February, 3rd, 2010

Energy Storage: needs and opportunities for dedicated actions at European level

Background

In the framework of the European Strategic Energy Technology Plan (SET-Plan) implementation, the Energy Storage has been identified as a critical technology for the transition to and operation of a more sustainable and low carbon European energy system. Therefore, in the aim of matching the most appropriate set of policy actions to the needs of different Energy Storage technologies at different stages of the development and deployment cycle, the European Commission has encouraged the European industry and research community to set up a European Task Force on Energy Storage. Its aim is to arrive at a shared European vision on the role of Energy Storage in power applications and to identify measures that may be needed by the sector to maximise its contribution in the implementation of the SET-Plan, in particular through its European Industrial Initiatives, towards building the future European energy system.

Working towards this objective, a European Workshop on Energy Storage was organised under the auspices of the Information System of the SET-Plan (SETIS) with the involvement of the European Commission's Joint Research Centre (DG JRC), Directorate General for Research (DG RTD) and Directorate General for Transport and Energy (DG TREN) in Brussels on November 27th, 2009.

To prepare this workshop a Core group was organized, including the following European stakeholders of energy sector:

ALSTOM Energy (France), DONG Energy (Denmark), E.ON (Germany), EirGrid (Ireland), Energias de Portugal (EDP, Portugal), Fraunhofer ISI (Germany), Instituto de Engenharia de Sistemas e Computadores do Porto (INESC Porto, Portugal) KEMA (Netherlands), MINES Paris (France), SAFT (France), SIEMENS (Germany), University of Lodz (Poland), University of Picardie (France).

The Core Group has elaborated the program of Workshop, based on the most "burning" question related to the energy storage implementation in Europe.

This workshop attracted more than 50 people from 36 major European energy stakeholders (utilities, manufacturers, regulators, academics, consultants) and resulted in producing recommendations to the European Commission regarding its research and industrial policies on the Energy Storage field.

These recommendations were reviewed and validated by the Core Group and are expected to be considered by the European Commission as the basis for planning and coordinating actions in connection with Energy Storage in the next years.

The next part of this document is devoted to the presentation of these recommendations, accompanied by some contextual elements of the workshop.

Workshop context: participants

36 major European energy stakeholders from 11 countries (Belgium, Denmark, France, Germany, Ireland, Italy, Netherlands, Poland, Portugal, Spain, UK) attended the meeting. A
few participants from the new European Members States and from small or medium sized companies were present. A large number of invitees could not attend the meeting but expressed their strong interest to review and to contribute to the workshop findings.

The repartition of the Workshop participants by categories is shown below:

A brief analysis of this figure could provide the following findings:

- The sector representation and the diversity of expertise and competence level was quiet high, with a good balance between utilities (generators, grid operators), manufacturers, academics and consultants.
- Although 11 regulators and 7 government representatives were invited to the event, only 1 regulator (Germany) attended the workshop.

**Workshop context: organisation**

This one-day workshop consisted in two parts: a plenary session in the morning, followed by 5 parallel sessions.

In the **plenary** session key speakers from European Commission, utilities, academia and consultancy have presented their vision of Energy Storage in Europe.

The afternoon **parallel sessions** were dedicated to the following specific issues:

- Assessment of the new needs for Energy Storage in Europe (split in two sessions);
- European Energy Storage Technology strategy;
- Regulation;
- Economics / Risk management.

**The main topics discussed during the workshop were:**

- Existing policy instruments used to facilitate the implementation of Energy Storage in the European electric system;
- Main Energy Storage drivers (technological, regulatory, macroeconomic, environmental);
- The most promising models of Energy Storage use;
The issue of arbitrage between centralized and decentralized solutions;
Positioning of Energy Storage compared to other flexibility solutions;
Outlook and perspectives of Energy Storage technologies;
Energy Storage equipment markets: present and future positioning of European actors;
Technological R&D activities: needs / domains of common interest;
Assessment and analysis of the existing EU regulation regarding the Energy Storage (ownership / operation, grid access and Renewables feed-in tariffs & taxes, harmonization);
The issue of Energy Storage ownership in the regulation;
Energy Storage valuation methods;
Energy Storage consideration in risk management

**Workshop’s key findings / messages**

**New roles of the Energy Storage (or why Europe needs more Energy Storage in the future)**
- Energy Storage is a key element to Europe’s goal for increased Renewables integration;
- Energy Storage technologies provide flexibility services, a key feature and need of the future European decarbonised power system;
- Energy Storage will contribute to the Green Building concept implementation (new & retrofitted buildings)
- Energy Storage will play a key role in the expected massive deployment of Electrical Vehicles (EV) and Rechargeable Hybrid Vehicles (RHV);
- The Smart Energy Systems (Demand Side Management, Smart Grid Solutions) will need Energy Storage.

**Barriers for Energy Storage implementation in Europe**
- Lack of European targets for Energy Storage whereas Storage can support meeting of the European Policy on Energy and Climate;
- There is still no European market for Energy Storage solutions (except improving Hydro Pumped storage) whilst the uncertainty on the future markets and their time horizons is high;
- Limited and fragmented R&D and Demonstration efforts on storage technology developments in Europe
- The level of communication & coordination between European actors on the Energy Storage field is quite low;
- Lack of quantified vision on the value of unconventional sources of flexibility that includes storage and on the future flexibility needs in the European electric system;
- Regulation barriers (in particular, lacking rights for TSO / DSO to own or operate the Energy Storage installations);
• Existing renewable feed-in tariffs, reducing the incentives for coupling Energy Storage to Renewables generation;
• Existing grid access tariffs, increasing the cost of Energy Storage operation;
• Lack of visibility of Energy Storage needs on the European level;
• Lack of standardization (storage solutions & interfaces) and harmonization (regulation)

How to potentially overcome these barriers?
• Establish European targets for Energy Storage;
• Identify the priority Energy Storage technologies and actions where efforts should be focused;
• Pursue research projects (assessing existing and future needs for flexibility; developing appropriate methodology & tools for valuation storage as flexibility mean);
• Demonstrate EU-supported/funded Energy Storage based solutions at the centralized and decentralized level (to test both new technologies and new business models);
• Review the European Regulation in particular, with respect to storage ownership and operation rights for regulated actors, feed-in tariffs, green certificates and reach a high level of European harmonization e.g. storage regulation, market rules;
• Increase European cooperation in the field of Energy Storage (e.g create a dedicated knowledge exchange platform, involving also academics / customers / car manufacturers);

What is needed for accelerating Energy Storage developments in Europe?
Develop and demonstrate through key R&D, Demonstration and market replication actions the validity of business models of Energy Storage applications for:
• **Renewable generation** (solar, on- and off-shore wind power penetration scenarios, management of the risk of Renewables shedding, regulation, actors interaction);
• **Smart Systems concepts** (smart service management, tariff signals, actors coordination, metering/controlling methods, innovative methods of distribution networks management,…);
• **EV & RHV deployment and for V2G** (Vehicle to Grid) concept (quantified scenarios of EV and RHV penetration in Europe, focusing inter alia on the EV and RHV local deployment forecasts, charging infrastructure design, monitoring system, customer behaviour aspects);
• **Green Building concept** implementation (integration of different energy sources like heat/cool/electricity, building powerflow and energy network design, metering/billing management, existing batteries management,…);
• **Reducing risks of energy storage investments** to cope with regulatory and market uncertainties.

Increase European cooperation in the field of Energy Storage, in particular by creating a dedicated knowledge exchange platform, involving also academics / customers / car manufacturers);

The idea of a European Energy Storage Association as independent industry-lead initiative was also debated and favorably considered by participants.
Recommendations to the European Commission for Actions in the very short term

1. **Assess the storage technologies and their prospects in terms of performance, cost and maturity. Identify the European potential and R&D and Demonstrators needs in this area and build a European vision on development of the European storage solutions industry in the short, medium and long term.**

This task may be entrusted on non-competitive basis to credible and independent European actors under the auspices of the European Commission and its Information System of the SET-plan (SETIS). One important outcome of this activity should be the establishment of a program based plan for strategic activities on storage over the next 10 years.

2. **Include in the up-coming Calls of the European Framework Programme the following actions:**

   - Demonstration projects to test and valuate the new Energy Storage solutions and its components and to assess and identify further R&D needs:
     - Promoting R&D on new storage concepts;
     - Combining technology demonstrator projects to test new Energy Storage business models is to be encouraged;
     - Combining different Energy Storage technologies to improve overall storage performance is to be encouraged;
     - Combining different flexibility solutions (storage, demand side management, flexible generation,….) to assess overall flexibility performance and costs;
     - Combining different Energy Storage solution within the same demonstrator project is to be encouraged;
     - Involving academics and utilities to the demonstrator projects is to be encouraged
     - Demonstrators in large power systems as well as in small (island based) power systems

   - Research & Demonstration projects for the assessment of new business models for the use of Energy Storage (Renewables integration, Green Buildings, Electrical an Rechargeable Hybrid Vehicles, Smart systems), that focus in particular on:
     - The development of relevant and appropriate technical and market scenarios;
     - The identification of interested actors (existing and new), their stakes, constraints and their ways of interacting; both regulated / deregulated actors are to be taken into account.
     - The assessment of different technical solutions and corresponding specifications; both centralized / decentralized solutions are to be taken into account.
     - The evaluation of the European regulatory and market frameworks in terms of needs, barriers, and gaps;
     - The development of appropriate valuation models and tools for studying storage solutions;
     - The identification of the most appropriate technologies of Energy Storage for each assessed business model;
- The implementation of demonstration / experimental pilots in order to test, adjust and validate assessed business models:

  *Nota:* Experimental pilots could be based on existing Energy Storage units or may need the building of new ones, regarding the specificity of each assessed business model.

- Research & Demonstration projects on the assessment of flexibility needs and its valuation in the European Electrical system:
  - Define the technical requirements for flexibility services;
  - Define methodologies and tools to quantify the value of flexibility;
  - Elaborate European regulatory solutions providing balance between incentives for the low-carbon & Renewables energies and flexibility devices.
  - Investigate the issue of common European flexibility market (go beyond ancillary services and balancing mechanisms);
  - Develop a pilot to test the actor's involvement into the flexibility market (consumers, producers, grid operators, aggregators are to be considered);

- Long term research programme to develop the next generation of storage technologies, including components and materials

3. *Facilitate the establishment of an independent industry-led platform for information sharing on Energy Storage at the European level.*
Information on the demonstrator-readiness level of main Energy Storage technologies (some updates may be needed)

During the workshop session "European Energy Storage Technology Strategy" it was suggested to include the following table into the Workshop's recommendations to the European Commission. This table is based on the information provided by participant to this session (Alstom Energy, AREVA TD, EDF, E.ON, Gaedic Energy Storage Ltd, Institute of Physical Chemistry of Muenster, Pluriion Systems, SAFT, SEVIL, Siemens CT, UMICORE).

<table>
<thead>
<tr>
<th>Technology</th>
<th>Ready for Component Demonstration?</th>
<th>Ready for System Demonstration?</th>
<th>Size of Demo (System)</th>
<th>R&amp;D Challenges</th>
<th>European manufacturer concerned</th>
<th>Existing non-European manufacturers</th>
<th>Priorities for demo, pilots, tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA-CAES</td>
<td>Yes (at list for reduced scale demonstrators)</td>
<td>no</td>
<td>Some 10 MW – some 100 MW</td>
<td>Compressor; Heat storage</td>
<td>Alstom, Siemens, Ed. Züblin AG, Man Turbo, Saint Gobain,...</td>
<td>General Electric, ...</td>
<td>Heat storage reduced scale and high temperature air compressor demonstrators are desirable in advance.</td>
</tr>
<tr>
<td>CAES</td>
<td>yes</td>
<td>Yes</td>
<td>Some 10 MW (conventional) – some 100 MW (unconventional)</td>
<td>Costs, Roundtrip efficiency</td>
<td>Alstom, Siemens, Ed. Züblin AG, Man Turbo, Saint Gobain,...</td>
<td>General Electric, ...</td>
<td>Cost reduction, performance</td>
</tr>
<tr>
<td>Pumped Hydro</td>
<td>yes</td>
<td>yes</td>
<td>&gt; 100 MW (known sites), 10 MW (new sites)</td>
<td>Mature, but : Variable-speed pumps, optimized control, retrofit strategies, new settings...</td>
<td>Alstom, Siemens, ABB</td>
<td>General Electric,...</td>
<td>Some advanced components need to be tested.</td>
</tr>
<tr>
<td>NaS</td>
<td>yes</td>
<td>yes</td>
<td>1 MW – 20 MW</td>
<td>Mature technology</td>
<td>No manufacturers</td>
<td>NGK (Japan)</td>
<td>No specific demo needs for technology improvement are identified. New settings for system integration could be addressed.</td>
</tr>
<tr>
<td>NaNiCl (ZEBRA)</td>
<td>yes</td>
<td>yes</td>
<td>Some 10 kW – 1 MW</td>
<td>To be completed</td>
<td>MES-DEA (Switzerland)</td>
<td>General Electric (Sodium-Metal Chloride)</td>
<td>Performance / cost</td>
</tr>
<tr>
<td>REDOX (V)</td>
<td>yes</td>
<td>Yes (Japanese and Australian demo already existing)</td>
<td>Some 10 kW – 1 MW</td>
<td>Lifetime of components, Standardization (pumps, cells)</td>
<td>Cellstrom (AT)</td>
<td>Prudent Technologies (China), Sumitomo (Japan)</td>
<td>New chemistries, performance / cost</td>
</tr>
</tbody>
</table>


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</tr>
</thead>
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<tr>
<td>REDOX (Zn-Br)</td>
<td>yes</td>
<td>yes</td>
<td>Some 10 kW – 1 MW</td>
<td>Lifetime of components, Standardization (pumps, cells)</td>
<td>No manufacturers</td>
<td>Prudent Technologies (China), ZBB (US), Premium Power (US)</td>
<td>New chemistries, performance / cost</td>
</tr>
<tr>
<td>REDOX (Cr-Zn)</td>
<td>no</td>
<td>no</td>
<td>100 kW</td>
<td>Cell designs, &quot;Mass&quot; manufacturing issues, Reliability of auxiliaries - maintenance</td>
<td>Plurion Systems (UK)</td>
<td>No manufacturers</td>
<td>New chemistries, feasibility / performance. (Components, reduced-scale demonstrator?)</td>
</tr>
<tr>
<td>Lithium Ion</td>
<td>yes</td>
<td>Yes (a MW US and Chinese demonstrators already operating)</td>
<td>Some 100 kW – some MW</td>
<td>Lifetime issues (?), Safety, System integration, Cost</td>
<td>SAFT, Batscap (France), Litec (Germany)</td>
<td>AltairNano, Enerdel, A123, BYD (US), Samsung (Corea), ...</td>
<td>Stationary large-scale applications (cost, performance)</td>
</tr>
<tr>
<td>NiMH</td>
<td>yes</td>
<td>yes</td>
<td>Some 10 kW – some MW</td>
<td>Mature technology</td>
<td>SAFT (France)</td>
<td>Number of manufacturers</td>
<td>No specific demo needs for technology improvement are identified</td>
</tr>
<tr>
<td>Flywheel</td>
<td>yes (US); 1 year needed for EU demonstrator of 10kWh flywheel</td>
<td>yes (US model), yes (EU model)</td>
<td>Some 100 kW – 10 MW</td>
<td>Efficiency, Autodischarge rate, reliability, rotor materials &amp; design, bearings, security issues.</td>
<td>Sevill (France, start-up), Rosetta (DE), Magnet Motor (DE)</td>
<td>Beacon Power (US), Pentadyne, PowerCorp (Australia)</td>
<td>Stationary application feasibility, performance (for low autodischarge rate technology), cost.</td>
</tr>
<tr>
<td>Super Caps</td>
<td>yes</td>
<td>yes</td>
<td>Some 1 kW – some 100 kW</td>
<td>Energy density (materials, ...) Costs</td>
<td>Batscap (France)</td>
<td>Maxwell (USA), Nesscap (Corea), ESMA (Russia)</td>
<td>Stationary application feasibility, performance cost.</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>yes</td>
<td>no (for the complete chain: H2 production / transport &amp; storage / H2 consumption)</td>
<td>Some kW – some 100 kW</td>
<td>Revertible fuel-cells, cell cost, efficiency, intelligent heat management, lifetime.</td>
<td>Manufacturers to be identified</td>
<td>Manufacturers to be identified</td>
<td>Laboratory tests are needed in advance (feasibility, cost,...), high pressure high eff. electrolyser</td>
</tr>
<tr>
<td>Advanced Lead Acid</td>
<td>yes</td>
<td>Yes (Japanese and US demonstrators already operating)</td>
<td>Some 10 kW – some MW</td>
<td>Lifetime</td>
<td>No manufacturers?</td>
<td>EXIDE Technologies, EnerSys (US), Shin Kobe, Xtrem power, Axion</td>
<td>Performances, cost, feasibility of large-scale stationary applications</td>
</tr>
<tr>
<td>Other Storage technologies</td>
<td>There might be a number of other storage technologies which potentially could enter the market (inter alia heat storage, superconductors, metal-air, ...). Moreover, as the presently existing commercial solutions do not fully satisfy the needs, the development of their 2nd or 3rd generations is to be considered.</td>
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