ORIENTATION PAPER

prepared in connection with the FP7 2013 Work Programme of

THEME 4 - NMP

NANOSCIENCES, NANOTECHNOLOGIES, MATERIALS AND NEW PRODUCTION TECHNOLOGIES

Important notice:

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The adoption and the publication of the work programme by the Commission are expected by mid-July 2012 via the Participant Portal:
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Only the adopted work programme will have legal value.

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DRAFT VERSION April 2012

The proposed NMP calls for collaborative projects following the two-stage procedure are:

FP7-NMP-2013-LARGE

FP7-NMP-2013-SMALL

FP7-NMP-2013-SME

with an **indicative deadline 23 October 2012** for the first-stage

The proposed NMP call for coordination and support actions following the one-stage procedure is:

FP7-NMP-2013-CSA

with an **indicative deadline 4 December 2012**

The proposed calls for public-private partnerships (PPPs) following the one-stage procedure are:

FP7-2013-NMP-ICT-FoF

FP7-2013-NMP-ENV-ICT-EeB

FP7-2013-GC-MATERIALS

with an **indicative deadline 4 December 2012**

Further calls are envisaged for coordination with China; coordination with Japan; Ocean of Tomorrow; and ERA-NET actions

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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

Against the backdrop of the current economic situation and increased global competition, the Union has defined a strategy to support growth and job creation, Europe 2020. The Innovation Union Flagship initiative supports this strategy through specific commitments. Research and innovation are key drivers of competitiveness, jobs, sustainable growth and social progress.

The work programme 2013 aligns with, and contributes towards, the objectives of Europe 2020, the **Innovation Union** Flagship[1], and other EU policies. There is a determined focus on fostering new ideas, supporting world class teams tackling significant societal challenges, and on ensuring that the fruits of our investments can be properly exploited.

In this way the work programme provides for a smooth transition towards the new research and innovation programme for 2014-2020, Horizon 2020.

I.1 Approach for 2013

Europe 2020 and the Innovation Union flagship stress the need for growth and the focus on societal challenges, which will be the basis for jobs and wealth creation in Europe.

There are more than 20 million active enterprises in the EU-27, of which a third are active in the manufacturing sectors (including construction). In terms of wealth creation, manufacturing and construction generate around a quarter of the total EU-27 added value and provide around 50 million jobs; however, they are facing growing competition.

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.

It covers the entire range of industrial research activities. Its central objective is to support the transformation of European industry from a resource-intensive (relying on raw materials, labour, energy etc) to a knowledge-intensive and sustainable industry. The issue for growth and employment is how industry can incorporate knowledge into products with high added value, and highly efficient processes. Sustainability and societal challenges have always been implicit in NMP strategies, but are receiving increased attention.

Activities under the NMP Theme in the last year of FP7 represent a natural continuation of those in 2012, in line with the multi-annual plans prepared in consultation with key stakeholders. Calls of the NMP Theme in 2013 will continue to span the spectrum from

[1] COM(2010)546

enabling research, to applications and demonstration activities. There is a continued emphasis on applications including demonstration, in order to support the goals of the Innovation Union.

A key feature of the 2013 work programme (WP) is the participation for the fourth year in actions within the European recovery package. Starting with the WP 2010, the NMP Theme 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. The role of the Programme Committee (NMP configuration) is also acknowledged.

This work programme contributes to the following priorities:

Oceans of the future

OCEAN.2013-1	Biosensors for real time monitoring of biohazard and man made chemical contaminants in the marine environment
OCEAN.2013-3	Innovative antifouling materials for maritime applications

Raw materials

4.1-1	Development of new materials for the substitution of critical metals – coordinated call with the Japan Science and Technology Agency
4.1-2	Breakthrough Solutions for Mineral Extraction and Processing in Extreme Environments
4.1-3	European Intelligence Network on the Supply of Raw Materials

Smart cities

EeB-1	Nanotechnology for multifunctional lightweight construction materials and components
EeB-2	Safe, energy-efficient and affordable eco-innovative materials for building envelopes and/or partitions to provide a healthier indoor environment
EeB-3	Integration of technologies for energy-efficient solutions in the renovation of public buildings
EeB-4	Integrated control systems and methodologies to monitor and improve building energy performance
EeB-5	Optimised design methodologies for energy-efficient buildings integrated in the neighbourhood energy systems
EeB-6	Achieving high efficiency by deep retrofitting in the case of commercial buildings

Anti-microbial resistance

1.2-2	Nanotherapeutics to treat bacterial infectious diseases

I.2 Research for industrial innovation and SMEs

This work programme contains **innovation measures** in support of activities closer to the market. These include the up-scaling of laboratory-based processes and other, pilot-scale

activities; and also a range of demonstration activities, such as pilot implementation in industrial settings, and technical and economic reviews of the new technology. These appear principally in the following topics:

1.1-1	Exploration, optimisation and control of nano-catalytic processes for energy applications
2.1-1	Developing new precursors, functionalisations and processing routes for carbon fibres
2.2-1	Biomaterials for Advanced Therapies and Medical Devices in the neurological/neuromuscular or cardiovascular fields
2.2-3	Wide band gap semiconductor materials and structures for power electronics in energy technologies
2.2-6	Alternative materials and cell concepts for Photovoltaic (PV) applications – from laboratory to production
3.0-2	Integrated processing and Control Systems for Sustainable Production in Farms and Forests
4.1-2	Breakthrough Solutions for Mineral Extraction and Processing in Extreme Environments
OCEAN.2013-1	Biosensors for real time monitoring of biohazard and man made chemical contaminants in the marine environment
OCEAN.2013-3	Innovative antifouling materials for maritime applications
FoF-1	Improved use of renewable resources at factory level
FoF-2	Innovative re-use of modular equipment based on integrated factory design
FoF-6	Mini-factories for customised products using local flexible production
FoF-7	New hybrid production systems in advanced factory environments based on new human-robot interactive cooperation
FoF-8	Innovative strategies for renovation and repair in manufacturing systems
FoF-10	Manufacturing processes for products made of composites or engineered metallic materials
FoF-11	Manufacturing of highly miniaturised components
EeB-1	Nanotechnology for multifunctional lightweight construction materials and components
EeB-2	Safe, energy-efficient and affordable eco-innovative materials for building envelopes and/or partitions to provide a healthier indoor environment
EeB-3	Integration of technologies for energy-efficient solutions in the renovation of public buildings
EeB-4	Integrated control systems and methodologies to monitor and improve building energy performance
GC-1	Improved materials for innovative ageing resistant batteries

The work programme also addresses further issues closely related to innovation: safety and regulation; IPR; standardisation; the availability of skilled workforces; substitution of critical raw materials; 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, about two thirds of the total. For the same reason, the allocation of budget per topic to large collaborative projects (used for application-oriented topics) was increased starting with the WP 2012 – from EUR 15 million to EUR 20 million per topic *on average*.

The NMP theme 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.

SME-relevant research

The participation of SMEs has been strongly encouraged in the FP7 NMP Theme, by using SME-targeted collaborative projects and appropriate topics. The SME participation is currently around 23% in budgetary terms, in projects funded under the NMP Theme.

In the work programme 2013, the budget for SME-targeted projects alone is 15% of the total (see details in section I.6 below). The following SME-targeted topics have been developed with the aim of reinforcing the S&T base of SMEs and validating innovative solutions:

2.2-1	Biomaterials for Advanced Therapies and Medical Devices in the neurological/neuromuscular or cardiovascular fields
3.0-2	Integrated processing and Control Systems for Sustainable Production in Farms and Forests
4.0-3	From research to innovation: substantial steps forward in the industrial use of European intellectual assets, stimulating the use of newly developed materials and materials technologies by the industry
FoF-11	Manufacturing of highly miniaturised components

Strengthening the European Research Area

The explicit contribution of this work programme to the European Research Area (ERA), as well as to innovation, is an ERA-NET to support Innovation in the NMP thematic area (topic NMP.2013.4.0-7). Support for the clustering activities of projects is a further contribution to the ERA (topic NMP.2013.4.0-4).

Dissemination actions

The NMP Theme 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**, to complement the IPR Helpdesk, and **standardisation**.

I.3 Bridging with Horizon 2020

The continued emphasis on applications including demonstration provides a natural bridge to Horizon 2020 Framework Programme for Research and Innovation, as proposed by the European Commission on 30 November 2011.[2] In the spirit of the competitiveness pillar of

[2] COM(2011)808, 809, 811

Horizon 2020, research in three of the six key enabling technologies (KETs) is directly supported, as an important driver of innovation. The three remaining KETs, micro- and nano-electronics, photonics and biotechnology are indirectly supported through cross-cutting advances in materials and nanotechnology. Particular emphasis is based on cross-cutting issues between different KETs, and also between enabling technologies and societal challenges. Finally, there is continued support for developments that can be integrated to create the basis for tackling societal challenges and sustainability. The emphasis is on resource and energy efficiency, protection of the environment and improvements in health care.

Thus, it is expected that activities under the competitiveness pillar of Horizon 2020 in the NMP area will be a natural and seamless continuation of those undertaken in the last years of FP7. 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.

With regard to **specific applications**, 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: This work programme contributes to the Commission's Raw Materials Initiative,[4] and to the aims of the proposed European Innovation Partnership on 'Raw Materials' (section II.4.1).

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.

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 initiative supports research on a broad range of technologies and smart

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

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

I.4 International Cooperation

The general focus is on subjects which are in the interest of European industries and lead to "win-win" scenarios.

This work programme includes coordinated calls with China and Japan, on aspects of biomaterials and raw materials respectively (topics NMP.2013.2.2-2 and NMP.2013.4.1-1).

Furthermore, two topics in the Factories of the Future PPP (FoF.NMP.2013-3 and FoF.NMP.2013-9) are particularly suitable for collaboration at international level, particularly under the IMS (Intelligent Manufacturing Systems) scheme.

I.5 Cross-thematic approaches

This work programme includes contributions to three cross-thematic public-private partnerships described above.

Special attention will be paid to cross-cutting marine and maritime research with the launch of a new cross-thematic call "The Ocean of Tomorrow": joining research forces to meet challenges in ocean management". It will be implemented jointly between Theme 2 "Food, Agriculture and Fisheries, and Biotechnology" (FAFB), Theme 4 "Nanosciences, Nanotechnologies, Materials and new Production Technologies" (NMP)[5]; Theme 5 "Energy", Theme 6 "Environment (including climate change)" and Theme 7 "Transport (including Aeronautics)". The main objective of the call is to promote research and innovation on marine technologies, in particular sensors, anti-biofouling materials, and innovative transport and deployment systems for the offshore energy sector. The topics and funding mechanisms will allow for large, multidisciplinary and multi-stakeholder topics with an appropriate balance between (basic/applied) research, knowledge transfer and demonstration, and to support a number of specific EU policies. The four topics are published in the Work Programmes of all participating Themes, as a cross-thematic call. "The Ocean of Tomorrow" call (FP7-OCEAN-2013) is subject to a separate call fiche.

I.6 Theme specific information

This work programme 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.

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

[5] section II.4.2 of this work programme

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.

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 was illustrated by the emergence of the 'Factories of the future' PPP initiative within the 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.

I.7 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.* 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, 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.2013.1.1-1 Exploration, optimisation and control of nano-catalytic processes for energy applications

Technical content/scope: Catalysis is of vital importance to our society. The availability of high quality and inexpensive chemicals necessary to support a competitive economy relies on industrial catalytic processes. Catalysts are also the key to the development of novel technologies for sustainable energy production and distribution as well as environmental protection (e.g. emission control).

While the call topic NMP.2012.1.1.-1 focused on the rational design of nano-catalysts, the aim of this call is to develop pilot scale production for rational exploration, optimisation and control of nano-catalytic processes for sustainable energy production. The specific energy production concepts could include production of different fuels (e.g. synthetic, bio or solar fuels) as well as different sustainable feedstock.

More specifically, the goal is to design and up-scale catalytic energy production processes utilising next-generation high-surface area nano-dimensional heterogeneous catalysts with improved activity, durability and/or controlled chemical selectivity from laboratory scale to pilot scale. Approaches can be based on improvement of existing catalytic materials, and/or by development of innovative concepts for which the proof of principle has been given already. The final target is to demonstrate the technical and economic viability of the global process, i.e. from synthesis to efficiency and durability of the nano-catalytic systems.

The novel nano-catalytic systems with pre-defined properties require:

– Precise control over size and shape over length scales spanning 1nm-100nm, structure and composition of the catalyst, allowing efficient control of reaction pathways;

– Significant advances in theoretical descriptions and modelling for increased understanding of catalyst-support interactions, complex catalytic reactions performance and deactivation phenomena;

– Advances in nanoscale techniques, especially those that offer in-situ monitoring and which characterise the 'working state' of the catalysts under real conditions (e.g. elevated temperatures and pressures, high reactant flux) with the objective of predicting and intensifying complete catalysing processes.

– Long-term stability under operating conditions; Catalyst deactivation mechanisms, such as thermal and/or gas-induced sintering of nanoparticles or degradation of nanoparticles or nanostructures, should also be considered.

– Reduction of rare earths/precious metals catalyst loadings or the use of low cost non-precious metal based materials.

The operation of the nano-catalyst process in a specific energy production application(s) should be demonstrated in a relevant environment, displaying an improvement with respect to the current state of the art. Proposals should also include cost/benefit calculations for the studied specific application(s), demonstrating the economic viability and positive energy balance. Life cycle analysis and evaluation of the process concepts concerning safety assessments and toxicological impact should also be included from the beginning of process development. For safety related aspects, projects are expected to coordinate and collaborate with other relevant projects of the Nanosafety Cluster[7].

Fuel cells are *not covered by this topic*, but by the topic SP1-JTI-FCH.2012.1.5, New catalyst structures and concepts for automotive PEMFCs.

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

The Commission will promote the exchange of information and identification of synergies between projects selected in this topic and in topic NMP.2012.1.1-1.

Funding Scheme: Large-scale integrating collaborative projects.

Expected impact: (i) Fast industrialization of tailor-made catalytic nanomaterials with high activity, selectivity and durability; (ii) Improved process performance, e.g. in terms of higher, precisely defined yield, optimum feedstock utilisation and lower energy consumption; (iii) Safer, greener nanocatalysts with minimum chemical waste; (iv) Alternative sustainable energy applications becoming technically and economically feasible; (v) Nano-catalysts also have the potential to reduce Europe's reliance on imported rare earths/precious metals.

NMP.2013.1.1-2 Self-assembly of naturally occurring nanosystems

Technical content/scope: The use of natural systems as either a source of inspiration or a template for developing or manipulating unique nano-, micro-, and macro-scale polymer composites via bio-mimicry and/ or direct assembly of molecules has become a promising field towards innovative products. Research on how naturally occurring nanostructures found in biomass self-assemble and the development of methods that use this self-assembly will be critical to manufacturing new products from this renewable resource.

The objective of the topic is to exploit the possibilities of biomass of plant origin (including aquatic plants and seaweed) in order to develop new innovative added value products from plant based nanosystems, such as glycopolymers, nanocrystals and nanofibres. These systems will, after self-assembly at nano-scale and functionalisation, present high added value properties, e.g. for flexible organic electronics, smart papers and surfaces, nanocomposites, glycosensors, self-healing materials, high thermal insulation materials etc.

Research should focus on the development of new nano materials or nano-intermediates through mastering the self-assembly of the elementary bricks at the nanoscale level, their properties at meso-scale and further their processing at macro-scale towards the elaboration of final products with controlled properties.

Research can also address the development of stimuli-responsive nano materials or nano-intermediates for applications in different value chains using biomimetics as design inspiration. Examples include specific and smart interaction with light, heat, chemical probes or other physical or chemical stimuli and the capability to change chemical and physical properties, e.g. enhancement of fibre-to-fibre bonds via photo excitation or switch from hydrophilic to super-hydrophobic character via ion exchange.

The project should target green processes and validate the industrial feasibility in a relevant environment of the new products with special attention on cost effectiveness with respect to the application market, from large volume sectors such as composites and surface treatments to niche markets and high added value sectors, like bio-active or stimuli responsive products for pharmaceuticals and health and safety applications.

The proposals should include Life Cycle Assessment (LCA) and risk assessment, contributing to the setting up of databases for LCA case studies, and address recyclability aspects as far as large volume applications are concerned. For safety related aspects, projects

are expected to coordinate and collaborate with other relevant projects of the Nanosafety Cluster[8].

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: (i) efficient technologies for self-assembly and functionalisation of naturally occurring nanosystems with smart properties for application in packaging, electronics, medicine, biocomposites, construction and other high-added value areas; (ii) development of green processes providing the industry with new solutions to create more value from plant based biomass through new high added-value products meeting societal needs; (iii) positive contribution to sustainability through the utilisation of renewable resources, replacing oil based ones.

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. environmental sensors 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.

NMP.2013.1.2-1 Nanotechnology-based sensors for environmental monitoring

Technical content/scope: Progress in nanosciences has led to a range of new technologies that allows us to drastically improve, and even rethink and create totally new industrial processes and products, offering new functionalities. Sensors are core elements in any intelligent system for monitoring and controlling natural and industrial environments, and nanotechnology is offering new functionalities opening for totally new sensors, sensing based systems and applications. For example high sensitivity allowing for new or lower levels of detection, , long term stability for reliability in use and a much reduced size and affordable cost, enabling the integration of nanosensors, including networks of nanosensors into many other devices and systems.

