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IoT and Blockchain in the Energy Transition – Use Case for the Energy Sector

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Allianza Energetica Mexico - Alemana
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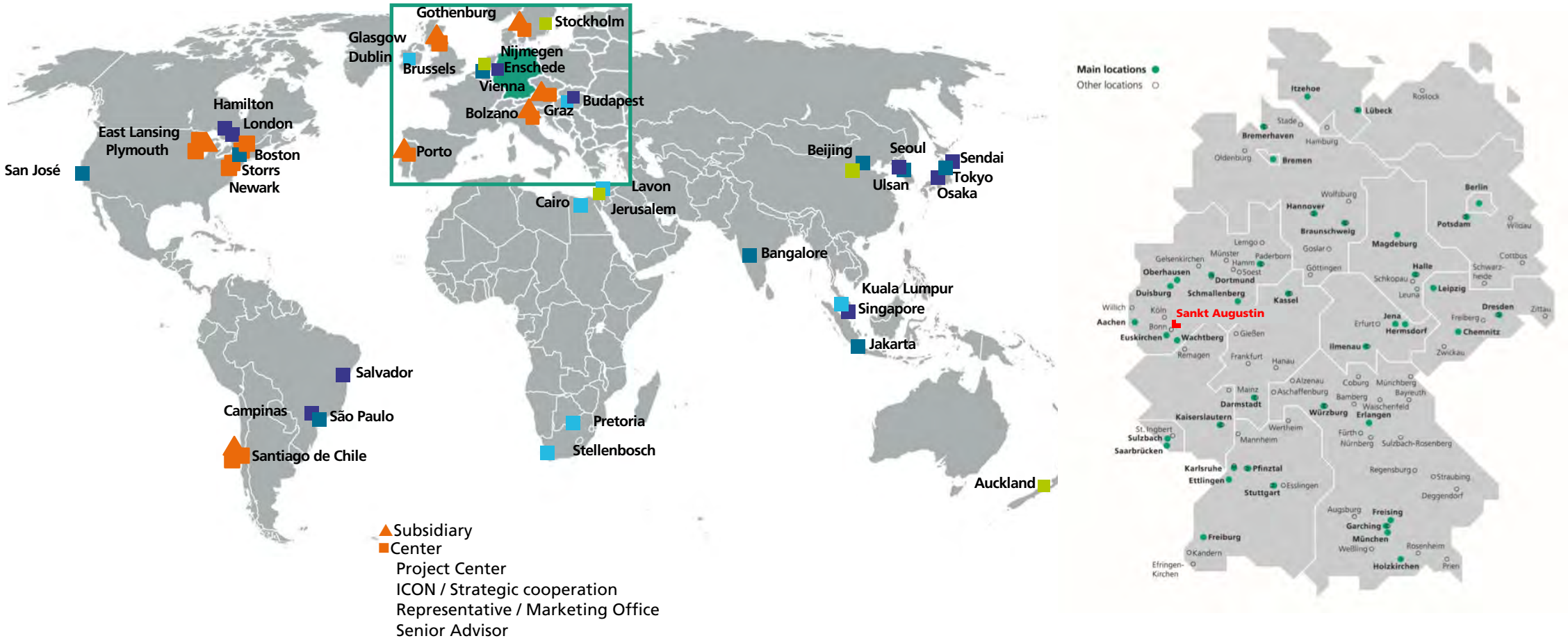
Fraunhofer* Society

- Founded 1949
- Non-profit organization for applied research
- 73 research institutes in six thematic groups
- Ca. 23.000 employees
- Annual budget € 2.300 mio.
- Finance model: ~1/3 (industrial) contract research
  ~1/3 research project grants
  ~1/3 base financing (federal & states)

*Joseph von Fraunhofer (1787 – 1826)
researcher, inventor, and **Entrepreneur**

Fraunhofer – Worldwide and Germany



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Fraunhofer Institute FIT
Applied Information Technology

User-Centered Information– and Communication Systems

- Goal: Optimizing usability and usefulness of IT in the Interplay with organizational work practice, structures, and processes.

Research departments:

Cooperation Systems and Augmented Reality	Life Science Informatics	Risk Management and Decision support	User-Centered Computing
Innovative work forms for the entrepreneurial change	*More Information for Health*	*Analysis, Minimizing and Management of risks*	*User-Centered IoT and CPS*

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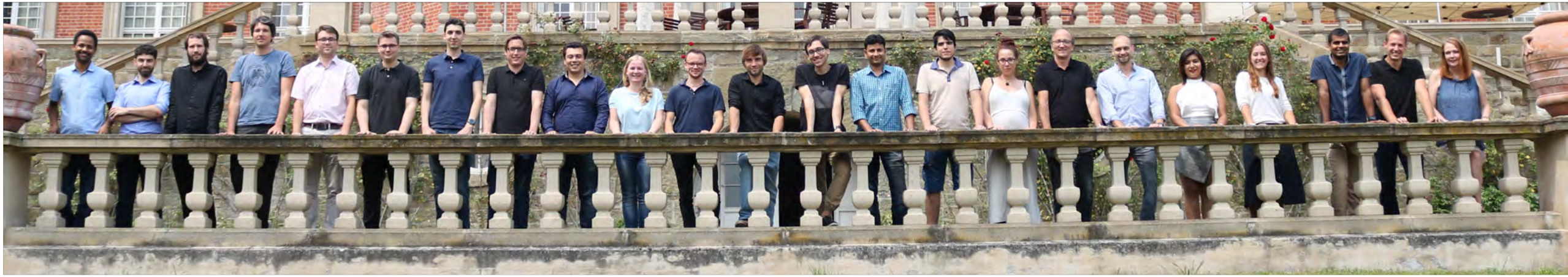
putting IoT into practice!



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Our topics

DOMAINS

INDUSTRY 4.0

SMART CITIES

SMART GRID

SMART FOOD

METHODS

UCD

IOT PLATFORMS

SMART DATA

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Current Projects

- **Optimizing Energy consumption with intelligent Realtime Monitoring and Control**
- 2 Projects: ME3Gas / SEEMPubS
- **Simulation and Decision support for Energy Savings**
  - 3 Projects: Adapt4EE / SEAM4US / BIMERR
- **Optimizing load balance in Energy Networks**
  - 3 Projects: GreenCom / Flex4Grid / Storage4Grid
- **Sustainable ICT-support for Smart Cities**
  - 2 Projects: ALMANAC / DIMMER
- **Optimzing Ressource Efficiency through process transparency in production**
  - 6 Projects: BEMO-COFRA /E3-Produktion / ebbits / SynErgie / EvoloPro / eFactory
  - 2 Projects: SPIRE: MAESTRI / MONSOON
  - 3 Projects: FoF: Satisfactory / COMPOSITION/ eFactory
- **Internet of Things, CPS – Middleware and tools**
  - 5 Projects: ECSEL / HYDRA / IMPRESS / CPSwarm / BIMERR
  - 1 Large Scale IoT Demonstrator: MONICA
  - 2 Smart Packaging Projekte: ALPINA / ICIPC
- **Large-scale Emergency Management, Healthcare, HCI and multimodal support**
  - 3 Projects: BRIDGE / MICA / PICASO
  - Aachen Lern and Informationssystem for deafs and hard of hearing

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Digital Energy

Department Overview

FIT.DE

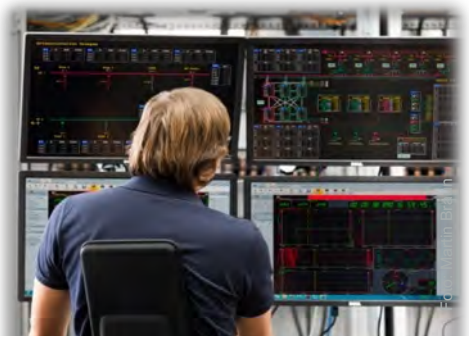
10 RA | 2 SA | 5 MA/ BA

- Planning and operation of sector-coupled and automated energy systems
- Integration and use of information and communication technologies (e.g. blockchain technology) in energy systems
- Simulation and development of central and local energy markets
- IT security technologies for prevention, detection and reaction

Energy Systems

Foto: Dieter Both 2013

Information Technologies



IT-Security

Foto: Martin Braun

Cyber-Physical Systems

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DISRUPTION

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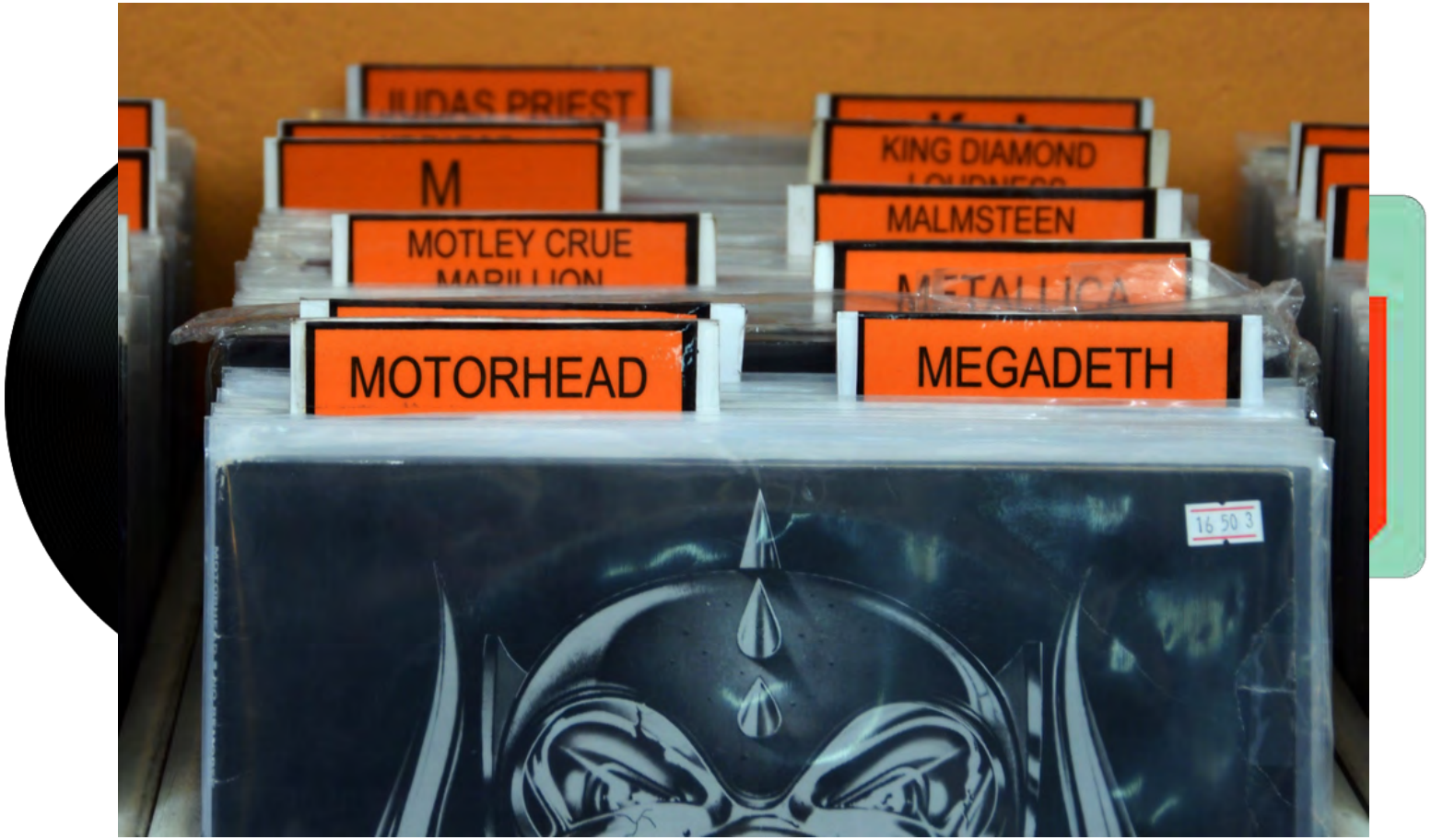
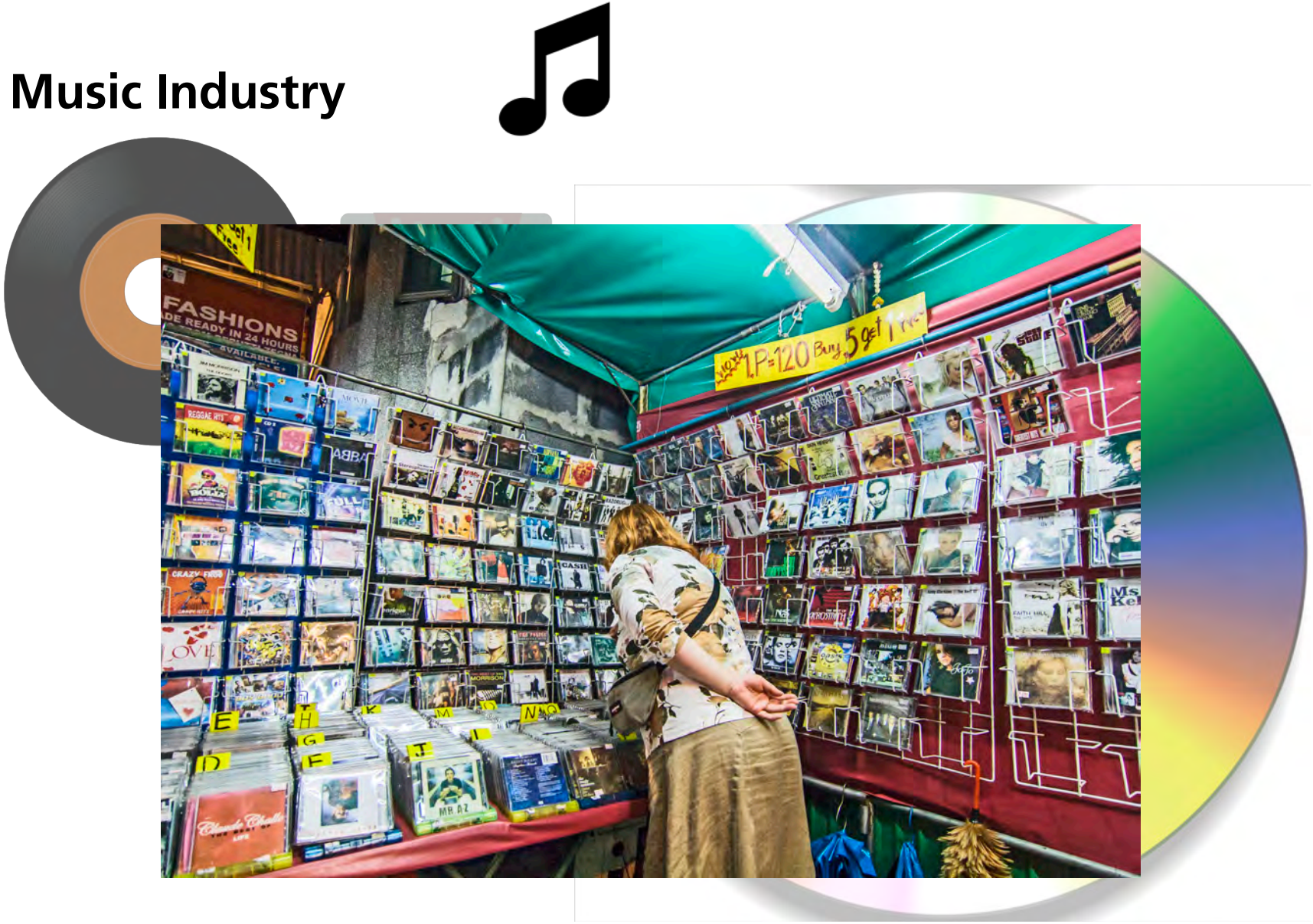
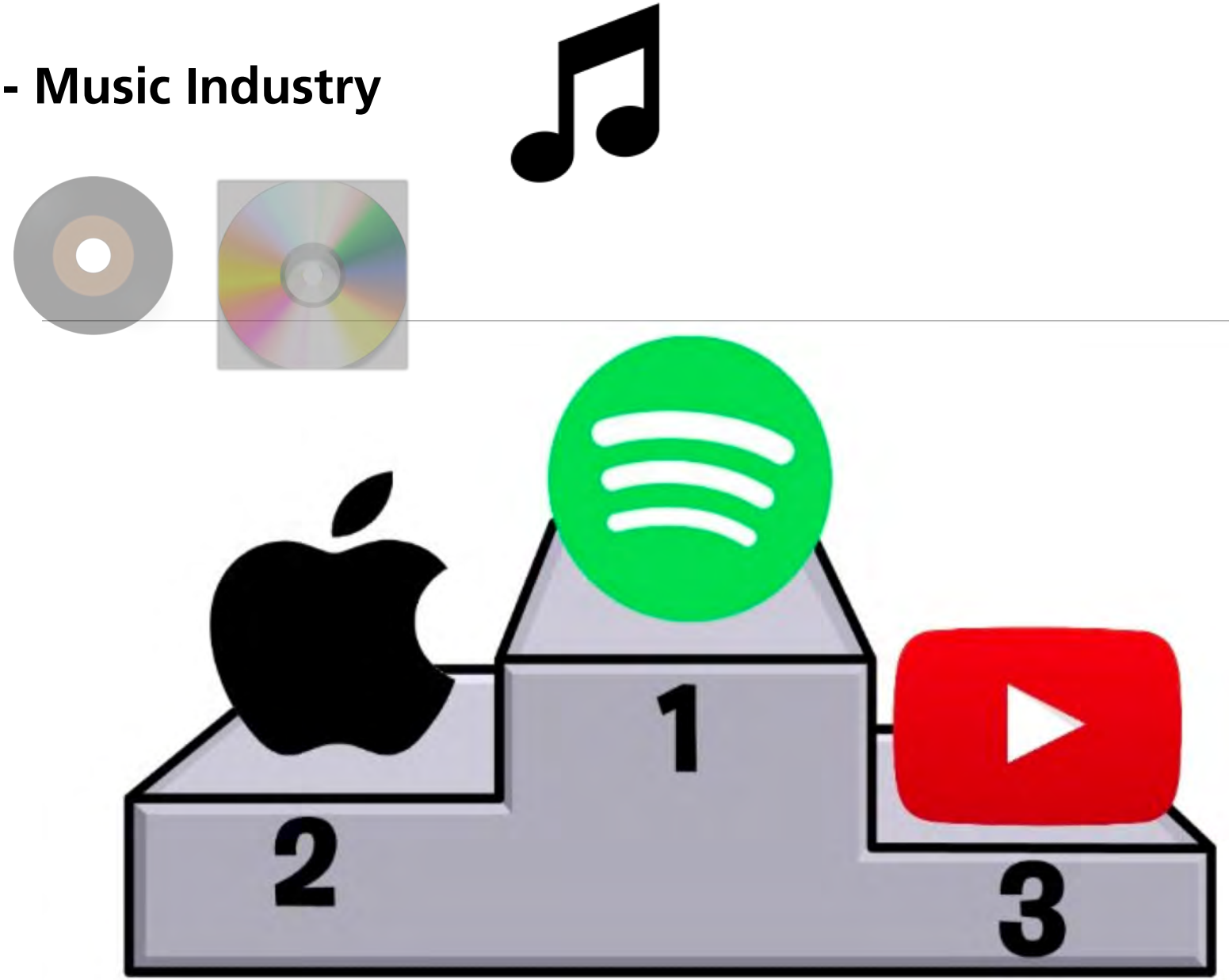
Example - Music Industry



Example - Music Industry



Example - Music Industry



Software is the key to Innovation

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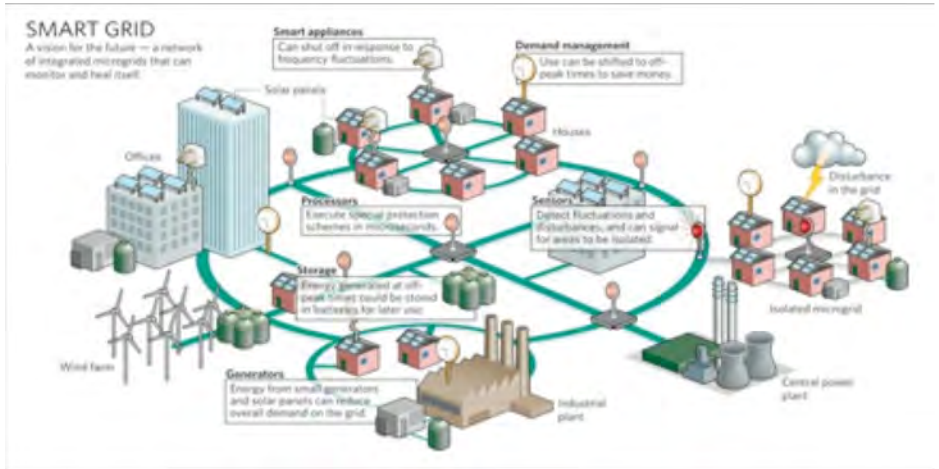
GreenCom

Energy Efficient and Interoperable Smart Energy Systems for Local Communities

- FP7-Strep – Smart Microgrid control on the island of FUR in Denmark using LinkSmart
- FIT – Technical Coordinator



- Development of new data analysis- und aggregation methods to optimize the energy distribution in and between Microgrids
- Development of an intelligent local Energy-Production- and storage network on community level
- Investigation of virtual peer-to-peer exchange models for local energy production

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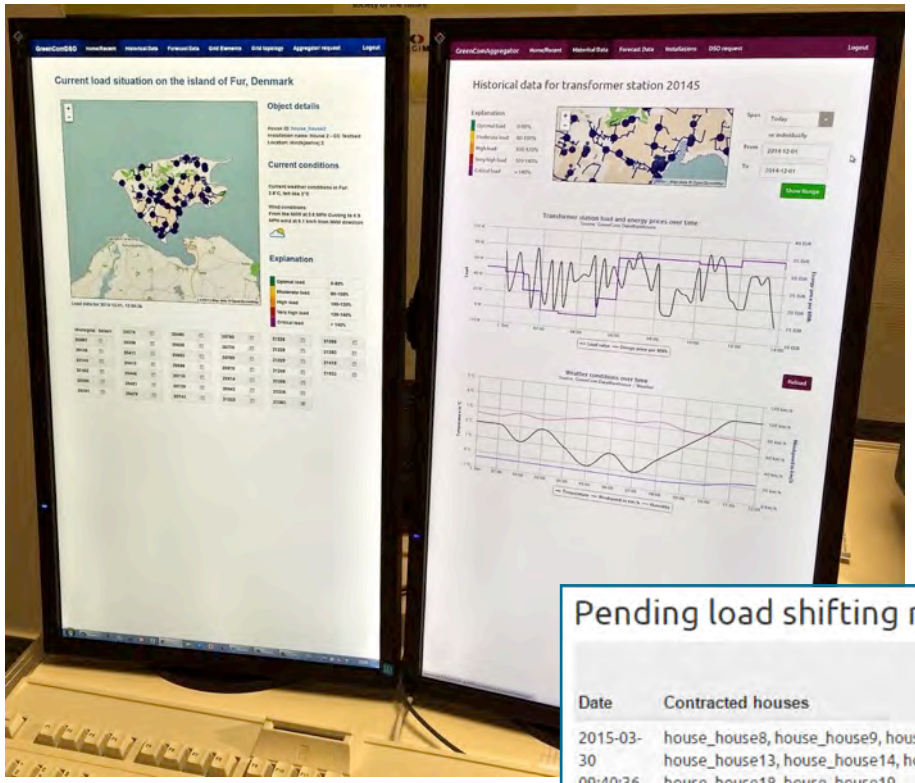
GreenCom

Intelligent Energy Management System



- Focus is on energy system efficiency instead of energy network efficiency
- New business models for load management (Demand-Side-Management)
- Aggregator as a new Player

Configure your request

...select the desired microgrids	
Microgrid	Select
21383	☑

...select a timespan

From 2015/03/30 09:38

To 2015/04/02 09:38

...select a load reduction: 15 kW

...select a reward: 3800 DKK

...and a fine.: 1600 DKK

Check

Pending load shifting requests

Date	Contracted houses	Time Start	Time End	Reduction in kW	Reward in DKK	Fine in DKK	MGR possible?	Accept	Reject
2015-03-30 09:40:36	house_house8, house_house9, house_house10, house_house11, house_house13, house_house14, house_house16, house_house17, house_house18, house_house19	2015-03-30 09:38:00	2015-04-02 09:38:00	15	3800	1600	true	Accept	Reject

This is only the first version of the algorithm. We have made asumptions that will be discarded and replaced with actual data in the future. We make assumption that we can reduce the consumption on each house by 1kw/0,5h. We have 432 halfs an hours in the given time interval For each house we multiply the time interval with the reduction per house per half an hour and add it to a total of reduction possible. The total possible reduction is: 4320 To reduce the chances of failure we multiply the possible reduction by 93% The new possible reduction is:4017.6 difference = possibleReduction - reductionAmount If the difference is less than -5% of the reduction requested we consider the reduction to be impossible. If the difference is more than 5% of the reduction requested we consider the probability of success to be almost certain. If the difference is between -5% and 5% we need to consider the financial aspect to decide if it's worth or not taking the risk. 5% of the requested reduction amount is 1.15 The possible reduction is much bigger than the requested one. We can consider this reduction request to be a certain success if accepted.

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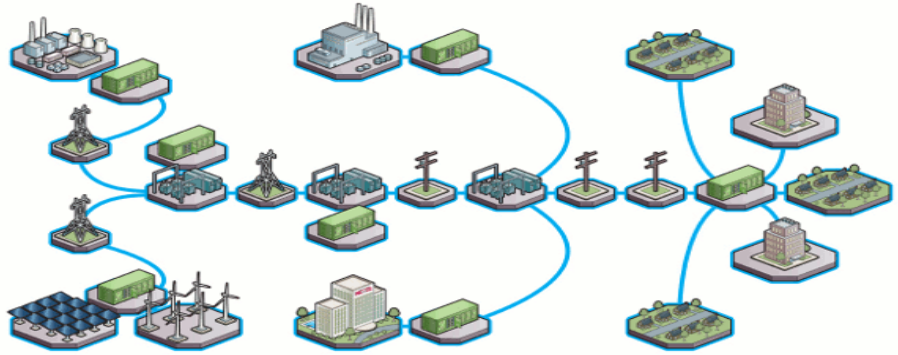

Flex4Grid

Prosumer Flexibility Services for Smart Grid Management

Goal for DSOs

- Cloud-based data analytics and aggregation services for Distribution System Operators (DSO)
- Active management of electricity consumption and micro-generation
- Unifies the data exchange between DSOs and their customers
- Open control interface to building management systems, home automation systems and smart appliances

Goal for customers

- Simplify the integration of building management system and renewable energy sources
- Energy management and optimisation
  - Real-time electricity costs
  - Other incentives offered by the energy retailers.

Introducing new business models and incentives for prosumers & DSOs

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STORAGE 4 GRID

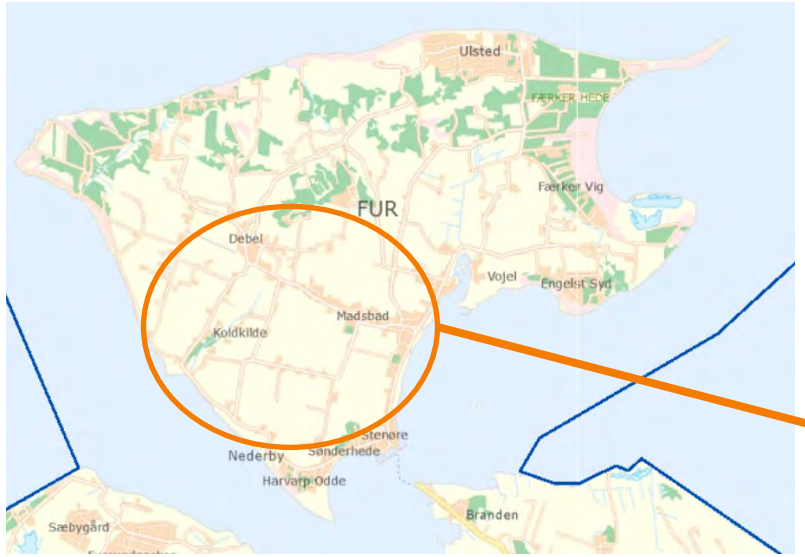
Aim: avoid or reduce network reinforcement:

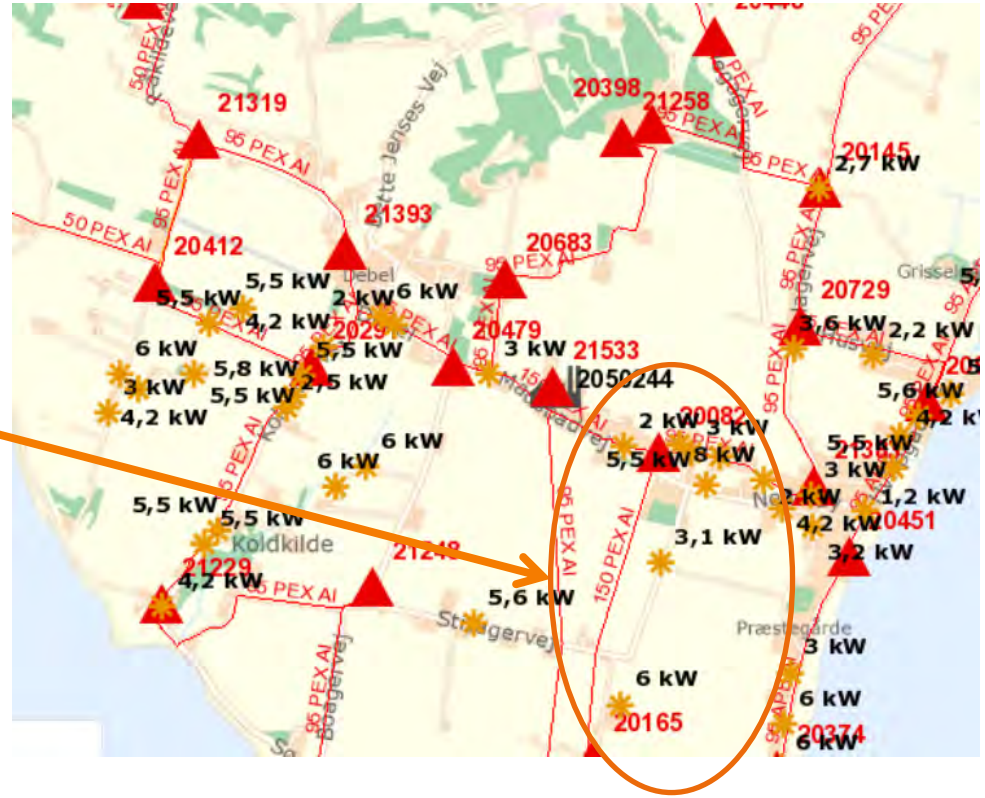
by enabling the coordination of local, grid-connected and mixed Energy Storage Systems (ESS)

by providing a new ICT framework for planning and optimizing ESS-based services

Scope: distribution grid level (ESS at substation level), end-user level (ESS at user premises) coordinated in conjunction with Electrical Vehicles (EVs) charging, innovative energy metering systems and energy routing systems.

Fur residential test site – Fur Skive municipality





Feederline (20082):

- 7 PV systems
- 2 storage systems

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SUSTAINABLE ENERGY MANAGEMENT FOR UNDERGROUND STATION

- Reduction of Energy consumption of a Metro station in Barcelona by 5% under real operational conditions

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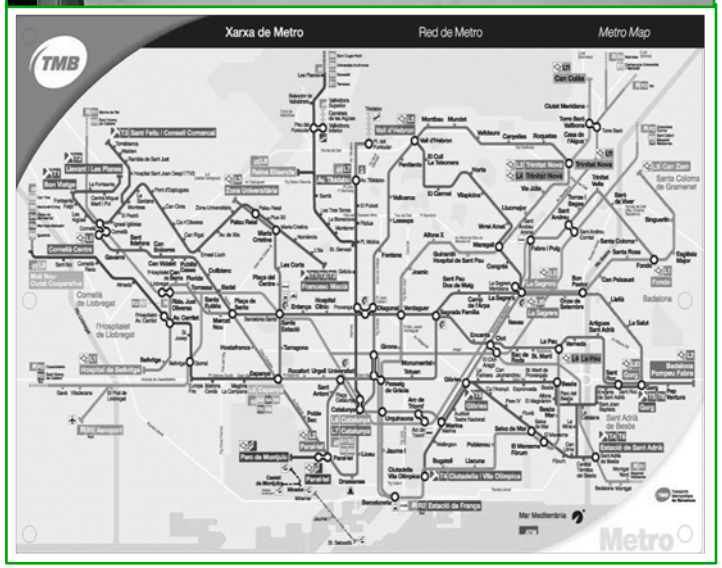
SUSTAINABLE ENERGY MANAGEMENT FOR UNDERGROUND STATION

Metros are large Energy consumers - Barcelona Metro Network uses 63,1 Millions kWh/year

A third is used by the Metro stations

Savings of 5% per year, equivalents to the average consumption of **700 households**



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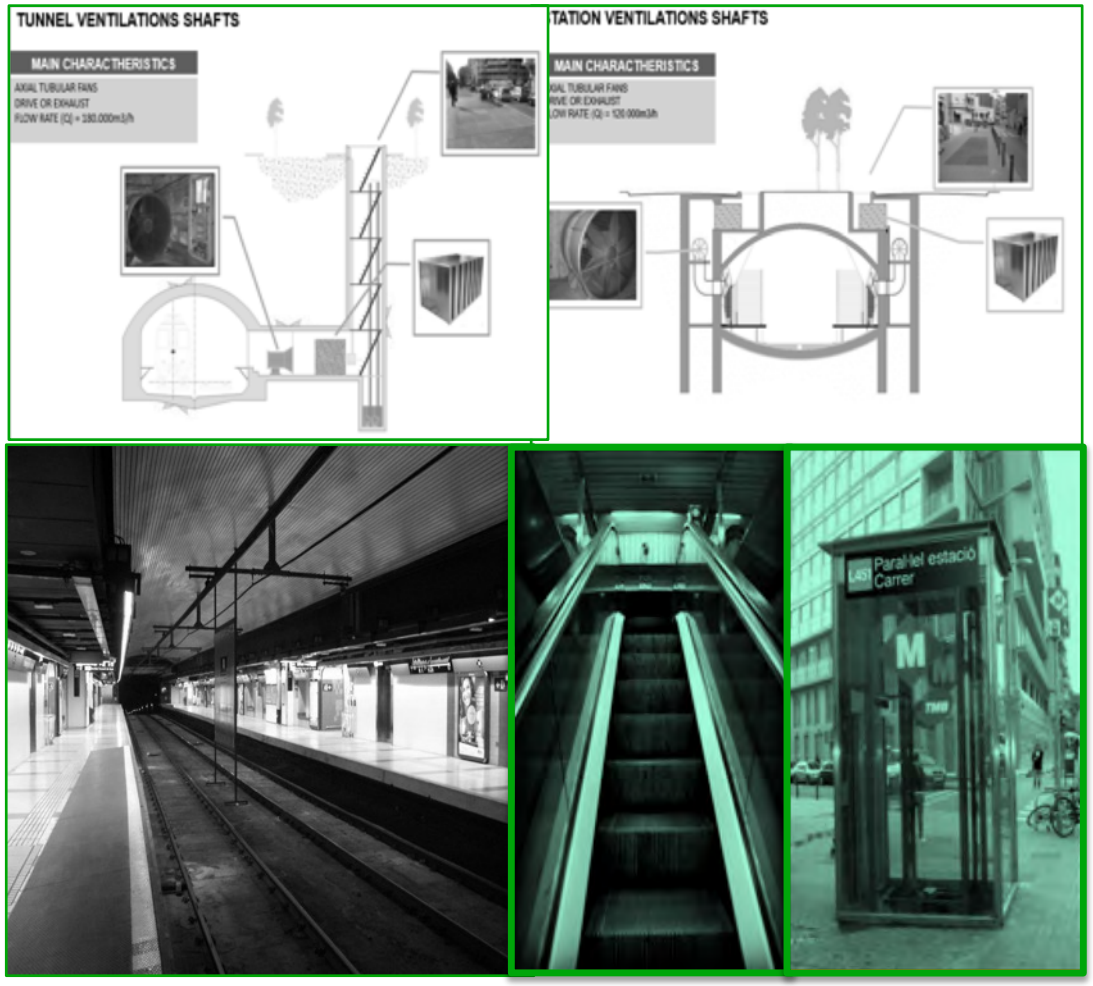
Ventilation, Lightning, vertical Transport

- intelligent ventilation control
- intelligent Light control
- optimized transportation



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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)	Saving Percentage
Lighting	239.91	40%	187.61	**22%**	145.39	**39%**	203.93	**15%**
Ventilation	75.81	13%	50.72	**33%**	46.93	**38%**	48.67	**36%**
Escalators	37.34	6%	25.17	**33%**	25.17	**33%**	25.17	**33%**
Controlled Energy	353.07	59%	263.50	**25%**	217.48	**38%**	277.77	**21%**
Demand Driven controllable 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%**

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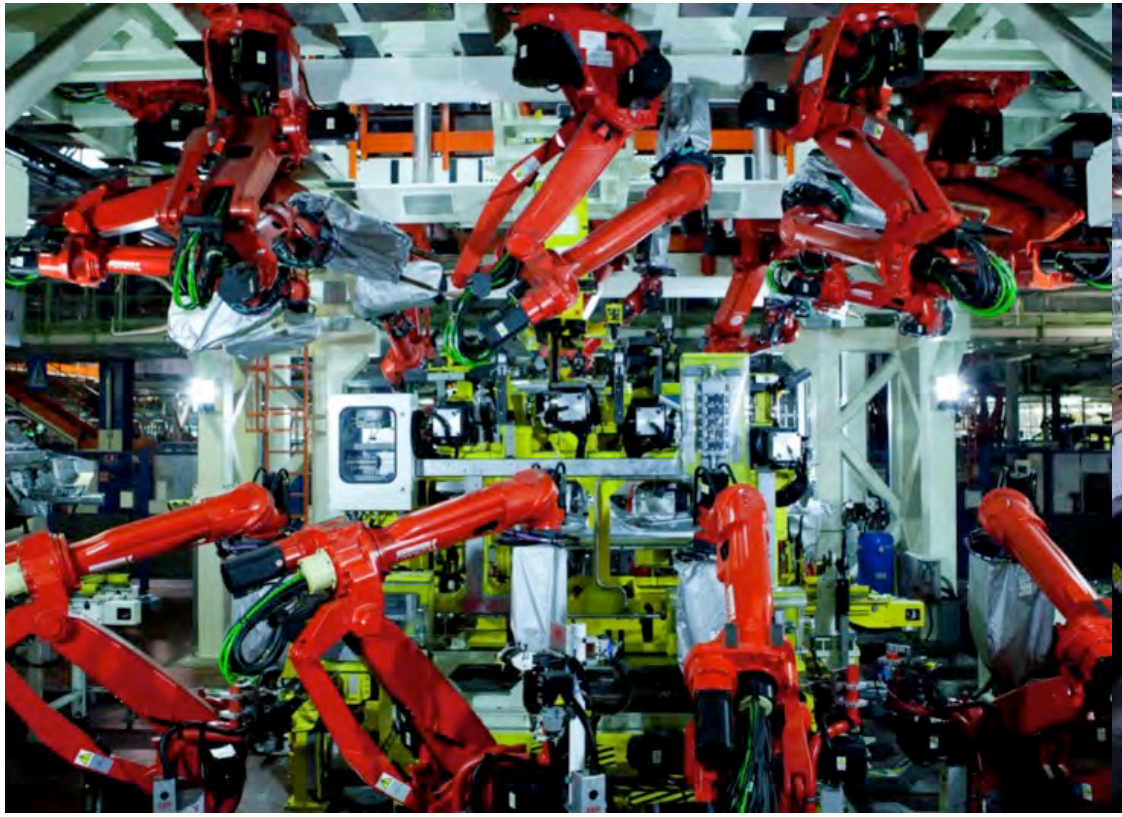
COMPOSITION

ebbits

BEMO-COFRA
Brazil-Europe Monitoring and Control Framework

Enabling **B**usiness-**B**ased **I**nternet of **T**hings and **S**ervices



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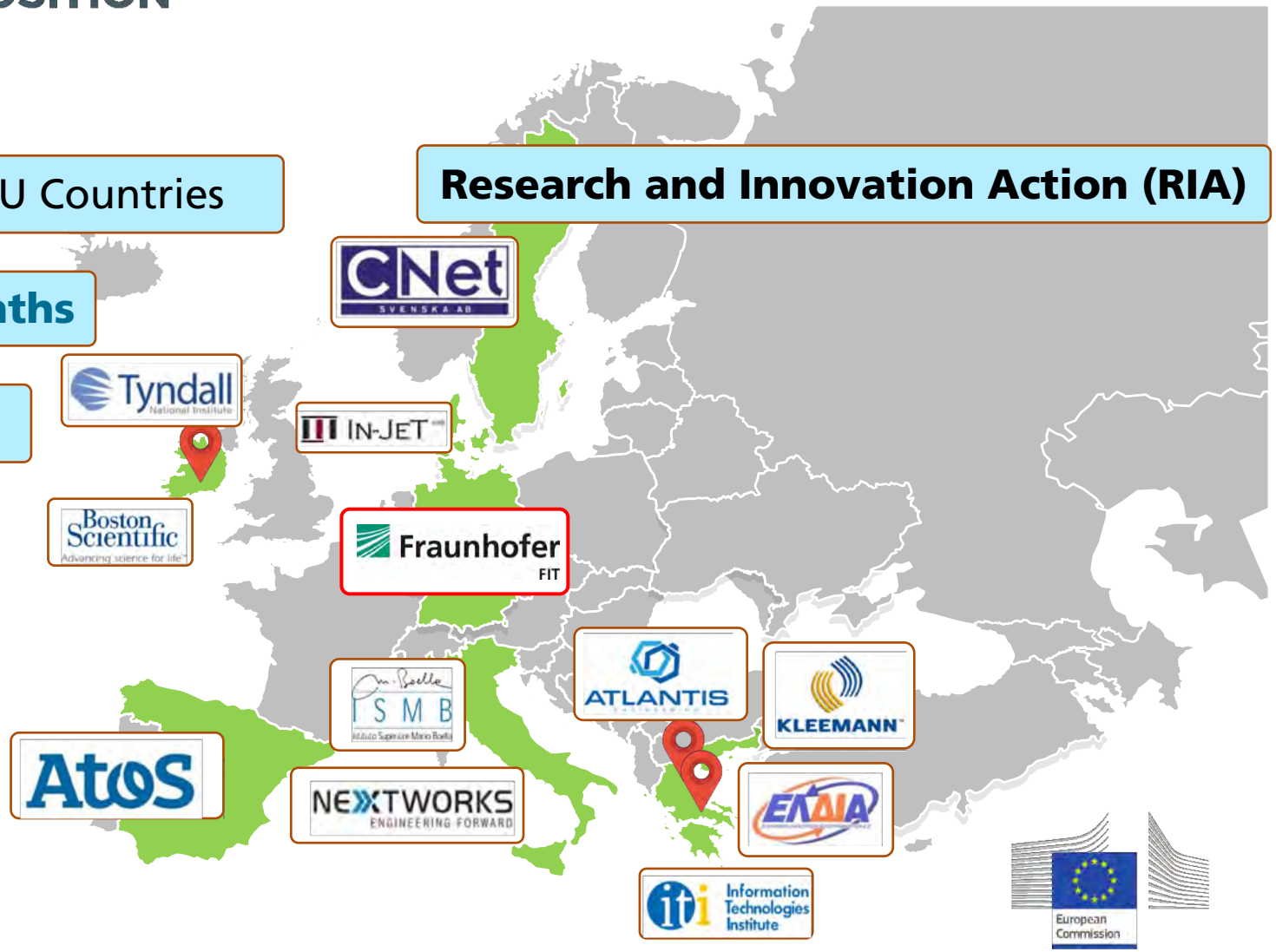
COMPOSITION

12 partners /**6** EU Countries

Duration: **36 months**

Budget: **9 M€**

Research and Innovation Action (RIA)



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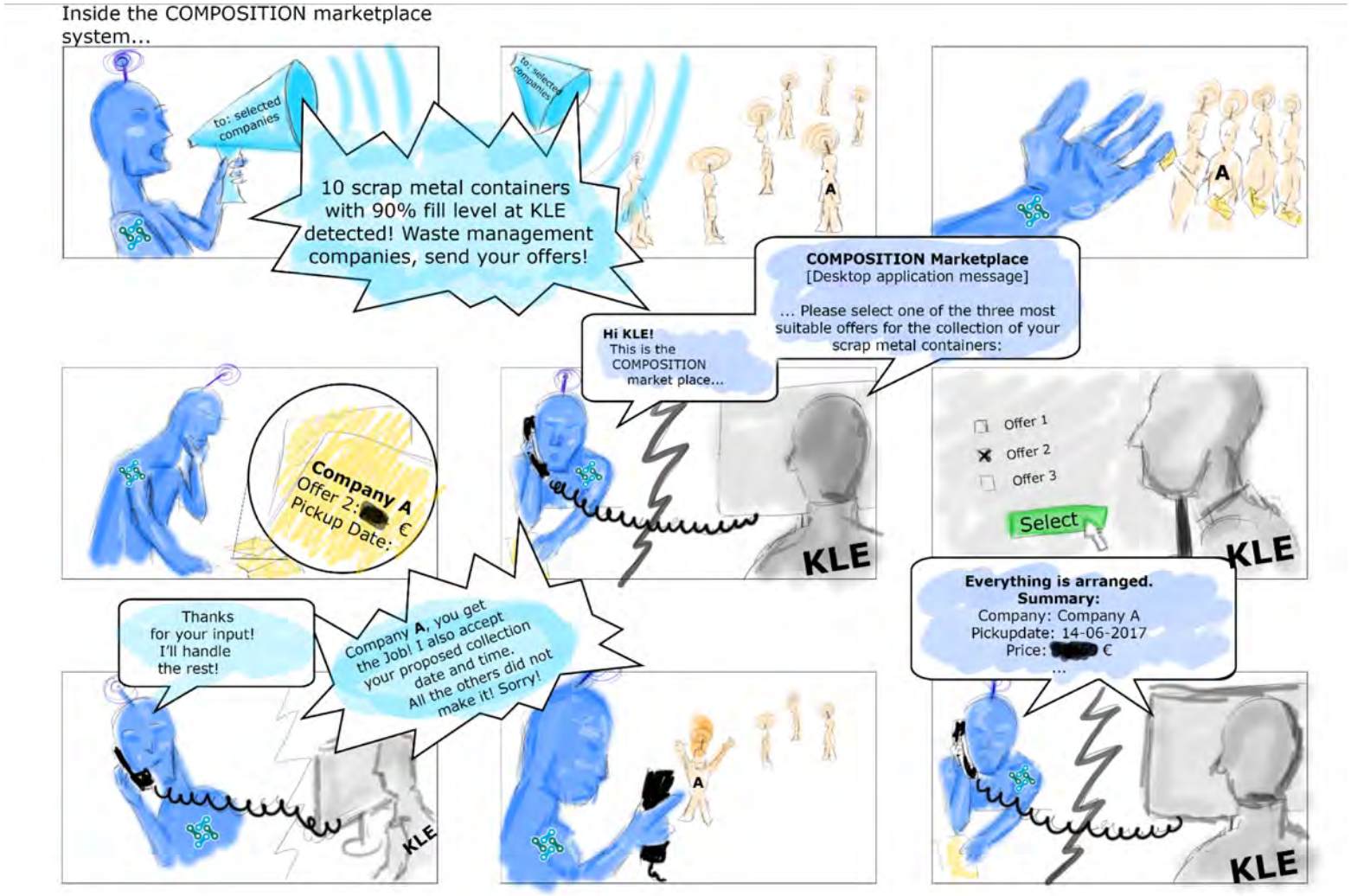
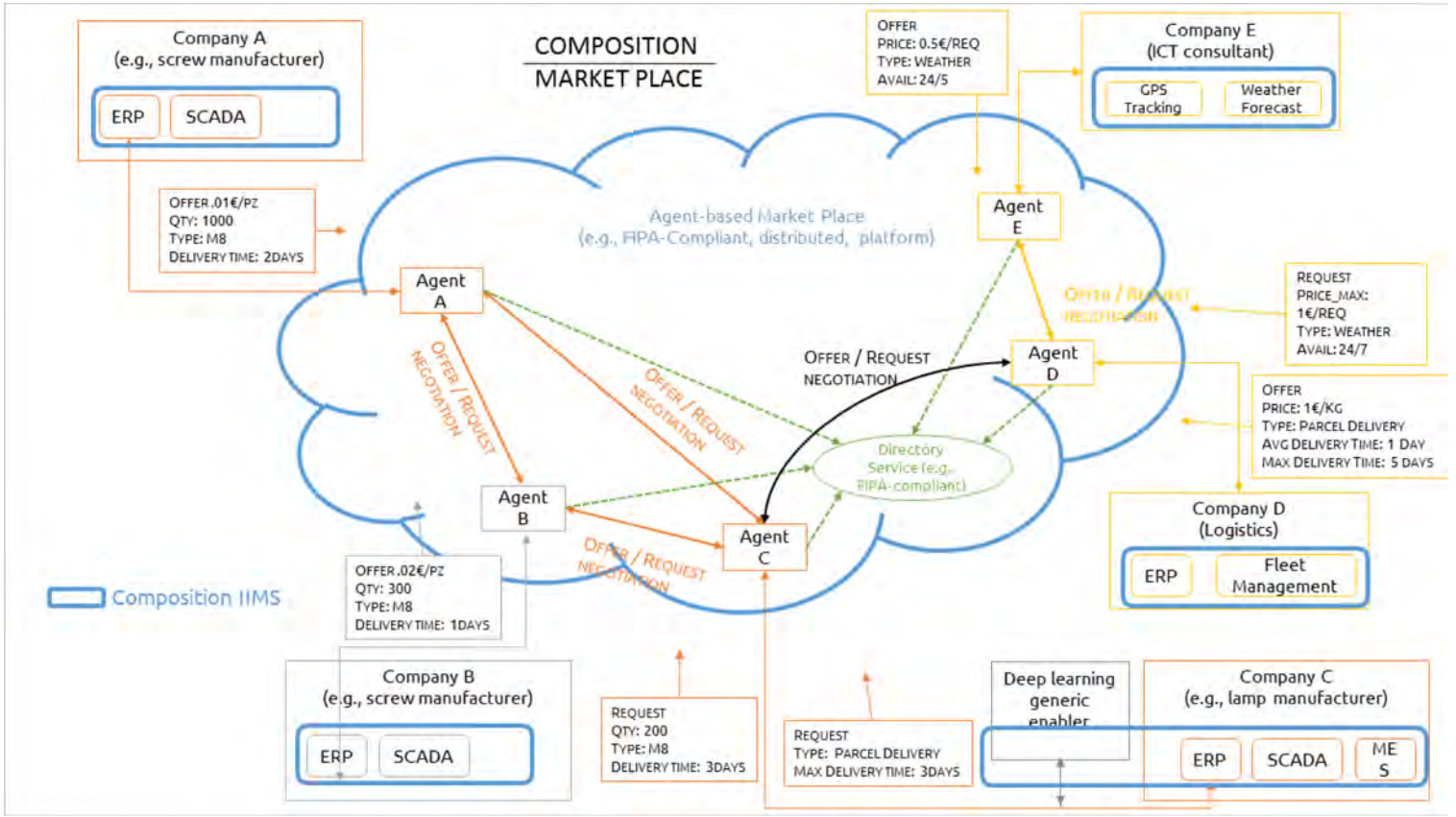
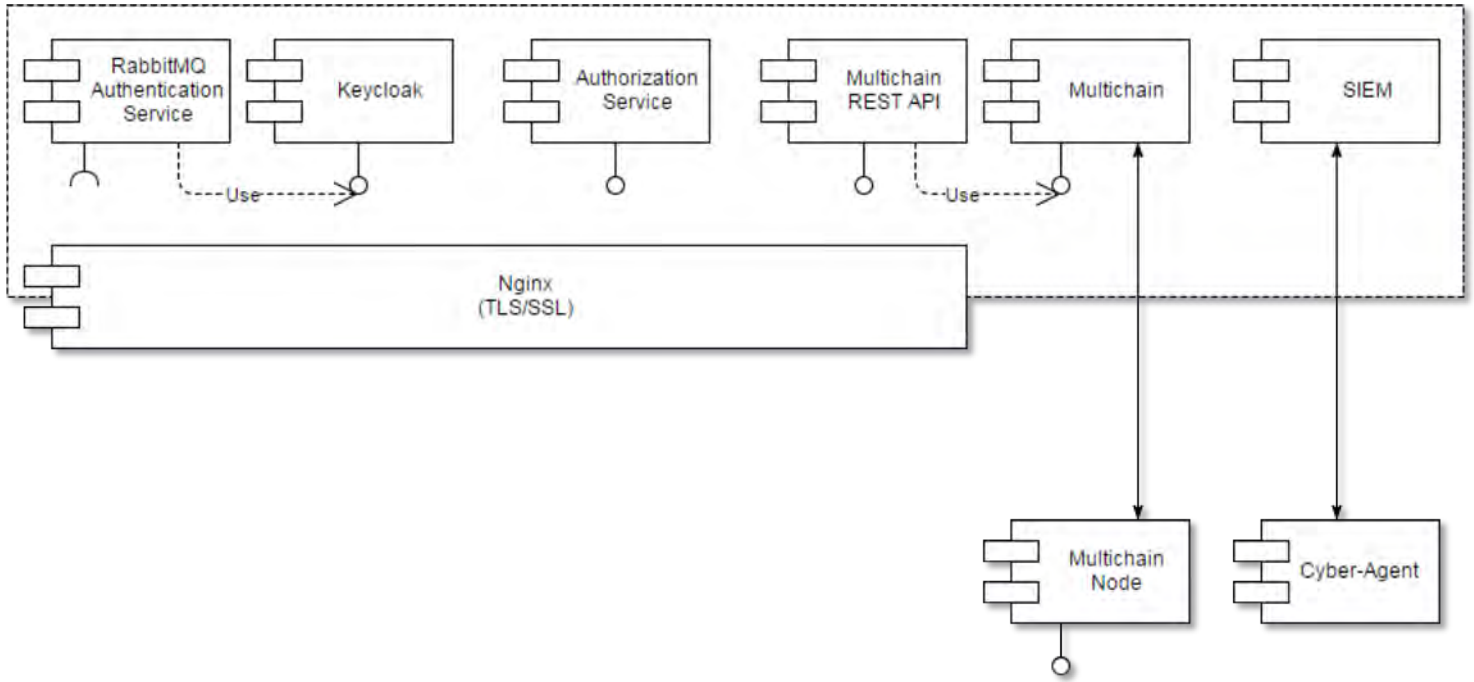
COMPOSITION Blockchain Marketplace Use Case



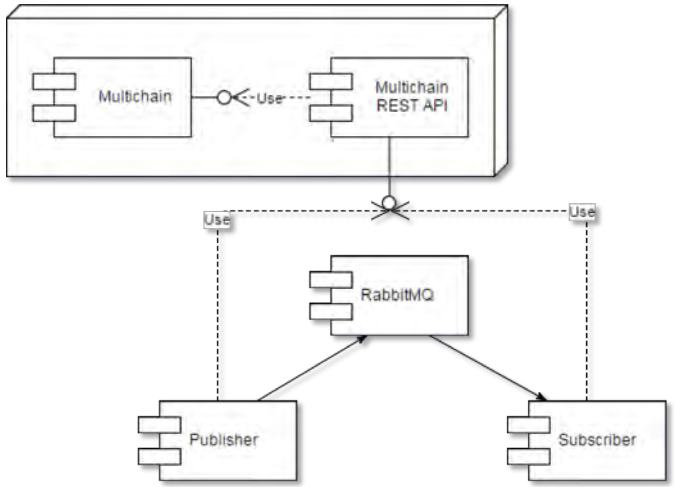
Marketplace Sketch

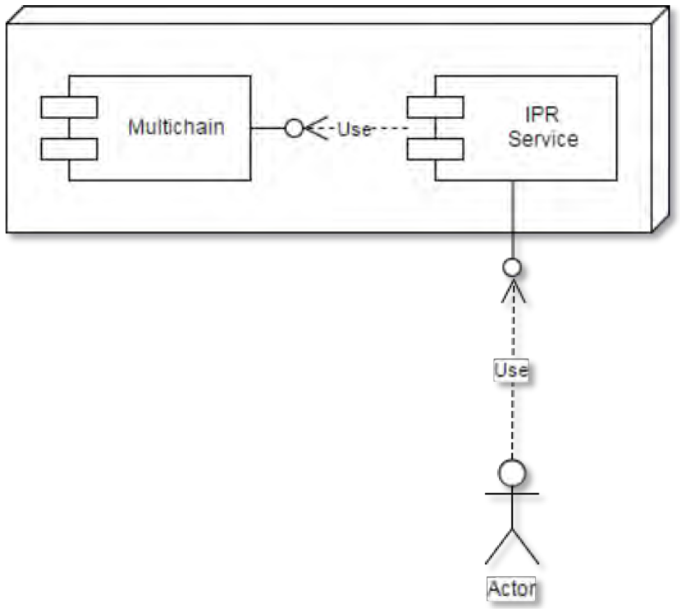


Blockchain-based Security

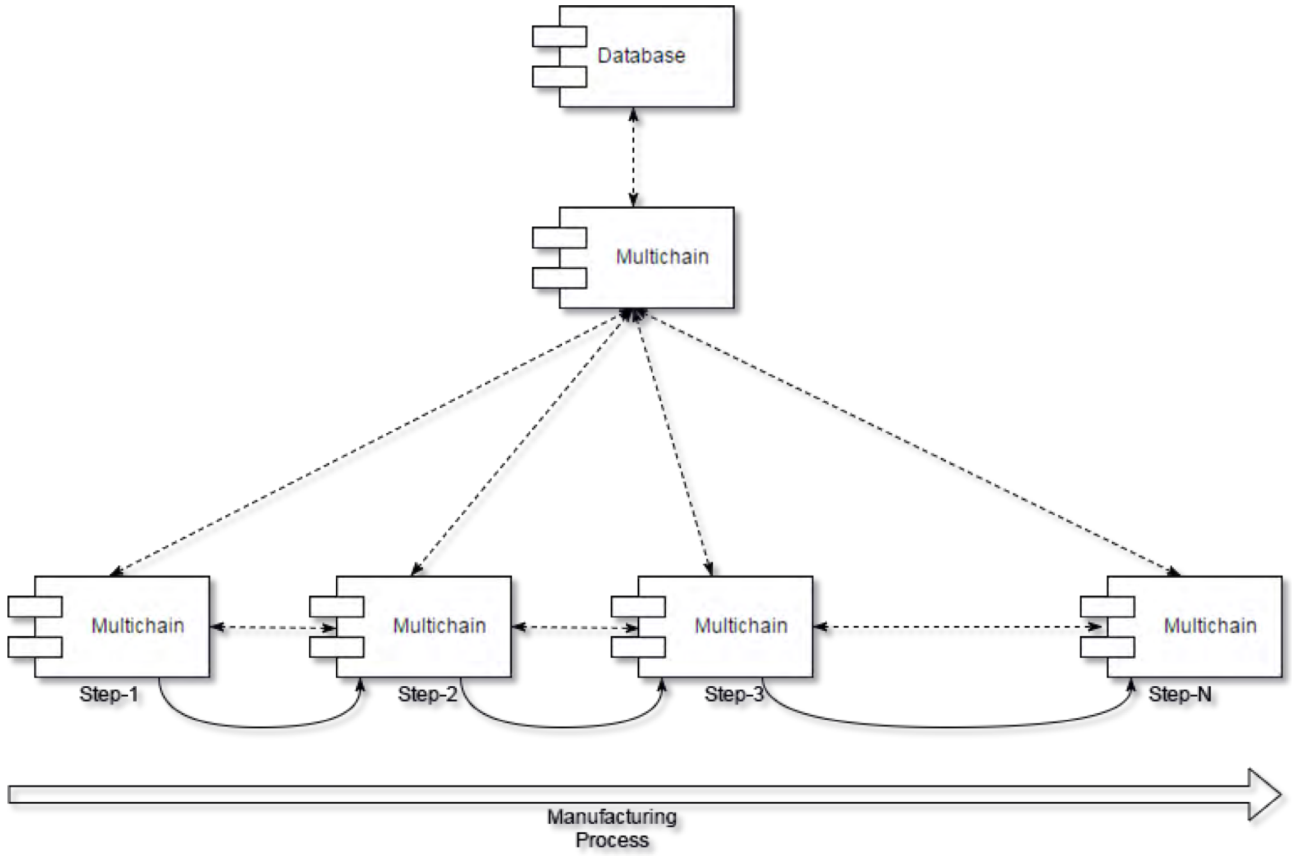


IPR, Confidentiality and Data integrity





Log and Traceability



pebbles
Energie verbindet

Bundesministerium
für Wirtschaft
und Energie

Key Data

- Duration: 03/2018 – 02/2021
- Milestones: Specification 09/18
  Prototype 02/20
  Demonstration 06/20
- Demonstration: Wildpoldsried (Allgäu)
- Financial Volume: ~10.5 Mio. €
- Funded: ~56 %
- Project Support : DLR
- Funding Authority: BMWi

Consortium

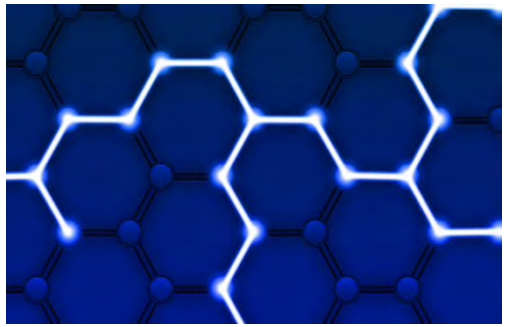
- Management of the Energy Campus: Wildpoldsried (Demo)
- Desing, Simulation, Smart Contracts-Bibliothek
- Prototyping: EMS, Cloud, Blockchain
- Grid SP; Provisioning and Infrastructure managemnt
- Local Markets; Stakeholders broker

Introduction Motivation

De-carbonization

65 % RE till 2030

De-centralization



coupling sector,
Cellular principle

Digitalization

Grid building vs. smart grids

Central Question of Pebbles

Which and how can different business models be realized in regional energy supply areas, taking into account innovative technological options?

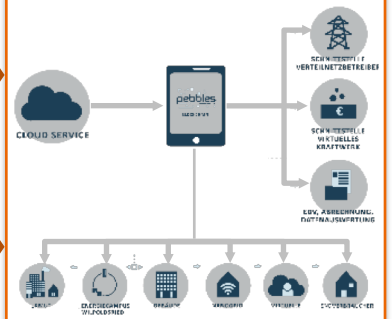
Development and demonstration of blockchain-based local energy trading and network services

Conceptual design and development of local energy markets (LEM)

Conceptual design and development of network services

Conception of the interfaces to the markets and to the distributed grid operator

Software und hardware technical Implementation

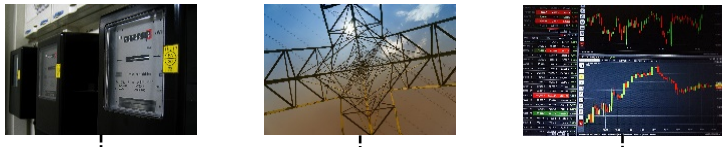


Field tests

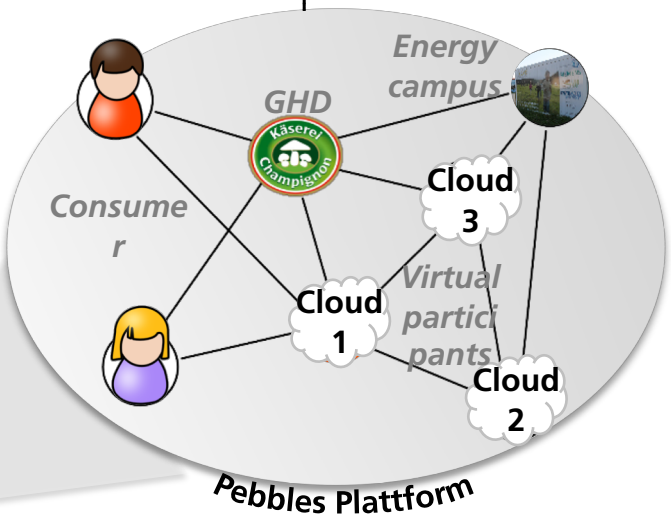
Derivation and evaluation of business models

Analysis of the legal-regulatory framework

http://wetter.bild.de



utilities DSO/TSO Virtual power plants



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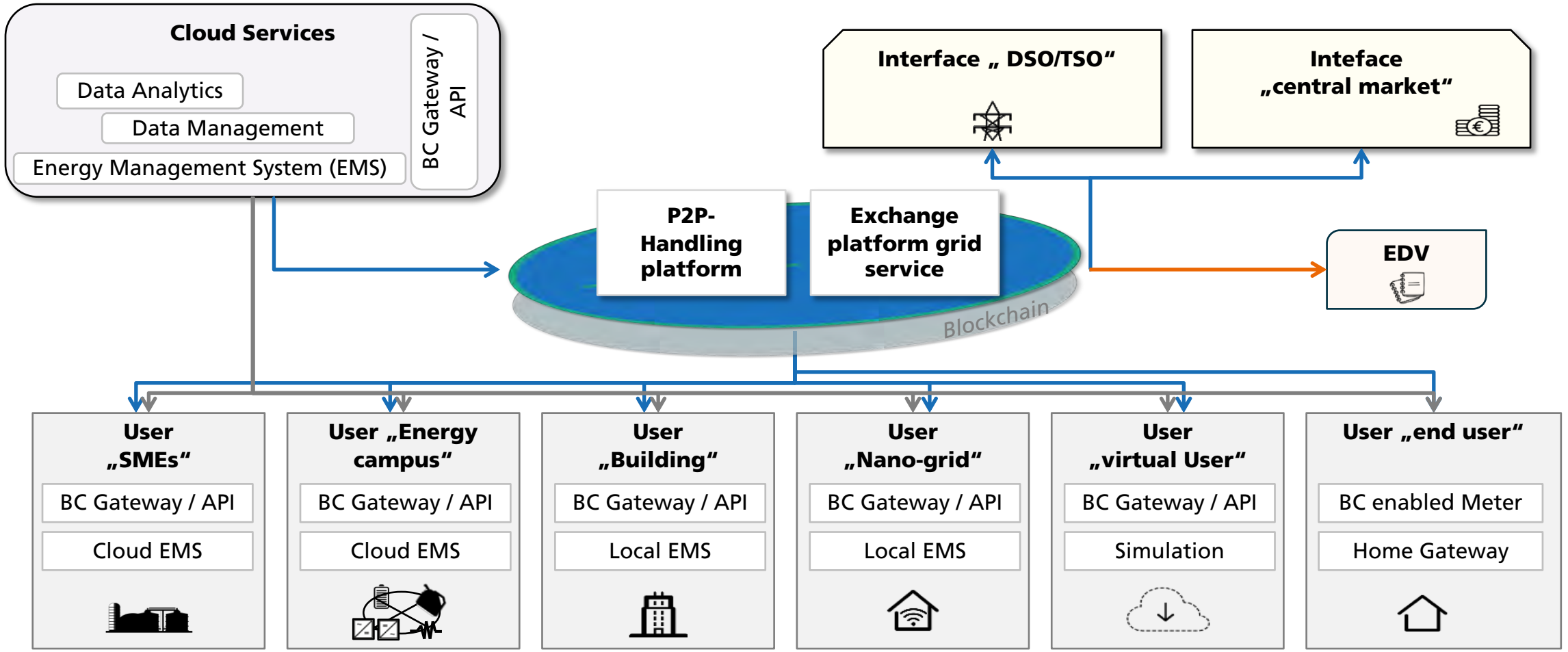
Introduction

System Architecture



✓(P2P-) Transactions without intermediary
- Execution
- Billing and archiving

✓Partial automation of processes

✓Secure, decentralized, transparent IT infrastructure

✓Access management of the data (Market Grid)

→ Comparison of different configuration options of the blockchain infrastructure in Pebbles:
- Plattform (Ethereum, Hyperledger,…)
- Smart Contracts

Thank you for attention!

Questions? Comments?

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http://www.fit.fraunhofer.de/fb/ucc_en.html