

## Balancing demand and supply with new storage systems

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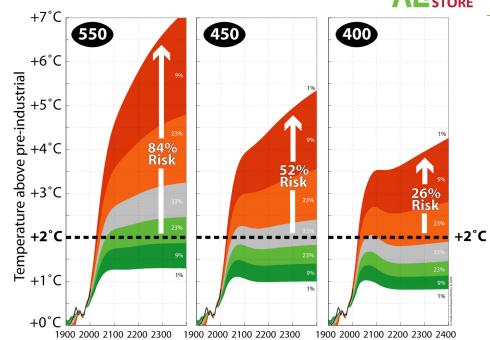
**400 ppm**

**280 ppm**

Carbon dioxide concentrations in the atmosphere, 1000-2014 A.D.  
Quelle: Scripps, ORNL und IPCC.



**0.8 degrees C**



The risk of overshooting two degrees

**280-350 ppm**  
survivable range

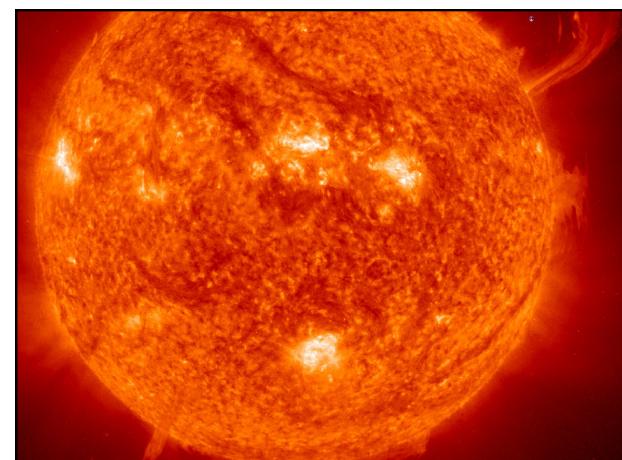
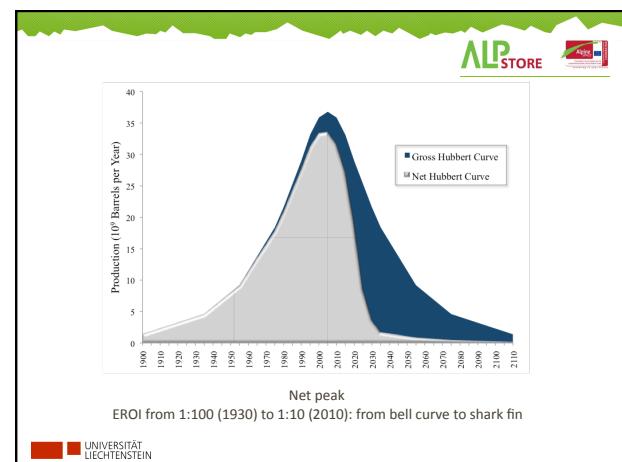
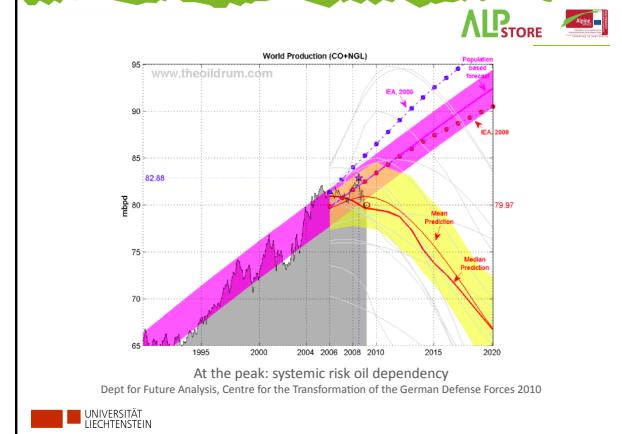


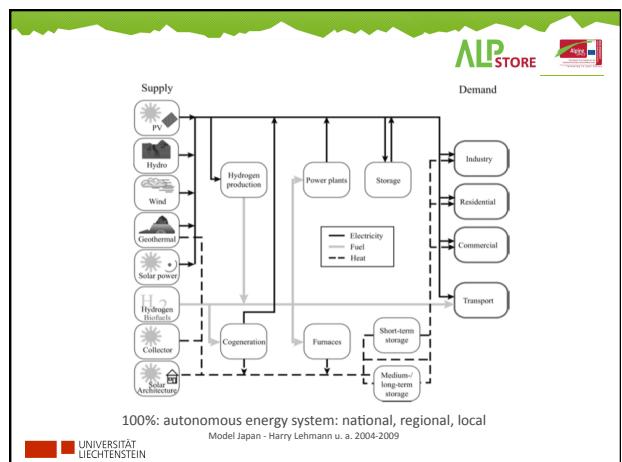
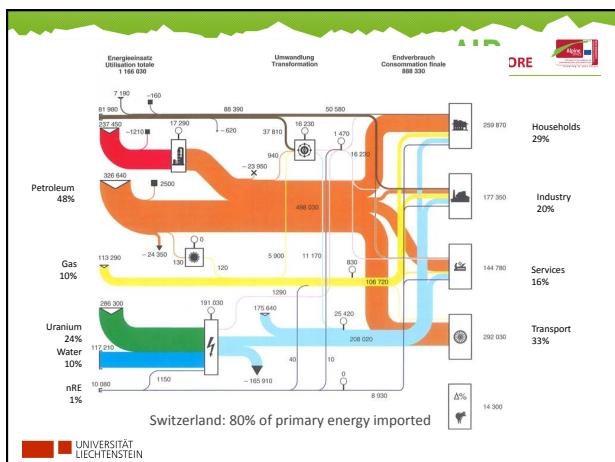
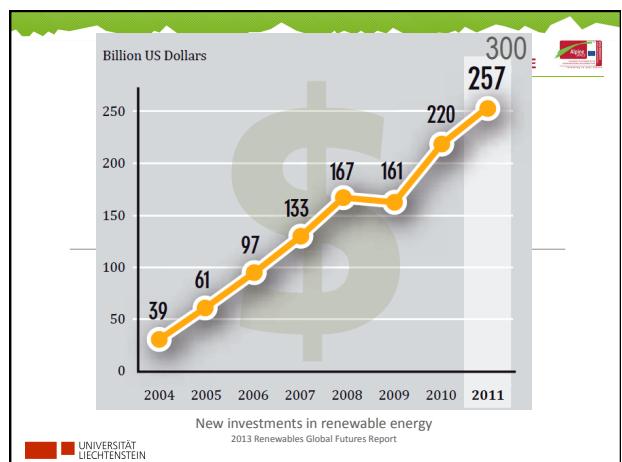
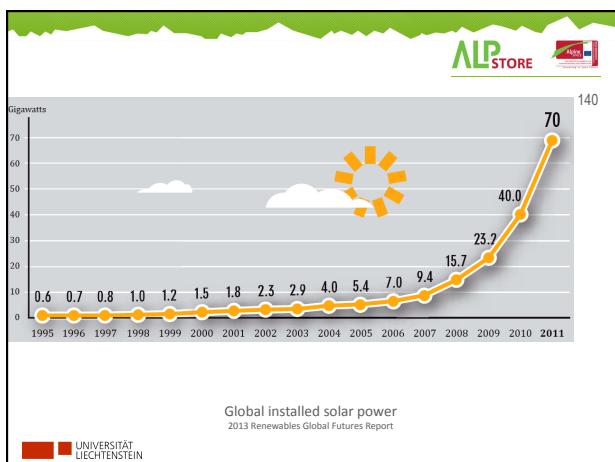
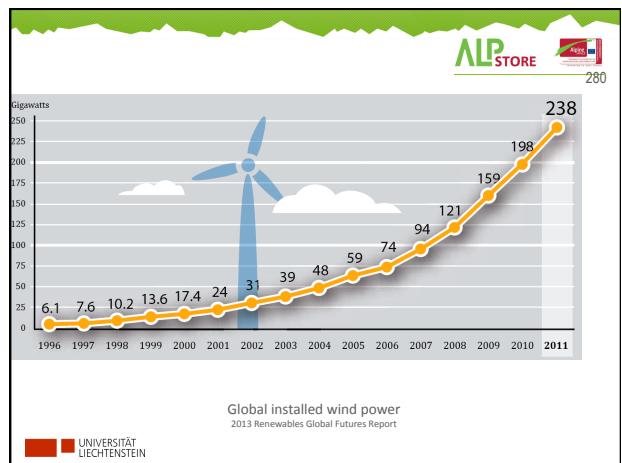
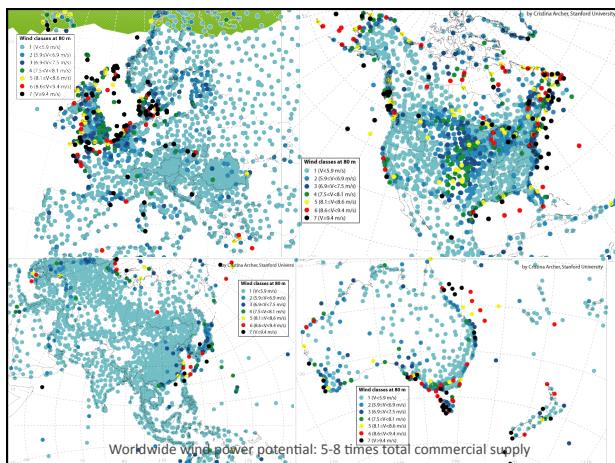
**2020**  
action horizon

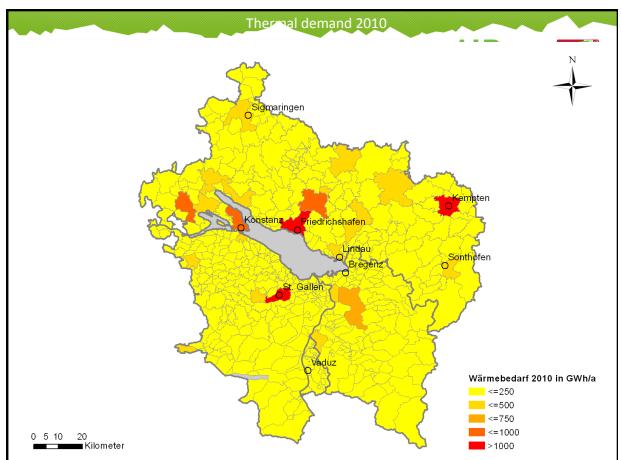
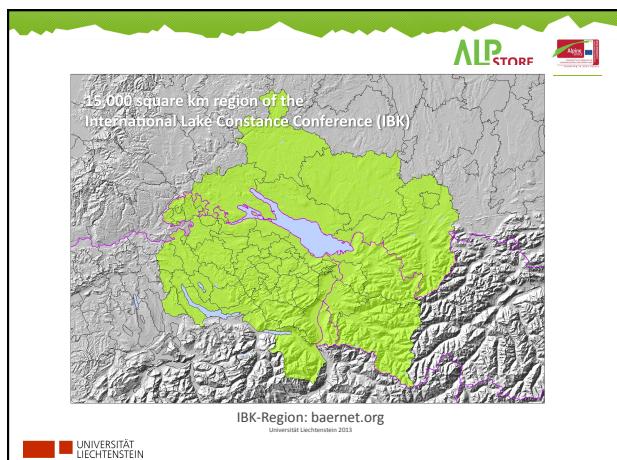
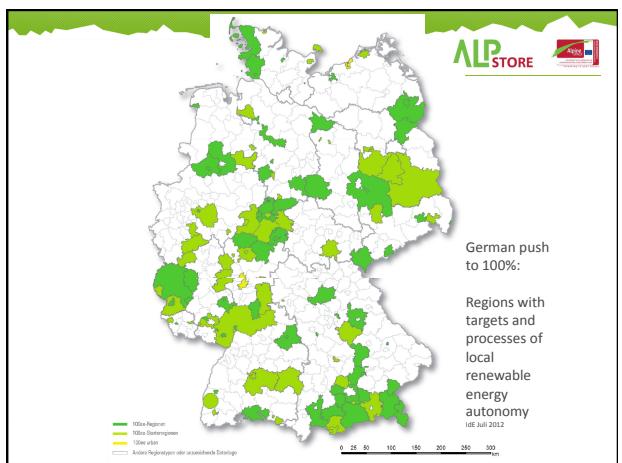
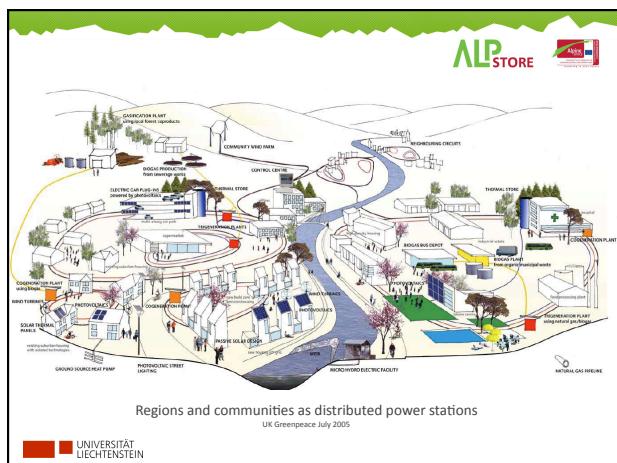
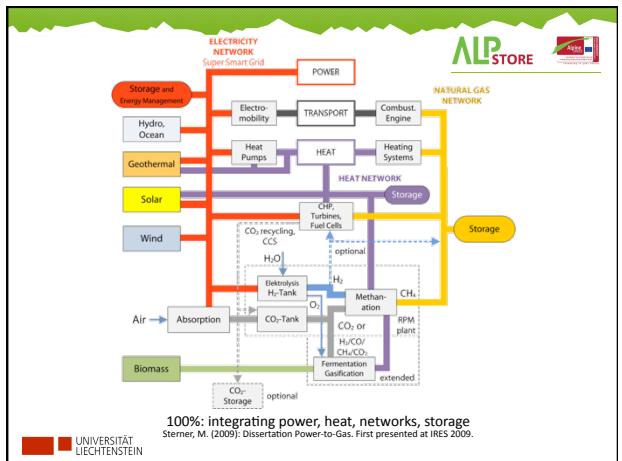
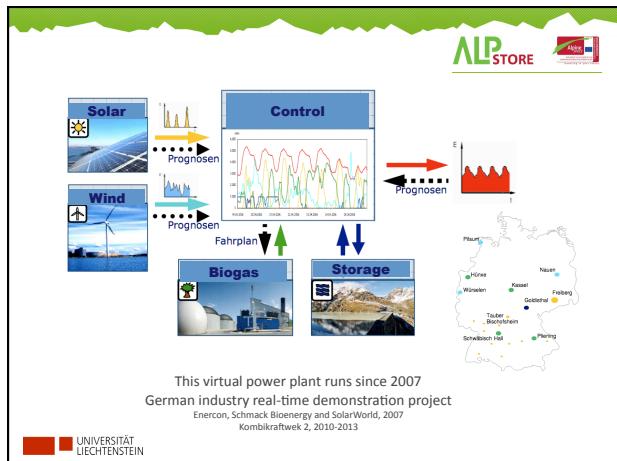


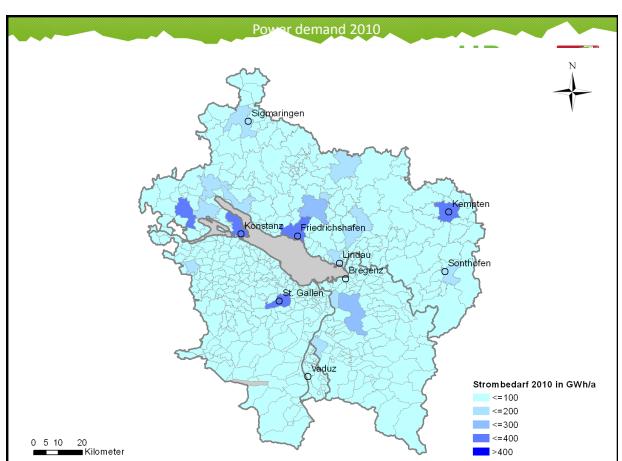
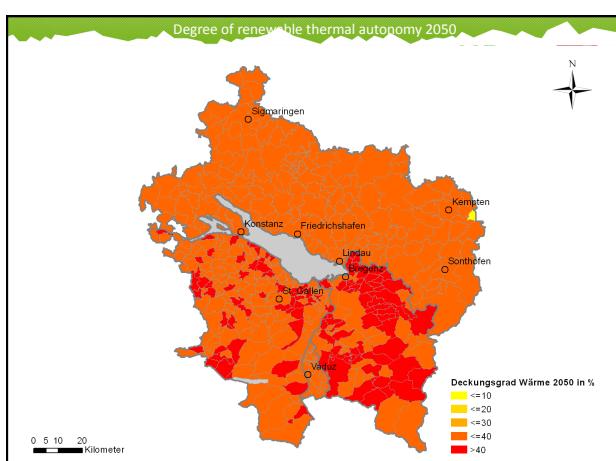
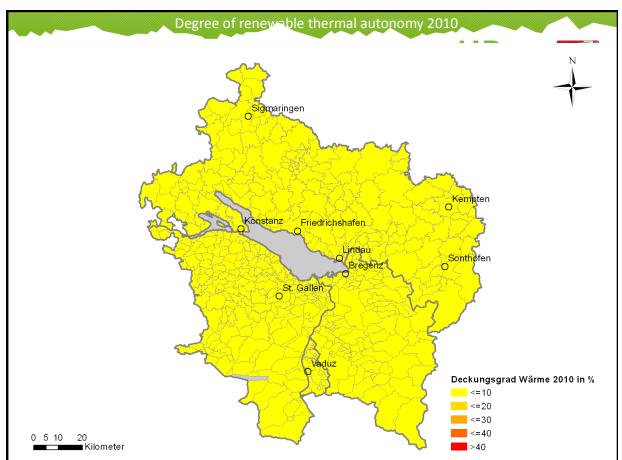
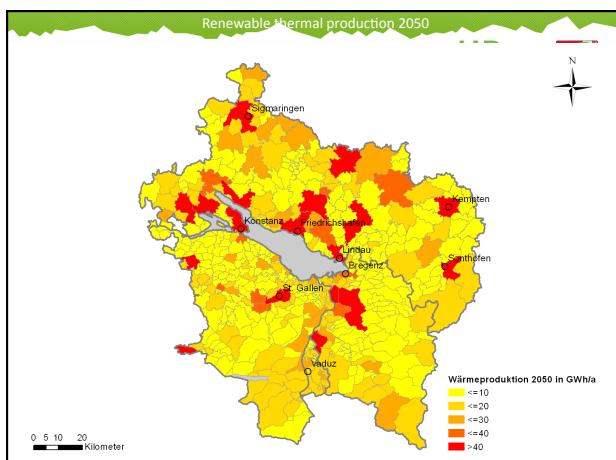
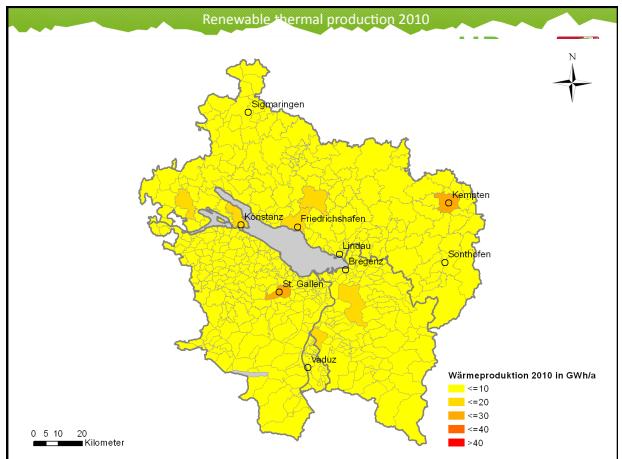
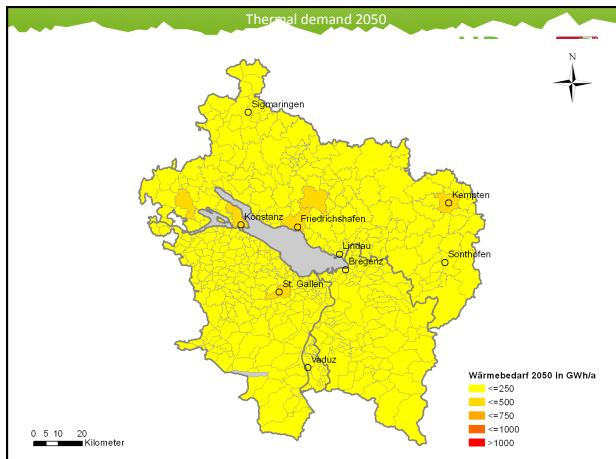
# 100% renewable

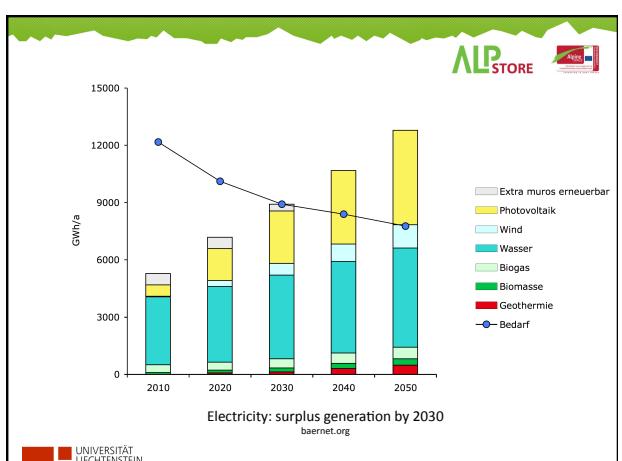
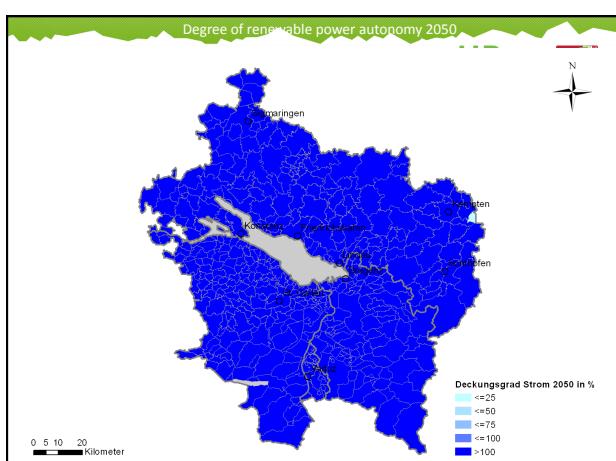
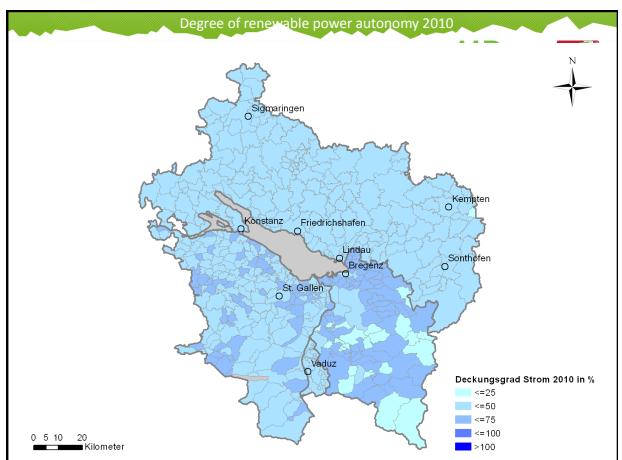
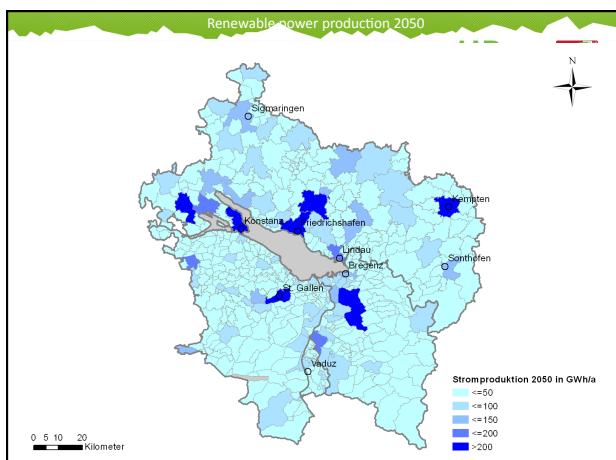
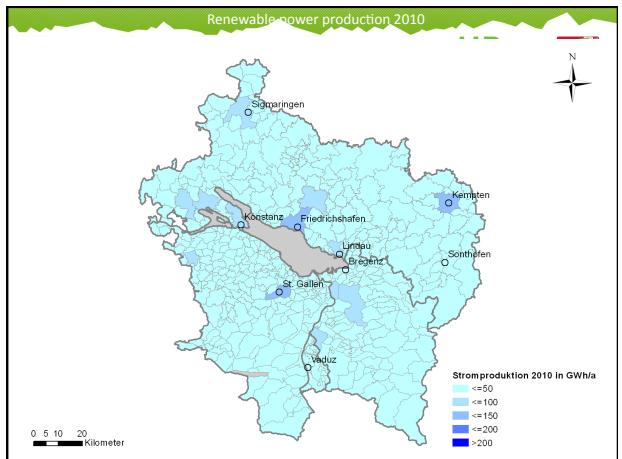
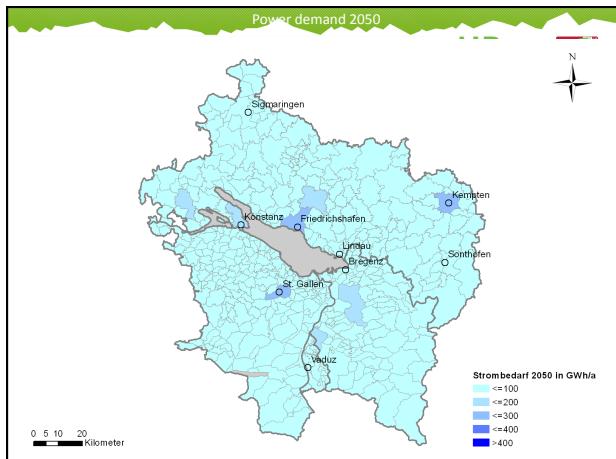
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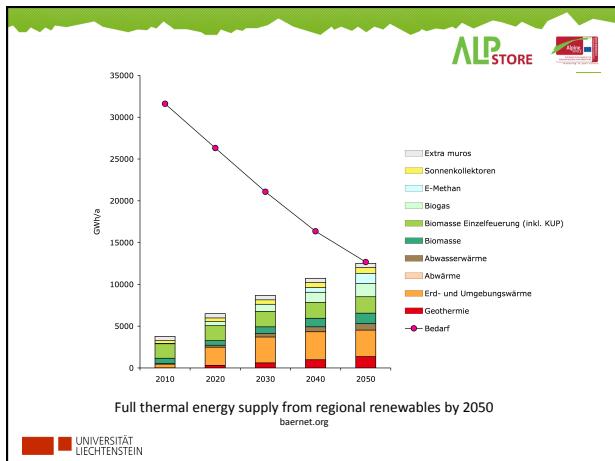




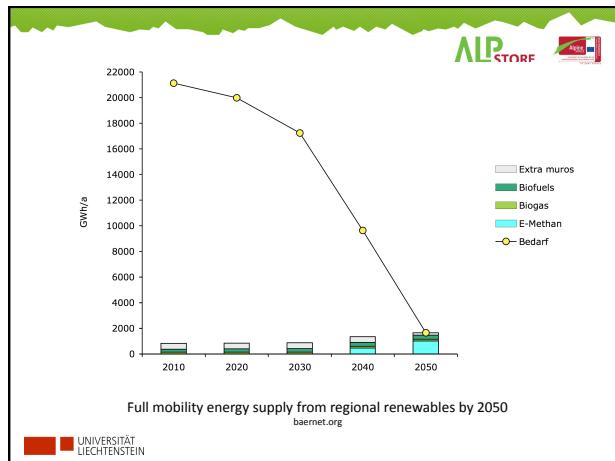




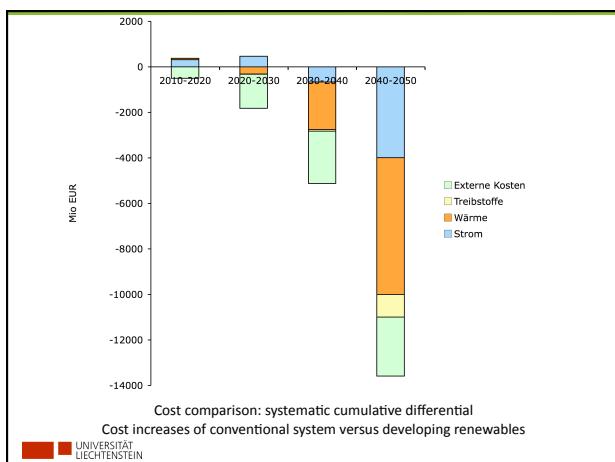




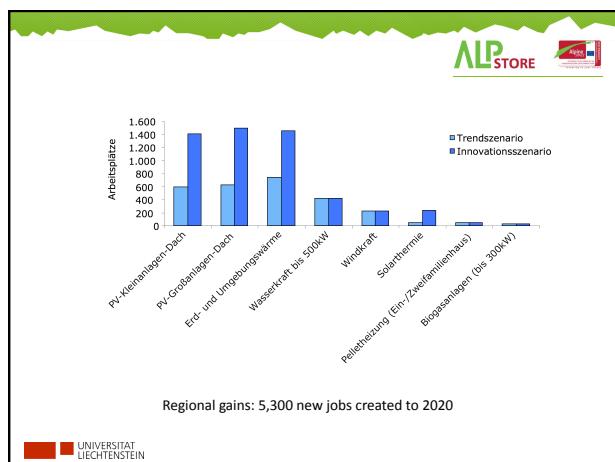
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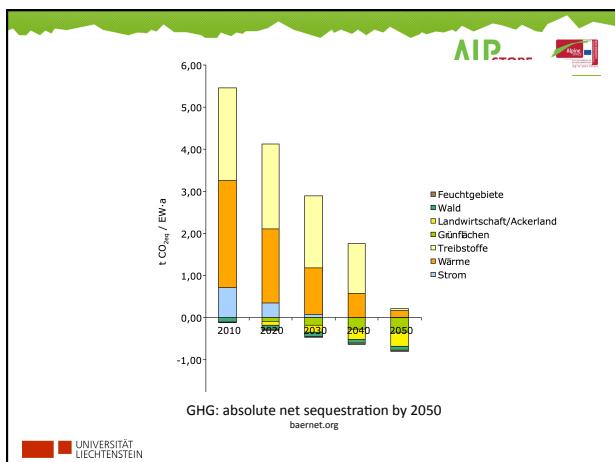
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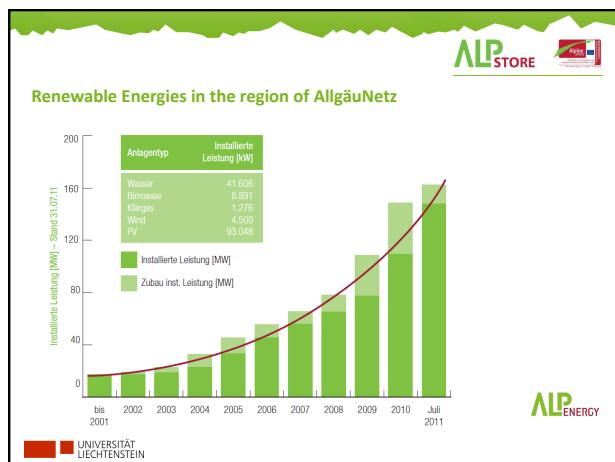
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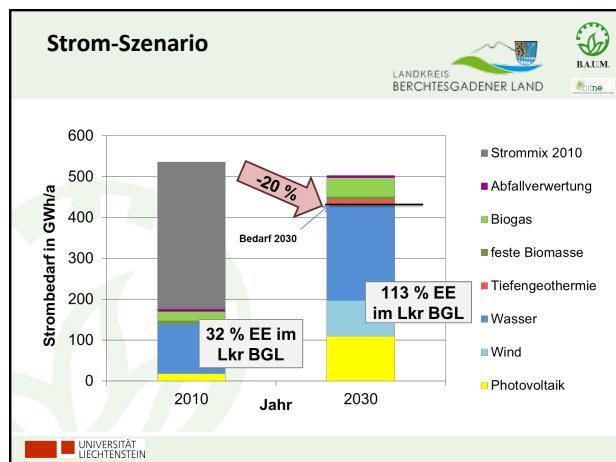
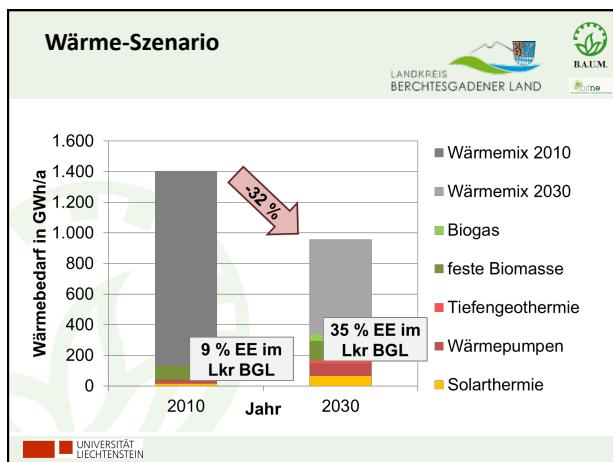
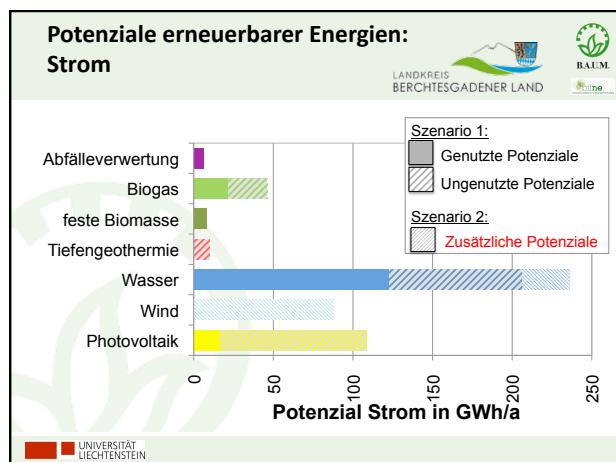
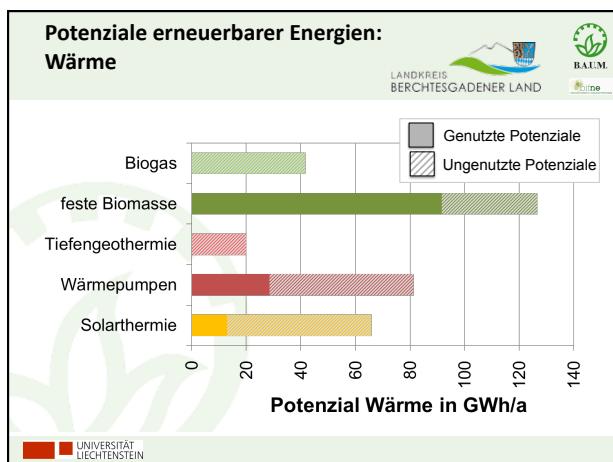
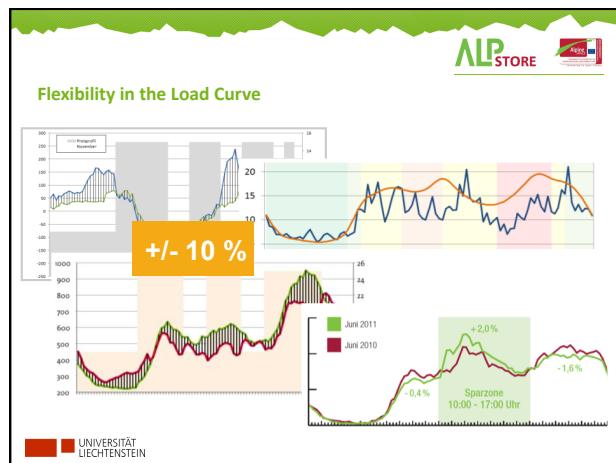
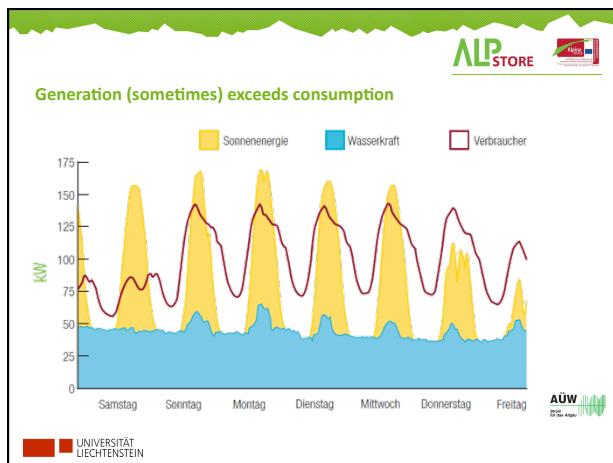
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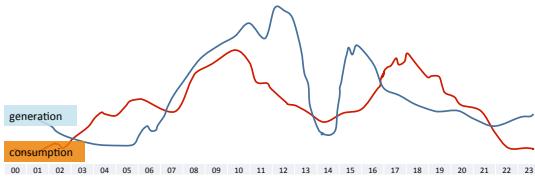
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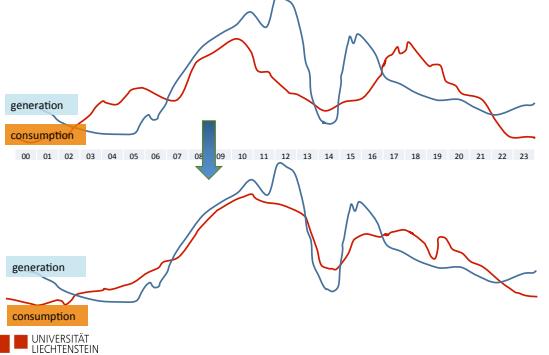


### The Challenge

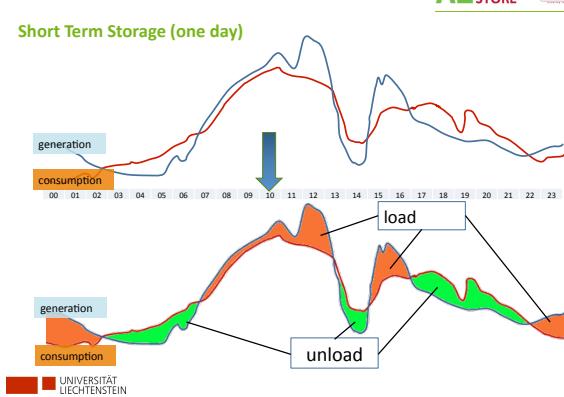


- Fluctuating generation from renewable energies
- Generation exceeding consumption at some points of time
- Stress on power grids - creating need to act
- Search for adaptive and cost efficient solutions
- Differing needs and frameworks in EU countries

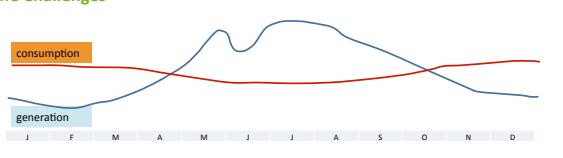
### Demandside Management (one day)



### Short Term Storage (one day)

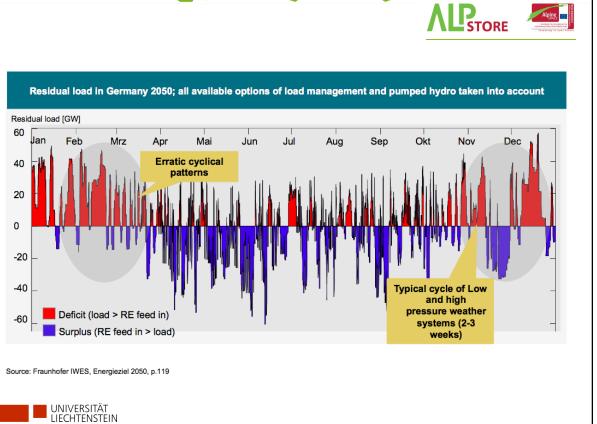
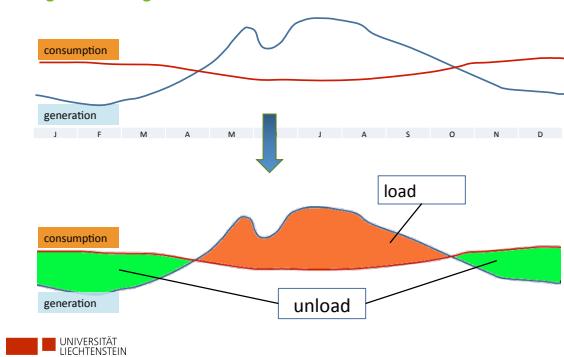


### The Challenges



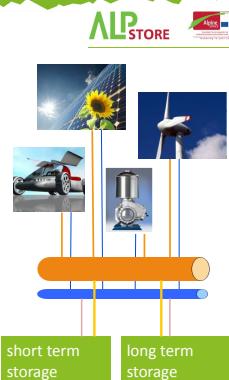
- Seasonal availability of renewable energies
- Long distances between generation and consumption sites
- Potentials of generation and demand side management too low
- Search for cost efficient storage solutions

### Long-term Storage



### The AlpStore Principle

- Connect stationary and mobile RES to the grid, managing generation and consumption
- Connect short term and long term storage systems to the grid and control them via ICT
- Implement algorithms to make best use of demand side management, generation side management and storage



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### AlpStore Project Brief

Topic:	Strategies to use a variety of mobile and stationary storage systems to allow for extended accessibility and the integration of renewable energy
Consortium:	20 partners and subcontractors in seven Alpine Countries (Germany, Austria, Switzerland, Italy, France, Slovenia and Liechtenstein)
Supporters:	over 70 formal observers
Budget:	3,3 Mio EUR
Funding:	76 % from ERDF/ Alpine Space Programme (equals 570 TEUR for German partners) 24 % national funds (equals 180 TEUR from German financing institutions)
Duration:	July 2012 through December 2014
Leadpartner:	B.A.U.M. Consult GmbH, München

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### University of Liechtenstein, Chair for Sustainable Spatial Development

- Leading the national profile development efforts, and centrally support the profiling, pilot and master plan initiatives
- Reporting on the most suitable energy storage systems for the Principality of Liechtenstein and developing concepts based on the renewable energy potential of the Alpine Rhine Valley
- Focusing on spatial dimensions of energy storage technology and their integration into our built environment, their spatial effects on urban design, but also their potential in combination with architecture
- Formulating recommendations for planners and political decisionmakers

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### A.L.O.T. s.c.ar.l. (Lombardy, Italy)

- Being responsible for Information, Publicity and Evaluation
- Developing a media communication plan, projecting the tools for project communication and tutoring the other partners in using and developing them during all project life time
- Defining indicators, measure instruments and assessment/validation criteria for all regional and transnational approaches

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### AGIRE Local Energy Agency (Mantova, Italy)

- Continuing improving the VPS installed during the AlpEnergy project in Suzzara
- Analyzing EV (cars, scooters and bikes) charging stations connected to the VPS and managed in order to respect the VPS energy forecast
- Analyzing biogas service station for connected to the VPS to increase the options for control, regulation and storage
- Analyzing new smart services for the sustainable mobility implemented by Euroimpresa.
- Implementing and connecting the existing VPS

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### Autonomous Region of Valle d'Aosta (Aosta, Italy)

- Analyzing the impact of electric mobility and stationary storage on the energy system, with regards to the possibilities, offered by these technologies, to better integrate in the grid
- Assessing the effects on the regional energy system and on the electricity distribution network, in different scenarios of technologies development and deployment and with particular emphasis given to the expected increasing diffusion of electric vehicles

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### Euroimpresa Legnano s.c.r.l. (Lombardy, Italy)

- Implementing an experimental small smart grid into "Tecnocity Altomilanese", a group of buildings, dedicated to productive activities and including offices, labs, sheds
- Monitoring the consumption of the internal users, compared to the internal energy production
- Developing a storage system (electrical vehicles and battery storage) in order to manage the energy drops and peaks
- Promoting the dissemination of storage systems in the Altomilanese Municipalities.

### University of Lugano, Advanced Learning Research Institute (Ticino, Switzerland)

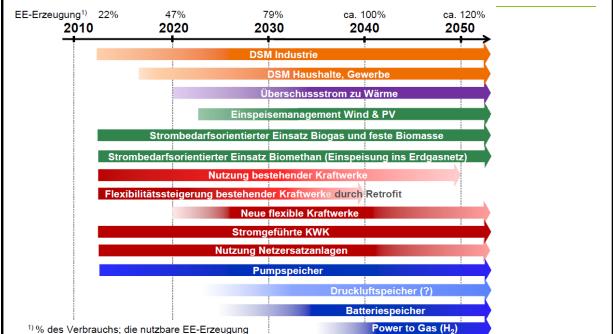
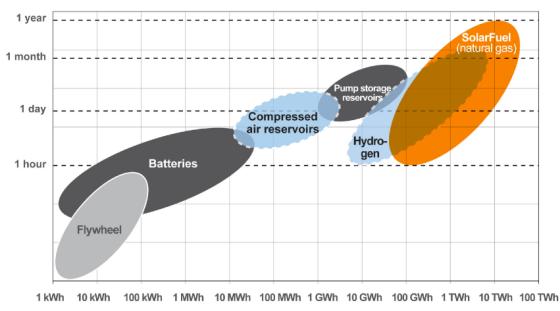
- Analyzing present industrial and academic state-of-the-art solutions for efficient stationary and mobile storages integration in power systems
- Defining system context, identification of stakeholders and their requirements
- Creating a reference model of the supporting ICT infrastructure as a result of iterative process of system engineering approach integrating research findings and pilot best-practices achievements

### Guiding Questions

- What are the **threats to the future energy system** in the Alpine Space?
- Which **needs for short and long term storage** will we face?
- Which storage technologies are and will be available?
- What can **mobility systems** contribute to the solution?
- What are the known **restrictions and benefits** of using storage technologies in the Alpine Space? (ie regional development, ecology, economy, acceptance etc.)
- How can appropriate technologies be **implemented today** in various Alpine frameworks (ie spatially, legally, politically) ?

### Assessment of Options

Technology	Market availability	Storage period	Storage volume	Response time	Local option
storage of energy before conversion (biogas)	+++	days	+	medium	+++
Power-to-Gas (methane in gas grid)	o	weeks	+++	quick	o
Power-to-Gas (hydrogen in gas grid)	o	weeks	+	quick	--
Power-to-Gas (hydrogen local)	--	days	-	quick	+
chemical storage (zeolite etc.)	+	days	o	slow	+
compressed air storage	+	weeks	o	medium	o
pump storage (regional in AS)	o	days	o	quick	++
pump storage (Scandinavia etc.)	+	weeks	++	quick	
fly wheels (small-sized)	+++	minutes	--	very quick	+++
fly wheels (large-sized)	--	weeks	o	very quick	o
mobile batteries (electric vehicles)	--	hours	-	very quick	+++
stationary batteries	o	days	-	very quick	+++



Bewertungskriterien: Kosteneffizienz, Potenzial, technische Reife

	2013 Ist	2013 Soll	2020	2030	2040	2050
Lastmanagement Industrie	gering	gering	mittel	mittel	mittel	mittel
Lastmanagement Haushalte, Gewerbe	null	null	gering	gering	mittel	mittel
Lastmanagement Wärmepumpen	null	gering	gering	mittel	mittel	mittel
Überschussstrom zu Wärme	null	gering <sup>1)</sup>	gering <sup>1)</sup>	gering	mittel	mittel
Einspeisemanagement Wind & PV	gering <sup>1)</sup>	gering <sup>1)</sup>	gering	mittel	hoch	hoch
Strombedarfsoorientierter Einsatz Biomasse	gering	hoch	hoch	hoch	hoch	hoch
Strombedarfsoorientierter Einsatz Biometan	gering	hoch	hoch	hoch	hoch	hoch
Nutzung bestehender Kraftwerke	hoch	hoch	hoch	mittel	gering	null
Flexibilitätssteigerung durch Retrofit	mittel	mittel	mittel	gering	gering	gering
Neu flexible Kraftwerke	null	null	hoch	hoch	mittel	mittel
Stromgeföhlte KWK	gering	hoch	hoch	hoch	hoch	hoch
Nutzung Netzersatzanlagen	gering	gering	mittel	mittel	mittel	mittel
Pumpspeicher	hoch	hoch	hoch	hoch	hoch	hoch
Druckluftspeicher	null	null	null	gering	(mittel)?	(mittel)?
Batteriespeicher	null	null	gering	mittel	mittel	mittel
Power to Gas (H2)	null	null	null	gering	hoch	hoch
Power to Gas (CH4)	null	null	null	gering	mittel	hoch

1) nur im Fall von Netzzugängen

Quelle: Norbert Krzikala, BET

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FINANCIAL TIMES DEUTSCHLAND

Ökostrom kommt ohne Speicher aus

VDE

Studie: Energiespeicher für die Energiewende

- Speicherbedarf erst ab EE > 40 % relevant
- bis 40 % Ausgleich durch Flexibilität in der Erzeugung (v. a. Biomasse-BHKW) und im Verbrauch
- in näherer Zukunft Speicher vorwiegend zur Einsatzoptimierung thermischer Kraftwerke (CO<sub>2</sub>-Reduktion!)

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Spatial requirements and solutions



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Storage in Building Elements



ROSA ZUKUNFT

UNIVERSITÄT LIECHTENSTEIN

Energy Bunker Wilhelmsburg IBA Hamburg



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Energy Bunker Wilhelmsburg IBA Hamburg



Bauantrag (Änderungsantrag)

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Mein Haus ist meine Tankstelle – deutsches Forschungsprojekt



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.... a STORM is brewing



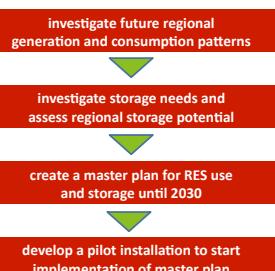
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## Smart Storage and Mobility

A model to develop holistic solutions to increase regional RES supply and balance through appropriate buffering means.

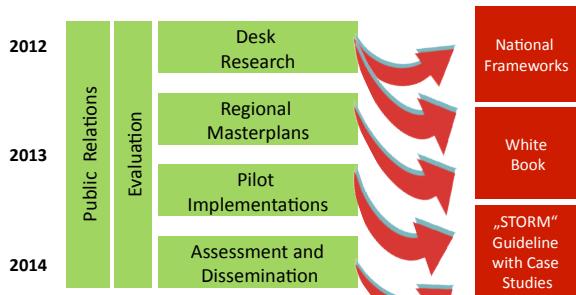
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### STORM Workflow



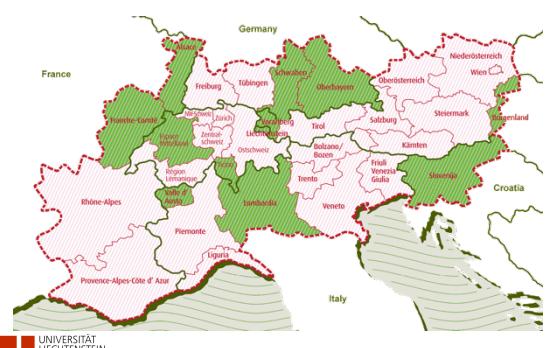
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### Work Process and Key Deliverables



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### ALPStore Project Regions



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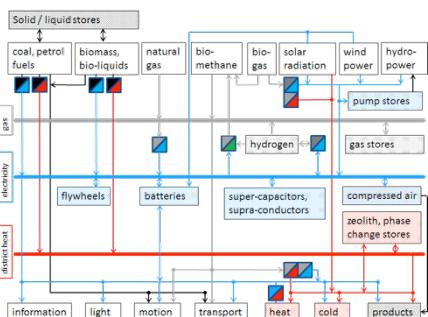
### Who shall use STORM?

- Local and regional power suppliers and grid operators
- Planning departments in local and regional administrations
- Investors and regional business entities
- Scientific institutes

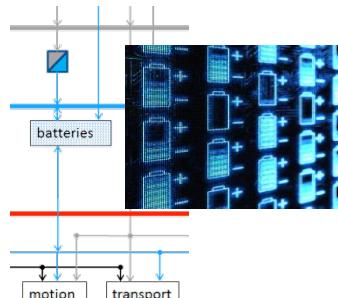
### AlpStore Goals

- To show how with **reliable energy provision** for Alpine regions as attractive habitats, working spaces and recreational sites.
- To help **develop holistic solutions** to regional RES supply and balance.
- To test storage technologies in **remote settlements** (e. g. small villages Slovenia and France) and **combined business and living areas** in metropolitan areas (e. g. Euroimpresa in Legnano) can become self-contained **energetic cells** on the grid.
- To show how **integrating mobility and energy** supply enables the establishment of entrepreneurial collectives managing local generation, storage and consumption cells.
- To **involve research and technology transfer institutions** and a large group of observers as supporters for intelligent regional master plans and implementation concepts.

### Energy Pathways and Storage



### Stationary and Mobile Batteries

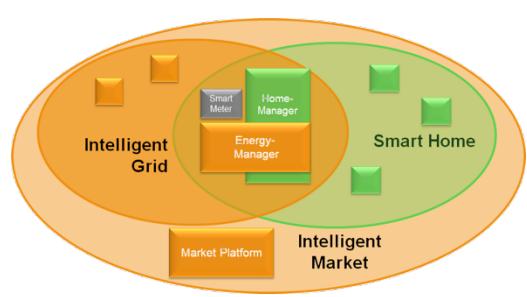


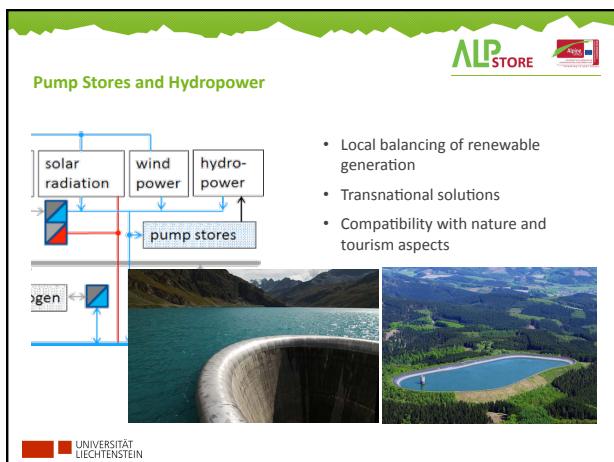
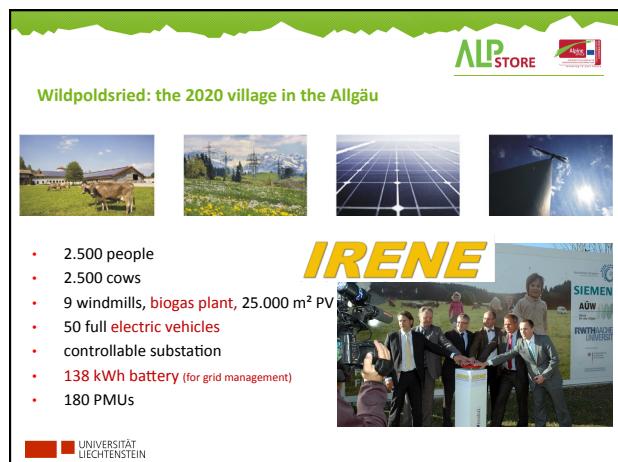
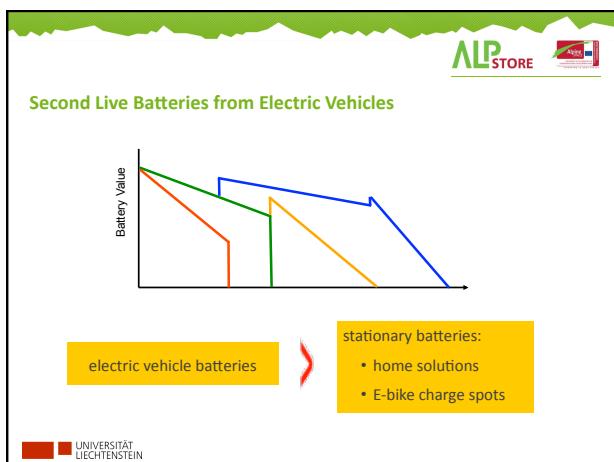
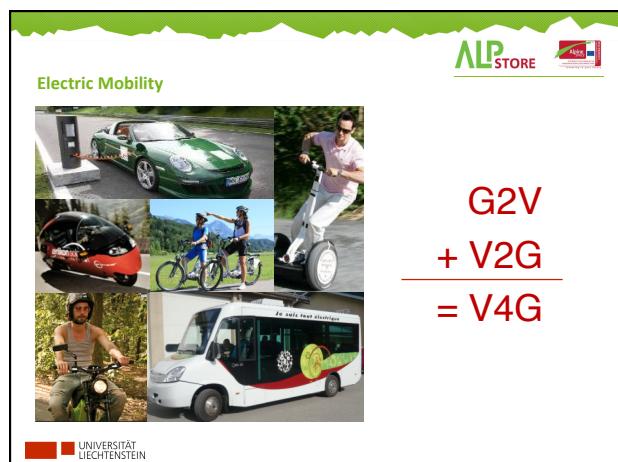
### My Home – My Energy System?



- grid parity of PV
- decentral energy management
- energy autarky

### Smart Buildings on Smart Grids





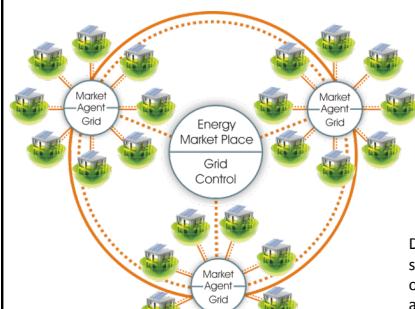
## Hydro power meets urban design (Kempten)

**ALP STORE**



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## Dezentralised Systems for a Secure Supply

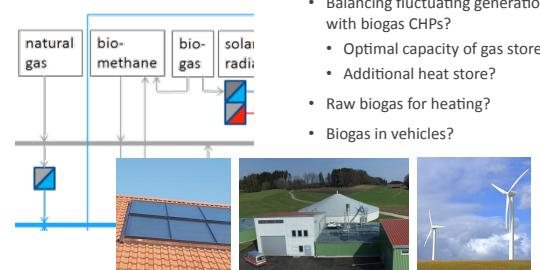


Decentralized steering structures consisting of object agents, grid agents and market agents

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**ALP STORE**

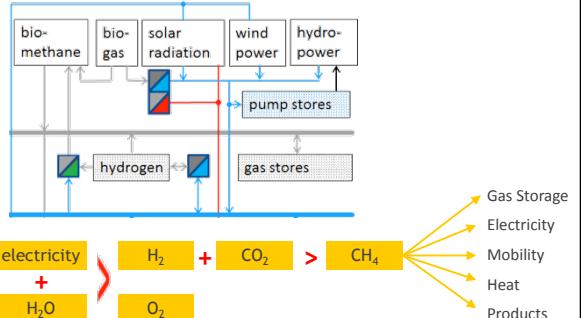
## Biogas



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- Balancing fluctuating generation with biogas CHPs?
- Optimal capacity of gas store?
- Additional heat store?
- Raw biogas for heating?
- Biogas in vehicles?

## Power to Gas: Hydrogen and Methane

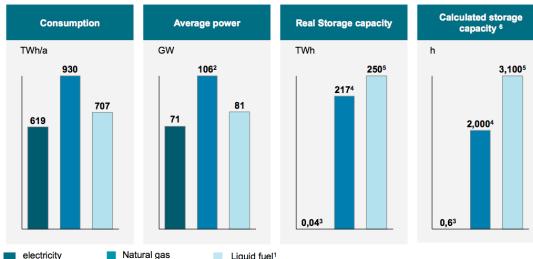


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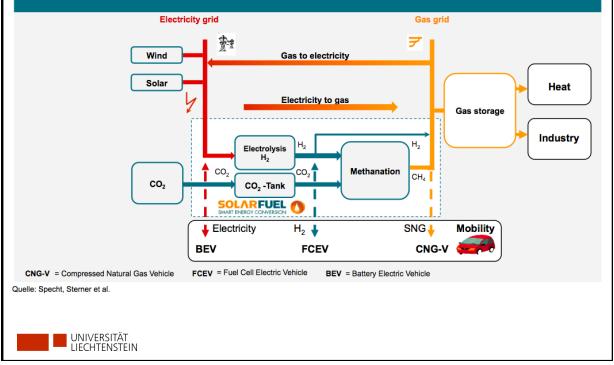
**ALP STORE**

## Energy consumption and storage capacity in Germany, 2008



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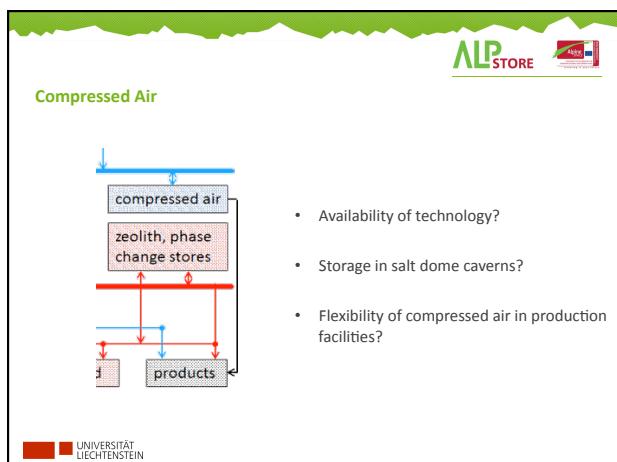
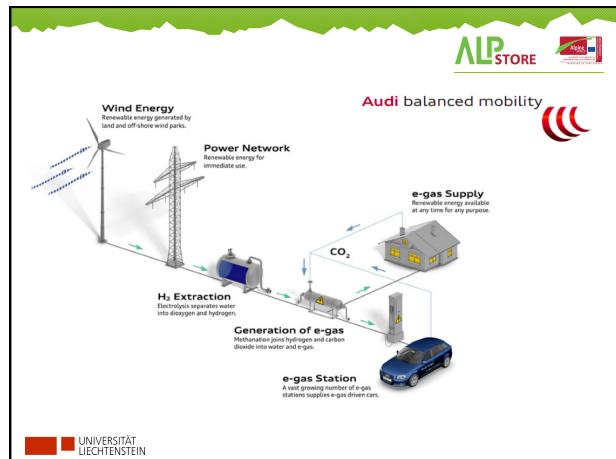
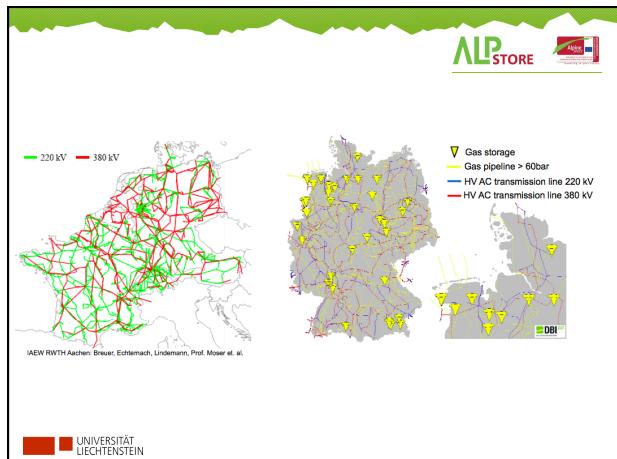
## Electricity, hydrogen and SNG can be used to provide all necessary functions



CNG-V = Compressed Natural Gas Vehicle      BEV = Battery Electric Vehicle      FCEV = Fuel Cell Electric Vehicle

Quelle: Specht, Sterner et al.

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**STORM Guidance for Investors (draft)**

- Continue installing RE and **don't wait for better storage systems**.
- In Germany, make use of the **federal support programme** for battery systems.
- Complement new biogas plants with **up-grading facilities**.
- Complement existing biogas plants with **further CHP and extended biogas storage tanks**, operate the plants in a flexible mode and **sell the electricity via an aggregator**.

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**STORM Guidance for Regional Energy Utilities (draft)**

- Invest yourself in renewable electricity generation.
- Optimise the installation of new generation facilities **in pattern with the grid extension**.
- Invest in **pilot storage facilities** to gain experience with different storage technologies.
- Develop **new service options and business models** to manage smart buildings and factories.
- Participate in projects to gain a better understanding of **connecting intelligent objects and vehicles** to the distribution grid, using their flexibility potentials.
- Support the development of a **new design of the energy market**.

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**STORM Guidance for Regional Authorities (draft)**

- Establish an **integrated regional energy development plan** for generation, energy saving, demand side management and storage.
- Motivate citizens and companies to invest in energetic **refurbishment of buildings** and use of renewable energy.
- Support established enterprises and startup companies** to develop and install intelligent solutions in residential and business buildings.
- Foster the development of sustainable mobility patterns including **gas or electricity driven vehicles**.
- Allow for **storage technology** when it contributes **balancing services** for the optimal operation of the local supply and consumption system.

**SEAP Alps**  
Sustainable Energy Action Plans

**PUMAS**  
PROFESSIONAL USE OF MOBILITY AS A SERVICE

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