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

The specific objective of this topic is to exploit progress in nanosciences to deploy nanotechnology in affordable, mass-produced sensors, and to integrate these into components and systems (including portable ones) for mass market applications in environmental monitoring. Sensing may include chemical, micro-biological and radiological parameters. Deliverables are expected to include the sensor design and fabrication considerations (including the use or development of modelling tools), a technology demonstrator and a positive production capacity feasibility study (including economic assessment) and plans for their commercial implementation.

Systems integration aspects to consider includes easy and fast (multi-)sensor interrogation and interfacing with monitoring and control functions. Reliability is required within the foreseen operating environment, considering temperature, humidity, and other parameters affecting stability. Initiation (re-setting) and calibration requires special attention.

The functionality should be demonstrated by integrating the developed sensor element into an existing or prototype system for validating its industrial relevance in a relevant environment.

Biosensors for monitoring the marine environment are *not covered by this topic*, but by the topic Ocean 2013.1 (section II.4.2).

Funding Scheme: Small or medium-sized collaborative projects

Expected impact: The projects are expected to: (i) demonstrate that nanosensors provide a technically superior, cost effective alternative to conventional sensors; (ii) contribute to the realisation of the market potential of the existing research results; (iii) to enable improved performance of applications in the fields of environmental monitoring, providing significant benefits to the citizens, environment and the European economy.

NMP.2013.1.2-2 Nanotherapeutics to treat bacterial infectious diseases

Technical content/scope: Infectious diseases are a major and increasing threat to human health and represent a very significant burden on healthcare systems worldwide and in particular for developing nations. Bacterial diseases such as Tuberculosis or infections with bacteria like MRSA often cannot be prevented by vaccination, lack early-stage diagnosis and treatment options. A major problem is the fact that bacteria are increasingly resistant to antibiotics.

The Commission recently launched its Action plan against the rising threats from antimicrobial resistance.[9] A package of call topics for proposals supporting the aims of this Action plan through reinforcing and coordinating research and innovation can be found in three FP7 Cooperation Work Programmes, Health (HEALTH.2013.2.3.1-1, HEALTH.2013.2.3.1-2 and HEALTH.2013.3.1-1), KBBE (KBBE.2013.1.3-05) and NMP (this topic).

This call topic aims at developing novel nanotechnology enabled therapies for bacterial infectious diseases. For example, it is recognised that molecules of biological or semi-biological origin present new opportunities to address infection. Formulating such molecules into effective agents will require innovative use of nanotechnology and strong interdisciplinary coordination between academics, research organisations, clinicians,

[9] Commission Communication 'Action plan against the rising threats from Antimicrobial resistance', COM(2011)748.

pharmaceutical companies, biotechnology communities and early involvement of regulators. Furthermore, new classes of drug delivery system are needed to allow therapeutic macromolecules to access diseased organs. These should inherently be at the nanoscale to take advantage of biological transport pathways, but also need novel functionalities and new mechanisms to be truly effective. Use of state-of-the-art diagnostics systems and access to expertise on diagnostics in the projects is encouraged, to support the therapy development. Attention should be paid to address regulatory aspects of safety, good laboratory practice and good manufacturing practice. Development may be taken to the end of the pre-clinical stage and may include the preparatory regulatory work for the start of clinical testing, but the clinical testing itself may not be part of the projects.

Funding Scheme: Large-scale integrating collaborative projects.

Expected impact: (i) potential for radical improvement of therapy for bacterial infectious diseases, directly benefiting EU citizens; (ii) improvement of the competitiveness of the European healthcare sector through novel new systems and therapies as well as improved cooperation and collaboration between the key actors in the value chain; (iii) increase of the application of nanotechnology in medicine; (iv) improve understanding by academics of medical regulatory issues.

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 should 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 material characterisation, hazard identification, 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.

For the production and use of passive nanoparticles and for their integration into nanomaterials or products a fair amount of work in the above fields of risk research is currently at hand or in preparation including regulatory testing. Attention should now shift to breakthrough research for the more challenging issues related to the safety of active nanoparticles and systems. As a next phase of the regulatory testing, attention should be put on targeting risk reduction and mitigation in industrial environments. The aim is to develop and demonstrate safe processes reducing or eliminating risk by engineering-out hazards or containing exposure, or other risk reduction solutions.

Two more specific actions aim at providing capacities of crucial nature though not entirely safety related. As data start accumulating on material properties, hazards and exposure, and their relationships, the question of saving, analysing, validating and sharing information for subsequent use in predictive computational models, simulations, rational design of nanomaterials and synthesis control, needs corresponding efforts in the area of ontologies and databases.

NMP.2013.1.3-1 Safety in nanoscale production and products

Technical content/scope: Ensuring the safety of the production processes involving nanomaterials as well as that of the final product, is a pre-requisite for the commercialisation and societal acceptance of these new technologies. This topic takes a bottom-up and top-down approach to safety, by securing both the nano-manufacturing processes and the nanoscale products' ultimate fate. This will ensure control over, and minimisation of, worker, consumer and environmental exposure to nanoscale materials throughout the whole product chain - from cradle to grave of nano-enabled products.

The objective is to ensure that the knowledge exists to allow safe processes for production and use/recycling of nanomaterials/nano-products. This will be addressed through the development of safe processes for production, transport and use of nanomaterials, as well as the development of methods, techniques and equipment reducing both adverse effects and exposure to acceptable levels.

The research should focus on:

- development of best practices for materials and product or process types where a lack of waste isolation and handling possibilities currently exist;

- risk mitigation methods, techniques and equipment involving nanomaterials or nano-manufacturing processes where the development or usage pattern may be as free form nanoscale materials, resulting in exposure in open and production environments;

- development of tools for assessing nanomaterials exposure and effects on ecosystem services (such as waste water treatment plants) and humans, especially in environments subjected to multiple stressors, diffuse pollution and global changes.

- development of methods to enable prediction of long term ecotoxicological effects and impacts on ecological services caused by exposure to nanomaterials (used e.g. in coatings, composites, energy and construction related applications), as well as raw materials for nutraceuticals, food and feed and nanocellulose derivatives.

- incorporating the generated knowledge into guidelines for safe nanoscale product and process design.

Outputs should be tailored to address the needs of each of the stakeholder communities, including industry and regulators.

Funding Scheme: Large-scale integrating collaborative projects.

Expected impact: (i) best practice guidance for securing both nano-manufacturing processes and nanoscale products' ultimate fate, including development of approaches for safe disposal of nanomaterials where needed; (ii) development of tools for assessing nanomaterials effects on ecosystems already subject to multiple stressors; (iii) development of implementable processes for all stages of the nano-manufacturing life cycle to reduce exposure to nanomaterials; and (iv) innovative solutions for risk management in industrial settings.

To maximise their impact, funded projects will be expected to align with the EU NanoSafety Cluster[10], in order to facilitate research cohesion, integration, and advancement of the

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

NanoSafety Cluster agenda; and to establish good cooperation with international organisations (OECD and ISO/CEN).

NMP.2013.1.3-2 Nanomaterials safety assessment: Ontology, database(s) for modelling and risk assessment

Technical content/scope: The issues surrounding coherence, management and uses of nanomaterials toxicological data is rapidly becoming a roadblock to progress in integrated approaches to risk assessment. A concerted effort is needed to systematically address these issues through the development of a comprehensive ontology and a computational infrastructure for transparent data sharing, data analysis, and computational models of structure-property-activity relationships. All aspects around nanomaterials safety assessment should be addressed, inter alia: nanomaterials synthesis and processing, nanomaterials characterisation (pristine and *in situ*), exposure and life cycle assessment, human and ecological hazard assessment, as well as high throughput and high content datasets (e.g. proteomics, transcriptomics, metabonomics, High Content Analysis), nano-bio interactions studies, inter-laboratory comparisons etc.

The development of ontologies should bear in mind existing standardization initiatives, allowing correlations between datasets, and should address mainly research purposes but with the capacity to link with regulatory databases and drive the latter's' further development. The database should be organised to facilitate a meta-analysis of the data, using methods such as QSAR, to identify the key physico-chemical parameters influencing the nano-bio interaction and therefore contribute to the future development of 'safe-by-design' nanomaterials. This project should also work in alignment with the project(s) funded under topic NMP.2013.1.3-3 to ensure that the needs of next generations of nanomaterials are also included in the database structure and ontology**.** It should also be cognizant of international efforts in this arena, including work done for regulatory purposes and market follow-up and ensure compatibility with these efforts for data validation and sharing.

Based on the developed ontology and data requirements, tools for optimal experimental design, data reporting and metadata structures and a database should all be developed and provided to the research and regulators communities. The database should ensure continuity with the experimental results from previous and running FP7 projects, bearing in mind the need to provide sufficient data to allow conversion to newly emerging standards and ensure appropriate quality and completeness. The database implementation should address the required levels of data protection (e.g. pre-publication or pre-commercialisation), data quality assurance, data-sharing capability, and communication with other national or international databases and search tools.

Funding scheme: Small or medium-sized collaborative projects. No more than one project will be funded**.**

Expected impact: (i) an agreed ontology for nanomaterials; (ii) a set of guidelines for experimental design to ensure production of high quality data of sufficient longevity and usefulness for research; (iii) implementation of the database structure with all of the necessary provisions for data protection, data sharing, data quality assurance, searchability, tailored interfaces for different needs and usages, comparability and cross-talk with other databases; and (iv) fostering an integrated approach in nanosafety assessment, which is inclusive, consensus-driven and serves the needs of the European research communities.

To maximise its impact, the funded project will be expected to align with the EU NanoSafety Cluster[11], in order to facilitate research cohesion, integration, and advancement of the NanoSafety Cluster agenda; and to establish good cooperation with international organisations (OECD and ISO/CEN).

NMP.2013.1.3-3 Development of a systematic framework for naming and assessing safety of the next generations of nanomaterials being developed for industrial applications

Technical content/scope: As part of the Innovation Agenda, concerted efforts are needed to develop a robust, implementable approach to the naming and safety assessment of the next generations of nanomaterials and nanosystems such as hybrid nano-molecular systems, and organic-inorganic or passive-functional nanomaterials. These systems are already being developed in industry for a range of innovative applications such as renewable energy and greener construction, and approaches are needed that will allow these products to reach the market safety and effectively, as a matter of priority. Research has shown that lack of clarity around regulation is significantly more costly to companies than additional safety assessment requirements, known at an early stage in the product development cycle, and thus the current regulatory uncertainly should be addressed as a matter of priority.

Among the challenges to be addressed is the issue of naming for such hybrid nano-molecular nanosystems and nanostructures; understanding which components determine the biological interactions and thus the fate and behaviour of these advanced nanostructures and nanomaterials, and understanding how to make these materials safe by design. Priority should be given to the next generation of nanomaterials for renewable energy, green construction, and other emerging technology areas.

The research elements should address development of the understanding of their environmental behaviour and fate, in indoor and outdoor air, water and soil, and their consequences for interaction with living systems and/or the environment, throughout the product lifecycles. The project should also account for management of risk perception around active nanomaterials.

Additional eligibility criterion: The requested EU contribution must not exceed EUR 7 000 000 per project.

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

Expected impact: The research approach should be innovative and represent a significant advance beyond the current state-of-the-art, offering innovative approaches to account for the unique features of complex nanosystems, and should result in (i) An implementable naming system to allow identification of the components and assembled structure; (ii) New methods for safety assessment of complex nanosystems, easily implementable by SMEs and technology development centres. Outputs should be tailored to address the needs of each of the stakeholder communities, including specifically the industry technology application developers and end users, taking into account the unique features of complex nanosystems.

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

To maximise its impact, the funded project will be expected to align with the EU NanoSafety Cluster[12], in order to facilitate research cohesion, integration, and advancement of the NanoSafety Cluster agenda; and to establish good cooperation with international organisations (OECD and ISO/CEN).

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, 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. The implementation of the recently published definition of nanomaterials requires validation of a number of available methods and equipment for high performance- low cost measurements of particle number or mass distribution of nanoparticles in media.

NMP.2013.1.4-1 Development of an integrated multi-scale modelling environment for nanomaterials and systems by design

Technical content/scope: The future of the European nanotechnology industry is associated with a strong modelling and simulation capacity. An efficient numerical approach is needed to shorten the development process of nano-enabled products, being key to increased global competitiveness of our industries. Therefore, the long term overarching ambition is to create an open, integrated and multi-purpose numerical nano-design environment. This environment will allow to bundle and connect existing solutions, to link them to validated data repositories and to harmonise the development of new simulation modules.

The proposals should clearly address key elements such as: (i) free and open source code principle, in the sense of the GNU Lesser General Public License (GNU LGPL), at least for the common environment and interface part developed within the project; (ii) harmonised approach in the interface design to facilitate the future implementation in larger and extendable framework architecture; and (iii) interfacing with commercially available simulation packages, where used for the project.

As required by the overall objective, part of the effort should be on the key and transverse issues of code modularity and reusability. These modules should connect a variety of models

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

which might range from *ab initio* codes, molecular dynamics and other discrete particle models up to Finite Element simulations at the continuum scale. The application of topology optimization techniques and modelling and optimization with uncertainties may also be included.

Work should also significantly contribute to the understanding of the underlying phenomena of multiscale modelling, such as the coupling of the scales in the model and the consistency between scales (e.g. reversibility across scales/boundaries).

Work should focus on a cluster of related technologies of significant economic impact. By implementing a multi-scale and multi-physics approach, it should target rapid progress on challenges tackled through dedicated codes to simulate at least a full device, possibly a system.

All proposals should have an element of model validation in which the models are validated against experimental data at least at functional level. This data should either be collected during the project or should be pre-existing.

Industrial end-user participation is recommended to guarantee relevance and facilitate validation.

Consortia should further demonstrate their future capability to distribute and provide support to the user environment. This will probably require participation from both scientific and industrial modelling and code developers and software code vendors or other established distributors of modelling tools.

To facilitate a harmonised approach the financed projects have to interact on the definition of software interfaces, and the development of inter-process, and inter-scale communication.

Funding scheme: Small or medium-sized collaborative projects

Expected impact:

(i) The resulting tool will allow predictive design of novel materials and material/shape/microstructure combinations, optimised for specified applications, (e.g. to minimise the environmental impact, reduced risk of product failure, increased life, device performance and efficiency).

(ii) Integration of computational codes from many different sources to interoperate allows solving of problems that are not addressable by individual codes.

(iii) To maximise their impact, funded projects will be expected to interact in a cluster aiming at creating the standards and processes required to enhance code modularity and reusability, in order to pave the way for an integrated and versatile numerical design environment.

(iv) The projects should increase the interaction between the nanotechnology research fields, in particular with respect to numerical code development and interconnectivity.

(v) Projects should provide an educational resource in computational science and engineering, with respect to the specific problems of multi-scale modelling, such as scale coupling and reversibility across scales.

NMP.2013.1.4-2 Metrology research for the development and validation of design rules for engineering of nanostructured and nano-enabled materials and devices

Technical content/scope: Solid basis of nano-metrology and standards is a key pre-requisite for reproducibly measuring key operational characteristics of materials, structures, devices,

facilitating also their simulation and design. Metrology is also a key for the reliable assessment of health, safety, and environment risks associated with nanomaterials and processes as well as operating processes in a reproducible manner.

Research efforts are needed at two levels: (i) the development of methods for measuring properties for which currently no methods exist; and (ii) ensuring the traceability, or at least the reproducibility, of existing methods; both for the entire range of physical, chemical, and biological properties that affect the performance of materials, devices and systems. This topic aims at projects realising a breakthrough in measurement and modelling ability that is directly relevant to production / manufacturing processes.

Projects should aim to:

- Characterise the relationship between measurable key parameters through the nanoscale to the higher order scales that provide new insight into the performance of nanostructured and nano-enabled material;
- Generate reference information to test and optimise new design rules derived from length scale models;
- Establish mechanisms to integrate new design rules to existing modelling techniques and apply these to industrially relevant materials and devices, delivering concrete results of industrial relevance (for example, the ability to design nano-coatings or nano-enabled coatings with specific performance properties).

Preference will be given to projects that include the development of 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.

Funding Scheme: Large collaborative projects

Expected impact:

(i) The move from 'trial and error' based product development to digital product development and product life cycle environment should dramatically reduce the cost of designing new products.

(ii) Help industry, and SMEs in particular, to access and deploy nanotechnology in existing and new products.

(iii) Improved performance of processes and final products.

(iv) Advancement of standardisation in the nanotechnology field.

NMP.2013.1.4-3 Development of methods and standards supporting the implementation of the Commission recommendation for a definition of nanomaterial

Technical content/scope: The Commission recommendation for a definition of nanomaterial provides a reference for determining whether a material should be considered as a 'nanomaterial' for legislative and policy purposes in the Union. This Definition addresses particulate materials only, is intended for broad application in Union legislation, is based only on the size of a material and covers natural, incidental or manufactured materials. Measuring average size and size distribution of particles in the range 1 nm to 100 nm in mixtures with

other particles and substances is challenging and for most nanomaterials different measurement methods will give different results. Depending on the type of nanomaterial and on its intended application, different methods will be required which ensure that the application of the definition leads to consistent results across similar nanomaterials and over time.

The research project envisaged by this call should therefore address the measurement of average size and number-based size distribution of particulate materials. The project should develop robust, cost-effective and fast validated methodologies for the quantitative analysis of the number-based size distribution of primary particles, of different shapes (e.g. nanoplates, nanofibres, nanotubes), of different coatings and in various media (including complex media and final products), which have one or more external dimensions in the size range 1 nm – 100 nm. The proposed methodology will have to be fully validated in the project, for an as wide as possible range of different materials, addressing size and particle number based size distribution of primary (constituent) particles in various environments, such as powder, aerosol, dispersion in water and other dispersion media. Validation should include sampling, calibration of equipment, estimation of measurement uncertainty, certified reference materials, reference materials and mixtures, and demonstration and training.

The project should aim at methodologies capable to measure the size of particles of different shapes in order to identify whether a material is a nanomaterial according to the Commission recommendation. It should also address the measurement of size and number-based size distribution in complex media (e.g., biological fluids, environmental media) as well as in final products such as cosmetic products and food/feed, and give clear quantitative information. Where possible, the project should also address the specific surface area by volume and its relation to the number based particle size distribution.

For each proposed method, the project will have to perform an intra-laboratory validation and an inter-laboratory study.

Preference will be given to proposals that develop traceable measurement methods that are readily implementable in the form of robust and cost-effective instruments. In stage-2 proposals, an indicator of this potential will be the involvement of metrology institutes (or institutes certifying reference materials). Active participation of nanomaterials manufacturers as well as instrument manufacturers, who commit to develop and market robust and cost-effective instrumental implementations of the developed methodologies, represents an added value. Additionally, it is also essential to establish links to CEN feeding such methodologies into the currently on-going Commission mandated standardisation work.

Additional eligibility criterion: The requested EU contribution must not exceed EUR 7 000 000 per project.

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

Expected impact:

(i) Development of methods for off-line or on-line measurements that ensure the reliable and economic implementation of the Definition in the most diverse fields and are applicable for the widest possible range of materials and products.

(ii) Development of one or more work item proposal(s) within the time schedule of the project, for a European or international standardisation body, including (a) detailed first draft(s) of the standard method(s).

NMP.2013.1.4-4 Developing innovative outreach and dialogue on responsible nanotechnologies in EU civil society

Technical content/scope: Effective governance of nanotechnology benefits and risks require innovative new means of information and communication. Such a communication is essential for public confidence in policies that respond to societal and economic needs.

Nanotechnologies evoke various opinions from full acceptance to rejection. The proposed action(s) should therefore aim at identifying the current information and communication needs in EU civil society on nanotechnologies, creating new models and tools for outreach and unbiased dialogue on nanotechnologies. Such models would be founded on balanced information about nanotechnologies and their relevant applications for daily life as well as incorporate attitudes, interests and value judgments. Further, the models would need to offer a profile both for benefits and potential risks associated with the applications of nanotechnology. While the work should build on the results of previous projects in the domain of communication of nanotechnologies, such as NANODIALOGUE, NANOYOU, NANOTOTOUCH, TIMEFORNANO, preference will be given to proposals targeting the development of new strategies for communication outreach and dialogue tailored for different stakeholder audiences. This would include the creation of effective mechanisms for engaging lay citizens, scientists, policymakers and NGOs in decisions about nanotechnology R&D over the long term, promoting responsible nanotechnology innovation in the EU. Efforts should be made to increase the diversity of the stakeholders and reach people who are often underrepresented in interviews and public opinion surveys, such as people with lower income.

Another key target is the enabling of the dialogue between young people and students who are ready to make career choices and universities and industries involved in nanotechnology applied research, involving young professionals working in small or medium sized companies, or university spin-offs, which exploit nanotechnologies is a key target. The effectiveness of the communication strategies and tools is also to be tested in various settings, such as science centres and museums or specific civic fora, using developments on key criteria and principles of responsible innovation and public engagement.

Additional eligibility criterion: The requested EU contribution must not exceed EUR 2 000 000.

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

Expected impact: The sustainable impact of this action should be to enhance and raise the levels of engagement of European citizens, expert and non-expert, in a measurable and traceable way on the subject of nanotechnologies and their related social, ethical and legal implications by supporting activities with broad range of stakeholders. Finally, innovative publishable materials (e.g. web, kits, media communications, books, DVD and events) should be developed to disseminate and assess the outreach and dialogue figures attained by the project during its entire life cycle. Increase the clarity of the role of public authorities, industry and society in formulating appropriate governance of nanotechnologies.

II.2 Activity 4.2 Materials

Better mastering of materials has characterised the development of human societies since the dawn of humanity. Nowadays, 70% of all technical innovations depend directly or indirectly on the properties of the materials and their use, and this percentage is expected to increase further. Therefore, unsurprisingly, materials have been identified as one of the Key Enabling Technologies for Europe. During the coming decades, materials research and innovation will herald a new age, allowing European products and industrial processes to become more competitive and sustainable, or devising completely new products and processes. To promote and accelerate progress, the NMP theme will foster an integrated and multidisciplinary approach, involving chemistry, physics, engineering sciences, theoretical and computational modelling, nanotechnology and increasingly the biological sciences. A thorough control of materials and their production at an atom/molecule scale, as well as the realisation of materials-based systems and their flow into and out of Europe will be the final target. The flow of materials will also be addressed to contribute to the efficiency of the European industrial economy.

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. The structure is composed of three parts: Enabling Research and Development (exploiting the interdisciplinary character of materials science and engineering and introducing the potential of opening new business areas or production routes), Innovative Materials for Advanced Applications (addressing five selected branches of industry: Healthcare; Information and Communication Technologies; Energy; Transport and Environment, including the substitution of critical raw materials), and Structuring Actions (creating or reinforcing synergies which will enable the release of the untapped potential of European research).

II.2.1 Enabling Research and Development

The development of solutions in materials sciences and engineering (including 'horizontal technologies') will be supported, 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.2013.2.1-1 Developing new precursors, new processing routes and functionalisations for carbon fibres

Technical content/scope: The use of carbon fibre based composites is of major importance in many industrial applications, such as (i) in transport e.g. automotive (body and chassis), marine (ship structures), rail (vehicle body, internal fittings), aerospace (fairings, seat structures, luggage racks, galley equipment), (ii) energy e.g. wind (blades and turbines), electrical (Li-ion batteries, supercapacitors), electrical storage and transmission (low mass, zero-CTE transmission cables, flywheels for energy storage), oil and gas (pipes, drill shafts, off-shore structures), pressure vessels (hydrogen storage, natural gas storage), (iii) infrastructures (retrofitting and repair of aging bridges and columns, pre-tensioning cables, pre-manufactured sections, and non-corrosive reinforcing bars) and many other industrial fields, whose extent may well increase in the future. However, carbon fibre applications risk being restricted or jeopardised because of the high cost of carbon fibres and their limited supply. Moreover, the translation of fibre properties into those of the final composite is not yet fully understood. Research is therefore needed to allow the opening of new ways for the industrial production in Europe of carbon fibres as well as their functionalisation for targeted applications, and at affordable cost.

Research proposals should address the development of new, economically viable precursors. Proposals should also address one or more technological challenges, examples of which include exploration of alternative sustainable carbon supplies (e.g. bio-based or from recycled fibres), innovative processes for fibre formation, stabilisation, carbonisation/graphitisation and their streamlining and improved control, lowering production costs in order to find favourable cost/performance solutions, fibre functionalisation through innovative surface treatments, carbon fibre ionised physical vapour deposition (I-PVD) on line treatment, sizing, fundamental understanding of interactions, e.g. between carbon fibre and composite matrix fields, dwelling fibre placement, mechanical interlocking of fibre to resin, etc. Life Cycle Assessment (LCA) of the new processes or materials used, their energy efficiency, as well as environmental and safety issues and recycling should be addressed. Proof of concept in terms of product and/or process should be delivered within the project, excluding commercially usable prototypes (in compliance with European Commission Communication 2006/C323/01), but convincingly proving scalability towards industrial needs. Non-destructive techniques for the characterisation of fibres at the various processing steps and of functionalised fibre products may also be addressed. Dedicated modelling of process and properties, qualification, standardisation and/or the production of (certified) reference materials may also be addressed as an integrated part of the research proposal. In order to ensure the industrial relevance and impact of the research efforts, 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: One or more of the following: (i) European independence from imported carbon fibres and precursors; (ii) Improved competitiveness for European industries via the use of improved, novel, better performing and/or more favourable cost/benefit solutions; (iii) Deployment in Europe of materials structures with overall performance comparable to existing technologies but at lower material cost; (iv) Securing adequate in-service performance of components in applications such as vehicles, construction, energy, sports, electronic applications etc. at lower material cost and with due concern for recyclability

issues; and (v) new skills in the European workforce resulting also in indirect socio-economic benefits.

II.2.2 Innovative materials for advanced applications

NMP-Materials research will 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. 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. 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.

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.2013.2.2-1 Biomaterials for Advanced Therapies and Medical Devices in the neurological/neuromuscular or cardiovascular fields

Technical content/scope: Advanced Therapy Medicinal Products [13] (ATMPs) are new medical products based on genes (gene therapy), cells (cell therapy) and tissues (tissue engineering). Their arrival heralds a new age for the treatment of a non-comprehensive list of diseases or injuries, such as skin regeneration for burns, Alzheimer's disease, cancer, myocardial infarction, stroke, muscular dystrophy or multiple sclerosis. Medical Devices[14] cover a wide range of products, from simple bandages to the most sophisticated life-supporting products, as well as instruments for the diagnosis, prevention, monitoring and treatment of diseases and the improvement of the quality of life of people suffering from disabilities. The value of the market for Value-Added Materials, of which biomaterials for these interventions are examples, is expected to double within the next ten years. Great potential therefore exists both for patients' well-being and for economic activity. As well as depending upon biological materials, such as tissues or cells, the success of these healthcare interventions also requires the presence of chemical structures such as prosthetic implants or polymer scaffolds. The success of these treatments will therefore depend critically on the

[13] As defined by Regulation (EC) No 1394/2007 on advanced therapy medicinal products (gene therapy, stem cell therapy and tissue engineering)

[14] As defined by Council Directive of 20 June 1990 on the approximation of the laws of the Member States relating To Active Implantable Medical Devices (90/385/EEC) (OJ L 189, 20.7.1990, p. 17) (as amended), Council Directive 93/42/EEC of 14 June 1993 concerning Medical Devices (OJ L 169, 12.7.1993, p. 1) (as amended) and Directive 98/79/EC of the European Parliament and of the Council of 27 October 1998 on *In Vitro* Diagnostic Medical Devices (OJ L 331, 7.12.1998, p. 1) (as amended) and with the relevant Implementing Measures.

biocompatibility and risk of infection of the biomaterial(s) used to produce these associated implants.

Research proposals should develop and/or validate specific biomaterials (including peptides/proteins) or a novel combination thereof, for use in an eventual Advanced Therapy Medicinal Product or Medical Device. Applications should address diseases or conditions in the neurological/neuromuscular or cardiovascular fields. They are expected to generate comprehensive pre-clinical data, but clinical trials may not be included. A realistic endpoint of the project should be appropriately described and justified. By the end of the project, the generated biomaterial should be in an optimal position to enter a clinical trial in humans, which is not within the terms of reference of this Call for Proposals. Preclinical regulatory affairs should be completed or taken to an advanced stage of preparation. Therefore, experimental protocols should be planned taking due account of current good laboratory practice (GLP) and ISO guidelines. Manufacturing processes will need to be addressed, including up-scaling, good manufacturing practice (GMP), process analytical technology (PAT), and regulatory work as appropriate. Biomaterials should be characterised with respect to the responses they elicit, such as toxicity, the migration properties and shape of cells, or changes in intracellular signalling pathways. In addition, proposals will be expected to show that the regulatory and IPR strategy is compatible with the overall RTD objectives. An expected deliverable will consist of at least one implant or components thereof, together with a proof of concept and preclinical validation.

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: One or more of the following: (i) Innovative biomaterials for the therapy of diseases whose treatment is expected to derive from and rely on advanced therapy medicinal products or medical devices; (ii) Improved performance of advanced therapy medicinal products or medical devices; (iii) Improved quality of life due to improved biocompatibility and longer duration of these healthcare interventions; (iv) Success of European biomaterials industries; and (v) Contribution to achieving EU policies, such as those mentioned in the Commission's Communication on dealing with an ageing population.[15]

NMP.2013.2.2-2 Biomaterials: Imaging and rapid precise prototyping technology for custom made scaffolds – coordinated call with China

Technical content/scope: The introduction of rapid prototyping or solid freeform fabrication (SFF) in the biomedical field has led to the possibility of dividing scaffold fabrication techniques into 'conventional' and 'novel' methods. By using the 'conventional' scaffold techniques it is difficult to control all structural properties, and they need to be shaped with custom-made moulds. Conversely, the application of solid freeform fabrication (SFF) to

[15] COM(2009)180

tissue engineering and material induced regenerative therapies represents the key to producing customised scaffolds with reproducible internal morphology. This allows for a higher degree of architectural control, making structures that, for example, increase the mass transport of oxygen and nutrients throughout the scaffold or mimic biological structures.

Research proposals should address 'novel' methods integrating medical imaging, e.g. computed tomography (CT) or magnetic resonance imaging (MRI), and rapid micro/nano prototyping in order to create customised scaffolds for tissue regeneration or repair. Application of novel biomaterials is of particular interest. The resulting scaffolds should have the shape as well as the mechanical and physiological properties required to correct the damaged tissue site. The ability of the structures to lead to physiological tissue regeneration should be demonstrated using appropriate model systems, ensuring that subsequent translation of the technology into the clinic is feasible. To this end, production and processing of the proposed materials as well as sterilisation of the implantable structure should also be considered.

This call targets a balanced cooperation from European and Chinese organisations in each project, with approximately equal research effort on both sides. In order to assure genuine EU-Chinese cooperation, it is important that the proposed research plan properly includes integrated and coordinated research activities in the EU and China. The establishment of a close collaboration between European and Chinese partners is mandatory, and *proposals not including such collaboration will be deemed ineligible*. The added value of the European-Chinese cooperative research should be described clearly in the proposal.

Additional eligibility criterion: The requested EU contribution must not exceed EUR 1 800 000.

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

Expected impact: One or both of the following: (i) Development of technologies for the production of custom-made structures for the repair or regeneration of human tissues; and (ii) Improved manufacturing and performance of custom-made scaffolds for tissue repair or regeneration in the medium to long term. *Additionally*: (iii) More robust European - Chinese research cooperation; (iv) Successful joint research, activities, publications, and contributions to scientific events; and (v) More intensive exchange and training of researchers.

NMP.2013.2.2-3 Wide band gap semiconductor materials and structures for power electronics in energy technologies

Technical content/scope: Technologies for energy generation (notably photovoltaics and wind power) or electricity transport and transformation between the grid and the systems would considerably benefit from the widespread use of reliable and low-cost power electronics devices, e.g. for making significant energy savings. Currently, power electronic devices based on wide band gap materials show the greatest market potential. However, not all materials have yet reached the technological maturity to lead to their breakthrough. This is recognised by the industrial initiatives in the European Strategic Energy Technology Plan (SET-Plan) on these technologies as described in the Materials Roadmap enabling Low

Carbon Energy Technologies[16]. In particular, new cost-effective materials, architectures, and processes are crucial for the next generation power electronics.

Research proposals should address the development of advanced, cost-effective, sustainable (non-critical) materials, architectures, and processes for power electronics suitable for use in energy technologies. The proposed solutions should demonstrate to cope realistically with the particular and stringent demands of envisaged energy applications in terms of operational characteristics, e.g. required voltage, current levels, or switching frequencies, as well as in long term maintenance-free operation in environments particularly hostile to electronics. This calls for, inter alia, the development of materials but also the optimisation of the bonding between semiconductor-metal interfaces to improve their resistance against mechanical stress or deep thermal cycling. The environmental sustainability of each proposed solution should be assessed with special emphasis on efficient materials usage. Proof of concept in terms of product and/or process should be delivered within the project, excluding commercially usable prototypes (in compliance with European Commission Communication 2006/C323/01), but convincingly proving scalability towards industrial needs. Dedicated multiscale modelling, tailored (e.g. interface) characterisation, standardisation and/or the production of (certified) reference materials may also be addressed as an integrated part of the research proposal. In order to ensure the industrial relevance and impact of the research efforts, the cost effectiveness and commercial potential of the innovative technologies compared to state-of-the-art solutions currently available on the market should be quantitatively monitored during the project. The active participation of end users as well as stakeholders involved in energy technologies represents an added value and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding scheme: Large scale integrating collaborative research projects.

Expected impact: One or more of the following: (i) Increasing the reliability and operational lifespan of components under realistic conditions; (ii) Considerable improvement of the operation of power-electronic devices, based on the properties of the materials, architectures, or processes; (iii) Improving the cost effectiveness, including maintenance intensity; (iv) Developing manufacturing concepts for the construction of components with less production defects; (v) Improving material use efficiency; (vi) More favourable cost/efficiency ratio; and (vii) Contributing to the objectives of the SET-Plan.

NMP.2013.2.2-4 Materials solutions for durable energy-harvesters

Technical content/scope: Many applications that need low power are now equipped with a primary battery that needs replacement or makes the device obsolete when exhausted. Energy harvesting technology is increasingly becoming more attractive for a wide variety of self- or low-powered applications, especially with advances in microelectronics and micro-electromechanical systems. For instance, secondary micro-batteries in combination with energy harvesters based on photovoltaic, thermoacoustic, thermoelectric, pyroelectric, mechanical/vibrational and electromagnetic sources can offer interesting opportunities to reduce the dimensions of the storage system and enhance the lifetime of the application.

Research proposals should address the development of energy harvesting and storage materials for low-power and/or pulsed applications, for example autonomous

[16] SEC(2011)1609

nano/microdevices, medical implants, smartcards, sensor networks which would lead to a quantifiable advancement on the state-of-the-art. The estimated improvements in output from the harvester, efficiency, reliability and lifetime of the device, technology cost effectiveness, commercial potential, and adequate availability of energy sources for the proposed application should be convincingly assessed in the proposal. Environmental and end-of-life issues should be addressed. Solutions that optimise the size of the harvester with respect to the device and the number of required peripheral components are welcome. Energy harvesting from multiple sources can be considered. Multidisciplinary approaches between physicists, modellers, chemists, engineers and end users are encouraged.

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.

Proposals focusing on the development of organic photovoltaic materials should be addressed to topic NMP.2013.4.0-2.

Funding scheme: Small or medium-sized collaborative projects.

Expected impact: (i) Harvesting material(s) that will significantly improve the efficiency of the devices; (ii) Storage materials that will improve the performance and durability of the devices in terms of power density, capacity and/or energy density; and (iii) advancement of cleaner energy technologies in Europe.

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 synergies. 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 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.2013.2.3-1 Advanced materials – our allies for a sustainable future

Technical content/scope: Materials play a key role in industry and society, enabling changes and progress, thus contributing to the generation of growth and the creation of wealth and jobs in Europe. Mastering the properties, design, production, reuse or recycling of materials and

creating new and improved ones is determinant for achieving the goals of the European Innovation Policy, in agreement with the European Strategy for a smart, sustainable and inclusive growth – Europe 2020. New materials enable industrial and commercial success for both existing and not-yet-existing products and processes. They introduce new functionalities and improved properties adding value to existing products, thus representing an invisible revolution in existing industrial productions. They also allow the conception and realisation of fully new products and processes, which are more competitive and sustainable. But do European citizens know enough about materials? Different studies and surveys indicate that the workforce demand related to technological developments in companies involved in the development and use of new materials will increase. Are our citizens sufficiently aware of this?

The proposed support action(s) should deliver media product(s) for a general public, often scientifically unprepared, presenting new materials (including nanostructured materials) and how they have helped, are helping and/or will help creating in Europe and world-wide an industrial economy that serves citizens better and is more favourable to the environment. One or more television productions, or a series of them, is a non-binding example of a product that is expected under the present call. While highlighting the importance and the positive contribution of new materials for our future sustainable industrial economy, propaganda tones should be avoided, and the issues should be presented responsibly and in a balanced way, including challenges, debates or still-existing critical aspects where appropriate. An interaction with local, regional or national authorities, science organisations, occupational health and safety organisations, expert institutes, social scientists, non-governmental organisations and other stakeholders can be considered, where this is relevant. A product dedicated specifically to children and younger people with the objective of attracting their interest to materials and its research would also be eligible within this call. Messages should be tailored to the needs and knowledge levels of specific audiences. An additional point that may be considered is that new materials (e.g. originating from converging technologies) put new requirements on educational institutions that have to train future workers and provide for future skills needs. The distribution of the media product(s) should be part of this action In order to maximise the impact of this action, the active participation of scientific journalists represents an added value to the activities and this will be reflected in the evaluation, under the criteria Implementation and Impact.

Funding scheme: Coordination and support actions (support action).

Expected impact: One or more of the following: (i) Increased awareness of Europe's citizens on materials science and its importance; (ii) A more positive attitude in Europe towards science, research and innovation in new materials; and (iii) Support of the relevant activities of various stakeholders such as researchers, industrialists, trainers and/or schools.

NMP.2013.2.3-2 Rational design of functional materials: networking and sharing of best practices

Technical content/scope: The capacity of conceiving and producing *materials by design* from an atomic or molecular level understanding will make it possible to fully master future industrial productions and optimise their sustainability. Overall computational materials science has greatly progressed and should now more and more strive to expand from explaining behaviours to being a predictive tool to drive both materials research and

development of novel and/or improved applications. With the recent advances in parallel computational power and availability, predictive multi-scale material modelling has the potential to grow stronger with the result of enabling a more systematic and faster development of efficient, economically viable and environmentally friendly materials, processes and products.

The proposed coordination action(s) should network stakeholders allowing them to benefit from sharing knowledge in the emerging field of multi-scale computational design of functional materials, the so-called *materials by design*. To accelerate progress and increase impact, the proposals should include activities to promote a deeper understanding between the different communities (atomic, molecular, meso-/macroscale, academia and industry) which may use very different tools/methods and have different expectations and requirements. Considerations of the needs of harmonisation and standardisation of protocols and databases can be included. The proposals can take into account the importance of relevant computational methods and software developments at international level, thus the inclusion of international aspects and involvement of international stakeholders' networks (such as e.g. those resulting from the US *materials genome initiative*) will be given positive consideration under evaluation of Implementation and Impact. To boost the impact of these efforts the proposals can include networking activities such as workshops and training events.

Funding Scheme: Coordination and Support Actions (coordination action). Not more than one coordination action will be funded.

Expected impact: One or more of the following: (i) Increased market impact of *materials by design*; (ii) Improved coordination between basic research and innovation actions in the field of computer based design of materials and training for the next generation of computational material scientists; (iii) Clear strategies for industrial take-up of novel technologies and materials; and (iv) Increased efficiency and effectiveness of the international research activities and open-source software developments in this 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.2013.3.0-1 Tools for Monitoring and Assessing Resource-efficiency in the Value Chain of Process Industries

Technical content/scope: Resource-efficiency goals encourage businesses to look for environment-related improvements that yield parallel economic benefits. These business opportunities should allow companies to become more competitive and more environmentally responsible by safeguarding key natural resources. The commission has therefore included resource-efficiency among the Flagship Initiatives of the Europe 2020 strategy. The transition of energy-intensive process industries towards resource-efficient economic sectors requires breakthrough solutions. Robust methodologies, models and tools will therefore be required, taking into consideration reuse and valorisation potential of resources along the value chain. The focus is on continuous processes, with a precise control of conditions, which also ensure product quality and safety of operation.

Research activities should address all of the following areas:

- Status of existing monitoring and modelling tools;
- Re-usability and valorisation of resources as input-sources;
- Integration of the tools into the process control systems;
- Resource-specific indicators to evaluate how negative environmental impacts have been decoupled from resource use;
- Integration of the value chain and include impact assessment studies to evaluate environmental and economic impacts as well as the suitability of the innovative technologies for application within the EU; and
- Innovation in the analytical systems.

In addition, the proposals are expected to include innovation related activities such as demonstration, including pilot implementation in industrial settings, and need to show a clear application potential in the medium term.

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.

Innovations exclusively addressing water efficiency in industry or minerals processing are not covered in this call topic, since these areas were specifically addressed in previous calls.

Funding Scheme: Small or medium-sized collaborative projects.

Expected impact: (i) Reduction of overall waste production and improvement of resource efficiency, through a more efficient input of materials and recycling processes and cleaner working environments; (ii) Competitiveness of greener process industries; and (iii) Standardisation of indicators for environmental performance.

NMP.2013.3.0-2 Integrated processing and Control Systems for Sustainable Production in Farms and Forests

Technical content/scope: Further optimisation of the agriculture/forestry production of food, feed, bio-energy, lumber and biomaterial towards overall sustainability and efficiency is a key pillar of the European Union economy and social development. Some major improvements in production efficiency have already been made by applying Variable Rate Technologies, Global Positioning Systems and similar technologies to agriculture and forestry. However, these technologies are still broadly independent and mainly represent singular solutions for solitary machines or small machine sub-systems. A breakthrough towards overall sustainability would require integrated processing and control systems for the automation of interactive reprogrammable production machines in rural areas. In this integrated automation, improvements in system architecture, equipment, sensor technology and real-time analysis will enable production equipment, whether stationary or mobile, to be managed automatically. By incorporating the traceability of products the new production equipment will contribute to enhanced product quality, safety and a lean supply chain.

The research should lead to an innovative model-based control of the crop- and/or forest-related economic processes. The models will need to make use of a large amount of information from manifold sources. Therefore innovative solutions to handle the data need to be developed. A system, integrating hardware and software, needs to be developed, using the new information based equipment control systems with autonomous operation of multi-machine processes.

These complex machine systems will also need to include new principles for effective Human Machine Interfaces (HMI) to guarantee easy and safe use in all potential situations. HMI will be integrated so that more complex and intelligent equipment could be adapted readily to specific working environments and users' requirements.

For the rapid introduction of the new sustainable technologies, the systems approach should be implemented and demonstrated, for stationary and mobile equipment in an agricultural or forestry 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.

Funding Scheme: SME-targeted collaborative projects.

Expected impact: The resulting new system technologies are expected to enhance the whole production process (arable and livestock feed farming, forestry and related production sectors), leading to: (i) Improved productivity including optimised resource efficiency and reducing total efforts and inputs (work, energy, protection chemicals, fertilisers etc); (ii) Improved sustainability including minimising soil damage and improving soil health, maximising water conservation and resource protection; (iii) Increased quality, safety and marketability of food, bio-energy, biomaterials and lumber products; (iv) A world-leading position for the European forestry and agricultural machinery industry; and (v) Benefits for European rural areas.

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 observing 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 should offer opportunities 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.2013.4.0-1 Graphene production technologies

Technical content/scope: Graphene and graphene-based materials have undergone a rapid development in recent years. Although there is a general consensus that they are very promising, they have not yet arrived at the stage of industrial applications. A concentrated effort is necessary in order not to lose Europe's leading role in terms of research capacity in the field, and to pave way for industrial innovation. A recent workshop on the future of

graphene (Graphene 2020[17]) gave an overview of its numerous possible and probable applications, such as e.g. printed electronics, photovoltaics, supercapacitors, light composites, medical sensors etc. However, one of the major bottlenecks is still the industrial-scale, reliable, economical and sustainable production of graphene for these potential applications.
Research proposals should focus on technological advancements for the development or up-scaling of production methods and techniques of monolayer or few-layer graphene, functionalised graphene, or graphene nanoribbons, aiming at improved throughput, targeting high yield, homogeneity and reproducibility and low-cost. In-situ monitoring methods allowing direct control of the graphene manufacturing process may also be addressed. One or more applications should be addressed, e.g. lightweight composites, coatings, flexible and printed electronics, supercapacitors and flexible batteries, sensors, catalysis or lighting. The materials science necessary to understand the factors that are key to controlling the relevant in-service properties of graphene (such as e.g. its reported high mobility, conductivity or stability of dopants) and its growth on different substrates or matrices, e.g. by Chemical Vapour Deposition but also by other chemical or physical routes – including subsequent lift-off and handling if necessary – may be addressed. Proof of concept in terms of product and/or process should be delivered within the project, excluding commercially usable prototypes (in compliance with European Commission Communication 2006/C323/01), but convincingly proving scalability towards industrial needs. Proposals should also include cost/benefit calculations for sample potential applications, demonstrating economic viability and adapted risk management. The development of final applications is outside the scope of the topic. Pre-normative activities may be included.
Process safety should be duly addressed. Subsequent steps, e.g. handling, packaging and transport, may also be addressed. In order to ensure the industrial relevance and impact of the research efforts, 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.
During negotiations, possible interactions with the relevant activities of a FET-flagship action devoted to graphene*, should one exist*, will be taken into account.

Funding scheme: Large-scale integrating collaborative research projects.

Expected impact: (i) Robust, reliable, cost-effective and fast processes capable of fulfilling all requirements for large volume production of functional graphene; (ii) volume processes that are capable of being integrated in appropriate manufacturing; and (iii) increase of the competitiveness of European industry.

NMP.2013.4.0-2 Innovative materials for efficient, stable and cheap organic photovoltaic cells

Technical content/scope: Organic photovoltaic (OPV) cells are photovoltaic (PV) cells, based on organic semi-conductor materials, which produce electricity upon light absorption. They have great potential to become flexible and economical power sources tailored to different applications ranging from small devices to public utilities. The highest independently confirmed power conversion efficiency for organic thin film PV cells has reached 10% (December 2011). OPV cells can be produced using low-cost mass production

17 http://ec.europa.eu/research/industrial_technologies/conferences-proceedings_en.html

processes such as sustainable printing techniques, albeit currently still at the expense of their stability. Moreover, thanks to the wealth of possible organic compounds, there are no intrinsic limitations for the availability of the photo-active materials. Up-to-date OPV cells are still mainly in the development phase with relatively few industrial or commercial initiatives as technological hurdles, especially in terms of materials and material properties, still remain to be solved.

Research proposals should address the development of innovative materials that convincingly demonstrate the cost-effective production of industrial modules which promise to be commercially competitive for well-defined applications in the next decade. Materials research can thereby lead to novel organic semiconductors with an improved thermal and photochemical stability in combination with a higher power conversion efficiency, e.g., by a better control of the band-gap. A better understanding of the long term stable operation and the degradation mechanisms at the material level can contribute to increasing the lifetime of the cells, which should be targeted. Since the attractiveness of OPV materials resides in the combination of enhanced performance, flexibility and economically interesting processing technologies, proposals could also cover advances in, e.g., non-vacuum coating and printing techniques. The environmental sustainability of each proposed solution shall be assessed with special emphasis on efficient materials usage. Dedicated modelling, standardisation and/or the production of (certified) reference materials may also be addressed as an integrated part of the research proposal. The performance of the OPV materials should be demonstrated in an environment relevant to its future application, displaying a clear improvement with respect to the current state-of- the-art.

In order to ensure industrial relevance and impact of the research effort, the active participation of end users 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: All of the following: (i) Efficiency of an OPV module of at least 15% in a relevant environment, with a considerable improvement in the service life-time, performance of the materials to be credibly planned to be reachable by 2030; (ii) Improvement in efficiency of material use and/or the OPV production processes; (iii) More favourable cost/efficiency ratio compared to inorganic PV; and (iv) Contributions to the implementations of the SET plan, in particular to the Materials Roadmap enabling Low Carbon Energy Technologies[18].

NMP.2013.4.0-3 From research to innovation: substantial steps forward in the industrial use of European intellectual assets, stimulating the use of newly developed materials and materials technologies by the industry

Technical content/scope: We know that innovation may lag behind after research results have been achieved. In particular, SMEs may miss opportunities of business; this is because of various reasons: undercapitalisation, lack of suitable human resources etc. In other cases, research-brokers may be needed who scout and advise SMEs on existing IPR and who can prepare economic and technical scenarios to help the SMEs to improve their product(s) and/or production. The complex path from research to innovation needs boosted impetus. Often

[18] SEC(2011)1609

original research has been co-funded by the EU Framework Programmes or by European National schemes, so that missing the exploitation of research results might represent an underperformance for public expenditures. Moreover, significant untapped innovation potential may exist in research carried out in Member States of more recent accession to the European Union. This call aims to stimulate and support the use of newly developed and IPR-protected materials and materials technologies, fostering innovation and their integration into future industrial production.

The proposals should involve innovation-oriented research in materials and materials technologies, further developing existing IPR-covered results, scaling them up to a prototyping or pilot stage. The consortium should demonstrate ownership of or exclusive rights to use the relevant IPR; the relevant IPR should be in the form of patents granted by the European Patent Office (EPO) or by national patent offices established in EU Member States or in Associated Countries. Proposers should demonstrate that the overall IPR situation is compatible with future commercialisation of their technology and prove the technical and economic viability of their approach. The consortium should also demonstrate appropriate knowledge on materials science and engineering as well as on the ways to manufacture the materials. Successful projects should prove the technological and economical viability of the solutions proposed. A business plan should be part of the final report. One of more of the following ancillary activities may also be included in the project - this list is not exhaustive, and is only given as an example: detailed market studies, scouting of SMEs or research organisations, evaluation of the success factors in the industries involved, educational courses, infrastructure use, insertion of qualified personnel (at least from the post-graduate level) into SMEs, specific regulatory survey, clinical trials, insurance issues, life cycle assessment studies etc. In order to ensure the largest possible impact, proposers should soundly detail the market perspectives and the potential for economic growth and jobs, and this will be reflected in the evaluation under the criteria Implementation and Impact.

Funding Scheme: SME-targeted collaborative projects.

Expected impact: One or more of the following: (i) Realise cases where research results are used by new or existing industries; and/or the 'European paradox'[19] and the 'valley of death'[20] are overcome; (ii) Creation of new businesses in Europe; (iii) Exploitation of research results; and (iv) Growth and jobs.

NMP.2013.4.0-4 Support for cluster activities of projects in the main application fields of NMP Theme

Technical content/scope: In FP7 the implementation focus has gradually shifted towards promising application areas. The potential of forming application clusters exists, in order to create additional synergies. Because of the multi-disciplinary nature of the applications, often also involving other KETs, this clustering approach could bring about benefits through cross-fertilisation (e.g. reporting of technological progress; exchange or licensing of IPR) and identification of value chain elements required for industrial success. Activities could also include roadmaps for large-scale demonstration and pilot-line activities, as well as other

[19] European Commission Green Paper on Innovation, http://europa.eu/documents/comm/green_papers/pdf/com95_688_en.pdf

[20] See e.g. Final Report of High-Level Expert Group on Key Enabling Technologies, http://ec.europa.eu/enterprise/sectors/ict/files/kets/hlg_report_final_en.pdf

support activities that would be required, e.g. forming of industry alliances, pre-commercial procurement and (formal or industrial) standardisation. The final target is to tackle the bottleneck for the deployment in Europe of new and promising technologies, in order to foster innovation in products and/or processes and/or the sustainability of our industrial economy.

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

Expected impact: One or more of the following: (i) Facilitating and speeding up the industrial exploitation and success of existing research results; (ii) Building up of networks and alliances for further R&D+I and industrial innovation; (iii) Additional added value beyond the original scope of projects; and (iv) Carrying out feasibility analysis and building readiness towards possible future large-scale demonstration and pilot line activities.

NMP.2013.4.0-5 Deployment of societally beneficial nano- and/or materials technologies in ICP countries

Technical content/scope: The potential of nano- and/or materials technologies to address major societal challenges, e.g. in health, energy and environment is widely recognised and several leading industrial nations are actively pursuing significant R&D&I programmes for accelerating the deployment of nano- and/or materials technologies in societally beneficial applications. Nanosciences and nanotechnologies: An action plan for Europe 2005-2009 emphasised the importance of international cooperation with less industrially advanced nations in order to secure their access to knowledge and avoid any 'nano divide'. NMP-Materials has created a particularly positive momentum with its calls with Africa, Middle-East Countries, Latin America, Eastern European Countries and South East Asia.

The goal of this topic is to support sustainable development in ICP countries through the deployment of societally beneficial nano- and/or materials technologies. The methods and solutions need to be tailored to meet the specific needs and circumstances using local knowledge and innovative ability, so that they will be adopted.

Activities may include, but are not limited to:

- Identification of tangible opportunities for pooling knowledge in the fields of: healthcare, clean energy, environment (including water);
- Networking of technology providers, representatives of ICP countries (scientists, industrialists, civil society representatives, decision makers) and potential sponsors for the development of implementation mechanisms (including appropriate business models);
- Education, training and exchange of scientists in the underlying technologies aiming at ensuring the sustainability and further development of the proposed solutions;
- Organisation of a series of events.

Proposals specifically addressing materials technologies may target networking of research projects funded at EU or National (EU and non EU) level as well as the creation of an open database of researchers; these two target issues are not called for in the case of nanotechnologies because dedicated measures are currently in place.

In order to create a particular benefit in the interaction amongst ICP countries, broad geographic areas and not individual countries should be addressed. The targeted geographic areas are:

- Eastern Partnership countries
- Mediterranean countries
- African countries
- Latin American countries
- ASEAN

A proposed support action may address one or more of above-mentioned geographic areas.

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

Expected impact: One or more of the following: (i) Support the development and promotion of concrete projects making the benefits of new technologies; (ii) Contribute towards the United Nations Millennium development goals; and (iii) Contribute towards building and strengthening of science in low and middle-income countries through entrepreneurship.

NMP.2013.4.0-6 Safe Life Extension management of aged infrastructures networks and industrial plants

Technical content/scope: In Europe many industrial facilities, such as power production plants and large chemical installations, as well as infrastructure network elements, like bridges, tunnels and railway systems, are reaching the end of their designed operational life time. New ways to extend the service life of current infrastructure networks and industrial plants without jeopardising their safety requirements need to be investigated in order to guarantee a decrease of major accidents in the industry and major disruptions of economic activity. Safe life extension becomes even more critical when the structure is part of an interconnected infrastructure network, is located in an urban area where the related environmental impacts are amplified, or is at risk due to more frequent climate-induced extreme events.

Areas of investigation to be addressed include new risk-based inspection technologies, innovative reliability-based solutions, comparison between deterministic and probabilistic approaches, influence of degraded physical state on potential domino effects, and resilience. Methods and technologies vary between industrial sectors and therefore a benchmark study is necessary to understand the practices in the various industries and Member States, and to prepare the deployment of best practice solutions in Europe without compromising on safety and sustainability. In addition to the technical approaches, barriers linked to financing, risk insurance, decision making, public acceptance and regulations need to be addressed. Safety risks have to be identified locally (at element level) and globally (at network level, taking into account the interconnection).

Deliverables should also include benchmarking with best practices outside Europe, and therefore this topic is particularly suitable for collaboration with partners from outside Europe.

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

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

Expected impact: (i) Improved synergy amongst major stakeholders in safe life extension; (ii) Identification of best practice solutions and research needs; (iii) Strategies for the systematic implementation of comprehensive life time extension solutions at European scale; and (iv) Significant contributions to new standards for life extension

NMP.2013.4.0-7 ERA-NET to support Innovation in the NMP thematic area

Technical content/scope: The objective of the Innovation Union is to improve framework conditions and access to finance for research and innovation so as to ensure that innovative ideas can be turned into products and services that create growth and jobs. Excellent research should have more opportunities for moving into the next stages of the innovation cycle.

The NMP Theme has funded and continues to fund a number of successful ERA-NET and ERA-NET Plus initiatives, whose aim is to coordinate the research efforts of the participating Member States and Regions in the field of Industrial Technologies and to implement joint transnational calls for innovative research initiatives. This has resulted in a large number of transnational projects funded by the participating Member States and regions, many of them with a strong SME participation.

The aim of this ERA-NET is to build upon those efforts to commercialise research results. This ERA-NET concentrates on second-stage research and innovation funding such as proof of concept, prototypes, scale-up studies, performance verification, reliability and viability of products. The objectives are

- to detect NMP research results likely to provide solutions for innovative products, processes or services;
- to analyse and assess the lessons from the measures taken and supported in various Member States to exploit transform research results; and
- to provide operational guidance for supporting efficiently the successive steps between research and innovation, paying particular attention to the use of Regional Development Funds, in the context of smart specialisation strategies.

The ERA-NET will complement the activities of existing ERA-NETs in the NMP field, in particular by helping to capitalise on their portfolios of successful projects. The proposed ERA-NET should therefore ensure a broad coverage of relevant Member States and regions and expand towards programmes or activities that cover the innovation aspect.

Proposals should focus on:

- Systematic exchange of information and good practices on existing programmes and experiences concerning exploitation and commercialisation of research results, and use of the Regional Development Funds for research, innovation and business development;
- Definition and preparation of common strategic activities;
- Implementation of joint activities between national and/or regional programmes;
- Funding of joint transnational research and innovation activities closer to the market.

The outcome of this topic could serve as input for the planning of further activities under Horizon 2020.

Funding Scheme: Coordination and Support Actions (coordinating actions).[21]

Expected impact: (i) Improve the efficiency of the process transforming research results into exploitable results in NMP; (ii) Disseminate and share good practices in supporting downstream research activities; and (iii) Inform policy development for Horizon 2020 and regional programming.

NMP.2013.4.0-8 The impact of the integration of key enabling technologies on industrial production and societal goals

Technical content/scope: To ensure European industrial production remains innovative and competitive at international level it will need to develop the competences to exploit multiple and integrated key enabling technologies (KETs), defined as micro- and nanoelectronics, photonics, nanotechnology, biotechnology, advanced materials and advanced manufacturing systems.

In developing the research and innovation programme, more emphasis is being put on innovation activities closer to market, e.g. demonstration projects, pilot lines and validation. The exploitation of single or multiple of KETs may require new and different business models and networking capabilities.

Understanding how effectively these multidisciplinary, knowledge and capital-intensive technologies are currently integrated, at global level, in different innovation cycles and value chains in European industrial production is a crucial starting point. The return on investment, based on tangible outcomes such as products, services and solutions in industrial, societal and novel applications, of existing and emerging business approaches to integrate KETs will provide a baseline on which future developments can be assessed.

The philosophy and underpinning building blocks emerging from the analysis should provide the knowledge and tools for EU industry to adopt new, adaptive business models, networks and configurations to optimise the integration of KETs. Furthermore, the approaches to integrate KETs should lead to a new model for European industrial production, based on more sustainable production and consumption patterns, supporting the pursuit of Sustainable Globalization and Sustainable Development.

The analysis should lead to:

- Existing good practices in the integration of KETs;
- Barriers (technological, economic, regulatory, organisational, social, cultural) to the integration of KETs and their take-up in industrial and societal applications;
- Evidence of innovative business models and adaptations in the structure of organisations to effectively manage the integration of KETs, for a globally competitive and sustainable European manufacturing industry.

[21] 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-2013-RTD.

Additional eligibility criterion: The requested EU contribution must not exceed EUR 1 000 000, and the project duration must not exceed 18 months.

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

Expected impact: (i) Improved understanding of the current situation and future perspectives for integrating key enabling technologies, and their application to different industrial and societal applications; and (ii) Orientations on the approaches and measures that could be adopted to facilitate the integration of key enabling technologies.

NMP.2013.4.0-9 Organisation of events, including those related to the Presidencies of the European Union

Technical content/scope: An integral part of the NMP Theme's activity is to organise events of a major strategic nature. Examples are events organised together with successive EU presidencies; and also EuroNanoForum, Manufuture, NMP Conferences and World Manufacturing Forum. 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 Greece and Italy (2014 Presidencies) and they may be particularly interested in this topic. 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 relevance at the date of its taking place. An appropriate equilibrium should be present in the proposed action(s), with balanced presentations of various research and industrial elements and points of view. Participation of non-EU actors is possible. Outreach activities may be included, such as a press programme or events dedicated to the wider public or schools.

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

Expected impact: One or more of the following: (i) Review of research, industrial and/or societal developments linked to the NMP areas, as appropriate; (ii) Sharing of information and comparison of points of views; and (iii) Networking various stakeholders and supporting their activities, e.g. natural scientists, social scientists, researchers, industrialists, investors, environmentalists, museums and 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 work programme, and the previous one, place renewed emphasis on raw materials. The topics in this section contribute to the aims of the proposed European Innovation Partnership (EIP) on Raw Materials.[22]

NMP.2013.4.1-1 Development of new materials for the substitution of critical metals – coordinated call with the Japan Science and Technology Agency

Technical content/scope: Many technologies with significant socio-economic benefits face material requirements that are, or will be, negatively affected by demand-supply disruptions. Research is needed in particular to improve our fundamental understanding of the development of new materials, with a completely eliminated critical metal content that could ultimately be used in highly performing products.

Projects are called for to investigate the development of such materials by rational design, with focus on the interplay between theory and/or large-scale computational screening and experimental methods. The synthesis or fabrication of nano- or microstructures with enhanced functionality as well as the use of advanced characterisation and measurement methods to determine how effects at the nano- or micrometre-level influence the materials' behaviour at the macroscopic level, should also be an integral part of the proposal. Aspects related to the recyclability of the materials can be addressed.

Projects should foresee the recruitment of researchers in the early stages of their career.

This call targets a balanced participation from European and Japanese organisations in each project. In order to assure genuine EU-Japanese cooperation, it is important that the proposed research plan properly includes integrated and coordinated research activities between the EU and Japan. The establishment of a close collaboration between European and Japanese partners is mandatory, and *proposals not including such collaboration will be deemed ineligible*.

Additional eligibility criterion: The requested EU contribution must not exceed EUR 1 800 000.

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

Expected impact: (i) Improved understanding of the development of materials for the substitution of critical metals for a well-defined technology; (ii) Improved performance of industrial products in the longer term; (iii) More robust European – Japanese research cooperation; (iv) Successful joint research, activities, publications, and contributions to scientific events; and (v) More intensive exchange and training of researchers.

NMP.2013.4.1-2 Breakthrough Solutions for Mineral Extraction and Processing in Extreme Environments

[22] http://ec.europa.eu/enterprise/policies/raw-materials/innovation-partnership/index_en.htm

Technical Scope/content: As a response to the shortage of some mineral resources on global markets, both the EU Raw Materials Initiative and the Europe 2020 strategy have called for improved efficiency in the raw materials supply. Europe has, however, been exploited by mining activities over many centuries and easy-to-access mineral deposits are mostly exhausted.

The biggest opportunities for the access to raw materials within the EU are in areas difficult to exploit, such as at great depth, in the Arctic region of Europe and in extreme marine environments.

Current technologies for mineral raw materials production, including in-situ exploration, are inadequate for these extreme environments (e.g. with high pressures, too high or too low temperatures and environments which are dangerous for humans). Major challenges related to human safety, performance and reliability of technologies, economic effectiveness and environmental efficiency need to be addressed.

The overall objective is to develop new breakthrough cost-effective solutions for environmentally friendly mining and processing under difficult conditions in extreme environments, to further unlock the large potential of raw materials in Europe. These solutions should also consider the sustainable management and possible use of mining and processing waste in extreme conditions. The proposals should take into account environmental issues and risks in the exploitation phase. Deliverables should include whenever possible a field demonstration in order to prove the viability of the developed technological solutions. Consideration should be given to mining concessions, ownership and commercial exploitation rights.

All non-energy non-bio-based raw materials necessary for European industries can be targeted. However, the economic relevance of the selected raw materials needs to be demonstrated and this will be reflected in the evaluation, under the criterion Impact.

In order to ensure industrial relevance and impact of the research effort, the active leadership and 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.

Relevant existing national or international R&D initiatives and projects have to be reflected in the state-of-the-art description and overlaps with them should be avoided.

This topic is complementary with the topic ENV.2013.6.2-6 on "Sustainable Management of Europe's Deep Sea and Sub-Seafloor Resources", where the emphasis is on assessing the environmental impacts.

Funding Scheme: Large-scale integrating collaborative projects.

Expected impact: (i) Increase access to raw materials via new mining solutions in order to decrease EU dependency on resource imports and to create jobs in Europe; (ii) Strengthen the leadership of the European mining sector and their technology providers; (iii) Create solutions with competitive investment and operational costs and ensuring minimal impact on environment and urban settlements; and (iv) Create inherently safe working and operating environments.

NMP.2013.4.1-3 European Intelligence Network on the Supply of Raw Materials

Technical content/scope: The EU Raw Materials Initiative calls for actions enhancing the knowledge base necessary for an efficient European raw materials strategy, for instance the harmonisation of relevant terminology and standardisation of minerals data or the creation of the 'European Raw Materials Yearbook'.

The EU needs a complete and reliable knowledge base as well as a supply and demand foresight on raw materials for a proper policy making to ensure an adequate access to raw materials.

Raw materials expertise is available in Europe, but is scattered amongst a variety of institutions, including government agencies, universities, NGOs and industry.

The major objective is to create a network to facilitate access for the EU to the raw materials information sources and to promote collaboration among experts.

The Coordination Action should in particular:

- Create a sustainable network gathering a critical mass of institutions with the relevant authority and competencies at world, EU and national levels, resulting in the creation of a permanent body before the end of the project.
- Create a harmonised and standardised EU knowledge base interoperable with national databases including information on primary and secondary resources on land and in marine environment down to 4 km depth, and estimations of the resource availability including urban mines (landfills and mining waste), and contribute to the establishment of the 'European Raw Materials Yearbook' in close coordination with EUROSTAT.
- Produce a foresight study on raw materials supply and demand in the EU, together with competent financial institutions, with special attention given to critical minerals. A strategy for annual updates of this foresight study on raw materials should be included as well.
- Develop a multi stakeholders' Internet portal providing information on the raw materials resources and deposits within European Union.

All presented data and information should conform to the relevant world or European standards and should be of value for decision making related to raw materials.

Industry relevant non-energy non-agricultural primary and secondary raw materials are targeted.

Additional eligibility criterion: The requested EU contribution must not exceed EUR 2 000 000.

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

Expected impact: (i) Contribute to the successful implementation of the Raw Materials Initiative and related activities; (ii) Create a sustainable network at the EU level with competence in collecting and providing information on raw materials; (iii) Improve harmonisation, standardisation and certification of national primary and secondary raw materials data; (iv) Identify needs for future research & exploration, and green public procurement; (v) Improve coordination in research and innovation actions in the field of raw materials intelligence; and (vi) Formulate the ideas for possible novel actions with high

European common interest and increase efficiency and effectiveness of the EU research activities in this field.

II.4.2 "The Ocean of Tomorrow – 2013": Joining research forces to meet challenges in ocean management

Please note that a separate orientation paper on 'The Ocean of Tomorrow 2013' potential joint call is expected to be published, and it is therefore not developed in this orientation paper. For details on the topics, please consult the relevant document on the Participant Portal.

The aim of this potential call will be to support the EU integrated maritime policy's objective of a thriving maritime economy, making the most of marine resources in an environmentally sustainable manner, in line with the EU Strategy for Marine and Maritime Research. The Strategy helps deliver the full potential of the maritime economy to the 'Europe 2020' goal of a smart, inclusive and sustainable growth for Europe.

The tentative orientation paper for 'The Ocean of Tomorrow 2013' will possibly include the following four topics:

- Biosensors for real time monitoring of biohazard and man-made chemical contaminants in the marine environment
- Innovative multifunctional sensors for in-situ monitoring of marine environment and related maritime activities
- Innovative antifouling materials for maritime applications
- Innovative transport and deployment systems for the offshore wind energy sector

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 and through dedicated topics, under the 2013 work programmes of the relevant FP7 Themes. Responsibility for these Cross-thematic Calls and dedicated topics is as follows:

- The 'Factories of the Future' initiative involves financial support from the NMP[23] and ICT[24] Themes;
- The 'Energy-efficient Buildings' initiative involves financial support from the NMP, ICT and Environment Themes;
- The 'Green Cars' initiative involves financial support from the ICT and NMP Themes (in two separate calls), as well as the Energy and Transport Themes (topics being part of broader calls in their respective work programmes).

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.

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

[23] Nanosciences, Nanotechnologies, Materials and New Production Technologies
[24] Information and Communication Technologies

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.

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

- Topics covered by the NMP Theme

FoF.NMP.2013-1 Improved use of renewable resources at factory level

Technical content/scope: A more efficient use, at factory level, of material and energy resources, while at the same time ensuring high productivity rates, has become a key issue for a sustainable manufacturing sector. In this regard, a more extensive integration of technologies related to renewable energy and material resources and an optimal re-use of air, water and scrap (or other waste) along the lifecycle of factories may become a valuable complement to current strategies for resources efficiency. The resources consumed in the production processes, including air and water, should be minimised and the energy efficiency should be optimised in a continuous and iterative manner.

This novel approach would allow European manufacturing companies to take a qualitative leap towards environmentally neutral factories where the production processes and systems will move towards reduced ecological footprints (e.g. near-to-zero carbon approaches), whilst ensuring competitiveness.

This strategy demands new concepts and solutions at factory level, both for existing and new production plants. Research activities should be multi-disciplinary and address all of the following areas:

- Methodologies and tools for eco-efficient design or re-adaptation of production facilities based on co-evolving product-process-production systems including the integration of technologies for energy scavenging and recovery.

- Seamless integration of renewable energy harvesting in production systems for high productivity and maximum energy efficiency in the factories.
- Simulation and optimisation tools for assessing both environmental and economic costs linked with the use of renewable materials and energy resources, as well as technologies for energy recovery with reliable predictive analytics to guide decision-making.

Standardisation, regulation and pre-normative research aspects should be considered. Proof of concept in terms of at least one demonstrator should be delivered before the end of the project, excluding commercially usable prototypes (2006/C323/01), but convincingly demonstrating 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 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.

Projects are expected to use appropriate Life Cycle Assessment techniques in order to estimate the impact of energy efficiency and improved use of renewable materials and energy resources on the price of final products. Projects are also expected to generate knowledge to support European policy development and promote standardisation (at national or international level).

Funding scheme: DEMO-targeted collaborative projects.

Expected impact:

- In economic terms, reduction of 20% in the total lifecycle costs of factories with respect to conventional factories of similar productivity rates, due to an increase in energy efficiency and improved use of renewable resources.
- In environmental terms, a major step towards zero-carbon footprint manufacturing systems and processes, with drastic reduction of total lifecycle environmental impacts.
- Strengthened global position of European manufacturing industry through the introduction of the new technologies related to an improved use of renewable resources and contributions to international standardisation.
- Strong support for eco-labelling policies and standardisation.

FoF.NMP.2013-2 Innovative re-use of modular equipment based on integrated factory design

Technical content/scope: Current markets and customer demands impose quick changes in terms of product models, with smaller lot sizes and increased variety. Moreover, with increased customisation, multiple similar products are produced in small lots in a shared production line as a result of just-in-time production. Therefore, for the economic

sustainability of the production systems, an innovative re-use of modular equipment based on integrated factory design methodologies needs to be addressed. This requires a cost-efficient and modular approach for production systems, with a higher standardisation level regarding production equipment and components, allowing a highly flexible and reconfigurable production in the long term.

Research activities should address at least the first two of the following areas:

- Proactive modularisation and re-use strategies for the development of the future machinery and production systems and their integration in old, new or renewed factory facilities.
- Innovative factory lay-out design techniques able to integrate new approaches to leverage all potential synergies between the concurrent design of plant and processes, taking into account best practices for de-manufacturing, dismantling, recycling and value-chain extension.
- Flexible, low-cost assembly/disassembly solutions to aim at a high market penetration with those solutions by the machine component suppliers and systems integrators, by developing low weight and mobile solutions (e.g. flexible grippers), as well as systems (e.g. automation, vision and control) for their seamless integration in factories.

Standardisation, regulation and pre-normative research aspects should be considered. Proof of concept in terms of at least one demonstrator should be delivered before the end of the project, excluding commercially usable prototypes (2006/C323/01), but convincingly demonstrating 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 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.

Projects are expected to use appropriate Life Cycle Assessment techniques and to generate knowledge to support European policy development and promote standardisation (at national or international level).

Funding scheme: DEMO-targeted collaborative projects.

Expected impact:

- Cost reduction of around 30% due to re-use of existing modular equipment when setting-up production systems for new product variants.
- Set-up and ramp-up time reduction of around 30% for new or retrofitted plant designs.
- At the end-of-life stage, a step contribution towards a 100% reuse of production system components in new life cycles.

- Strengthened global position of European manufacturing industry through the introduction of the new technologies related to an innovative re-use of equipment based on integrated factory design and contributions to international standardisation.

FoF.NMP.2013-3 Workplaces of the future: the new people-centred production site

Technical content/scope: The workplaces of the future will give much more importance to the human dimension. Putting people at the centre of future factories will provide a stimulating environment for the employees, and make the most from their knowledge, skills and cultural background, in particular through life-long learning and training. Those new workplaces should effectively be integrated into the social (e.g. urban/rural) environment in order to sustainably respond to the needs of the citizens (e.g. quality of air, level of lighting and noise, traffic congestions, etc) and, at the same time, provide extended services to the workers in terms of safety, accessibility, inclusiveness, efficiency and work satisfaction.

This approach would lead European manufacturing industry to make a qualitative leap towards new people-centred and knowledge-based production workplaces which take into account the constraints of the work force, for example those of aged workers. The workplaces of the future should, therefore, be based on methodologies for enhancing flexible, safe and smart production where adequate levels of automation are applied, while maintaining a level of employment with highly satisfied and skilled workers and, at the same time, ensuring competitiveness.

This strategy demands new concepts and solutions at factory level, both for existing and new production plants. Research activities should be multi-disciplinary and address several of the following areas:

- New approaches to integrate the European factories of the future in their social (urban/rural) environment including urban transport, parking, shopping and entertainment centres, support to families, etc.
- New methods and technologies for an optimised use of workers' knowledge and cognitive capabilities (e.g. for data acquisition, transmission, handling and post-processing), for the stimulation of team interactions and to enhance work related satisfaction, in order to achieve a more human centred and safe workspace, e.g. through the use of knowledge management and decision making systems which are better designed to access, capture and share know-how.
- New methods and technologies for enhanced cooperation of the human operators and the production systems (e.g. Human Factors Engineering), in a safe, flexible and dynamic way, to carry out tasks interactively. New models for human/system integration taking into account the skills, capabilities, and knowledge of the human operator early in the production system design process. New methods and technologies for efficient human/human interaction and team collaboration, to enhance joint decision-making and team-based efficiency.
- New approaches related to safety and ergonomics of the working areas by the optimisation and personalisation of working environment parameters (e.g. indoor/outdoor lighting, temperature, and humidity) and the integration of advanced safety systems, taking into account worker's age, experience and physical condition, and workers interactions.

- Methodologies and tools for people-centred production to guarantee an efficient transition from current to future worker task/role definitions and multi-skilled involvement of individual workers with expanded responsibility in broader sets of operations (e.g. maintenance, logistics, and quality control).

Screening of existing national/international standards (e.g. safety regulations) and of the needs for new standards is required. Other standardisation, regulation and pre-normative research aspects should also be considered.

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.

This topic is particularly suitable for collaboration at international level, particularly under the IMS scheme[25]. Project partnerships that include independent organisations from at least three IMS regions[26] are therefore encouraged.

Funding scheme: Small or medium-sized collaborative projects.

Expected impact:

- In economic terms, an increase of above 20% in the productivity rate due to an enhanced use of human resources, reduction of costs related to accidents and occupational diseases, reduction of absenteeism in the workplace and by increasing the pool of potential workers through widening the skill profile.
- In environmental terms, a more friendly integration of the factory in the social environment, with drastic reduction of total environmental impacts.
- In social terms, a reduction in the number and severity of work accidents and diseases, an improvement in the working conditions in factories and in the attractiveness of the working environments for the right-skilled people due to knowledge-based ergonomic approaches to manufacturing.

FoF.NMP.2013-4 Innovative methodologies addressing social sustainability in manufacturing

Technical content/scope: In order to ensure the social well-being of people in the factories of the future, there is a need to redefine the human role in manufacturing.

New forms of interaction between process, machinery and human beings need to be addressed in such a way that future factories can be operated profitably, and at the same time provide a stimulating environment for the employees, and make the most from their skills and knowledge through life-long learning. On the basis of these new interactions, manufacturing jobs need to be re-defined and re-engineered and new roles for people in the factory need to be introduced. Cross-discipline studies are needed in order to explore profitable business

[25] 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

[26] 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.

approaches where the social element in sustainability can be a key factor to ensure midterm economic success while maintaining a high level of employment, even in a period of crisis.

Those business approaches may require an adaptation of organisational structures and management strategies to take into account social sustainability requirements.

Developments in this area are expected to lead to:

- Work satisfaction of employees within the factories of the future.
- New profitable business approaches benefitting from the relevance given to the importance of social sustainability.
- Sustainable use of human capital (e.g. staff knowledge) in the factories of the future.

Within this context, this Support Action should deliver an assessment of relevant past and current activities in Europe (and worldwide) towards the achievement of social sustainability in manufacturing, a set of recommendations on how social sustainability can be measured and enhanced, a definition of what is necessary to support this in terms of research, i.e. a future research roadmap on relevant S&T themes, a definition of the conditions in a factory and /or in society that are favourable for this purpose, and a relevant pilot case.

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

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

Expected impact:

- Improved understanding of the current situation and future perspectives for social sustainability in European manufacturing.
- Improved synergy among stakeholders around Europe, and community building for future take-up actions.
- Facilitation of a structured approach to promote social sustainability for the European factories of the future.
- Improved production and consumption strategies in line with the societal challenges foreseen by the Europe 2020 strategy.

FoF.NMP.2013-5 Innovative design of personalised product-services and of their production processes based on collaborative environments

Technical content/scope: New product-services go nowadays beyond the physical and service oriented concept, since they are designed in order to be always connected, self-learning, adapting and intelligent. In order to generate economic growth, manufacturers should focus on delivering *solutions* for customer needs rather than simply *products* (or product-services) for their customers. Therefore, new business opportunities will be generated when providing increased added-value to users by integrating personalised innovative functions into traditional and high-tech products.

This business challenge can be addressed by embedding more and more knowledge in highly-personalised innovative product-services (i.e. the so called Meta Products). These novel products are expected to be self-innovative and become smarter while ensuring simplicity for users. They will be upgradable through software applications or hardware module enhancement, which extend their lifespan, and reduce the environmental impact. In addition, they will provide improved value-added services for a wide range of users, but with personalisation aspects so as to consider individual demands. Meta Products will therefore require the use of new, interoperable, self-organising and collaborative design methodologies and systems. Product development should take place through a collaboration within the product ecosystem, involving multiple companies and actors, in order to offer the high-value personalised product-services to users.

On the other side, new product design and development is fully linked to the concurrent design of the related manufacturing processes, equipment and facilities, including plant lay-out. This need has a strong influence on several aspects related to the life-cycle of both the product and its manufacturing processes (e.g. costs, production, disposal, environmental footprint). Meta Products will be capable of providing advanced service solutions along the whole customer value chain (from the product acquisition to the product dismissal), integrating personalised design, sustainable production, efficient distribution, after sale services, as well as foreseen recycling and re-manufacturing. Cost-effective design solutions with high potential in terms of eco-design content (i.e. minimal footprint impact along the product life-cycle) leading into a new technological cycle (i.e. cradle to cradle concept), should aim at the simultaneous life-cycle optimisation of product-services and related processes.

Research activities should focus on several of the following areas:

- Methodologies and systems for cross-sectoral collaborative design (e.g. 3D drawings, simulation models) enabling the seamless connection and use by all the stakeholders (e.g. product designers, service providers, users) involved in the Meta Product life cycle.
- Collaborative design tools to support the development of Meta Products based on Service Oriented Architecture (SOA). They should be able to connect the design of the product hardware with the development of the software related to the embedded services, based on open source software applications.
- Novel approaches for embedding knowledge into product-services (e.g. use of smart materials, tracking systems, sensing and interacting technologies) in order to add more personalised innovative functions into traditional and high-tech products.
- Embedded tools for product adaptability to enable Meta Products to store usage behaviour and utilise the data to re-organise the embedded services. Feedback mechanisms should be integrated within the tools and should provide the data to the networked companies involved in the design, manufacturing and service-related operation of the Meta Products.
- User-oriented simulation systems (e.g. virtual reality, reverse engineering) for product-service modelling and production-related decision-making approaches (e.g. requirements identification by means of the demand market and user-perceived quality analysis), covering the needs all along the life-cycle.

Standardisation, regulation and pre-normative research aspects should be considered. Proof of concept in terms of at least one demonstrator should be delivered before the end of the project, excluding commercially usable prototypes (2006/C323/01), but convincingly demonstrating 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 projects are expected to cover demonstration activities, including pilot implementations in industrial settings, and this will be likewise reflected in the evaluation.

Projects are expected to use appropriate Life Cycle Assessment techniques and generate knowledge to support European policy development and promote the standardisation (at national or international level).

Funding Scheme: Large-scale integrated collaborative projects.

Expected impact:

- Increased ability to rapidly follow the market dynamics by means of fast production and delivery of personalised final products
- Cost reduction of around 30% by decreasing lead times in product/process development.
- Set-up and ramp-up time reduction for new processes and plant designs (30%).
- Reduction of around 40% in the environmental footprint and the resources consumption during the production and use phases of the Meta Products, together with an increased use of more environment-friendly materials.

FoF.NMP.2013-6 Mini-factories for customised products using local flexible production

Technical content/scope: Product customisation on functional and aesthetic aspects is a common trend to different market segments (e.g. fashion and interior furnishing, sport and leisure, metal working, bio-medical and safety-related products). Advanced production equipment and innovative systems are needed to enable ultra-fast and cost-effective manufacturing of fully customised products on the spot and exactly at the required time. Innovative production solutions should be developed to bring manufacturing operations closer in time and space to the final customer, eventually exploring the possibilities of moving from batch to continuous flow manufacturing. In addition, new factory concepts need to be developed, such as on-site factories or factories-in-a-container, which provide instant manufacturing and customisation services locally, for example in retail environments or utilisation sites.

Those mini-factories, addressing adaptation to customer needs at or near the point of sales or use, will be characterised by fast ramp-up, small environmental footprint and reusability, and will be easy to handle and to set-up. Those production systems should also include new technologies for supply chain management, product distribution and direct end-user interaction.

Research activities should focus on some of the following areas:

- Scale reduction and increased flexibility of production systems in order to satisfy the special requirements of the local flexible mini-production units, which have to show a competitive advantage compared to the traditional larger factories in terms of space, complexity and operator skills.
- Adaptive control and auto-configurable automation systems for local flexible production with high customisation capabilities, where manufacturing operations and sequences need to accommodate to the highly unpredictable customer demands.
- New and integrated product/process engineering solutions, including CAD-CAM systems, able to automatically adapt product features to specific customer demands and accordingly configure processes and machines for local production.

Standardisation, regulation and pre-normative research aspects should be considered. Proof of concept in terms of at least one demonstrator should be delivered before the end of the project, excluding commercially usable prototypes (2006/C323/01), but convincingly demonstrating 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 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:

- Increased ability to rapidly follow the market dynamics by means of fast production and delivery of customised final products.
- Reduction of the time to market by 50%.
- Cost reduction (around 30%) by decreasing lead times in product and process development.
- Reduced environmental impact per produced unit compared to traditional larger factories.
- Set-up and ramp-up time reduction (around 30%) for new processes and plant designs of the mini-factories.

FoF.NMP.2013-7 New hybrid production systems in advanced factory environments based on new human-robot interactive cooperation

Technical content/scope: The future factory environments for manufacturing, and in particular assembly/disassembly operations and auxiliary processing such as lifting and moving of heavy goods, will radically improve by integrating new forms of interaction between process, machinery and workers in such a way that future factories can be operated

profitably and make the most from employees' knowledge and skills. Hybrid production systems, where robots physically interact with humans, need to ensure an intuitive and safe cooperation among them and an enhanced awareness of the work conditions and the constraints imposed by the factory environment.

A new generation of production systems (e.g. machinery as well as industrial and service robots) will maintain the competitive advantage of the European manufacturing sectors. Future machinery and robots will be based on intelligent features, increasing flexibility in a totally safe environment, enhancing the use of this advanced equipment in a cooperative way with their human operators (machine/robot-human and machine/robot-robot interactions), as well as on self-learning functionalities that allow them to be aware of the current and future tasks.

Research activities should focus on at least three of the following areas:

- Technologies for a reliable and safe machine/robot-human and machine/robot-robot interactive cooperation in applications where the equipment will carry out the tasks which provide power, repeatability and extended work-space while the human operators will provide accuracy, flexibility and problem solving capacity.
- Methodologies for the improved planning of the shared tasks, based on analysis and simulation of real-time collaboration at the production site and by the user-friendly programming of complex tasks, using information from factory sensor networks, and taking into account the constraints from factory environments in predefined automatic or semi-automatic assembly/disassembly operations, e.g. using advanced real-time augmented reality in complex operations.
- Novel methods of programming for fast-teaching and guided-learning in order to adapt robot work tasks dynamically during operation to the changeable production requirements (e.g. in hybrid assembly of serial products such as automotive, white goods, airplanes, where frequent changes of production require regular updates of the assembly tasks as well as adjustment of workplaces, fixtures and tools).
- Technologies on mobile robots for improved intra-factory logistics, based on enhanced safe navigation in non-structured environments. Dynamic planning methodologies, coordination control and path reconfiguration strategies, taking into account wireless communication, in a safe interaction with operators have to be addressed.

The human-robot safety features, enabling production operation in workspaces shared with humans without separating safety fences or in direct human-robot operations, should lead to advances in the certification of the related production systems working in industrial environments and in the characterisation of risks and safety systems.

Screening of existing national/international standards (e.g. safety regulations) and of the needs for new standards is required. Other standardisation, regulation and pre-normative research aspects should also be considered.

Proof of concept in terms of at least one demonstrator should be delivered before the end of the project, excluding commercially usable prototypes (2006/C323/01), but convincingly demonstrating 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 projects are expected to cover demonstration activities, including pilot implementations in industrial settings, and this will be likewise reflected in the evaluation.

Funding Scheme: Large-scale integrated collaborative projects.

Expected impact:

- Increasing use of robot installations in manufacturing. Today, only some 15% of robot automation potential is being exploited. Further improvement in robot exploitation will contribute to higher employment as more manufacturing capacity will remain in Europe.
- Increasing adaptability of advanced factories by combining the flexibility inherent to humans with the enhanced potential of cooperative production systems, maintaining reduced investment costs and allowing a wide use of those systems in new production areas and sectors, particularly SMEs.
- Promotion of equal opportunities on the shop-floor in terms of gender, age and skills, due to less physically demanding jobs in manufacturing and improved working environment and including accessibility for programming and use.

FoF.NMP.2013-8 Innovative strategies for renovation and repair in manufacturing systems

Technical content/scope: Extending the life and performance of manufacturing equipment as well as designing for re-use/upgrade or ease of renovation (including functional/technological upgrade) and repair requires innovative methodologies which may include Life Cycle Assessment (LCA) and smart devices based on ICT or advanced materials. Design and manufacturing of plants and equipment which integrates renovation, refit and repair strategies (including upgrade for the enhancement or lifetime extension of equipment) as well as increased ability to track equipment use should be simultaneously addressed to optimise the life cycle of production systems.

Research activities should focus on several of the following areas:

- Renovation and repair approaches for manufacturing plants and equipment including the design phase and life-cycle evaluation.
- Use of existing smart devices and systems based on ICT or advanced materials in the renovation and upgrade of existing structures.
- Repair, upgrade, re-manufacturing and re-assembly processes (including replacing modules by less energy-consuming ones) in the in-situ renovation of infrastructures.
- Systems providing (self) monitoring and diagnostic tools to manage plant and equipment usage and addressing maintenance/renovation/repair or substitution needs.
- Mathematical methods and algorithms for failure mode detection and component degradation assessment.
- New engineering methodologies and supporting tools for machinery recovery and re-use approaches for substituted components.

Standardisation, regulation and pre-normative research aspects should be considered. Proof of concept in terms of at least one demonstrator should be delivered before the end of the project, excluding commercially usable prototypes (2006/C323/01), but convincingly demonstrating 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 projects are expected to cover demonstration activities, including pilot implementations in industrial settings, and this will be likewise reflected in the evaluation.

Projects are expected to use appropriate Life Cycle Assessment techniques and to generate knowledge to support European policy development and promote the standardisation (at national or international level).

Funding Scheme: Large-scale integrated collaborative projects.

Expected impact:

- In terms of economic sustainability, reduction of around 20% of renovation and repair costs, through a better condition-based monitoring and condition-based substitution and repair.
- In terms of environmental sustainability, recovery of at least 80% of the substituted materials for its re-use.
- In terms of social sustainability, eventual elimination of hazardous materials and renovation of outdated plants and structures.

FoF.NMP.2013-9 Advanced concepts for technology-based business approaches addressing product-services and their manufacturing in globalised markets

Technical content/scope: In order to remain on the leading edge and to extend their shares in future global markets, European companies need to offer new user-oriented higher value-added solutions, with appropriate global service infrastructures. Moreover, the decreasing lifecycle times of products and the increasing number of variants require the design and operation of assembly plants and production networks that are fully flexible, i.e. capable of switching production from one model to another to meet the fluctuating and diverse demand.

Therefore, advanced holistic concepts for technology-based business approaches are needed, in order to help European global enterprises to dynamically operate at multiple locations around the world in a volatile economic environment, taking into account local resources such as commodities, energy, labour, etc. Such global business approaches should include emerging technologies and innovative manufacturing systems and methods, in order to enable European companies to offer their customers a broader variety of affordable products and an extended range of services.

These innovative concepts should provide a fast and efficient response to market variations and should be easily adaptable to the requirements of other industrial sectors. They should support the transition of a European manufacturing enterprise from a traditional product-based approach to a global-minded approach, in which a complex network of actors (mainly SMEs) is able to provide a customised product-service solution to each final customer in the global market. Such a global approach should define standardised formats and interfaces,

models and procedures for planning and running fast, integrated, flexible and scalable manufacturing related activities for product-services, using a global supply chain.

Research activities should focus on all of the following areas:

- Technological concepts to address economic and risk assessment in order to support decision-making in the early design of the manufacturing systems, in particular for the integration of new complex technologies in the factory.
- Interactive, model-based decision-making processes for business management, able to assess the impact on performance of alternative configurations of the network of actors involved in the global supply chain for product-services and related production systems.
- Methodologies and tools to manage the co-evolution of products-services and the related production systems in the framework of innovative business approaches.

Screening of existing national/international standards (e.g. safety regulations) and of the needs for new standards is required. Other standardisation, regulation and pre-normative research aspects should also be considered.

Projects are expected to use appropriate Life Cycle Assessment techniques and to generate knowledge to support European policy development and promote the standardisation (at national or international level).

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.

This topic is particularly suitable for collaboration at international level, particularly under the IMS scheme.[27] Project partnerships that include independent organisations from at least three IMS regions[28] are therefore encouraged.

Funding scheme: Small or medium-sized collaborative projects

Expected impact:

- Cost savings of around 30% in production due to improved scheduling and to more robust manufacturing methods.
- Higher reactivity to customer needs around 40% as result of real time adaptable business approaches which include proper legislation monitoring.
- Increased robustness of the supply network around 30%.
- Product-services and their manufacturing processes which are more environment-friendly at global scale.

[27] 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

[28] 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.

FoF.NMP.2013-10 Manufacturing processes for products made of composites or engineered metallic materials

Technical content/scope: Products made of composites or engineered metallic materials are becoming more popular in many industrial sectors due to the increased capabilities of design techniques which are able to simulate material properties with a high level of accuracy and, therefore, to optimise the exploitation of their improved properties. Increasingly challenging demands continue arising from market and society in terms of better functional properties, weight reduction, cost decrease, compact design, and minimal carbon foot-print. Composites and engineered metallic materials are now used in many products, either as standalone components or embedded reinforcements in order to locally provide their specific performance in terms of enhanced mechanical properties. An extensive use of such materials leads to significant product improvements that cannot be achieved with the traditional metals or polymers.

However, the processes for manufacturing such products require a better understanding and further optimisation in order to ensure the required quality for the specific applications and a high productivity rate for cost-efficient manufacturing. Production technologies for composites and engineered metallic materials include casting, forming, removal and additive processes related to 3D metals, sandwich materials, multi-materials, new metallic alloys, thermoplastics or composite laminates.

Research activities should focus on several of the following areas:

- Innovative methodologies and technologies for manufacturing which are capable of producing and post-processing new engineered metals and composites taking into account the needs for specific applications.
- Systems and devices to monitor and optimise the process parameters for these new materials to be produced and post-processed at industrial scale.
- New technologies for joining and assembly of multi-materials components (e.g. metal/composite, polymer/composite, and engineered metallic/composite) based on enhanced understanding of the material-interface behaviour at micro/nano scale.
- Characterisation and testing techniques to evaluate the performance (e.g. quality, throughput rate, robustness) of the manufacturing processes for products made of new materials.
- Development of product repair technologies and methodologies to assess the repair feasibility of the manufactured product and to ensure repeatable, safe and certified repair procedures.
- Recycling technologies and routes that guarantee a minimal environmental foot-print of the products made of the new materials at the end of their life.

Screening of existing national/international standards (e.g. safety regulations) and of the needs for new standards is required. Other standardisation, regulation and pre-normative research aspects should also be considered.

Proof of concept in terms of at least one demonstrator should be delivered before the end of the project, excluding commercially usable prototypes (2006/C323/01), but convincingly demonstrating 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 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:

- Higher utilisation of advanced materials in products with improved performance without a cost increase.
- Decrease in raw materials and energy consumption by at least 20% during the processing, manufacturing and/or dismantling phases.
- Reduction of waste and emissions (e.g. fumes, chemicals, dust, hazardous materials) by at least 30% during the processing, manufacturing and/or dismantling phases.

FoF.NMP.2013-11 Manufacturing of highly miniaturised components

Technical content/scope: Product miniaturisation requires a good understanding of the intended application, the scale-related property variation, the manufacturing methods and the material behaviour. Miniaturisation has been an increasing trend in the last 15 years because of the drive for minimisation of energy and materials use in manufacturing processes, the increased need for redundancy, the requirements of faster and more energy-efficient devices, and the enhanced functionalities (such as selectivity and sensitivity).

Micro-fabrication techniques are widely exploited by the semiconductor industry, which has invented many micro- and nano-scale manufacturing methods. These methods could be regarded, in general, as potential techniques for the miniaturisation of components in many other industry sectors. However, they are mostly addressing a particular class of materials and 2D surfaces with specific features, and are highly sophisticated and expensive (high cost of ownership).

Alternative manufacturing technologies are currently needed to overcome the challenges of volume production of miniaturised components or sub-components made of a wide range of materials (e.g. metallic alloys, composites, ceramic and polymers). These techniques should be cost-efficient and flexible in terms of both the shapes of the features and the materials being used. In order to reach this objective in a competitive way, the upgrading of appropriate high-throughput and cost-efficient processes like conventional forming, moulding, imprinting and surface deposition processes, or new integrated process chains, will be needed. New materials pose new challenges for cost-efficient manufacturing in order to shape, handle and assemble complex structures that can involve macro-micro-nano scale features and may require the analysis of the micro-structural behaviour of materials and its interaction with the production process.

Research activities should focus on at least three of the following areas:

– Processing techniques for miniaturised components made of a wide range of materials with different properties (e.g. thermo-responsive, piezoelectric, or phase-change materials), in order to achieve a flexible and high-throughput production.

- Integration of multiple material combinations and smart materials for the sensing and actuation technologies.
- Merging the top-down and bottom-up approach in order to go into parallel and/or continuous manufacturing.
- Novel on-line monitoring and quality inspection systems in manufacturing of highly miniaturised components, in order to ensure efficiency, reliability and high product quality.

Projects are expected to address issues like energy savings, cost and waste reduction, and recycling that should be studied through Life-Cycle Assessment.

Projects should show substantial improvements in the manufacturing of components at the micro and nano-scale in terms of cost/performance balance (e.g. lower costs per integrated function), accuracy and reproducibility by providing the appropriate cost-efficient and reliable manufacturing technology.

Screening of existing national/international standards (e.g. safety regulations) and of the needs for new standards is required. Other standardisation, regulation and pre-normative research aspects should also be considered.

Proof of concept in terms of at least one demonstrator should be delivered before the end of the project, excluding commercially usable prototypes (2006/C323/01), but convincingly demonstrating scalability towards industrial needs.

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:

- Improved high-throughput and/or highly flexible and cost-efficient processes for micro/nano-manufacturing of components for application areas such as tools, electrodes, solar cells, consumer products, and communication and medical devices.
- Scaling up of micro-production processes from lab-scale to an industrial scale for multifunctional applications such as in medicine, energy, transport and electronics.
- Further progress on micro/nano-manufacturing towards intelligent, scalable and adaptable systems, enabling the cost-efficient, competitive and market-demand-targeted production, ranging from small/medium volumes to high throughput and thus facilitating the access to target markets characterised by small or growing volumes.

II.5.2 'Energy-efficient Buildings (EeB)' – Public-Private Partnership – Cross-thematic Coordination between NMP, ICT 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.

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

EeB.NMP.2013-1 Nanotechnology for multifunctional lightweight construction materials and components

Technical content/scope: Nanotechnologies represent a promising opportunity for the energy-efficient transformation of the current building stock and the energy efficiency of new buildings. Although main efforts are given to the reduction of thermal transmittance of the envelope, there are other key functionalities which are becoming more and more relevant in retrofitting and new buildings.

With state-of-the-art products and combinations of materials, the envelope thickness during energy-efficient renovations is increasing and it gets more massive both in terms of architectural design and in terms of actual physical mass. Nanotechnology has the potential to enable multi-functionality in envelope components, fostering the development of systems which can combine functionalities like being light-weight, high thermal capacity in a defined temperature range, fire resistance in particular for steel structures, sound insulation as well as others such as Volatile Organic Compounds (VOCs) abatement, bio-protection, self-cleaning or humidity control, paving the way for industrial prefabricated new-to-build and deep-renovation packages, which can outperform on-site construction on issues as thermal-bridges and air tightness while ensuring high quality for the indoor environment. These new technologies will ultimately diminish the time required for the renovation itself while reducing the energy bill during the entire building service life. They will also address emerging health issues related with materials and ventilation such as allergies or pathologies like the sick building syndrome. On top of increased technical performance, nanotechnology enabled multifunctional light-weight solutions should increase affordability and overall return on investments.

Nanotechnology research should focus on development of new light-weight multifunctional components with high potential for energy savings, in particular for façades or roofing and for better indoor environment quality, while complying with building codes and regulations. Furthermore, potential exists to exploit nanotechnology through the development of nano-electromechanical systems (NEMS) embedded in the components and which could see whole buildings become networked with detectors and sensors to monitor energy efficiency and the

quality of the indoor environment. As a result, new improved multi-functional lightweight high insulation, high reflectivity elements with low heat transfer in relation to thickness and improved mechanical properties are foreseen, providing clear benefits for the occupants in terms of high quality of the indoor environment. The new materials and their combination into components should also consider durability, easy installation, integration and aesthetics, increased indoor comfort, embodied energy, resource-efficiency, economic, health and safety aspects, environmental aspects, disassembly and reuse, etc. For safety related aspects, projects are expected to coordinate and collaborate with other relevant projects of the Nanosafety Cluster[29].

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners will represent 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-scale focused research projects.

Expected impact: Lightweight building components are expected for low-cost, low-energy new buildings or quick low-cost refurbishments, aiming at a factor of 2 to 4 in total (primary) energy reduction with respect to the current situation, and a cost-level equal to or better than traditional (in terms of energy performance improvement) renovation activities[30].

Nanotechnology solutions will contribute to develop new components with key advantages in terms of thermal performance and reduced construction time due to 40% decrease of the dead load of the building components compared to existing solutions. It is expected that the elements will achieve at least the same fire resistance as conventional material consuming solutions while reducing the mass of the components and energy consumption[31].

EeB.NMP.2013-2 Safe, energy-efficient and affordable new eco-innovative materials for building envelopes and/or partitions to provide a healthier indoor environment

Technical content/scope: A healthier indoor environment during the service life of a building is becoming more and more critical because the implementation of energy efficiency measures leads to the construction of more tightly sealed buildings with reduced ventilation rates. Furthermore, increasingly synthetic building materials and furnishings, or natural products formulated with chemicals, biocides etc, are used.

Improved construction techniques, caulking and sealing limit the amount of air which escapes. Consequently pollutants can build up to unhealthy levels inside the buildings.

Several factors affect a healthy indoor environment. Among the most important are: release of dangerous substances, Volatile Organic Compounds (VOCs) such as formaldehyde, wood preservatives, radon, fibres, particulate matters, moisture and humidity, rotting and microbiological/mould growth, etc.

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

[30] Nanotechnology-based lightweight solutions should be demonstrated at industrial component level in relevant environments. The innovative elements should be low-cost (LCCA) and environmental friendly (LCA), with high thermal resistance and high fire resistance in relation to thickness. The 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.

[31] Safety, fire resistance, mechanical and other features should be properly addressed, in line with building codes and regulations.

Building envelopes play an important role in controlling the amount of moisture which enters in the building or leaves it. Noise protection and comfort with regard to temperature and humidity distributions are also important factors that may be valorised to contribute to a healthy indoor environment. Comfort influences health also in the long term.

Research proposals should address the development of new eco-innovative materials for the building envelope and/or internal walls/partitions leading to healthier indoor environment. Issues on indoor environment related to the building content (interior decoration, carpets, paints and lacquers, furniture, electronic equipment, cleaning supplies etc.) or use (e.g. cleaning agents) are *not covered by this topic*. Technological solutions, such as improved ventilation and air filtration, are likewise *not covered by this topic*.

The proposed solutions should go well beyond the state of the art and primarily improve the indoor environment. The cost-effective use of nanotechnologies can contribute to solve humidity, odour and pollutant problems.

The following factors should also be considered : low embodied energy and enhanced durability for increased use duration, reduced maintenance and consequently reduced costs, respect of sustainability principles (the 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); application to both new build and renovation when relevant; ease of installation; offer of realistic solutions at a reasonable price; offer of increased comfort and noise reduction. Recycling/reuse of materials may also be addressed. Standardisation aspects can be considered particularly in relation with the work carried out in CEN/TC 350 and CEN/TC 351. Proof of concept in terms of one (or more) component(s) containing the new eco-innovative materials developed should be delivered within the project, excluding commercially usable prototypes (2006/C323/01), but convincingly proving scalability towards industrial needs. Information guides for applications, installation and training on the new solutions should be provided before the end of the project.

All aspects should be considered within a holistic approach to the problem and effect of the adopted solutions should be quantified.

In order to ensure the industrial relevance and impact of the research effort, the active participation of industrial partners, including SMEs, represents a significant 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, as public authorities own a large part of the building stock at European level.

Funding scheme: Large-scale integrating collaborative projects.

Expected impact: Compared to the applications and impacts of presently available materials with the same functionalities, the expected improvements are: (i) healthier indoor environment; (ii) lower embodied energy on materials (at least 15%); (iii) enhanced durability of materials (at least 20%); (iv) lower implementation costs, either in manufacturing or in application and use of the developed products (minus 20-30%, e.g. by combination of several functionalities in a single material); and (v) improved energy efficiency in buildings.

EeB.NMP.2013-3 Integration of technologies for energy-efficient solutions in the renovation of public buildings

Technical content/scope: Existing public-owned non-residential buildings represent a valuable asset in Europe. Many of them are in need of innovative retrofitting solutions, in particular those grouped in multi-building installations, since their energy efficiency is typically low. Moreover, due to the current economic crisis the investments in building retrofitting are limited. Breakthrough solutions are, therefore, needed which combine affordability along the whole life cycle with reduced energy use and maintenance effort and with increased durability, in innovative business models. These should be in line with current net zero energy standards and should allow upgrading in the future, as new targets in energy use and greenhouse gas emissions reduction emerge. The feasibility to transfer solutions from office buildings to social housing could also be considered. Technical solutions that address barriers such as cost-effectiveness, continued operation during renovation, inefficient and under-used sites, may be also considered.

Systemic approaches need to be developed which integrate the most promising technologies and materials, including for example: energy production and storage through a combination of renewable energy sources and zero-CO2-emission micro-cogeneration at building level; energy use through innovative HVAC systems; solid state lighting; innovative fire-resistant insulation; light-weight components and made-to-measure solutions addressing the challenge of keeping, where necessary, the original aesthetics and architectural features; as well as nanotechnologies and smart materials promoting a building's reactive and adaptive behaviour following the outdoor/indoor conditions.

The district scale, since public buildings being often grouped in dedicated areas, as well as the interactions between buildings and the grid (i.e. impact on the energy demand) and with an eventual heating network should be considered. The integration of safety and security aspects should also be taken into account. The systemic approach should create economy of scale in the investment and improve return on investments. Energy efficiency should be addressed by proper system integration and installation, e.g. through synergy between technologies which have already been proven at a small scale and need a larger scale demonstration.

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. In addition, to ensure appropriateness of business models, the participation of public building owners (local, regional or national governmental organisations) is recommended.

The proposals should cover both research and demonstration activities. 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.

A high replication potential is necessary. At least two demonstration sites should be considered in two different climatic conditions and with different end-uses, in order to ensure that the technologies are as widely applicable as possible. The corresponding district environment should be taken into account when defining the overall approach and should be reflected in the selection of the demonstrators.

Funding scheme: DEMO-targeted collaborative projects.

Expected impact: The innovative retrofitting solutions should be proven in the demonstration buildings as real cases. They should result in a reduction of at least 50% in energy consumption compared to the values before renovation while ensuring affordability. Therefore, associated investment costs are expected to represent a maximum of 20% of the total costs of building an equivalent new building in the same location. The replicability potential should be demonstrated and the return on investment should be around 7 years (in the case of deep retrofitting). Creation of a new generation of skilled workers and SME contractors in the construction sector, conscious of a systemic approach towards energy efficiency.

EeB.NMP.2013-4 Integrated control systems and methodologies to monitor and improve building energy performance

Technical content/scope: The monitoring of real energy use in energy-efficient buildings frequently shows major differences with respect to the predicted performance. Building energy performance simulation (BEPS) models, which have proven to be very useful to compare buildings design alternatives, have difficulties to capture the real complexities of the actual building energy performance. For instance, they do not properly consider deviations due to building fabric performance, malfunction of energy and comfort systems, differences in user behaviour and variations in climate conditions. With today's high energy prices, a monitoring of the building energy consumption, together with a good assessment on the best strategy to reduce it, is crucial in terms of savings and comfort. In addition, effective methodologies for the correct understanding of user behaviour need to be developed in the context of building energy performance.

The research focus is on developing methodologies and tools to monitor and assess real building energy performance, including user behaviour, energy systems performance and climate conditions. The new methods and tools could include energy performance diagnostics for predictive maintenance (related to different construction typologies and their thermal behaviour), and should be accurate enough to support decision making during the different stages in the life of the buildings. The effective monitoring and management of energy flows to help reduce energy consumption should be addressed. There is also a need to help standardising the measurement and characterisation of building energy performance, exploiting the latest advances in predictive analysis and modelling of thermal transfer based on multi-variable techniques and image recognition.

A holistic approach to building control and monitoring systems is required, by implementing dynamic full scale methods which accurately characterise building behaviour. High quality and reliable data acquisition methodologies are also needed. Projects should, whenever possible, address the integration of autonomous wireless sensors and sensor networks for data delivery together with smart equipment, and should also demonstrate a reduction of the typical assessment time.

If it provides added value, projects could use the developed tools and methodologies prior to a deep retrofitting, to analyse in-use building energy performance and to determine the best retrofit opportunities, as well as to calculate the savings from potential building retrofits.

Cost-effective solutions should be demonstrated in at least two different types of buildings preferentially located in regions with clearly different climate conditions and for which user behaviours are expected to differ.

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: Large-scale integrating collaborative projects.

Expected impact: Significant reduction in the difference between real and predicted energy behaviour in a building, after the demonstration of the viability of the new tools and methods for measuring and analysing real building energy performance. Reduction of the typical assessment time.

EeB.NMP.2013-5 Optimised design methodologies for energy-efficient buildings integrated in the neighbourhood energy systems

Technical content/scope: The development of sustainable solutions for energy-efficient buildings properly integrated in their neighbourhood and their corresponding construction processes requires major innovations in the design tools, construction methods and management practices.

Latest advances in modelling and optimisation techniques should enable improvements in buildings design and control in order to facilitate decision-making before the construction stage. To improve the reliability of modelling tools for the construction sector, the main challenge is to ensure their interoperability and connectivity with other information systems used during the building life-cycle. Knowledge in the fields of modelling and computation should be applied to ensure the interoperability between tools from various domains and different scales in order to propose solutions adapted to collaborative multi-disciplinary work. The use of standards (e.g. ISO IFC, City GML) should be promoted, fostering interoperability.

Research activities should be focused on design at the building scale (including components and buildings systems), taking into account the adjacent systems such as district heating/cooling and decentralised thermal energy generation and other interactions with the neighbourhood. Projects should promote and set up an integrated approach in support of innovation, by providing actors with holistic methods and tools to support the optimised design of integrated energy-efficient buildings. The design phases for new buildings will be considered as priority as well as the design phases linked to retrofitting of existing buildings taking into account subsequent operation and maintenance. Knowledge based design can also be used to provide input into management systems. The Building Information Models concept and other advanced virtual approaches may also be used, including dynamic data integration. Projects should also cover validation actions on a technical level, which apply the tools on real construction projects; and on a societal level, i.e. validation with the occupants of the building. For the latter, involvement of organisations within an Integrated Project Delivery Approach, supporting a participatory design approach, could be an asset.

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: Large-scale integrating collaborative projects.

Expected impact: Optimised design of integrated energy-efficient buildings, considering the different physical dimensions in a coupled and comprehensive overall way (energy, comfort, air quality, acoustics etc), enabling actors to take validated and quantified choices as early as possible in the design/construction/operation processes on the basis of quantified performance objectives with compliance with regulation and user-oriented comfort expectations and constraints. Proper management of interactions between different building design domains. Continuity of information flows during the life of a building from design to maintenance.

EeB.NMP.2013-6 Achieving high efficiency by deep retrofitting in the case of commercial buildings

Technical content/scope: Advanced retrofitting of existing commercial buildings, such as shopping malls and multi-functional centres, or of buildings redesigned for retailing use, requires innovative approaches in order to meet targets for reduced energy use and greenhouse gas emissions. New systemic retrofitting methodologies should be developed for buildings that have redesigned functions (e.g. an industrial warehouse being changed into a shopping or leisure centre). Such methodologies could integrate smart energy management systems and local energy generation/storage solutions that fully exploit renewable energy sources. Equipment adapted to be operated in such redesigned buildings is also needed, including for instance photovoltaic panels, panel heating and cooling, heat pumps, smart grids, flexible energy storage systems (compact and seasonal solutions) as well as smart lighting systems combining natural and artificial light. Cost effective solutions integrating emerging technologies are needed, to achieve innovative industrialised solutions and products, adaptable to the final conditions of the building (size, complex shapes, finishing, etc) and with lower implementation time and shorter interruption of the activity of the building. Solutions that enable intensification of commercial buildings operation by solving systemic inefficiencies (e.g. unutilised roofs, inaccessible site areas) may also be considered.

The redesigned indoor environments should optimise comfort and health conditions and, therefore, integrate new functionalities and solutions, such as: self-cleaning and de-polluting materials and coatings; insulating materials with integrated air ducts for central heat recovery systems; innovative acoustic solutions; cool roofs and pavements; and smart integration of vegetation in order to avoid the heat island effect.

Health, safety and security issues as well as architectural aspects and aesthetics should also be considered. Return on investment calculations based on reliable methodologies and benchmarks are needed, within a holistic perspective including the base investment, maintenance costs and energy savings. The replication potential of the systemic approach proposed should be reflected in guidelines applicable for different buildings typologies throughout Europe.

The research activities should focus on the systemic solutions for retrofitting existing commercial buildings or those redesigned for retailing use, as well as the required adaptation of equipment and material. The deliverables can, for instance, include configuration design tools, intelligent E-catalogues, logistics scenarios, templates and guidelines. Clear evidence of technical and economic viability should be provided by demonstrating the developed solutions in a real retrofitting project.

Synergies within the energy policy framework should be promoted.

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

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: Large-scale integrating collaborative projects.

Expected impact: Significant improvement in primary energy demand is expected, reducing it from over 300 kWh/m² to less than 80 kWh/m² per year as an average. Subsequent reduction of greenhouse gas emissions, considering that in Europe 80% of the 2030 building stock already exists today. Increased share of renewable energy sources at least by 50% compared to the state of the art. The return on investment should be below 7 years. Creation of a new generation of skilled workers and SME contractors in the construction sector, conscious of a systemic approach towards energy efficiency.

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

Cross-thematic cooperation between NMP, ICT, Energy 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)[32].

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-

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

methane), intelligent control systems, 'mild' hybridisation (use of recuperated electricity to power the auxiliary systems) and special tyres for low rolling resistance.

- **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 2013 work programme includes three groups of topics:

- Materials for batteries, implemented through the NMP Theme.

- Development of electric vehicles for road transport and on-road charging, research for heavy duty vehicles for medium and long distance road transport, and logistics and co-modality, implemented through the Sustainable Surface Transport (SST) sub-theme of the Transport Theme.

- Architectures for electronics in the car; and comprehensive energy management systems for its infrastructure integration, implemented through the ICT Theme.

II.5.3.1 'Green Cars (GC)' Topics implemented by the NMP Theme

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 kilometres 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 the development of innovative materials for batteries.

GC.NMP.2013-1 Improved materials for innovative ageing resistant batteries

Technical content/scope: Electric cars in the form of Battery Electric Vehicles (BEV) or Hybrid Electric Vehicles (HEV) are a key technology for reaching a cleaner and more sustainable society and its development is considered in actual Commission Policies, in particular in the PPP on Green Cars. However, a lot of challenges still have to be faced before being able to introduce electric vehicles that could perform as well as combustion engine powered vehicles, and a main issue is related to battery technology. A main challenge in this respect is to produce batteries that may provide e.g. sufficient power density, energy density and rechargeability while having a low weight and that may be quickly charged or re-charged, yet maintaining the safety that is necessary for the use in electrical vehicles. Furthermore battery production and usage should be sustainable, thereby considering a complete Life Cycle Assessment of the used solution. And finally the production and running cost and battery lifetime are other key factors. A way forward to reach this goal is looking towards new and improved battery materials. In the last years the research on battery materials technology was boosted worldwide, and huge investments were made in the development of new battery materials, going beyond the nickel based and improving the current lithium-ion technology. In order to maintain competitiveness, battery and battery cell and system production technology should be improved in Europe. The Commission reflected this in three consecutive calls related to the PPP on Green Cars, and started activities with the work programme of 2010 fostering the improvement of currently available lithium batteries, passing to its production techniques (WP 2011), and looking towards the next generation of post lithium-ion-technology (WP 2012). Some progress could be made in the last years with respect to energy density and power density, but a main problem that has not been considered thoroughly is the charging modality during practical use. Batteries may be charged slowly, overnight, or quickly in 30 minutes. New electrical grid technologies foresee also bi-directional charging/discharging as well as continuous charging. The depth of discharge (DOD) level thus may vary significantly at every single discharging cycle. Due to this usage, charging behaviour and materials lifetime are strongly affected. In practice the effects lead to a shorter battery lifetime, as after certain charging cycles only a much reduced charging capacity and respective battery power and performance remains. However, the full life-time performance of novel electrical vehicle battery cells and systems, including those based on the current Li-Ion technology, has not thoroughly been studied so far.

Research proposals should focus on the investigation of ageing mechanisms in battery materials, including the current lithium-ion technology, in order to understand the basic physical and chemical phenomena and processes that lead to the deterioration of battery performance (at cell and system level) over time. The active materials should be considered to be already suited for automotive EV/HEV applications.

Improvements in cell chemistry (liquid or solid electrolytes, separators, additives, non electrochemically active materials, surface treatments, innovative architectures in electrode micro or nanostructure) and system (SOC strategy, thermal management) should be developed to improve the minimum residual charging capacity after a suitable amount of charging cycles. Today a life time of 10-15 years and recharging number of 1200 cycles at 80% DOD is envisaged; ideally 3000-5000 charging cycles after 10-15 years of use should be reached (new promising high energy density battery materials actually permit only about 10 charging cycles, depending on the battery technology). The performance of the newly developed aging resistant cells and systems should at least equal the energy density and power density that are reachable with existing materials, taking into account the variety of user profiles and its translation in current regimes, average DOD, external temperature variation and the like. The development of new chemistries and technologies to overcome the aging mechanism should take into account the various types of charging that occur during the lifetime of the battery, overnight charging, fast charging, recharging, grid charging and grid de-charging, charging in different climatic conditions (-20 to +50°C, for instance). In particular the effects of fast charging/discharging and deep discharging that are related to huge temperature gradients should be considered, also with respect to safety issues. The performance, lifetime and reliability of the advanced cells and battery systems should be assessed and tested under typical operational and extreme conditions with respect to durability and intrinsic safety, as well as environmental health and safety and external mechanical, electrical and climatic stress, e.g. safety after short circuit, fire and car accident/crash. Proof of concept in terms of product and/or process should be delivered within the project, excluding commercially usable prototypes (2006/C323/01), but convincingly proving scalability towards industrial needs, while maintaining the safety and the stability of the technology. Test methods and simulation tools that enable a thorough modelling and understanding of the aging and degradation processes at both cell and system levels are of great importance. Dedicated modelling can be developed to allow predicting the lifetime, reliability and residual value of the new electric vehicle battery and the results should be backed up with strong evidence provided by "post-mortem" analysis. A related testing procedure applicable at European level should be developed.

In addition to the above, the following issues have to be taken into account:

- Considering the intensive research efforts occurring in the field so far, and the dynamics of development of new knowledge, it should be thoroughly demonstrated that new developed materials and technologies permit a considerable increase with respect to the state-of-the-art. This should by underpinned by an extensive study and presentation of the existing knowledge at the date of proposals submission;
- The new technologies should permit a sustainable maintenance of the battery at cell and/or system level;
- Standardization and regulatory issues should be addressed;
- The effect of battery materials and cell production processes on the environment should be minimised,
- An appropriate Life-Cycle Analysis of the advanced materials and the respective components and systems, including dismantling and recycling technologies should be carried out;

- The life-cycle cost of the materials and assemblies as well of the production technologies should be considered by carrying out an economic analysis, including material resources availability. A thorough cost analysis should demonstrate the real advantages of the new materials, cells and systems;
- IPR issues and the use of background and foreground should be intensively discussed and the arrangements in the consortium should allow suitable access of the knowledge to all participants of the consortium, while safeguarding industrial competiveness through adequate measures (i.e. through patents, licenses or other agreements)

Funding Scheme: Large-scale integrating collaborative projects.

Expected impact: (i) Understanding and verification of ageing and degradation processes in electrical vehicle batteries; and (ii) Considerable improvement of the battery lifetime while maintaining optimal battery performance: it should be demonstrated that the new materials used in the cells and systems would allow recharging, at system level, of a minimum of 4000 cycles at 80% DOD in typical BEV conditions over 10 to 15 years, while maintaining energy densities of at least 250 Wh/kg over the lifetime and permitting a considerable reduction of the battery "memory effect"; 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) Improvement of European battery production capacities; and/or (v) Options for the use of environmentally friendly and sustainable materials.