

Analysis of potentials for synergies and collaboration in Energy Technologies



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1. Introduction

This document outlines the analysis of the energy technology competencies in the regions of Carinthia and Friuli Venezia Giulia (FVG). The identified competencies are the basis for the definition of potential synergies and cooperative research areas.

Chapter 2 describes shortly the company landscape based on extensive online and offline research and a classification of the competencies. The regional competencies have been organized in an online database – the so called competency map.

Chapter 3 lists the research institutions and their respective research areas in energy technologies in the considered regions.

Chapter 4 summarizes the potential research areas and lists possible research tasks derived from the former analysis of competencies.

A more detailed elaboration can be found in the Roadmap for Energy Technologies in the Alps Adriatic Region.

2. Company landscape

In order to identify competencies in the considered regions and to develop promising fields of synergy, companies have been mapped with respect to their individual strengths in the field of energy technologies. Through thorough analysis of online and offline resources, domain experts in collaboration with regional authorities developed an online-database containing information on the type of company, their location and contact details, a short description and their innovation capacity which is now available on the respective project websites.

The analysis described in this chapter is based on a representative sample of 272 companies with activities in energy technologies. It includes 93 companies from Carinthia, 101 companies from Slovenia and 65 from Friuli Venezia Giulia. The analysis presented here just takes into account the number of companies, regardless of their size and innovation capacity, but still gives an insight into the company activities in the main energy technology fields.

The main energy technology categories are the following:

- Bioenergy
 - Including Biogas, Cogeneration, Combustion and Heating, Biofuels and Feedstock
- Solar Energy
 - Including Photovoltaics, Solarthermal and Concentrating Solar Power
- Wind Energy
 - Including Design, Construction and Deployment of Wind Energy Plants
- Other renewables
 - Including Hydropower, Geothermal Energy, Marine Energy, etc.
- Conventional Energy
 - Including Advanced Fossil Fuel Power Generation, Carbon Capture and Storage, Nuclear Fission, Nuclear Fusion
- Energy storage and hydrogen technologies
 - Including Fuel Cells and Hydrogen Generation Technologies, Electricity Storage Systems
- Energy efficiency
 - Including Energy Efficiency in Buildings (Construction and HVAC), Industry and Transport
- Management Systems
 - Including Control and Measurement Systems for Smart Homes and Smart Cities
- Smart Grids
 - Including Grid Optimization, Power Electronics and relevant Communication Technologies
- Cross-Sectional technologies
 - Including ICT, Mechatronics, Sensors and Material Technologies applied to Energy Solutions

The following graph summarizes the number of companies within the Alps Adriatic region, assigned to each energy technology category.

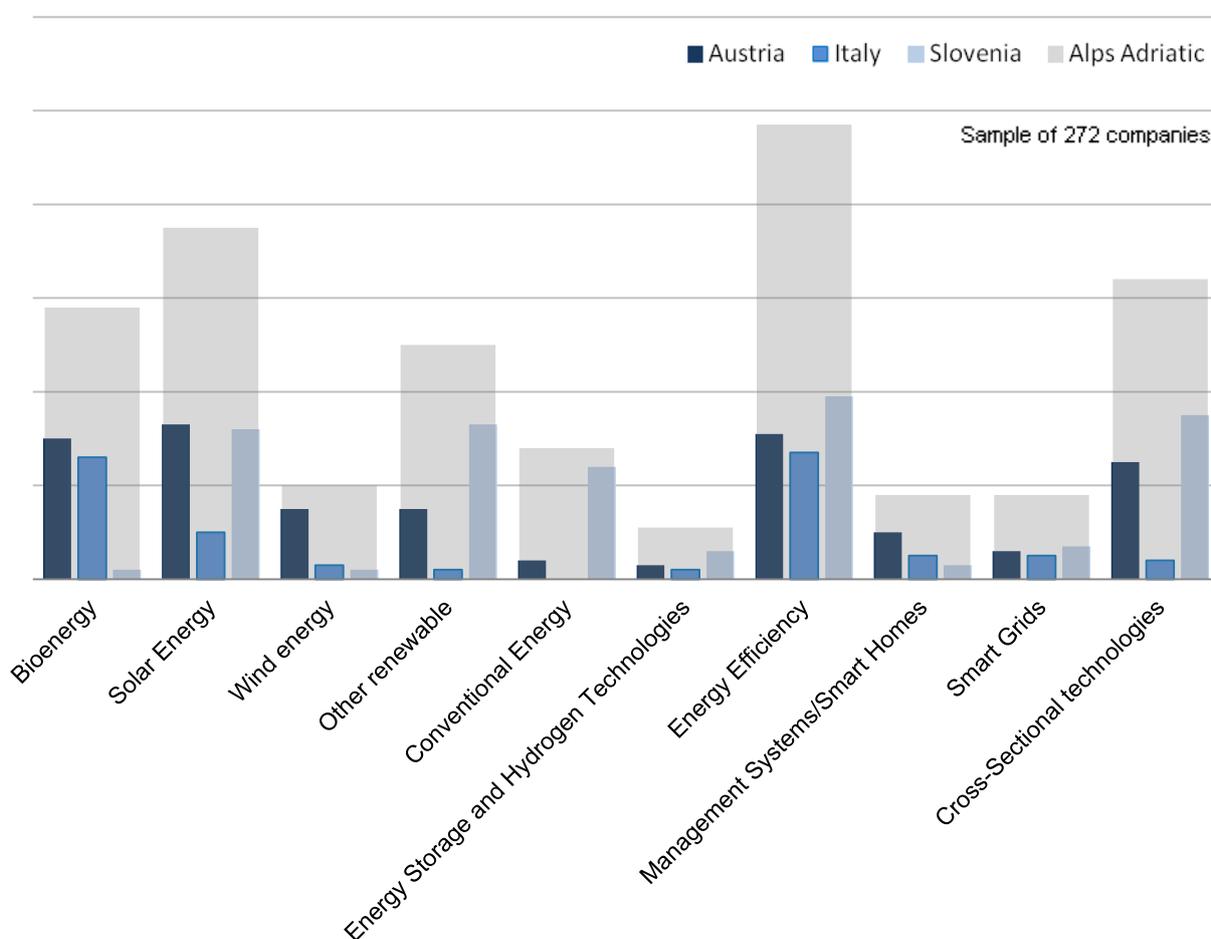


Figure 1: Alps Adriatic region strengths related to energy technologies

The column for the **Carinthian** region depicts, as expected, main company activities in solar and bioenergy. While solar technologies in photovoltaic and solar thermal are backed up with leading companies and specialized research capacities, bioenergy competencies can mainly be found at innovative companies. There are also renowned companies dealing with hydropower and some players in wind energy. Conventional energy and energy storage technologies are very limited in Carinthia. The strong energy efficiency field mainly belongs to constructional measures (insulation) and energy consultancy companies. The field of management systems and smart grids is still quite small but could profit from the brought expertise in ICT and microelectronics (cross-sectional technologies).

In **Italy** the situation is quite different. Main company activities are in the fields of bioenergy, with focus on advanced biomass heating systems also in combination with cogeneration and emerging competencies in biomass gasification. The strongest field is energy efficiency, with main competencies in the production of building components (insulation) and HVAC systems. As in the neighbouring regions solar energy technologies are also a very active field. There is an increasing number of companies dealing with management systems in Smart Homes and Smart Cities which profits from a generally strong ICT sector.

Taking into account all three regions in the **Alps Adriatic area** brings us to the following **conclusions**:

- There is a strong company sector in **bioenergy**, combining mainly the competencies in Friuli and Carinthia.
- The strongest common technology field is **solar energy** with competencies at companies and research institutions in all regions, possibly lead by Carinthia.
- **Energy efficiency** measures are broadly backed-up by companies in all regions, while Friuli Venezia Giulia has a focus on constructional measures and HVAC systems, Carinthia benefits from its strong building sector and a growing consultancy market.
- There are yet only few companies dealing with **management systems for Smart Homes and Smart Grids**, but there is an increasing focus on this topic in regional research institutions that can support the development of respective company activities.
- **Hydropower expertise** can mainly be found in Carinthia.
- **Cross-sectional technologies** like ICT and microelectronics in Carinthia, material technologies in Slovenia and both ICT and material technologies in Friuli Venezia Giulia are important enablers for energy technologies, but it is a consequent challenge for companies to adopt them for energy applications.

3. Research Institutions in Friuli Venezia Giulia and Carinthia

Within the Alps Adriatic Region several competence, research and excellence centres could have been identified, listed in detail in the following table.

Austria and especially the region of Carinthia sees its main competencies in energy management and solar energy – always connected to the cross-sectional competencies in ICT and micro-electronics. Friuli Venezia Giulia possesses special expertise in constructional measures for energy efficient buildings and heat and ventilation systems. Solar technologies are widely backed up and there is scientific research in bioenergy systems.

To ease the analysis, research fields are classified in these main categories:

- 1 Energy Efficient Buildings
- 2 Energy Management in Building and Grid
- 3 Bioenergy
- 4 Solar Technologies
- 5 Energy Storage
- 6 Advanced Materials
- 7 e-Mobility
- 8 Multidisciplinarity

3.1. Carinthia

University of Klagenfurt (AAU) (Academic Research)

MAIN FACULTIES

- [Faculty of Management and Economics](#)
- [Faculty of Technical Sciences](#)
 - [Department of Networked and Embedded Systems](#)
 - [Department of Smart Systems Technologies](#)
 - [Department of Informatics Systems](#)
 - [Department of Applied Informatics](#)

ENERGY RELATED RESEARCH FIELD [2, 4, 8]

- Interdisciplinary focus on energy management and energy technologies
- Smart (Micro) Grids and Energy Management
- Green Energy Business Models
- ICT and Simulation
- Embedded Communication Systems

SPECIALIZED INFRASTRUCTURE

- Science cluster on Energy Management and Energy Technology
- SmartLab Carinthia

Lakeside Labs (Research facility)

PARTNER STRUCTURE

- Lakeside Labs have a close relationship to the University of Klagenfurt
- <http://www.lakeside-labs.com/about/partners/>

ENERGY RELATED RESEARCH FIELD(S) [2, 4, 8]

- Self-organizing networked systems
- Intelligent energy systems – Smart Grids and Energy Management
- Photovoltaic Systems – Prediction Models

SPECIALIZED INFRASTRUCTURE

- Smart Microgrid Lab
- Communications and Signal Processing Lab
- Programmable Radio Lab
- Sensor Networks Lab

Carinthia University of Applied Sciences (CUAS) (Academic Research)

PARTNER STRUCTURE

The Carinthia University of Applied Sciences cooperates with more than 120 universities worldwide, whereas six partner universities in five different countries are specialized in the field of electrical energy and mobility systems / biomimetic in energy systems (<http://www.fh-kaernten.at/ueber-die-fh/partnerorganisationen.html>)

ENERGY RELATED RESEARCH FIELD(S) [1, 2, 5, 8]

- Electrical energy and mobility systems (Storage Systems, eMobility)
- Biomimetic in energy systems
- Materials, Design and Construction – building science
- Embedded and Mechatronic Systems

SPECIALIZED INFRASTRUCTURE

- Science and Energy Lab
- Experimental Testbed (innovative energy storage concepts)
- EMC-Laboratory (electromagnetic compatibility)
- SmartLab Carinthia

SERVICES

The service divisions of CUAS are competence centres, supporting the study areas in various fields. The Research Management of CUAS supports the setup of research projects: <http://www.fh-kaernten.at/en/research/research-development-at-cuas.html>

Carinthian Tech Research (CTR) (Research facility)

PARTNER STRUCTURE

- <http://www.ctr.at/en/company/networks-partners.html>

ENERGY RELATED RESEARCH FIELD(S) [2, 4]

- Competence centre for intelligent sensors
- Photovoltaic research- and network integration
- Smart City

SPECIALIZED INFRASTRUCTURE

- Photovoltaic Laboratory

SERVICES

- CTR provides R&D Services (Contract research, Technology research, -conception, -prototyping, sensor development, quality control etc.)
- CTR provides services by industry. Energy projects concerned about gas recycling, photovoltaic, power lines, smart socket etc. More about CTR energy services can be found following: <http://www.ctr.at/en/services/by-industry/energy-environment.html?print=0.html>
- CTR advises on various funding opportunities for innovative projects and assists in finding suitable partners for project implementation via technology transfer

An overview of the objectives, functions and services is provided under the following link: <http://www.ctr.at/en/services/by-r-d-service.html>

3.2. Friuli Venezia Giulia and South Tyrol

University of Udine (Academic Research)
MAIN FACULTIES
<ul style="list-style-type: none"> • Department of Electrical, Management and Mechanical Engineering • Department of Agriculture and Environmental Science
ENERGY RELATED RESEARCH FIELD(S) [1, 3]
<ul style="list-style-type: none"> • Renewable Energy production, energy systems • Cooling- and Thermal transfer, Fluid Dynamics • Biomass power plants, biomass gasification, raw materials
SPECIALIZED INFRASTRUCTURE
<ul style="list-style-type: none"> • Specialized laboratories
SERVICES
<ul style="list-style-type: none"> • Services for researchers

University of Trieste (Academic Research) [1, 3]
MAIN FACULTIES
<ul style="list-style-type: none"> • Department of Engineering and Architecture
ENERGY RELATED RESEARCH FIELD(S)
<ul style="list-style-type: none"> • Simulation and optimization of nearly zero-energy buildings, HVAC-systems • Thermodynamic machine design and distributed power generation systems • Combined heat and power generation plants • Mechanical Engineering and Industrial energy efficiency
SPECIALIZED INFRASTRUCTURE
<ul style="list-style-type: none"> • Specialized laboratories

CETA – Centro di Ecologia Teorica ed Applicata (Research facility)
PARTNER STRUCTURE
<p>Among the founder members, CETA counts eminent personalities of the academic and scientific world like the Nobel prizes Abdus Salam and Carlo Rubbia. Public bodies (University of Udine, Province of Gorizia, Province of Pordenone, Municipality of Gorizia, Chamber of Commerce, Industry and Handicraft of Gorizia) and also several individual bodies are Members of CETA.</p>
ENERGY RELATED RESEARCH FIELD(S) [1, 2, 3, 4, 8]
<ul style="list-style-type: none"> • Bioenergy: Biofuels, Biogas, Biofuels • Solar energy, wind power, geothermal and hydroelectric energy • Energy efficiency in buildings • Energy programming and planning, Energy governance, Economic impacts
SERVICES
<p>Research activities, applied experimentation, programming and planning of innovative technological systems in different sectors. Also innovative technological systems planning, with particular reference to the applications in the sectors of water management and renewable sources for energy production.</p>

MAIN INSTITUTES

- [Institute for Renewable Energy](#)
 - [Solar Thermal Systems](#)
 - [Photovoltaic Energy Systems](#)
 - [Energy Efficient Buildings](#)
 - [Energy Strategies and Planning](#)

ENERGY RELATED RESEARCH FIELD(S) [1, 4, 8]

- [Solar Thermal Heating and Cooling Systems](#)

focuses on the combination of solar thermal systems with thermal and electrical heat pumps)

- [Photovoltaic Systems](#)

research group focuses on performance characterization and their integration into buildings

- [Energy Management in Buildings](#)

focuses on net-zero-energy buildings and the energetic refurbishment of historical structures)

- [Energy Strategies and Planning](#)

for cities and territories, CO₂ reduction roadmaps, smart cities modeling and monitoring

SPECIALIZED INFRASTRUCTURE

- Institute for Renewable Energy

4. Patent Analysis

To amplify the research situation in the Alps Adriatic region a benchmarking of existing research capacities of involved regions in the specific OECD sectors and in the field of environment related technologies to other European regions has been performed.

Patent activities in the years between 2000 and 2010 in the following OECD sectors have been analysed:

- (A) Biotechnology
- (B) ICT
- (C) Nanotechnology
- (D) Medical technology
- (E) Pharmaceuticals
- (F) Selected environmental related technologies divided into:
 - (F1) General Environmental Management (air, water, waste)
 - (F2) Energy generation from renewable and non-fossil sources
 - (F3) Combustion technologies with mitigation potential (e.g. using fossil fuels, biomass, waste, etc.)
 - (F4) Technologies specific to climate change mitigation
 - (F5) Emissions abatement and fuel efficiency in transportation
 - (F6) Energy efficiency in buildings and lighting

Besides selecting the appropriate sectors, in order to compare and subdivide the EU area in homogenous manner, it was furthermore necessary to adapt the NUTS classification where for each EU member country a hierarchy of three NUTS levels has been established by Eurostat. Within the regions, there are altogether big differences in population. Thus, patent applications were calculated as there were 1,000,000 inhabitants in each region.

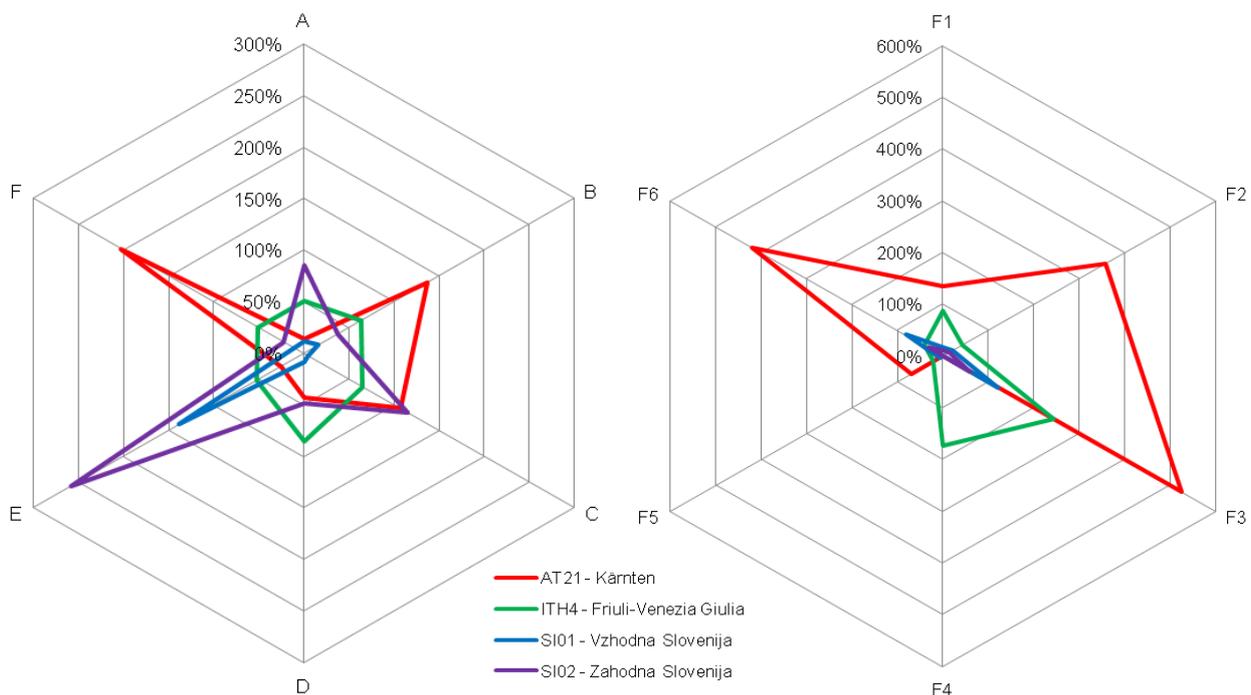


Figure 2: Comparison of patent applications in the Fields A-F (left) and between environmental related technologies F1-F6 (right) between Alps Adriatic NUTS 2 regions with the average NUTS 2 regions in Europe (normalized data)

The analysis of the left graph, when comparing the individual Alps Adriatic NUTS 2 regions with average NUTS 2 regions, comprise/shows that Carinthia is settled above the EU average in the fields of selected environmental technologies (F), ICT (B) and nanotechnology (C), while Friuli Venezia Giulia comes close to the EU average in the field of medical technology (D).

When focusing on the figure on the right hand side, the individual fields of “selected environment related technologies”, it is obvious that Carinthia is the most successful region compared to the other Alps Adriatic regions, since it exceeds the EU average in 4 out of 6 analyzed fields (F1, F2, F3, and F6). The most successful fields in Carinthia are visible in F3 ‘Combustion technologies with mitigation potential’, in F6 ‘Energy efficiency in buildings and lighting’ and in F2 ‘Energy generation from renewable and non-fossil sources’, exceeding the EU average by 5 and 4 times. Also the Friuli Venezia Giulia region exceeds the EU average in the field F3, but further the Friuli Venezia Giulia region goes beyond the EU average in the field F4 ‘Technologies specific to climate change mitigation’.

Patent activities in environmental technologies are the strongest in Carinthia, but the other regions are increasing their patent activities. The sector F3 ‘Combustion technologies with mitigation potential’ is a common field of strength, which mainly belongs to the activities of innovative companies in bioenergy technologies. The patent activities in F6 ‘Energy efficiency in buildings and lighting’ support the importance and potential of energy efficiency technologies. Surprisingly, a good performance in F2 ‘Energy generation from renewable and non-fossil sources’ is only visible in Carinthia. Nevertheless, an increased cooperation will also boost the other regions and strengthen the position of Carinthia, especially if the complementary competencies in material and energy storage technologies can be leveraged.

It is obvious that the ICT sector has evidently the most fruitful patent activity on all levels of analysis, due to its cross-sectional use. Although the Alps Adriatic regions are not comparable with the very best European regions, as large disparities between them exist, results nevertheless show that they are competitive in relation to the average NUTS 2 European regions in specific environment related technologies, where further common cooperation can be prospectively enhanced.

5. Derived potential common research areas

Based on the analysis of the company landscape and the competencies of the regional research institutions and a series of workshops and discussions the following list of potential research areas has been arranged. Although this list is kept short and simple, interdisciplinary aspects and overlapping between the listed main research areas can be seen.

- **Construction of Energy Efficient Buildings**
 - Building Envelope for new buildings or refurbishment of existing buildings
 - Including advanced insulation technologies (in roof, walls and floor), advanced transparent element-materials, building materials using recyclable materials, building materials obtained from natural sources, thermal storage materials
 - Renewable heating and cooling (RHC) for new buildings or refurbishment of existing buildings
 - Including more efficient heat pumps, thermal storage materials and technologies, advanced solar thermal systems, alternative refrigeration (Stirling cycles, brayton cycles, and acoustic, magnetic and thermal-electric technologies), Hybrid systems: Solar-thermally assisted heat pumps
 - Cross-cutting technologies
 - advance in materials, thermal energy storage, ICT and management systems
 - Supporting measures
 - Definition of energy efficient solutions for renovation, building Industry transformation, market transformation, acceptability by customers

- **Energy management in buildings and the grid**
 - Development and sustainability evaluation of novel overall microgrid and building energy management concepts including renewable energy resources, storage technologies, energy trading with the main grid, etc.
 - Integration of electrical and thermal energy management into one sustainable concept
 - Development and adaptation of novel sensor technologies and concepts for user behaviour, system, and grid monitoring
 - Development of hardware and software for identifying consumption behaviour using non-intrusive-load monitoring approaches
 - Integration of smart and legacy devices in smart microgrids
 - Introduction of novel control hardware for energy management
 - Concepts and protocol for communication between system components
 - Integration of predictive methods for energy production (weather forecast), consumption (user behaviour) and variable grid prices for optimal resource scheduling
 - Clustering of different building microgrids to whole neighbourhoods and evaluation of their potential for local resource production and consumption
 - Development of algorithms for the automatic determination of optimal goal-specific energy management strategies
 - Investigation of economic, legal, and user-acceptance aspect of such novel system technologies and finding of implementation possibilities

- **Bioenergy**
 - Woody biomass for combustion and heating
 - local woody biomass supply chains
 - sustainable production (biomass feedstock)
 - development and implementation of quality and sustainability standards
 - improving efficiency of biomass CHP systems
 - residential-scale low emission boilers
 - emission reductions
 - Biogas and biomethane from agricultural and municipal wastes
 - produce high biogas yields
 - electricity and heat co-generation
 - production of a very stable digestate
 - use of slurry and organic waste
 - syngas
 - security and safety of installations
 - distribution of bio-methane

- **Solar technologies**
 - Development of building-integrated PV systems
 - Improvement of efficiency and durability of PV modules
 - Optimization of PV-module and inverter manufacturing processes
 - Development of PV 2.0 (smarter production and new materials for PV-modules)
 - Combination of PV concepts with electrical storage concepts and energy management concepts
 - Combined concept for electricity and heat to optimize the energy consumption in households
 - Investigation of the advantages/disadvantages of east/west orientation of PV modules on facades
 - Modelling and characterization of PV systems at different altitudes
 - Optimal operation and control of PV systems in Microgrids
 - Establish legal and socially accepted frame work conditions for efficient energy sharing

- **Energy Storage**
 - Integration of sensor and control technologies for efficient battery monitoring and management
 - Development of concepts for overall microgrid systems, making the most efficient use of their storage capacity

- **Inter- and multidisciplinary aspects**
 - Enhanced use of ICT as cross-sectional technology
 - Combination of several energy sources and integral management system
 - Economic aspects
 - Ecological aspects
 - Legal aspects
 - User acceptance and user behaviour