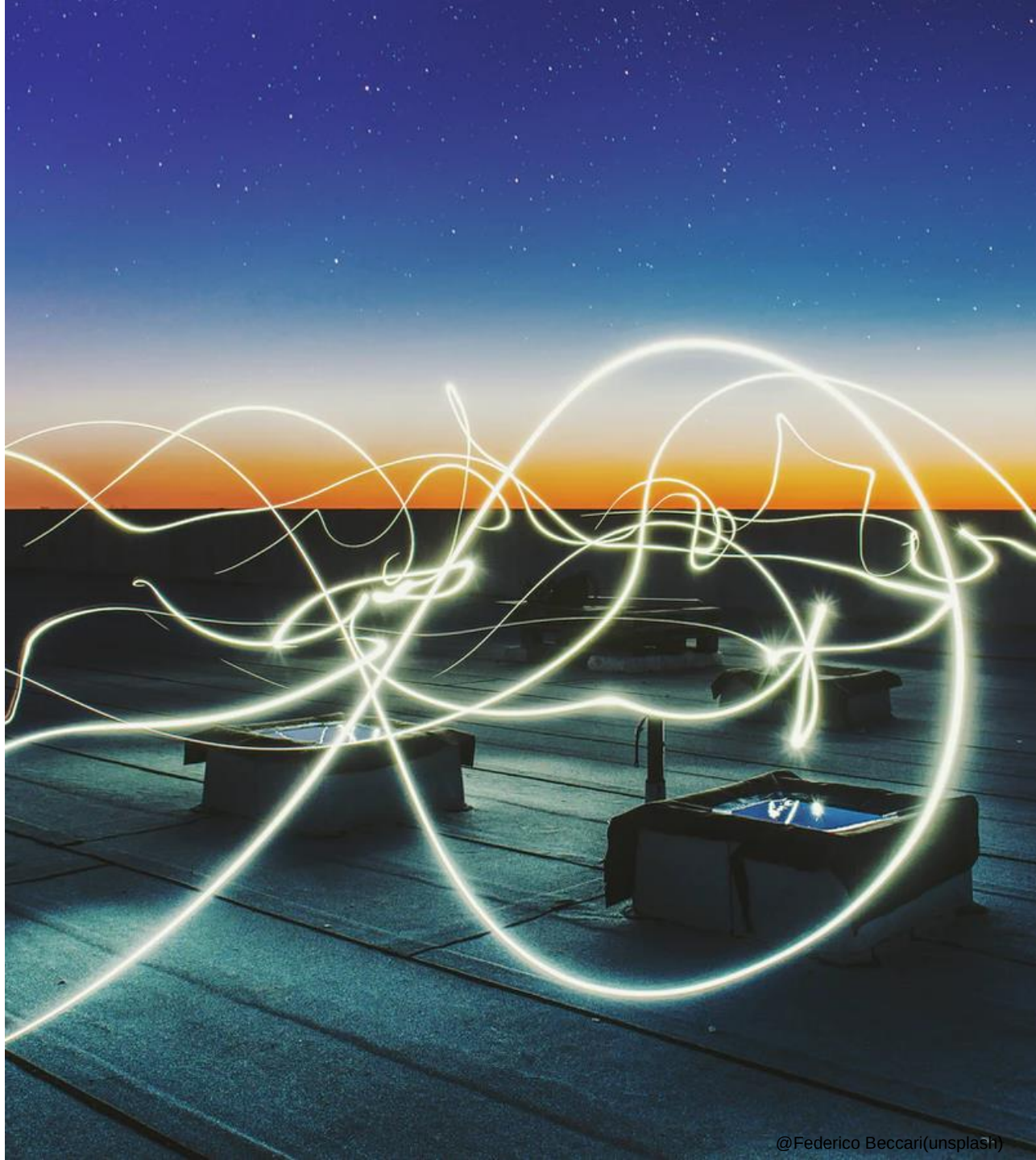
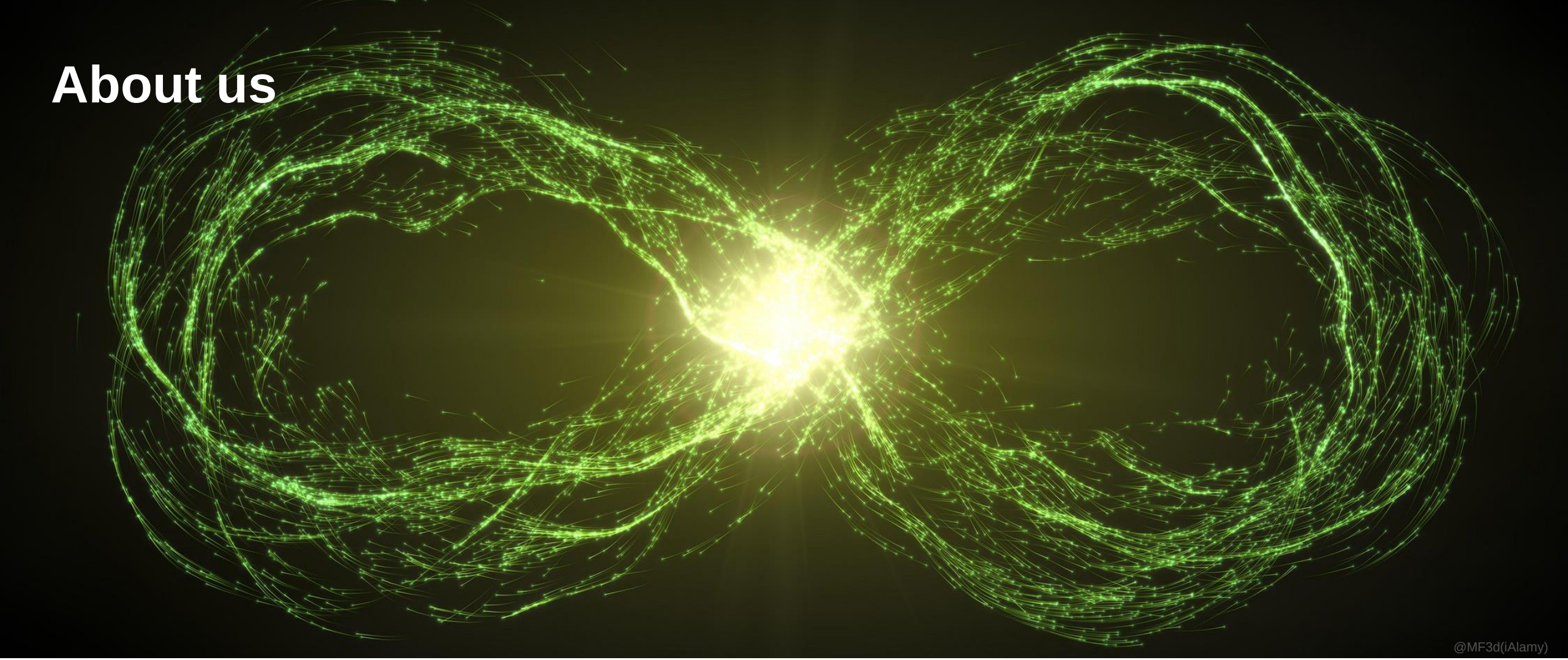
Hochschule
München
University of
Applied Sciences

ISES
Institute for Sustainable Energy Systems

Version 2021.05.20



About us



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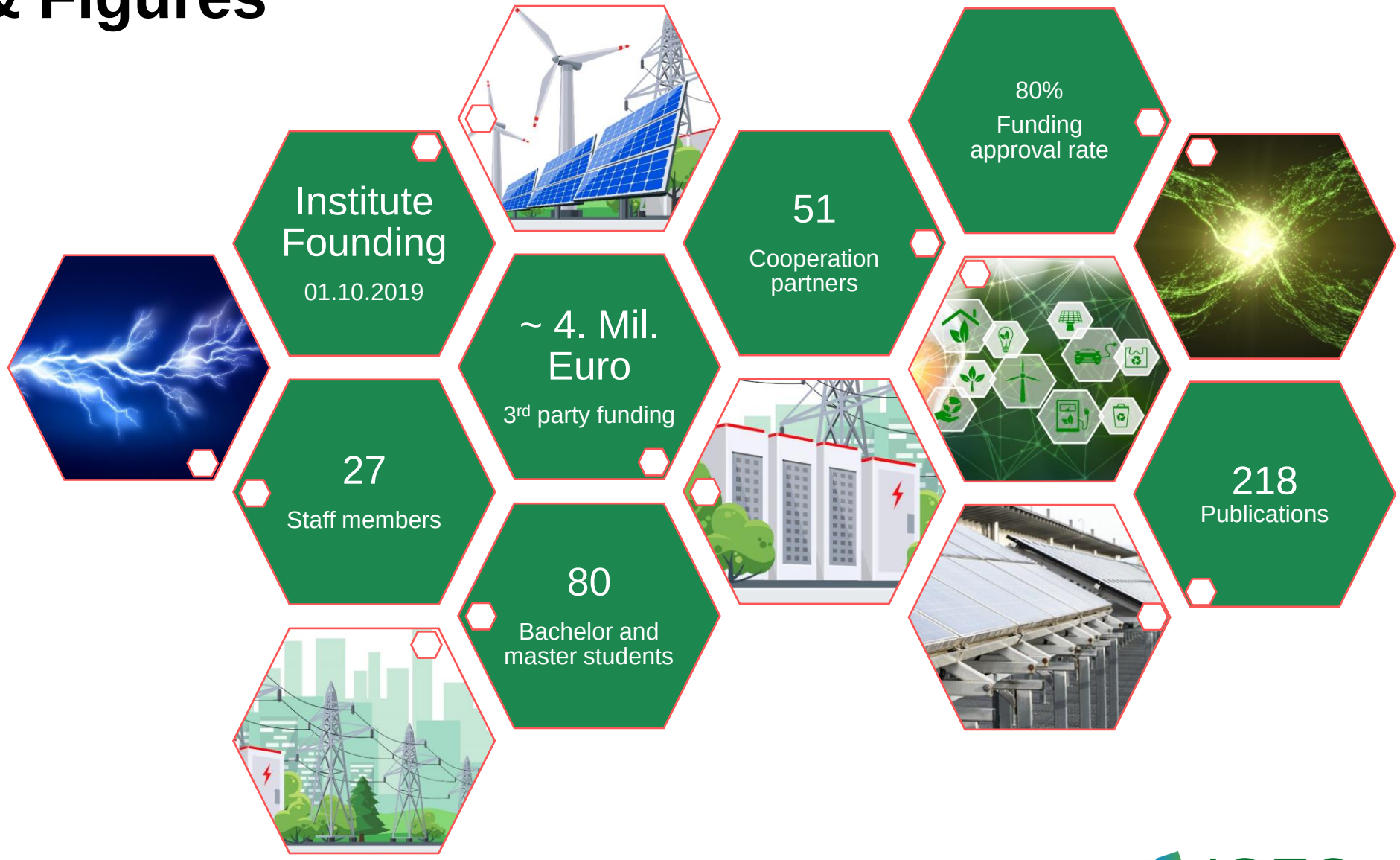
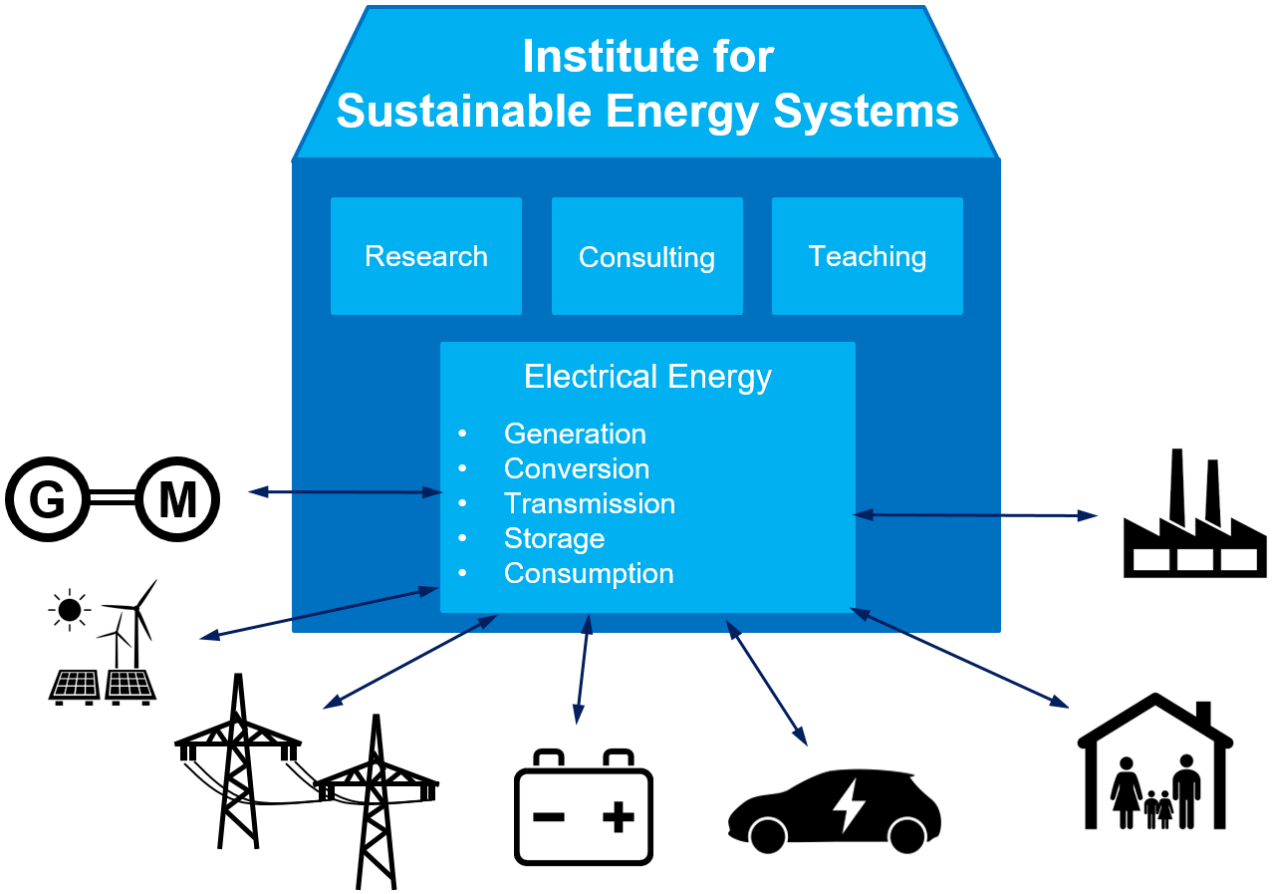
Facts & Figures



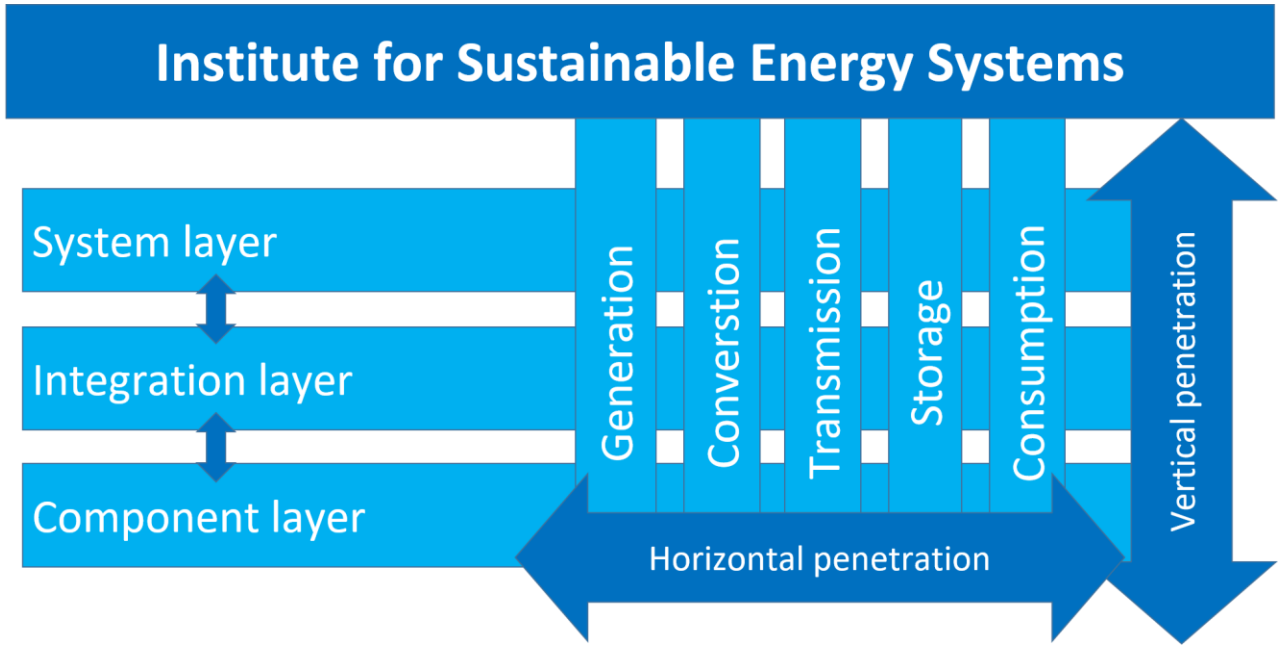
Status 19.04.2021

Our Mission



- With our research, consulting and teaching activities, we make a considerable contribution to a more efficient, sustainable and resource-conserving approach to energy supply and use
- Meeting global climate and energy targets is a major goal we aim to contribute to
- Sustainability is our focus area

Our Expertise



- We conduct research on the conversion, distribution and storage of electrical energy
- We research energy systems in their entirety, from the component to the system level, and across all stages of the value-added chain, from power generation to consumption

Our Team

Leading team and research areas

- Florentina Alecu
  Managing Director / Research Coordinator

- Oliver Bohlen
  „Electrical Energy Storage“

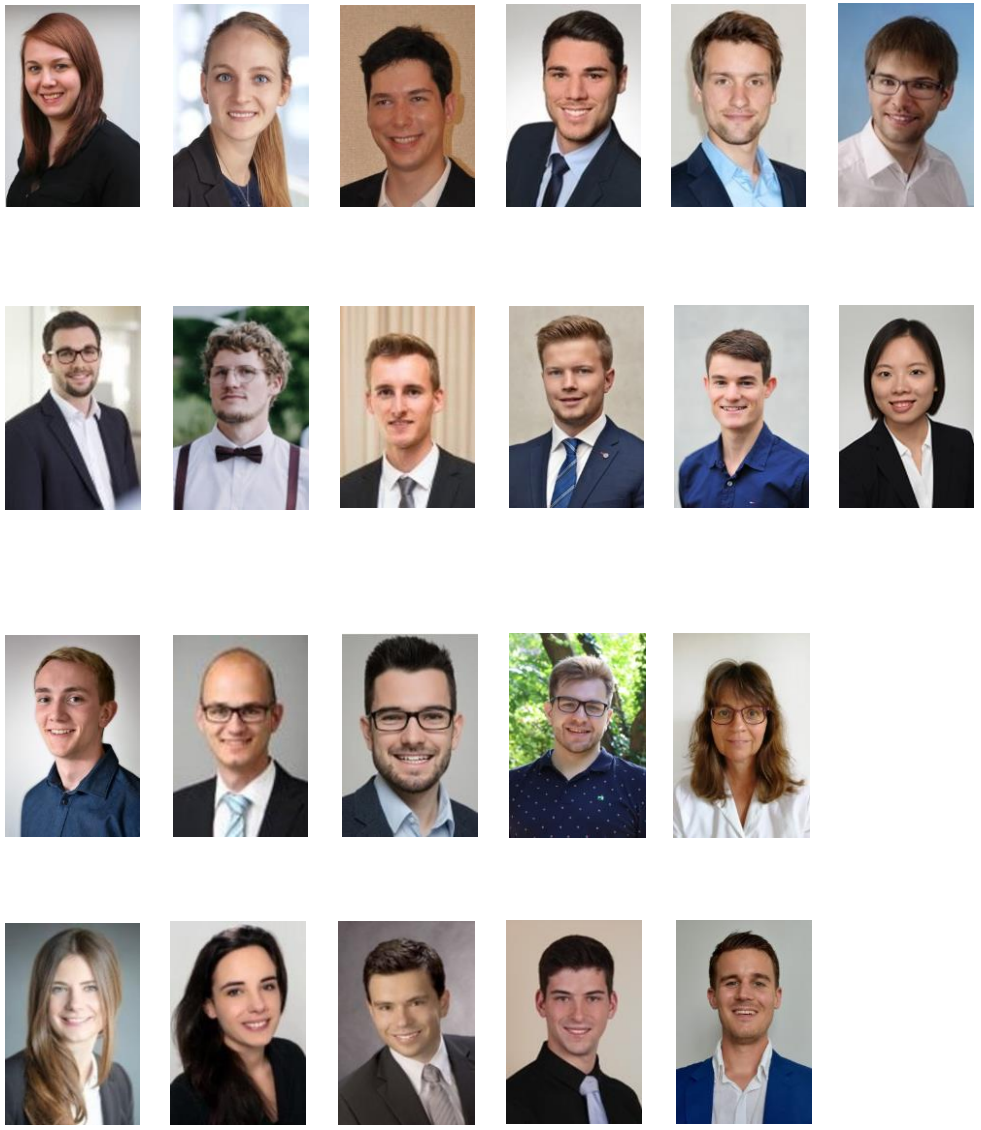
- Christoph Hackl
  „Mechatronic and Renewable Energy Systems“

- Herbert Palm
  „Systems Engineering“

- Simon Schramm
  „Solar Technology and Electrical Power Systems“

- Stephanie Uhrig
  „Electrical Power Engineering“

Our research scientists



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Our Research Areas

@Riccardo Annandale(unsplash)

Areas of Expertise

Electrical
Energy Storage

Mechatronic and
Renewable
Energy Systems

Systems
Engineering

Solar Technology
and Electrical
Power Systems

Electrical Power
Engineering

Electrical Energy Storage

- The research group “Electrical energy storage” focuses on systems for storing electrical energy - primarily batteries - and the respective applications such as electric vehicles, home storage systems, e-bikes, etc.

- The thematic focus is on battery system technology, i.e. everything that goes with it to turn battery cells into a functioning overall system. This includes:

  - **Battery characterization**, such as pulse and capacity tests, impedance spectroscopy, thermal analysis
  - **Modelling and simulation** of electrical, thermal and ageing behaviour using tools such as Modelica, Python and Matlab/Simulink
  - **Battery management** systems and algorithms for state of charge and state of health monitoring, energy management and optimal power flow in storage systems
  - **Battery electronics**, prototyping for battery systems and BMS electronics for e-bikes and other applications

Mechatronic and Renewable Energy Systems

- The research group „Mechatronic and Renewable Energy Systems“ focuses on: system modelling, identification, fault detection, condition monitoring and control of mechatronic and renewable energy systems
- Particular interests are efficiency, fault tolerance, intelligence, robustness and reliability oft he considered, self-learning systems and components
- The interdisciplinary expertise of the group merges the engineering disciplines electrical drives, power electronics & mechatronics and the mathematical disciplines control and systems theory
- Recent research projects deal with
  - the modelling and analyses of the future power grid as a four-wire three-phase system (including harmonics and arbitrary faults)
  - the modelling and control of the electrical components of of electric vehicles, biogas plants, airborne wind energy systems, geothermal power plants, large-scale and small-scale wind turbine systems and wave converters
- More details are available on https://lmres.ee.hm.edu/.

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Systems Engineering

- The research group „Systems Engineering“ focuses on methods and tools for modelling, simulation and multicriterial optimization of complex systems
- Particular interest focuses on development of effective and efficient search algorithms to identify non-dominated („Pareto-optimal“) system layouts for a high (larger than ten) number of design degrees-of-freedom
- The interdisciplinary expertise of the group merges technical engineering disciplines such as power engineering, mechanical engineering and computer science with methodological (INCOSE) systems engineering competencies
- Recent research projects deal with
  - Pareto-optimal layout of sector-coupled, decentralized, sustainable energy systems for multi-use-case scenarios
  - Pareto-optimal power-flow operational strategies for stationary battery-energy storage systems (BEESs)
  - Hyper-Space-Exploration for highly effective and efficient layout of neural network hyperparameters

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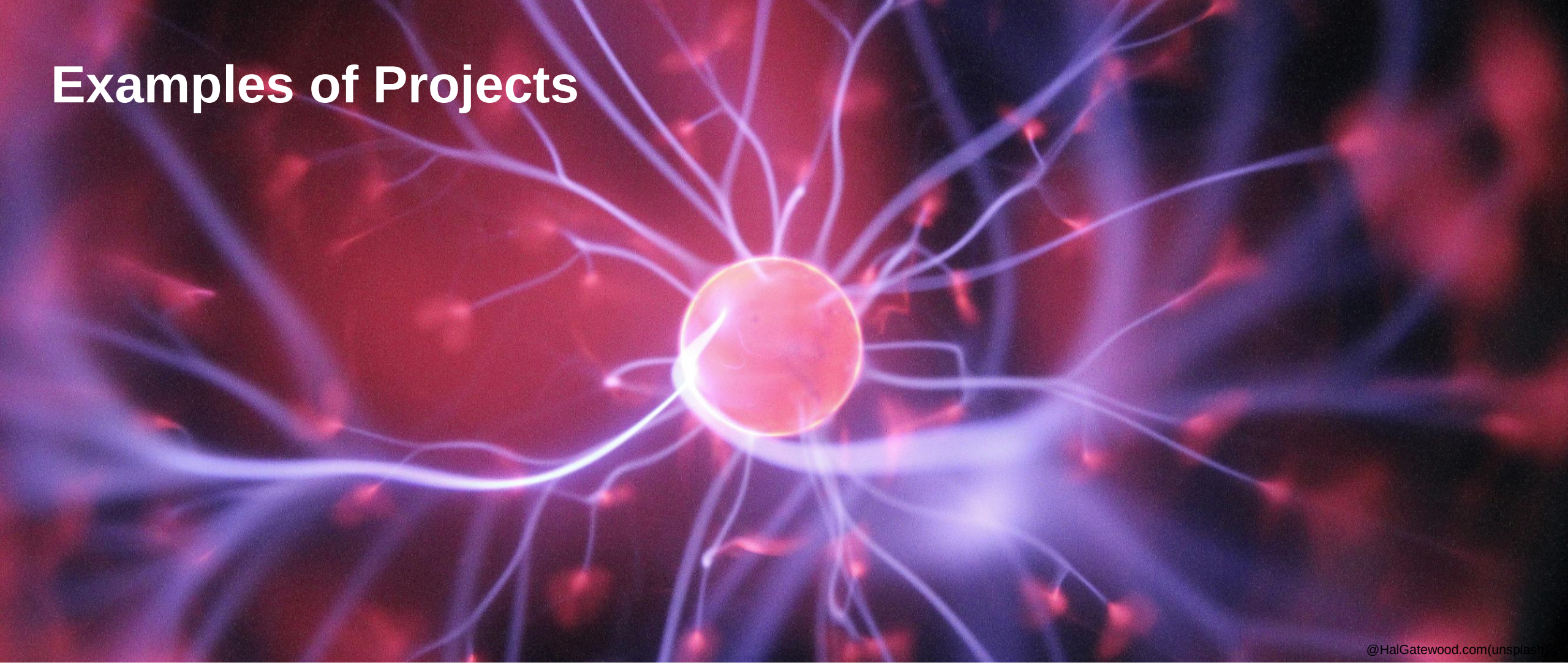
Solar Technology and Electrical Power Systems

- The research group „Solar Technology and Electrical Power Systems“ focuses on topics relevant for the “Energiewende”:
  - Solar generation, e.g. accelerated life time test of components, e.g. of vehicle integrated PV, low cost high performance monitoring, system design and operation
  - Power electronics required to connect AC to DC or DC to DC-Systems, e.g. high performance AC/DC and DC/DC-converter with galvanic insulation – design, control, test, operation (e.g. with predictive control based on analytic equations)
  - Energy efficiency, e.g. data driven analysis of energy consumption in small up to complex building systems
  - Energy system planning, e.g. system planning tool energy systems with high penetration renewables, including sector coupling, and its control
- All topics include theory and practice, applied research, including e.g. modelling, automated data analysis, rapid prototyping, and test, thus theory and validation

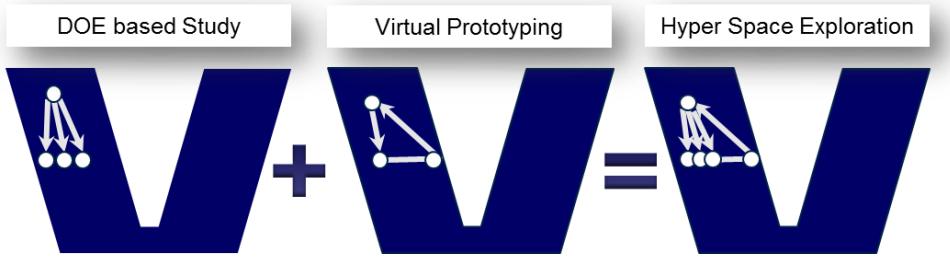
Electrical Power Engineering

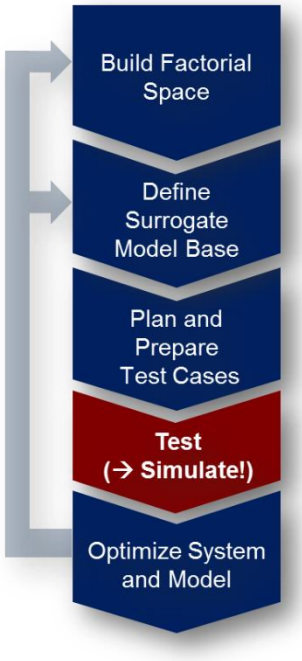
- Diagnostics and condition assessment of power system equipment:
  - Equipment in our power grid is subjected to loads and stresses, resulting in ageing or occurring defects
  - Using diagnostic measurements, it is possible to assess the condition of the equipment, i.e. to estimate the degree of aging and to identify possible causes of errors at an early stage
- Controllable loads in the distribution network:
  - Smart Grids of tomorrow are achievable only by higher efficiency and optimized utilization of existing structures
  - A promising approach uses controllable loads (time-flexible consumers) in the distribution network
  - Energy consumption is shifted to times with energy surplus

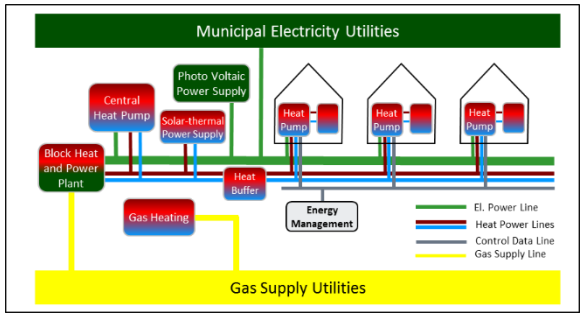
Examples of Projects



Engineering of Complex Systems







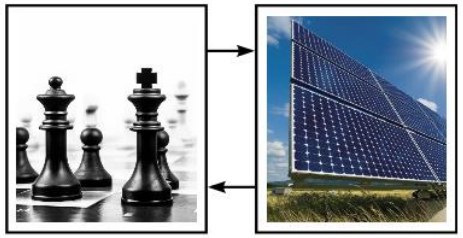
- Entering new technologies involves:
  - Large amount of unknown solutions
  - Lack of „proof-of-concept“
- Extending the V-Model allows to manage related uncertainties
- „Hyper Space Exploration“ is a multi-criterial trade-off-analysis making use of:
  - Design of (virtual) experiment
  - Surrogate modelling
  - Model-driven system optimization
- Our applications:
  - Sustainable energy systems
  - Automotive top-level design (FEVs)
  - Complex Controler Design

Intelligent mechatronic and regenerative energy systems

Wind turbine systems

Small-scale WTS

(N)MPC for RES



Airborne wind energy systems

Geothermal energy systems

Wave energy converters

Electric vehicles

Power systems

Bio gas systems

Multilevel converters

Electrical drives

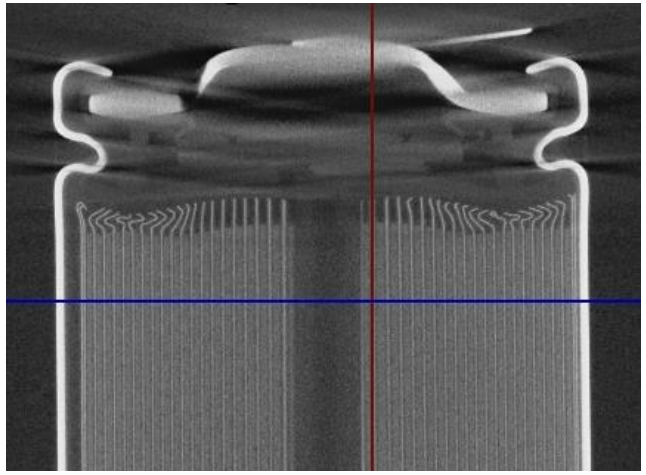
Motion control

Detection & Localization of mechanically induced damages in lithium ion batteries (ReVISEDBatt)

ReVISEDBatt

Research:
- Realistic mechanical stresses, such as shocks, vibrations and external forces
- Damages in cell and module components
- Effects on operational and aging behavior
- Detection methods

Objectives:
- Knowledge of damage mechanisms
- Development of novel early detection methods
- Online application in battery management systems



Project:
- Project period: 2017/09 – 2021/03
- Staff at HM: one research fellow, student workers

Supported by:
Federal Ministry for Economic Affairs and Energy
on the basis of a decision by the German Bundestag

Fraunhofer ISC · TÜV SÜD · thyssenkrupp · infineon · HOPPECKE · HILTI

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Prof. Dr.-Ing. Bohlen

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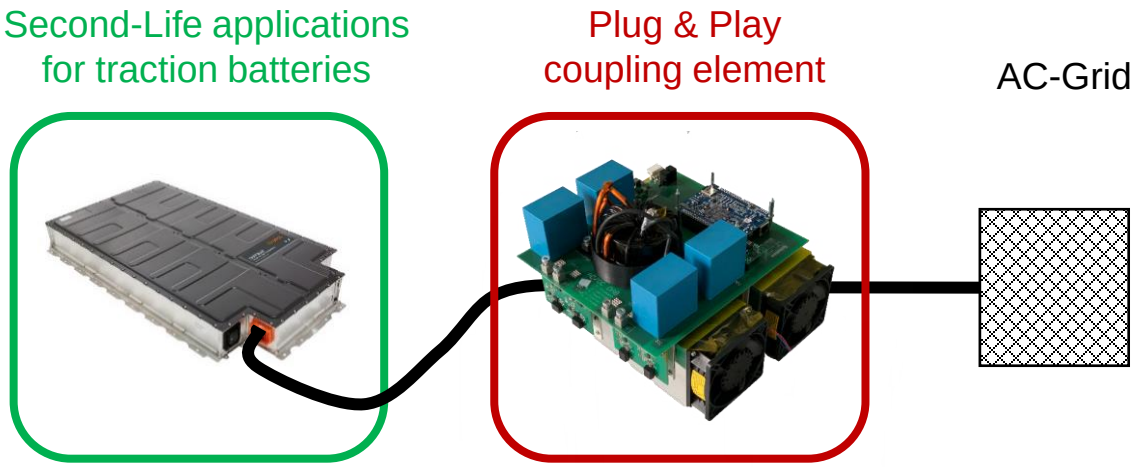
Universal connection of automotive traction batteries for stationary applications (UnABESA)



Research objectives

- Universal architecture for different batteries and applications
- Highly efficient power electronics with innovative control
- Optimized power flow in heterogeneous battery systems

Applications

- Frequency regulation
- Peak shaving
- Decentralized storage

Challenges

- No standardized design
- Different battery properties
- Costs

Project:

- Project period: 2017/06 – 2020/12
- Staff at HM:
  two research fellows,
  student workers

Supported by:
Federal Ministry for Economic Affairs and Energy
on the basis of a decision by the German Bundestag

Inductron® Inductive Electronic Components GmbH

HM

Prof. Dr.-Ing. S. Schramm, Prof. Dr.-Ing. Bohlen

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Private Grid Coupling

Bundesministerium für Wirtschaft und Energie

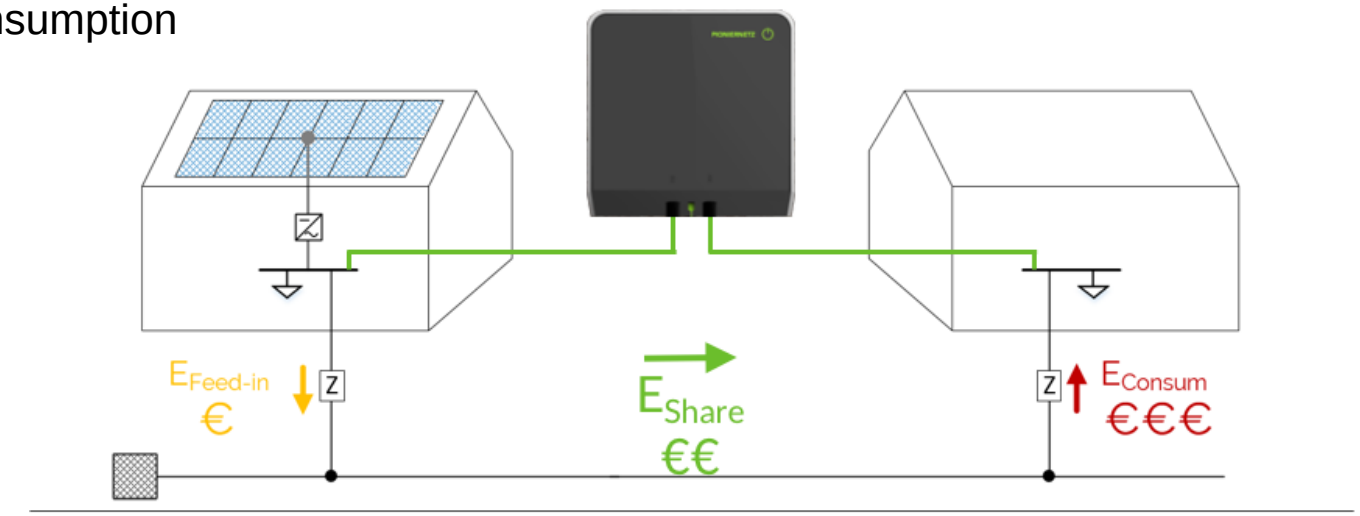
PIONIERKRAFT

Hard Facts

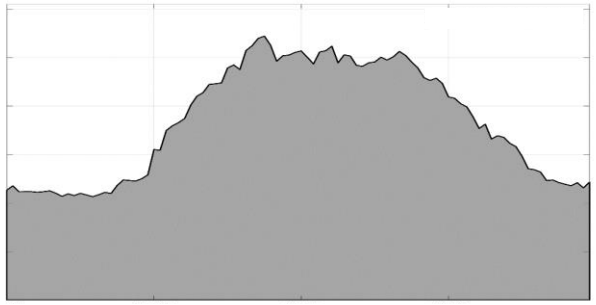
- Mains parallel
- Galvanic isolated
- Surplus energy transferred
- Depending on energy production and - consumption

Customer Value

- PV plant is more profitable
- economic benefits for producer and receiver
- more people get access to renewable energy.
- contribution to a successful energy revolution



Analysis of complex building structures



Goals

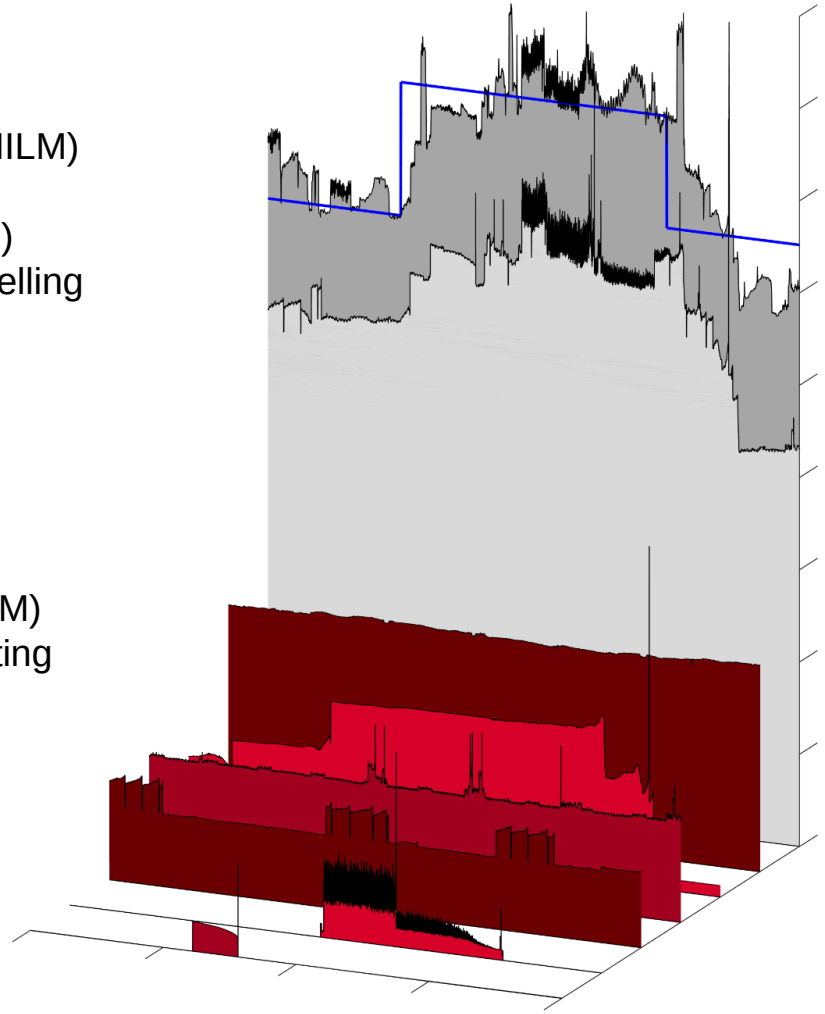
- Analysis of complex building structures
  - Office and administration building
  - Industry & Craft
- Automated and data-based process
- Identification of the operating mode of essential electrical consumers on the basis of high-resolution measurement of the total consumption

Research priorities

- Non-intrusive load monitoring (NILM)
- measuring technology
- Data analysis (machine learning)
- High-resolution load profile modelling

Application Areas

- Energy consumption monitoring
- Identification and evaluation of energy efficiency measures
- Peak-Load reduction
- Demand Side Management (DSM)
- Design and operation of generating plants and storage facilities
- Failure detection



Supported by:

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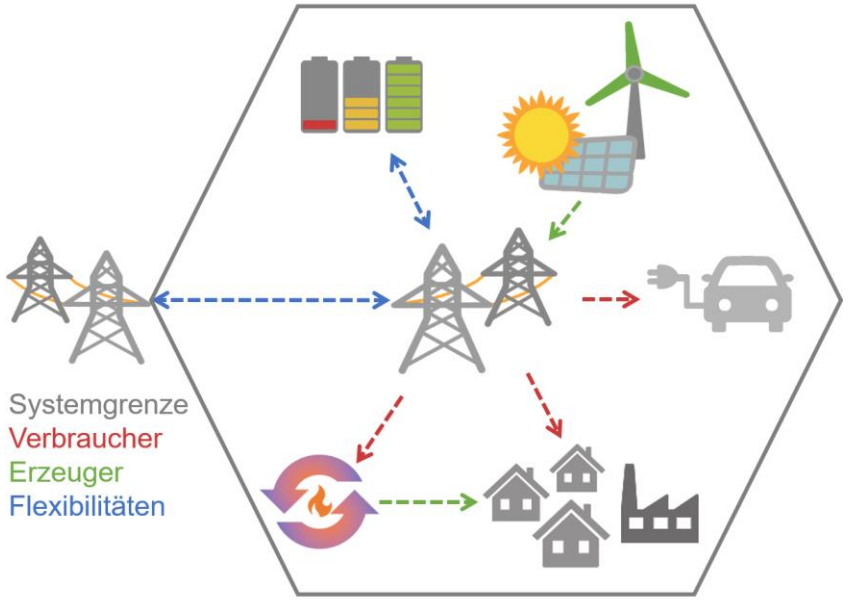
on the basis of a decision by the German Bundestag

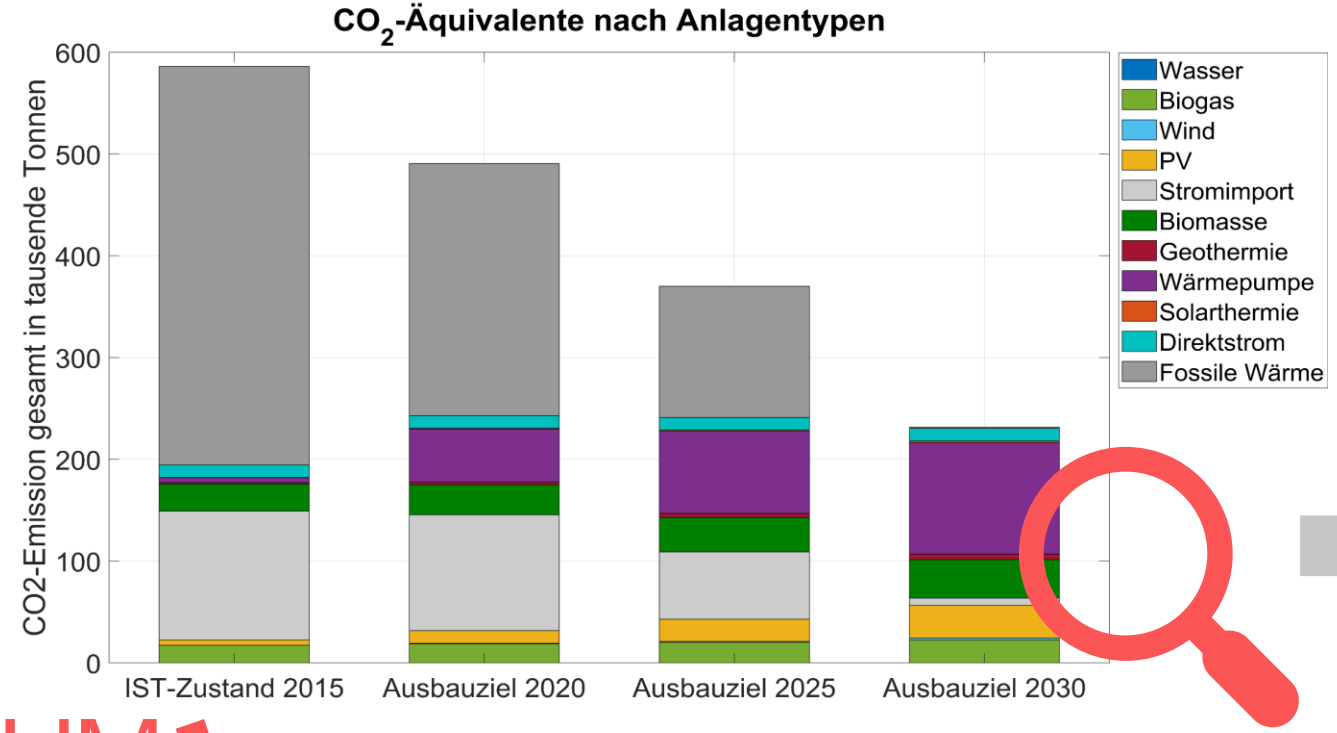
As part of the research project:
NuData Campus - Usage Data Based Optimisation of Buildings and Facilities using the Example of Munich

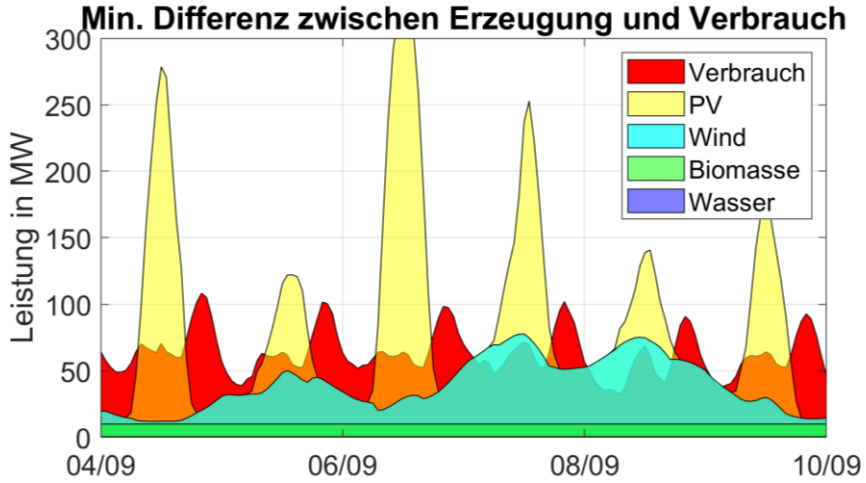
opEn – Optimal Design of Energy Cells

Motivation and Goals

- Balance sheet planning of the energy transition not sufficient
- Development of a tool chain for individual design of energy systems (cells) based on time series simulation and consideration of the relevant criteria
- Participatory process to involve the population in the decision about various energy transition scenarios for their energy cell







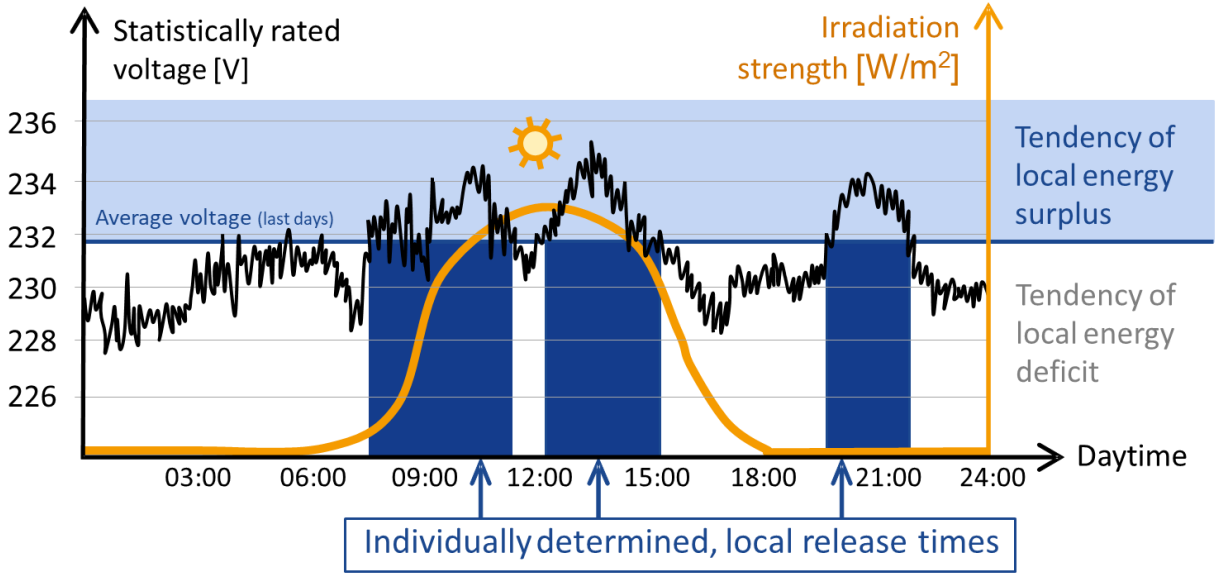
Prof. Dr.-Ing. S. Uhrig
Prof. Dr.-Ing. S. Schramm

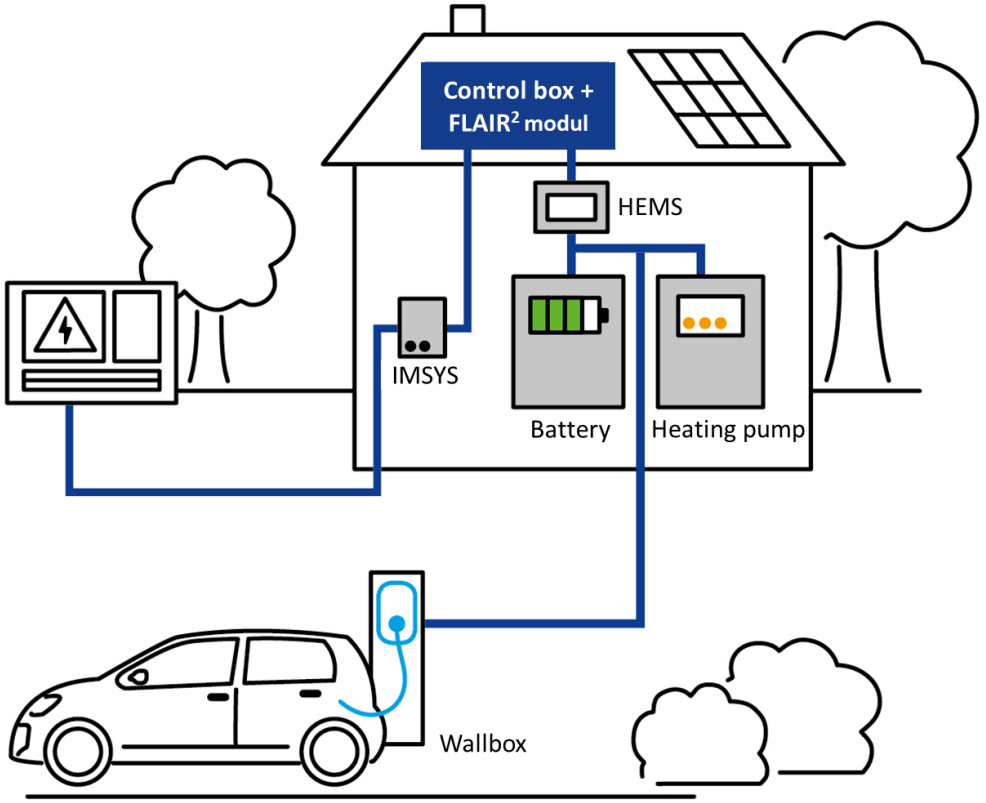
FLAIR² - FLexible Anlagen Intelligent Regeln
Local and Automatic Control for Flexible Loads

Motivation and Goals

- Intelligent and decentralized solution to control flexible loads
- Optimization of the grid state applying demand side management
- Based on the actual and local grid state e.g. voltage measurement data

Project: Period: 2020/11 – 2023/10, Staff at HM: two research fellows

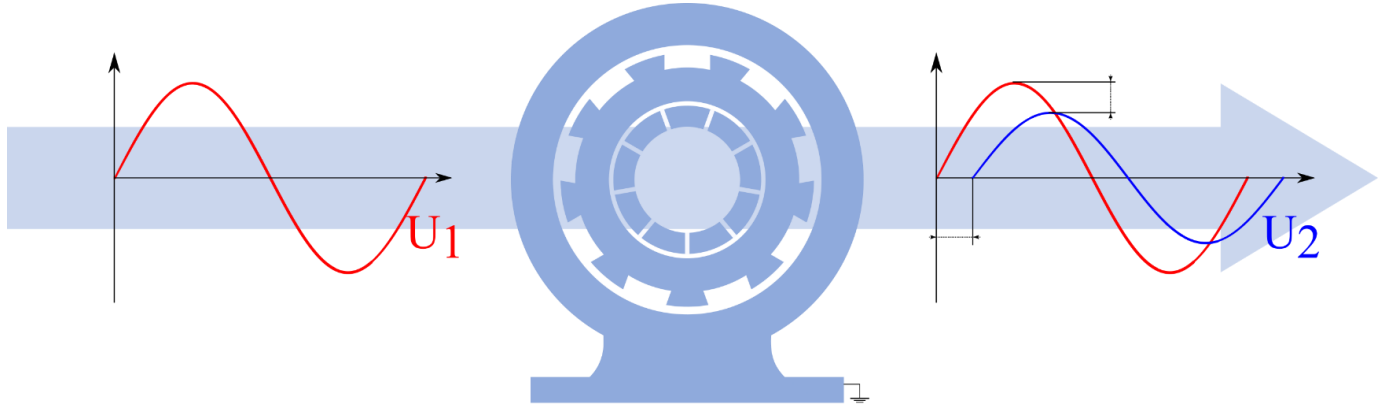




Reliable Diagnosis on Electrical Machines (CarpeDiem)

Research objectives

- Development of reproducible method for failure diagnosis on rotating machines
- Use of non-intrusive frequency response measurement and analysis (FRA)

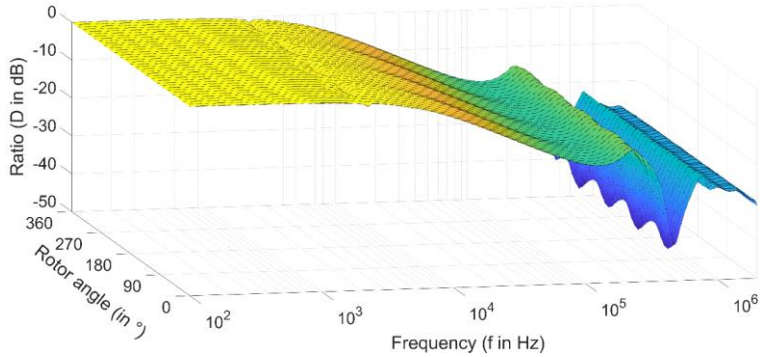


Challenges

- Finding general behavior
- Influencing factors unclear
- Assure high reproducibility
- Modeling of frequency response highly challenging

Applications

- Different types and power classes of rotating machines
- Detection of different failure modes like broken rods or shorts within windings
- Condition assessment



Project

- Period: 2020/04 – 2022/03
- Staff at HM:
  one research fellow

Further project examples

- BaPoBs - Battery aging and Pareto-optimal operating strategy (Prof. Dr.-Ing. Oliver Bohlen and Prof. Dr. Herbert Palm)
- ifMMCC - Intelligent and fault-tolerant modular multilevel cascade converter in future renewable energy systems under different grid-fault conditions (Prof. Dr.-Ing. Christoph Hackl)
- e-TWINS - Holistic digital twins for the energy system (Prof. Dr.-Ing. Christoph Hackl)

Thank you!