

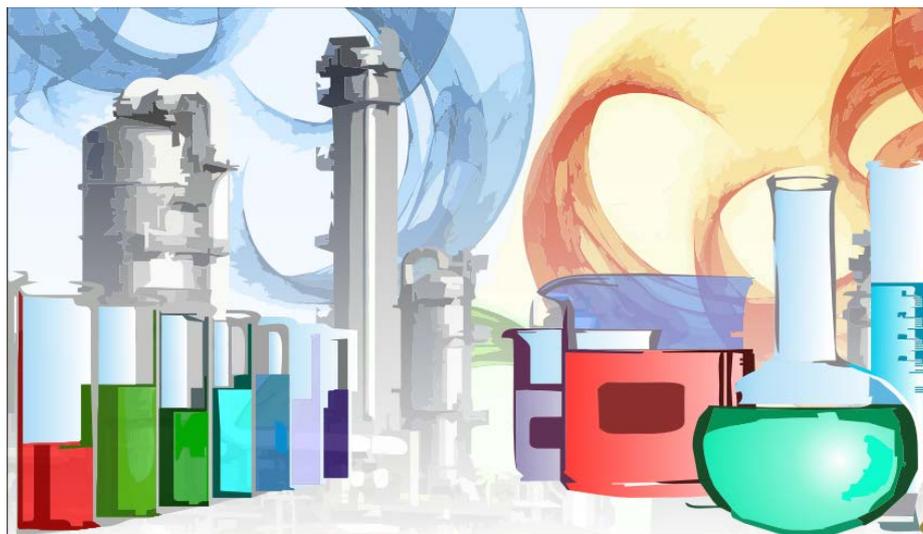
This fiche is part of the wider roadmap for cross-cutting KETs activities

**'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 Chemical Processes, Chemicals, Chemical Products and Materials 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.

## CH.3.5: Condition-monitoring for continuous assessment of plant component state and residual life time

### Scope:

Advanced condition-monitoring tools (based on e.g. robust miniaturised sensors and inline analyser technology) for continuous assessment of plant component state and residual life-time.

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

- Tackle the “climate action, resource efficiency and raw materials” challenge, indirectly also contributing to address challenges such as “smart, green and integrated transport” and “secure, clean and efficient energy”

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

- Cope with highly flexible modes of plant operation, resulting in more frequent start-ups and shutdowns, thus in higher fatigue
- Improve reliability as well as safety of plants through the effective prediction (and then avoidance) of equipment failures
- Minimise down-time through the integrated planning and scheduling of repairs
- Maximise equipment and component life time by avoiding the conditions that would normally reduce it
- Maximise equipment performance and throughput
- Provide for preventive maintenance approaches in order to ultimately reduce operational and maintenance costs

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

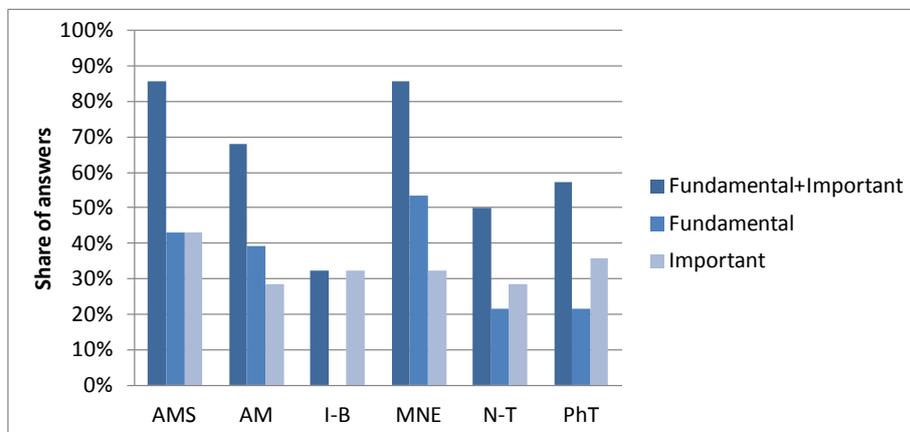
- Development of robust miniaturized sensors and inline analyzer technology utilizing advanced process analyzers which meet the requirements of process analytical technology to enable local process control
- On a global plant operation level, development of new monitoring tools for continuous assessment of plant component state and residual life time
- Development of methods allowing to achieve greater accuracy in failure prediction

### 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 condition-monitoring tools as well as approaches for the real-time, continuous assessment of the state as well as residual life-time of plant components, thanks to the integration of pervasive sensing approaches provided by a multitude of robust, miniaturised and highly specialized sensors and in-line analysers.

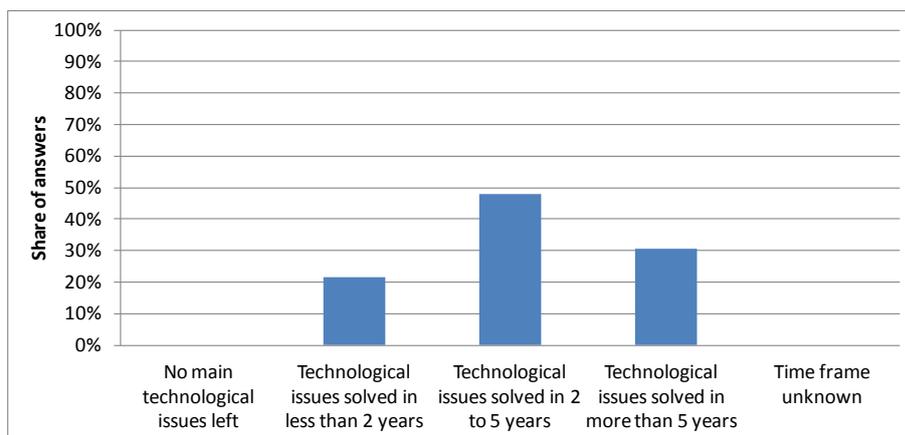
To this aim, the combination of KETs experts' opinions collected through the dedicated survey (whose result is depicted in the below bar chart), the examination of KETs-related patenting activity in respect to this Innovation Field, and desk research activities, have allowed identifying a rather strong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



### 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 both shorter and 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 term should be taken into consideration within this framework.

### Additional information according to results of assessment:

#### ➤ Impact assessment:

- Especially the power plants face today, more than in the past, the need to cope with highly flexible modes of operation, resulting in more frequent start-ups and shutdowns, hence in higher fatigue. Within this framework, preventive maintenance approaches can ultimately reduce operational and maintenance costs thanks to preventing failures, while ensuring safer operation. Online diagnostics enabled by the introduction of robust miniaturized sensors and inline analyzer technology can have a number of benefits in this respect when increasingly integrated into process control systems.
- Stemming from the nuclear power sector, online condition monitoring and diagnostics nowadays enabled by the use of advanced technologies (such as, but not limited to, Vibration Measurement and Analysis, Infrared Thermography, Lubricating Oil Analysis and Tribology, Ultrasonics, Motor Current Analysis, Corrosion Analysis, etc.) that allow the determination of equipment condition, and potentially to predict failure, has more recently been introduced as well in conventional power plants as well as chemicals, petrochemicals, pulp and paper, metals production, and heavy equipment manufacturing, while it is also generating interest in smaller size manufacturing plants for machine performance monitoring.

- Growth in the condition monitoring equipment market has long been driven by capital investments. Condition monitoring has gained importance, over the years, as companies critically focused on asset utilization and productivity. The need for eliminating catastrophic breakdowns and unnecessary maintenance costs in production processes has and will continue to drive the adoption of condition monitoring solutions across several industries. As a result, the global machine condition monitoring equipment market has been predicted to reach 1.5 billion Euro by 2015.
- Similar to most technology-driven instrumentation industries, the condition monitoring market is dominated by large international players driving industry growth, price points, and technology innovation. Among the major players in the marketplace there are Brüel & Kjær Vibro, ClampOn AS, Corpro Companies Inc, Data Physics Corporation, DLI Engineering Corp, Emerson Process Management, FLIR Systems Inc, GE Energy, Honeywell Process Solutions, ITT Corporation, Kittiwake Developments Limited, PCB Piezotronics Inc, Rockwell Automation Inc, Rohrback Cosasco Systems, Scientific Monitoring Inc, Shinkawa Electric Co Ltd, SKF Condition Monitoring Inc, SPM Instrument AB, The Timken Company, among others. This restricts the growth and business potential of some of the smaller participants who may not have the financial wherewithal or marketing strengths that their larger counterparts command in order to compete in the most conventional markets such as power generation, chemicals, petrochemicals, pulp and paper, metals production, and heavy equipment manufacturing.
- Yet the challenge can be overcome by the smaller players by focusing on emerging opportunities from geographical, technological, and application perspectives. Besides the demand from the bulky industries, there is in fact increasing interest for new and different approaches that fulfil condition monitoring requirements, relying on simple, yet efficient solutions that can analyze and provide insight into machine conditions without having to spend excessively or interpret large volumes of data.
- Trends indicate that in North America and Europe, the condition monitoring business will be driven by upgrade and retrofit opportunities. As such, it is likely that end users will continue working with their current suppliers or vendors. In other geographical regions, however, and in the industrial sectors not conventionally applying condition monitoring approaches, new equipment sales and new installations are expected to drive revenue and generate opportunities for the smaller market players and new participants. Renewable energy, particularly hydroelectric and solar power, is an end-user market that offers significant growth potential for the future. Moreover, customers with limited budgets who cannot afford permanent systems can opt for temporary online systems. Helping companies that have identified a particular asset or machine with regular problems by installing a temporary system to gather data over a certain period until the problem is identified and resolved, presents an important revenue opportunity for condition monitoring vendors.
- There are several smaller European players that specialize in process control, which can today expand their business to integrated process control providing condition monitoring and diagnostics as part of their offer. In terms of value chain, this encompasses condition monitoring equipment manufacturers and suppliers, condition-monitoring contractors, and organisations employing condition monitoring techniques for services aimed at effective plant operation and maintenance.
- Sources: Reliable Plant, [www.reliableplant.com](http://www.reliableplant.com); PRWeb, [www.prweb.com](http://www.prweb.com); Frost & Sullivan Research Service, [www.frost.com](http://www.frost.com); Global Industry Analysts Inc., Machine Condition Monitoring Equipment: A Global Strategic Business Report, 2011

➤ **Results of patents scenario analysis:**

- 3 exclusively KETs-related patents identified in the period 2001-2011 for the specific Innovation Field
- No significant patent-related indicators can be reported in this field