
www.alpstore.info

Ludwig Karg
B.A.U.M. Consult GmbH (Leadpartner)
Future under construction
When is a good moment for the turn?

Now!
Goals are set

2°
2 t
2 m
A new era of energies

era of fire

era of power
The Future of Energy Supply

[Diagram showing various energy sources like nuclear, solar, wind, biomass, coal, natural gas, water, and oil, with a triangle labeled "volatile & decentral" and another labeled "triangle of hope"]
Generation exceeding Consumption

![Graph showing generation exceeding consumption for different days of the week, with categories for consumption, solar, water, and biogas.](image)
Adapting Consumption to Generation

![Graph showing consumption, solar, water, and biogas generation over a week.](image-url)
Curtailment

- **consumption**
- **solar**
- **water**
- **biogas**

*Graph showing daily energy consumption, solar, water, and biogas production over a week.*
Flexible Production ...

- **Consumption**
- **Solar**
- **Water**
- **Biogas**

**Power (kW)**

- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Sunday

... plus Storage

![Graph showing consumption, solar, water, and biogas over a week]

- **Consumption**
- **Solar**
- **Water**
- **Biogas**

**KW**

- Monday
- Tuesday
- Wednesday
- Thursday
- Friday
- Saturday
- Sunday

Regional Value Added

material and energy flow

financial flow

potentials
Ancestors and Successors
AlpStore Project Regions
**AlpStore Project Brief**

**Topic:** Strategies to use a variety of mobile and stationary storages to allow for extended accessibility and the integration of renewable energies

**Consortium:** 20 partners and subcontractors in all 7 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
24% national funds

**Runtime:** July 2012 through April 2015

**Leadpartner:** B.A.U.M. Consult GmbH, München

[alpstore@baumgroup.de](mailto:alpstore@baumgroup.de)
Kickoff in Jezersko in Slovenia
A dynamic team with lots of energy
A dynamic team with lots of energy
Energy Pathways and Storage
Cross Energy Carrier Synergies

- Power grids
- Gas grids
- Heat grids
- Mobility networks
Use Cases for Storage

- Storage as part of energy management on properties (home, enterprise, district)
- Storage as a means to better manage regional energy supply
- Mobile storage (electric vehicles) as a means of balancing the electricity grid
Energy Pathways and Storage
Stationary and Mobile Batteries

- Smart Homes
- Smart Factories
- Smart Mobility
- Smart Grids
My Home - My Energy System?

- grid parity of PV!
- decentral energy management ...
- energy autarky?
Smart Buildings on Smart Grids

Intelligent Grid

Smart Meter

Home-Manager

Energy-Manager

Smart Home

Market Platform

Intelligent Market

Electric Mobility

G2V + V2G = V4G
Second Live Batteries from Electric Vehicles

- electric vehicle batteries
- stationary batteries:
  - home solutions
  - E-bike charge spots
Energy Pathways

[Diagram showing various energy pathways involving solid/liquid stores, coal, petrol fuels, biomass, bio-liquids, natural gas, biogas, biodiesel, solar radiation, wind power, hydro-power, pump stores, gas stores, hydrogen, flywheels, batteries, super-capacitors, supra-conductors, compressed air, zeolith, phase change stores, information, light, motion, transport, heat, cold, and products.]
Pump Stores and Hydropower

- Local balancing of renewable generation
- Transnational solutions
- Compatibility with nature and tourism aspects
Energy Pathways
Biogas

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

Solid / liquid stores
- coal, petrol fuels
- biomass, bio-liquids
- natural gas
- bio-methane
- solar gas
- wind power
- hydro-power

Gas
- flywheels
- batteries
- super-capacitors, supra-conductors
- compressed air
- zeolith, phase change stores

Electricity

District heat
- information
- light
- motion
- transport
- heat
- cold
- products
Power to Gas: Hydrogen and Methane

\[ \text{electricity} + H_2O \rightarrow H_2 + O_2 \]

\[ H_2 + CO_2 \rightarrow CH_4 \]

Gas Storage
Electricity
Mobility
Heat
Products
Storing in the gas grid
Energy Pathways

