

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.2.3: Carbon Capture and Storage (CCS)

Scope:

To develop new and improved carbon capture technologies – i.e. post-combustion, pre-combustion, oxy-fuel – as well as to optimize the storage capacity and efficiency along with the development of a complete storage infrastructure (encompassing Enhanced Oil or Gas Recovery (EOR/EGR), depleted Oil and Gas fields, deep saline aquifers, etc.), all allowing for the reduction of costs and energy consumption in carbon capture and storage (CCS).

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

- Contribute to tackle the “secure, clean and efficient energy” challenge
- Contribute to the reduction of greenhouse gas emissions

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

- Cope with regulation related to greenhouse gas emissions
- Keep costs low under the EU's Emissions Trading Scheme (ETS)

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

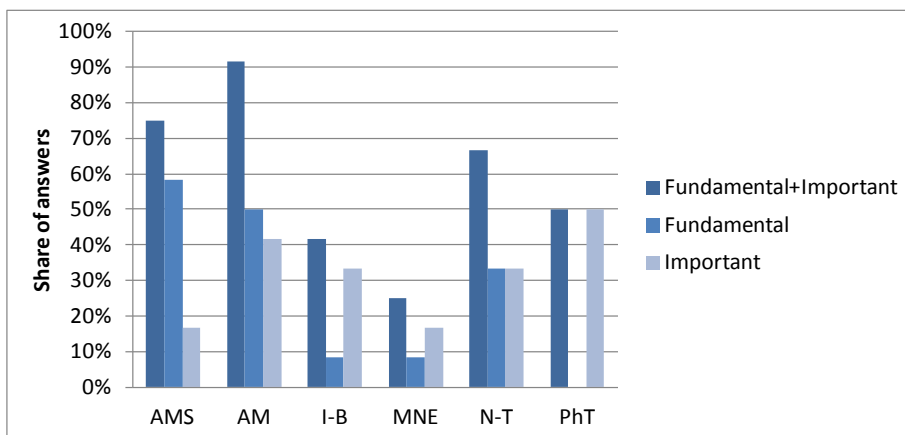
- Further R&D on the current portfolio of capture technologies – post-combustion, pre-combustion and oxy-fuel – and identification of improvements in those closest to commercial maturity
- Development of new CO₂ sorption media and processes for post-combustion technology
- Improvements in combustion, flue gas treatment and CO₂ cleaning for oxy-fuel technology
- Development of integrated processes for pre-combustion and oxy-fuel technologies
- Plant integration for all three capture technologies
- Improvements and up-scaling of gasifiers, hydrogen-gas turbines, carbon monoxide-shift and CO₂ capture for pre-combustion technology
- Enhancement of CO₂ compression
- Development of a complete transportation infrastructure (encompassing onshore pipeline, offshore pipeline, ships, rail/road tankers), including industrial sources of CO₂
- Optimization of storage capacity and efficiency and development of a complete storage infrastructure (encompassing Enhanced Oil or Gas Recovery (EOR/EGR), depleted Oil and Gas fields, deep saline aquifers, etc.)

Contribution by cross-cutting Key Enabling Technologies:

In respect to this Innovation Field, the integration of KETs could contribute to the further development of the current portfolio of carbon capture technologies, along with the improvements and up-scaling of gasifiers, hydrogen-gas turbines, CO₂ compression, and the development of a complete transportation and storage infrastructure (encompassing pipelines, ships, rail/road tankers, reservoirs, etc.).

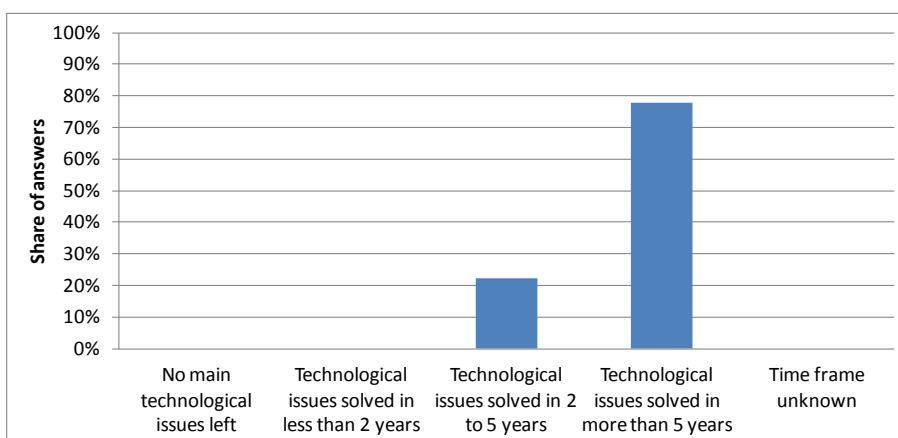
To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong 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)
- 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 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, the provision of support in the medium term should be taken into consideration within this framework.

