TC “Photovoltaics”

General Presentation

Individual success through exchange of experience within **vgbe energy**

vgbe ENERGY IS US

Agenda

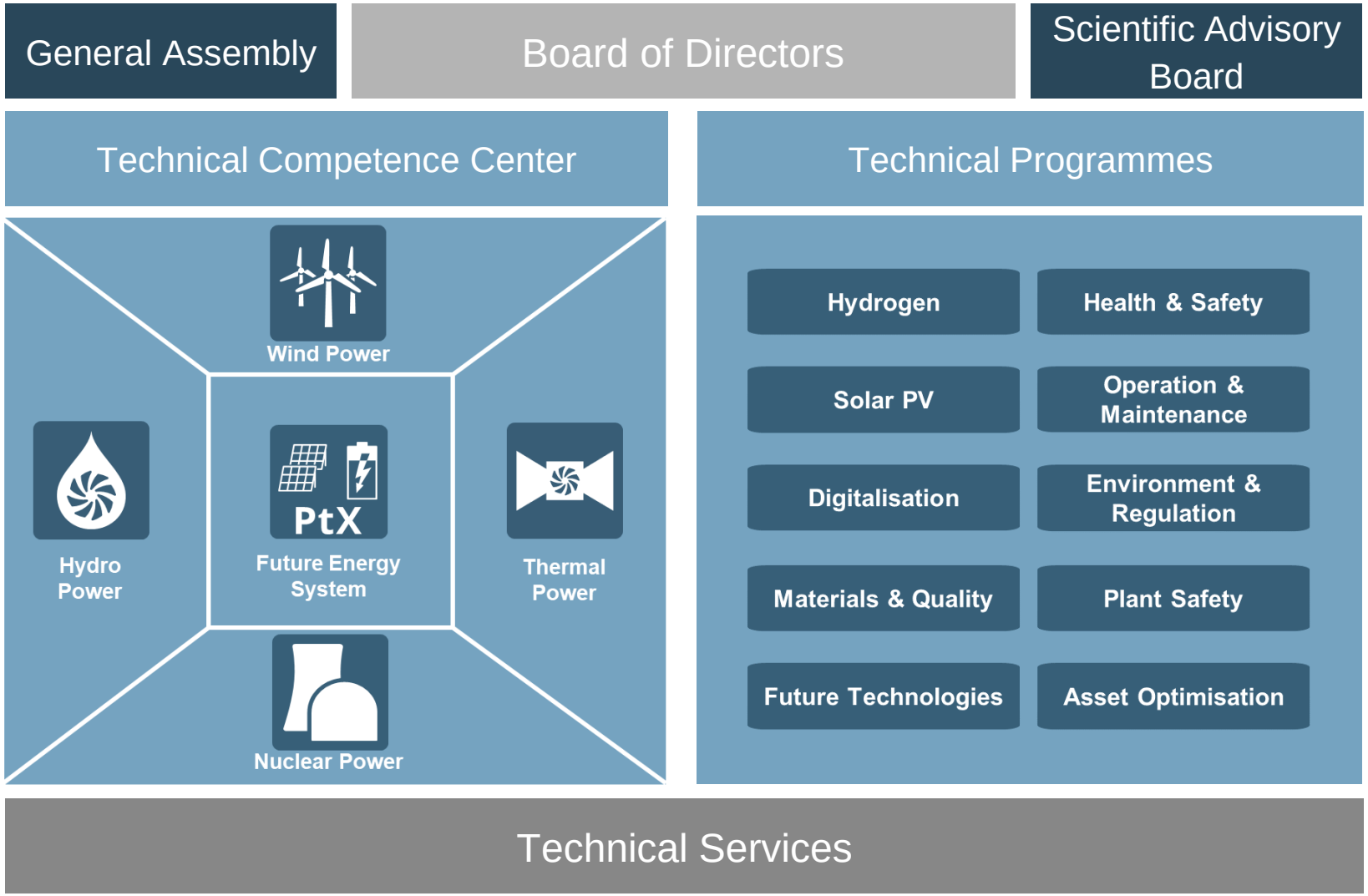
1 The Association

The Association

vgbe energy e.V.

vgbe energy e.V. is the technical association of energy plant operators. Our members are companies that operate power, heat and cooling, energy storage and sector coupling plants worldwide. Since its foundation in 1920, vgbe energy has become the technical centre of competence for the operators of power and energy plants.

