European Commission

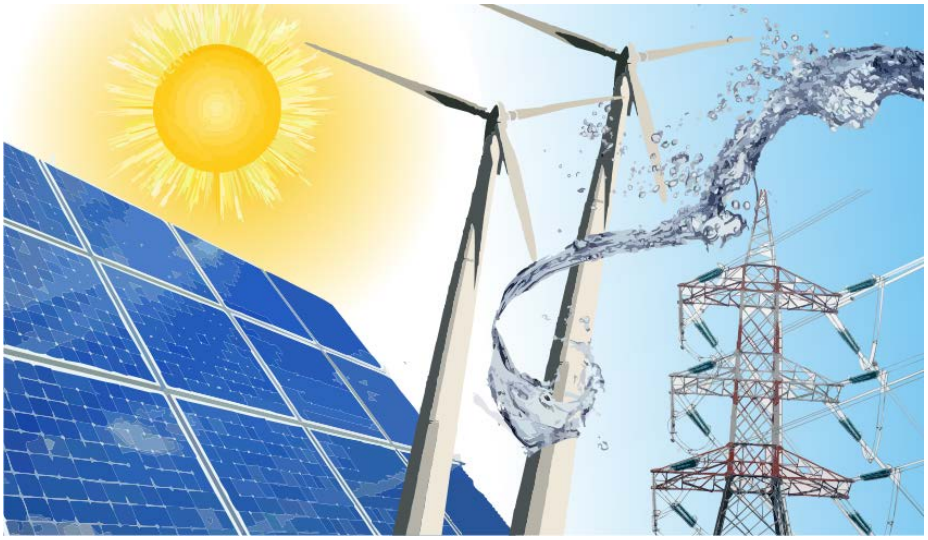
This fiche is part of the wider roadmap for cross-cutting KETs activities

'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.1.5: Highly cost-efficient and reliable large wind turbines

Scope:

To develop large wind turbines based on lightweight materials and designs for improved flow dynamics, structural integrity, and recyclability, as well as including failure identification, condition monitoring and fault prediction capabilities, along with large and more flexible rotors with improved performance.

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

- Contribute to achieving competitive, sustainable and secure energy
- Achieve levels of renewable energy consumption within the European Union of 20% by 2020 (as mandated by the Renewable Energy Directive (2009/28/EC))
- Achieve the largest proportion of renewables in the final energy consumption by 2050 as identified in the Energy Roadmap 2050
- Achieve net zero-energy buildings in the future, serving as driver to boost the market for novel renewable energy applications in the residential sector (according to the Energy Performance of Buildings Directive (2010/31/EU))

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

- Increase efficiency of energy generation systems and equipment in order to maximize yield
- Increase reliability of energy generation systems and equipment
- Reduce cost / payback of energy generation systems and equipment
- Reduce costs of installation as well as of operation and maintenance

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

- Investigation of wind turbine as a flow device: fluid dynamics methods (CFD) and aero-elastic models, experimentals for large and more flexible rotors with improved performance
- Investigation of wind turbine as mechanical structure/materials: materials and design for improved structural integrity and recycling
- Investigation of wind turbine as an electricity plant: light-weight, low-speed and low maintenance power electronics, power converters and new generators for improved system performances
- Development of control systems in wind turbines and wind farms to optimize the balance between performance, loading and lifetime: advanced control strategies and devices, sensors and condition monitoring systems
- Development of a full systematic design methodology (integrated design) and investigation of innovative solutions for wind turbines and sub-system concepts (e.g. for rotors) to increase system efficiency (reduction in the lifetime cost of energy)
- Development of automated manufacturing solutions for large wind turbines enabling cost-efficient manufacture
- Development and adoption of wind turbine operation and maintenance (O&M) strategies: failure identification, condition monitoring and fault prediction capabilities
- Development of models, simulation tools, and experimental campaigns; exploitation of new installation contexts for small size wind turbine with high efficiencies, low environmental impacts and reduced costs for distributed energy production
- Optimization of wind power plant capabilities: tools and methods for operation and interoperability for adapting to electricity grid code requirements (e.g. power electronics, control strategies, monitoring, prediction tools, automation, etc.)
- Adoption of grid planning and operation strategies for improved transmission capacity: grid extension and reinforcement, improved EU wide operation and interoperability, models and simulation of the EU interconnected power system, new power and monitoring systems, analysis of offshore grid options
- Adoption of energy and power management systems for improved flexibility on both generation and demand-side: management tools for Transmission System Operators (TSOs) and market parties; options for ancillary services (i.e. transmission of electric power from seller to purchaser) and power balancing in higher wind penetrations; energy storage and interaction with other renewables

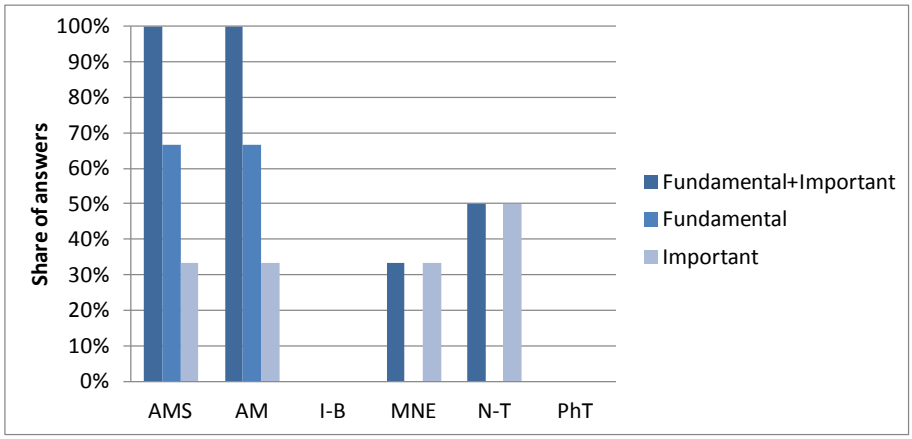
- Siting of wind farms in sites with poor accessibility: improved and reliable design criteria of turbine components (mast, blade and nacelle) for the installation of large scale wind turbines with reduced costs
- Investigation of models and systems to optimize integration of wind energy in Smart Grids, including regulation strategies, compensation systems and storage

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of high-strength, lightweighter large wind turbines, including thanks to the use of high-strength/low-weight fibre-reinforced polymer composite materials or of advanced materials and new material architectures with added functionalities, enabling designs for improved flow dynamics, enhanced structural integrity, and recyclability, along with large and more flexible rotors with improved performance. The integration of KETs could moreover contribute to integrating failure identification, condition monitoring and fault prediction capabilities as well as to the development of automated manufacturing methods for large and very large structures.

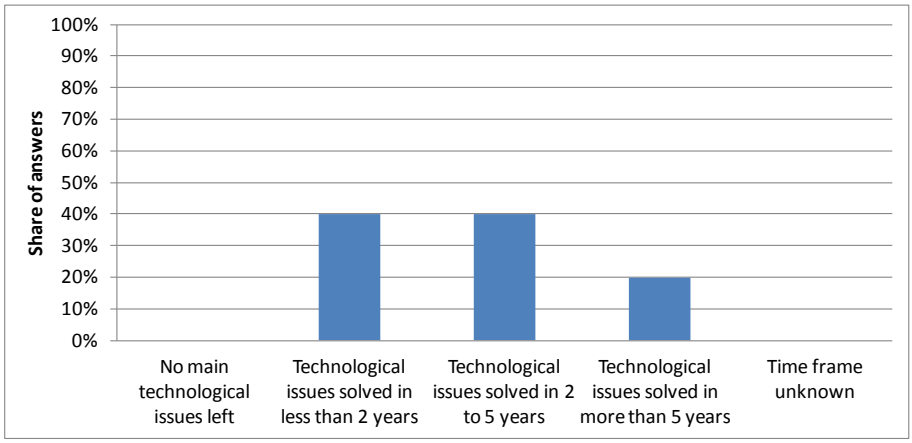
To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong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

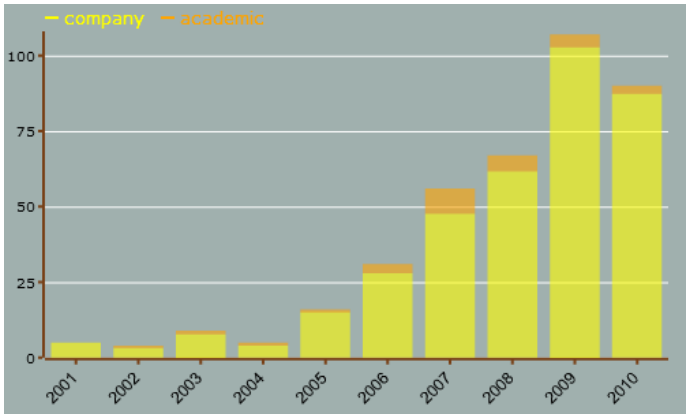
According to the majority of KETs experts' opinions (whose result is depicted in the below bar chart), desk research, and in line with the KETs-related patenting activity in this field, it is considered that the main technological issues holding back the achievement of cross-cutting KETs based products related to this Innovation Field could be solved in a time frame of 2 to 5 years, or shorter (less than 2 years), yet a pool of KETs experts indicates also greater periods being necessary. According to the interviews carried out throughout the study and as confirmed during some of the workshops that took place during the period when the study was active, it emerged that while the main technological issues holding back the wind turbines as equipment can be solved in a short time frame, manufacturing issues would instead require more time:



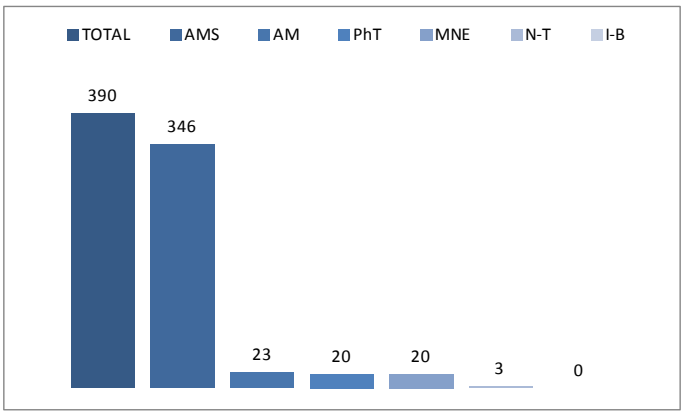
Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, the provision of support in the short term should be taken into consideration to solve the main technological issues holding back the wind turbine as equipment, while the provision of support in the medium term would be more appropriate to solve the main technological issues holding back the automated manufacture of large wind turbines.

Additional information according to results of assessment:

- ***Impact assessment:***
  - Global wind energy capacity experienced an increase by 12.4% in 2013 to 318.6 GW, while for the first time the global market decreased (to 35.6 GW dropping of 10 GW). The worldwide market contraction is to be attributed to the collapse of the US market. The European market also contracted because of investors' lack of confidence in the new renewable electricity promotion policies by a number of countries. If the US and Europe are taken out of the equation, the global market continued to grow, driven by the Chinese and Canadian wind power sectors.
  - Despite the European market slowed down in 2013, it managed to keep above the 11 GW threshold, which represents the sector's second best performance for annual installations.
  - On the crest of the wave, there is clearly the offshore market, with 1.5 MW out of every 10 MW of capacity installed offshore in 2013.
  - Source: EurObserv'ER's, Wind Energy Barometer, February 2014.
- ***Results of patents scenario analysis:***
  - 390 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
  - Increasing trend curve (number of patents per year) with very slight downturn in 2011
  - Highest share of industrial applicants:



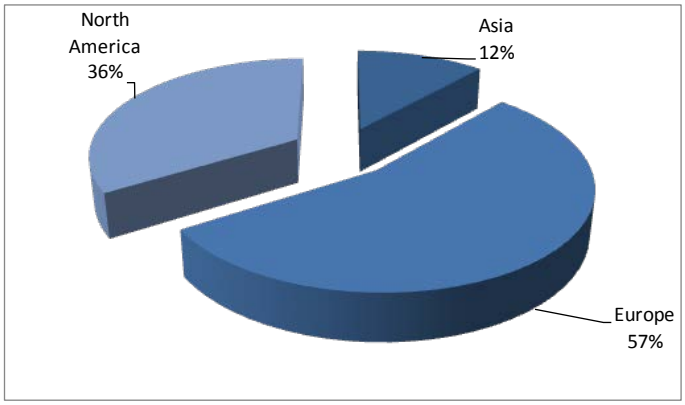
- Patents by KET(s):



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

KET(s)	*Number of patents*
AM	23
AM / N-T	1
AMS	346
AMS / AM	3
AMS / MNE	4
AMS / PhT	2
MNE	20
MNE / PhT	12
N-T	3
PhT	20

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: