European Commission

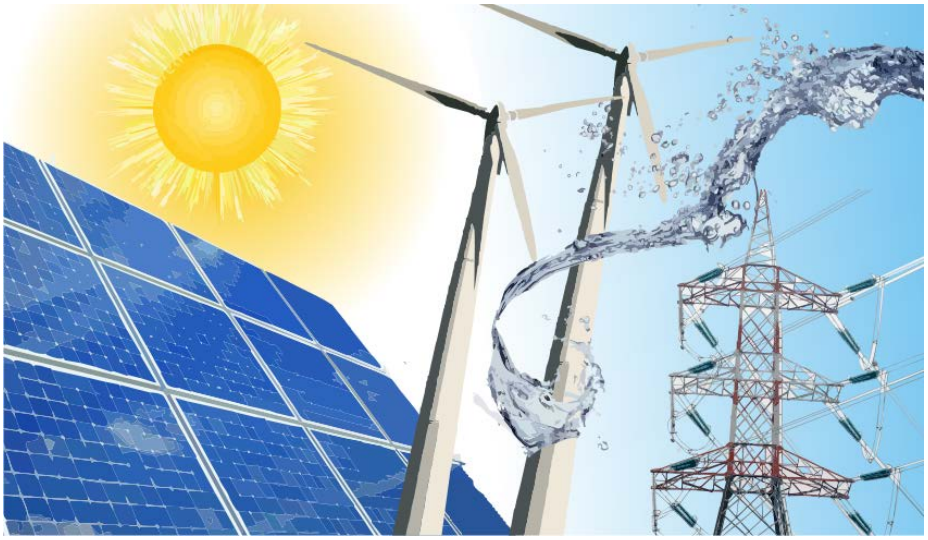
This fiche is part of the wider roadmap for cross-cutting KETs activities

'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.1.1: Flexible solar cells (modules) enabling improved PV integrability

Scope:

To develop flexible solar cells (modules) based on thin-films layers, organic dyes, deposited organic polymers, etc., enabling flexibility for improved PV integration, major modularity, easier installation, better aesthetics, and in which cost is reduced thanks to optimization of materials' consumption as well as improvements at the manufacturing level.

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):

- Identification of alternatives for scarce chemical elements applied in PV technologies (such as Tellurium, Gallium, Indium, Selenium, among others)
- Research and innovation into recycling of solar panels in order to mitigate the risk of loss of precious metals, tackle dependence for these materials and eliminate negative impacts on the environment due to e.g. leaching of toxic metals and lead out of solar panels
- Increase of the recovery rates of critical materials used in solar technologies, encouraging more efficient practices for primary production and by-product separation and recovery of some primary metals (like Zinc, Copper, or Aluminium for extracting Tellurium, Indium or Selenium)
- Demonstration of new conversion principles and basic operation of new device concepts (active layers), toward PV cells performances improvement (efficiency, costs, functionalities, etc.)
- Improvement of nanoparticle synthesis methods for advancement in existing thin film technologies and novel PV cells (active layers) design
- Development of materials, processes and devices concepts for improved processing and higher cells efficiency
- Investigation and improvement of deposition techniques for advancement in existing thin film technologies and novel PV concepts design (toward improvements in cells performances and costs)
- Increase in reliability and cost-effectiveness of thin film technologies' production equipment
- Design of low-cost packaging solutions for flexible PV modules
- Development of processes and equipment for improved throughput, yield, standardization in thin film PV technology

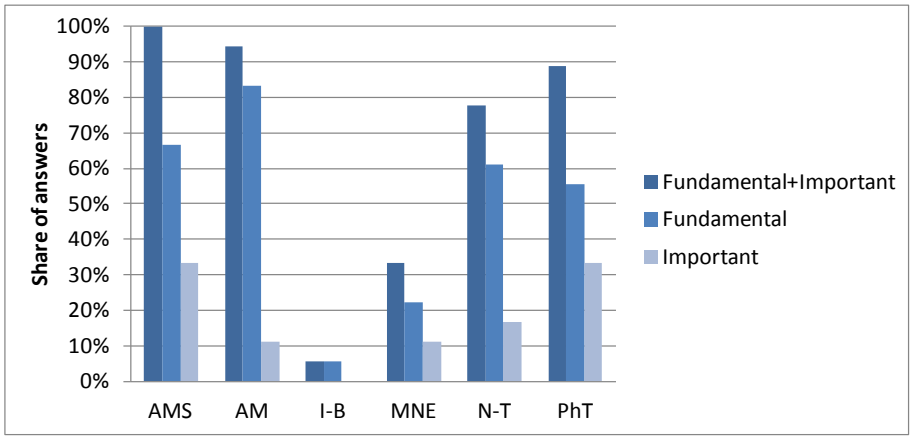
Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could trigger higher efficiencies at reduced costs thanks to the optimization of materials consumption (including through the identification of alternatives for scarce chemical elements and the substitution of critical raw materials) and improvements at the manufacturing level.

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

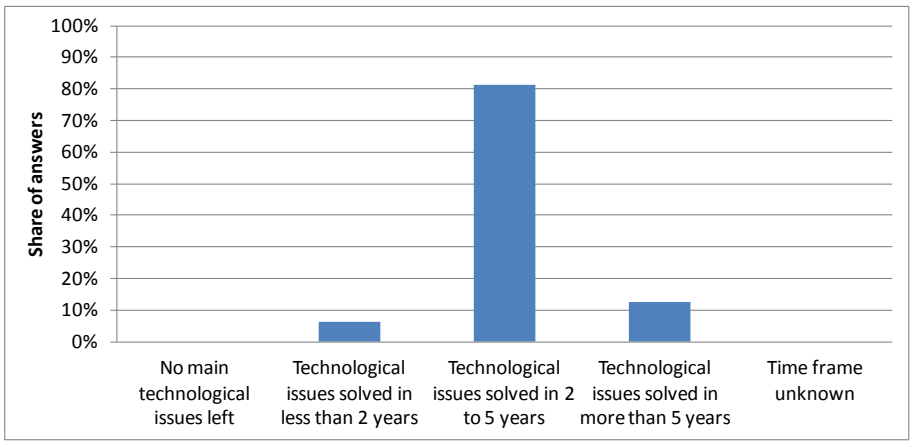
Innovation Field, and desk research activities, have allowed identifying a rather strong interaction of KETs with respect to this Innovation Field, with either fundamental or important contribution mainly by the following KETs:

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



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:



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 within this framework.

Additional information according to results of assessment:

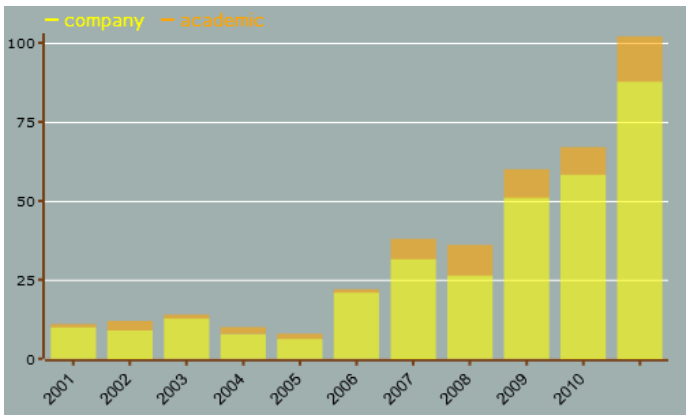
➢ ***Impact assessment:***

- The EU, whose global share in the solar photovoltaic market in 2011 was 73.6%, is now only 26.5%. Newly installed capacity in the EU was 9.9 GWp in 2013, significantly lower than in 2012, when it had been 16.7 GWp. For various reasons (including the fact that most of the EU Member States have either withdrawn or sharply reduced their incentive system) the European market is now clearly shrinking and no longer leads the world, leaving the main scene to the Asia-Pacific regions (Source: EurObserv'ER, Photovoltaic Barometer, April 2014).

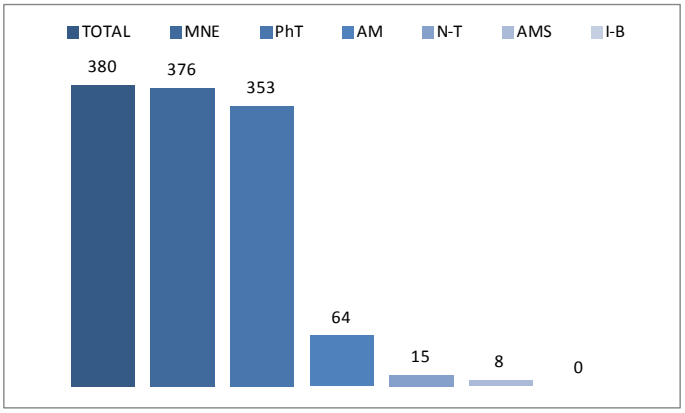
- While however China plays the leading role in the production of rigid solar cells (modules), Europe remains competitive in the production of flexible solar cells (modules). With respect to thin film production, Europe played an important role in 2012 by keeping above 20% share in actual production (Source: EPIA, Global Market Outlook for Photovoltaics 2013-2017, May 2013).
- Flexible solar cells (modules) can have a number of applications; flexible PV installations can be foreseen in relation to building applications (i.e. Building Integrated Photovoltaics, BIPV) but also in relation to any other renewable power application requiring the flexibility feature (e.g. PV car roofs).
- Having this in mind, the flexibility feature enabling improved PV integrability allows value chain cooperations that are the smoother, the closest production and integration of the various components can be, which lets foresee chances for Europe to maintain its share in the domestic market. In this respect, opportunities for growth and jobs creation will not only be linked to production, but also to the integration of the PVs in the final components according to the application, thus having impact at the whole value chain level.

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

- 380 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:



- Patents by KET(s):

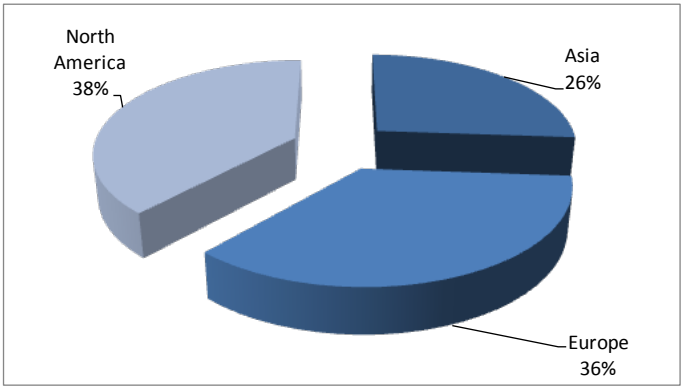


- Patents by KET(s) and relevant combinations of KETs:

KET(s)	*Number of patents*
AM	64
AM / MNE	63
AM / MNE / N-T	3
AM / MNE / N-T / PhT	2
AM / MNE / PhT	60
AM / N-T	3

KET(s)	*Number of patents*
AM / N-T / PhT	2
AM / PhT	60
AMS	8
AMS / MNE	8
AMS / MNE / PhT	8
AMS / PhT	8
MNE	376
MNE / N-T	14
MNE / N-T / PhT	11
MNE / PhT	351
N-T	15
N-T / PhT	11
PhT	353

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection: