The institute’s name has changed, but its goals have remained the same. Since the beginning of 2018, we are now named the «Fraunhofer Institute for Energy Economics and Energy System Technology IEE», exploring new technologies and business models for the success of the energy transition in Germany and international energy system transformations.

Since it was established in 2009, both divisions of the former Fraunhofer Institute for Wind Energy and Energy System Technology IWES have grown significantly and have successfully developed largely independent profiles as part of their strategic alignment. The Fraunhofer-Gesellschaft has therefore taken the decision to continue the branches of the institute as independent institutes as of January 2018.

Fraunhofer IWES Northwest, headquartered in Bremerhaven, will continue to operate under the slightly modified name «Fraunhofer Institute for Wind Energy Systems IWES». It has established itself as an institute for the validating wind turbine technology and related services.

In Kassel we have become the new «Fraunhofer IEE», a name which embodies our two established business areas energy economics and energy system technology.

We continue to explore solutions to technical and economic challenges in the transformation of energy systems in order to further reduce the costs of using renewable energy, to secure the supplies despite volatile generation, to ensure grid stability at the usual high level and to make the energy transition a successful business model.

The basis for successful contract research in our business areas is provided by our areas of expertise: energy economics and system design, energy meteorology and renewable resources, energy informatics, energy process engineering, electrical grids as well as device and system technology.

In the future, we intend to focus more strongly on the system coupling of electricity, heat, gas and mobility. This enables the necessary increase in flexibility between energy generation and energy demand in a system with strongly volatile components. Being system experts, we therefore created two years ago a new area of expertise «energy process engineering» and are now expanding our expertise in the area of buildings, quarters, heating and cooling.

We thank all our partners and sponsors for their trust and support. We look forward to continuing our existing partnerships and to establishing new scientific and business relationships. Get in touch with us.

Clemens Hoffmann
Executive Director
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At present, there is no alternative to renewable energy sources to decarbonise the energy system. Wind turbines and photovoltaic systems offer high technical exploitation potential and deliver electricity directly, efficiently and affordably. But how can the sectors of heating, cooling, production, mobility and transport be supplied with carbon-neutral energy?

**Synchronising fluctuating energy generation with energy consumption dynamics**

Weather-related fluctuations in energy generation using wind turbines and photovoltaic systems require a many times higher total installed capacity compared to that of power plants currently used for electricity supply. It would make sense to increasingly integrate the other so far non-electric sectors, in particular heating and cooling, mobility as well as industrial and chemical processes, into the electric sector. Only then can the fluctuating generation pattern of renewable energy sources be synchronized with the consumption dynamics.

The national and international expansion and the enhanced cooperation between the transmission grid and distribution grid levels increase the flexibility and make it possible to level out differences between regions and countries. Short-term power peaks and shortages in the range of few hours can be counterbalanced by chemical battery storage systems, which are highly efficient, but also involve high costs. Longer periods of time and higher amounts of energy can only be supplied economically using European hydropower with natural inflow, pumped-storage power stations and by converting electricity into chemical energy carriers using for instance power-to-gas. Balancing power plants are additionally needed to be able to secure the supply at all times. However, the operating times and costs of operation of such power plants will only account for a small percentage compared to those of the overall system.

**Efficiency through sector coupling**

The increasing electrification of all consumption sectors also opens up considerable efficiency potential. Measured by the primary energy input, electric vehicles and heat pumps, for example, are at least three times as efficient as the conventional technologies. The replacement of oil and petrol is a multistage process.

In the field of heat generation, the low-temperature processes of space heating can be fully replaced in the next few decades. Likewise, it will be possible to quickly electrify about half of all traffic.

The replacement of fuels used in high-temperature processes as well as heavy-duty and air traffic is more difficult and will take more time. Electric options are discernible here as well. An alternative option is the synthetic and carbon-neutral production of fuels using renewable energy. In the end, fossil fuels will be replaced completely.

**Heating with heat pumps**

For reasons of efficiency, the heat pump technology offers a future option for both space heating and cooling. Four kilowatt-hours of heat can be generated by using one kilowatt-hour of electric power. However, the lower initial temperature level requires buildings to be equipped with thermally insulated as well as large-scale wall, ceiling or floor heating. In combination with thermal energy storage systems capable of storing heat for several days, the flexibility of electricity supply can be enhanced. The establishment of small associations through local heating networks and thermal energy storage systems on a housing estate level can offer further optimization potential.

The main obstacle to introducing such technology is the extensive structural changes required in some cases. For this reason, this will be a slow but steady conversion process.

**Electricity for mobility**

The vehicles of the future can be classified by the remaining combustion engine portion of the vehicles, ranging from »mild hybridization« to fully electric vehicles. The selection of the type of vehicle depends on the personal driving profile. However, »hybridization« is also possible outside the vehicle platform. As well as electric vehicles being used for short distances, long distances, such as holiday trips and removals, can be covered by hiring vehicles fitted with combustion engines.

In addition, the more battery technology develops to a higher mass-specific capacity level, the more the focus will be shifted from hybridization towards purely electric vehicles.

As a rule, electrification should be maximized for reasons of efficiency. However, the multifaceted issue of mobility sets complex boundary conditions, entailing a broad range of solutions. In this context, the fuel cell also deserves mention, which is able to replace the remaining internal combustion engines. Furthermore, the fuel cell itself also has technological development potential.

**Chemical energy sources**

Energy-related technology is being revised on a large scale. The technology for converting electric power into chemical energy sources in the order of hydrogen, methane, light alkanes and other syntheses should be mentioned. This technology represents the last step in the large-scale conversion process that is currently being observed.

**Digitization**

The rapidly progressing digitization and automation process of the energy supply will pave the way for a strongly decentralized and flexible supply structure. The interaction of energy generation, marketing, transport, distribution and consumption requires extensive and full digitization of the supply system. In the future, established and well-described processes, such as customer or supplier change processes as well as market process communication, will coexist with new processes, such as peer-to-peer trading and the definition and exploitation of the properties of energy generated or consumed.

**Regulatory boundary conditions**

At present, the development of boundary conditions for the energy markets is even more important than the technological processes, all of which are well under way. Most technologies are ready to be launched on the market. Since they all aim to reduce the CO₂ emissions in the energy sector, appropriate instruments need to be developed to promote this market entry.
The energy economics business area encompasses products and services supporting the planning and operation of power supply structures and their components.

We accompany the transformation process of energy supply systems by combining market and technology with software solutions, information and data services, concepts and business models as well as energy economics analyses and assessments.

**BUSINESS FIELDS:**
- Analyses and consultancy in energy economics
- Energy meteorology information systems
- Virtual power plants
- Wind resource assessment with LiDAR
- Training and knowledge transfer

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**FUTURE ENERGY SYSTEM**
- Future market design
- Analysis of interaction between the sectors of electricity, heat and transport
- Future technologies
- Scenarios and time series

**FLEXIBILITY**
- Investment decisions for bioenergy and Combined Heat and Power (CHP)
- Load management in trade and industry
- Wind energy in the control reserve market
- Use cases for storage

**DECENTRALIZED ENERGY SUPPLY**
- Systems for energy consumption of buildings and real properties
- Sustainable energy concepts for cities and quarters
- Regional energy generation and supply

**INTERNATIONAL ENERGY TRANSITION**
- CO2 savings in energy sectors
- Technical and economic potential of sustainable energy technology
- Modeling of energy system and power generation
- Paths towards transforming the energy system

[www.iee.fraunhofer.de/analyses](http://www.iee.fraunhofer.de/analyses)
VIRTUAL POWER PLANTS

**MONITORING OF DECENTRALIZED PLANTS**
- Monitoring of individual plants and farms
- Acquisition and storage of data points up to a resolution of one second
- Active monitoring of the communication link

**CONTROL OF DECENTRALIZED PLANTS**
- Set-point-setting for single power installations
- Scheduling for individual plants
- Schedule management, e.g. conversion of schedules into set-point parameters for each plant unit
- Control criteria in dependence of the portfolio's operating point
- Calculation of portfolios' schedules according to the selected energy management strategy

**ENERGY MANAGEMENT**
- Spot market, intraday and operating reserve optimization
- Consideration of restrictions for grid operation
- Loads and generators
- Cross-sectoral restrictions

**POWER FROM WIND, SOLAR, BIOMASS AND HYDROPOWER**
- Forecast and extrapolation, current and expected generation (minutes, days, week)
- Individual plants, plant portfolios as well as grid regions (grid connection points, transformer stations/transformers, supply regions), countries
- Actual and possible generation as well as grid feed-in with feed-in management, energy consumption, storage and market influences, etc.

**CONSUMPTION OF ELECTRICITY, HEAT/COLD AND WATER**
- Forecast, current and expected consumption (minutes, days, week)
- Households, small to large industrial businesses and supply grids (grid connection points, grid nodes, supply regions)
- User behaviour modeling using information of available sensors (e.g. Smart Meter, Smart Home, SCADA, etc.)

**DYNAMIC LINE RATING**
- Identification of critical meteorological points (e.g. hot spots) on overhead lines
- Design and implementation of specifically adapted meteorological measuring stations in transformer stations and on transmission towers
- Current ampacity of individual circuits and the entire electricity grid
- Forecast of expected ampacity

**SUPPORT OF USE CASES**
- Remote control and remote parameter-reading according to national law (German EEG)
- Provision of operating reserve with decentralized plant
- Provision of operating reserve with wind turbines
- Optimization of schedules

**ENERGY METEOROLOGY INFORMATION SYSTEMS**
- Forecast and extrapolation, current and expected generation (minutes, days, week)
- Integration of generation and consumption forecasts into grid status calculations
- Forecast of horizontal and vertical power flows (minutes, days, week)
- Detailed mapping and aggregation of the generation and consumption landscape
- Weather, grid, market, extreme situations, etc.
WIND RESOURCE ASSESSMENT WITH LIDAR

SITE ASSESSMENT WITH LIDAR SYSTEMS
- Measurements with wind-profiling lidars to supplement or replace met masts
- Many reference projects in complex terrain sites
- Measurements at multiple heights up to 300 m
- Remote monitoring and reliable stand-alone electricity supply

RESEARCH PLATFORM: WIND-SCANNER AND 200 METER MAST
- Test and field measurements with lidars, met masts, ice sensors etc.
- Mobile long-range scanning lidars for measurements of the wind field at a range up to 8 km
- 200 m met mast with over 20 IEC-compliant, MEASNET-calibrated wind sensors

OPTIMIZED WIND MEASUREMENTS IN COMPLEX TERRAIN
- Development of individual measurement strategies for best results at lowest cost
- Use of high-resolution wind flow simulations to reduce the uncertainties of measurement campaigns
- Visualization and correction of LiDAR measurement errors to facilitate the selection of the optimum measurement location

POST-CONSTRUCTION PRODUCTION ASSESSMENT OF WIND FARMS
- Performance assessment of wind farms based on lidar measurements, SCADA-data and CFD-Modeling
- Identification of improvement potential in the operation of wind turbines also in complex terrain

TRAINING AND KNOWLEDGE TRANSFER

TRAINING
- National and international
- Demand- and customer-oriented programs for skilled and managerial staff
- Project know-how for renewable resources, grid integration, energy storage, energy management
- Cooperation with external business and research experts

KNOWLEDGE TRANSFER
- Latest findings from research projects
- Expert dialogues
- Workshops
- Symposia

MADE TO MEASURE SEMINARS
- Failure behaviour of wind turbines
- Wind resource assessment with LiDAR technology
- Grid stability in decentralized energy generation
- Simulation and emulation of lithium ion batteries
- Energy management and electricity procurement

ONLINE STUDY PROGRAM IN ENGLISH
- M. Sc. Wind Energy Systems WES
- Cooperation with the University of Kassel
- Seven different certificate programs
- Work-and-study parallel

www.iee.fraunhofer.de/windlidar
www.iee.fraunhofer.de/training
Energy system technology delivers solutions for effectively using and expanding renewables, supply networks, storage systems and electromobility. A special role plays the re-design of the transmission and distribution grids. The coupling of electricity, heat, gas and transportation enables the necessary increase in flexibility between energy generation and energy demand.

We develop the necessary structural and planning methods, operational strategies, equipment, system technology, control engineering and energy management systems. Our research facilities allow standardization and client-specific components and system tests.

**BUSINESS FIELDS:**
- Grid planning and operation
- Power electronics and device technology
- Hardware-in-the-loop systems
- Decentralized energy management
- Plant engineering
- Measuring and testing

**GRID STUDIES**
- Strategic network development
- Multi-sector grid planning
- Charging infrastructure for e-mobility
- Island- and microgrids
- Reactive and active power management
- Power system restoration
- Power system stability and interconnection
- Grid losses

**TOOLS AND MODELS**
- Automated grid planning with PandaPower Pro
- Pilot systems for grid operations management
- Co-simulation »OpSim as a Service«
- Grid calculation modules
- Plant and grid models
- Algorithms for grid optimization
- GIS- and weather data-based energy scenarios
- Energy meteorology information systems

**TESTS AND MEASUREMENTS**
- Tests of grid operation management
- Tests of distributed automation systems
- Hardware-in-the-loop studies
- Grid connection of plants
- Power quality analysis
- System tests

**CONSULTING**
- Policy consulting
- Strategic consulting for businesses
- Training and knowledge transfer
- Grid code development
- Smart grid laboratory development

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www.iee.fraunhofer.de/grids
POWER ELECTRONICS AND DRIVE SYSTEMS

- High efficient components from a few Watts to MW class
- Numerous patented topologies
- PV inverters
- Bidirectional charging technologies
- Uninterruptible power supply
- Wireless power transfer systems
- Battery power converters
- Multilevel converters

ELECTRIC MACHINES AND DRIVES

- Construction and electromagnetic design of ring generators and ring motors
- Large drives
- Gearless high-power applications
- Maritime drive technologies
- Extended maintenance intervals due to distributed electrical design and control
- Extended lifetime due to axial oscillation control
- Laboratory tests, proof-of-concept

BATTERY SYSTEM AND CELL SIMULATION

- Real-time capable simulation for the development, testing and optimization of battery systems
- Simulation and quantification of ageing processes (calendrical/cyclic)
- Simulation of currents, temperatures, charging and ageing conditions

WIND TURBINE AND WIND FARM SIMULATION

- Real-time capable simulation for the development, testing and optimization of wind turbine controllers
- Real-time capable virtual wind farms for the testing and optimization of wind farm controllers and operating strategies

POWER CONVERTERS

- Semiconductor switching cells
- Calorimeter for power electronic components
- Power hardware-in-the-loop systems
- Testing technology for MPP tracking of PV systems – ISET MPP meter
- Photovoltaic irradiation sensors – ISET sensor

CONVERTER CONTROL AND EMBEDDED SYSTEMS

- Embedded control
- Control of electrical machines
- Parallel operation for grid building inverters in public and island grids
- Ancillary services and power quality
- Patented control concepts (Selfsync)
- Rapid prototyping

DEVELOPMENT OF TESTING AND MEASUREMENT TECHNOLOGY

- Battery Simulation Studio (BaSiS): modular simulation system for electro-chemical energy storage systems
- WTsIm and WPsIm: real-time capable simulation of wind turbines and wind farms
- Model analysis and control tools for wind turbines

PRODUCTS AND TOOLS FOR SYSTEM DEVELOPMENTS

- Integration into hardware-in-the-loop systems

SYSTEM ANALYSES AND SERVICES

- Customer-specific model and tool development for batteries and wind turbines
- Model parameterization and validation
- Algorithm development for battery management systems

www.iee.fraunhofer.de/powerelectronics

www.iee.fraunhofer.de/hilsystems
DECENTRALIZED ENERGY MANAGEMENT

USER-ORIENTED ENERGY CONCEPTS
- Measurement and visualization of energy in buildings, quarters and municipalities
- Smart meter rollout and control box
- Open-source platform for energy management
- Tools for energy data evaluation

SOCIAL ENERGY MANAGEMENT
- Real-time monitoring and optimization of energy consumption
- Personalized feedback on the consumption behaviour
- Energy community with other consumers
- Energy management applications in buildings
- Tariff and incentive systems for efficient energy consumption

DEMONSTRATION PLANTS
- Development of plants from a technical scale to the operating scale
- Design, dimensioning, construction, delivery, and commissioning of plants as well as system integration on site
- Development and delivery of software for technical plant operation and plant monitoring
- Scientific support

TECHNOLOGY DEVELOPMENT AND TESTING
- Provision of experiment and test centers, e.g. for biogas and PV systems
- Power-to-gas test platform with 50 kW electrolyzer
- Technology setup and integration
- Operation and testing of technology

SOCIAL ENERGY MANAGEMENT
- Real-time monitoring and optimization of energy consumption
- Personalized feedback on the consumption behaviour
- Energy community with other consumers
- Energy management applications in buildings
- Tariff and incentive systems for efficient energy consumption

CONSULTING, SYSTEM DESIGN AND DEVELOPMENT
- Design and specification of energy management systems
- Demonstrators for energy management
- Tests of energy management applications in a virtual environment and in the laboratory

TECHNO-ECONOMIC STUDIES
- Analysis of specific sites, technology, and plants
- Technological evaluation
- Cost finding, analysis, and evaluation of cost structure
- Comparison of technology and benchmarking

FEASIBILITY STUDY AND SITE ASSESSMENT
- Preliminary studies and detailed site evaluation including the clarification of various technical issues
- Concept design
- Clarification of the technical integration on site
- Technical feasibility study with cost evaluation

BUSINESS FIELD
www.iee.fraunhofer.de/plants

www.iee.fraunhofer.de/energymanagement
MEASURING AND TESTING SERVICES

LABORATORY TESTING
- Component tests (converters, internal combustion engines, smart grid operating equipment, drive engines)
- Grid connection tests, EMC tests
- System tests (hybrid systems, PV (storage) systems)
- Hardware-in-the-loop tests (power HIL, controller HIL)
- Calorimetric measurements, semiconductor switching cell

ON-SITE MEASUREMENTS
- Electromagnetic compatibility (EMC)
- Power quality measurements, synchronized distributed long-term measurements
- Performance analyses for generation plants
- Site-specific evaluation of PV systems and components
- Performance of generation plants in the event of grid faults (FRT)

LABORATORY CONSULTING
- Specification of laboratory infrastructure, in particular for smart grid applications
- Specification and design of HVRT and LVRT testing equipment
- Development of recommendations for grid connection guidelines/grid codes
- Development of test methods and test procedures

SYSTEM ANALYSES AND SIMULATION
- Performance analyses and optimizations
- System evaluation an optimization
- Demonstrators/proof-of-concepts for components and systems
- Grid emulations, simulations and model development
- Models for power generating units in accordance with the FGW Technical Guideline 4

TEST CENTERS

SYSTEC – SMART GRIDS
- Testing of generation plants in accordance with different grid connection guidelines
- Testing of protection devices and distribution grid components
- Measurements of grid quality and analyses of performance
- Testing of hybrid systems
- Real-time distribution grid simulations to test control centers and the grid integration of plants

SYSTEC – ELECTROMOBILITY AND DRIVE TECHNOLOGY
- Performance of electric vehicles in the grid
- Investigations during operation and field tests
- Energy management and grid integration
- Development and testing of charging infrastructure
- Investigations of the vehicle in combination with virtual batteries including during operation (chassis dynamometer, temperature chamber)
- Testing of electric drives

DEMOTEC – MODULAR SUPPLY TECHNOLOGY
- Decentralized electricity generators, storage systems and loads
- Grid integration of converters
- Hybrid systems and island grids
- Energy management systems

HBFZ – HESSIAN BIOGAS RESEARCH CENTER
- Control and management systems for flexible electricity generation with biogas plants
- Improvement of biogas processing plants
- Power-to-gas with biogas plants
- Energy crops and their integration into sustainable agricultural crop rotation
- Identification and evaluation of value creation potential for agriculture
Energy economics and system design
How do we move on from the technology for the energy transition to market integration and an economical system design?

Energy meteorology and renewable resources
What potential do renewables have and how can their spatial and chronological behaviour be modeled and forecasted?

Energy informatics
How can energy economics be supported to allow the energy system to run smoothly when a large amount of power is generated decentrally?

Energy process engineering
Which technology enables the efficient and economical coupling of thermal, electrical and biochemical conversion stages?

Electrical grids
How can we further develop electrical energy power supply systems to enable the integration of the greatest possible share of renewable energy?

Device and system technology
How can the technical specifications of the energy system on devices and systems be efficiently and inexpensively implemented and verified?

AREAS OF EXPERTISE AND CENTRAL RESEARCH QUESTIONS

Our areas of expertise aggregate the skills necessary for providing excellent services and products within our two business units, Energy Economics and Energy System Technology. They comprise the skills and experience of our staff, state-of-the-art equipment in our laboratories and testing environments, our great networking ability in the scientific community, as well as numerous patents and IPRs.

The strategic goals of our publically funded projects are to reduce the costs of renewable energy, ensure consistent energy supply despite of volatilities in energy production, ensure energy grid stability on a high level, and make the energy transformation an economic success story. Already at the stage of project development, we aim at reaching an agreement with our business partners on the reuse of research results in innovative business solutions.

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THE KASSEL SYMPOSIUM DISCUSSES KEY QUESTIONS CONCERNING THE ENERGY TRANSITION

The Kassel Symposium was initiated by Fraunhofer IEE in 2015. The section offers a platform for experts discussing key issues concerning the transformation of the energy sector (»Energiewende« in German). It facilitates a constructive and structured exchange of views and opinions of experts from business, finance, politics, and science. Integral elements of the symposium are:

- the »Energiewende Barometer«,
- expert discussions and presentations,
- the international perspective, and
- the structured summary.

The »Energiewende Barometer« is an instrument for measuring and assessing the progress that has been made in the transformation of the energy sector with regard to various technical dimensions. The Barometer allows determining the status quo regarding all energy system components. The results of this analysis are then put into perspective against the calculated values of an energy supply scenario based on one-hundred percent renewable energy.

The four symposia that have taken place so far had the following focal topics:

- 2015: Energiewende as a business model
- 2016: Legal framework | Renewable energy as an asset class
- 2017: Citizen involvement | Capital investments
- 2018: Energy-intensive industries | Carbon pricing

The expert presentations as well as the main outcomes from the expert discussions of each incarnation of the symposium section are summarized in a report.

OVERVIEW OF KEY RESULTS

2015: Energiewende as a business model
Experts from the finance industry have confirmed the hypothesis of the Energiewende being a profitable, future-proof business model. In order to successfully establish this business model, however, it is mandatory that laws and regulations are harmonized across the EU. Furthermore, legal entities must be given the opportunity to take legal action if they see operating permits for existing facilities being endangered by unilateral changes in legal provisions.

2016: Legal framework | Renewable energy as an asset class
Financial market regulation is yet another obstacle when it comes to establishing the Energiewende as a business model. Fund managers would definitely double down on their investments in renewables if regulations allowed that these investments could be assigned to an asset class of lower risk. While this demand can clearly be justified, the German Federal Ministry of Finance took a different standpoint on that issue so far. The Federal Ministries for Economic Affairs and for Finance should reach an agreement here in order to provide more incentives for investors.

2017: Citizen involvement | Capital investments
Involving citizens in the process of transforming the energy sector must not be limited to pure rhetoric. Instead, people need to be made aware of the tangible financial benefit of the Energiewende. A lot of capital is waiting for being invested. However, institutional investors may not necessarily engage in the German energy market, as they can find a lot of promising alternatives for investments in renewable energy abroad.

2018: Energy-intensive industries | Carbon pricing
It has become apparent that another important player should enter the debate on the transformation on the energy sector: the group of energy-intensive industries. German energy-intensive companies, which all operate on a global level, feel increasingly threatened by the fact that their competitors in other countries benefit from low energy prices. The symposium could establish a basic understanding of what the notion of »Energiewende as a business model« can mean to energy-intensive companies. All debaters agreed that if the specific requirements of these industries are taken into account, German companies will massively benefit from the transformation of the energy sector.
PERSONNEL AND FINANCE

PERSONNEL

of which from industry in EUR

REVENUES in EUR without investments

of which from industry in EUR

YEAR

2010

2011

2012

2013

2014

2015

2016

2017

2018

223

288

349

344

319

330

337

359

370

12.0 Mio

2.8 Mio

14.4 Mio

2.9 Mio

17.5 Mio

3.3 Mio

18.7 Mio

3.3 Mio

18.9 Mio

3.7 Mio

19.8 Mio

3.7 Mio

20.8 Mio

4.8 Mio

22.5 Mio

5.0 Mio

25.3 Mio

6.0 Mio

Planned
The first spades in the ground on 20 September 2017 by Volker Bouffier, Minister President of Hesse, Christian Geselle, Mayor of Kassel, Dr. Reimund Neugebauer, President of the Fraunhofer-Gesellschaft and Prof. Dr. Clemens Hoffmann, Executive Director of the Institute, marked the start of construction of the new Fraunhofer building in Kassel. A research and development facility for about 320 staff members will be erected next to central station by 2020. The Federal Ministry of Education and Research and the state of Hesse each contribute half of the investment volume of roughly EUR 60 million.