Currently, vgbe energy has 411 members, comprising operators, manufacturers, and institutions connected with energy engineering. The members come from 29 countries and represent an installed power generation capacity of 342,000 MW.



2 vgbe energy | Future Energy System

vgbe energy | FES – Structure

Technical Competence Center Future Energy System

Steering Forum Future Energy System

vgbe Committees

- **TC Future Technologies (TC FT)**
- **TC Hydrogen (TC H2)**
- **TC Photovoltaics (TC PV)**
- **TC Biomethane (TC BM)**

Current Subjects

- Operational experience analysis
- Plant operation and maintenance
- Availability, reliability and safety
- Cost-efficient lifetime management
- Environmental management
- Digitalisation measures
- IT/OT and cyber security
- Health & Safety

TC FT
- Storage technologies
- Flexibility in energy systems

TC H2
- H_2 market ramp up
- Green hydrogen production

TC PV
- Fault and failure analysis
- O&M (AI-monitoring, night inspection...)

TC BM
- Biogas upgrading
- Process control

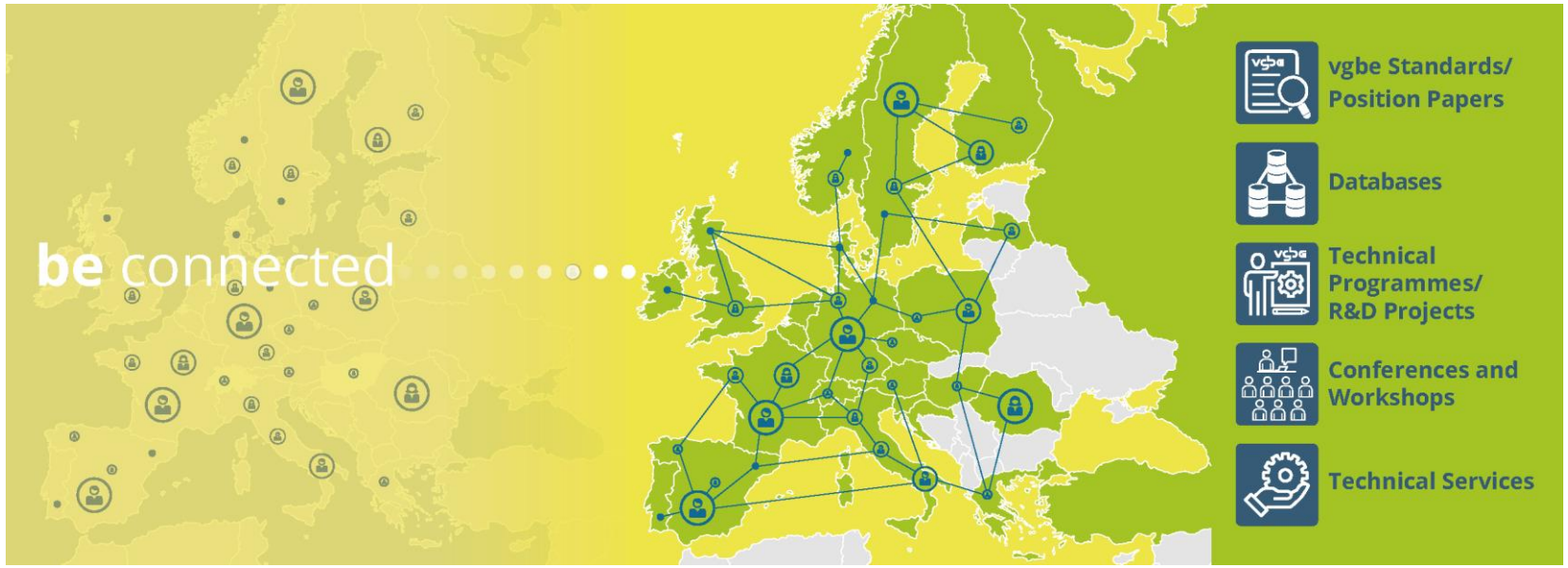
Activities

- Exchange of experiences and information
- Position papers
- Publications
- Conferences
- Participation in other organisations
- vgbe-Standards
- Research projects
- Technical Programmes
- Databases
- Platform
- Subject-specific workshops

TC … Technical Committee

vgbe energy | FES – Exchange of experience

be energised
be inspired
be connected
be informed



Comprehensive experience transfer and exchange

- operational issues
- techno-economic issues
- environmental issues
- energy strategies
- energy policy aspects

Networking throughout Europe

More than 80 professionals participating in vgbe energy | FES committees.

- Future Technologies
- Hydrogen
- Photovoltaics
- Biomethane

vgbe energy pushes the practical exchange of experience.

vgbe energy | FES – Members

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Operators

Ørsted, kelag, fortum, steag, uniper, iqony, GKM, RWE, swb, BASF We create chemistry, Verbund, ESB, EnBW, LEAG, Latvenergo, EDF, EVN, Wien Energie, Elektrárna Chvaletice, Vattenfall, RheinEnergie, ΔEH, Stadtwerke Düsseldorf, HOFOR, enercity, Salzgitter AG, Energie AG Oberösterreich Wir denken an morgen, ENGIE, CEZ Group, stadtwerke rosenheim, Pfeifer & Langen, Enervie, Eskom

Research Institutes

Fraunhofer UMSICHT, Fraunhofer IWM, NORCE, gwi Gas- und Wärme-Institut Essen e.V., ifk, DNV·GL, International Centre for Sustainable Carbon

vgbe energy | Future Energy System as part of vgbe energy is the first address for interested parties in techno-economic, ecological and strategic issues concerning photovoltaics, biomethane, hydrogen, storage and other future technologies.

It is precisely the different perspectives within the membership of this non-homogeneous body that lead to creative approaches to developing common and viable solutions to the challenges of transformation in the energy sector.

Currently, experts from 56 organizations, mostly operating companies, are actively participating in vgbe´s Technical Competence Center “Future Energy System” and benefit from our offers as a member of the successful network.

3 Technical Committee “Photovoltaics”

Competences in Photovoltaics

vgbe energy | Photovoltaics

The photovoltaic sector in Europe faces many challenges, whilst at the same time, photovoltaics provides plenty of opportunities for a safe and stable energy supply.

vgbe energy | Photovoltaics as part of the Technical Competence Center “Future Energy System” is the first address for parties interested in techno-economic and ecological issues as well as in research and innovation topics concerning photovoltaics.

The platform offers operators the exchange and transfer of **practice-oriented experience and best practice measures** as well as know-how to improve and optimize operation and maintenance.

Our slogan for our common work is:
Success through Exchange of Experience

Operators

EnBW, HOFOR, LEAG, EDF, Latvenergo, ENERGIE AG Oberösterreich – Wir denken an morgen, CEZ GROUP, Verbund, Eskom, kelag

Research Institutes

NORCE

TC “Photovoltaics”

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In the TC “Photovoltaics” vgbe energy brings together experts from this fast-growing sector. Using the extensive experience of vgbe energy and its network of industry experts, solutions to the various techno-economic, environmental and strategic challenges related to the installation and operation of PV systems will be developed.

Tasks / *Benefits for members*

- Coordination of operator interests towards manufacturers, authorities, and standardization bodies
  Representation and “one voice” of the operator’s interests
- Initiation and update of vgbe-Standards
  Optimisation of the life cycle profit
- Sharing and joint analysis of operational experience
  Reduction of the operational costs
- Initiation, coordination and evaluation of research projects
  Cost savings and build-up of know-how
- Organisation of events and workshops
  Direct exchange of experience with external experts

Planned works

- Developing new concepts to improve the operation, maintenance and performance (nighttime inspection, AI monitoring, etc.)
- Improving availability, reliability and safety
- Supporting cost-efficient lifetime and environmental management
- Supporting work in Digitalisation, IT and Cyber Security in the PV industry
- Initiate research projects on interesting up-and-coming topics (Agri-PV, Floating-PV, PV disposal, etc.)
- Service life and failure analysis

TC “Photovoltaics“– Focus

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Focus on operation, maintenance and plant optimization in techno-economic and ecologic issues as well as research and innovation

vgbe’s work

- ***Supporting in operation, maintenance and plant optimization as well as in technical, environmental and strategic challenges***
  - improving the availability, reliability and plant safety
  - supporting cost-effective durability and environmental management
  - developing new concepts to improve or optimise operation and maintenance
- ***Drafting of technical and operational standards***
  - compiling practice-oriented vgbe-Standards and guidelines considering experiences of operators
  - coordinating the elaboration of international technical standards
- ***Initiating and coordinating national and international research projects and industry self-funded technical programmes***
  - connecting subject-specific experts from industry and research
  - building and exchanging knowledge
- ***Organizing conferences and workshops***
  - presenting the state of technology and future developments
  - networking and directly exchanging experiences with experts at issue-specific professional events

TC “Photovoltaics”– Benefits

Technical Committee

- Regular exchange of operational experience and development of proven practices within a topic-specific framework

Benefits

- **Expand your network**
  Through a topic-specific assignment, you gain access to a valuable and targeted network in your field of expertise.
- **Improve your business**
  Benefit from mutual exchange and support each other through best practices in their professional endeavours.
- **Free choice of design**
  Depending on topic and expected outcome, different formats can be used to work on specific topics. Collaboratively develop a data model or database, create a guideline, or expand the exchange to overarching topics in a vgbe Expert Workshop.

TC “Photovoltaics” – Ongoing committee work

Project	Description
Fault / Failure catalogue	Guidance for the maintenance of photovoltaic power plant components through tracking and describing failures and conducting risk assessments.

Initial situation

For many photovoltaic plant operators, tracking failures in plant components is an important step towards improved plant monitoring and maintenance and reducing losses. Maintenance of plant components, which in the past was often carried out reactively or preventively, is increasingly being carried out predictively. In predictive or forward-looking maintenance, the condition of a plant component is monitored at periodic intervals or continuously. The monitored variables are used to draw conclusions about the future condition of the plant component:

- How efficiently will a plant component work in the near future?
- How long will the plant component be operational?
- When does the risk of failure become too great?

With the help of predictive maintenance, reduced generation and outages can be avoided by replacing or repairing plant components before a failure occurs. Maintenance can be carried out in a cost-optimized manner, as the effort is concentrated on the most important plant components and can be planned in advance. In addition, a cost-optimal replacement time can be determined for each plant component. System components have a service life specified by the manufacturer, taking into account specified conditions and operating hours. For many system components, the manufacturer guarantees a service life depending on certain conditions, from which the remaining service life of a system component in operation can be derived. Well-maintained system components and the timely implementation of maintenance measures can, nevertheless, exceed the expected service life.

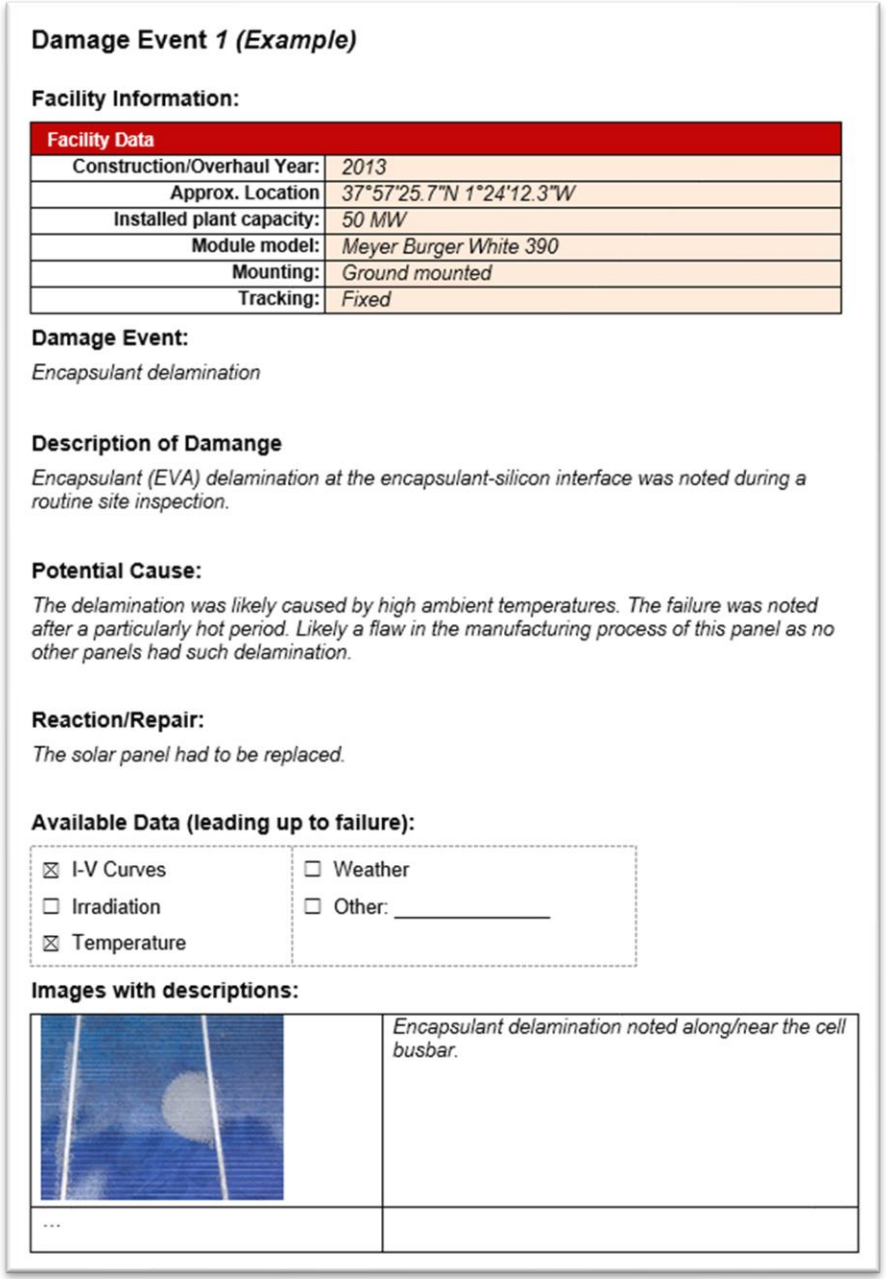
TC “Photovoltaics” – Ongoing committee work

Objective / Procedure

This guide aims to develop a maintenance concept based on the minimum approach - "good enough to ensure safe operation with regard to people and the environment" - based on past damage and years of practical experience in maintenance and repair. This concept is intended to support decisions regarding maintenance measures to be taken and, above all, to show which risk scenarios can occur in plant components. This objective will be achieved with the following steps, with the potential for further development:

1. Damage events will be collected and described
2. Damages will be clustered into categories
3. Maintenance for specified events will be prescribed
4. Collection and analysis of data associated with the failures
5. Bow-tie risk assessments will be developed
6. Potential next steps (ex. expansion of the catalogue using external input)

On the basis of this specification, risk assessments with possible damages (risk scenarios) are developed and assessed with regard to the effects on people and the environment.



Damage Event *1 (Example)*

Facility Information:

Facility Data	
Construction/Overhaul Year:	*2013*
Approx. Location	*37°57'25.7"N 1°24'12.3"W*
Installed plant capacity:	*50 MW*
Module model:	*Meyer Burger White 390*
Mounting:	*Ground mounted*
Tracking:	*Fixed*

Damage Event:

Encapsulant delamination

Description of Damange

Encapsulant (EVA) delamination at the encapsulant-silicon interface was noted during a routine site inspection.

Potential Cause:

The delamination was likely caused by high ambient temperatures. The failure was noted after a particularly hot period. Likely a flaw in the manufacturing process of this panel as no other panels had such delamination.

Reaction/Repair:

The solar panel had to be replaced.

Available Data (leading up to failure):

☒ I-V Curves	☐ Weather
☐ Irradiation	☐ Other: _____
☒ Temperature	

Images with descriptions:

	Encapsulant delamination noted along/near the cell busbar.
...	

4 Technical Programmes

Technical Programmes – Objectives

Technical Programme Examples

- **Cost-comparison**
- **Digitalisation barometer**
- **Fault / Failure Catalogue**
- **…**

Objectives

vgbe energy with its leading role in understanding good and best practices in operation and development launches different Technical Programmes in cooperation with its members.

These programmes are part of the comprehensive activities of vgbe energy for the future energy sector to support the daily work in operation, maintenance and plant optimisation as well as in techno-economic and environmental challenges. Therefore, the programmes are open for vgbe members as well as vgbe non-members.

The programmes can be carried out as:

- Platform
- vgbe-Standard
- Industry funded project
- Database

Technical Programmes – Tasks and benefits

Benefits

- **Management of industry funded projects**
  vgbe energy initiates, coordinates and/or conducts industry funded projects together with scientific partners.
- **Development and management of databases**
  vgbe energy develops databases or IT-based tools to support the optimisation of operation and maintenance.

Participation

- vgbe members and vgbe non-members
- Charged service (discount for members)

vgbe's contribution

- Initiating and coordinating industry-funded projects (e.g. description of the programme, contracts, organizing the meetings)
- Developing databases (e.g. description, implementation, recruiting of participants, hosting and operation)

5 Research Projects

Research Projects – Objectives

Some Example Research Projects

- **ETIP Hydropower**
- **HYDROPOWER EUROPE**
- **RELY – REliable Reinforcement Learning for sustainable energY systems**
- **INADAR – Innovative and Ecological Approach for Dam Restoration**
- **DigiWind: The digital twin of a wind turbine**
- **ICING III**
- **XSTAND-H2**
- **…**

Objectives

vgbe energy offers collaborative research activities to meet new challenges. In these projects, manufacturers and operators, universities, research institutes and the public sector pool their specific know-how and financial resources.

- Initiation and coordination of **industry, national and international** research projects
- Building of know-how and knowledge transfer
- Saving costs through joint research projects

Research project

Benefit from international collaboration to improve access to public funds as well as from cost-savings, build-up and sharing of know-how.

Research Projects – Tasks and benefits

Benefits

- **Improved funding opportunities**
  Higher likelihood of being awarded a contract due to our network with various stakeholders and institutions**.**
- **Expertise in the submission phase**
  Benefit from vgbe's expertise in developing a dissemination, exploitation and communication plan for submission.
- **Dissemination network**
  Events and conferences across Europe, partner organizations and editors of journals.
- **Topic-specific expert network**
  Pooling of expertise and resources to answer larger and more complex scientific questions or to conduct surveys.

Participation

- vgbe members and vgbe non-members

vgbe's contribution

- Recruiting project partners and/or self-participation
- Co-coordinating the submission proposal
- Responsible for different Working Packages (e.g. dissemination, exploitation and communication)

6 Expert Workshops

Expert Workshops – Objectives

Potential Expert Workshops

- **Disposal of PV-panels**
- **Nighttime inspection**
- **Floating-PV**
- **H2 Coupling**
- **AI monitoring**
- **Central control stations**
- **Agri-Photovoltaics**
- **Inverters: centralized vs. decentralized**
- **…**

Objectives

vgbe energy organises topic-specific expert workshops for vgbe members only to foster exchange and problem-solving between experts at the highest technical level.

The Expert Workshops are planned by vgbe energy in cooperation with its members and cover a broad variety of applications that include established and emerging technologies for energy generation and storage. They can be organised on short notice and can therefore not only address pressing issues in the industry but also be used proactively to find solutions for upcoming challenges.

The Expert Workshops are targeted at operators that are vgbe members and require an active participation according to the policy “give and take”. Therefore, it is mandatory to give a presentation in order to join the active discussion and benefit from the experience of the other participants.

Networking opportunity

Topic-specific workshops

Expert Workshops – Tasks and benefits

Benefits

- **Proactive approach**
  Overcome emerging challenges before they become an issue at your company.
- **Expert talks**
  Discuss with experienced and specialized experts.
- **Train young professionals**
  Take the opportunity to train your young professionals on specific topics through exchanges with experienced industry experts.
- **Documentation**
  Presentations available to all members.

Participation

- vgbe members

vgbe's contribution

- Organizing and facilitate the expert workshops

7 vgbe-Standards

vgbe-Standards
Reference Designation System for (RDS-PP®)

RDS-PP is based on international standards, thus providing a globally recognized standard for the labelling of photovoltaic (PV) powerplants and their components.

- **vgbe-Standard**
- **2018**

Objective

- RDS-PP provides a structured and systematic way to label and reference components and equipment (e.g. locations, plants, systems, functions, and equipment).
- The created labels serve as the basis for encoding signals, connections, and documents.
- The standard was published under the title "RDS-PP Application Guideline Part 33: Photovoltaic Power Plants" as vgbe-Standard VGB-S-823-33-2018-07-EN-DE in July 2018 as a dual English and German standard.

Some benefits

- Based on international standards, RDS-PP is globally recognized and can be applied to various generation technologies.
- RDS-PP provides a consistent and standardized way to name and label components and equipment.
- It was developed in close cooperation with experts from manufacturers and operators in the PV industry.

8 Contact

Thank you to all members for your participation and assistance

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Performing as the collective European platform for operators of photovoltaics.

Being the first address for interested parties in technical, ecological and strategic issues concerning photovoltaics.