ORIENTATION PAPER

PROPOSED PRIORITIES FOR 2012

Working document ***– not legally binding***

COOPERATION

THEME 4

NANOSCIENCES, NANOTECHNOLOGIES, MATERIALS AND NEW PRODUCTION TECHNOLOGIES - NMP

(European Commission C(2011) XXXXX)

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Table of Contents

(page 4 left blank)

Objective: Improve the competitiveness of European industry and generate knowledge to ensure its transformation from a resource-intensive to a knowledge-intensive industry, by generating step changes in knowledge and implementing decisive knowledge for new applications at the crossroads between different technologies and disciplines. This will benefit both new, high-tech industries and higher-value, knowledge-based traditional industries, with a special focus to the appropriate dissemination of RTD results to SMEs. These activities are primarily concerned with enabling technologies which impact all industrial sectors and many other Seventh Framework Programme themes.

I. CONTEXT

The **Innovation Union**[1] initiative underlines that research and innovation are key drivers of competitiveness, jobs, sustainable growth and social progress. The Work Programme 2012 has been designed to support the implementation of the Innovation Union Initiative and in particular to bring together research and innovation to address major challenges.

The Work Programme can contribute to the innovation objective in two ways, and constitutes a significant change to the approach in earlier work programmes:

- By supporting more topics aimed at generating knowledge to deliver new and more innovative products, processes and services. This will include pilot, demonstration and validation activities.

  The focus on innovation will be reflected in the description of the objectives and scope of the specific topics, as well as in the expected impact statements. The innovation dimension of the proposals will be evaluated under the criterion 'Impact'.

- By identifying and addressing exploitation issues, like capabilities for innovation and dissemination, and by enhancing the use of the generated knowledge (protection of intellectual property rights like patenting, preparing standards, etc).

Information on the Risk-Sharing Finance Facility (RSFF), an innovative financial instrument under FP7, is available on line[2]. The Commission will respond to further needs of potential beneficiaries for information on the RSFF (by, e.g., awareness-raising activities in conjunction with the European Investment Bank, participation to thematic events).

I.1 Approach for 2012

Broadly speaking, calls of the NMP Theme in 2012 and 2013 will continue to span the spectrum from enabling research, to applications and demonstration activities. The NMP Theme covers the entire range of industrial research activities. Sustainability and societal challenges have always been implicit in NMP strategies, but are receiving increased attention. In a few words, the NMP Theme focuses on smart and sustainable growth, for a greener industry, its three constituent activities being the tools rather than ends in themselves.

A key feature of the 2012 Work Programme (WP) is the participation for the third year in actions within the European recovery package. Starting with the WP 2010, the NMP Theme

[1] COM(2010)546
[2] http://www.eib.org/products/loans/special/rsff/?lang=en and http://ec.europa.eu/invest-in-research/funding/funding02_en.htm

supports the **European Economic Recovery Plan**, through three **Public-Private Partnerships** (PPPs): 'Factories of the future', 'Energy efficient Buildings' and 'Green cars'.

The development of this Work Programme benefited from many different inputs, such as those of the NMP Expert Advisory Group and the European Technology Platforms. Inputs from other FP7 Themes and policy needs have also been taken into account, as have the results of studies, workshops and surveys carried out in the last years.

Although there is an increasing emphasis on applications, longer-term, research in **key enabling technologies** is seen as a crucial driver of innovation in the areas of nanotechnology, materials and advanced manufacturing, and is also supported, mainly through small and medium collaborative projects. The guiding policy in this area is the Strategy for Key Enabling Technologies,[3] which includes nanotechnology, materials and manufacturing, and sets the basis of the future of European industry.

In the nanotechnology field, another guiding policy is the Nanotechnology Action Plan.[4] The current emphasis is on the three pillars of enhanced innovation in nanotechnology; effective safety and regulatory measures; and a strong societal and communication dimension. This Work Programme will develop the potential of nanotechnology to address both industrial competitiveness and societal challenges, while ensuring safety for the consumer and the citizen.

With regard to **specific challenges**, the following issues are addressed:

Energy and Energy efficiency: These activities are in tune with the Strategic Energy Technology (SET) Plan. They include topics in support of the '**European energy-efficient buildings**' PPP initiative, outlined below.

Environmental issues and sustainable development: These topics complement activities of the Environment and the Food, Agriculture and Fisheries, and Biotechnology (FAFB) Themes.

Raw Materials: In support of the Commission's Raw Materials Initiative,[5] research is supported on the extraction and processing of raw materials; reduction of waste and recycling.

Health and safety: This covers research based on nanomedicine and materials for health, complementing the Health Theme. It also includes research necessary to ensure the safe use of nanotechnologies, building on an extensive body of previous work under the NMP Theme.

Factories of the Future: The objective of this PPP initiative is to help EU manufacturers across sectors, in particular SMEs, to adapt to global competitive pressures by increasing the technological base of EU manufacturing through the development and integration the enabling technologies of the future, such as engineering technologies for adaptable machines and industrial processes, ICT, and advanced materials. Demonstration-targeted activities include high-performance manufacturing technologies (covering efficiency, robustness and accuracy); and technologies for casting, material removing and forming processes.

European energy-efficient buildings: This PPP initiative promotes green technologies and aims at the development of energy-efficient systems and materials in new and renovated buildings with a view to reducing radically their energy consumption and CO2 emissions. These activities are in tune with the Strategic Energy Technology (SET) Plan.

Green Cars: This PPP supports research on a broad range of technologies and smart energy

[3] COM(2009)512
[4] COM(2009)607
[5] COM(2008)699

infrastructures, essential to achieve a breakthrough in the use of renewable and non-polluting energy sources, safety and traffic fluidity.

I.2 Research relevant for industrial innovation and SMEs

NMP pays particular attention to the involvement of industry, through its direct participation in projects (which has increased from 35% in FP6 to 40% in FP7), as well as more general and strategic interactions, in particular with the ETPs. It ensures that innovation issues are properly addressed.

By using SME-targeted collaborative projects and appropriate topics, the NMP Theme will continue to provide **strong support to SME participation** – which is currently around 23% in budgetary terms in projects funded under the NMP Theme. In the Work Programme 2012, the budget for SME-targeted projects alone is 15% of the total. The topics in question will continue to be defined with the aim of reinforcing the S&T base of SMEs and validating innovative solutions.

Innovation-specific elements have been included in 29 out of 47 topics in this Work Programme:

Demonstration and validation activities, already addressed in PPP topics, receive increased attention, possibly going beyond pilot implementations in industrial settings. For nanotechnologies, in particular, demonstration activities will continue to explore ways of evolving from a laboratory environment into industrial scale production. An example is the up-scaling in the precision synthesis of nanomaterials for high-value sectors. Further examples include on-site validation of nanoparticles for soil and groundwater remediation; pilot implementations of new high-performance manufacturing technologies; and validation of solutions for energy efficiency in existing buildings and different climates.

Ancillary issues in innovation are also being addressed: these are safety and regulation; IPR; standardisation; the availability of skilled workforces; substitution of critical raw materials; and support for technology transfer.

The increasing emphasis placed on innovation-related activities is reflected in the proportion of the budget dedicated in this Work Programme to large, DEMO- and SME-targeted collaborative projects, more than 60% of the total. For the same reason, the average allocation of budget to each topic for large collaborative projects (used for application-oriented topics) is being increased – from EUR 15 million to EUR 17 million per topic *on average*.

Computer simulations and models, which have seen many advances and have the potential to revolutionise the design approaches of European industry, can be included where appropriate.

Standardisation, for projects whose results are nearing market introduction, is often a key enabler for interoperability and ensures product quality and open markets, thereby building consumer confidence. Standardisation can foster access to the market for innovative solutions and thus help ensure the practical application of research results. Projects can strengthen future innovation through standardisation by considering the inclusion of pre- and co-normative research, and the integration of standardisation organisations.

High-quality and creative product design is recognised as a key asset for the future ability of European industry to respond to demand and lead in the global competition. Where appropriate, innovative design has to be integrated with the development of technology. The knowledge base necessary for innovation combines cutting-edge science and technology with

creativity and culture in the broader sense.

NMP also aims to enhance the use of project results and provides external assistance through the '**Exploitation Strategy and Innovation Consultants**' (ESIC) service. This helps identify and address possible obstacles in the exploitation of the intended results. It is being extended to *include support for patenting*.

I.3 International Cooperation

The focus is on subjects which are in interest of European industries (e.g. standardisation). An example is the support for the international initiative of Intelligent Manufacturing Systems (IMS), in the topic on standardisation and in Factories of the Future. Further examples are the SICAs for cooperation with Eastern Partnership and ASEAN countries on materials.

I.4 Theme specific information

The Work Programme 2012 introduces each area and gives a description of the topics for which project proposals are invited. The description of each topic, in addition to the technical content and scope, includes any participation requirements (e.g. industrial participation) and the expected impacts. For each topic, the Work Programme also specifies which funding scheme is to be used:

- ***Collaborative Projects*:** *Small or medium scale focused research projects* and *Large scale integrating projects* (which may include additional activities such as demonstration, innovation-related activities, education and training) are implemented via separate calls. For these two funding schemes, there are upper and lower limits respectively on the requested EU contribution, set out in Section III, Implementation of Calls. **It is important to note that these funding limits are applied as additional eligibility criteria**. In general, *Small or medium scale focused research projects* are more research-oriented, whereas *Large scale integrating projects* are aimed more at research for applications and innovation.

- ***SME-targeted collaborative Projects*:** In these projects, the participating SMEs should have the decision making power (although the coordinator need not be an SME); and the output should be for the benefit of the participating SMEs and the targeted SME dominated industrial communities. Whilst there is no lower or upper limit on the requested EU contribution for this funding scheme, an **additional eligibility criterion** applies: the estimated EU contribution going to the participating SME(s) has to be 35% or more of the total estimated EU contribution.

- ***DEMO-targeted collaborative Projects*:** These collaborative projects have a special emphasis on demonstration activities, in order to prove the industrial viability of new technologies that have clear economic potential and/or societal advantages. Projects should focus on both research and demonstration activities, with a clear connection between them. The demonstration activities can include, for example, technical/economic review of the new technology, benchmarking and validation activities; the creation and testing of prototypes, test-beds or mock-ups; the up-scaling in industrial environments of research results available at laboratory scale; pilot implementation in industrial settings; and the possible creation of technology infrastructure for end users. The deliverables under the demonstration activities should lead to market uptake but should not be commercialised themselves, and product development is excluded. Demonstration of the new technologies to the wider community is also important in these projects and therefore a thorough dissemination and exploitation plan

has to be among the project deliverables, in order to guarantee further application and market uptake. Whilst there is no lower or upper limit on the requested EU contribution for this funding scheme, the target is that proposals allocate around 50% of the total eligible costs of the project (excluding management costs) to demonstration activities.

- ***Coordination and Support Actions*** may relate to coordination, networking or supporting activities at European and international, national or regional level. The organisation of events, studies, where relevant, organisation and management of joint or common initiatives may be included, as well as activities aimed at supporting the implementation of the Theme, such as dissemination, information and communication and activities to stimulate and encourage the participation of civil society organisations.

The forms of the grant to be used for the funding schemes in this part of the Work Programme are set out in Annex 3.

NMP focuses on a wide range of industrial sectors and a wide range of RTD domains.

- The **range of industrial sectors** evidently covers those key sectors which concern industrial production, such as manufacturing and chemical processing, but it also extends to traditional sectors (construction, textiles etc), which are moving up the high-technology innovation stream, and to other sectors striving to maintain and increase their leading position within the EU (electronics, photonics, medical equipment etc). Manufacturing and construction have been specifically and particularly addressed through the PPP initiatives.
- The **RTD domains** supporting the transformation of industry include (a) nanosciences and nanotechnologies that are becoming one of the new paradigms and enabling factors across virtually all fields of science and technology; (b) materials that are rapidly acquiring knowledge-based features; and (c) the products/production-related technologies that are pushing towards the 'factories of the future', something that will strongly underpin the revolution that is needed, as it is was illustrated by the emergence of the 'Factories of the future' PPP initiative within the recent EU recovery package.

Industrial involvement is crucial in safeguarding the industrial relevance of the activities supported in the NMP Theme. Direct industrial participation as partners in projects is encouraged across all topics of the NMP Theme.

The **submission** and **evaluation of proposals** for Collaborative Projects (including those dedicated to SMEs) will be carried out in **two stages**. The rationale for this is the nature of this Theme, which is multidisciplinary, cross-sectoral and SME intensive, and for which a 'bottom-up' approach is encouraged. On the other hand, the calls for the PPP initiatives will use a single-stage evaluation, reflecting the urgency of the recovery plan.

The first-stage proposal in two-stage evaluations should focus on the S&T content and on a clear identification of the intended results, their intended use and the expected impact (economic, social, environmental etc). It will be evaluated on the basis of two criteria: **scientific quality** and **expected impact**. Coordinators of retained first-stage proposals will be invited to submit a complete proposal, which will be evaluated against the entire set of evaluation criteria.

Participation of women in research and gender dimension

The pursuit of excellence in scientific knowledge and in its technical application towards socially acceptable products, processes and services requires greater inclusiveness of a

diversity of perspectives. In particular the overall process of transforming European industry will not be achieved without the talent, perspectives and insights that can be added by a more balanced participation of women and the integration of gender issues in RTD activities.

Increasing the diversity of perspectives particularly (but not exclusively) to gender issues at the level of the NMP objectives and topics may have a particular relevance in areas such as new business and organisational models, increasing the level of comfort and user friendliness provided by materials and industrial products, improved understanding of toxicity and risk and in all areas where industrial technologies research is aimed at medical application (e.g. nanomedicine - diagnostics, drug delivery or regenerative medicine). The NMP Theme is committed to undertaking specific measures to ensure practical uptakes of this issue together with industry.

More generally, and in accordance with the rules for the submission and evaluation of proposals, a reasonable gender balance in evaluation panels is sought[6].

[6] The European Communities pursue an equal opportunities policy and aims in particular at achieving in the medium term at least 40% of members of each sex in each expert group and committee (Commission Decision n°2000/407/EC of 19 June 2000 relating to gender balance within the committees and expert groups established by it).

II. CONTENT OF CALLS

This section describes all the topics for which proposals will be called in this work programme. This concerns only the content of the calls. For the practical modalities related to these calls, please refer to section III 'Implementation of calls'. For actions not implemented through calls for proposals, please refer to section IV 'Other actions'.

II.1 Activity 4.1 Nanosciences and Nanotechnologies

Nanosciences and nanotechnologies research, development and innovation are governed by an *integrated, safe and responsible policy framework*[7]. This development strategy is being implemented through a wide range of activities whose purpose it is to ensure that development and deployment of nanotechnology are carried out in a way that takes people's expectations and concerns into account, especially as regards human and environmental safety, and delivers tangible benefits for the citizen and the society.

Sales forecasts for products incorporating nanotechnology range from $1 trillion to $3 trillion by 2015. Current sales figures are still some way away from these figures, but the growth trend is following the projections. Indeed, nanotechnology research results have started to migrate from the confines of the laboratory towards real applications in various industrial sectors.

Societal, governance and health-safety-environment related issues must seamlessly accompany the development of industrial applications. Research must be complemented by, and provide support to a careful review of the regulatory landscape, reflections on ethical issues and outreach.

This is reflected in the WP structure, highlighting four areas of emphasis for nanosciences and nanotechnologies: *Maximising the contribution of nanotechnology on sustainable development; Nanotechnology for benefiting Environment, Energy and Health; Ensuring safety of nanotechnology; and Cross-cutting and enabling R&D.*

During the second half of FP7, the implementation is characterised by a gradual shift from fundamental research towards more application-oriented research. Faster introduction of nano-based applications into markets contributes to innovation-led competitiveness for European industry as well as provides significant societal and economic benefits.

In this context, the significant public investment made in nanotechnology research must provide a return to society in terms of contributing towards solutions to major societal challenges. Nanotechnology has significant potential to improve sustainability and to become a source of innovation in many industrial sectors.

The aim is, therefore, to cover important European Technology Platform related priorities for sustainability, e.g. in chemistry, construction, textile, fibres and forest based industries,

[7] Nanosciences and Nanotechnologies :An action plan for Europe2005-2009

transport and agro-food related sectors, with nanotechnology as the key enabling technology. Further, Energy, Environment and Healthcare are at the forefront of global challenges, and of concern to every citizen. Notwithstanding the significant economic potential of environmental, energy and health technologies, nanotechnology must stand in the forefront for providing solutions.

In the light of available scientific evidence and public concerns associated with the potential risks of nanotechnologies and their applications, **scientific investigators are strongly encouraged to pay renewed attention to safety** – the safety of workers, the public and the environment. This Work Programme stresses not only the necessity to consider safety aspects from the beginning and the desirability of inherently safe design, but also requires that projects include a full scientific and/or technical risk assessment as well as proposals for risk mitigation measures, where appropriate.

Although safety is an integral part of all application related research, there is also a need for a more concerted approach. In nanosafety research, the emphasis of the NMP Theme is shifting from toxicology studies of individual nanomaterials towards more holistic safety assessment and management that manages overall risks. Agreed methods, techniques, equipment for toxicity studies, occupational exposure assessment and for risk reduction and mitigation will be an important part of this work.

As material systems and device structures become nanosized and nanostructured, significant challenges exist related to design and growth of these structures in a precise and reproducible manner. The analysis of their three-dimensional structure, properties and functions with a high level of precision poses another challenge. Detailed knowledge of e.g. the chemical, electronic and magnetic properties of nanomaterials is a pre-requisite for being able to tailor their functions in a controlled way. In the face of these challenges, the development of a wider range of nano-enabled applications requires continued significant R&D support in cross-cutting areas and technologies, such as instrumentation, characterisation, modelling and design.

II.1.1 Maximising the contribution of Nanotechnology to sustainable development

The potential contribution to sustainable development makes nanotechnology one of the key enabling technologies. This activity will give priority to potential applications incorporating nanotechnology in various industrial sectors which have a significant potential to improve sustainability e.g. in terms of material, energy or process efficiency, industrial productivity in addition to contributing industrial competitiveness and bringing benefits to consumers. The uptake of nanotechnologies in existing industrial sectors, while addressing unintended consequences, is expected to promote a step change in industrial performance and possibly leading to totally new production-consumption patterns or manufacturing processes.

Wherever appropriate, an interdisciplinary approach integrating different technologies, sciences or disciplines should be considered. This includes health, safety and environmental issues from life-cycle perspective as well as modelling, nomenclature, metrology and standardisation.

NMP.2012.1.1-1 Rational design of nano-catalysts for sustainable energy production based on fundamental understanding

Technical content/scope: Catalysis is a major science behind sustainability. No matter what the energy source is – oil, natural gas, coal, biomass or solar – a clean sustainable energy future will involve catalysis. Even today catalyst development remains largely descriptive and phenomenological because of the complexity of catalyst compositions and reaction pathways. A development based on fundamental understanding and prediction of catalyst efficacy at the atomic scale is imperative if we are to harvest the enormous potential of catalysis. The strategic objective is to progressively establish over the next years a rational catalyst design strategy based on microscopic (atom-to-atom) understanding that would release the potential of catalysts for sustainability and productivity.

The aim of this topic is to target the rational design of novel nano-dimensional catalysts for sustainable energy production. It would be based on the detailed understanding gained from fundamental experimental and theoretical studies that relate bulk and surface structure and performance stability to application requirements with very high selectivity. Projects should develop design capability for novel catalytic systems with pre-defined properties, such as improved activity and/or controlled chemical selectivity.

The specific challenges relate to:

- Elucidating the atomic-scale structure and related properties of catalytically active materials and, in interplay between experiment and theory, resolving the key parameters that control catalytic activity and product pattern distribution on the macroscopic scale.
- Catalyst development with respect to porosity, acidity, basicity, metal-support interactions, controlled formation of appropriate (size, shape and composition) catalyst particles.
- Exploration, optimisation and control of the catalytic process. Improved hydrothermal stability and resistance to catalyst deactivation should be considered.

Laboratory-scale validation of the nano-catalyst design and modelling for a specific catalytic process for energy production is essential.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Small or medium-sized collaborative projects.

Expected Impact: Rational catalyst design capability will enable fast industrialisation of tailor-made, catalytic materials of very high activity and selectivity, and minimum energy use in their preparation and during the work cycle. Apart from improving the performance of existing industrial processes for energy production, nano-catalysts have the potential to lead to exploitation of renewable, efficient, and inexpensive sources for alternative energy production. Nano-catalysts also have the potential to reduce Europe's reliance on imported rare earths/precious metals.

II.1.2 Nanotechnology for benefiting environment, energy and health

Nanotechnology is an evolving technology which can significantly contribute to raising living standards and improving the quality of life. Many promising applications and products have been identified in the fields of environmental protection, energy efficiency, and healthcare and many more applications are expected in the future. Nanotechnology offers a potential

'win-win' opportunity for both meeting the most urgent societal challenges while contributing to the transition towards an eco-efficient economy and innovation-led growth. However, this potential is as of yet far from full realisation – and in many cases, the viability of industrial-scale applications needs to be verified in a way that replaces established industrial products and practices.

The main objective of this activity is to support the development of nanotechnologies that can benefit the environment, energy and health while addressing unintended consequences. Industrial innovation is promoted by developing nanotechnologies that will enable both the manufacturing of new, higher performance 'nano-enabled' services, products, components, devices and systems across a range of applications, e.g. water purification, innovative photovoltaics and new therapeutics using nanotechnology. Whenever appropriate, an interdisciplinary approach integrating different technologies, sciences or disciplines should be considered. This includes health, safety and environmental issues from life-cycle perspective as well as modelling, nomenclature, metrology and standardisation.

This section includes one topic related to the environment and two related to health (including an ERA-NET), while two topics related to energy have been included as part of the Energy-efficient Buildings initiative (see section II.5.2 below); and of the Green Cars initiative (see section II.5.3 below).

NMP.2012.1.2-1 Nanotechnology solutions for in-situ soil and groundwater remediation

Technical content/scope: The quality of soil and groundwater is an essential asset. Because of industrial and military activities or accidents, harmful substances are often present in soil and groundwater (pesticides, nitrates, mineral oils, heavy metals, chlorinated, aromatic or polycyclic aromatic hydrocarbons, phenols, cyanides, arsenic, H2S, etc). Cleaning these substances ex-situ by mechanical removal of the contaminated material (e.g. pump and dump) or active in-situ methods (e.g. pump and treat) is often very costly. Passive in-situ remediation methods utilising nanoparticles, e.g. zero-valent materials (ZVM) which are introduced into the soil have been shown to be effective catalytic materials to transfer organic or inorganic contaminants into less harmful or harmless substances. Absorption of contaminants can also be considered. The topic aims to address the various problems which are still present preventing the widespread use of mobile nanoparticles for in-situ site remediation.

The research objectives are as follows:

- Determination and optimisation of the mobility, reactivity (or absorbability) and functional life-time of nanoparticles in the soil using model soils;
- Determination of the reaction products of model reactions of mobile nanoparticles and assessing any possible unintended secondary effects on environment and ecosystem;
- New analytical methods for determining the fate of nanoparticles in the soil;
- Improving nanoparticles or associated carriers/coatings with respect to efficiency in treating various contaminants or groups of contaminants by modifying e.g. the size, surface chemistry, structure or formulations, as well as treatments schemes.

The project work should include on-site validation of the results on a representative scale both in terms of the effectiveness of nano-remediation as well as the environmental fate of the utilised nanomaterials and associated by-products.

Photo-catalytic materials are excluded from the scope of this topic, as they are covered by topic NMP.2012.2.2-6.

In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Large-scale integrating collaborative projects.

Expected Impact: Current methods for contaminated soil and groundwater treatment are costly and time-consuming. Nanoparticle-based remediation has the potential to minimise the need for treatment and disposal of contaminated soil, by removing organic contaminants or transforming inorganic contaminants into harmless forms. In turn, this will reduce the overall costs and time of cleaning up large-scale contaminated sites. New knowledge will be generated on the long-term feasibility of nanoparticles-based remediation, e.g. for sites involving heavy metals and inorganic contaminants. Understanding the interaction of nanoparticles with their geological and biological surroundings will also contribute to improve current technologies for mining, oil and gas refining etc. After having more information about the potential hazards of mobile nanoparticles in soil and liquid media, further applications in waste water treatment may be feasible, for instance in removing valuable raw materials such as phosphates.

NMP.2012.1.2-2 Development and phase-I clinical trials of novel therapeutic nanotechnology-enabled systems for the diagnosis and treatment of atherosclerosis

Technical content/scope: Despite the progress of medical science of the past few decades, cardiovascular diseases remain the main cause of death worldwide and their management requires further improvement especially with regard to diagnosis and therapy of atherosclerosis and its main clinical manifestations (e.g. coronary artery disease and stroke).

This call topic aims at developing novel nanotechnology enabled diagnostic and therapeutic systems for atherosclerosis. An example might be the development of a nanotechnology-enabled combination system which targets atherosclerotic lesions with drugs activated by an external device and which is supported by a system for diagnosis and therapy follow-up. Priority will be given to research projects starting with available preliminary *in-vitro* efficacy experimental results and preliminary *in-vivo* safety data.

The development of a diagnostic and therapeutic nanotechnology-enabled system should be addressed in a multidisciplinary approach. Projects are expected to establish collaboration between stakeholders such as hospitals, the pharmaceutical industry, the medical devices industry, research organisations and academia. Support from an industry and/or a clinical research group with clinical trials experience is highly recommended.
In order to demonstrate biocompatibility and safety of the nanotechnology-enabled system, full toxicology studies have to be performed. Where appropriate, environmental and industrial safety risk assessments will be required. Animal testing should apply the 3R's principle (replacement, reduction, refinement).

The project should include appropriate regulatory work allowing initial studies on the safety and efficacy of the proposed diagnostic and therapeutic nanotechnology enabled system for human use. Subject to approval by the competent authorities, the conduct of clinical trials can then (but does not have to) be included in the proposed research project.

Funding Scheme: Large-scale integrating collaborative projects.

Expected Impact: The expected impacts are: (i) potential for radical improvement of diagnosis and therapy of atherosclerosis; (ii) improvement of the competitiveness of the European healthcare industry sector; (iii) increase of the application of nanotechnology in medicine.

NMP.2012.1.2-3 ERA-NET on Nanomedicine

Technical content/scope: This ERANET aims at coordinating the research efforts of the participating Member States and Regions in the field of nanomedicine and to implement joint transnational calls for proposals to fund multinational innovative research initiatives in nanomedicine.

Funding Scheme: Coordination and Support Actions (coordinating actions).[8]

Expected Impact: (i) Improve coordination and reduce overlapping and fragmentation in the fields of research of nanomedicine; (ii) achieve critical mass and ensure better use of limited resources in fields of mutual interests; (iii) share good practices in implementing research programmes; (iv) promote transnational collaborations and generate new knowledge.

II.1.3 Ensuring the safety of Nanotechnology

Nanotechnology-based applications will substantially improve the performance of many products through the unique properties of engineered nanoparticles. The same properties, however, raise questions and generate concerns with regard to potential health and safety risks. To support the safe development of nanotechnologies, these risks must be managed through identification of the hazard, knowledge of the potential adverse effects, measurement and control of the exposure. Risk management should become an integral part of the culture of the organisations involved in the supply chain. The objective is to support methods, techniques and equipment for occupational exposure assessment and risk reduction and mitigation; and their demonstration. The environmental fate and end-of-life treatment of products and waste containing nanomaterials are also of prime importance.

A key factor of success is the capacity to detect and measure the presence, mass, number and surface area of engineered nanoparticles; and to distinguish these from naturally occurring ones. These activities, in combination with the projects that have been launched with EU, national and international funding addressing the knowledge gaps on adverse effects on health and environment, will provide a good basis for risk management in industry and research facilities. A second objective is to prepare an 'intelligent testing' strategy to be applied for future toxicity testing of engineered nanoparticles. The variety of forms, functionalisation, and toxicity end-points necessitate a consistent strategy, streamlined with similar efforts around the world.

NMP.2012.1.3-1 Systematic investigations of the mechanisms and effects of engineered nanomaterial interactions with living systems and/or the environment

[8] This topic is for an ERA-NET. Only ERA-NET eligible partners can participate. The minimum number of participants is set at three independent legal entities managing publicly funded national or regional programmes, each of which is established in a Member State or Associated Country. Please refer to Annex 4 of the Cooperation Work Programme, including the Call Fiche FP7-ERANET-2012-RTD.

Technical content/scope: The rapid expansion of nanomaterials production and use in several products creates a need for understanding the mechanisms of nanomaterial interactions with living systems, and the environment, along their life cycle from manufacturing to recycling and to final disposal processes. Projects should be hypothesis driven investigations focusing on mechanisms of impact and seeking to identify to which degree commonalities across species exist. They should also seek to identify the key physico-chemical parameters and surface functionalities of nanomaterials that control environmental fate and biological effects, influence release and (environmental) mobility. To this end, the used materials should be thoroughly characterised, to establish a relationship between material features and observed biological effects. The overall aim is to identify commonalities across particle classes/types, resulting in a framework for classification of nanomaterials according to their biological impacts and to establish a link between nanomaterial-biomolecule interactions, the final sub-cellular localisation and the specific interference with cellular or extracellular signalling pathways (pathogenic mechanism) observed.

Proposals should address some or all of the following issues:

- Understanding the biological processes influenced by nanomaterials in living organisms throughout the life cycle of the nanomaterials.
- Quantification of nanomaterial interactions with biomolecules (proteins, lipids, sugars, nucleic acids) before and after uptake and localisation, and correlation of nanomaterial-associated biomolecules with nanomaterial fate & behaviour in cells / organisms / animals.
- Investigation of the potential for indirect effects related to nanoparticle exposure – e.g. genotoxicity, reproductive toxicity, immunological and signalling responses (including bystander effects between different cell types). Suitable endpoints for the assessment of indirect exposure effects should be defined and appropriate in vitro and in vivo methods for testing these should be assessed and validated. These should be suitable for nanomaterial testing, relevant in terms of outputs, and robust in terms of reliability and reproducibility.
- Systems biology approaches (transcriptomics, proteomics, metabolomics) to understand and compare pathogenic mechanisms of different nanomaterials across several species of increasing complexity.

In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners and other relevant parties such as authorities represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Large-scale integrating collaborative projects.

Expected Impact: The research will significantly advance the current state-of-the-art towards (i) increased understanding of the role of nanoparticle-biomolecule interactions in nanoparticle-induced impacts in living systems; (ii) gene or protein fingerprints or biomarkers with potential for determination of specific pathogenic mechanisms; (iii) new methods for systems toxicology leading to safer final nanoproducts through providing targets for engineering refinements of products; (iv) a framework for categorisation of nanomaterials on the basis of their bioaccumulation / biopersistence and a set of risk-factors for specific end-points, pathogenesis mechanisms; and (v) a screening platform for nanomaterials as part of a 'safe nanomaterials by design' strategy. Solutions will be provided to the long-term challenge of nanosafety and nanoregulation through the generation of high quality, systematic data

enabling the identification of no-observed-adverse-effect levels (NOAELs) as well as QSARs and modelling. Tailored outputs will address the needs of each of the stakeholder communities, including the modelling community.

To maximise their impact, funded projects will be expected to establish synergy with the EU NanoSafety Cluster; the EU Research Infrastructure for NanoSafety Assessment and other ongoing projects; and the NanoMedicine ETP; in order to facilitate research cohesion, integration, and advancement of the NanoSafety Cluster agenda.

NMP.2012.1.3-2 Modelling toxicity behaviour of engineered nanoparticles

Technical content/scope: The aim is to develop scientifically justified and technically viable methods for modelling human health and environmental effects of engineered nanoparticles, including their long term effects in the body or the environment.

The key research challenge is to establish techniques for modelling relationships between nanoparticle properties and toxicity. To this end, research projects should address (quantitative) structure-activity relationships, the modelling of the interaction of nanoparticles with biological (macro)molecules, biochemical pathways and systems and/or the analysis of biomolecular signatures and the development of biomarkers suitable to characterise the impact of engineered nanoparticles. The project should aim at the identification of physicochemical properties to be chosen for establishing groups of structurally similar particles, characterisation and classification techniques, the identification of biological responses relevant for establishing groups of nanoparticles with similar mechanisms of action, the test methods, and the relation of structural descriptors to toxicological targets. Projects should deliver the basis for categorising nanoparticles on the basis of physicochemical, structural and toxicological properties, and establishing relations between experimental (based on available, and critically evaluated, data) and simulated properties.

The Commission will facilitate the clustering of projects financed in this call and other relevant ongoing or future projects in the field of generic toxicity data acquisition and modelling methods. Dissemination of project results to health and environmental authorities as well as to industry must be considered in the proposals.

Additional eligibility criterion: The EU contribution must not exceed EUR 1 000 000 per project.

Funding Scheme: Small or medium-sized collaborative projects.

Expected Impact: (i) Contribution to the development of robust systems for evaluating the health and environmental impact of engineered nanomaterials. (ii) Reducing the need for empirical testing (reduction of costs, reduced need for animal testing). (iii) In the long term, contribution to predictive models for designing and engineering nanomaterials that are safe by design.

To maximise their impact, funded projects will be expected to establish synergy with the EU NanoSafety Cluster; the EU Research Infrastructure for NanoSafety Assessment and other ongoing projects; and the NanoMedicine ETP; in order to facilitate research cohesion, integration, and advancement of the NanoSafety Cluster agenda.

NMP.2012.1.3-3 Regulatory testing of nanomaterials

Technical content/scope: The fast development of manufactured nanomaterials and their presence on the market make it necessary to evaluate their environmental and health impacts. Significant research is being funded from FP7 resources to address these issues. However, these concentrate on breakthrough research and their results are often inadequate for uptake by regulatory bodies. Additional nanotoxicity data for risk assessment are needed. As safety concerns about some nanomaterials undermine the whole range of nanotechnology applications through inappropriate generalisations, it is necessary to address this gap for all steps of the production process and remove this barrier to innovation. The scientific and technical objectives of the topic are therefore (i) to provide legislators with a set of tools for risk assessment and decision making for the short to medium term, by gathering data and performing pilot risk assessment, including exposure monitoring and control, for a selected number of nanomaterials used in products; and (ii) to develop, for the long term, new testing strategies adapted to a high number of nanomaterials with many factors susceptible to affect their environmental and health impact. A second objective is to bring together the activities of national authorities responsible for worker protection, public health and environment and create the basis for common approaches, mutually acceptable datasets and risk management practices.

Nationally funded projects and programmes and industry active in production and use of nanomaterials in products are encouraged to coordinate their already running efforts for validation and benchmarking and jointly plan and manage future investment for toxicity testing. Governmental authorities and industry participating in the project should define priorities for materials and toxicity end-points. The project may include coordination activities for running projects in toxicity testing, decision making on material characterisation and testing protocols, and exposure and data management. The total value of the effort leveraged by the project in this way (consisting of the EU contribution, and funding or in-kind contributions by governmental authorities or programmes, industry and other stakeholders) is expected to reach from 3 to 5 times the EU contribution.

Partners should conclude a results communication policy before the start of the project. Work should be streamlined with OECD-WPMN, CEN and ISO, and the FP7 projects in the nanosafety cluster.[9] Active participation of industrial partners represents an added value.

Additional eligibility criterion: The EU contribution must not exceed EUR 10 000 000 per project.

Funding Scheme: Large-scale integrating collaborative projects. No more than one project will be funded.

Expected Impact: The project should establish seamless collaboration among authorities of the MS governments with regard to the knowledge required for appropriate risk management in this field. This collaboration should be complemented by solid mechanisms networking state and private laboratories in nanotechnology toxicity testing and exposure control.

II.1.4 Cross-cutting and enabling R&D

The future development and uptake of nanotechnology by EU industry depends upon the development of an efficient and productive research and innovation infrastructure based on interdisciplinarity. It requires as an input collaborative research from several fields of sciences such as: biological sciences, physics, chemistry, electronic, engineering, mathematics,

[9] http://www.nanosafetycluster.eu

environmental and safety related disciplines, cognitive sciences, social sciences, etc. Its targeted outcome is the creation of knowledge, based on the understanding of the phenomena (nanoscience) at the nano-scale, and their translation into technological know-how (nanotechnologies) to master processes and to develop leading edge research tools, techniques and productive assets, vital for nano-enabled product development.

This activity supports cross-cutting and enabling R&D activities that would enable atomically precise control of processes. The target is to preserve the designed nano-structure and (active) nano-systems with novel or pre-defined properties and behaviour when translated into scalable industrial systems related to their applications. Metrology and instrumentation that underpin most nanotechnology research and tools supporting industrial application development receive particular attention. Availability of affordable, high-quality nanomaterials and intermediates presents another bottleneck which will be addressed through the development of novel chemical, biological and physical nanomaterial synthesis and bottom-up assembly of nano-scale building blocks.

NMP.2012.1.4-1 Pilot lines for precision synthesis of nanomaterials

Technical content/scope: Following the call topic in the 2011 Work Programme on 'Large-scale green and economical synthesis of nanoparticles and nanostructures' for low cost, high-volume synthesis, the primary focus of the present call is the precision synthesis of nanomaterials.

The precise synthesis of nanomaterials with tailored properties is a pre-requisite for many potential high-value applications for example in the fields of nanoelectronics and photonics, energy, nanobiotechnology and nanomedicine.

Most current synthesis routes carrying scale-up potential suffer from the lack of precision and definition of the resulting nanomaterial structure (including size, shape, internal structural gradients) limiting their intended functionality.

Therefore, the aim of this topic is to:

- integrate research activity, science and technology advancements for the synthesis of nanomaterials in order to increase their reproducibility, precision, control of structural parameters (size, shape, roughness, morphology and chemical composition) and to control purity and agglomeration at all synthesis steps. Novel chemical, biological and physical synthesis routes and the combination of these can be considered;
- develop in-situ monitoring methods allowing direct correlation and control of the growth parameters with the nanomaterial structure and composition;
- advance understanding of the initial nucleation and growth process, including theoretical modelling and simulation of the synthesis process as appropriate.

The developed flexible synthesis routes and platforms in this topic are expected to be demonstrated at a pilot-line-scale and deliver a step change in the availability of nanoparticles and nanostructures with high precision. Hence the focus is on materials and synthesis routes with significant demonstrable reduction in critical parameter variation compared with the current state of the art. High-throughput, cost efficient processes for nanomaterials synthesis should be developed for the integration of novel nanomaterials into new products. The flexibility of the synthesis process to produce several product variants for cross-sectoral applications should be demonstrated.

Process safety must be ensured, taking into consideration also the subsequent steps, e.g. handling, packaging and transport. Environmental friendliness, e.g. in terms of energy consumption, waste reduction and recyclability is a further aim.

Proposals should also include cost/benefit calculations for sample potential applications, demonstrating the economic viability and positive energy balance for utilising nanotechnology in these applications. The actual development of these applications is outside the scope of the topic.

Bulk nanomaterials covered by the previous call topic NMP.2011.1.4-1 are excluded from the scope of this topic.

In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Large-scale integrating collaborative projects.

Expected Impact: In the short to medium term, the results are expected to yield up-scaled, innovative industrial processes providing high quality nanomaterials, conforming to specifications required by high value added applications for example in the fields of nanoelectronics and photonics, energy, nanobiotechnology and nanomedicine; the results are also expected to pave way the synthesis and processing of intelligent and smart nanomaterials with multiple functions (third-generation nanomaterials) in the long term. Projects are expected to provide substantial innovation and market perspectives in industry and to contribute to competitiveness, sustainability and employment in the medium term, enabling competitive and sustainable industrial production of new, high added-value products and components based upon nanomaterials for cross-sectoral applications.

NMP.2012.1.4-2 Hierarchical assembly of nano-scale building blocks

Technical content/scope: The properties and functionalities of many hybrid materials, components and devices depend on the organisation of single components on the nanoscale. Current industrial processes for nanofabrication rely mainly on deterministic top-down processes using techniques such as photolithography. However, the fundamental limits of top-down miniaturisation are approaching, not to mention the typical high investment costs of the manufacturing 'fabs'.

Building nano-devices, assemblies and architectures through development of 'bottom-up' approaches represents a unique possibility to develop radically new bottom-up concepts towards mass fabrication of the next generation of complex nanotechnology products, including electronics, sensing applications, medicine and multiple other applications that requires hierarchical assembly. These processes should be capable of integrating a high number - potentially billions - of nanoscale building blocks with disparate functions. Hence, a massively parallel assembly approach capable of producing higher order structures with designed properties at industrially relevant scales is required and is the primary aim of this topic.

The focus of the topic is the development of viable and cost effective processes for the assembly of nanoscale building blocks into useful macroscopic devices and products. The proposals should address:

- Organisation and integration of heterogeneous components of different sizes and compositions into higher level structures and devices. Components may include biomolecules, organic molecules and inorganic nanostructures.
- Design principles and new control methods for tunable dimension, structure and property complexity.
- Control and scalability of the process, including quality aspects, as required by the specific application.

The proposals should be application driven and tunability, control and scalability be demonstrated in a laboratory environment. In addition, the project work should include the preparation of a roadmap detailing further development needs for industrial deployment of the developed technology. The process design should aim at inherent safety and EHS assessment from life-cycle perspective must be included.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: In the long term, the results will contribute towards industrialisation of new energy- and material efficient products and processes of breakthrough character; in the medium term the results are expected to provide nanoscale components and structures for applications e.g. in electronics, sensors, energy conversion and storage and biomedical devices; in short term the results will advance the control of nanoscale building blocks and lead to better understanding of scaling problems and phenomena.

NMP.2012.1.4-3 Nanoscale mechanical metrology for industrial processes and products

Technical content/scope: Manufacturing of nanostructured surfaces aims at fundamentally affecting the functionality of manufactured parts. This requires control, over a relatively large areas (not just over nanoscale areas), of parameters related to tribology, optics, fluidics (affect flow properties by changing the surface), adhesion. Current state-of-the-art processes for measuring at the nanoscale have significant practical limitations as they measure over small distances. The characterisation of surface structures at the nanoscale over large areas, in terms of improved and novel operational performance, will open the way for new products into existing markets.
Nanostructured coatings are used in diverse applications from automobile components where low friction can increase the fuel efficiency of transport systems, through cutting tools where increased efficiency in manufacture can be realised, to forging and forming operations where increased production rates and less tool wear can be achieved. They provide potential to improve energy efficiency in many areas, with projected improvements in fuel efficiency of 20% in transport and 30% to 50% in manufacturing processes along with major tool lifetime improvements. Reduction of friction in fluid transport (drag) is also known to be improved by introduction of nanostructured coatings. Friction control for transport is a key technology identified by the International Energy Agency. The key performance properties of nanocoatings are the low friction that can be achieved, the reduction and control of wear, and the durability of the coatings under the conditions that pertain in real applications. These

properties will in turn depend on how the chemistry of the wear interface, and the mechanical properties of the coatings such as hardness, fracture and adhesion.

Projects proposed under this topic shall aim at establishing advanced measurement capability in one or more of the following areas:

- To resolve the structure of surfaces of materials at the nanoscale at an acceptable speed. A step change is required in measurement techniques, sampling methodologies and data processing to enable key 3D physical parameters to be measured in a reasonable time frame. Research is also required to validate correlations made between the physical measurements and functional effects. The results will produce a knowledge base enabling designers and producers to shift from empirical to computer aided approaches. Beyond this, a new raft of measurement tools will be needed to support the tooling of microstructures within the prototyping, product development and manufacturing phase.
- To assess the performance of newly developed nanostructured coatings. This should deliver reliable and accurate measurement results at the nanoscale for morphology (roughness profile), for chemical composition (of surface layers and wear debris), for basic mechanical properties (indentation hardness and stiffness), and for the relevant tribological properties of the coatings (e.g., friction coefficient) in a range of highly demanding industrial applications. In addition, new nanoscale methods need to be developed to evaluate the durability of nanostructured coatings (e.g., scratch resistance). The corresponding materials data are required for input into the design of new coating systems to meet challenging operational demands. Methods also need to be developed to evaluate the durability of coatings for severe environments.

Preference will be given to projects that will lead to traceable measurement methods which can become the basis of international standards. In stage-2 proposals, an indicator of this potential will be the involvement of metrology institutes and/or standardisation bodies.

In order to ensure an efficient implementation and maximum impact of SME-related activities, the leading role of SMEs with R&D capacities will be evaluated under the criteria 'Implementation' and 'Impact': the coordinator does not need to be an SME but the participating SMEs should have the decision making power in the project management; and the output should be for the benefit of the participating SMEs and the targeted SME dominated industrial communities.

Funding Scheme: SME-targeted collaborative projects.

Expected Impact: The results will lead to radical innovation in the design of products and production processes and to improving the performance of nanostructured coatings, rationalising industrial material selection, and boosting the competitiveness of the product manufacturers. In the long term, this will lead to enhanced operational performance of products, with impact on both competitiveness and sustainability. Measurement standards are a prerequisite to bring on-line the tooling technologies required to produce these products.

The end users will benefit through lower energy bills and increased robustness of manufacturing systems. Also in the process industry, manufacturers will benefit from lower transportation costs. The results will also create new product opportunities for European instrumentation industry.

NMP.2012.1.4-4 Evaluation of EC communication and dialogue on research and innovation in nanotechnologies and design of future needs for the EU (industry and society)

Technical content/scope: Providing European citizens and stakeholders with science-based, balanced and updated information on research and innovation in nanotechnology is part of the European Commission's Action Plan on Nanotechnology. Appropriate activities in communication outreach, dialogue and engagement have been developed from 2008 to 2011 as its main implementation tool. To be effective, communication and dialogue should enjoy continuity and build on results, considering changes in expectations and concerns, in order promote responsible social support for nanotechnology. Ex-post evaluation is therefore crucial in designing activities to match the future needs of the EU in communication and dialogue on nanotechnologies. The intention is to finance one support action, which should assess the effective (i) outreach, (ii) feedback and (iii) dialogue generated by these activities in various audiences of EU population (e.g. industry, scientists, NGOs, media, educators and the public), with a specific focus on young people. This action should also develop robust methodologies to evaluate the drivers of the changes in awareness, knowledge, attitudes, opinions and behaviours these activities have generated, considering national and/or cultural specificities.

Finally, validation through open and participative approaches is essential: future communication/dialogue needs for the EU must be identified, also considering OECD Working Party's works on controversial issues (e.g. safety, decision-making, privacy and ethics), and future EC actions designed: these should be made public to receive and integrate the inputs via an appropriate open web-platform (e.g. NODE).

Additional eligibility criteria: The EU contribution must not exceed EUR 250 000 per project. The project duration must not exceed 12 months.

Funding Scheme: Coordination and Support Actions (supporting actions). No more than one supporting action will be funded.

Expected impact: (i) analyse, measure and interpret the impacts of EC activities on communication, dialogue and engagement on nanotechnologies, how they changed awareness, and 'social sustainability' of nanotechnology following these activities, e.g. how contributions to knowledge, attitudes, opinions, behaviours, expectations and concerns of relevant audiences contributed to effective outreach and dialogue considering national, regional and cultural specificities across the EU; (ii) assess the support these activities have provided to key stakeholders (e.g. industry, scientists, NGOs, media, educational decision-makers) in dealing with controversial issues (e.g. safety, decision-making, privacy and ethics); (iii) contribute to the implementation of the European Commission's Action Plan for Nanotechnology, identifying future needs and measures for the EU to improve good governance on awareness and responsible social sustainability *through consensus or agreed pathways* between various stakeholders, with a specific focus on research and innovation between various stakeholders, with a specific focus on research and innovation.

NMP.2012.1.4-5 Improving education in nanotechnologies to match the skill needs of EU industry and society

Technical content/scope: Conventional educational and academic disciplines often constrain the introduction of interdisciplinary courses and trans-disciplinary approaches that are necessary to nanotechnology. Overcoming such limitations is mandatory in order to educate

highly skilled nano-scale scientists and engineers, whose scarcity is pinpointed by industry as a major obstacle to innovation. The multidisciplinary and multi-sectoral character of nanotechnologies requires developing novel forms of integration in the education systems, in order to prepare flexible and adaptable scientific and engineering pools of talent, while at the same time enhancing the necessary in-depth scientific background. This requires new frameworks of cooperation between schools, universities, research institutes and industry, as well as convergence of educational departments in nanotechnologies, biotechnologies, ICT, cognitive and other sciences, such as physics and chemistry (for example quantum mechanics and physical chemistry are fundamental to nanotechnology). Connection should also be made to social and business sciences. Special attention is required to encourage females to study nanotechnologies. The emphasis should be on graduate and post-graduate university level. This Support action should provide:

- mapping and critical assessment of best practices across the EU to identify enhanced integrated strategies for education in nanotechnologies;
- development of pilot teaching materials, lab activities and assessment tools as independent subjects or modules;
- development of a platform for disseminating, testing and fine tuning of the strategies and the 'open courseware'.

Funding Scheme: Coordination and Support Actions (supporting actions). No more than one supporting action will be funded.

Expected impact: (i) Promote the integration of nanotechnologies into the educational systems by favouring its responsible convergence with other sciences and stimulating the on-field cooperation of industry with educational and research bodies to respond to skill needs of industry and society. (ii) Contribute to making nanotechnology studies more attractive, thus increasing the numbers of students, especially female students.

II.2 Activity 4.2 Materials

The European Commission recently highlighted the relevance of materials science and engineering for the European well-being and industrial competitiveness. A few major initiatives of relevance are Key Enabling Technologies, Europe 2020, The Innovation Union and the initiative on the creative industries. A Materials Summit was held in 2010, highlighting the key importance of materials for industrial innovation and socio-economic progress.

Materials are at the core of industrial innovation and enable it. Added value materials with higher knowledge content, new functionalities and improved performance are critical for industrial competitiveness and sustainable development; the materials themselves represent a key step in increasing the value of products and their performance. To accelerate progress, a multidisciplinary approach will be fostered, involving chemistry, physics, engineering sciences, theoretical and computational modelling and increasingly the biological sciences. The 'convergence of disciplines' will be a key tool for progressing in materials science and engineering; research implementing this concept will be supported in this Work Programme.

Materials also have to be seen as a flow that enters into Europe. They are transformed and/or manufactured into value-added products with subsequent export but also possible collateral production of waste and emissions. The EU environmental policies as well as the Raw Materials Initiative were taken into consideration in this Work Programme. An integrated systemic and systematic approach must be pursued.

Within an integrated approach, research will focus on materials science and engineering to contribute to resolving Europe's grand challenges, in line with the recent 'Lund Declaration', which states that 'Meeting the Grand Challenges also requires (…) taking a global lead in the development of enabling technologies such as (…) materials'. This implies a rigorous exercise of prioritisation. Appropriate advanced materials are of paramount importance for technological developments in virtually all Themes of the Seventh Framework Programme and in their respective fields of application. Attention is paid to activities launched by Member States, in order to achieve the most effective synergy possible; and international cooperation in appropriate areas is addressed.

This work programme is streamlined with respect to previous years and is structured in three parts: Enabling Research and Development, Innovative Materials for Advanced Applications, and Structuring Actions.

Enabling Research and Development builds on and exploits the interdisciplinary character of materials science and engineering and has the potential of opening new business areas or production routes. It supports advances in key enabling technologies through the development of new techniques, processes and equipment, thus providing the means to generate giant steps in performance and capabilities. Key Enabling Technologies (KETs) such as advanced materials are of exceptional importance. Mastering such technologies lays a stable foundation for well paid jobs in the EU and allows for sustainable, inclusive growth.

Materials characterisation, design methods and simulation techniques are also essential to better understand and control materials phenomena, in particular the structure–property relationships at different scales, to improve materials assessment, reliability and durability, and enable industrial applications of materials by design. The integration of atomic, molecular to macro levels in chemical and materials technologies will be supported for developing new

concepts, systems and processes. Issues related to the integration of materials and technologies, particularly for multi-sector applications, process development, scaling-up and industrialisation of high added value materials will also be addressed.

For Innovative Materials for Advanced Applications, the present work programme will adopt a novel and more effective focus to medium/long-term research in five selected branches of industry: Healthcare; Information and Communication Technologies; Energy; Transport and Environment (including the substitution of critical raw materials). If robust research competences in materials research and relevant industrial innovation are built and maintained, Europe will be able to play a significant and lasting role in the global arena, and the potential societal and economic returns in the field of materials' industrial applications will be maximised. Research will address the development of new knowledge-based multifunctional surfaces and materials with tailored properties and predictable performance, for new products and processes targeting a wide range of applications. This requires knowledge of raw materials and their natural or commercial availability, the control of intrinsic properties, processing and production, taking into account potential impacts on health, safety and the environment throughout their entire life-cycle.

Structuring actions will aim at exploiting the potential of the ERA to boost efficiency and effectiveness of research and innovation in materials science and engineering via creating or reinforcing synergy which will enable the release of the untapped potential of European research. A better linking of actors in research and innovation is envisaged. A reinforced synergy will be promoted amongst stakeholders, including e.g. European societies on materials research and/or the European Science Foundation.

II.2.1 Enabling Research and Development

The design of knowledge-based materials relying upon an accurate control of their properties can take advantage of highly performing modern engineering methods and powerful computer-based tools. Engineering tools, associated with modelling and simulation approaches often based on multi-scale methods can help in creating more reliable high performance materials, based on an accurate prediction of their in-service behaviour and life-cycle analysis.

Discoveries of new materials with tailored properties and advances in their processing are the rate-limiting steps in product development in many industrial sectors. The key objective is to radically improve materials by increasing knowledge in materials science, in particular at the nanoscale, as well as to make progress in the field of environmentally friendly materials able to substitute currently harmful applications, and in the field of clean, flexible and efficient materials processing.

NMP-Materials will also support the development of solutions in materials sciences and engineering (including 'horizontal technologies') in order to overcome scientific, technological and related bottlenecks enabling new technologies that can give European industry a strong competitive advantage in the years to come. These technologies are multidisciplinary, cutting across many technological areas with a trend towards convergence and integration, and can assist technology leaders in other fields to capitalise on their research efforts as well.

Greater emphasis on the fundamental understanding of materials will lead to a qualitatively better control over their properties, as well as to the development of new materials. With this respect, European competitiveness will be directly related to the ability in maintaining

advanced technology in experimental facilities and continuously developing new analytical tools. Cross-cutting priorities will be the development of new instrumentation methods; the early characterisation and prognosis of the behaviour of new materials in components and under operating conditions; and the understanding of complexities, nonlinearity and functionalities through bottom-up approaches and materials design.

NMP.2012.2.1-1 Joining dissimilar materials (excluding applications specific only to healthcare)

Technical content/scope: In the drive towards innovation and efficiency in industrial products there is an increased demand for novel materials and components with improved properties e.g. they should be strong, corrosion resistant, impact resistant, lightweight etc. These are described as 'hybrid' structures, constructed of two or more different types of material, each contributing with unique properties and complementing the properties of the other; different parts of a structure or a product will be thus enhanced in terms of more favourable performance/cost ratios. In addition, many of the new materials are hybrids themselves (such as metal/composite laminates). A great challenge faced by designers and engineers is joining dissimilar materials in a manner that ensures the integrity of the structure throughout its design life, production and in-service performance. In a similar manner to joining of similar materials, the strength of a joint is a function of the strength of the interface between the two materials and the presence of defects.

The research proposals should address novel joining approaches and technologies between dissimilar materials, e.g. organic and inorganic and/or metals, and novel lightweight materials, as well as integrated characterisation methodologies of the joint. Issues to be investigated are e.g.: type of joining, mechanical properties, surface and interface corrosion etc. To ensure that the best bond is achieved at the interface, surface compatibility between the adhesive agent and the two main constituent materials of the joint should be studied as well as the manufacturing approach to ensure consistency and reproducibility of the joint strength, the design of the joints themselves such as e.g. joint geometry, microstructure, modelling, repair and recycling issues and the inspection of the integrity of the joints. Validation tests should be performed. Standardisation and/or the production of (certified) reference materials may also be addressed as an integrated part of the research proposal, as well as the definition of novel specific training modules for personnel engaged in the industrial production (not including the training activities *per se*). Cost-benefit analysis should also be performed. The research proposals should not focus on materials whose exclusive (or principal) applications are in the healthcare and medical fields.

In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Small or medium-sized collaborative projects.

Expected Impact: (i) Deployment of materials structures with improved performance; and/or (ii) Improved reliability and in-service performance of components in applications such as vehicles, construction, hybrid materials for electronic application or goods, to name some potential examples; and/or (iii) Improved competitiveness or European industries via more favourable cost/benefit solutions; and/or (iv) New skills (via advanced up-to-date training) in the European workforce resulting also in indirect socio-economic benefits.

NMP.2012.2.1-2 Fine chemicals from CO_2

Technical content/scope: CO_2 can be a precious raw material for European industry. CO_2 and other unconventional carbon sources are becoming an attractive raw material and can open new routes for the sustainable production of fine chemicals and high added-value materials. The use of CO_2 as material - direct or indirect, e.g. through algae or synthetic biology - opens up new opportunities for creating value on the basis of a waste product from e.g. the energy intensive industry. The field is new and challenging. Even though fundamental research into organometallic chemistry could deliver important insight into potential catalytic cycles, no efficient processes are currently available. A possible research route is to develop new photocatalytic or electrocatalytic routes modelled on natural processes to directly convert CO_2 to high added-value chemicals, which can be competitive to current processes, lowering the overall impact on the environment e.g. in terms of greenhouse gases or the synthesis of value-added products in which CO_2 remains in the product as a building block. Another option of CO_2 recycling is the CO_2 fixation by marine and freshwater micro algae and the utilisation of the biomass harvest as energy source or raw material. The intelligent use of algae for the recycling of CO_2, coupled with the production of platform chemicals, is a highly innovative approach inspired by the natural processes in the oceans and could provide a basis for worldwide sustainable growth.
The research proposals should address the production of valuable fine chemicals starting from CO_2 directly (e.g. via new photocatalytic, plasma catalytic or electrocatalytic routes) and/or indirectly (e.g. via algae, but not in competition with more socially or economically valuable productions such as food). The potential contribution to the reduction of greenhouse gases emissions should be estimated as well as the cost effectiveness and commercial potential of the innovative technologies. Due to the specific thermodynamic and kinetic boundary conditions, interdisciplinary approaches can be necessary between chemists, biotechnologists, chemical engineers and process engineers.

In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners represents added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Small or medium-sized collaborative projects.

Expected Impact: (i) New industrial routes for using CO_2; and (ii) Reduction of overall greenhouse gases emissions deriving from industrial processes in Europe.

NMP.2012.2.1-3 Self-healing materials for prolonged lifetime

Technical content/scope: Nature has optimised its materials, where needed, for damage management, i.e. the occurrence of damage is accepted as a fact of life and natural materials can cope with damage because of inbuilt healing abilities. These have in recent years also been developed experimentally in new types of manufactured materials, thus creating a new or improved class of multifunctional materials - the so-called self healing materials.

The research proposals should address the substantial improvement of manufactured materials with the new functionality of self healing after damage caused for example by impact, abrasion, corrosion, wear, fire, ice, etc.

Modelling and characterisation as ancillary activities can be included. Standardisation and/or the production of (certified) reference materials may also be addressed, as well as appropriate novel inspection technologies and methods that might be required for damage detection for

specific applications. Research in the field of regenerative medicine is excluded under this topic. In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Small or medium-sized collaborative projects.

Expected Impact: i) Improved materials with prolonged lifetime and reliability leading to enhanced safety in applications such as for example vehicles, roads and bridges; and/or ii) Societal and economic benefits deriving from the reduction of accidents, injuries, casualties, and permanent damages; and/or iii) Improved competitiveness of European industry via more favourable cost/benefit ratios.

II.2.2 Innovative materials for advanced applications

Sustainable products adapted to societal needs, distinguished by a combination of innovative materials, successful design and intelligent functionalities, are in demand in all sectors of technology and all industries. However, innovations can realise their full potential only if they are transferred rapidly from research into products and released onto the market. Innovative materials with novel or enhanced properties for customised applications represent a real part of potential innovation, beneficial to the competitiveness of European industry, including small and medium-sized enterprises (SMEs). Securing and expanding a leading technology position with this integrated approach is key to sustainably enhancing Europe's international competitiveness. Against a continuing background of concerns about the environment, resource and energy pressures, along with increasing global competitiveness, a focused strategy for advanced materials innovation and application is increasingly vital. The development of application-oriented materials requires the specific design of highly efficient materials and processes that encompass phenomena and architectures at the atomic scale. Research should lead to optimising the engineered properties of materials at higher length scales and thus to improve the functional properties of the final products. Research and innovation in materials science and engineering are therefore critical components of Europe's industrial policy towards a competitive and sustainable industrial future. Meanwhile current budgetary constraints may cause a risk-adverse approach in the research investments of many industries and particularly SMEs, thus jeopardising their competitiveness in the medium to long term as well as their ability to cope with increasingly stringent demand for sustainability of products and processes.

NMP-Materials research will therefore support industry's longer-term research and ambitious industrial innovation, particularly in those branches of industry where considerable potential exists in terms of socio-economic impacts. The application of new materials has a large potential for the conservation of all Earth resources and also for the protection of the environment. Addressing these issues successfully will grant our children the right to live in a world similar to, or even better than, that of our generation. Research will focus on the design, development and engineering of innovative added-value materials and unlock their potential for selected technological applications.

Following the input of the NMP Expert Advisory Group, five priority key areas of activity will be addressed: Healthcare; Information and Communication Technologies; Energy; Transport and Environment (including the substitution of critical raw materials). In addition to the topics in this section, a topic related to energy has been included as part of the Energy-

efficient Buildings initiative (see section II.5.2 below); and a topic related to transport has been included as part of the Green Cars initiative (see section II.5.3 below).

NMP.2012.2.2-1 Biomaterials for improved performance of medical implants

Technical content/scope: Implants are widely used in therapeutic applications in many branches of modern medicine. The success of such treatments critically depends on the biocompatibility, risk of infection and long-term stability of the biomaterial(s) used to produce the implant. Applications may in principle address any disease or condition, with due justification.

Research proposals should aim to develop one or more functional biomaterials for improved biocompatibility and long-term stability of degradable or non-degradable implants. They should also develop (one or more) *in vitro* assays, useful as indicators of long-term *in vivo* performance and behaviour. The potential for a significantly improved therapeutic outcome in a defined clinical application should be demonstrated. Proposals should generate comprehensive pre-clinical data, but funding for clinical trials is not eligible. A realistic endpoint of the project should be described and justified. After completion of the project, the material should be in an optimal position for entering clinical trials. Preclinical regulatory affairs, including the investigational medicinal product dossier (IMPD), should be completed or taken to an advanced stage. Consequently, experimental protocols should be planned in consideration of good laboratory practice (GLP) and ISO guidelines. Also, the manufacturing process should be addressed, including up-scaling, good manufacturing practice (GMP), process analytical technology (PAT), and regulatory work as appropriate. In addition, proposals should show that the regulatory and IPR situation is compatible with the overall RTD strategy. At least one implant or implant component should be delivered at the end of the research project together with a proof of concept and preclinical validation.

In order to ensure industrial relevance and impact of the research effort, the active participation of clinicians and industrial partners, including SMEs, represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Large-scale integrating collaborative projects.

Expected impact: (i) One or more biomaterials with improved biocompatibility and long-term functional stability; and/or (ii) One or more *in vitro* assays to predict *in vivo* behaviour of implants in the long term; and/or (iii) Improved therapeutic outcome in a defined clinical application; and/or (iv) Improved quality of life thanks to increased biocompatibility and longer duration of implants; and/or (v) Increased competitiveness of European biomaterials industries.

NMP.2012.2.2-2 Materials for data storage

Technical content/scope: Data mass storage technologies are fundamental building blocks of information and communication technologies (ICT), which are becoming increasingly ubiquitous in the daily life of EU citizens. An exponentially increasing need for more and more 'memory' is shared by most areas of ICT applications, such as enhancing life comfort and security, leisure, education, business and improving work productivity. However, the limits of improving the performance of current technologies in terms of storage density or power consumption are already being approached.

Research proposals should focus on developing advanced materials and/or their precision preparation for next generation non-volatile data storage applications; developments leading to incremental improvements of 'classical' charge-storage and magnetic hard disk based memories are excluded. The developed materials should show a clear route to memory cells with a significant advance over the state-of-the-art in terms of parameters such as storage density, reading/writing time, power/energy requirements, stability, in-service reliability and cost and/or allow additional functionalities. Scalability to the pre-industrial phase may be investigated. While the bulk of the research should be on the materials science, the development of a memory test structure, possibly operational at room temperature, can be included as proof of viability of the new material. The design of devices as such is not included in the present call.

Research under this topic will contribute to the FET-Flagship initiative, in synergy with the FP7-ICT work programme.

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: (i) Memory cells with storage densities of 5 Tbits/sq.in; and/or (ii) write energy consumption less than 50 pJ/bit; and/or (iii) data rates higher than 10 Gbits/s; and (iv) reasonable future cost per Tbit.

NMP.2012.2.2-3 Advanced materials for high-temperature power generation

Technical content/scope: High-temperature technology is of major importance in many industries including e.g. primary metal and non-metal production, material processing, chemical engineering, transportation and power generation. For many of these industries the price of fuel is a major component of overall operating costs and the temperature *per se* may well influence the environmental performance of industrial processes. Materials that allow operation at high temperature are essential for sustainable industrial competitiveness because the efficiency of fuel conversion and use is related to the operating temperature. For instance, power plants operating at temperatures higher than 615 °C are usually not constructed, because of the limitations imposed by the materials used for making the tubes, drums, and pipes which contain and transport the steam; another limitation relates to the materials needed for high temperature sensors used for structure monitoring in power generation. The efficiency of power plants using such concepts is expected to improve as a result of the significant increase of the working temperature.

The research proposals should target radical improvements of materials' in-service properties, such as corrosion resistance, erosion resistance, radiation resistance, reliability and durability, ionic conductivity and mechanical properties. Design studies should also be performed when necessary in order to investigate the potential of reductions in the use of expensive materials so as to make the concept as economically attractive as possible. The materials concepts proposed should be cost effective, easy for fabrication, construction, monitoring and control. Environmental and safety issues should be addressed as appropriate. Attention should also be paid to the life cycle analysis of the new solutions in comparison to the ones currently used. Modelling as an ancillary activity for improving and optimising design and for producing cost effective predictive tools could be included, as well as specific sensors to ensure monitoring and enable in-service control. Emphasis should be given to material behaviour modelling and structural integrity analysis under extremely severe operating conditions (e.g. creep, fatigue, thermal-mechanical fatigue, oxidation and their interactions, at high service temperatures). Standardisation and/or the production of (certified) reference materials may

also be addressed as an integrated part of the research proposal as well as appropriate novel inspection technologies and methods that might be required.

In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Small or medium-sized collaborative projects – Specific International Cooperation Actions (SICA) to promote the participation of emerging economies and developing countries: Eastern partnership countries (Armenia, Azerbaijan, Belarus, Georgia, Moldova and Ukraine). Consortia must include at least two participants from different Eastern Partnership countries.

Expected impact: (i) Increased power plant efficiency by at least 30% allowing operations at substantially higher temperatures; and/or (ii) Lower emissions (e.g. CO_2 and/or other pollutants) in a cost effective way; and/or (iii) Improved reliability of in-service materials; and/or (iv) Increased safety in the plants of application; and (v) Boosted cooperation between the EU and the Eastern partnership countries.

NMP.2012.2.2-4 Cost-effective materials for larger blades for off-shore wind energy applications

Technical content/scope: Off-shore wind offers enormous potential but also poses great technical challenges. The industrial initiative in the European Strategic Energy Technology Plan (SET-Plan) on wind energy thus considers this as one of its strategic objectives. In particular, new cost-effective materials, architectures, and processes are crucial for the next generation large-scale off-shore wind turbine generators. As a non-binding example: 90-metre blades are considered to be a possible target combination with materials that can offer a weight reduction of about 40% compared with standard designs.

Research proposals should address the development of innovative advanced materials and/or material combinations (including coatings) associated with the rotor, and in particular the blades, of an off-shore wind turbine generator. The reduction of the weight of the components without sacrificing their strength is a key objective with increasing rotor diameter. The proposed solutions should demonstrate to cope realistically with the particular and stringent demands of large blades in view of off-shore applications, such as e.g. long term operation in a corrosive and humid environment, under severe temperature variations and high load conditions. Compliance with environmental regulations as well as the environmental sustainability of each proposed solution shall be assessed with special emphasis on the recyclability. Blade design may be addressed if specifically relevant to the development of the materials. Dedicated modelling, standardisation, improvement of rotor blade test methods and/or the production of (certified) reference materials may also be addressed as an integrated part of the research proposal.

In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners, including end users and those involved in industrial development in harsh environments, represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

A complementary call for proposals can be found under Theme 5 'Energy'.

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: (i) Considerable reduction in weight of components, based on the properties of the materials, architectures, or processes; and/or (ii) Increasing the reliability and operational life of components under realistic conditions; and/or (iii) Improving the cost modelling, including maintenance intensity; and/or (iv) Developing manufacturing concepts for the construction of components with less production defects; and/or (v) Improving material use efficiency; and/or (vi) More favourable cost/efficiency ratio; and/or (vii) Improvement also of blades for on-shore turbines; and (viii) Contributing to the achievement of the SET plan.

NMP.2012.2.2-5 Halogen-free flame retardant materials

Technical content/scope: Flame-retardant materials are a major business for the chemical industry and can be found practically everywhere in modern society. However, many additives have detrimental effects on the environment and human health and thus should be limited in use. Some Brominated Flame Retardants have in effect been banned via the RoHS directive (2002/95/EC), but this does not imply that all other flame retardants are free from health and environmental concerns.

Research proposals should focus on developing commercially viable materials for halogen-free flame retardants well beyond the state of the art. The proposals should include a credible validation and demonstration of the required fire classification for the intended applications e.g. by testing for ignitability, fire resistance, fire toxicity, burning behaviour, reaction to fire, and/or flammability according to the appropriate standards. If appropriate, the development of techniques and apparatus to assess the capacity of flame retardants could also be included. Technical, performance, health, environmental and economic factors must be duly considered in the justification of the choice of the optimum novel flame retardant material for the selected applications. It would be beneficial if the flame retardant could be produced from renewably sourced raw materials. The proposals should follow a life cycle approach at both the level of material and selected products/applications. This includes assessment of health and environmental impacts, Life Cycle Assessment in accordance with the ILCD handbook,[10] economical viability, and development of routes for recycling and/or reuse. The proposals may, if appropriate, address REACH compliance. Standardisation activities may be included; in such cases, collaboration with a suitable technical committee of a standardisation body and/or national metrology institute is encouraged. Up to 10% of the requested contribution may be allocated to development of other uses of the proposed materials, such as replacement of phthalates as plasticisers in consumer goods.

In order to ensure an efficient implementation and maximum impact of SME-related activities, the leading role of SMEs with R&D capacities will be evaluated under the criteria 'Implementation' and 'Impact': the coordinator does not need to be an SME but the participating SMEs should have the decision making power in the project management; and the output should be for the benefit of the participating SMEs and the targeted SME dominated industrial communities.

Funding Scheme: SME-targeted collaborative projects.

Expected impact: (i) Deployment and use of new and better performance flame retardants; and (ii) Contribution to achieving EU policies.

[10] http://lct.jrc.ec.europa.eu/assessment

NMP.2012.2.2-6 Photocatalytic materials for depollution

Technical content/scope: The photocatalyst-based destruction of noxious organic compounds in air, water or soil is a versatile and clean technology, which can be applied to the treatment of a large variety of chemicals, including not fully biodegradable or toxic compounds. This technological approach appears extremely promising for the recovery of polluted media in industrial environments or in difficult to reach areas such as e.g. in the case of accidental oil spills in remote zones, as unfortunately witnessed in the recent past. Successful and timely intervention can indeed avoid major damages to people, the environment and the economy. Furthermore, remote areas may lack power supplies so that the possibility of using solar light or other naturally available energy would be advantageous. As a non-binding example, nanostructured photoactive films can be mentioned to improve light harvesting and charge separation, and to extend the photoactivity into the visible light region by altering the band structure of the materials, as well as to develop improved photoreactor units using solar light.

The research proposals should unite EU and ASEAN researchers around the common goal of generating new knowledge on photocatalytic materials and processes, and delivering improved ways to enhance the efficiency. Reaction temperatures are critical and photocatalysis should take place at normal environment temperatures. Cooperation of scientists from different fields is welcome in order to profit from innovative inter-disciplinary or 'converging' approaches.

This topic is complementary to other topics in Theme 4, NMP and Theme 2, FAFB, which deal with groundwater ('Reactive nanoparticles for in-situ site remediation') and oil-spill remediation ('Innovative biotechnologies for tackling oil spill disasters').

Funding Scheme: Small or medium-sized collaborative projects – Specific International Cooperation Actions (SICA) to promote the participation of emerging economies and developing countries: ASEAN countries[11]. Consortia must include at least two participants from different ASEAN countries.

Expected impact: (i) Reinforced scientific knowledge base on improved photocatalytic materials and technologies, particularly when could operate in remote areas; and/or (ii) Improved protection of the environment via pollution control; and/or (iii) Reinforced international cooperation and interactions between scientists throughout the two geographic areas; and/or (iv) spread of knowledge to stakeholders, particularly decision takers; and (v) Reinforced scientific knowledge base and the synergies in EU-ASEAN cooperation.

II.2.3 Structuring actions

To contribute more effectively to industrial innovation in Europe, NMP-Materials should also have a structuring effect, building up and exploiting the potential of the European Research Area or – in selected fields – acting at an international level. Actions will be supported to network actors of research and innovation, or to create new synergy. The cross-sectoral nature of materials research and the widespread impact of its applications create obvious links with the other Themes under the Specific Programme 'Cooperation'. The increasingly important international dimension of industrial research requires a proactive approach to working with third countries in the field of materials research. International cooperation

[11] ASEAN is the Association of Southeast Asian Nations; the member nations at the deadline of the call can be found at http://www.aseansec.org/18619.htm.

activities are, therefore, an important issue, in particular for those research areas where there is clear mutual benefit in terms of knowledge generation and market expansion. Specific actions may be foreseen, such as joint research activities that may be implemented via coordinated calls to address objectives of mutual interest. This may be of interest, in particular, in the case of industrialised countries and those having signed an S&T cooperation agreement which includes the materials field. In addition, specific Support and Coordinated Actions can promote better links with international co-operation partner countries. These activities will also support, and contribute to, a variety of other European policies as described in the topics.

NMP.2012.2.3-1 Networking of ETPs and main materials collective stakeholders in materials science and engineering

Technical content/scope: Several European Technology Platforms (ETPs) as well as other collective stakeholder's entities are operating in technology fields and sectors relevant to the NMP Theme. Although they have been capable of addressing the specific needs and challenges of their technology areas effectively, issues such as broader socio-economic challenges going beyond the technological needs can only be tackled through a cross-platform, collaborative approach. This is expected to improve the efficiency of transferring R&D results into products.

In view also of the realisation of the Innovation Union and other Europe 2020 priorities having strong links to research and innovation, proposals should address: (i) creation of synergies between major materials stakeholders such as e.g. ETPs, materials societies, National and/or Regional Programmes and Platforms, ERA-NETs, activities on the Lead Market Initiative, Networks of Excellence etc; (ii) identification of common elements between ETPs, and where appropriate, the initiatives mentioned above; these elements may e.g. concern: socio-economic studies, industrial and research strategies, priority settings, etc; (iii) development of strategies for boosting research in materials science and engineering, e.g. proposing measures concerning education, continuous training, synergies to be reached, reinforced infrastructures etc; (iv) development of strategies for boosting innovation in materials science and engineering e.g. proposing measures concerning better regulation, standardisation, public procurement, fiscal incentives, continuous training, open innovation models, etc; (v) development of a programme of commonly-defined activities on the elements mentioned above with the objective of meeting major challenges.

Additional eligibility criteria: The EU contribution must not exceed EUR 1 000 000 per project. The project duration must not exceed 36 months.

Funding Scheme: Coordination and Support Actions (coordinating actions). No more than one coordination action will be funded.

Expected Impact: (i) Improved synergy amongst major stakeholders in materials research and innovation; (ii) More efficient implementation of ETPs' Strategic Research Agendas and Road Maps; (iii) Facilitating the development of future research and innovation initiatives in the NMP-Materials field.

II.3 Activity 4.3 New Production

The approach remains focused on the transformation of EU industry from a resource intensive to a sustainable knowledge-based industrial environment. This entails creating the appropriate conditions for continuous innovation (in industrial activities and production systems, including design, infrastructure, equipment, and services) and for developing generic production 'assets' (technologies, organisation, production facilities and human resources), while also meeting overall industrial safety and environmental requirements. Particular attention should be paid to promoting activities which support the adaptation and integration of SMEs to the new needs of the supply chain as well as to giving an impulse to the innovation in SMEs and the creation of high tech SMEs.

The research content in this activity is heavily influenced by the Public-Private Partnership initiatives adopted within the framework of the European recovery package. Many topics which will be covered by the PPP initiatives are relevant to the scope and objectives of the New Production activity of the NMP Theme. The following topics, which do not fall entirely within the PPP initiatives, remain under the New Production activity.

NMP.2012.3.0-1 Highly efficient chemical syntheses using alternative energy forms

Technical content/scope: Novel reaction concepts using alternative forms of energy for precise control of chemical transformations and reaction pathways may lead to totally new and highly efficient procedures for chemical synthesis. Examples include electricity as activator for physical and chemical transformations, microwave/plasma-enhanced reaction or ultrasound-assisted dispersion. Selective energy input can also be facilitated by the use of active species with differences in absorbance, e.g. to heat catalytically active particles.

Many of those energy forms can facilitate the intensification of chemical processes with effects exceeding two or even three orders of magnitude. Alternative forms and transfer mechanisms of energy may also significantly enlarge the applicability potential of microstructured reactors via the acceleration of chemical processes to 'fit' in microsystems, reaching higher product yields by combining alternative energy transfer mechanisms with microprocessing features (e.g. fast heating-up of the reactants and a fast quenching of the products), reducing or preventing some basic problems in the microprocessing system operation, such as fouling.

The focus is on visionary research in relation to methodologies for targeted supply of innovative forms of energy integrated with novel reactor concepts for precise control of chemical transformations and reaction pathways. Basic scientific and engineering understanding of the mechanisms behind the alternative energy-based processes and of the relations between various parameters influencing those processes has to be developed using experiments, characterisation and modelling. The project results should determine the range of application for alternative energy based operations and deliver evidence of technical and economic feasibility of corresponding process concepts as well as concepts for robust and scalable equipment meeting industrial standards.

Close research collaboration between chemical engineering and other disciplines, chemistry, materials science, catalysis, electronics and applied physics in particular, are envisioned. In order to ensure industrial relevance and impact of the research effort, the active participation

of industrial partners is expected. The integrated reactor concepts should be demonstrated in order to verify the future potential of the technology.

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: Substantial advantages in terms of functionalities difficult to achieve with conventional technologies, precision control, selectivity process performance and energy savings are expected to lead to a targeted improvement in resource and energy efficiency of 50%.

NMP.2012.3.0-2 Total Safety Management for industrial organisations

Technical content/scope: The traditional risk analysis and probabilistic safety assessment methodologies are usually based on oversimplified accident models which in many cases, during major accidents of the recent past, proved to be not completely adequate, often because the total risks arising from the global interactions between the technical system and the human and organisational dimensions were not or just to a limited extent addressed.

To improve industrial systems reliability and safety performances it is necessary to develop methods and tools to cope with the complexity of risk generation and events propagation. It is necessary to investigate ways to analyse risk exposures and to provide an estimation of the ability to recover from regular and irregular variations, disruptions and degradation of expected and unexpected events (resilience) and properly manage the vulnerabilities through dynamic risk control in their operating environment to enable proper monitoring of production activities including organisational ones and to evaluate the implementation of change.

Particular focus should be on developing integrated solutions coupling the technical procedures for safety-critical operations and equipments with the concerned industrial organisation and possibly contribute to relevant standardisation activities.

A test-bed facility could comprise many supporting technologies for testing proposals and ideas, such as process performance models, risk metric identification, communication networks, virtual/augmented reality representations, computer aided design, information systems and enterprise resource planning, rapid prototyping, etc.

The models, tools and test facilities developed in the project must help predicting the short and long term effects of changes and safety-related decisions which often involves a multi-level decision making process. The developed approaches must be conceived as life long learning systems which should include the experience feedback aspect.

These tools and associated methods should prove to deliver cost-effective added value to the business and should be of practical use, in particular for European SMEs and companies which do not necessarily possess competent expertise within risk analysis in order to substantially reduce the number of accidents in Europe.

It is expected that efforts in safety-related research will be coordinated across several industrial sectors. Demonstration and training activities should be given substantial coverage in the project. International cooperation and possible cooperation with ERA-NETs are welcome.

In order to ensure industrial relevance and impact of the research effort, the projects are expected to be driven by industry or service providers to industry, and this will be reflected in

the evaluation, under the criteria Implementation and Impact. End-user participation is also expected and this will be likewise reflected in the evaluation.

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: Improved global safety performance, integrated into business strategies and management decisions, will benefit the whole value chain and stakeholders. This is expected to generate a competitive advantage for European companies leading to more, healthier and highly specialised jobs. The development and consolidation of an innovative knowledge-based industrial safety management system and culture, at company level, inside a whole industry sector and across industrial sectors is expected to support the sustainable growth of European industry and the development of a more risk informed society.

II.4 Activity 4.4 Integration

The integration of knowledge and technologies of the three areas of research above is essential in order to speed up the transformation of European industry and its economy, while adopting a safe, socially responsible and sustainable approach. The research will focus on new applications and novel, step-change solutions responding to major challenges, including the RTD needs identified by the different European Technology Platforms.

This research should enable and sustain the knowledge-based transformation of current industrial sectors and the development of new science-based sectors through the integration of new knowledge from nano-, materials-, and production technologies in sectoral and cross-sectoral applications. The RTD approaches and objectives applied by the partners should lead to results (products, processes, methods, etc) and impacts which must observe the guidelines of the sustainable development paradigm, namely the public health, worker safety, environmental protection and the societal dimensions, including governance concerns (public awareness and acceptance). Furthermore this research work must constitute an opportunity for Europe to consolidate the optimal normalisation and standards needed.

Several cross-cutting dimensions could be considered while handling the vast array of sectors and applications and could further inspire the emergence of topics:

- **Transforming traditional industry**, which faces the challenge of low-cost competition, as well as rapidly changing market expectations and behaviour. It should increase its productivity through new processes, high-added value products and new business models;
- **Fostering scale-intensive and specialised suppliers industry** through the adoption and integration of new advanced technologies thus enabling the improvement of its leadership in the global market;
- **Promoting Science-based Industry** which will play a key role in establishing a high-value European industry. It will need the integration of most of the advanced technologies dealt with in Nanotechnologies, Materials and Production activities, enabling the development of new, high value, products and services, processes and even leading to new industries.
- **Towards a sustainable supply industry** is another key objective in supporting product and productivity innovation, especially for sectors with a large environmental impact.

NMP.2012.4.0-1 Novel materials and design-based solutions for the creative industry

Technical content/scope: Seventy per cent of all technical innovations have been estimated to be directly or indirectly linked to innovative materials. 'Creative industries', as defined in the EC green paper 'Unlocking the potential of cultural and creative industries', are those industries which use culture as an input and have a cultural dimension, although their outputs are mainly functional. They include architecture and design, which integrate creative elements into wider processes, as well as subsectors such as graphic design, fashion design or advertising. The economic importance of creative industries has been estimated in terms of employees (almost 6 million in 2004 in EU-25) and in terms of contribution to the GDP

(2.6% of the EU-25 GDP).[12] The large majority are SMEs (even micro-companies) producing unique products and services. Materials for the creative industry are normally associated to interdisciplinarity in the materials science, design and engineering, responsiveness to cultural and social evolution, addressing breadth and depth of human centred applications. Novel and profitable business areas for the European industry can be searched for, through conceiving, manufacturing and marketing innovative products, processes and services which are which are human-centred, need-driven, design-led and materials-anchored. Examples can be touch-screens, 'feeling-good materials' or materials for interior design (at home or office, in the car etc). A great challenge is to conceive a new material at the same time as a new product, thus also defining the appropriate production process and bringing it down the production chain as fast as possible. The advantage of coupling product design with materials development is enormous. A dedicated workshop has recently identified technological and non-technological bottlenecks in the connection materials vs. creative industries; launching dedicated research actions was recommended as well as establishing reinforced relationships between material scientists/engineers and the creative industry professionals/designers.
Research proposals should develop fully novel smart and functional materials which feature particular properties and functionalities, not solely based on physical parameters, but also embedding aesthetic, sensual, tactile, and cultural properties. Materials scientists and industrial designers should work together in the research. Having scientists involved in the design process is expected to increase the designers' knowledge of the performance potential of materials that could be used and their properties; having designers involved in the materials research is expected to boost a 'pull' approach inspiring the conception of novel materials adapted to their industrial use and later on to the commercial success of the future product. Sustainability, environmental impacts and energy efficiency issues must be taken into account and represent an added value of research proposals, which will be taken into account in the evaluations, under the criterion 'Expected impact'.

Funding Scheme: SME-targeted collaborative projects.

Expected Impact: (i) Novel materials and products where design and the advancement in the properties of the materials are key factor for success; and/or (ii) Boosted dynamism of innovation in the field(s) of the creative industry; and/or (iii) Improved communication between actors in the innovation chain also in view of novel consumption patterns; and/or (iv) Contribution to achieving EU policies, particularly the Europe 2020 and the Innovation Union goals as well as those of the initiative addressing the creative industries.

NMP.2012.4.0-2 Support for standardisation needs

Technical content/scope: Standardisation is an important tool to facilitate innovation and bring new products to the market. However, closing the gap between the knowledge obtained through research and the actual market introduction of a new product or technology is often proving very difficult. In order to strategically facilitate the transfer from research to innovation within different domains of the NMP programme, supporting activities to prepare standardisation are requested.

The proposed support actions should build on the scientific and technical achievements of NMP projects, or clusters of projects, funded under FP6 and/or FP7. It should address the

[12] 'The impact of culture on creativity' – study conducted by KEA for the EC, June 2009

preparation of standards and metrology issues in order to vigorously push the knowledge towards industrial innovation. The proposals should address the specific standardisation needs and deliver the elements needed (e.g. as a new CEN work item or workshop agreement) to fully achieve the final standards; and suggest methods to better measure and control them. The implementation of methodologies and/or inter-comparisons to facilitate the preparation of standards may also be addressed. The identification of the relevant standardisation needs should be based on advanced enabling technologies, while taking into account the international situation and the potential for European consensus building. As such, beneficiaries should liaise in an appropriate manner with ongoing activities by National and European standardisation bodies in the fields. The projects must be able to address all related IPR issues.

Active participation of representatives of technology providers and potential end-users, such as industrial associations represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact. Collaboration with EURAMET (including EMRP[13]) may also be foreseen.

In less mature fields this may take the form of a roadmap for future standardisation needs in the field together with a detailed timeline for the actions (e.g. manufacturing systems dealing with small and medium size batches or advanced materials systems).

Duplication of work already completed or ongoing in this area (e.g. projects NANOSTRAND and Co-Nanomet) must be avoided.

Additional eligibility criterion: The EU contribution must not exceed EUR 500 000 per project and the project duration must not exceed 18 months.

Special Feature: This topic is particularly suitable for cooperation at the international level, however, such cooperation is not obligatory.

Funding Scheme: Coordination and Support Actions (supporting actions).

Expected Impact: (i) Delivery of new standardisation documents (e.g. a CEN new work item); and/or (ii) Consolidation of the technical background for standardisation, unification and certification of advanced materials, manufacturing processes and their production environment; and/or (iii) A substantial contribution to international standardisation, helping to strengthen the position of European industry; and/or (iv) Improved quality control for the entire process chain (from design, over production and certification up to product disposal), increased inter-operability and potentially improved time to market; and (v) Support to EU policies relying on standardisation.

NMP.2012.4.0-3 Innovation in the forest-based sector for increasing resource efficiency and tackling climate change with competitive customer solutions – ERA-NET Plus topic jointly implemented by Theme 2, FAFB, and Theme 4, NMP

Technical content/scope: The aim of this ERA-NET Plus is to pool the necessary financial resources from the participating national (or regional) research programmes and the EU, to launch a joint transnational call for proposals for research, development and innovation in the forest sector. The objective is to support the transformation of European forest-based industry and sustainable forest management for increasing resource efficiency and adapting to and mitigating climate change effects. This will be achieved by integrating knowledge and

[13] http://www.emrponline.eu

technologies of large-scale industrial products and processes, as well as primary production. One possible strategic approach could be the substitution of non-renewable resources (e.g. materials and chemicals, in construction or as an energy source), by renewable forest-based solutions to reduce carbon emissions and waste. Strategic renewal in forest industry value chains also needs to consider change in raw material availability and composition due to anticipated impacts of environmental and climate change on forest resources. The joint transnational call will address the whole forest-based value chain, from the sustainable management of forest resources through their efficient utilisation in industrial processes to value added products and competitive customer solutions.

Thematic focusing of this joint transnational call should be commensurate with the funds available, so as to ensure a reasonable rate of success in the call. Details on the topics covered by the call will be decided by the participants in due time but shall be selected upon consultation with the Commission services concerned.

Funding Scheme: Coordination and Support Actions (coordinating actions).[14]

Additional evaluation criterion: Participants shall include a target of 20% or more of the total estimated EU contribution going to SME(s). This will be assessed during the evaluation under the criterion Impact.

Additional information:

- The topic is implemented jointly with Theme FAFB (under topic identifier KBBE.2012.1.2-08). It is identical to both themes. Hence each proposal must be submitted only once, either for topic KBBE.2012.1.2-08 or topic NMP.2012.4.0-3, but not both. Only one of the activity codes above should be used to submit application.
- One project may be funded.

Expected Impact: (i) Improve coordination and reduce overlapping in key fields of research; (ii) achieve critical mass and ensure better use of limited resources in fields of mutual interests; (iii) share good practices in implementing research programmes; (iv) promote transnational collaborations and new knowledge generation and innovation; (v) mobilise SMEs in the transnational projects to enhance innovation.

NMP.2012.4.0-4 Organisation of events related to the Presidencies of the European Union

Technical content/scope: An integral part of the NMP Theme's activity is to organise, particularly together with successive EU presidencies, events of a major strategic nature. The proposed Support Action(s) should contribute to creating better synergy between initiatives launched by the Commission and by the Member States, to the benefit of the coherence of the overall actions within the field of research and innovation in industrial technologies as intended in FP7-NMP. Member States which will hold a forthcoming Presidency of the European Union are Ireland and Lithuania (2013 Presidencies) and they may be particularly interested in the present call. In order to ensure high political and strategic relevance, the active involvement of the competent National Authority(ies) will be evaluated under criteria 'Quality' and 'Impact'. The proposed Support Action(s) should address topics that are of high

[14] This topic is for an ERA-NET Plus. Only ERA-NET eligible partners can participate. The minimum number of participants is set at five independent legal entities managing publicly funded national or regional programmes, from five different Member States or Associated Countries. Please refer to Annex 4 of the Cooperation Work Programme, including the Call Fiche FP7-ERANET-2012-RTD.

relevance at the date of its taking place. An appropriate equilibrium should be present in the proposed action(s), with balanced presentation of various research and industrial elements and points of view. Participation of non-EU actors is possible. Outreach activities may be included such as e.g. a press programme and/or an event dedicated to schools.

Funding Scheme: Coordination and Support Actions (supporting actions).

Expected Impact: (i) Review of research, industrial and/or societal developments linked to the NMP areas, as appropriate; and/or (ii) Sharing of information and comparison of points of views; and/or (iii) Networking various stakeholders and supporting their activities, e.g.: natural scientists, social scientists, researchers, industrialists, investors, environmentalists, museums and/or schools.

II.4.1 Raw materials

Raw materials are essential for the sustainable functioning of modern societies. Access to and affordability of mineral raw materials are crucial for the sound functioning of the EU's economy and the competitiveness of European industry. For this reason, this wok programme places renewed emphasis on raw materials: in particular, extraction and processing, reduction of waste and recycling.

NMP.2012.4.1-1 New environmentally friendly approaches in minerals processing

Technical content/scope: As a response to the shortage of some minerals on global markets, the EU Raw Materials Initiative and the Europe 2020 strategy has called for improving the raw materials efficiency and supply to the EU society. The overall objective is to develop new innovative clean and resource efficient mineral processing routes and technologies for a better utilisation of mineral raw materials that will be acceptable for the EU citizens and easily applicable in a highly regulated EU environment.

The proposals should address the whole processing chain from mined rock to high grade marketable material of one or more selected metallic, industrial or construction minerals.

The research should aim at innovative approaches for developing and integrating new automated, safe, cost-effective and resource-efficient mineral processing routes and technologies, closely linked to extraction. Research activities should focus on several of the following areas:

- in-situ comminution and separation, minimising transport of process volumes and waste;
- novel technologies for the processing of low-quality raw materials and tailings with increased removal of impurities and recovery of usable minerals, including base and precious metals, but also critical raw materials for the EU[15], for example rare earth elements.
- closed process system with non-toxic reagents with zero impact on existing surroundings, and where appropriate mobile mineral processing plants;
- advanced waste, water and energy management;

[15] http://ec.europa.eu/enterprise/policies/raw-materials/critical/index_en.htm

- better process control and automation through intelligent IT based systems for process intensification and reducing human exposure.

Deliverables include the field demonstration of the integrated processes and technologies above. Project proposals are also expected to contribute to:

- roadmaps and other contributions to related policies and initiatives on raw materials at the EU and Member State levels;
- promoting best practices and new best available technologies in the field;
- related standardisation and normalisation activities.

In order to ensure industrial relevance and impact of the research effort, the active participation of both minerals and downstream industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Large-scale integrating collaborative projects.

Expected Impact: (i) Increase material production efficiency; (ii) Strengthen leadership of European technology providers; (iii) Increase access to raw materials in Europe via new clean minerals processing activities in order to decrease EU dependency on resource imports and to create jobs in Europe; (iv) Mineral processing operations with zero impact on existing surroundings; (v) Create inherently safe working and operating environments; (vi) Replace polluting or dangerous processes, minimise waste, effluents, energy consumption and CO2 emission.

NMP.2012.4.1-2 Innovative recycling technologies of key metals in high-tech applications

Technical content/scope: The EU industry is becoming more and more dependent on metals which are essential in the manufacture of advanced technological products, such as circuit boards, semiconductors, coatings, magnets, mobile phones, computers, home electronics, and solar panels. For example, these metals include platinum group and rare earth metals. The use of electronic products is increasing globally, because of the combination of shorter product lifecycles and stricter legislation, which are making electronic waste the fastest growing recycling segment.

Recycling technologies reduce waste going to disposal, consumption of natural resources and play an essential role in the move towards sustainable consumption and production.

Within this SME intensive sector, there is also potential to significantly improve recycling efficiency and capacity by encouraging innovation and introducing more effective processes and technologies. This would save costs, energy, and natural resources and thus help Europe to be less dependent on prices and imports of the key metals in high-tech applications.

Research activities should address all of the following areas:

- assess the status of major sensing technologies for the separation of the various materials and address the challenges of a more efficient pre-treatment and the metallurgical refining process for key metals;
- assess the re-usability and recyclability at the end of life of key metals;

- cover the logistics aspects of the value chain of high-tech advanced technological products and include integrated impact assessment studies to assess and evaluate environmental and economic impacts as well as the suitability of the innovative technologies for application within the EU.

The proposals are expected to cover demonstration activities, including pilot implementations in industrial settings and to show a clear application potential in the short-term.

The recycling of batteries for vehicles is already addressed within the Green Car PPP initiative and therefore it is not covered in this call topic.

In order to ensure an efficient implementation and maximum impact of SME-related activities, the leading role of SMEs with R&D capacities will be evaluated under the criteria 'Implementation' and 'Impact': the coordinator does not need to be an SME but the participating SMEs should have the decision making power in the project management; and the output should be for the benefit of the participating SMEs and the targeted SME dominated industrial communities.

Funding Scheme: SME-targeted collaborative projects.

Expected impact: (i) Reduction of overall waste production and improvement of resource efficiency, through a more efficient recycling of critical materials, for instance from electronic waste, efficient recycling processes, clean recycled products and good working environments within a circular economy. (ii) Competitiveness of SMEs and development of skills.

This topic is complementary to a topic in Theme 6, Environment on 'Innovative resource efficient technologies, processes and services' (ENV.2012.6.3-1).

NMP.2012.4.1-3 Development of advanced magnetic materials without, or with reduced use of, critical raw materials

Technical content/scope: Permanent magnets are essential e.g. in transport, wind energy and refrigeration applications, while externally controllable magnetic materials are being used in IT applications. Magnetic materials may require the use of critical raw materials which are increasingly sensitive to market distortions. Within the present call, the critical raw materials are the 14 priority ones given in the report 'Critical Raw Materials for the EU'.[16] In the light of possibly reduced levels of exports due to trade restrictions resulting in an uncertain long-term availability of these elements, there is a need to focus research on developing new magnetic materials without critical raw materials (or with drastically reduced quantities), without compromising their functional performance. Substituting magnetic materials and/or reducing the use of critical raw materials in view of the raw materials initiative[17] has already been initiated, but finding high-performing magnetic materials is only in its infancy and further research is needed.

Research proposals should address the development of novel advanced magnetic materials that reduce the dependency on Critical Raw Materials. The proposed solution should show substantial improvement on their performances and/or on the elimination or drastic reduction of use of critical raw materials The nature of magnetism to be investigated could be, but is not limited to, carbon-based magnetism (e.g. in graphene and functionalised nanotubes), molecular magnetism, interface- and defect- (impurities or structural defects) based

[16] http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/report-b_en.pdf
[17] COM(2008)699

magnetism, or magnetism in complex heterostructures or in magnetic fluids. New magnetic material with better characteristics, hard permanent magnets with a high energy product (high magnetisation and high coercivity) and soft permanent magnets with low coercivity, materials exhibiting half-metallicity or a high magnetocaloric effect and externally controllable magnets are included. The research should investigate how to reduce or substitute the quantities needed of scarce elements via modelling and material design improvements. Eco efficient production and recycling processes as integrated part of the material science and engineering research should be proposed to increase manufacturability and to reduce the total amount of critical raw material necessary. Estimates of cost comparisons should also be elaborated. Standardisation and/or the production of (certified) reference materials may also be addressed as an integrated part of the research proposal. The research should include test structures to validate the material properties and should also consider how to extend the life time of materials; an LCA should prove the targeted reduction in the use of critical raw materials. General device design is excluded.

In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Special Feature: This topic is particularly suitable for cooperation at the international level, e.g. with research teams from Japan and/or USA, however, such cooperation is not obligatory.

Funding Scheme: Small or medium-sized collaborative projects.

Expected Impact: (i) Availability of high performing materials for e.g. sensors, actuators, ICT applications, refrigerators and/or transport applications (hybrid or pure electric vehicles) or wind turbines or innovative niche applications; and/or (ii) Availability of magnetic material with reduced reliance on scarce elements; and/or (iii) Increased independence of the European supply of critical raw materials; and (iv) support to EU policies.

NMP.2012.4.1-4 Substitution of critical raw materials: networking, specifying R&D needs and priorities

Technical content/scope: Raw materials are an essential part of both high tech products and every-day consumer products. The European Commission has adopted a new integrated strategy which sets out targeted measures to secure and improve access to raw materials for the EU (Communication on raw materials COM(2008)699 and accompanying Commission Staff Working Paper SEC(2008)2741 of 4 November 2008). The ad-hoc group of the Raw Materials Supply Group has issued a report containing policy-oriented recommendations to secure access to critical raw materials and to enhance its efficient use (*Critical raw materials for the EU – Report of the Ad-hoc Working Group on defining critical raw materials*[18]). Amongst other actions, the report recommends: (i) to improve the availability of reliable, consistent information in relation to raw materials; encouraged more research into life-cycle assessments for raw materials and their products on a 'cradle-to-grave' basis; (ii) to create a working group(s) to further analyse the impact of emerging technologies on demand of raw materials; and (iii) to engage in policy actions to make recycling of raw materials or raw material-containing products more efficient, including the promotion of research on system optimisation and recycling of technically-challenging products and substances, according to an appropriate LCA approach. The report also recommends that substitution should be

[18] http://ec.europa.eu/enterprise/policies/raw-materials/files/docs/report-b_en.pdf

encouraged, notably by promoting research on substitutes for critical raw materials in different applications and to increase opportunities under EU RTD Framework Programmes.

The proposed support action should network interested stakeholders, in order to create a pole of competence on the emerging field of the substitution of critical raw materials. It should identify and propose initiatives to help to address relevant EU policies effectively, and also address the specificities of this area such as its industrial, environmental, economic and geopolitical aspects. During its life, the action should collect and elaborate data and make available to the EU Institutions and Member States accurate pictures, analysis of needs, threats and opportunities and proposals for further action. A roadmap of actions, actors and timing, including mapping and networking of existing national activities and/or centres should be developed. During negotiations, complementarity will be ensured with work performed in response to topic GC.SST.2012.1-3, 'European strategy for rare materials and their possible substitution'.

Additional eligibility criterion: The EU contribution must not exceed EUR 3 000 000 per project.

Funding Scheme: Coordination and Support Actions (supporting actions). No more than one supporting action will be funded.

Expected Impact: (i) Contribution to the successful implementation of the Raw Materials Initiative and related activities; and/or (ii) Collection and elaboration of data and formulation of ideas for possible novel actions with high European common interest; and/or (iii) Identification and prioritisation of R&D needs in order to support the EU strategic approach regarding the substitution of critical raw materials; and/or (iv) Improved coordination in research and innovation actions in the field of raw materials substitution; (v) Increased efficiency and effectiveness of the EU research activities in this field; and/or (vi) Creation of one (or more) leading pole(s) of excellence that will be able to support and enhance the competitiveness of the EU industry and economy.

II.5 Recovery Package: Public-Private Partnership (PPP) topics within NMP

The European Economic Recovery Plan adopted by the European Commission on 26 November 2008 and endorsed by the European Council on 11-12 December 2008 proposes actions to develop technologies for the manufacturing, construction and automotive sectors, which have recently seen demand plummet as a result of the crisis and which face significant challenges in the transition to the green economy. The Commission proposed to increase research financing through the RSFF instrument and to launch three Public-Private Partnerships (PPPs) which provide the required support to the three sectors:

- in the manufacturing sector: a 'Factories of the Future' initiative to help EU manufacturers across sectors, in particular SMEs, to adapt to global competitive pressures by increasing the technological base of EU manufacturing through the development and integration of the enabling technologies of the future, such as engineering technologies for adaptable machines and industrial processes, ICT, and advanced materials (EUR 1.2 billion);

- in the construction sector: an 'Energy-efficient Buildings' initiative to promote green technologies and the development of energy-efficient systems and materials in new and renovated buildings with a view to reducing radically their energy consumption and CO_2 emissions (EUR 1 billion);

- in the automotive sector: a 'Green Cars' initiative, involving research on a broad range of technologies and smart energy infrastructures essential to achieve a breakthrough in the use of renewable and non-polluting energy sources, safety and traffic fluidity (EUR 1 billion).

These initiatives are part of a comprehensive, integrated package to be implemented in cooperation between all the responsible services within the Commission, complemented by actions on the demand-side, such as public procurement, technical standards, and regulatory measures. This includes a further EUR 4 billion for non-research activities under the Green Cars Initiative.

The three PPPs are intended to prevent the crisis from deflecting attention from the EU's longer-term interests and the need to invest in its future. Research and Innovation are considered as strategic and 'smart' investments to prepare the ground for the future of the EU economy which has to become a knowledge-based and low carbon economy, as stated in the Europe 2020 strategy. This is crucial for the EU to come out from the crisis stronger, more sustainable and more competitive.

The Commission, working in close collaboration with industrial representatives, has developed multi-annual roadmaps and longer-term research strategies for the three sectors. The initiatives will continue to be implemented through a series of Cross-thematic Calls under the 2012 Work Programme between the relevant FP7 Themes. Responsibility for these Cross-thematic Calls is as follows:

- The 'Factories of the Future' initiative involves financial support from the NMP[19] and ICT[20] Themes;

[19] Nanosciences, Nanotechnologies, Materials and New Production Technologies

- The 'Energy-efficient Buildings' initiative involves financial support from the NMP, Energy, ICT and Environment Themes;

- The 'Green Cars' initiative involves financial support from the Transport, ICT, NMP and Environment Themes.

In addressing the industrial needs and objectives of each PPP, the Themes will work closely together to ensure a coherent, complementary and holistic approach. To ensure high visibility and to promote cooperation and exchange of information between the research projects funded under the different Themes, it is intended to gather the researchers and the industrial stakeholders together in annual cross-thematic workshops and seminars for each PPP. This would be part of the implementation of the projects.

[20] Information and Communication Technologies

II.5.1 'Factories of the Future' Public-Private Partnership (FoF) - Cross-thematic Coordination between NMP and ICT

Manufacturing is still the driving force of the European economy. Manufacturing activity in Europe represents approximately **21% of the EU GDP** and provides about **20% of all jobs** (more than 30 million) in **25 different industrial sectors**, largely dominated **by SMEs**. With each job on the factory floor generating approximately two other jobs in services, about 60 million people are additionally engaged in the related service areas. Therefore, manufacturing is of high importance to Europe, with a huge potential to generate wealth, jobs and a better quality of life. The long-term shift from a cost-based competitive advantage to one based on high added value requires that European manufacturing increases its technological base, building on the EU's excellent R&D in this domain, and develops a number of **enabling trans-sectoral production technologies**.

The *Factories of the Future* PPP Initiative aims at helping EU manufacturing enterprises, in particular SMEs, to adapt to global competitive pressures by developing the necessary enabling technologies to support EU manufacturing across a broad range of sectors. It will help European industry to meet the increasing global consumer demand for greener, more customised and higher quality products through the necessary transition to a demand-driven industry with lower waste generation and energy consumption.

The activities will concentrate on increasing the technological base of EU manufacturing through the development and integration of the enabling technologies of the future, such as engineering technologies for adaptable machines and industrial processes, ICT for manufacturing, and the novel industrial handling of advanced materials. The initiative will concentrate on industry-led R&D projects and will include demonstration activities, such as large-scale production-line demonstrators for validation and market applications. The partnership will work together to identify the R&D needs of manufacturing industry and in particular SMEs. In order to further ensure the PPP character of the initiative, a large part of the activities in the projects is expected be performed by industrial organisations themselves. This initiative, being by nature **cross-sectoral** and including efforts to address the **needs of SMEs**, aims to transform Europe into a dynamic and competitive knowledge-based economy by delivering:

- A new European model of production systems for the factories of the future (e.g. transformable factories, networked factories, learning factories) depending on different drivers such as high performance, high customisation, environmental friendliness, high efficiency of resources, human potential and knowledge creation.

- ICT-based production systems and high quality manufacturing technologies capable of optimising their performance with a high degree of autonomy and adaptability for a balanced combination of high throughput and high accuracy production.

- Sustainable manufacturing tools, methodologies and processes that have the capability of cost-efficiently shaping, handling and assembling products composed of complex and novel materials.

The indicative budget for 'Factories of the Future (FoF)' is EUR 160 million in 2012, of which EUR 100 million is from the NMP Theme and EUR 60 million from the ICT Theme.

II.5.1.1 'Factories of the Future (FoF)' - Public-Private Partnership –

- Topics covered by the NMP Theme

FoF.NMP.2012-1 Adaptive production systems and measurement and control equipment for optimal energy consumption and near-to-zero emissions in manufacturing processes

Technical content/scope: One of the cornerstones for a sustainable development of the manufacturing sector lies in achieving high productivity rates while reducing the environmental impacts associated with the manufacturing processes. This challenge can be tackled by designing in an integrated manner adaptive production systems for eco-efficient processes and systems, using the information of sensors and in-process measurement methods. A suitable energy efficiency performance measuring system would help fulfilling customer needs with the minimum possible use of energy and material resources. This control system needs to focus on concepts which facilitate the evaluation, control and improvement of energy efficiency in manufacturing processes. Firstly, an energy performance measurement system at European or global level with suitable and measurable energy Key Performance Indicators (KPIs) has to be developed, utilising new sensors and visual systems for in-process measurement as enablers. Secondly, concepts for evaluating this KPI related information have to be developed, followed by decision support, i.e. which control mechanisms and improvement measures have to be implemented on the basis of this information. With the development of such concepts, factories would know their energy performance in real-time, facilitating more effective business decisions based on accurate and up-to-date information.

Research activities should address all of the following areas:

- Environment-conscious, life cycle and holistic process-machine approaches, to minimise the overall impact of production systems and to produce added-value products with minimised consumption of resources and process emissions.
- The definition of effective (specific and quantitatively measureable) Energy KPIs as well as the visualisation of these KPIs, together with the development of conceptual frameworks and software to measure and evaluate Energy-KPIs.
- Technologies capable of harvesting and recovering portions of the energy involved in the production processes, both at machine and at a system level, as well as in the plant environment.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners, including SMEs, represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact. The projects are expected to cover demonstration activities, including pilot implementations in industrial settings, and this will be likewise reflected in the evaluation.

Special features: This topic is particularly suitable for collaboration at international level, particularly under the IMS scheme [21]. Project partnerships that include independent organisations from at least three IMS regions[22] are therefore encouraged.

[21] IMS (Intelligent Manufacturing Systems) is an industry-led, global, collaborative research and development programme, started in 1995 as the world's only multilateral collaborative R&D framework: www.ims.org

[22] The current member regions of IMS are the European Union, the United States of America, Korea, Mexico and the EFTA states of Norway and Switzerland.

Funding Scheme: Large-scale integrated collaborative projects.

Expected impact: An efficient use of material and energy resources along the lifecycle of manufacturing processes will lead to notable reductions in environmental impacts while at the same time a sustainable economic growth and an increased social well-being will be assured. These processes will know their energy performance in real-time, facilitating more effective business decisions and reactions, based on accurate and up-to-date information. In quantified terms, the new generation of production processes and systems of near-to-zero emissions will be expected to lead to the following impacts along their lifecycle:

- At the use stage, reduction above 40% in the consumption of energy resources when compared with conventional manufacturing processes.
- At the use stage, reduction in the process emissions (e.g. chemicals, hazardous materials, dust, air, water, oil) far below the prescriptive limits and standards to almost zero.
- At the end-of-life stage, contribution towards a 100% reuse of machine components in new life cycles.

These quantified impacts will have to be corroborated by appropriate Life Cycle Assessment techniques. Moreover tools and methods developed in this research topic will help end-users become compliant with the new standards EN16001 or ISO50001 for Energy Management Systems. Projects are also expected to generate knowledge of new scientific, technical, economic and social factors to support European policy development and promote the standardisation and definition of eco-labelled processes and products. Finally, projects will have to support EU policies and legislation on eco-design activities in the manufacturing sector.

FoF.NMP.2012-2 Methodologies and tools for the sustainable, predictive maintenance of production equipment

Technical content/scope: Maintenance methodologies and approaches based on intelligent data processing techniques are crucial when improving productivity and reducing machine stoppages, but also in order to avoid expensive repair costs. Detection of potential failure and the corresponding corrective maintenance are well established and accomplished, but predictive maintenance derived from a correct failure prediction is not yet a reality.

Intelligent methods for collecting and organising data (e.g. Artificial Intelligence and Data Mining) will provide new concepts of advanced maintenance addressing flexibility, easy integration in production environments and easy to interpret recommendations and results. By combining different sources of process data coming from advanced embedded information devices, the knowledge inferred from production equipment will be reinforced and reused in the maintenance learning/training process. These techniques will also provide a useful decision making support tool based on optimal planning and scheduling of maintenance operations in order to optimise the energy consumption.

Research activities should address all of the following areas:

- Developing R&M (Reliability & Maintainability) design practices/methods (including organisation) to predict and assess the availability of equipment during production already at an early design stage;

- Developing and integrating of advanced and generic embedded information devices designed to capture relevant information, with data pre-processing capabilities (sensors, ambient intelligence devices, RFID tags etc);
- Defining new algorithms and techniques based, for example, on Artificial Intelligence and Data Mining methodologies, in order to provide intelligent data processing and knowledge extraction from information gathered from production equipment and in order to integrate knowledge reuse into production.

By improving predictive maintenance, the lifetime of the system and the availability of the whole process will be increased. The detection of unforeseen decline on its operational life cycle, depending on process data and contextual information (operational time, number of stoppages, environmental conditions, etc), will be the key issue in maintenance tasks in order to provide a higher resistance of equipment, leading to improvements in future design of components involved in manufacturing processes.

In order to ensure an efficient implementation and maximum impact of SME-related activities, the leading role of SMEs with R&D capacities will be evaluated under the criteria 'Implementation' and 'Impact': the coordinator does not need to be an SME but the participating SMEs should have the decision making power in the project management; and the output should be for the benefit of the participating SMEs and the targeted SME dominated industrial communities.

Funding Scheme: SME-targeted collaborative projects.

Expected impact: Manufacturing companies in Europe are investing in new smart and agile maintenance approaches that may increase the lifetime and energy efficiency of the production equipment and reduce its maintenance costs. New tools and methodologies for the sustainable maintenance of production equipment should contribute, in particular, to energy consumption management and optimisation tools, reducing energy costs and environmental pollution by a factor of 20%. Moreover, research projects in this field should contribute to their worldwide competitiveness and to the creation of new jobs.

FoF.NMP.2012-3 Intelligent production machines and 'plug-and-produce' devices for the adaptive system integration of automation equipment, robots and other intelligent machines, peripheral devices, smart sensors and industrial IT systems

Technical content/scope: 'Plug-and-Produce' is a coveted feature for the realisation of increasingly agile manufacturing systems in a globalised industry that demands continuous change of processes, products and production volumes. This feature should allow the automatic configuration and seamless integration of heterogeneous devices in(to) a system. The so-called smart factories are meant to be production sites featuring higher levels of (cost- and time-) efficiency, productivity and re-configurability. A successful realisation of this paradigm requests the incorporation of the latest developments in automation, control, mechatronics, ICT technologies, human-machine interaction, optimisation techniques, strategic planning and smart robotics. Moreover, the further integration of any newly developed technologies into the production lines and the industrial environments requires complementary research and innovation efforts.

'Plug-and-Produce' devices allowing the adaptive connection of automation equipment would need to focus on concepts and solutions in the fields of advanced agent-oriented software and service-oriented architecture middleware that pave the way for the actualisation of smart

factories compliant to the 'plug-and-produce' principles. Some instances of the outcome of the research might be results in configuration modules, communication protocols, discovery -and retrieval of abilities- and negotiation protocols and tools, end-user interfaces. The incorporation of extensions guaranteeing interoperability and harmonised cooperation among intelligent manufacturing components whilst yielding enhanced fault-tolerance and self-configuration skills at system level shall be welcome.

Future smart factories are meant to increasingly comprise, probably heterogeneous, intelligent machine-tools, automation equipment, peripheral devices, robots and actuators, smart sensors and industrial IT systems, including safety-oriented systems.

Research is needed on concepts or solutions for such manufacturing systems that guarantees interoperability. Research should focus on several of the following areas:

- Scalable extension of the system capabilities through addition of new components;
- Reconfiguration of the system functionality whenever new components are brought into it;
- Reuse of manufacturing equipments on all levels;
- Migration and transition of the manufacturing systems to modern architectures (e.g. service oriented architectures) with the objective to reduce commissioning effort or ramp-up time);
- Customisation of products by flexible manufacturing.

All these features should be enabled in a seamless and user-friendly manner such that all the intelligent, but probably heterogeneous, elements in the ensuing system can still successfully operate in a cooperative manner, which exploits the full potential of the installed components in a safe and ergonomically designed working environment.

In order to ensure an efficient implementation and maximum impact of SME-related activities, the leading role of SMEs with R&D capacities will be evaluated under the criteria 'Implementation' and 'Impact': the coordinator does not need to be an SME but the participating SMEs should have the decision making power in the project management; and the output should be for the benefit of the participating SMEs and the targeted SME dominated industrial communities.

This topic is complementary to topic FoF-ICT-2011.7.1(b), which deals with large-scale validation of advanced industrial robotics systems.

Funding Scheme: SME-targeted collaborative projects.

Expected impact: Standardisation and developments in 'Plug-and-Produce' should lessen the commissioning effort and ramp-up time whilst enhancing context-awareness, maintainability, modularity, re-usability, safety and versatility of manufacturing systems. Such capabilities explain the relevance of the subject to SMEs as in addition to the enumerated benefits, 'Plug-and-Produce' should imply big savings in terms of the expertise required for both customisation and system integration as well as in time devoted to installation and configuration of new elements. Intelligent manufacturing should help Europe to catch up on competitiveness with respect to other major industrial players through the easy incorporation of latest technology developments to manufacturing sites. Versatile manufacturing should lead to safe production sites with a large variety of sophisticated products featuring flexible, short cycle-time manufacturing capability.

FoF.NMP.2012-4 High-performance manufacturing technologies in terms of efficiency (volumes, speed, process capability etc), robustness and accuracy

Technical content/scope: The current industrial market is characterised by a turbulent and uncertain demand for highly customised products, of a complexity which is in constant increase. Compared to the past, customers require higher quality, faster delivery times, and shorter times between successive generations of products. Moreover, manufacturers nowadays need to reduce investments in production resources over time and sustainability issues impose that machines are able to efficiently and ecologically support the production of new products without being substituted. All this requires high flexibility and permanent adaptation of machines, process equipment and production systems to any changes in products and in process evolution.

The reliability and availability of machines, equipment and production systems are paramount for efficient production. The key goal is to have maximum availability of machinery, producing high-quality parts with almost zero-defects and in-specification materials at highest production rates. As an example, mechatronic strategies based on adaptronic systems or intelligent materials can compensate deviations from initial accuracy requirements detected by the continuous monitoring and control systems.

Research activities should focus on new high performance manufacturing technologies in terms of efficiency (volumes, speed, process capability), flexibility, robustness and accuracy based on new system architectures with self-adaptive machine structures and on mechatronic modules, multi-layer controls and highly redundant measurement, sensing and actuator structures. These R&D lines should lead to new equipment, lean and smart machines and production systems which are capable of taking into account tacit knowledge from operators and require less shop-floor space, by means of reduction of peripherals, reduction of system complexity, optimisation of cycles and process planning.

The aim is to allow improvements through successive investments in production equipment using flexible technologies such as modular production units. Furthermore, the new solutions should bring the integration of the necessary ICT support providing simplification and real user friendliness.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners, including SMEs, represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

The proposals should cover both research and demonstration activities. Prototypes and pilot implementations in real industrial settings represent a clear added-value. Whilst there is no lower or upper limit on the requested EU contribution, the target is that proposals allocate around 50% of the total eligible costs of the project (excluding management costs) to demonstration activities and this objective will be taken into account in the evaluation under the criteria S/T Excellence and Impact.

Funding Scheme: DEMO-targeted collaborative projects.

Expected impact: An increase in competitiveness and in production flexibility has become a critical aspect for the European manufacturing industries in the changing and uncertain global scenario. For most manufacturing factories, activities such as material handling, scheduling, part or process setup or changeover times still occupy too large a fraction of the total time that parts are 'in process'. In some cases, up to 90% of product manufacturing time represents non-value-added delays. Reducing this wasted throughput time is and will continue to be a major driver for improvement in productivity.

The achievement of more reliable and efficient manufacturing systems (e.g. machine tools, fixtures, cutting tools, process and peripheral equipment), integrating process modelling and part quality prediction, is expected to give rise to benefits such as:

- Reduction of the number of rejected components or products and the amount of raw material used by a factor of 20%;
- Reduction of power consumption, down time of the equipment, and effective required floor space by making it less sensitive to distortion from outside;
- Increased throughput and capability of processes, endurance, tool and equipment life and productivity maintaining repeatability and accuracy by a factor of 20%;
- Reducing volume of scrap/chips/waste and number of finishing operations with a minimal use of additional operating materials, fluids (coolants), additives and substances;
- Minimisation (or even elimination) of the use of services, e.g. air, water, coolants, by a factor of 30%.

FoF.NMP.2012-5 High precision production technologies for high quality 3D micro-parts

Technical content/scope: Production technologies are clearly advancing towards the manufacturing of topologically 3D optimised parts with complex internal structures such as conductive or cooling channels/micro reaction chambers and material gradient structures. Miniaturisation of products and production appliances and integrated compact systems design will be key issues. High quality and high performance (e.g. accuracy tolerances, repeatability) manufacturing, parts consolidation and simplification, multiple materials and the reduction of manufacturing and assembly costs must therefore be addressed. In order to ensure efficiency, reliability, robustness and high product quality, novel in-line monitoring and quality inspection systems, including non-statistical process control for maximum yield, are needed as well as equipment that can evaluate, in an automated way, the quality properties and their evolution under conditions of use.

Research activities related to the micro-parts and micro-topography should focus on some of the following areas, as appropriate:

- Novel approaches for 3D micro-parts production, including 3D micro-components using a wide range of materials (e.g. metallic alloys, composites, polymers, bio-polymers, ceramics, smart materials) and in large volume production;
- New process chains integrating different process technologies (e.g. micro-forming, machining by µEDM, Micro Powder Injection Moulding, Micromilling, Stereo Micro Lithography and printing), as well as multitasking machines integrating multi-process capabilities in one setup combining different production technologies;
- Tolerance system for micro parts and micro topography to evaluate the accuracy and/or precision which can be the base for standardisation;
- Analysis of the micro-structural behaviour of materials and its interaction with the production process, together with systems and devices for quality check of the micro-components;

- Measurement technologies and equipment (e.g. for micro-parts with high aspect ratio features, 3D-metrology), new handling, manipulation and fixture devices and systems.

Projects should also involve research activities related to the development of new micro-factory and micro-manufacturing concepts and systems capable to reduce finishing operations which should focus on the following areas, as relevant:

- Easily configurable assembly lines taking up a small space to assemble and test small parts (e.g. MEMS, devices, sensors, actuators, micro reactors);
- New generation of modular macro/meso/micro machine tools and fast, accurate and energy efficient robots with self adaptive and reconfigurable capabilities to implement a portable and easily configurable factory for manufacturing and assembly of high tech miniaturised devices;

Projects are expected to yield innovative processes and equipments for manufacturing of 3D micro-parts/systems with increased precision and accuracy to ensure small tolerances for the products, high quality standards and enhanced product reliability and to demonstrate the potential for high-throughput, cost efficient manufacturing.

In order to ensure the potential for high-throughput, cost efficient manufacturing (industrial relevance and impact of the research effort), the active participation of industrial partners, including SMEs, represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact. The projects are expected to cover demonstration activities, including pilot implementations in industrial settings, and this will be likewise reflected in the evaluation.

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: The micro-parts manufacturing industry in Europe is becoming increasingly important in terms of production and jobs and the research addressed in this topic should contribute to its competitiveness. The production of 3D micro parts/systems and the structuring of materials at the micro-scale introduce new functionalities that will enable a new generation of products with improved features, create new market opportunities, improve competitiveness and generate new jobs. The projects are expected to enable industry to realise economically and sustainably the specific functional and technical requirements of new emerging products in sectors such as medical/surgical, micro reactors, communication and consumer products.

New processes and equipment for micro-parts production should contribute in particular to all of the following objectives:

- Improving the capacity of European manufacturing industry concerning competitive production of innovative micro-components and devices (in terms of geometric complexity, high precision, high throughput, low cost and high flexibility) that allow high mix – high volume production;
- Improving the technological base and the competitiveness of European industry, in particular of those innovation fields which show high economic potential for the use of Micro-technology (e.g. micro-tooling, bio-medical, high-precision measurement and testing, process control and automation);
- Reduction of emissions by at least 30% (e.g. chemicals, hazardous materials, dust, waste) and of the consumption of energy resources when compared with conventional micro-manufacturing processes in line with a significant cost reduction.

FoF.NMP.2012-6 Knowledge-based tools and approaches for process planning and integrated process simulation at factory level

Technical content/scope: New product varieties, and high-performance processes, machines and production systems will require new methods and tools for the design of production systems and operation monitoring. Considering the need for production systems to evolve in line with products and processes, new ways to manage initial and ongoing system configurations are needed. Knowledge-based tools supporting production planning should be developed, and simulation methodologies should be introduced in Manufacturing Execution Systems (MES) and on board in machines, integrated with process control. Using the input from sensorial supervision and monitoring and to measure the current demand compared to manufacturing capacity, it will be possible to predict the process and system behaviour and, if necessary, to compensate for deviations from required precision and accuracy or to plan future manufacturing processes. These systems must be smooth (smart and fault-tolerant) in their interaction with human workers. Research activities should address some of the following areas:

- Development of platforms and tools integrated in the information and execution system of factories for non-linear process planning;
- New tools and methodologies that enable robust optimisation of process chains in the design phase in order to achieve first-time-right processes;
- New tools which will allow, by considering local production, the optimisation and monitoring of manufacturing processes seen from a factory perspective, wherever in the world these are performed;
- Design of structures to support processes of human-system interaction, system mediated human-human interaction, and human psycho-social considerations, in developing high reliability, responsive/adaptable systems, with high performance outcomes.

Projects should also include an integrated process simulation focused on one or more of the following areas, as appropriate:

- Modelling tools that will allow changes to be made at a design level to both the product and the corresponding manufacturing process in order to maximize the system efficiency.
- Modelling and system knowledge management tools working in an integrated way on different shop-floor levels (process, machine, cell, line and factory).
- Multi-level decision support management systems based on on-time simulation starting from the real current status and on the interaction between the machine and the production system.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners, including SMEs, represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact. The projects are expected to cover demonstration activities, including pilot implementations in industrial settings, and this will be likewise reflected in the evaluation.

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: With the growing importance of manufacturing SMEs within the European economy in terms of GDP and number of jobs, the research addressed in this topic should contribute to their competitiveness and production flexibility. The application of knowledge-based tools for process planning and integrated shop-floor simulation that can be adapted to SME requirements will improve scheduling, process set-up or change-over times, contributing to increased SME competitiveness.

Moreover, projects should contribute to some of the following objectives:

- Reducing consumption of resources by a factor of 40% through the use of energy- and material-efficient processes and machinery, and smart energy management;
- Higher and more stable product and customer service quality through 30% higher process robustness and accuracy;
- 30% higher productivity and reduced cycle times under more reliable and efficient manufacturing conditions.

FoF.NMP.2012-7 Innovative technologies for casting, material removing and forming processes

Technical content/scope: Manufacturing technologies shall move towards sustainable, low resource consuming, flexible and high performance processes at low cost to ensure competitiveness. The recycling aspect is also a key issue for future manufacturing processes. New process technologies are needed to support casting and forming processes, material removing and additive manufacturing technologies, considering product and process life-cycle impacts as well as the performance requirements for these processes (e.g. tolerances, accuracy, surface quality, robustness, and higher properties). New approaches are demanded for low resource consuming processes and process intensification, integrated with hybrid processes, as well as knowledge-based processes exploiting advanced modelling, simulation and optimisation techniques for processes and equipment.

In addition, the European industries are increasingly working with new materials including nano-alloys to take advantage of enhanced functionality, lower weight, lower environmental burden and improved energy efficiency all along the production process. This is needed to achieve a sustainable manufacturing base when moving to high added value products and customised production. New materials pose new challenges for cost efficient and sustainable manufacturing. These new materials include, among others, 'carbon neutral' materials as well as materials for improved product quality, versatility, weight saving and improved behaviour and functionality.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners, including SMEs, represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

The proposals should cover both research and demonstration activities. Prototypes and pilot implementations in real industrial settings represent a clear added-value. Whilst there is no lower or upper limit on the requested EU contribution, the target is that proposals allocate around 50% of the total eligible costs of the project (excluding management costs) to demonstration activities and this objective will be taken into account in the evaluation under the criteria S/T Excellence and Impact.

Funding Scheme: DEMO-targeted collaborative projects.

Expected impact: Manufacturing companies are nowadays facing more and more demanding production processes, while they cannot compete with the low labour costs of emerging countries. Thus, research addressed in this topic should contribute to their competitiveness. The development of new casting, material removing and forming manufacturing technologies should contribute to some of the following objectives:

- Have a direct economic impact on innovation and research in manufacturing, for reducing process chains from raw material to finished parts being applicable across many industrial sectors;
- Facilitate the development of cost-effective, safe, capable, affordable and sustainable technology and its incorporation into an industrial environment;
- Increase the efficiency of material use including improved recyclability and of energy consumption in the range of around 20%, depending on the specific technologies;
- Performance and capability of processes with high value added materials and engineered materials for new functionalities of products.

II.5.2 'Energy-efficient Buildings (EeB)' – Public-Private Partnership –

Cross-thematic Coordination between NMP, ICT, Energy and Environment (including Climate Change)

The construction industry accounts for more than 10% of the EU's GDP and employs 32 million people in large, medium and small enterprises (direct and indirect employment). The creation and operation of built environment is the highest contributor to the emission of Green House Gases with an average value estimated in most developed countries at close to 33%, knowing that around 40% of the total energy use corresponds to buildings, while their fossil-fuel heating represents a major share. Therefore, in the near future, the built environment in Europe needs to be designed, built, operated and renovated with much higher energy efficiency. In order to achieve the objectives of the Energy Policy for Europe adopted early in 2007 and to contribute through Energy-efficient Buildings to the 20% reduction of energy consumption, 20% use of Renewable Energy Sources and 20% reduction of CO_2 emissions, a strong and continued effort in RTD and innovation in the short, medium and long term is needed.

The objective of the *Energy-efficient Buildings PPP Initiative* is to deliver, implement and optimise building and district concepts that have the technical, economic and societal potential to drastically reduce energy consumption and decrease CO_2 emissions, both in relation to new buildings and to the renovation of existing buildings. This new initiative should have a large payoff, as it will increase the market for energy-efficient, clean and affordable buildings. Research priority will be given to delivering new building materials and components for energy saving and energy generation, thermal energy storage systems, advanced insulation systems, thermal distribution systems, lighting technologies, windows and glazing technologies, energy generation systems based on renewable sources, but also to reliable simulation and prediction tools, including assessment methods that integrate economical, social and environmental issues, including comfort and safety. To date, the construction industry has failed to effectively integrate key technologies into its operations in order to achieve sustainable, long-term competitiveness.

The aim of the activities is to identify, through the partnership with industry, the main RTD needs, and address a number of areas of clear industrial interest, such as tools, the building envelopes, systems and equipment, ICTs for energy efficiency, environmental technologies, social and behavioural aspects, standardisation and business models. Specific deliverables expected for new and refurbished buildings (including cultural heritage) are:

- Research for new design and manufacturing technologies, focusing on materials and components, thermal energy storage systems, advanced insulation systems, thermal distribution systems, lighting technologies, windows and glazing technologies, and assessment methods and tools which include guidelines/methodologies for the eco-design and the Life Cycle Assessment of energy-efficient buildings.

- Research on ICT for energy efficiency in buildings, such as design and simulation tools, inter-operability/standards, building management systems, smart metering and user-awareness tools.

- Research for systemic, optimised and validated coherent set of solutions for all categories of existing buildings and climate in Europe.

- Research on resource efficiency (waste and energy use) to identify best practices to help set standards and establish public policies for higher energy efficiency and reduced environmental impact.

- Research on the application of technological, design and organisational improvements at district-level with the aim of reducing the energy and resource consumption.

- Research-related activities on key demonstration topics concerning integration of innovative products and systems, grid issues and business models.

The indicative budget for 'Energy-efficient Buildings (EeB)' is EUR 140 million in 2012, of which EUR 70 million is from the NMP Theme, EUR 30 million from the ICT Theme, EUR 35 million from the Energy Theme and EUR 5 million from the Environment Theme.

II.5.2.1 'Energy-efficient Buildings (EeB)' - Topics covered by the NMP Theme:

EeB.NMP.2012-1 Interaction and integration between buildings, grids, heating and cooling networks, and energy storage and energy generation systems

Technical content/scope: Innovative solutions are needed for higher energy efficiency and improved connection between storage systems, smart grids, buildings and vehicles/mobility systems, as well as methodologies for interconnectivity between smart grids and other networks (e.g. heat networks), in line with the SET Plan. The interconnection between systems in buildings (including room conditioning equipment as well as home appliances) is a key challenge in improving energy recovery, in particular through the integration of water management and ventilation systems, by developing new energy and water management strategies at community level. New methods for real-time management of energy demand and supply are required. In this framework, new technologies and approaches are needed to enable effective Building-to-Building and Building-to-Grid interactions as it should be in a real energy market. Energy-efficiency interoperability of buildings with other urban domains (transportation, energy grids, etc) has to be achieved. Methodologies and tools for reduction of CO2 emissions and improved energy efficiency, keeping at least the same comfort level as well as certification procedures at district level are required to contribute to a low carbon economy. This integrated approach requires considering simultaneously storage of energy of different types: thermal, electrical or other (e.g. chemical, hydrogen, mechanical, biogas, magnetic). Specific solutions are needed, allowing the best solution to be selected to store renewable thermal or electrical energy at district level or at another scale including seasonal, geological or geographic specificities. Storage capabilities are expected to be combined with systems and equipment for energy production and distribution at building and district level. Solutions are needed for achieving the highest coverage of built environment energy demand by renewable (heat, cool and electrical) energy production at building and district level. This has to come along with new methods of predicting well in advance the renewable energy production and use, choosing accordingly the best storage and usage strategy.

Regarding systems and equipment for energy use at building and district level, energy-conversion hub/router concepts are needed. They should enable maximum renewable energy usage from decentralised (electrical, thermal) production, by combination of storage and energy-conversion techniques at a district demand-supply scale which will be fully integrated with the smart grid systems. Projects have to address thermal and/or electrical system optimisation at building or district level. The projects should include technological demonstration and testing which will validate advanced energy-efficient infrastructure and strategies. Solutions and technologies should be validated in order to be easily replicable throughout all countries and variety of European climatic areas.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Appropriate industrial standards and new business models should be addressed.

Funding Scheme: Large-scale integrating collaborative projects.

Expected impact: Involvement of the construction industry and all relevant industrial, research and public stakeholders in ambitious research initiatives including technological demonstration and testing, which will validate advanced energy-efficient infrastructure and strategies at district level. For thermal systems, projects should demonstrate 20% reduction in annual primary energy demand while for electrical systems a nearly zero energy annual balance is expected for a community of buildings compared to their expected energy performance summed on an individual building basis. Projects should also demonstrate a reduction in peak load after retrofit without forgetting a 20% reduction of CO2 emissions. Clear evidence of the cost benefit will be provided and solutions should be replicable in at least two EU countries with clearly different climate conditions.

EeB.NMP.2012-2 Systemic Approach for retrofitting existing buildings, including envelope upgrading, high performance lighting systems, energy-efficient HVAC systems and renewable energy generation systems

Technical content/scope: The deep renovation of the existing buildings stock to drastically improve their energy efficiency requires a systemic approach which includes integrated concepts consisting of building and system technologies. Energy-efficient refurbishment packages are needed in order to reduce primary energy demand. Innovative systems which introduce greener solutions into the existing buildings need to be specifically analysed from the point of view of the integration issues. This systemic approach should include improved comfort and quality of the indoor environment, as well as industrialised solutions, making optimal use of local energy opportunities and boundary conditions. This approach should also consider the large diversity of the European existing building stock presenting a lot of technical specificities. The optimisation of the refurbishment of existing buildings should integrate, as appropriate, various technological solutions (envelope, systems, renewable energy sources, thermal storage, natural ventilation, etc) which will interact with each other and with all the existing building systems to optimise overall performance. In this framework, energy-efficient 'kits' may emerge as an opportunity to retrofit buildings at affordable prices. Furthermore, proposed solutions should address issues like how targets for improving the carbon performance of a building during a refurbishment are set at the design phase and monitored while ensuring the quality of installation and commissioning. The ability of modelling the building status, during the design stage and/or during operation, can help to

increase the quality of the installation, to better exploit the installed components during building operation, as well as to have a better assessment of the energy savings actually obtained after refurbishment. It is also important to develop methods to model and simulate the existing building configuration. Feedback data from deep renovation experiences, including the comfort data, should be analysed as well. The proposed solutions should include the envelope, which will benefit from new materials performances, products and components, in order to address energy-efficiency with fault tolerant procedures and building techniques.

There is a need to develop insulation systems specifically designed for the energy-efficient retrofitting of occupied buildings. In addition, we are missing nowadays high performance adapted products for external thermal insulation which keep the aesthetic aspect of buildings fabric and which are easy to install and are affordable. Multifunctional systems, including energy production, distribution and storage technologies, shall be integrated into the envelope system. Regarding systems and equipment for energy use, breakthroughs are needed in new methodologies to integrate comfort systems, energy management systems and local energy generation. Existing technologies have high potential (e.g. heat pump, fuel cells) but still need further development to target higher performances and suitability for retrofitting buildings at affordable prices. There is a need to design reliable, scalable and cost-effective solutions for solar systems and electricity production and distribution in buildings. Energy efficiency enhancement is required, to be achieved by applying new concepts of heating and/or cooling sources. Passive systems need to be developed that will enable replacement of conventional ventilation and cooling systems, to be used both in office and residential buildings. New lighting technologies such as Solid State Lighting devices (including organic or inorganic) require large-scale demonstration actions to bring its full potential for energy efficiency into practice. The proposed solutions should be assessed based on their life-cycle energy performance and should demonstrate a genuine life-cycle improvement beyond the existing scenario.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Appropriate industrial standards as well as databases on buildings stock and retrofitting technologies should be taken into account.