Energy economics and energy system technology – these are the two research areas of the Fraunhofer Institute in Kassel. More than 350 staff members are now employed at the four locations in the city; in 2008, it was 180. The operating budget rose from roughly EUR 10 million to about EUR 23 million over the same period. This successful development is acknowledged by erecting the new institute building.

To offer the Fraunhofer institute sufficient space for further development, the city of Kassel has developed the area north of the central station. »The development of the former freight yard is one of Kassel’s largest conversion projects in recent years«, Mayor Christian Geselle explained. »I am convinced that the decision of the Fraunhofer-Gesellschaft – to consolidate the facilities currently still distributed throughout the city into an innovative institute – will be of lasting benefit to the development of the whole city«.
Innovative in terms of design, structural physics and energetics, the new building is based on a design of architect Günter Schleiff from HHS Planer + Architekten in Kassel and is to facilitate more direct communication and coordination, making the collaboration between scientists more efficient. The 4-storey building with a usable floor area of almost 7,600 m² will accommodate a large technical center, several laboratories as well as an «Energy Transition Hub», in addition to offices and seminar rooms. For the national energy transition and for accompanying and networking the international energy system transformations, data streams of the cross-sectoral energy systems of electricity, heat and mobility will be merged, analysed and system options will be developed and explored in the multifunctional room of the Energy Transition Hub.

Boasting a 220 kW heat pump for heat generation and a 600 m² ice storage system, the new institute building follows a sustainable energy concept. A gas-fired 600 kW cascade of condensing boilers serves as a peak load boiler and backup system. Air conditioning in summer takes place via a centrally regulated concrete core temperature control supplied by the ice storage system. Decentralized ventilation systems supply fresh air. «We develop solutions to challenges in the transformation of energy systems and consistently implement them in our new research building as well», Executive Director Prof. Dr. Clemens Hoffmann emphasized.

Establishing new areas of expertise

The system coupling of electricity, heat, gas and mobility enables the necessary increase in flexibility between energy generation and energy demand in a system with strongly volatile components. This is why the new area of expertise, energy process engineering, has been established in the institute over the last two years. As a second significant addition, the expertise in the area of buildings, quarters, heating and cooling will continue to be expanded.

»The «Urban Energy System» research model is of special significance for many industry branches in Hesse. We benefit from the extraordinary expertise of Fraunhofer IEE in sustainable urban and regional development and will continue to support the institute in the upcoming years in implementing innovative solutions for renewable energy supply, for enhanced energy efficiency and smart grids«. Minister President Volker Bouffier affirmed.

»The researchers of Fraunhofer in Kassel have established themselves as central players of energy research in Germany and in the Fraunhofer-Gesellschaft«, Fraunhofer President Prof Dr. Reimund Neugebauer said. »With its research focus on energy economics and energy system technology, the institute has developed to become an established and important point of contact for politics, economy and teaching, not least thanks to the generous support of the state of Hesse and the favourable local conditions in energy research in Germany.«
CONVERTER TECHNOLOGY
Starting in the 1990s, ISET substantially contributes to the development of converters to be used for photovoltaics. In addition, ISET sets major impulses for establishing industrial innovations and standards – such as patented voltage-impressing converters, which can be used to stabilize the wide-area synchronous grid of the future.

BATTERY SIMULATION
Using state-of-the-art methods and physical models, ISET is able to simulate the behavior of lead-acid batteries on the computer with high accuracy. Today the simulation software can be used for lithium-ion batteries as well and is used by car manufacturers and their suppliers all over the world.

HIGHLIGHTS: 30 YEARS OF RESEARCH

WIND POWER FORECASTING
ISET’s forecasting system enables grid operators to reliably integrate wind energy into the grid and the market and contributes to reliable grid operation with its precise forecasts. This also saves costs for balancing energy and control power.

WIND MEASUREMENT PROGRAM
In 1990, the German federal government mandates ISET to launch and implement the scientific measuring and evaluation program «250 MW Wind». Over the course of 16 years, ISET systematically collects, evaluates and processes data from over 1,500 wind farms in one of the world’s largest data bases about the wind energy.

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CONVERSER TECHNOLOGY
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BIOGAS AND POWER-TO-GAS
Recognizing the great potential and flexibility of biogas plants at an early stage, ISET develops methods for demand-driven gas production. Regarding power-to-gas and long-term energy storage, ISET develops plant and system concepts as well as operating models and methods for optimization.

JOINING FRAUNHOFER
In 2009, ISET becomes one of two sub-institutes of the newly established Fraunhofer IWES (Fraunhofer Institute for Wind Energy and Energy System Technology). Headed by Prof. Jürgen Schmid, the energy system technology branch is further extended, and the number of staff quickly increases from about 180 to over 350.

COMBINED POWER PLANT
With the «Combined Power Plant» project, Fraunhofer IWES counteracts the widespread prejudice that power supply based one-hundred percent on renewables cannot be consistent. The Institute develops system services ensuring the stability of power grids as well as virtual power plants comprising multiple, distributed producers.

SECTOR COUPLING
The coupling of power, heat, gas, and mobility allows more flexible production and consumption in a system characterized by highly volatile sub-sectors. Fraunhofer IWES develops methods, components, and business models for cross-sector energy supply structures and energy storage systems.

ON THE ENERGY TRANSITION

POWER GRIDS
By extending power transmission and distribution grids, flexibility in terms of balancing fluctuations in power production and grid utilization can be increased, reducing the need for energy storage. Fraunhofer IWES develops grid extension scenarios, concepts of grid extension to be used for concrete regional demands, and methods for cost-efficient grid extension planning.

AN AUTONOMOUS INSTITUTE
In 2018, each of the two sub-institutes of Fraunhofer IWES becomes an autonomous institute, leading to the formation of Fraunhofer Institute for Energy Economics and Energy System Technology IEE. Energy economics was added to the Institute’s portfolio by Prof. Dr. Clemens Hoffmann, who assumed the position of Director in 2012.

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Fraunhofer IEE successfully collaborates with numerous public and industrial research institutions on a both national and international scale. The institute’s application-oriented work is highlighted by the large number of projects with industry involvement and direct contracts with businesses.

Universities

Fraunhofer IEE closely collaborates with various universities, in particular the Universities of Kassel, Hannover and Darmstadt.

Fraunhofer

Within the Fraunhofer-Gesellschaft, use is made of the expertise and experience of partner institutes, in particular the Fraunhofer Groups for Materials and Components – MATERIALS and ICT as well as the Fraunhofer Energy and Battery Alliances.

Hesse

The Hessian Biogas Research Center HBFZ in Bad Hersfeld is operated by Fraunhofer IEE in collaboration with the Hessian Department of Agriculture LLH and the Hessian State Laboratory LHL.

Fraunhofer IEE is a board member in the Hessian House of Energy HoE. The HoE is a network of major Hessian energy utility companies, service and production businesses, universities, colleges and research institutions as well as two Hessian ministries.

In addition, the institute participates in the cluster networks deNet – Kompetenznetzwerk dezentrale Energietechnologien e.V. and MoWiN.net – Network for the North Hessian Mobility Economy.

Germany

Together with other German non-university research institutions, Fraunhofer IEE is a member of the Renewable Energy Research Association FVEE.

International

On the initiative of Fraunhofer IEE, the leading European laboratories and research institutes focusing on decentralized energy sources established the DERlab network.

Fraunhofer IEE is a member of the European Energy Research Alliance EERA, the alliance of European public research centers and universities.

Bodies

The research findings are the basis for the participation of many scientists in national and international bodies, such as DKE, CENELEC and IEC, and the use of those findings for standardization and norms.

The technical expertise of Fraunhofer IEE also shapes the political, legal and commercial framework.

Fraunhofer-Gesellschaft

Fraunhofer IEE is a legally dependent establishment of Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. headquartered in Munich. The Fraunhofer-Gesellschaft is the leading organisation for applied research in Europe. Its research activities are conducted by 69 institutes and research facilities at locations throughout Germany. The Fraunhofer-Gesellschaft employs more than 25,000 staff members, who work with an annual research budget totalling EUR 2.1 billion, EUR 1.9 billion of which is generated by contract research. International collaborations with excellent research partners and innovative businesses throughout the globe ensure direct access to regions of greatest importance to present and future scientific progress and economic development.

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