European Commission

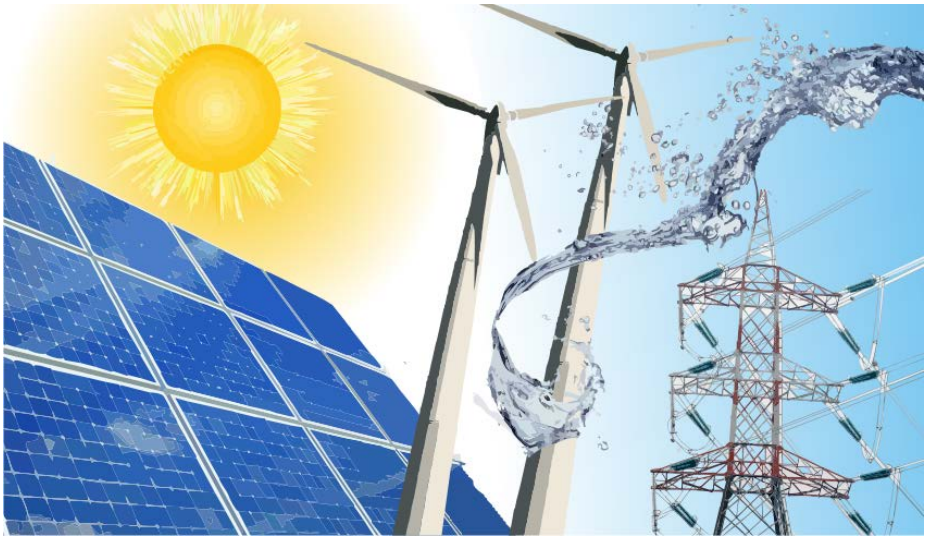
This fiche is part of the wider roadmap for cross-cutting KETs activities

'Cross-cutting KETs' activities bring together and integrate different KETs and reflect the interdisciplinary nature of technological development. They have the potential to lead to unforeseen advances and new markets, and are important contributors to new technological components or products.

The complete roadmap for cross-cutting KETs activities can be downloaded from:

http://ec.europa.eu/growth/industry/key-enabling-technologies/eu-actions/ro-ckets

Potential areas of industrial interest relevant for cross-cutting KETs in the Energy domain



This innovation field is part of the wider roadmap for cross-cutting KETs activities developed within the framework of the RO-cKETs study. The roadmap for cross-cutting KETs activities identifies the potential innovation fields of industrial interest relevant for cross-cutting KETs in a broad range of industrial sectors relevant for the European economy.

The roadmap has been developed starting from actual market needs and industrial challenges in a broad range of industrial sectors relevant for the European economy. The roadmapping activity has focused on exploring potential innovation areas in terms of products, processes or services with respect to which the cross-fertilization between KETs can provide an added value, taking into account the main market drivers for each of those innovation areas as well as the societal and economic context in which they locate.

Taking the demand side as a starting point, cross-cutting KETs activities will in general include activities closer to market and applications. The study focused on identifying potential innovation areas of industrial interest implying Technology Readiness Levels of between 4 and 8.

E.3.1: Voltage level-dependent energy storage facilities in the grid

Scope:

To develop voltage level-dependent energy storage facilities for the grid, meaning storage facilities for the transmission, distribution and consumer grid to cope with the volatility of renewable energy sources, including bulk energy storage (at grid level to maximize use of distributed energy sources) and small size storage (in the distribution network).

Demand-side requirements (stemming from Societal Challenges) addressed:

- Contribute to achieving competitive, sustainable and secure energy
- Cope with the various European efforts (directives, policies as well as initiatives) aimed at deploying Smart Grids
- Cope with the various European efforts (directives, policies as well as initiatives) aimed at developing a single energy market for Europe
- Cope with the increasing levels of renewable energy deployment within the European Union (the Renewable Energy Directive (2009/28/EC) mandating to achieve levels of renewable energy consumption of 20% by 2020)

Demand-side requirements (stemming from market needs) addressed:

- Reduce energy consumption (resulting in savings over the conventional energy purchase for private as well as industrial end-users and in the overall reduction of the energy demand on a global scale)
- Provide for easier integration of renewables in general with existing energy distribution networks and with other energy generation systems
- Increase use of effective energy storage systems into existing energy distribution networks (to resolve the mismatch issue between energy generation and demand)
- Increase electricity usage flexibility in order to cope with today's lifestyles

Specific technical / industrial challenges (mainly resulting from gaps in technological capacities):

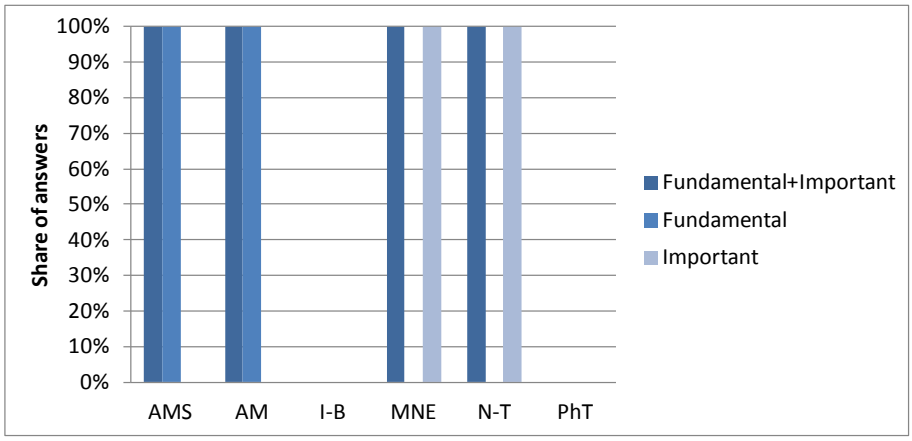
- Adaptation of electrical equipment (in this case, electricity storage, at different voltage levels) to the increased share of electricity generated through renewable energy sources and its special characteristics (intermittent or DC)
- Development of longer-lasting rechargeable batteries, supercapacitors or of other energy storage devices able to store more energy per volume and per weight

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the adaptation of electrical equipment (in this case, electricity storage, at different voltage levels) to the increased share of electricity generated through renewable energy sources and its special characteristics (intermittent or DC) thanks to the development of longer-lasting rechargeable batteries, supercapacitors or of other energy storage devices able to store more energy per volume and per weight.

To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong interaction of KETs with respect to this Innovation Field, with either fundamental or important contribution mainly by the following KETs:

- Advanced Manufacturing Systems (AMS)
- Advanced Materials (AM)
- Micro- and Nano-Electronics (MNE)
- Nanotechnologies (N-T)



Timing for implementation:

No consensual indication could be retrieved from KETs experts' opinions concerning the time frame required for solving the main technological issues holding back the achievement of cross-cutting KETs based products related to this Innovation Field. However, considering the specific technical and/or industrial challenges and the maturity of technologies in this field, the provision of support in the short term is suggested within this framework.

Additional information according to results of assessment:

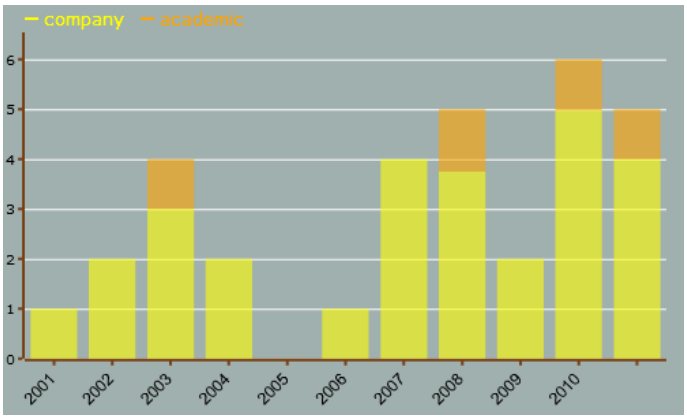
- ***Impact assessment:***
  - Similarly to what reported for thermal energy storage, electrical energy storage will be key, along with other energy storage systems and methods, in supporting the transition towards a secure, competitive and decarbonised energy system in Europe. The increasing intermittency at the generation side due to an increased integration of renewable as well as distributed energy generation in the energy system requires technologies and procedures for balancing energy demand and supply, thus allowing displacement between consumption and generation to take place in both time and space. Within this framework, electrical energy storage, like thermal energy storage, will become an integral part of future's energy systems and related value chains, being expected to solve, in on-grid areas, issues related to power fluctuation and undependable power supply, which are typically associated with the use of large amounts of renewable energy. In the off-grid domain, electric vehicles using electric storage will be among the most promising technology to replace fossil fuels by electricity from mostly renewable sources (Source: Joint EASE/EERA recommendations for a European Energy Storage Technology Development Roadmap towards 2030, March 2013).
  - Most promising markets for electrical energy storage systems will be for achieving time shift, smoothing of output fluctuations and efficiency improvement of conventional generators and adjusting power supply to meet demand that fluctuates within short periods. These two applications are reported to be promising due to the expected broad introduction of renewable energies on the one side and the consequent need for balancing energy that is likely to rise as renewable energy generation causes fluctuations on the supply side to increase, and more and more power markets will introduce sophisticated market mechanisms for the procurement of balancing energy (Source: Joint EASE/EERA recommendations for a European Energy Storage Technology Development Roadmap towards 2030, March 2013).
  - Global demand for advanced energy storage systems is expected to grow to 32 000 TWh by 2035, a 70% increase from 2012. The global consumption of electricity is expected to grow by over 60% from 2011 to 2030. This huge rise in demand has to be met by increased power generation which requires 6 000 GW of added new capacity, apart from the existing capacity. The bulk of required electricity, though could be generated, has to be managed due to frequently changing demand peaks, making energy storage an imperative element within the system. Globally, the advanced energy storage systems market that includes grid storage and transportation is expected to grow at a compound annual growth rate (CAGR) of 10% in from 2013 to reach over 8 billion Euro by 2018. The key growth drivers include growing renewable implementation, new transmission and distribution grid construction and upgrades, smart grid installation, and growing demand for electric and hybrid vehicles (Source: Markets and Markets, Advanced Energy Storage Systems Market by Technology (Pumped Hydro,

Compressed Air, Batteries, Flywheels, Supercapacitors), By Applications (Grid Storage & Transportation), & Geography - Global Trends & Forecast to 2018, 2013).

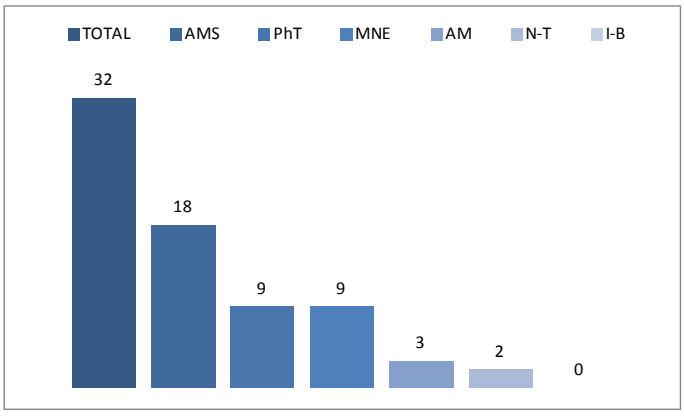
- Pumped hydro-storage is the most prominent and oldest of all the storage technologies. Yet, numerous other technologies with different capabilities are now in the market with continuous research and development in progress. These include Compressed Air Energy Storage (CAES), batteries, supercapacitors, and flywheels. Emerging and developing technologies include hydrogen storage as combined with fuel cells or combustion engines/turbines, super magnets and synthetic gas.
- The European industry has a strong market leadership in large-scale energy storage technology. Three market leaders for hydro-pumped storage are based in Europe. Similarly, although Compressed Air Energy Storage technologies are not widely deployed, at least two of the two projects currently in operation were built with European technologies. For intermediate or smaller scale technologies, the European industrial base is weaker. Flywheels and flow battery manufacturers are mostly based outside Europe. For batteries and supercapacitors, although there are world-class European manufacturers, the global battery storage market was dominated by North America in 2012, followed by Asia-Pacific and Europe. Increasing grid storage needs and encouraging policies for electric vehicles in the US are the key drivers for this market. Asia-Pacific is expected to become the key market gainer in the next five years (Sources: Electricity storage in the power sector, http://setis.ec.europa.eu; Markets and Markets, Advanced Energy Storage Systems Market by Technology (Pumped Hydro, Compressed Air, Batteries, Flywheels, Supercapacitors), By Applications (Grid Storage & Transportation), & Geography - Global Trends & Forecast to 2018, 2013).

➢ ***Results of patents scenario analysis:***

- 32 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
- Increasing trend curve (number of patents per year)
- Highest share of industrial applicants with intermittent relevant patenting activity by academic applicants, most probably standing for new technologies having been patented in the corresponding periods:



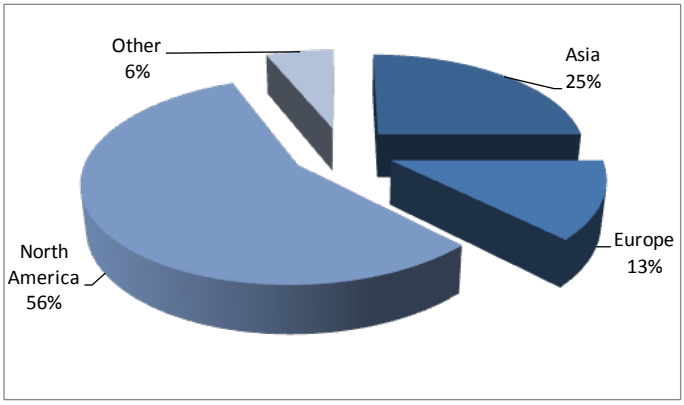
- Patents by KET(s):



- Patents by KET(s) and relevant combinations of KETs:

KET(s)	*Number of patents*
AM	3
AM / N-T	1
AMS	18
AMS / AM	1
AMS / MNE	1
MNE	9
MNE / PhT	6
N-T	2
PhT	9

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: