

“Digital Energy”

Aachen, 5/9/2020

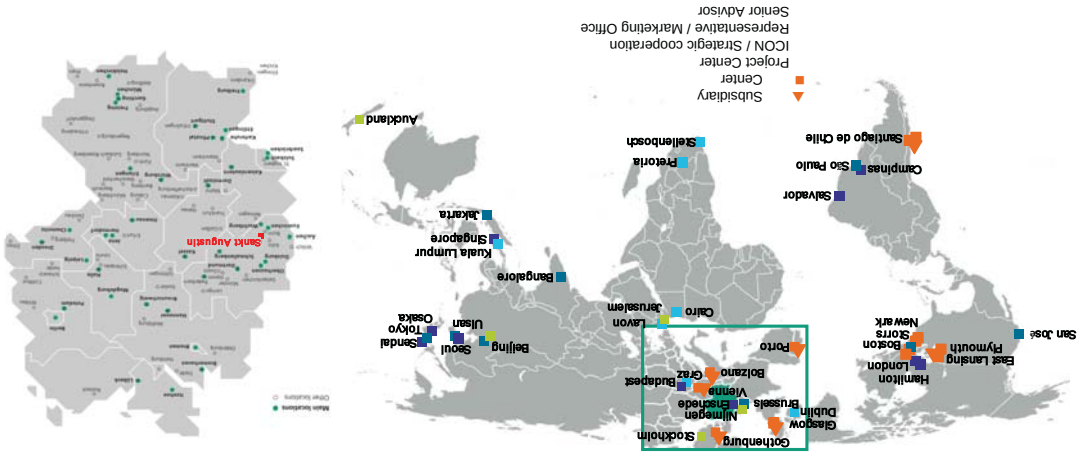
Mathias Jarke, RWTH Aachen University and Fraunhofer FIT



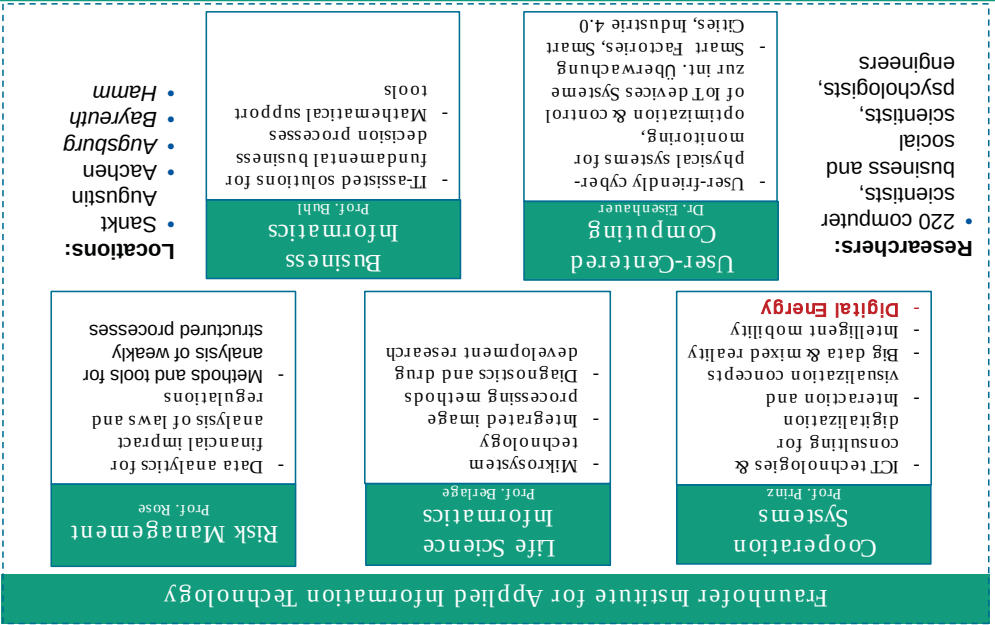
© Fraunhofer FIT

Fraunhofer Society

- 74 applied research institutes with ca. 28.000 employees (incl. student researchers)
- Annual research volume 2,800 mio. Euros,
- with >2.000 mio. Euros financed by contracts with industry and by publicly financed research projects.



© Fraunhofer FIT



Stefan Decker

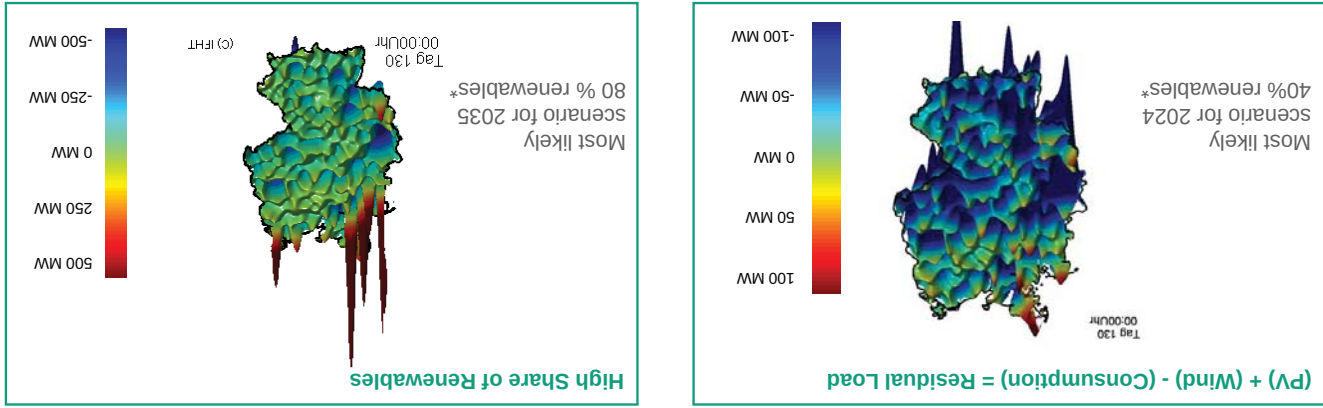


Matthias Jarke

Talk Outline

- Motivation and Concept of the Digital Energy Center
- Research Challenge Digitization – Seam4Us
- Research Challenge Energy Systems -- PLAMES
- Research Challenge IT Security -- MEDIT
- Research Challenge Business Models -- Pebbles
- Summary

Motivation – Changes in Electricity Supply



*The simulations are based on scenario B of the German grid development plan.

Motivation – Future Action Lines of the Energy System Transformation

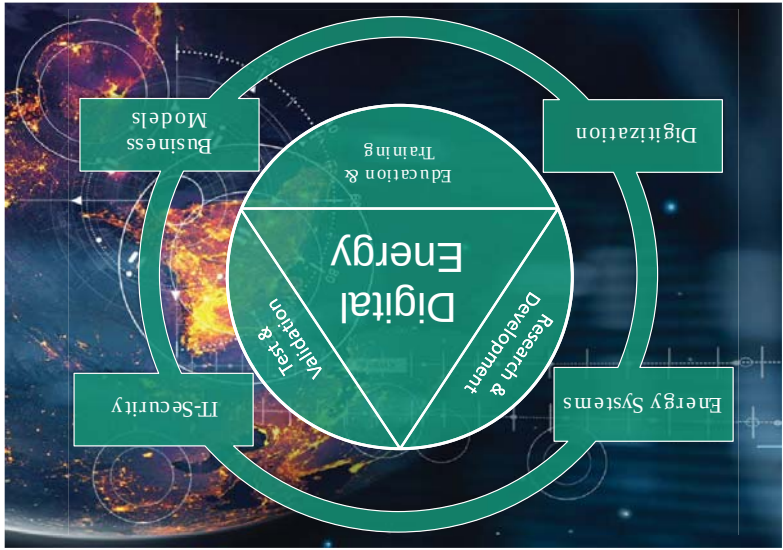
- 1. Ensuring Reliability of Supply:** Management of Renewables, Storages, Industry and Historical Grid Equipment
- 2. Digitization & Automation:** e.g. Integration of Information Technologies for Operation
- 3. Cyber Security:** Key Technology for a successful Digitization of critical Infrastructures / Sectors
- 4. Planning & Operation of Energy Supply Systems:** Forward-looking development with Digital Twins
- 5. New Business Models** in changing Environments

Establishment of domain-spanning expertise of leading research institutions with their own laboratory infrastructure in the Rhineland: "Deep knowledge of the energy sector combined with deep knowledge of cyber security, digitization and financial management".



“Fraunhofer-Center Digital Energy” - Objectives and Concept

- Establishing an interdisciplinary, directly operational, trustworthy and independent cooperation under the Fraunhofer umbrella to promote IT security, digitization and financing of energy supply:
- **Energy Systems:** EE @ RWTH Aachen University
- **Digitization:** Fraunhofer FIT
- **IT-Security:** Fraunhofer FKIE
- **Business Models:** Fraunhofer FIT
- Supporting services, organized close to the application:
- **Research & Development:** New Technologies and Methods
- **Education & Training:** Young Talents, Specialists and Managers
- **Test and Validation:** Integration in real systems



Talk Outline

- Motivation and Concept of the Digital Synergie Center
- **Research Challenge Digitization – Seam4Us**
- Research Challenge Energy Systems -- PLAMES
- Research Challenge IT Security -- MEDIT
- Research Challenge Business Models -- Pebbles
- Summary

Research Area „Digitization“ – Digital Technology Integration

- Central challenge in ICT research and application for the coming decades is the comprehensive linking of data, algorithms, devices and people via networks and software in all areas of business and life.
- Internet of Things, Big Data, Industry 4.0, Cyber-Physical Systems, ...
- Key challenges focus on **controllability of the resulting systems** and structures:
 - **Dealing with complexity and heterogeneity**
(reliable software, architectures, middleware, usability, acceptance, ...)
 - **Integration of innovative information technologies** (e.g.: Blockchain, HPC, ...) in different industries and fields of application
 - **Dealing with large, heterogeneous masses of data**
(big data analytics, visualization, machine learning, ...)



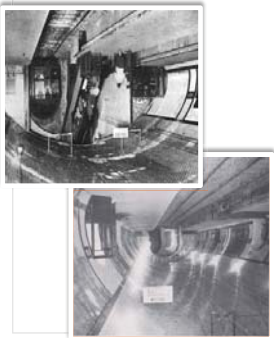
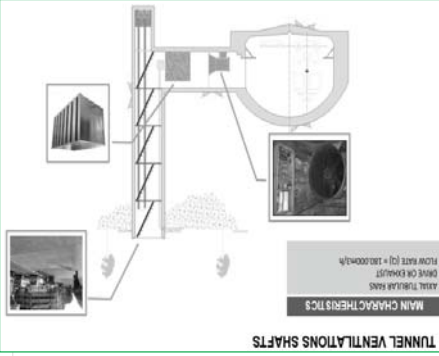
9

© Fraunhofer FIT



SUSTAINABLE ENERGY MANAGEMENT FOR UNDERGROUND STATION

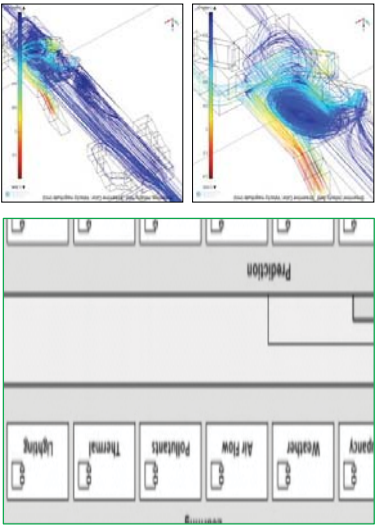
- Energy consumption of Metro station Passeig de Gràcia in Barcelona reduced by 5% (= 700 households) at ventilation shafts, lighting, escalators and lifts





Environmental Monitoring

- Provides data for the post processing and sensor-fusion.
- Links Sensor network data with the numerical model
- Based on several local Sensor Models



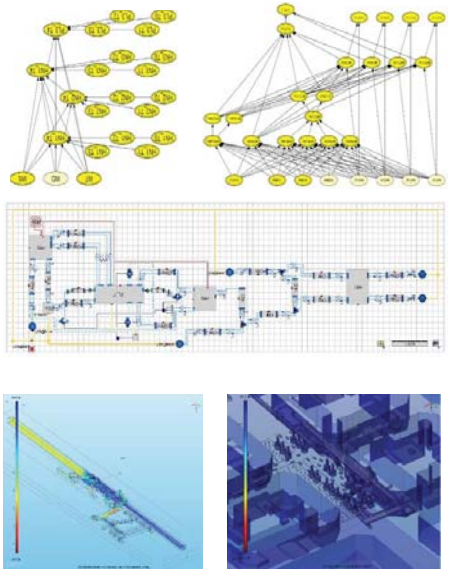
SEAM4US – MODELLING

Predictive-adaptive Models

Estimate the future thermal and airflow conditions of the station on the basis of the past history, of the weather forecasts, of the occupancy predictions

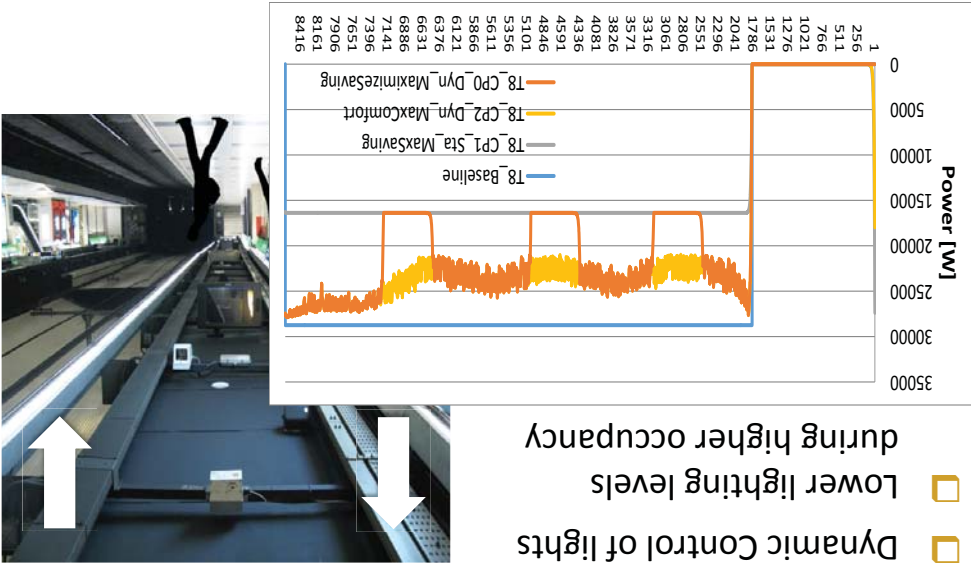
Seam4Us models can learn from control history and adapt accordingly

Seam4Us developed a unique methodology for the development of embeddable predictive-adaptive models



SEAM4US – CONTROL POLICIES

- Dynamic Control of lights
- Lower lighting levels during higher occupancy



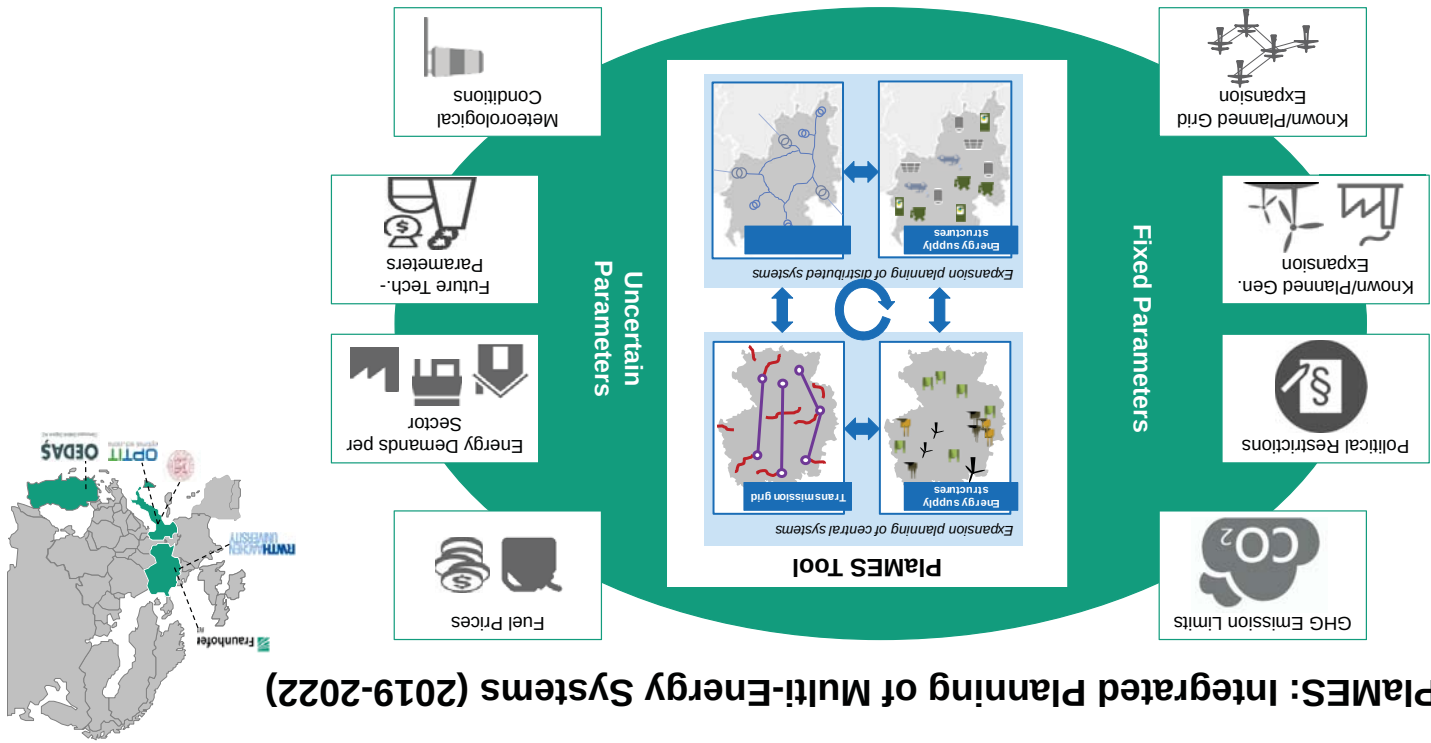
Reduction Potential

Baseline (Energy Audit)		CP0: Normal		CP1: Max Saving		CP2: Max Comfort	
Load categories	Yearly consumption (MWh)	Role Percentage	Yearly consumption (MWh)	Saving Percentage	Yearly consumption (MWh)	Saving Percentage	Yearly consumption (MWh)
Lighting	239.91	40%	187.61	22%	145.39	39%	203.93
Ventilation	75.81	13%	50.72	33%	46.93	38%	48.67
Escalators	37.34	6%	25.17	33%	25.17	33%	25.17
Controlled Energy	353.07	59%	263.50	25%	217.48	38%	277.77
Demand Driven equipment	128.72	21%	128.72		128.72		128.72
Out of Scope Equipment	118.25	20%	118.25		118.25		118.25
Total consumption	600.04		510.47	15%	464.45	23%	524.73
							13%

Talk Outline

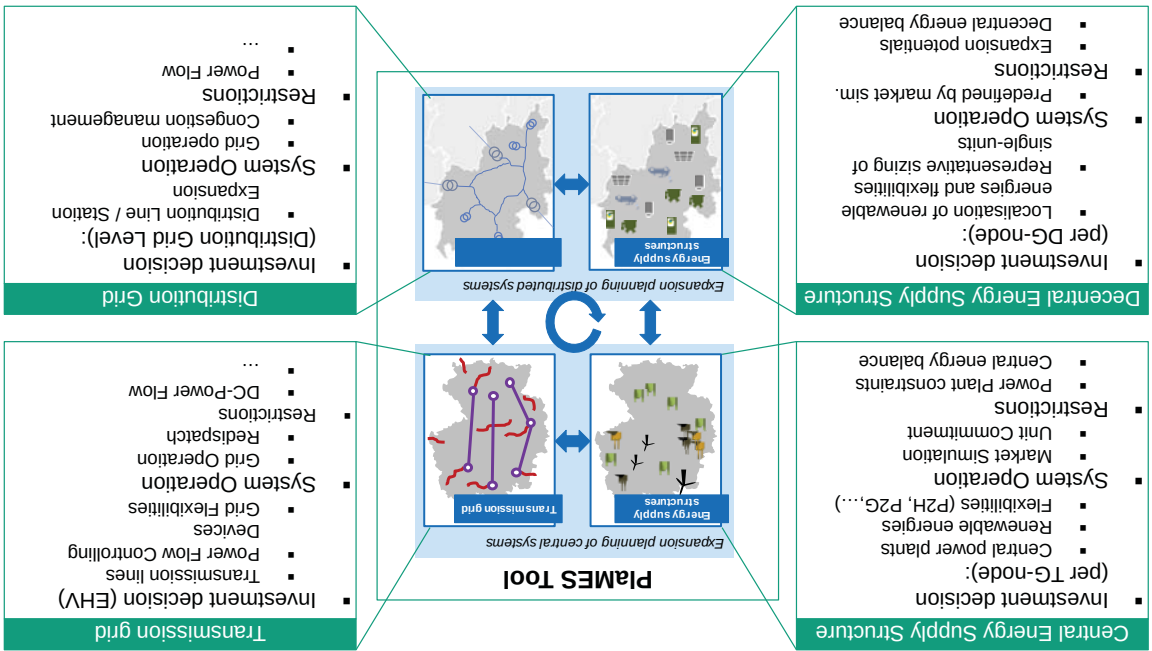
- Motivation and Concept of the Digital Synergie Center
- Research Challenge Digitization – Seam4Us
- **Research Challenge Energy Systems -- PlaMES**
- Research Challenge IT Security -- MEDIT
- Research Challenge Business Models -- Pebbles
- Summary

PlaMES: Integrated Planning of Multi-Energy Systems (2019-2022)

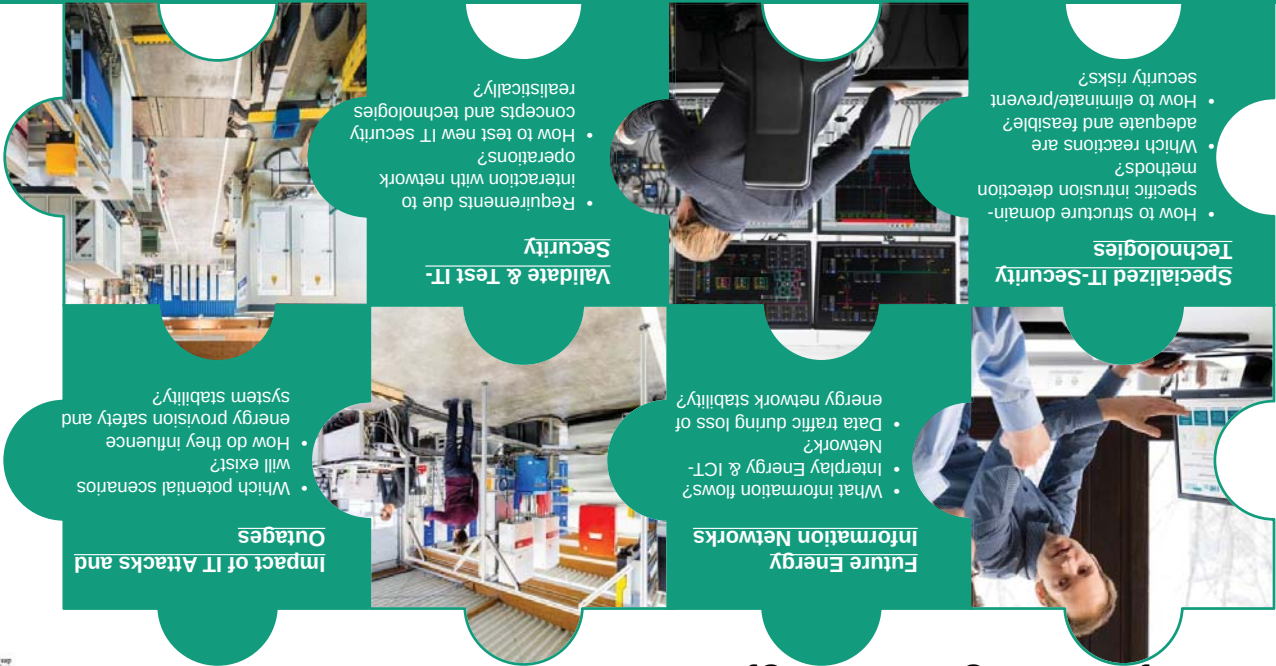


Talk Outline

- Motivation and Concept of the Digital Synergie Center
- Research Challenge Digitization – Seam4Us
- Research Challenge Energy Systems -- PLAMES
- Research Challenge IT Security -- MEDIT
- Research Challenge Business Models -- Pebbles
- Summary

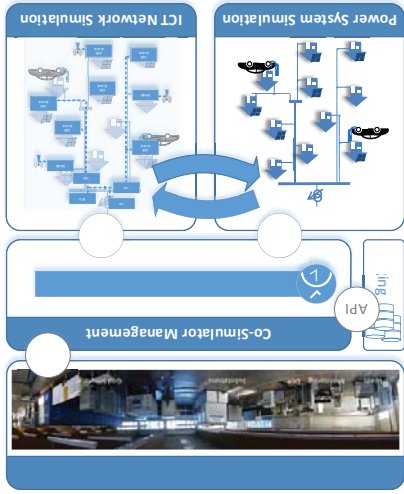


IT Security Challenges in Energy Networks



MEDIT

Methods for energy network actors to prevent, detect, react to IT attacks or failures



Ziele	Methodik
- Develop ICT-Monitoring and Intrusion Detection systems for process data - Guidelines and training center for human Incident Response Teams - Study special actor security requirements (Network operators, virtual power plants, measurement station operators, ...)	- Construct development environment (link co-simulation of energy networks and IT networks to real physical infrastructure) - Develop IT security tools and validate in real environments - Conduct verification and field tests



Talk Outline

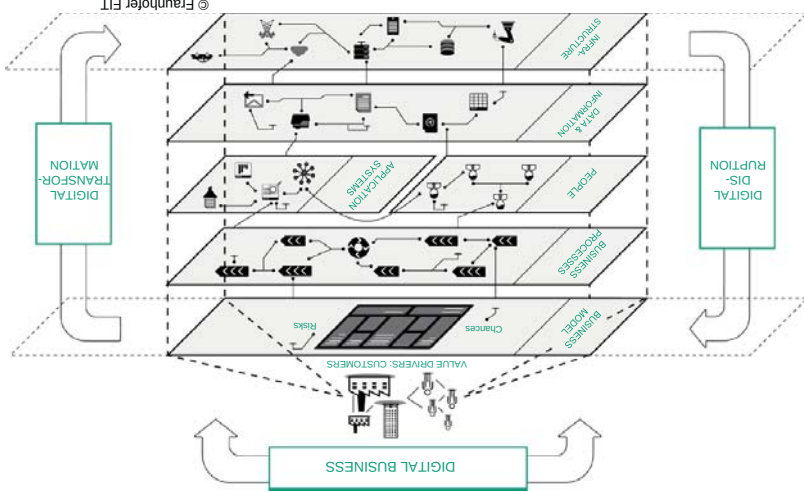
- Motivation and Concept of the Digital Synergie Center
- Research Challenge Digitization – Seam4Us
- Research Challenge Energy Systems -- PLAMES
- Research Challenge IT Security -- MEDIT
- Research Challenge Business Models -- Pebbles
- Summary

Research Area “Business Models” for Digitizations

Digital Business

- Development and evaluation of innovative business models under consideration of:
 ■ Opportunities and risks of current technical and economic framework conditions and changes
 ■ Effects on the entire company against the background of digitization.

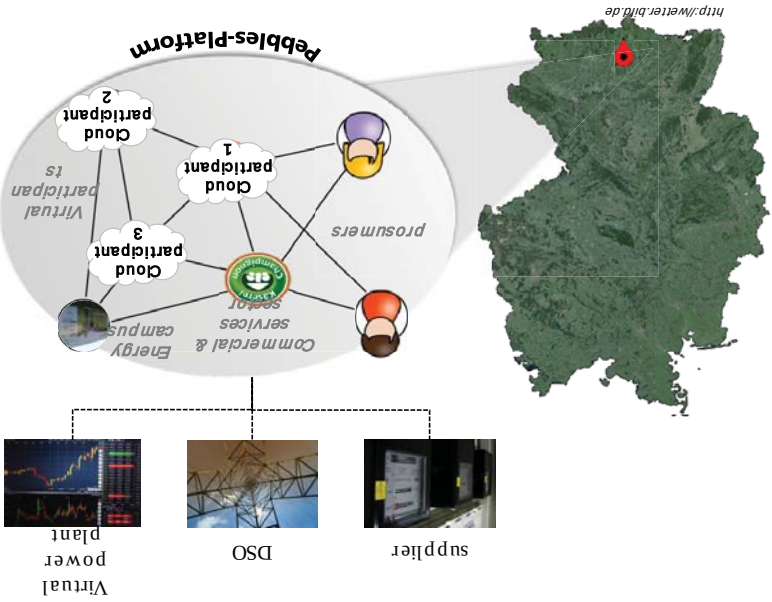
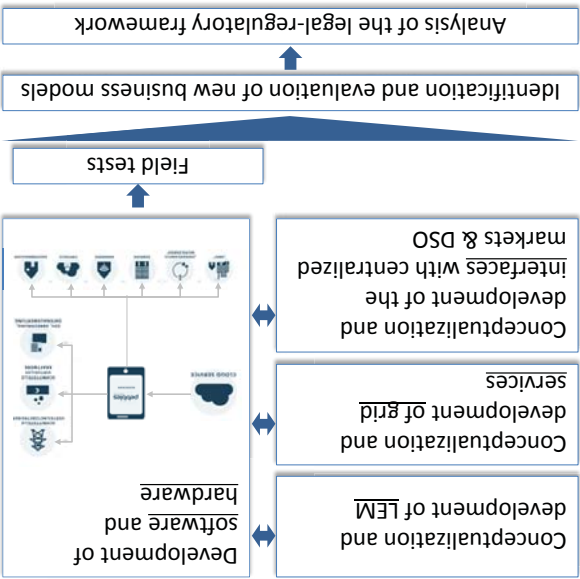
Example: Sharing Economy in the area of energy and mobility



- Digital Disruption
 ■ Replacement of existing technologies, products or services by digital innovations
 ■ Goal: To unlock the economic potential of new information technologies
 Example: Change in the energy industry due to blockchain technology

- Digital Transformation
 ■ Scientific consulting, conceptual design and implementation support
 ■ Derivation of economically sensible and technically feasible transformation paths.
 Example: Flexibility of energy demand through end-to-end IT systems

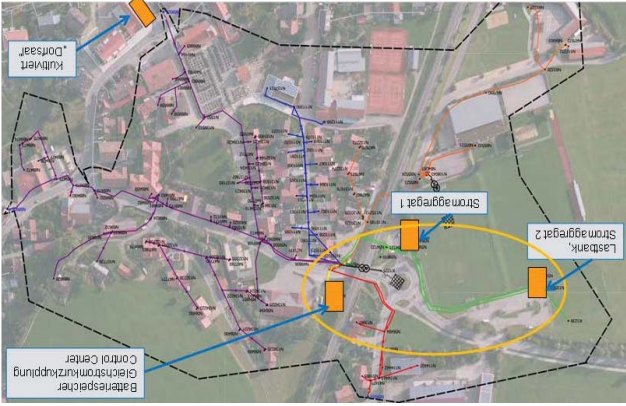
Pebbles: Blockchain-Based Local Energy Markets (LEM)



Pebbles: Grid Services (I)

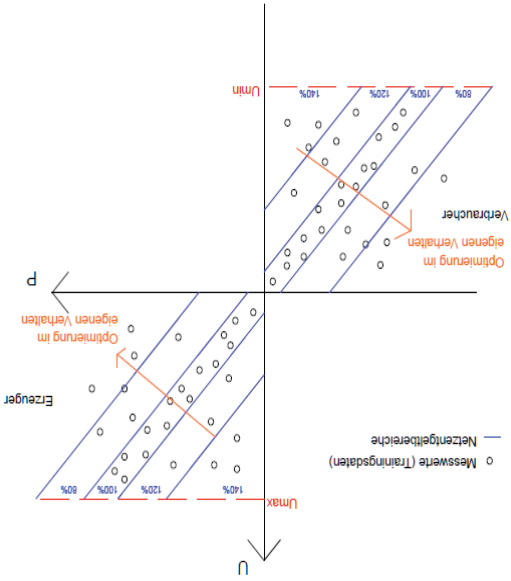
Situation

- DSO faces voltage problems, mainly in the low voltage grid
- Only DSO knows the grid state, grid topology and connection power of customers
- Objective:** motivate local energy market to a grid-friendly trading
- Idea**
 - React to voltage problems with grid-oriented price incentives
 - The grid price incentive is considered in the market-matching mechanism



Pebbles: Grid Services (II)

- Voltage in LV grids subject to lower and upper boundaries
- Every phase's voltage measured at the connection point of each market-participant
- By using historical data EMS predicts voltage levels
- DSO defines grid fees for voltage ranges considering grid operation factors
- The customer's software agent is able to optimize its residual load profile considering the grid fees

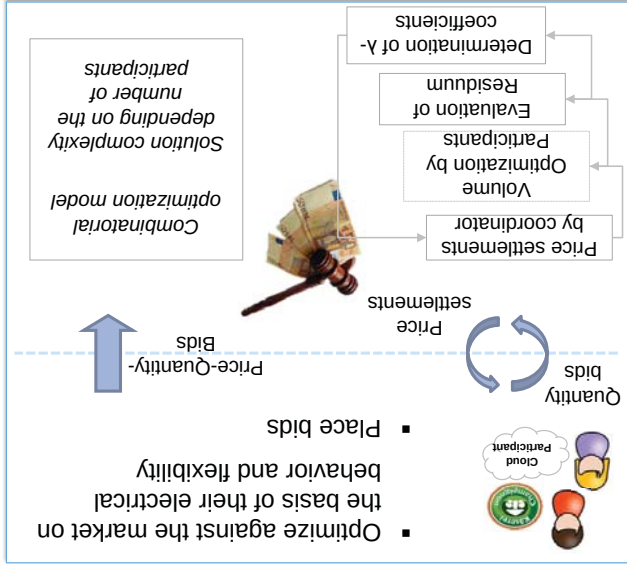


Pebbles Simulation Framework

Objectives & premises

- Efficient energy allocation at local level
- Transaction object: Discrete energy products
- Individualized forecasts for generation & load available
- LEM determines allocation and prices
- Residual is processed via back-up instances

Market Design & Participants



Talk Outline

- Motivation and Concept of the Digital Synergie Center
- Research Challenge Digitization – Seam4US
- Research Challenge Energy Systems -- PLAMES
- Research Challenge IT Security -- MEDIT
- Research Challenge Business Models -- Pebbles
- Summary

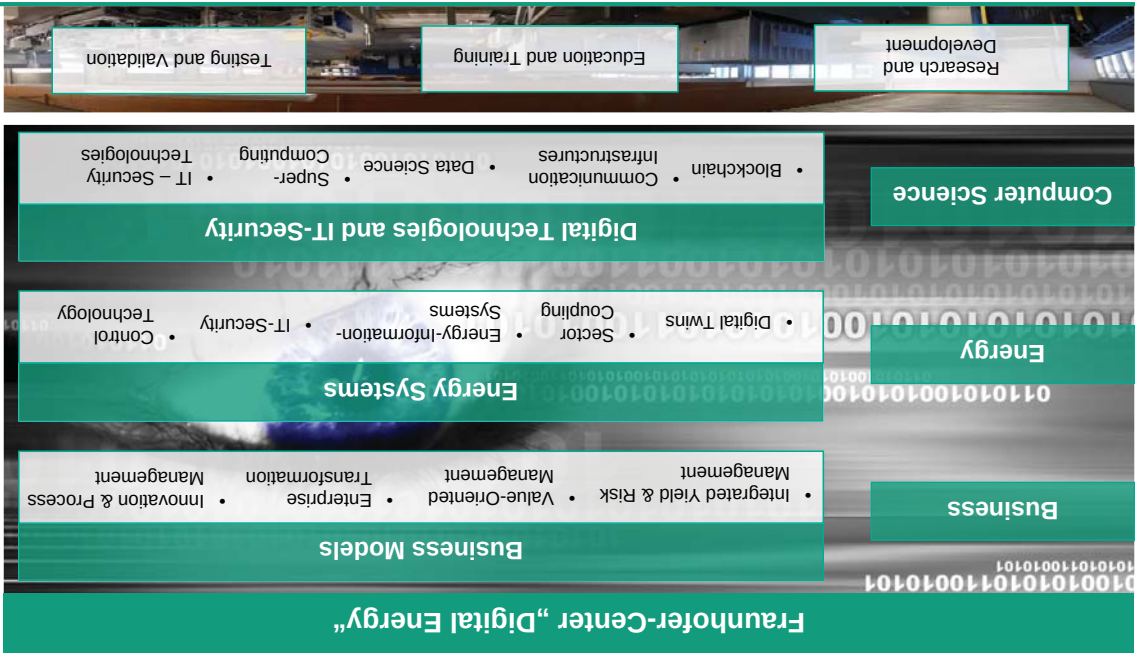
Synergie – National 10-Year Strategic Project with over 60% of German industrial energy usage

**KOPERNIKUS
SYNERGIE PROJEKTE**
Die Zukunft unserer Energie

- Make energy-intensive processes more flexible
- Synchronize the demand of energy-intensive industrial processes with the volatile character of renewable energies.



Summary of Research Themes



More information on www.digitale-energie.fraunhofer.de

