



This document 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>

How to read the Fiches describing the potential areas of industrial interest relevant for cross-cutting KETs

This document 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.

This document is aimed at providing instructions for how to read the Fiches describing the potential areas of industrial interest relevant for cross-cutting KETs.

How to read the Fiches describing the potential areas of industrial interest relevant for cross-cutting KETs

Innovation fields are first of all grouped within cross-sectoral domains and moreover classified within sub-domains. For each innovation field relevant for cross-cutting KETs activities, a dedicated fiche describes the relevant information retrieved throughout the study for the specific innovation field.

I. Demand-side requirements and challenges

For each sub-domain, the demand-side requirements stemming from specific societal challenges that the specific group of innovation fields addresses are described. One activity in this study has been an analysis of the relevance of each innovation field towards the grand societal challenges burdening today's society. Moreover, if relevant for a whole group of innovation fields identified under the umbrella of a specific sub-domain, then the demand-side requirements stemming from specific market needs that the specific group of innovation fields addresses are also described. On the contrary, if specific only to one innovation field (rather than to a whole set of innovation fields), demand-side requirements stemming from specific market needs are described with reference to the specific innovation field and hence they are introduced within its dedicated fiche.

Sub-domain (self-explanatory short description)

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

- Demand-side requirement 1
- Demand-side requirement 2
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Demand-side requirements (stemming from market needs) addressed:

- Demand-side requirement 1 (if relevant for a whole set of innovation fields)
- Demand-side requirement 2 (if relevant for a whole set of innovation fields)
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The dedicated fiches provide firstly a self-explanatory short description of the innovation field, as well as an extended description providing additional details and explanation ('Scope'). Subsequently, demand-side requirements stemming from specific market needs are described, if referred to the innovation field (rather than to a whole set of innovation fields, as reported above). Moreover, technical/industrial challenges (mainly resulting from gaps in technological capacities) specific to the innovation field are reported. Both the demand-side requirements stemming from the market needs and the technical/industrial challenges are the result of the extensive analysis carried out in order to map potential innovation areas along with their associated market needs and industrial challenges, thanks to a thorough screening of Strategic Research (and Innovation) Agendas and Strategic Roadmaps developed by European Technology Platforms and other European initiatives (such as Joint Technology Initiatives or Undertakings) as well as from other available acknowledged sources of information with European relevance (e.g. market studies, foresight studies, sector analyses, etc.). The initial desk analysis to gather preliminary information was subsequently complemented by further input from more than 80 representatives of key industrial players, collected through interviews and workshops.

Innovation field (self-explaining short description)

Scope:

- Extended description of the innovation field

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

- Demand-side requirement 1 (if relevant for a specific innovation field only)
- Demand-side requirement 2 (if relevant for a specific innovation field only)
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Specific technical/industrial challenges (mainly resulting from gaps in technological capacities):

- Technical/industrial challenge 1
- Technical/industrial challenge 2
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II. Contribution by cross-cutting KETs

Afterwards information is provided about the contribution that cross-cutting Key Enabling Technologies could have with respect to the innovation field. This information is the combined result of three main actions, namely a Europe-wide survey involving KETs experts, an extensive patent scenario analysis, and deskwork combined with evaluation and harmonization by the project team experts. On the one side, a survey that extensively involved high level experts in Key Enabling Technologies and that was aimed at matching the identified innovation fields with the technological offering to be provided by the cross-fertilization between KETs was established. This part of the analysis leveraged views of 272 experts in all the six KETs, mobilized via a dedicated Europe-wide online-based survey. Technology experts were called to identify which KETs could contribute to each innovation field and moreover to assess whether the integration of the potentially contributing KETs beyond their mere combination could constitute an additional success factor for the achievement of highly innovative products, processes or services. On the other side, an extensive patent scenario analysis aimed at examining the KETs-related patenting activity in relation to each innovation field was carried out. A KETs-related patent database was exploited for the purpose, which had been obtained by having identified and extrapolated from patent databases only those patents dealing with KETs thanks to search strings delineating each of the six KETs. Activities were furthermore complemented by extensive deskwork.

