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.1.5: Vehicle embedded power and heat systems

Scope:

To develop more efficient embedded subsystems, utilities and power components that require less energy provision and entail less heat dissipation altogether, facilitating overall on-board energy management and making it possible to address most demanding needs as electric propulsion or broadband communications.

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) objective of a 60% reduction of CO_2 emissions from transports, at least 40% for shipping
- Support the Smart Vehicle initiative of the i2010 strategic framework on the innovation society (COM(2005) 229 final)
- Continuously enhance safety, resistance/resilience and security of vehicle operation all along end-to-end transport chains
- Increase recyclability of vehicles and systems and resource efficiency in the manufacturing processes and reduce dependency to rare or foreign controlled materials and components (as per the Raw Materials Initiative (COM(2008)699) and numerous waste management regulations)

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

- Reduce vehicle operation costs, including through increasing energy efficiency and reducing final vehicle energy bill, but also through optimising overall vehicle lifecycle cost of ownership, including maintenance, repair and overhaul
- Reduce or maintain numbers and rates of accidents in Europe at an acceptable number, whatever traffic growth
- Enable new transportation services dealing with changing mobility and transportation needs, changing trade patterns as well as citizen and logistic chains request for affordable, timely, comfortable, seamless and ubiquitous transport services
- Enable time to market reduction and production ramp up / adaptation so as to cope with European and global market requests on new vehicle supply

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

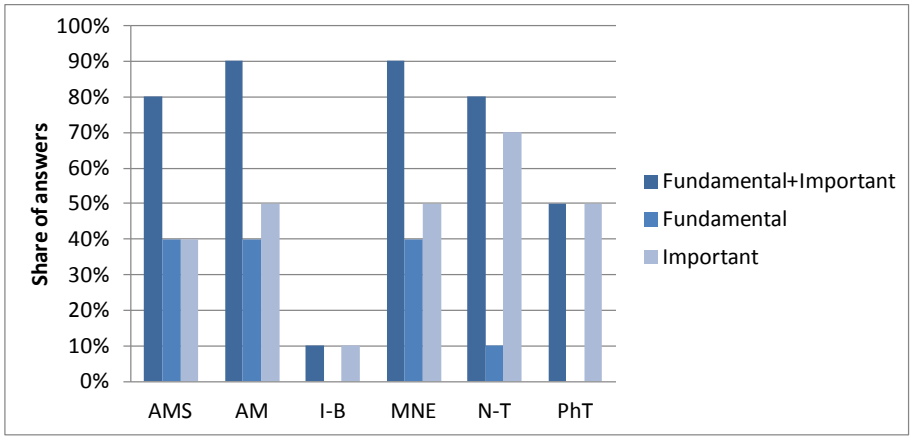
- Replacement of on board mechanic / hydraulic / pneumatic energy transfers by more energy-efficient / lighter / smaller / more robust electric utilities
- Development of low consumption lighting, heating, air renewing/filtering/conditioning, de-icing, etc.
- Increase of the power density of embedded energy storage systems, in particular batteries and low power super capacitors, whilst mastering lifetime and resilience to severe operational conditions
- Development of high efficiency light and low heat dissipation power conversion capabilities (power electronics), including with low required peak power, i.e. lower mass
- Development of cabling superconductivity
- Optimization of on-board power management and architecture, including between on-board power generation, energy storage, propulsion and non-propulsive electric subsystems
- Extension of voltage operational range of embedded power electronics and electrical systems, in particular for supporting electrical propulsion or high performance telecommunication payloads
- Perform efficient thermal management, including with high efficiency heat pipes, advanced radiating structures and other cooling systems
- Enhancement of thermal rejection for high energy missions (as telecommunication) with the help of advanced deployable radiators or other fluidic and mechanical solutions
- Development of energy recovery capability (from braking, waste-heat, suspension, environment energy harvesting), including thermo-electricity solutions for reliable and cost-effective reversible generation of cold or power

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the development of more efficient vehicle-embedded power and heat subsystems, utilities and components, including solutions such as high-efficiency, light-weight and low-heat dissipation power electronics, superconductive cabling, energy recovery systems along with efficient thermal management approaches, including thermo-electricity solutions for reliable and cost-effective reversible generation of cold or power.

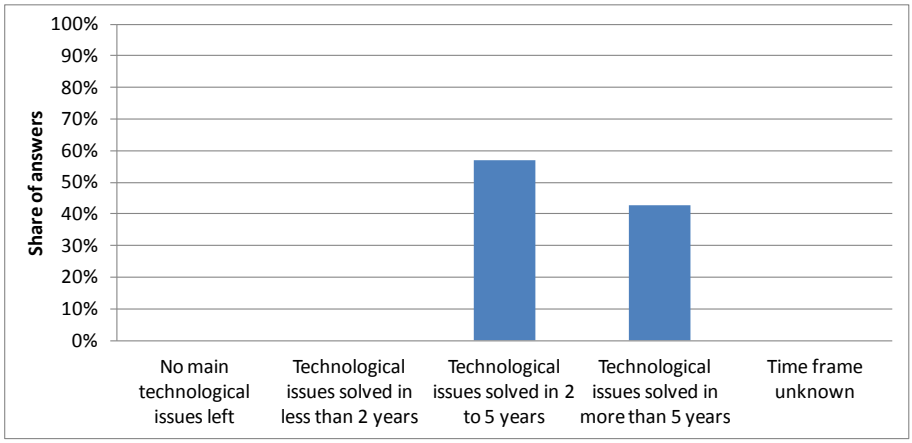
To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong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



Timing for implementation:

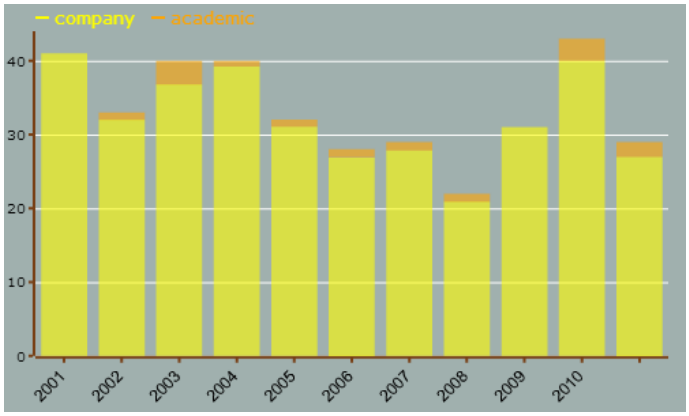
According to the majority of KETs experts' opinions (whose result is depicted in the below bar chart), desk research, and in line with the KETs-related patenting activity in this field, it is considered that the main technological issues holding back the achievement of cross-cutting KETs based products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



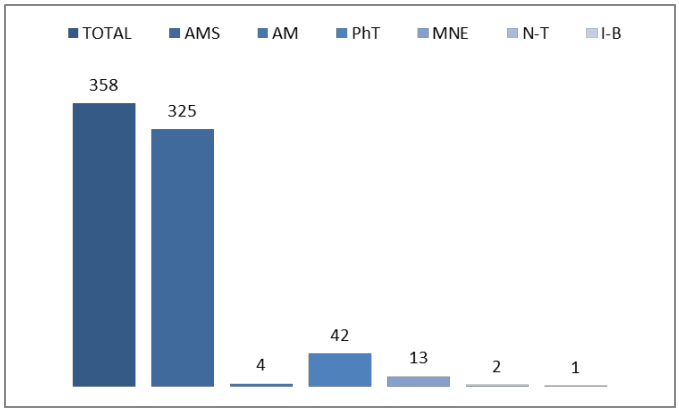
Hence, depending on the specific technical and/or industrial challenges holding back the achievement of cross-cutting KETs based products related to this Innovation Field, the provision of support in the short to medium term should be taken into consideration within this framework.

Additional information according to results of assessment:

- ***Impact assessment:***
  - Vehicles are getting more and more electric, not only for propulsion but for all sorts of subsystems. An efficient power management in all on board subsystems is therefore a growing contributor to the overall vehicle energy efficiency. *An example of the gains was given in aeronautics by FP5 POA and FP6 MOET projects around the "More electric aircraft" concept, with potential progress from improving power systems demonstrated on direct energy consumption, power systems weight and maintenance costs reduction, better designs enabling lesser unexpected events.*
  - Heat, mainly produced by the propulsion systems, has for long been considered as an undesirable spoiler to be dissipated. Knowledge and technologies, especially supported by advanced simulation means, are now enabling to see it as a resource to be valued, or at least optimally managed. In the automotive sector, the Exhaust Gas Reinjection (EGR) systems in combustion engines are a good example on how a better management of heat can participate to the overall consumption reduction.
  - With the development of KETs-based solutions as advanced heat exchanger materials, thermoelectricity and power electronics, a holistic approach of on board energy management is at hand for contributing to continued improvement of on board energy-consuming services while keeping energy consumption on a decreasing trend.
  - Space (advanced energy management for maximum satellite autonomy) and military (e.g. heat signature control) have synergies to be explored with civil applications in this Innovation Field.
  - Embedded systems must perform many different tasks to support war- fighters, and as technology advances the power consumption increases, leading to greater excess heat and a higher demand for systems that can control their power use. On this regard, the significant knowledge of such systems developed for the defence sector may be transferred to civilian applications where systems designers struggle with ever-increasing computing power and the intense levels of heat, and look for innovative ways to cool systems without compromising performance.
- ***Results of patents scenario analysis:***
  - 358 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
  - Quite stable trend curve (number of patents per year)
  - Highest share of industrial applicants, with many of the main applicants coming from the German automotive industry, a significant number from the Japanese industry, then from large aeronautical firms:



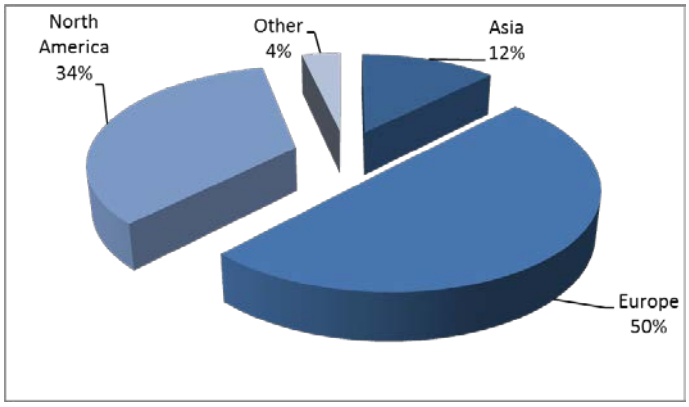
- Patents by KET(s):



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

KET(s)	*Number of patents*
AM	4
AM / N-T	2
AMS	325
AMS / MNE	3
AMS / MNE / PhT	1
AMS / PhT	4
IBT	1
MNE	13
MNE / PhT	11
N-T	2
PhT	42

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: