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 Transport and Mobility 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.

T.3.1: Electric vehicle powertrain

Scope:

Even though at widely different levels of maturity depending of the category of vehicle (trams and trains, cars, ships, aircraft and even satellites with ion thrusters), electric propulsion is physically the most energy efficient way of moving vehicles, with a high potential for also for operation optimization. Around the electric vehicle powertrain, shared challenges appear on embedded energy storage and charging, on-board power management, overall cost-effectiveness, use of rare materials and all sorts of hybridization.

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

- Tackle the “Smart, green and integrated transport” societal challenge
- Contribute to the achievement of the EU Transport 2050 strategy (COM/2011/0144 final) objectives of a 60% reduction of CO_2 emissions from transport and no more conventionally-fuelled cars in cities
- Achieve levels of renewable energy consumption within the European Union of 20% (as mandated by the Renewable Energy Directive (2009/28/EC)), considering use of renewable electricity in electric vehicles
- Ensure sufficient critical resource efficiency and recyclability so as to enable large scale deployment of e-Mobility without creating shortages, dependencies or environmental issues (as per the Raw Materials Initiative (COM(2008)699))
- Bring a mobility and transport contribution to the smart grids and smart cities projects

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

- Support development of innovative, green, fluid, resilient and efficient end-to-end urban mobility solutions
- Enable new transportation services dealing with changing mobility and transportation needs, including ageing and citizen ability for making informed real-time mobility choices
- Make sure energy grids are able to deal with a shift towards e-Mobility, or even that transports are an active support of smart grids deployment
- Enable e-Mobility to act as a growth driver for the European transport industry in the global competition

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

- Development of affordable high energy density, long lifetime embedded storage, mainly batteries, and the charging systems suited for each type of vehicle application
- Development of lightweight, compact and cost-effective electric engine and related embedded electrical equipment, including in case of hybrid propulsion
- Development of low consumption electric power components (power electronics, converters, engines, supra-conductors) for electric powertrain
- Development of miniaturized low cost, highly efficient multi-purpose and modular technologies for electric thrusters, including for small satellites, for all sizes of Low Earth orbit (LEO) to Geostationary orbit (GEO) satellites
- Development of range extending thermal power generators able to supplement the normal vehicle autonomy when needed
- Development of human assistance systems including power management assistance, charging infrastructure finding and subsidiary systems to manage change in operational habits (artificial noise creation or driving sensations, vehicle brio reproduction, reaction times, etc.)
- Development of optimized on board power monitoring and management, potentially relying on supercapacities, for feeding the electric powertrain as well as all non-propulsive electric subsystems
- Development of synthetic equivalent of rare materials for electric engine magnets and other rare and costly materials in the electric power chain
- Enable energy recovery (from braking energy, waste heat or other losses)
- Make sure the power grid is able to match the energy requirements for charging electric vehicles, whatever charging technologies are in use and including while electric vehicles are being deployed on a large scale

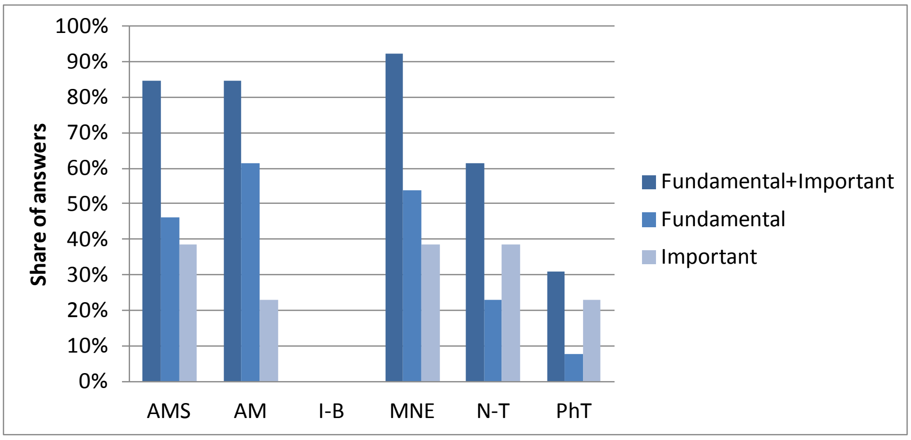
- Implementation of low and very low electric thrust for spacecraft station keeping and attitude control, including with full electric or hybrid propulsion systems

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of more advanced electric vehicle powertrains, building on solutions such as affordable high energy density and long lifetime storage, versatile charging systems, and lightweight, compact and cost-effective electric engines. The integration of KETs could also contribute to optimized on board power monitoring and management and to the development of technologies enabling energy recovery. It may also contribute to the development of synthetic equivalents of rare materials for electric engine magnets.

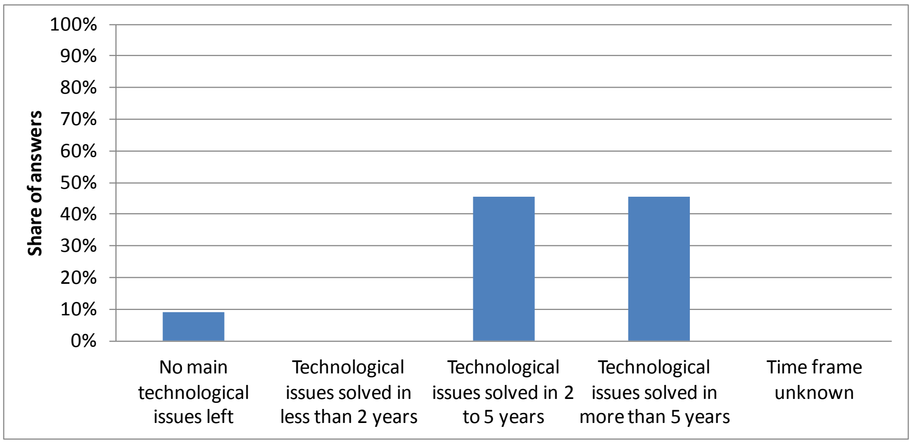
To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong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

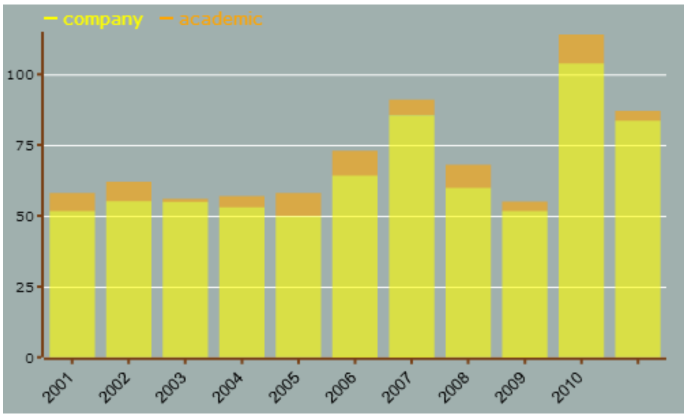
According to the majority of KETs experts' opinions (whose result is depicted in the below bar chart), desk research, and in line with the KETs-related patenting activity in this field, it is considered that the main technological issues holding back the achievement of cross-cutting KETs based products related to this Innovation Field could be solved in a time frame of either 2 to 5 years or more than 5 years:



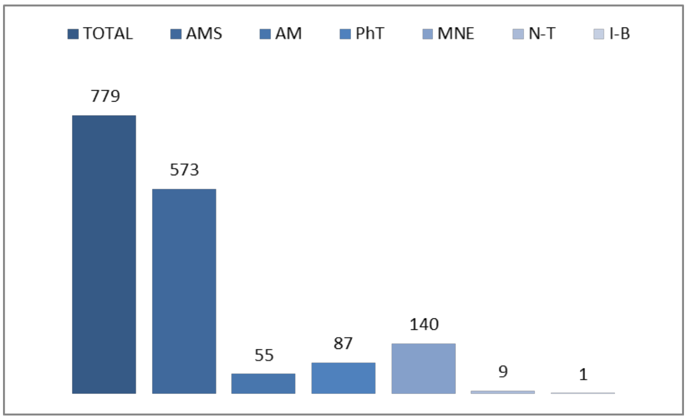
Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field and from on the families of technologies in this field, the provision of support in the short to medium term should be taken into consideration within this framework.

Additional information according to results of assessment:

- ***Impact assessment:***
  - Transport accounts for 13% of global greenhouse gas emissions (Source: IEA 2009). Except for trains and urban transports where it is already widely applied, electric mobility is considered a mandatory enabler for Europe to meet its CO_2 reduction target. Even in sectors where it remains technically very exploratory, as in aeronautics and space, electric propulsion is being investigated.
  - Moving from fossil fuel combustion to electric mobility will be a paradigm shift for the whole EU economy and society, with impacts on whole industrial sectors, including energy, chemistry (from petro-chemistry to bio-base), many raw materials and of course the transport industries. In the latter, it is to be recognized that combustion engine expertise has for long been one of the strengths of Europe and adaptation to electric mobility requires a huge card reshuffling, along with long-term effort. Setting up the bricks for electric mobility, including breaching the remaining barriers on the existence of a European industrial capability on the electric vehicle powertrain, is definitely one of the major axes of what a European industrial policy can be about.
  - The battery can account for as much as 40% of an electric vehicle's manufacturing cost. The global market for automotive Lithium-ion batteries is estimated to increase from 3.3 billion Euro in 2014 to 16.4 billion Euro in 2020 (according to Japanese research firm B3 (Source: article Bloomberg)). Sales of hybrid and electric vehicles are projected to grow steadily to reach 5.2 million units by 2020, or 7.3% of all passenger vehicles (Source: November 2010 report by J.D. Power & Associates).
  - Considering the efforts given on this topic in other parts of the world as well as issues on some critical materials to be used in this field (e.g. rare earths in permanent magnets), securing a strong European capability in this field is also a matter of strategic non-dependence.
- ***Results of patents scenario analysis:***
  - 779 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
  - Slightly increasing trend curve (number of patents per year)
  - Highest share of industrial applicants, with a strong presence to be noted of Japanese large industries in the top applicants (Toyota is world leader in the topic, by far), but European players are still evident in the top positions (better than US):



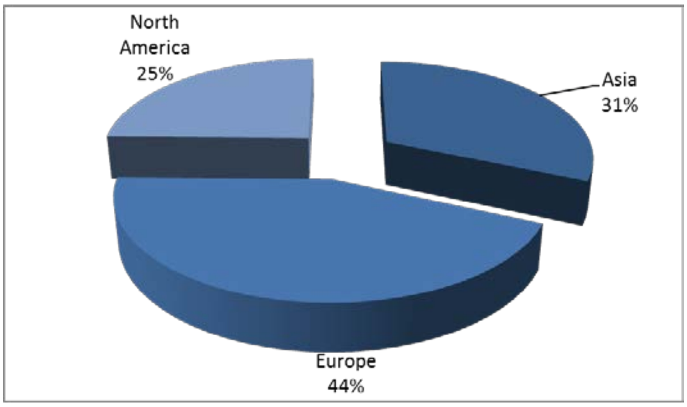
- Patents by KET(s):



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

KET(s)	*Number of patents*
AM	55
AM / MNE	5
AM / MNE / PhT	1
AM / N-T	2
AM / PhT	3
AMS	573
AMS / AM	2
AMS / MNE	10
AMS / MNE / PhT	4
AMS / PhT	11
IBT	1
MNE	140
MNE / N-T	3
MNE / N-T / PhT	1
MNE / PhT	55
N-T	9
N-T / PhT	1
PhT	87

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: