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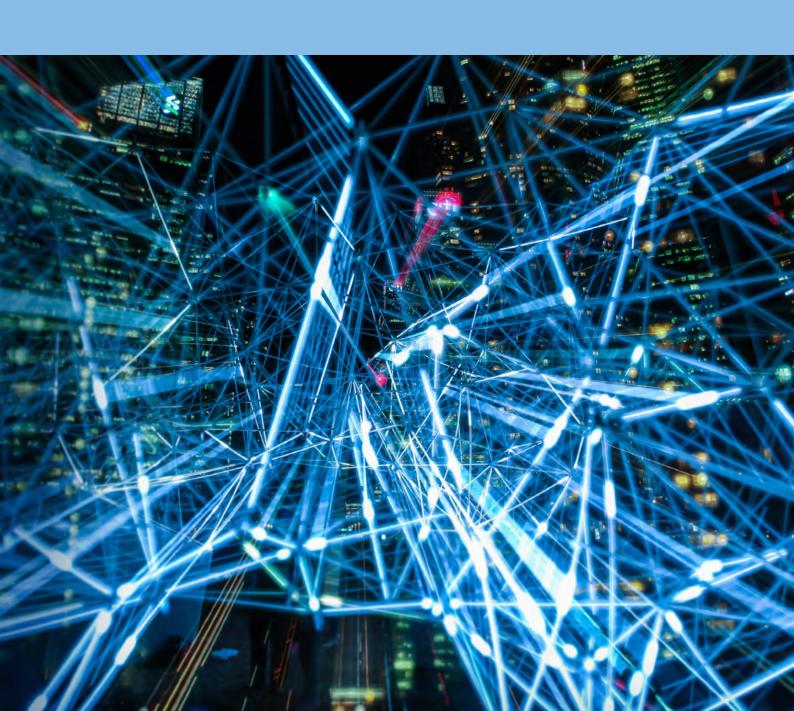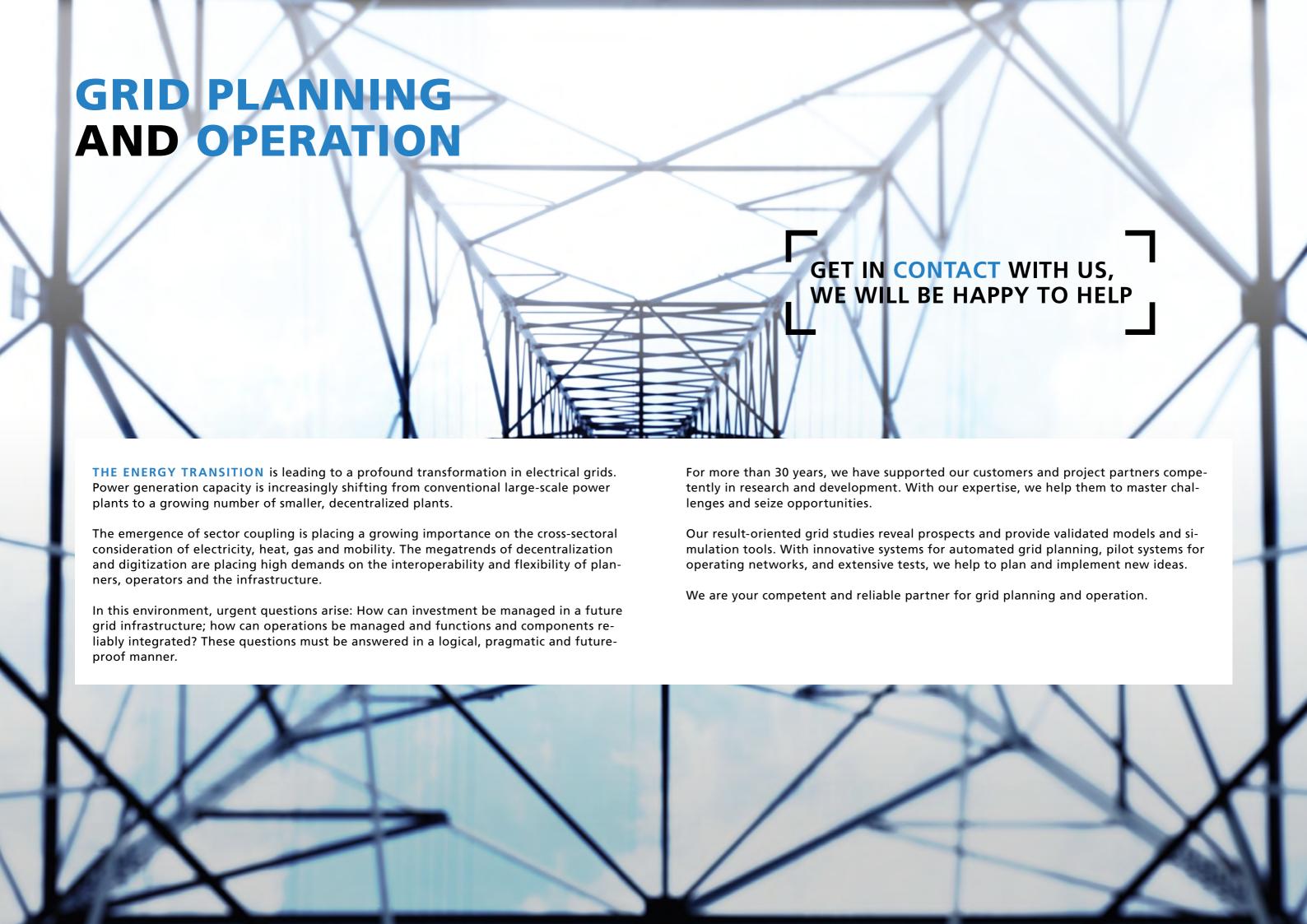**FRAUNHOFER INSTITUTE FOR ENERGY ECONOMICS AND ENERGY SYSTEM TECHNOLOGY IEE**

GRID PLANNING AND OPERATION

GRID PLANNING
AND OPERATION

**GET IN CONTACT WITH US,
WE WILL BE HAPPY TO HELP**

THE ENERGY TRANSITION is leading to a profound transformation in electrical grids. Power generation capacity is increasingly shifting from conventional large-scale power plants to a growing number of smaller, decentralized plants.

The emergence of sector coupling is placing a growing importance on the cross-sectoral consideration of electricity, heat, gas and mobility. The megatrends of decentralization and digitization are placing high demands on the interoperability and flexibility of planners, operators and the infrastructure.

In this environment, urgent questions arise: How can investment be managed in a future grid infrastructure; how can operations be managed and functions and components reliably integrated? These questions must be answered in a logical, pragmatic and future-proof manner.

For more than 30 years, we have supported our customers and project partners competently in research and development. With our expertise, we help them to master challenges and seize opportunities.

Our result-oriented grid studies reveal prospects and provide validated models and simulation tools. With innovative systems for automated grid planning, pilot systems for operating networks, and extensive tests, we help to plan and implement new ideas.

We are your competent and reliable partner for grid planning and operation.

GRID STUDIES

IN ADDITION TO analysing the current state of an electrical grid, we calculate optimized expansion scenarios and predict the necessary grid development. Our focus is not only on cost efficiency, but also on robustness and flexibility in the face of future risks and uncertainties.

In our studies, we calculate the grid's statistics such as load flows, short-circuit currents, grid losses, the reactive power balance and limits for the maximum load or feed-in. In addition to this, we consider dynamic processes that influence grid stability.

Our recommendations for grid expansion thus combine optimal grid operation management with a holistic view of technical and economical aspects.

Profit from our strengths and our decades of experience in converter-dominated grids!

STRATEGIC GRID DEVELOPMENT

- Strategic and operational grid planning
- Integrating grid levels and operators
- Cost minimization (investments, operation)
- Detailed scenarios

CROSS-SECTOR GRID PLANNING

- Save money by jointly planning supply structures
- Customer-specific development of multi-sector concepts
- Simulation of cross-sector networks
- Dimensioning and simulation of heating grids for districts and cities

ELECTROMOBILITY CHARGING INFRASTRUCTURE

- Detailed scenarios including user behaviour
- Grid analysis and planning also considering existing asset structures
- Optimized design of charging infrastructures
- Optimized concepts

MANAGEMENT OF REACTIVE AND ACTIVE POWER

- Control concepts
- Analyses of control concepts
- Coordination between grid operators/ grid levels (cascade)
- Transfer to pilot systems and extension of the control systems

POWER SYSTEM STABILITY AND INTERCONNECTION

- Integration of decentralised generation and renewable energies
- Stability analysis
- Compliance with standards and directives
- Laboratory infrastructure for testing

MICROGRIDS AND ISLAND MODE

- Economical and technical system design
- System simulation and testing in the laboratory
- Monitoring
- More than 20 years of experience in converter-based grids

GRID RESTORATION

- Automated grid analysis
- Increased reliability of grid restoration concepts
- Reduction of downtime
- Black start capability with renewable energy
- Extensive model library
- Recommendations

GRID LOSSES

- Determination of energy flows between network levels for each quarter of an hour, taking into account most types of losses
- Flexible and universal processing of data formats

TOOLS AND MODELS

TO DEVELOP INNOVATIVE SOLUTIONS and test and implement them in the field, tailor-made tools and simulation models are required.

Our portfolio ranges from basic load flow calculation modules to complex simulation environments or hands-on integration systems for the solutions developed.

The modular structure of our tools and models makes individual and efficient solutions possible.

PILOT SYSTEMS FOR GRID OPERATIONS

- Insights into the optimized operation of your own grid
- Interoperability with existing control center environments
- Tests with adapted optimization algorithms
- Easy integration via standardized interfaces

ALGORITHMS FOR GRID OPTIMIZATION

- Simulation and technological / economic evaluation of redispatch actions
- Integration of RE scenarios and sensitivity assessment
- Determination of flexibility under constraints

MODULES FOR GRID CALCULATION

- Highly automated creation of grid models from GIS databases
- Load flow solver
- Power System Analysis Modules for integration in other software solutions

ENERGY SCENARIOS BASED ON GIS AND WEATHER DATA

- Analyses of energy potential
- Detailed future scenarios and transformation paths
- Meteorological database for time series

PLANT AND GRID MODELS

- RE plants, conventional plants, HVDC, storage systems, dynamic loads, transmission and distribution networks
- Compliance with standards and directives
- Suitable for static, RMS, EMT, real-time simulations
- Extensive long-term experience

ENERGY METEOROLOGY INFORMATION SYSTEMS

- Power from the wind, sun, biomass and hydropower
- Consumption forecasts for electricity, heat / cold and water
- Prognosis of power flows and grid conditions
- Dynamic line rating

AUTOMATED GRID PLANNING

- Tools for automated grid planning (Pandapower Pro)
- Seamless integration into existing planning environment possible
- Efficient grid planning approach leading to robust results and high quality

CO-SIMULATION »OPSIM AS A SERVICE«

- Test and simulation environment from controller concepts to operational (control) systems
- Distributed simulation via web interface
- Can be combined with HIL simulations
- Digital twins of real systems

BETTER TOOLS AND MODELS FOR YOUR SUCCESS

TESTS AND MEASUREMENTS

LET OUR QUALIFIED, EXPERIENCED EXPERTS test your solutions and products in our powerful, flexible testing environments.

We can test and validate a broad range of systems: electrical systems at the grid connection point, control units, automation solutions and systems for network operation management.

Tests for systems at the grid connection point are available in accordance with current grid connection guidelines or to suit customer-specific projects, e.g. using our powerful power hardware-in-the-loop systems.

Tests of automation systems include product tests for microgrid automation and smart grid technologies within our special controller hardware-in-the-loop environment and the IEE-SysTec, our smart grid laboratory for low- and medium-voltage systems.

TRUST IS GOOD, TESTING IS BETTER

HARDWARE-IN-THE-LOOP STUDIES

- Reproducible tests of generating plants, grids, loads and related controllers in field-like conditions
- Worst-case test scenarios
- Risk elimination and test cost reduction

REAL LABORATORIES AND FIELD TESTS

- Support during planning and preparation
- Metrological / analytical monitoring
- Digital twins
- Operational pilot systems

MEASURING AND TESTING SERVICES

- Grid quality analysis
- Plant grid connection
- System tests

TESTS OF GRID OPERATION TOOLS

- Verification of controller and control system functionalities
- Reliable, reproducible tests
- Evaluation of functionalities
- Real-time co-simulations

AUTOMATION SYSTEM TESTING

- Function tests and performance
- Microgrid solutions
- Model development and validation
- Software / controller / hardware-in-the-loop

CONSULTING AND TRAINING

PROFIT FROM OUR KNOW-HOW

TAKE ADVANTAGE OF OUR EXPERIENCE in the development of customer-specific, cost-efficient, pioneering solutions.

Put yourself and your employees in a position to develop more efficient and future-proof investment strategies.

Reliably establish technology paths for coming developments in the context of energy system transformation.

STRATEGIC CONSULTING FOR POLITICS AND BUSINESS

- Technical analysis and evaluation
- Development of business models
- Development of roadmaps

GRID CODE DEVELOPMENT

- Many years of experience in the development and testing of grid codes
- Grid code design
- Grid code compliance tests
- Evaluation of configuration options

TRAININGS AND KNOWLEDGE TRANSFER

SMART GRID LABORATORY DEVELOPMENT

- Support during the planning phase
- Specification of laboratory infrastructure and equipment
- Support during commissioning

Solutions from research and development for sustainable grids during the energy transition

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WE ARE YOUR RELIABLE PARTNER FOR QUESTIONS REGARDING

- Transparent consulting
- Informative studies
- Efficient tools
- Measurement and testing services

OUR OFFERS FOR YOU

- Software tools for automated grid planning (Pandapower Pro)
- Grid planning and asset management as part of strategic grid development
- Cross-sectional grid planning
- Integration of electromobility and storage taking into account energy scenarios based on GIS and weather data
- Grid stability studies
- Island mode and micro grids
- Pilot systems for grid operation (beeDIP)
- System services (e.g. reactive and active power management, grid reconstruction)
- Algorithms for grid optimization
- Forecasts and state estimation
- Level-specific grid loss determination
- Co-Simulation (OpSim)
- Grid calculation modules, plant and grid models
- Testing and checking of systems, controllers, operation management modules, grid operation management and automation systems
- Grid connection conditions for plants, grid quality analyses and system tests
- Smart grid laboratory development
- Grid code development
- Support for strategic corporate development
- Policy advice