Specifically as regards the survey, the questionnaire had been designed in such a way to allow KETs experts to choose one or more specific domains within which to assess related innovation fields. The system hence gave respondents a list of innovation fields that were either directly classified within the chosen domain(s) or cross-sectorally linked to such domain(s). Each innovation field had been in fact redundantly classified within more than one domain in order to increase its opportunity to be reached through different paths regardless of the initial choice of the domain, if relevant for more than one domain. Accordingly, each innovation field could be assessed by a variable number of KETs experts. Notably, the result of this survey is not intended to be statistically relevant, but rather to be a source of input along the same line as an expert consultation process. It should be noted that, according to profiling, more than 90% of the respondents had an expertise of longer than 5 years. Throughout the questionnaire, KETs experts were specifically asked to assess how important each of the six KETs was in relation to a specified innovation field (with possible multiple choice among fundamental, important, marginal, not needed) and, in case at least two KETs had been selected as being at least important or fundamental, the respondent was asked to assess to which extent those technologies interrelate and interact beyond their mere combination so to provide novel technological opportunities (i.e. the cross-cutting KETs relevance was assessed). A multiple choice was again possible among the categories: rather strong interaction, rather low interaction, mere combination without interaction. Since it was a fundamental requirement to identify cross-cutting KETs opportunities, only innovation fields for which a rather strong interaction had been indicated were selected as relevant and further considered throughout the next assessment steps.

This information was combined with the result of the KETs-related patent scenario analysis and particularly cross-checked against the indication of the patent distribution by KETs and related combinations of KETs. This particular piece of information provides indication of how many patents identified in relation to a specific innovation field refer to any of the six KETs and, as a part of this number, how many refer to specific combinations of KETs as indicated in the right column of the table provided in the relevant section of the fiche 'Results of patent scenario analysis'.

As a result of this process, the contribution by cross-cutting Key Enabling Technologies toward each innovation field is indicated in the fiches through a list of the relevant KETs and a description of how they can contribute. Moreover, a histogram provides an indication of the related shares in terms of experts' answers (with a focus on the two answers pointing to either the fundamental or important role of each KET, besides which the total share referring to the two combined answers is also indicated).

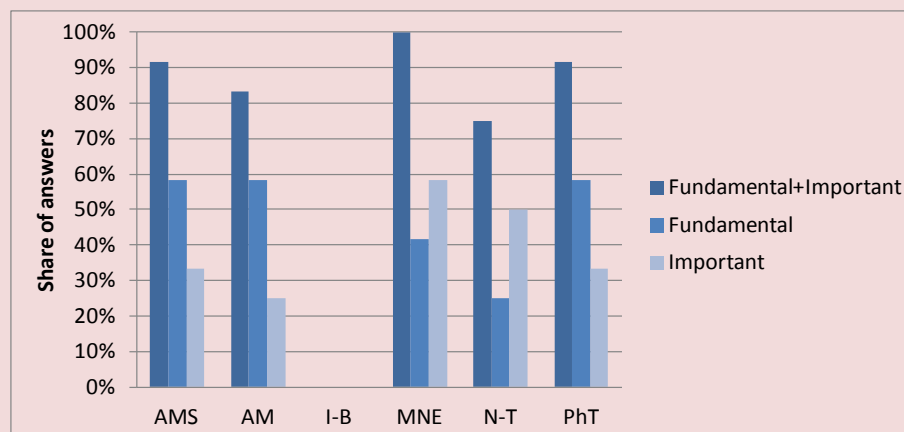
Contribution by cross-cutting Key Enabling Technologies (EXAMPLE):

In respect to this Innovation Field, the integration of KETs could contribute to the development of enhanced displays offering more realistic and immersive 3D video reproduction, including energy-efficient and wearable displays, also supported by new methods and tools for immersive sound reproduction and adequate video processing hardware. Exploration of the use of flexible materials, thin film glass and organic electronics to develop flexible/wearable displays can also be an opportunity. 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 fundamental contribution mainly by the following KETs:

- Advanced Manufacturing Systems (AMS)
- Advanced Materials (AM)
- Photonics (PhT)

and important contribution by:

- Micro- and Nano-Electronics (MNE)
- Nanotechnologies (N-T)



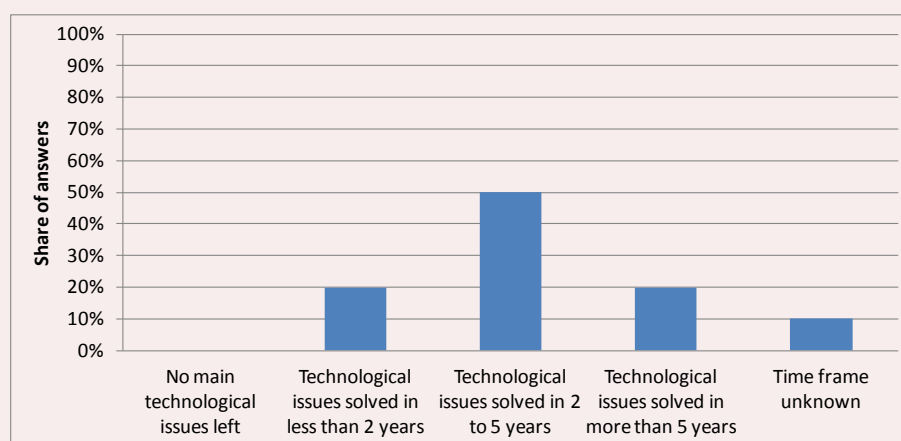
III. Timing

KETs experts had been additionally asked to provide their opinion about how long it would take to solve the main technological issues holding back the achievement of cross-cutting KETs based products within a specific innovation field. Answers had to be chosen among the following options: no main technological issues left, less than 2 years, from 2 years to 5 years, from 5 to 10 years, more than 10 years. This allowed the grouping of innovation fields into two main blocks, namely innovation fields with short-term priority relevance (if the answer 'from 2 years to 5 years' was selected) and innovation fields with medium-term priority relevance (if the answers 'from 5 to 10 years' or 'more than 10 years' were selected), despite the fact that many of the innovation fields could be considered as being subject to continuous, incremental improvement as they are associated with well-established market needs driving the development of new products, processes, goods, and services as soon as new enabling technologies or technological solutions become available. On the other side, innovation fields for which 'no main technological issues left' was indicated were considered state-of-the-art, whereas for innovation fields for which 'less than 2 years' were indicated were considered as already planned within commercial plans of industrial organizations and thus out of the scope of pre-commercial development.

Also this set of information was combined with the result of the KETs-related patent scenario analysis, as well as with deskwork. Within respect to the patent scenario analysis, the shape of the patenting activity's trend curve as well as the relative share of industrial and academic applicants in relation to a specific innovation field were used as indicators to provide useful information about the maturity of developments in a given framework, in the assumption that a growing trend curve would normally point out to an evolving, thus not yet mature technological scenario (as opposed to a stable or even descending trend curve pointing out to technological maturity or even obsolescence) according to the typical S-shaped curve describing technology life cycles, and that the presence of academic applicants would normally point to research activities, highlighting lower technological maturity, going on in a given framework (as opposed to a high share of industrial applicants pointing to innovation activities and a higher technological maturity).

Timing for implementation (EXAMPLE):

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 to 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:



Hence, depending on the specific technical and/or industrial challenges holding back to 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 within this framework.

IV. Market / industrial potential

Activities were then aimed at assessing the identified innovation fields in terms of market impact and opportunity toward industrial growth and job creation. This assessment involved two main actions as well as desk analysis. A second Europe-wide online-based survey allowed industrial experts' opinions to be obtained with regard to market demand aspects. The survey leveraged opinions from 285 industry experts. Moreover, also for this part of the analysis, patent-based indicators were exploited in order to provide information about Europe's positioning in terms of KETs-related patenting activity in relation to each innovation field. Furthermore, extensive desk analysis activity allowed the assessment of potential markets and related drivers.

As regards the industry representatives' survey, the questionnaire had been designed in such a way to allow industry experts to start the process by selecting a specific domain as well as sub-domain in line with their markets and business activities. The system thus provided respondents with a list of the innovation fields that were either directly classified within the chosen domain as well as sub-domain or cross-sectorally linked to such domain as well as sub-domain, within which to select a maximum number of 3 innovation fields of strategic relevance or interest for their company to assess in major details whilst remaining strictly anonymous. Considering that the purpose of this survey was to characterize industrial interest toward the identified innovation fields, this filter logic was already intended to identify interesting innovation fields to industrial organizations so to gain relevant aggregated information about their strategic relevance for industry in Europe.

A set of questions followed, which were aimed at gathering qualitative information about R&D activity and industry plans in relation to each of the selected innovation fields. The gathered information was complemented by extensive deskwork aimed at retrieving, whenever possible, information about potential market size and specific market drivers for each innovation field.

These pieces of information were once again combined with the result of the KETs-related patent scenario analysis. The use of patent-based indicators has intrinsic limitations, but can anyway be a powerful aid in qualitative assessments. Patent-based indicators, such as particularly patent distribution by applicant organization, geographical zone, and patent distribution by geographical zone of priority protection were used to provide information about Europe's relative industrial strength (in the assumption that European applicant organizations contribute to industrial strength in Europe) and market relevance (in the assumption that filing for a patent is used as a way for applicants to protect themselves in a specific geographical market) in relation to a specific innovation field, respectively.

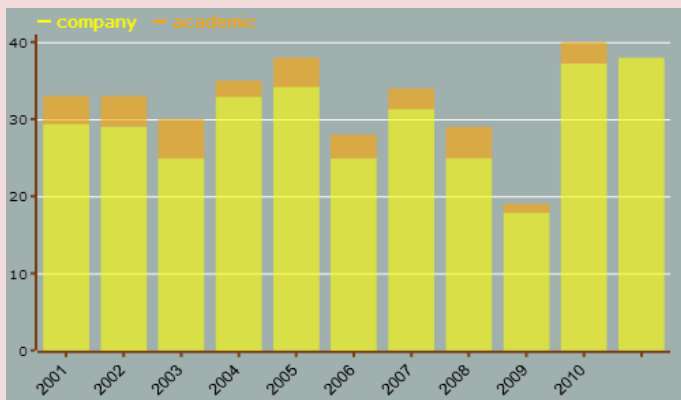
Additional information according to results of assessment:

➤ **Impact assessment:**

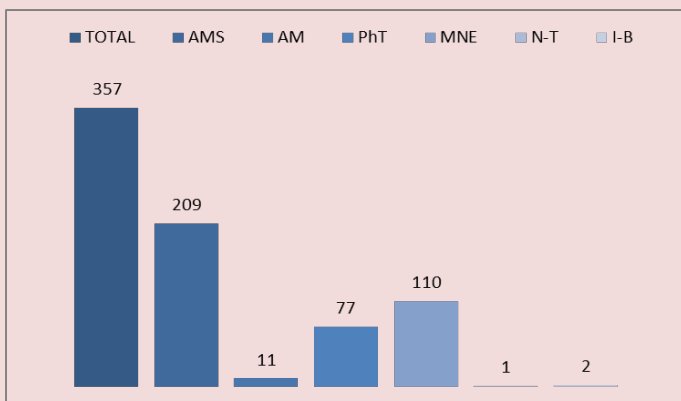
- Market drivers, market size, etc. (whenever specific information could be gathered through desk analysis)

➤ **Results of patent scenario analysis:**

- Indication of the number of exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
- Indication of the shape of the trend curve (number of patents per year)
- Indication of the relative share between industrial and academic applicants (EXAMPLE):



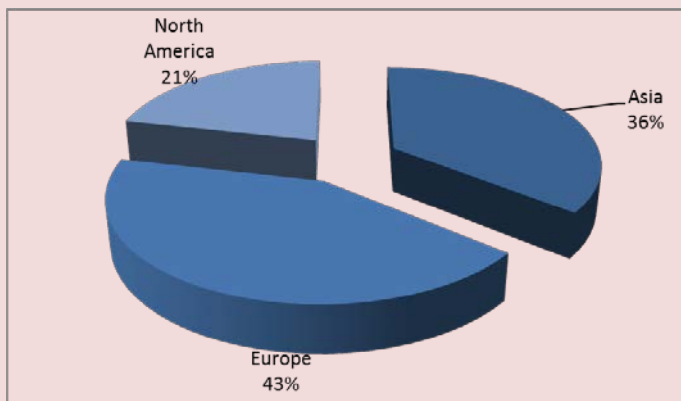
- Patents by KET(s) (EXAMPLE):



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

<i>KET(s)</i>	<i>Number of patents</i>
AM	11
AM / MNE	1
AM / PhT	1
AMS	209
AMS / MNE	15
AMS / MNE / PhT	2
AMS / PhT	5
IBT	2
MNE	110
MNE / N-T	1
MNE / PhT	32
N-T	1
PhT	77

- Patents distribution by (Applicant) organization geographical zone (EXAMPLE):



- Patent distribution by geographical zone of priority protection (EXAMPLE):