[Diagram showing various energy pathways including solid/liquid stores, gas, electricity, district heat, information, light, motion, transport, heat, cold, and products.]
Compressed Air

- Availability of technology?
- Storage in salt dome caverns?
- Flexibility of compressed air in production facilities?
Storage periods and market availability
(revised version M. Stöhr)

- **state of art**
  - lead-acid batteries
  - Li-ion batteries
  - flywheels
  - pumped-hydro
  - hot water
  - high temperature heat
  - hydrogen/power-to-gas
  - compressed air energy storage
  - redox-flow batteries
  - chemicals

- **market launch**
  - 1 second
  - 1 minute
  - 1 hour
  - 1 day
  - 1 week
  - 1 month

- **Technology readiness level (TRL)**

- **R&D research**
  - field test
  - D&D developed
  - market launch

- **storage period**
  - power quality & frequency control
  - peak shaving
  - short-term storage
  - seasonal storage

- **fields of application**
  - thermal storage system
  - batteries
  - mechanical energy storage
  - chemical energy storage

**island self-sufficient**
Opportunities for the Suppliers of Today and Tomorrow
Storage needs and options

- Do we need storage for using renewable energies?
- Do we rather need short-term or long-term storage?
- Since storing creates losses: does it make sense at all?
- Can pumped hydropower meet long-term storage needs?
- Is power-to-heat a solution for the near future?
- Can storage optimize energy management in buildings?
- What could reasons be to deploy storage today?
- To what extent can batteries foster local energy autarky?
Storage needs and options

- Do we need storage for using renewable energies?
- Do we rather need short-term or long-term storage?
- Since storage is necessary for:
  - the more intelligence in the grid the less demand for storage
  - emphasis on demand side management for < 40% renewable energy in the grid
  - long term storage need with > 80% renewables
- Can pump systems be applied?
- Is power-to-gas a possible option?
- Can storage be combined with wind or solar?
- What could be the long term solution?
- To what extent will new storage technologies be developed for renewables?
Storage needs and options

- **Do**
  - increased supply security
  - more cost effective electricity supply
- **Do**
  - renewables with storage below electricity purchase tariffs
- **Since**
  - cutting power peaks, thus saving electricity purchase costs
- **Can**
  - stabilization of electric grid
- **Is possible**
  - postponing grid reinforcement and deferral of investments
- **Can**
  - obtaining experience with new storage technology

**What could reasons be to deploy storage today?**

**To what extent can batteries foster local energy autarky?**
Storage needs and options

- Do we need storage for using renewable energies?
- Do we rather focus on power-to-x?
- Since storing energy is expensive, can pumped hydro be a solution?
- Is power-to-x a solution for the near future?
- Can storage be integrated into the power grid?
- What could be the economic benefits?
- To what extent can batteries foster local energy autarky?

• absolute or relative energy autarky?
• full autarky desirable in cases of emergency
Readiness of technology

- Which technologies are mature and cost-effective?
- What is the price perspective of batteries?
- Could flywheels provide options for medium and long-term storage?
- To what extent can biogas meet the regional energy demand?
- When will be power-to-gas an option?
Readiness of technology

- Which technologies are mature and cost-effective?
- When will be power-to-gas available?

regional energy demand?
Readiness of technology

- Which technologies are mature and cost-effective?
- What is the price perspective of batteries?

- further significant cost decrease expected
  (for self-supply: 10 ct/kWh in 2020 and 5 ct/kWh in 2030)

Allgäu: batteries in private homes
Readiness of technology

- few percent in total, locally significantly higher
- equip with gas and heat stores!

- To what extent can biogas meet the regional energy demand?
- When will be power-to-gas an option?
Mobility and storage

- Are fully electric and hybrid vehicles an option for sustainable mobility?
- Which actions will drive the take up of an electric mobility plan?
- Can batteries of electric vehicles be used to store excess power from wind and PV?
- Will charging electric vehicles jeopardize grid stability and energy supply?
- Are there long-term sustainable alternatives to electric mobility?
Mobility and storage

- Are fully electric and hybrid vehicles an option for sustainable mobility?
- Which actions will drive the take up of an electric mobility plan?

- introduce in vehicle fleets!
- offer advantages such as free parking at electric vehicle charging stations

Brescia: network of charging stations
**Mobility and storage**

- same as any household appliance
- no fast charging on private sites!
- controlled charging!

Mantova: extra storage with fast chargers!

- Will charging electric vehicles jeopardize grid stability and energy supply?
- Are there long-term sustainable alternatives to electric mobility?
**Mobility and storage**

- Are fully electric vehicles an option for sustainable mobility?
- Which actions are required to support electric mobility?
- Will charging electric vehicles improve grid stability and reliability?
- Can batteries of electric vehicles be used to store excess power from wind and PV?
- Gas driven cars an option with power-to-gas
- Hydrogen mobility quickly evolving

**Belfort: getting out of lab with hydrogen!**
Environmental impacts

- Is there a recycling option for batteries?
- Will there be enough natural resources to build batteries?
- Can batteries receive a second life?
- Does biogas storage smell and inadvertently hassle its neighbourhood?
- Is there a danger for natural or biogas stores to explode?
Environmental impacts

- Is there a recycling option for batteries?
- Will there be environmental damage if we build batteries?
- Can batteries really help to improve the environment?
- Does biogas storage smell and inadvertently hassle its neighbourhood?
- Is there a danger for natural or biogas stores to explode?

- only in cases of malfunction
- better handling and storage of the substrate strongly reduces the problem
Regional benefits

- To what extent can renewable energies and local storage foster the economy in a region?
- How can local SME`s benefit from storage development and deployment?
- Are there specific relations between energy storage and tourism?
- Which links exist between energy storage and health?
Regional benefits

- To what extent can renewable energies and local storage foster the economy in a region?

- value creation relocated into the region
- enterprises to optimise their energy purchase
- SME to benefit from storage development and deployment

Regional benefits

- underlining the sustainability of touristic offerings
- Baedeker: travel guide to RE installations

- Are there specific relations between energy storage and tourism?
- Which links exist between energy storage and health?
Communication aspects

- How can I motivate fellow politicians to support the local energy transition?
- How can we make energy storage attractive for energy suppliers and grid operators?
- What are means to make consumers interested in storage technologies?
- Where do I find latest information on storage topics?
Communication aspects

- How can I motivate fellow politicians to support the local energy transition?
- How can we make energy storage attractive for energy suppliers and grid operators?
- What are means to make consumers interested in storage technologies?
- Where do I find latest information on storage topics?
Communication aspects

- How can we support politicians?
  - “Self-supply with RE maximised by storage saves electricity purchase costs.”
- How can we make storage attractive to operators?
  - make storage visible!

- What are means to make consumers interested in storage technologies?
- Where do I find latest information on storage topics?
Decision process

- How can we change the framework conditions on a local or regional level?
- Can a self-sufficient regional energy system be implemented without subsidies?
Decision process

- How can we change the framework conditions on a local or regional level?
- Can a self-sufficient regional energy system be implemented without subsidies?

- Yes, it can ...
- ... with citizen involvement
Joining Forces

citizens

local government

public administration
STORM
**Smart Storage and Mobility**

A model to develop and decide upon holistic solutions to increase regional RES supply and outbalance volatility with appropriate buffering means.
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
STORM Workflow

1. Investigate future regional generation and consumption patterns
2. Investigate storage needs and assess regional storage potential
3. Create a master plan for RES use and storage until 2030
4. Develop a pilot installation to start implementation of master plan
Work Process and Key Deliverables

2012
- Public Relations
- Desk Research

2013
- Evaluation
- Regional Masterplans
- Pilot Implementations

2014
- Assessment and Dissemination

National Frameworks
White Book
„STORM“ Guideline with Case Studies
Results of AlpStore

- White Book
- Guidelines for Decision Makers
- Guidelines for Planners and Practitioners
- Case Studies on Pilot Implementations (local language)
- Regional Storage Masterplans
- Videos on Regional and Technological Approaches (local language)
- Study for Academia

www.alpstore.info