Funding Scheme: Large-scale integrating collaborative projects.

Expected impact: Projects will develop a set of holistic solutions in the areas of buildings retrofitting, by integrating the most suitable HVAC, electricity and heat networks, lighting technologies and ICT solutions that offer clear cost benefit advantages to the building owners and operators. The holistic approach will result in cumulative annual energy savings of at least 40% measured against building performance before retrofit without forgetting a 20% reduction of CO2 emissions. Retrofitting should have a global target of 50 kWh/m²/year for energy consumption (excluding appliances) while reducing peak loads against the values measured before retrofit. The energy saving target of new lighting should be at least 50% over the average consumption of the installed base. Projects are expected to demonstrate the in-use success of integrated packages developed. This includes user acceptability and long term continued efficient operation, while leading to a pay-back of maximum 7 years compared to current state of the art.

EeB.NMP.2012-3 Development and validation of new 'processes and business models' for the next generation of performance based energy-efficient buildings integrating new services

Technical content/scope: New business models which are triggered by new emerging technologies and processes need to be developed to reach the energy efficiency targets in the vast majority of construction SMEs. Organisational and financial models which include Energy Service Companies (ESCOs), should address the marketing and the demonstration of energy saving measures and energy generation within buildings. For instance, regional flagship projects like schools or residential homes could be addressed, with the involvement of local authorities or property developers. Common energy tool sets for simulation and analysis at the EU level are needed, taking into account country or regional specific issues: energy supply and demand, best available technologies, structured information on typology etc of the existing building stock. Performance based contracts and the shift towards life-cycle-performance based business are needed, including risk/value distribution across the value chain. This requires an early involvement of all relevant stakeholders including clients and the introduction of the role of all value chain actors with a real focus on SMEs. Business models using collaborative value chain approach, life-cycle costing and/or total cost of ownership at building or even at district level are needed. Synergies with on-going initiatives should be established, by mapping the relationship between relevant programmes and actions at national and regional level. This applies to the elaboration of innovative business models with a high SME involvement and private and public incentive schemes, to encourage efficient and pragmatic solutions at district scale or greater.

In order to ensure an efficient implementation and maximum impact of SME-related activities, the leading role of SMEs with R&D capacities will be evaluated under the criteria 'Implementation' and 'Impact': the coordinator does not need to be an SME but the participating SMEs should have the decision making power in the project management; and the output should be for the benefit of the participating SMEs and the targeted SME dominated industrial communities.

Funding Scheme: SME-targeted collaborative projects.

Expected impact: The global market for energy-efficient or low carbon solutions is expected to increase significantly in the next decade. The projects should enable economic, organisational and social innovation solutions which will boost the transformation towards low carbon cities. New business performance-based models should clearly support market adoption of new energy-efficient solutions by increasing their market share by 10% per year measured on the basis of each technology. The business models should incentivise uptake of these energy-efficient solutions by increasing profitability and reducing risk.

EeB.NMP.2012-4 Nanotechnology based approaches to increase the performance of HVAC systems

Technical content/scope: Heating, Ventilation, and Air Conditioning (HVAC) systems represent 39% of energy use in residential buildings and 32% in commercial facilities. Although heating is today the most demanded need, cooling trends are increasing and not only in Mediterranean countries. These trends are expected to continue, because of climate change combined with increased presence of heat releasing equipment in buildings. Ventilation is also of increasing concern as energy saving efforts through air recirculation can lead to worsening air quality and increased presence of allergies. Nanotechnology could

effectively contribute to a reduction of the overall energy demand. Proposals under this topic should address this potential reduction by improving HVAC systems or building components performance both for the cooling and heating mode. Different technological solutions may be considered, such as the introduction of advanced insulation for cooling/heating purposes, energy harvesting systems or improved material properties, the separation of cooling and dehumidification loads using advanced nano-structured membranes (e.g. nanoporous/hollow fibre membranes) or nano-dessicants, or the improvement of storage capabilities in energy tanks or integrated ventilation enthalpy recovery systems. Nano-fluids (e.g. fluids + iron, aluminium or boron nanoparticles or carbon nanotubes) or nano-structured surfaces could also be used to introduce more efficient heat transfer mechanisms with associated energy saving. Nanotechnology development of non-fluorocarbon refrigerants has the potential to significantly reduce the global warming effect of HVAC systems.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: Nano-technology solutions will be demonstrated at industrial system level, highlighting key advantages both in terms of performances and benefits and in terms of total service life costs for owners and occupants including increased quality of the indoor environment. Optimised heat exchangers for energy efficiency are expected to reduce energy consumption by 50% relative to similar conventional systems. A shift to non-fluorocarbon refrigerants which significantly reduce impact on global warming should be included. The relevant safety issues should be addressed.

EeB.NMP.2012-5 Novel materials for smart windows conceived as affordable multifunctional systems offering enhanced energy control

Technical content/scope: Windows are critical elements to control the energy performance of a building. There is a need to develop affordable 'smart active windows', defined as multifunctional systems offering multiple properties and functions in one single construction element.

Research proposals should address materials for smart windows with measurable and enhanced energy control, namely energy saving and/or harvesting. The proposed solutions should go well beyond the state of the art, e.g. in terms of embodied energy and durability, respect sustainability principles (environmental sustainability of each developed solution should be evaluated via life cycle assessment studies carried out according to the International Reference Life Cycle Data System - ILCD Handbook); be applicable to both new built and to renovation; be applicable to both hot and cold climates; be easy to install; offer realistic solutions at a reasonable price; offer adequate luminosity, adequate light transmittance, lighter weight, glare control, increased fixed or variable thermal inertia, increased thermal comfort and noise reduction. Developments should be based on new materials for new window concepts and on the better understanding and improvement of material combinations and synergies. Additional improvements to the 'smart windows' may also be included in the research, such as e.g. the application of OLEDs for lighting, adjustable infrared radiation transmission, or sensor technologies, material analysis and modelling. Recycling/reuse of materials may also be addressed. Standardisation aspects can be considered. Proof of concept in terms of one (or more) component(s) should be delivered within the project, excluding

commercially usable prototypes (2006/C323/01), but convincingly proving scalability towards industrial needs.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners, including SMEs, represents an added value to the activities, and this will be reflected in the evaluation under the criteria 'Implementation and Impact'. The participation of public authorities may also be an asset for the proposals.

Funding Scheme: Small or medium-scale focused research projects.

Expected impact: Compared to presently available state-of-the-art smart windows, expected improvements are: (i) Reduction of U-value down to 0.3 W/ (m^2.K); (ii) Weight reduction of at least 50%; (iii) Cost reduction of at least 15%; (iv) improved energy efficiency in buildings; and (v) greenhouse gases reduction deriving from buildings in Europe.

EeB.NMP.2012-6 Methodologies for Knowledge transfer within the value chain and particularly to SMEs

Technical content/scope: In order to successfully transform the energy efficiency market, SMEs have a key role to play. To facilitate their critical involvement there is a need to develop viable business models that SMEs can use to reduce risk and provide clear growth areas for their businesses. To encourage the transfer of good practices, technologies and methodologies, including cross-sectoral cooperation, the set up of a communication infrastructure and the organisation of a number of coaching events are also needed. New tools which are cost effective, fast and easy to use have to be developed to overcome present barriers (e.g. cultural, linguistic, financial, etc). To achieve coordination between the EU and national/regional levels activities need to be developed and implemented, such as spreading the information, in particular with regard to public procurement, standardisation and regulation, outreach programmes, energy innovation platform, training and providing an infrastructure of experimental buildings that incorporate new technologies in the field of Energy Efficiency. Methodologies and tools to strengthen the involvement of SMEs, including in particular the role of contractors, architects, engineers and designers, within the value chain should allow later to develop and use these advanced technologies in an integrated way to enable energy saving solutions to be largely disseminated into the market.

Funding Scheme: Coordination and Support Actions (supporting actions).

Expected impact: Energy-efficient solutions and market uptake measures including easy-to-apply reliable business practice guidelines for SMEs will be provided for one homogenous climatic area. In addition we expect evidence-based recommendations in support of policy-making on public procurement rules, regulations and standards, to provide SMEs with a lean and coherent framework of definitions and of assessment, certification and verification procedures for buildings. Validated methodologies and tools that demonstrate cost and comfort benefits and reduce risk will boost effective exchange of knowledge and best practices among SMEs, allowing them to actively contribute to the promising low carbon economy. Such tools could include mechanisms to develop multi-skilled partnerships of SME businesses.

II.5.3 'Green Cars (GC)' - Public-Private Partnership –

Cross-thematic cooperation between NMP, ICT, Environment (including Climate Change) and Transport (including Aeronautics)

The automotive industry is one of Europe's key industrial sectors, whose importance is largely derived from its linkages within the domestic and international economy and its complex value chain. It is estimated to account for close to 8% of total manufacturing value added (ca. EUR 120 billion, 2006) and about 6% of total manufacturing employment (over 2 million employees). The automotive industry also provides an indirect employment to 10-11 million persons and is one of the largest RTD investors in the EU with over EUR 20 billion annually (ca. 5% of its turnover)[23].

The foreseeable shortage in crude oil based energy carriers is driving fears about energy security: 73% of all oil consumed in Europe is used in transport and estimates predict a doubling of passenger cars within the next 20 years. From an environmental and energy point of view there is an urgent need to find alternatives to fossil fuels in order to secure future energy supply, to guarantee the availability of appropriate material recycling technologies, and to reduce greenhouse gas emissions and other potential environmental impacts related to the automotive industry entire life-cycle. It is thus increasingly evident that a particular emphasis should be put on the rapid development of technologies supporting the massive emergence of more efficient and sustainable road transport solutions based on alternative fuels/energy, and on the RTD efforts associated with them.

The *'European Green Cars' PPP Initiative* is a series of measures boosting research and innovation aiming at facilitating the deployment of a new generation of passenger cars, trucks and buses that will spare our environment and lives and ensure jobs, economic activity and competitive advantage to car industries in the global market. A series of different measures are proposed: support to research and innovation through FP7 funding schemes, specific EIB loans to the automotive and other transport industries and its suppliers, in particular for innovative clean road transport, and a series of legislative measures to promote the greening of road transport (circulation and registration taxes, scrapping of old cars, procurement rules, the CARS21 initiative).

Other actions that are very closely related to the 'European Green Cars' Initiative but not formally included in it are being implemented, such as the 'Fuel Cell and Hydrogen' (FCH) Joint Technology Initiative and the road transport projects funded under the FP7 Transport Theme.

The 'European Green Cars' Initiative includes three major research and development avenues within its RTD pillar:

- **Research for heavy duty vehicles based on internal combustion engines (ICE)** (Sustainable Surface Transport (SST) sub-theme): The research will primarily concentrate on advanced ICE with emphasis on new combustion, the use of alternative fuels (e.g. bio-methane), intelligent control systems, 'mild' hybridisation (use of recuperated electricity to power the auxiliary systems) and special tyres for low rolling resistance.

[23] 'European industry – a sectoral overview', 2006 update, EC-DG ENTR

- **Research on electric and hybrid vehicles**: This component will be the most essential in this package. To have a real impact on the green economy, research in this field should no longer focus on electric vehicle technologies seen in isolation from the rest of the transport system: a massive introduction of the technology requires the availability of smart electricity grids and intelligent vehicle charging systems tailored to customers' needs.

- **Logistics and co-modality** combined with **intelligent transport system** technologies are essential to optimise the overall system efficiency and sustainability avoiding for example that empty trucks circulate on highways due to sub-optimal logistics. In this respect, smooth and co-operative interactions between the different transport modes will be essential.

The 2012 Work Programme focuses on the second research avenue: electric and hybrid vehicles and their infrastructures. Three groups of topics covering collaborative research activities as well as coordination and support actions are included:

- Materials, technologies and processes for sustainable automotive electrochemical storage applications, implemented through a call jointly implemented with other Themes.

- Research on electric and hybrid vehicles, implemented through the Sustainable Surface Transport (SST) sub-theme of the Transport Theme.

- Information and Communication Technologies for the fully electric vehicle, implemented through the ICT Theme.

The indicative budget for 'Green Cars (GC)' is EUR 118 million in 2012, of which EUR 20 million is from the NMP Theme, EUR 30 million from the ICT Theme, EUR 63 million from the Transport Theme and EUR 5 million from the Environment Theme.

II.5.3.1 'Green Cars (GC)' Topics implemented jointly by NMP, Transport (including Aeronautics) and Environment (including Climate Change) Themes

During the last 30 years, significant measures have been taken to improve the efficiency of vehicle propulsion systems. At the same time, the weight of cars has tended to increase in order to achieve significant improvements in terms of comfort, crashworthiness and occupant safety. Indeed the weight of a typical vehicle has increased by approximately 30% within the same class. Since the mass of the vehicle has a direct impact on the traction force required and thus fuel consumption (increasing by about 0.5l/100 km for each 100 kg of extra weight), a reversal of this trend is paramount to respect a fundamental requirement for all future automobiles to achieve the highest levels of energy efficiency possible.

Moreover the range of electric vehicles, generally seen as a critical issue regarding the acceptance of such vehicles in practice, is directly related to the several factors: the efficiency of breaking energy recovery, the performance and cost of the energy storage systems, and not least the weight of the vehicle and its battery. The application of lightweight materials offers an important potential in this regard as it helps to partly compensate for some of the battery's high mass.

Correspondingly, in addition to improving recuperation, and to making batteries less expensive, improving their rechargeability and increasing their energy density, every

opportunity for getting more kilometers out of the same amount of energy by has to be fully exploited in order to arrive at a product that the customer accepts and chooses to use.

Already a multitude of innovative concepts and materials are available and used in vehicles and transport carriers today; their further market uptake has been hindered to date by the relatively high costs associated with the development and implementation of advanced materials and production technologies. So, further research is needed to improve this situation.

Considering the large scope of potential novel materials applications, this call will focus on two issues: the development of innovative materials for batteries based on nanotechnology; and the development of new lightweight materials and respective technologies for vehicle applications.

GC.NMP.2012-1 Innovative automotive electrochemical storage applications based on nanotechnology

Technical content/scope: Volume production plans for large-capacity Li-ion rechargeable batteries are being made one after another around the globe, targeting electric vehicles (EVs) and other applications. However, most car manufacturers would agree that lithium ion technology is still not satisfactory for long distance EV use. More energy density, power density, cost and safety improvements are needed. Although the development of second generation Li-ion batteries delivering roughly double the energy density (200Wh/kg to 300Wh/kg) is in progress (with a target implementation of 2015 to 2020), post Li-ion rechargeable batteries – solid-state, Li-S, or metal-air batteries, for example – are expected to provide a long term solution to current range and cost issues.

Projects shall exclusively address the development of innovative materials and technologies for battery components, material architectures and systems for automotive electrochemical storage at cell level within a responsible, sustainable and environmental-friendly approach looking at the entire life cycle. Activities shall focus on the understanding of the phenomena which affect the battery properties at the nanoscale across a full cell, including modelling and simulation. Research shall focus on innovative technologies, architectures and chemistries and should address the following issues:

- performance, safety, recyclability and cost;
- potential for fast charging without significant life reduction;
- effect of bidirectional flow at charge stations;
- availability of constituent materials;
- eco-design and material production;
- characterisation, standardisation and synergies with other applications.

Proof of concept in terms of product and/or process (not necessarily reaching the industrial scale but convincingly proving scalability towards industrial needs with cells of automotive size) is encouraged as is participation from the manufacturing industrial sector within strong interdisciplinary consortia.

Proposals for electrochemical capacitors are excluded, as these have been extensively covered in a previous Green Cars call.

Funding Scheme: Small or medium-sized collaborative projects.

Additional Eligibility Criterion: The EU contribution must not exceed EUR 3 000 000 per project.

Expected Impact: (i) High energy densities with respect to the state-of-the art (i.e. higher than 400 Wh/kg); (ii) Overall performance, safety, recyclability and life-cycle sustainability; (iii) A minimum lifetime of 3000 cycles in a 80% DoD window in typical automotive conditions over 10 years; (iv) Establish and maintain world-class status for the European automotive battery industry.

GC.NMP.2012-2 Innovative advanced lightweight materials for the next generation of environmentally-friendly electric vehicles – topic implemented jointly by NMP, Transport and Environment Themes

Technical content/scope: Research proposals should focus on the development of advanced materials for cars and light-duty vehicles, contributing to an accelerated market introduction of new energy-efficient electric vehicles, while ensuring sustainability and viability by rapidly achieving the appropriate economies of scale. The research proposals should address also several of the following issues or all of them:

- Reducing the structural weight, e.g. by deploying light alloys, thermoplastics, carbon or other fibre-reinforced polymers, composites, honeycombs, foams, advanced steels and tailored, multifunctional materials into the body parts, chassis and heavier interior systems, and including e.g. optimisation of structural layouts, multi-functional design, numerical simulation, testing, prototyping and/or manufacturing processes. Standardization issues should be considered;
- Exploiting new materials characteristics in association with the innovative structural layouts made possible by new electric vehicles, in order to improve safety by enhanced energy absorbing capability. For instance, this could allow to better deal with asymmetric crash conditions (opponent of higher size and weight) in the case of very light vehicles. Fire resistance of the proposed advanced materials should be taken into account, where appropriate;
- Addressing related production process challenges, in particular developing suitable forming and joining technologies, to guarantee reliability, robustness and safety (e.g. guaranteeing that crash performance as tested does not degrade over time), reducing the cost of assembly while permitting a wide range of vehicle variants;
- Assessing the performance of the behaviour of the advanced materials and the respective components and systems under typical operational and extreme loading conditions (e.g. with respect to durability and safety) and external environment (e.g. for corrosion resistance), including the potential for accelerated lifetime testing while ensuring reliability;
- Carrying out of an appropriate life-cycle analysis of the advanced materials and the respective components and systems, including dismantling and recycling technologies; for brand new materials, a recycling method should be outlined with appropriate lab-scale experimental part;
- Carrying out an economic analysis, including material resources availability and costs, that demonstrates the real advantages of the new materials over conventional ones. Trade-offs between the extra cost of lightweight design and possible gains from lower lifetime costs for energy consumption and emission of vehicles should also be assessed.

While the focus of the proposal should be on electric cars, the potential for synergies with other types of environmentally-friendly vehicles or the cabs of heavy-duty vehicles can also be taken into account.

In order to ensure industrial relevance and impact of the research effort, the active participation of industrial partners (including SMEs) represents added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Proposals may (i) include research results validation and the physical demonstration of the performance achieved with the innovative advanced material(s), e.g. even via a complete body in white structure or vehicle demonstrator, or (ii) consist of focused research, limiting validation of the innovative advanced material(s) to substructure level.

Special Features: The proposed projects should not duplicate similar FP6 or FP7 projects, e.g. projects funded under the FP7 European Green Car Initiative. Coordination or ex-ante clustering with projects in topic GC.SST.2012.7.1-4 can be foreseen.

Funding Scheme: Large-scale integrating collaborative projects.

Additional Eligibility Criterion: The EU contribution must not exceed EUR 10 000 000 per project.

Expected Impact: (i) Considerable weight reduction: a 30% body in white weight reduction was already demonstrated in recent EU projects on conventional vehicles; a further 20% reduction (taking into account the higher acceptable cost) is to be demonstrated, with the relevant safety, energy efficiency and environmental benefits; and/or (ii) Overall reduction in time-to-market and development costs while increasing product flexibility; and (iii) Economic viability and technological feasibility of the advanced materials and the related processes with reference to real applications of industrial relevance; and/or (iv) Options for the use of globally available, recyclable or recycled, and carbon-neutral materials; and/or (v) Extended lifetime of durable components of a vehicle and lower life-cycle costs.