

Conclusion on supporting new feeders and improving data collection

First of all, direct cooperation between all parties involved is necessary. This applies within the company, i. e. with trading, maintenance engineers, site staff and externally with vgbe. In this case, a meeting between the vgbe KISSY expert and the EDF INGEUM team was needed to define and achieve the objectives.

It is important to highlight that the first level of basic data to be collected (time and energy) is extracted from the trading files, which exactly match the vgbe TSR availability report.

In conclusion, it is helpful to have the right data available at the right time, although human interpretation is also of particular importance for good data collection. In the future, automatic IT-based collection might be possible, but this requires the CMMS to be adapted for automatic uploading and downloading into the vgbe template.

The experience at EDF has demonstrated that the activities were a first step towards data management, optimising maintenance, improving reliability and being able to use numerical tools for statistical models. The final goal is to achieve a feedback loop in the field of power generation.

The EDF activities were actively supported and accompanied by the vgbe Technical Group "Performance Indicators". EDF worked trustfully with all partners and within the vgbe community it was possible to look deeply at data and processes anonymously.

This first step taken by EDF can also be an encouragement for other non-KKS users to transfer and "translate" internal company data in such a way that they can correspond with the "vgbe languages" KKS and EMS in order to take full advantage of the vgbe technical benchmark and to improve plant optimisation.

Solid basis for the accelerated transformation of the energy system

The year 2022 clearly demonstrated that the transformation of the energy system has to proceed rapidly. Politicians and society agree that only the massive expansion of renewable energies will reduce the dependence on energy imports and will achieve the overarching goal – the mitigation of climate change. Apart from necessary reliable political framework conditions, such as accelerated development, expansion areas, etc., aspects like availability of skilled labour, sufficient raw materials and optimal use of resources are also of decisive importance.

This is where the two vgbe designation systems **KKS** (**K**raftwerk **K**ennzeichen**S**ystem, Power Plant Identification System) and **RDS-PP®** (**R**eference **D**esignation **S**ystem for **P**ower **P**lants) are invaluable: Systematic plant designation systems are used for comprehensible, clear and uniform designation of technical systems. They support planning and construction of plants as well as their smooth and safe operation. Operating, maintenance and repair costs can be reduced with such systems, operating errors can be avoided and occupational safety is improved. With the systematically structured abbreviations of a plant identification system, plant parts, components, structures, signals in control and information technology, etc. are clearly identified, e. g. on site with readable or digitally processable signs and electronically in the control system of a plant.

From KKS to RDS-PP®

While the KKS was still a national association guideline, the RDS-PP® is based on the technical standard DIN ISO/TS 81346-10:2016 (ISO/TS 81346-10:2015), which was published in 2016 and forms the normative basis for the RDS-PP®. In order to support its practical application, vgbe supplemented this technical standard with a series of application standards for different technologies and plant types (from wind power plants to PV and power-to-X). As a result, the RDS-PP® established itself worldwide, especially in the field of renewable energies.

In August 2022, a new edition of the international technical standard for energy supply ISO 81346-10 was published and since then it has been promoted with the name RDS-PS. However, this new edition differs decisively from ISO/TS 81346-10:2015. The approach to plant designation pursued in the new edition is unsuitable for practical application, as essential features required for direct use as an identification system, as they exist in KKS and RDS-PP®, are not represented there:

- same principles for plant structuring based on the international basic standard IEC 81346,
- applicable for all energy supply systems,
- same designation structure for all areas,
- same rules for planning, construction and operation,
- integration of signals, connections and documents,
- basis e. g. for cost centres, work orders, damage statistics,
- application of language-independent codes.

Therefore, vgbe cannot recommend application of this new edition of the technical standard.

In contrast, the use of KKS or RDS-PP® offers the following main advantages:

- economic plant planning, construction and operational management,
- increase of plant availability,
- acceleration of failure analysis and localisation,
- compliance with occupational and operational safety regulations,
- unique addressing in engineering and operational management systems,
- fast and accurate access to documents and information,
- reduction of malfunction costs.

In this sense, vgbe speaks not only the "language of power plant technology", but overall the language of the urgently needed rapid transformation of the energy system. The practical and operational application of the vgbe identification systems was also highlighted by Jörg Richnow in his editorial in the October 2022 issue of the vgbe energy journal:

> *In power engineering, the KKS, the "Power Plant Identification system (Kraftwerk KennzeichenSystem)", has been established for almost 50 years now. It is something like a lingua universalis, because it is used uniformly worldwide. And so it is always fascinating to listen to a power plant manager in the far east of our world explain in difficult-to-understand English: "Of course, we use KKS". There you have already found a first common level of conversation.*

Dipl.-Ing., Dipl.-Wirtsch.-Ing.
Jörg Richnow
Chairman of the
vgbe Technical Committee
"Designation and
Documentation"

This solid basis will continue to serve the accelerated expansion of renewables and the energy transition.

vgbe RDS-PP® universally applicable and tested – from planning to dismantling

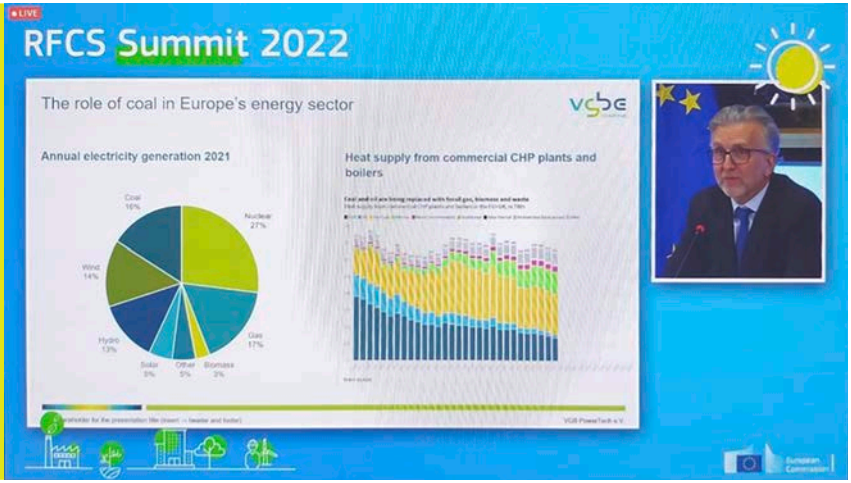
vgbe expertise internationally in demand

In addition to specific projects, the association was also active in its role as interface with European and international activities and stakeholders.

In 2022, international lectures were held almost exclusively online due to the Corona pandemic. These included, e. g. a presentation on “Status and challenges of the European energy transition – and learnings for the Indian power sector” at the Indian Power Plant Summit 2022 in September or a paper on “Thermal power generation in Germany and Europe between decarbonisation and security of supply” at the 31st Clean Coal Symposium of the Japanese partner organisation J-Coal.

Presentations were also given at the VDE-ETG symposium in Kassel on the topic of “Security of supply on the way to a climate-neutral electrical energy supply system – an operator perspective” and at the Enlit Europe 2022 in Frankfurt with an entire session on the topic of “Repurposing of power plant sites”.

The WindEnergy Hamburg trade fair, where vgbe was represented on the NRW joint exhibition stand, is also an international event; the same applies to the Spreewindtage, which now also attracts European participants and exhibitors in a regional setting.



Feasibility for flexible operation of Indian power plants successfully demonstrated

vgbe supports the Indo-German Energy Forum with its expertise on the way to sustainable and renewable energy supply in India

In 2006, the then German Chancellor, Dr Angela Merkel, and the Indian Prime Minister Manmohan Singh, launched the Indo-German Energy Forum (IGEF) to improve and deepen bilateral cooperation and strategic dialogue on the ongoing energy transition. Within the framework of these activities, subgroups and task forces were set up to work on the current issues.

The Indian Government wants to double its power generation capacity by 2030 to secure the country's electricity supply. In expanding this capacity, at least 300 GW of photovoltaics and 140 GW of wind power are to be installed, i. e. around 50 % of India's energy demand is then to be covered by renewable energies. In this context, the flexibilisation of existing thermal power plants plays a significant role in India's energy policy and thus represents the new paradigm of thermal power generation in India, i. e. fluctuating renewable energies have to be balanced out through flexible operation of thermal base-load power plants. Flexible thermal power plants are therefore of utmost importance for India's energy transition towards sustainable, renewable generation.

In this context, the "IGEF Flexibility Task Force" has set itself the goal of demonstrating technical feasibility of flexible operation of existing Indian thermal power plants. The task force is chaired by the Director Operations at the National Thermal Power Corporation Limited (NTPC) and the Excellence Enhancement Center (EEC) manages offices and coordinates the work of the group. Apart from NTPC, the Central Electricity Authority (CEA), the grid operator POSOCO (Power System Operation Corporation Limited) and BHEL (Bharat Heavy Electricals Limited) are also involved on the Indian side.

On the German side, Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ, service provider in the field of international cooperation for sustainable development and international education work) and vgbe energy e. V. are supporting this working group on behalf of the German Federal Ministry for Economic Affairs and Climate Action (BMWK).

Investigations were carried out in four Indian power plants from January 2017 to July 2022 to demonstrate the feasibility of flexible operation of existing thermal power plants. This included test runs in the following power plants:

- Dadri power plant run by NTPC (national energy supplier),
- Maithon power plant run by Tata Power (private energy supplier) and
- Andal power plant run by DVC (energy supplier of federal state)

Another study was conducted at NTPC's Simhadri power plant. The investigations focused on subcritical 500 MW units.

Apart from the above-mentioned balancing and necessary grid stability in the case of fluctuating feed-in from renewable energies, flexible coal-fired power plants also contribute to the reduction of CO_2 emissions. Flexible power plant operation reduces full-load hours and thus CO_2 emissions. These savings are much greater than higher CO_2 emissions resulting from efficiency losses in part load operation.

Besides technical feasibility, market design aspects also have to be taken into account, i. e. the economic operation of plants has to be guaranteed, if necessary through incentives for flexible plant operation. Such mechanisms are already part of India's energy policy.

The respective plant personnel also have to be trained for flexible operation. Extensive activities are already underway ("Flexperts").

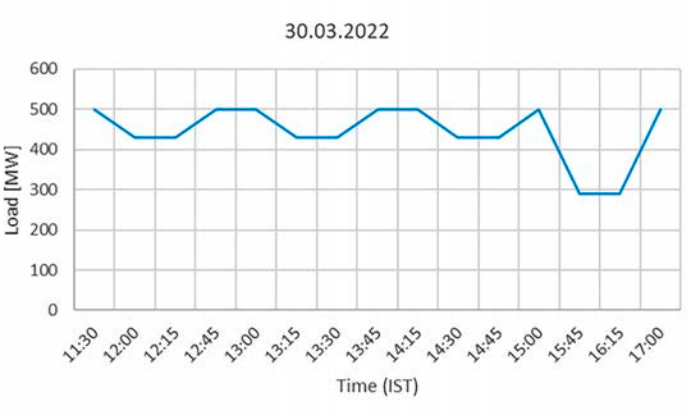
The investigations on flexible operation of the four reference power plants comprised several steps:

- **Pre-test phase:** Analysis of the status quo of the plant with evaluation of operating data
- **Test runs:** The programme included part load and minimum load operation as well as load ramps with maximum health and safety requirements
- **Flexibilisation plan:** The data from the test runs were analysed to ensure stable and flexible plant operation
- **Implementation:** Realisation of planned flexible plant operation

How to flexibilise the plant

40 % minimum load and load ramps of up to 2 % per minute are feasible

The studies were conducted by vgbe in cooperation with its members Steag Energy Services GmbH and Siemens Energy Global GmbH & Co. KG at the sites. Both the Indian and German partners cooperated in a very trusting atmosphere with all parties involved. The test runs showed that the minimum load of the plants is about 40 % and that this load level can be achieved without great effort. Some 1.5 to 2 % load per minute were estimated as achievable load ramps. With these results, it has been impressively demonstrated that India's energy policy



can continue to pursue its goals with regard to the expansion of renewables, as Indian thermal power plants are capable of reliably ensuring security of supply and grid stability. This brings the goal of sustainably reducing global CO_2 emissions and thus meeting the COP26 targets, to which India has also committed, within reach.

Again, vgbe energy e. V. and its member companies have impressively demonstrated their expertise in this project and shown themselves to be competent partners, thus underpinning vgbe's commitment as international association for the energy sector. The results of this project can also lead to positive developments in other countries. Similar activities are already being pursued in Türkiye, e. g. within the framework of the Turkish-German Energy Partnership.

A comprehensive report with all the details of this five-year activity was published in December 2022 on the vgbe energy e. V. website for downloading.

https://www.vgbe.energy/en/news/flexibility-field-report-results-of-flexibility-studies-in-indian-power-plants-at-a-glance/

Further information can be found on the website of the Energy Forum:

www.energyforum.in

NUCLEAR POWER

Limited extension of lifetime in favour of security of supply

In October 2022, the Federal Government had initiated a modification to law, which came into force on December 9, 2022, in order to secure power supply in Germany. Accordingly, the last three German nuclear power plants in operation, Emsland, Isar 2 and Neckarwestheim II, were enabled to produce electricity until mid-April 2023. Before, the end of generation was legally scheduled for December 31, 2022.

These three nuclear power plants are pressurised water reactors of the so-called Konvoi series. The German Government stipulated that only fuel assemblies already in the plants were to be used for the extended production time. By rearranging these partially spent fuel elements, the energy content still available can be converted optimally. For this purpose, short shutdowns were carried out in autumn 2022 (Isar 2 nuclear power plant) and at the beginning of 2023 (Neckarwestheim II and Emsland nuclear power plants). The plants can thus produce as much electricity as possible and make it available to the electricity grid. However, a reactor output of 100 %, comparable to stretch-out operation mode towards the end of a normal cycle, is no longer possible for physical reasons.

The amount of radioactive waste, i. e. spent fuel elements, targeted in the 2011 phase-out decision, will not be affected because no new fuel elements are being used.

In this way, utilities are making their contribution to supporting the Federal Government in its efforts to secure energy supply in Germany in the current crisis situation.

Competence Centre Nuclear Power – the new structure comes to life

Reorganisation of the nuclear vgbe committees, which was conceived in 2021 and confirmed by the vgbe Board, came into force on July 1, 2022, as already described in detail in the vgbe Highlight 2021. The new committee structure is geared to the main topics of "decommissioning and dismantling".

As early as spring 2022, the nuclear power plant operating companies staffed the leading committees (Steering Forum "Decommissioning of Nuclear Power Plants", Technical Committee "Decommissioning Process", Technical Committee "Safety and Monitoring"). With consolidation of these committees, the work was assigned to the subordinate working committees and groups and corresponding profiles were drafted. On the basis of these profiles, operating companies made targeted appointments.

The second half of 2022 was accordingly characterised by consolidating the committees, which was accompanied by vgbe Offices. The vgbe-wide working platform "eNet" was expanded to include the new committees and groups, also for the coordination of their activities. The vgbe coordination office still provides organisational support to the working committees and groups.

Due to the introduction of the new financing model in the nuclear sector, services provided by vgbe are offered in form of Technical Programmes and solidarity projects from January 1, 2023. Therefore, the new committees and groups focussed on preparing these programmes and projects.

The new committee structure was complemented by an annual workshop which took place for the first time in September 2022. The workshop is aiming at the exchange of experience among plant/dismantling managers.

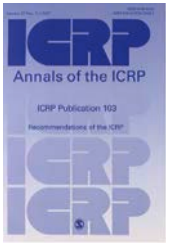
Around 20 plant representatives accepted the invitation to the Heinz-Maier-Leibnitz Forschungs-Neutronenquelle (research neutron source) of the Munich Technical University (FRM II) in Garching. Apart from presenting the FRM II with plant tour and exchange of experience, the following topics were also discussed:

- developments at vgbe,
- dismantling activities in Sweden,
- innovations for efficient dismantling,
- pilot application of a safety culture assessment system in deconstruction.

In addition to the dismantling-oriented committee structure, the new, English-language Steering Forum "Nuclear Power Plants" will also deal with operational topics in order to ensure exchange of information between international, nuclear power plant-operating vgbe members.

On the floor of the fuel pool of KKI 2, from r. to l.:
Prof Dr Werner Rühm, Carmen Overheu, Dr Lena Jentjens, Dr Max Würtemberger, Ralph Brunner and Thomas van Appeldorn

Future radiological protection



In 2007, the International Commission on Radiological Protection (ICRP) published its updated recommendations (ICRP Publication 103), which serve as basis for the current international and national regulatory framework in radiological protection.

ICRP has launched a public consultation process with stakeholders from research, operation and regulatory communities to ensure that these recommendations remain fit for purpose and that the radiological protection system remains sustainable. At the end of this consultation process, the updated recommendations will be presented.

The vgbe Project Group "International Safety Standards" of the Working Group "Radiation Protection" is following with great interest how the radiological protection system will develop in the future. For this reason, it was highly appreciated that Prof Dr Werner Rühm, Chairman of the ICRP, could be welcomed on this topic at the Isar site on February 1, 2023. In his lecture, Prof Rühm explained the topic areas that are examined and discussed in more detail within the framework of the consultations as well as the systematics according to which the ICRP has opened up the consultation process for broader participation of stakeholders compared to previous years. On the part of vgbe, the challenges in radiological protection were presented from the nuclear operators' point of view. During a tour of the plant in both units and in the interim storage hall, individual radiological protection aspects of operation and dismantling could be examined on site.

Apart from topics such as maintaining competencies in radiation protection, individual aspects were discussed, e.g. interpreting and implementing the recommendations. In particular, the focus was on how to prevent misinterpretation of the ICRP intentions thus impairing the practical application of the radiological protection system. Even though different points of view are held on individual points, it is agreed that the application of the radiological protection system has led to very good results and that in many cases further optimisations could only be achieved with disproportionate effort.

Following the valuable discussions with interesting insights, a positive conclusion was drawn by all participants. vgbe will continue to accompany the developments in radiological protection and is very grateful to Prof Rühm for his commitment to making the ICRP consultation process open and transparent.

vgbe TECHNICAL SERVICES

Laboratories and engineering services create valuable synergies for the energy industry

vgbe Technical Services (Technische Dienste), which are integrated into vgbe energy service GmbH, the business enterprise of vgbe energy e. V., provide economic and solution-oriented services for vgbe member companies and the entire energy sector.

With its materials and oil laboratory, supervision of construction and assembly, chemical investigations (water chemistry) and special engineering services, vgbe Technical Services create valuable synergies for the association's work. In this way, the practical results of the engineering activities of vgbe Technical Services flow into the exchange of experience of the association. Thus, the association and its laboratory and engineering services form an optimal symbiosis for the benefit of the vgbe community.

vgbe Technical Services optimise water-steam cycle thus creating significant cost savings

During the reporting period, vgbe Technical Services were commissioned with the periodic inspection of the water-steam quality in a paper mill. Three boilers with a total output of 72 MW are operated at the site examined.

When checking the water-steam quality, the vgbe Team "Water Chemistry" found a very low oxygen content (O_2) of < 5 ppb in the feedwater with simultaneously very high amount of steam removal (amount of steam to be removed for degassing feedwater). At the same time, the feedwater quality was characterised by very low acid conductivity (good quality). In discussions with the client and by reviewing the operating records, it was determined that this very good water quality would be always achieved.

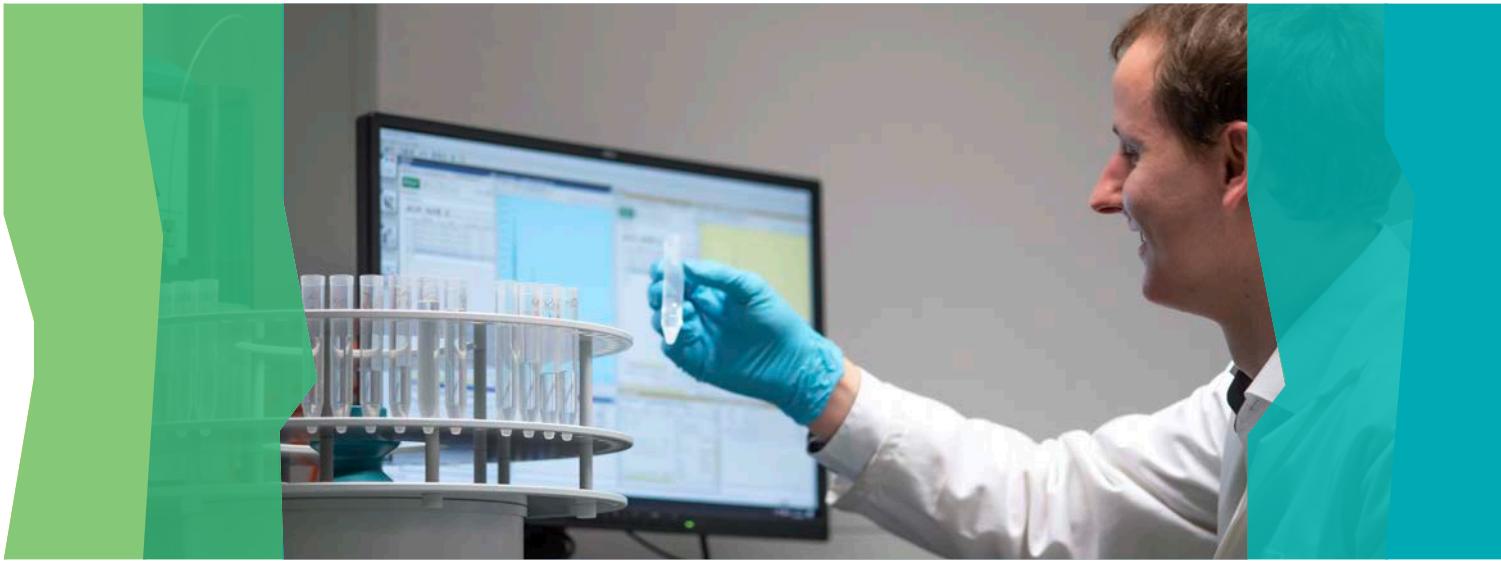
Higher oxygen values can be considered uncritical due to the very good water quality, because under these conditions no signs of corrosion are to be expected even with higher oxygen contents (< 50 ppb).

The very high amount of steam removed results in equally high steam loss, which needs to be made up for by additional water and fuel to generate the required amounts of steam. In total, this results in poorer plant efficiency with corresponding negative effects on the water and emissions balance.

Already on site and in the subsequent detailed investigation report, it was suggested to reduce the amount of steam extracted in a controlled manner. Apart from O_2 content, acid conductivity and hydrogen content (H_2) in the steam were to be measured. With the O_2 measurement, feedwater deaeration was to be adjusted in a targeted manner so that an acceptable O_2 content was set with the smallest possible amount of steam extraction. The H_2 measurement also ensures that no corrosion processes occur or are triggered by any modified O_2 value.

The optimisation proposals and the benefits to be expected in terms of overall efficiency were discussed intensively with the client. Based on the plausible proposals by vgbe Technical Services, the order for implementation was placed.

The corresponding settings and the accompanying measurement campaign were carried out on site over a week. According to the VGB Standard VGB-S-010 "Feedwater, Boiler Water and Steam Quality for Power Plants/Industrial Power Plants", margins are permissible and accordingly 20 to 60 µg/l O_2 was redefined as the normal operating value.



After vgbe Technical Services had optimised the process, the client estimated the amount of steam extracted could be reduced by about 1 t/h. With an annual plant operation of 7,200 h and an estimated steam price of 25 Euros/t, the annual savings on part of the client correspond to about 180,000 Euros. The positive environmental aspects already mentioned above (less water and fuel consumption resulting in reduced emissions) have not yet been taken into account.

Our client's one-off investment of a lower five-figure amount for the consultancy of vgbe Technical Services has already paid for itself in the second month.

Since the optimisation does not lead to any disadvantages for the water-steam cycle, the client has decided to have the periodic inspection carried out annually by vgbe Technical Services.

Figures

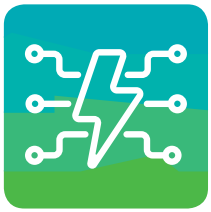
vgbe 2022 in figures: In addition to the highlights presented, a multitude of activities, offers and campaigns were arranged in 2022 for our member companies and for the industry.

411 members in 29 countries

301 members from Germany
110 members from another 28 countries

State: December 31, 2022

237 ordinary members (operators)
145 sponsoring members
29 affiliated members (universities, authorities, associations)



Installed capacity

292 Gigawatt electrical
50 Gigawatt thermal

140 committees

300 meetings
more than 2,500 experts online and in presence

The association's trade journal was relaunched in 2022 with a new layout as “vgbe energy journal“. It is one of the leading international trade journals providing information on the generation and storage of electricity, heat, hydrogen and energy carriers based on it, as well as sector coupling.

29 publications

14 vgbe-/VGB-Standards
2 Reports
New edition of KKS- and RDS-PP®-Pocketbook (bilingual, German/English)

11 issues of the trade journal **vgbe energy journal**

25 vgbe events

1,656 participants from 30 countries
7 events online
5 technical exhibitions
78 exhibitors

1,405 orders

1,245 oil analyses
126 in materials laboratory and water chemistry

11 in supervision of construction and assembly
23 consulting services in engineering

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- Onyx Kraftwerk Wilhelmshaven GmbH & Co. KGaA, Wilhelmshaven, Germany
- MHKW Müllheizkraftwerk Frankfurt am Main GmbH, Frankfurt, Germany
- Vattenfall Heizkraftwerk Moorburg GmbH, Hamburg, Germany
- Essity Operations Mainz-Kostheim GmbH, Mainz, Germany
- Highview Enterprises Limited, London, Great Britain
- Vattenfall Europe New Energy Ecopower GmbH, Rostock, Germany
- Zweckverband Restmüllheizkraftwerk Böblingen, Böblingen, Germany
- Papierfabrik Julius Schulte u. Söhne GmbH & Co.KG, Düsseldorf, Germany

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- TLT-Turbo GmbH, Zweibrücken, Germany
- PPCHEM AG, Hinwil, Switzerland
- WinJi AG, Zürich, Switzerland
- Optioil GmbH, Cloppenburg, Germany

Affiliated members
(universities, authorities, associations)

- NORCE Norwegian Research Centre A/S, Bergen, Norway

vgbe energy welcomes its new members who joined our association in 2022.

vgbe members

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- 1 Heiz Energie GmbH, Eberswalde, Germany
- 3M Germany GmbH, Wuppertal, Germany
- Abfallwirtschaftsbetrieb des Landkreises Neu-Ulm, Weißenhorn, Germany
- Abfallwirtschaftsbetrieb Stadt Nürnberg, Nürnberg, Germany
- Air Liquide Industrie B.V., Rotterdam – Botlek, The Netherlands
- Allessa GmbH, Frankfurt am Main, Germany
- AMK – Abfallentsorgungsgesellschaft des Märkischen Kreises mbH, Iserlohn, Germany
- AS Latvenergo, Riga, Latvia
- Aurubis AG, Hamburg, Germany
- AVA Velsen GmbH, Saarbrücken, Germany
- AVBKG Abfallverbrennungs- und Biokompost-Gesellschaft mbH, Tornesch-Ahrenlohe, Germany
- AVEA Entsorgungsbetriebe GmbH & Co. KG, Engelskirchen, Germany
- AVG Abfallentsorungs- und Verwertungsgesellschaft Köln mbH, Köln, Germany
- AVR-Afvalverwerking B.V., Duiven, The Netherlands
- AWG Abfallwirtschaftsgesellschaft mbH Wuppertal, Wuppertal, Germany
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- BASF SE, Ludwigshafen/Rhein, Germany
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- Bayer AG, Berlin, Germany
- Berliner Stadtreinigungsbetriebe, Berlin, Germany
- Bernegger GmbH, Molln, Austria
- biotherm Hagenow GmbH, Hagenow, Germany
- BKW Energie AG, Bern, Switzerland
- BMC Moerdijk B.V., Moerdijk, The Netherlands
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- envia THERM GmbH, Bitterfeld-Wolfen, Germany
- EPZ, Vlissingen, The Netherlands
- ERZ Entsorgung + Recycling Zürich, Zurich, Switzerland
- ESB Electricity Supply Board, Dublin, Ireland
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- Grace GmbH, Worms, Germany
- Grosskraftwerk Mannheim AG, Mannheim, Germany

- Gunvor Raffinerie Ingolstadt GmbH, Ingolstadt, Germany
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vgbe Congress *
September 20/21, 2023, Berlin

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March 8/9, 2023, Karlsruhe

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Conference with technical exhibition
April 25/26, 2023, Nürburgring

Maintenance of Wind Power Plants ***
Conference
May 10/11, 2023, Vienna (A)

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May 25/25, 2023, Weimar

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June 6/7, 2023, Koblenz

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June 14/15, 2023, Vienna (A)

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October 24 to 26, 2023, Ingolstadt

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November 21/22, 2023, Hamburg

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Conference with technical exhibition
December 5/6, 2023, Hamburg

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February 14/15, 2023, Online

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Workshop
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13. Emder Workshop „Offshore Windenergieanlagen – Arbeitsmedizin“ **
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Advanced training
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https://events.vgbe.energy/events

* event in German and English language
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