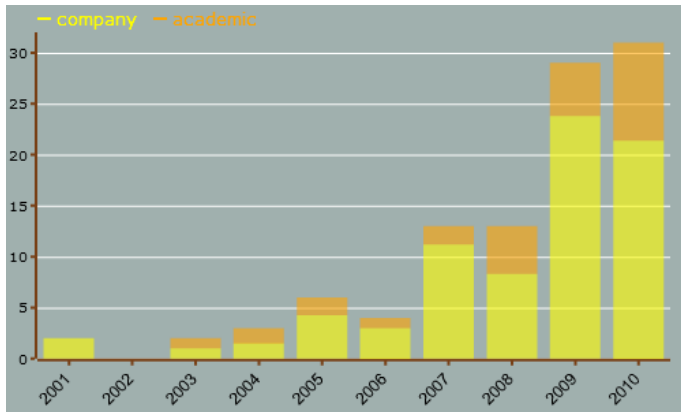
Additional information according to results of assessment:

➤ **Impact assessment:**

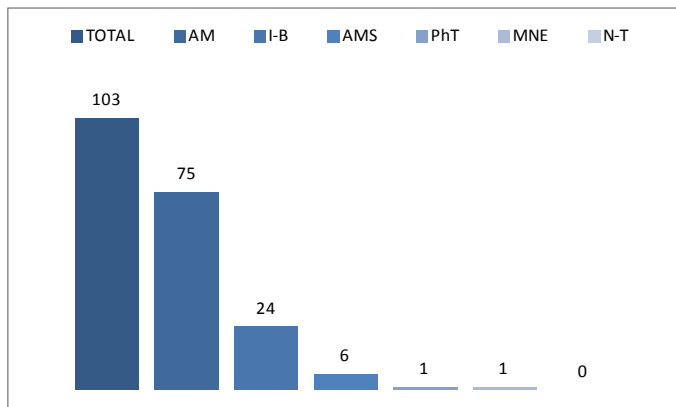
- Though carbon capture and storage (CCS) technologies and processes have been leveraged in industrial and oil and gas applications for decades, only in recent years they have been adapted and demonstrated on large-scale coal power plants. The driving force behind capturing and sequestering carbon is the need to find cost-effective solutions for the reduction of CO₂ emissions globally where there is a continuous and rising demand for energy worldwide.
- Carbon capture and storage is likely to spread globally through expanded international collaboration and financing for the deployment especially in developing countries. Within this framework, the competitive landscape for supplying the equipment and the engineering in the carbon capture and sequestration market is rapidly intensifying. Among the leading market players of this industry there are European companies operating worldwide such as Aker Clean Carbon (Norway), Siemens (Germany), Linde AG (Germany) and ALSTOM Carbon Capture (France) that are competing mainly with companies from the US.
- Sources: International Energy Agency Coal Industry Advisory Board, Clean Coal Technologies, Accelerating Commercial and Policy Drivers for Deployment, February 2008; MarketResearch.com, Clean Coal Technologies Markets and Trends Worldwide, 2nd Edition, January 2012.

➤ **Results of patents scenario analysis:**

- 103 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 with intensification in the patenting activity by academic applicants in most recent periods, most probably standing for new technologies having been patented in the corresponding periods:



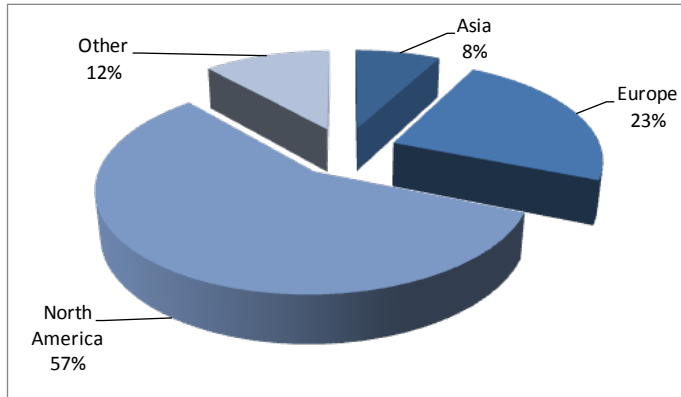
- Patents by KET(s):



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

KET(s)	Number of patents
AM	75
AM / IBT	2
AMS	6
AMS / AM	1
IBT	24
MNE	1
MNE / PhT	1
PhT	1

- Patent distribution by (Applicant) organization geographical zone:



- Patent distribution by geographical zone of priority protection:

