Scoping Paper for

Horizon 2020 work programme 2018-2020

Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing (NMBP)

Important Notice: Working Document

This scoping paper will guide the preparation of the work programme itself. It is a working document not formally endorsed by the Commission, and its content does not in any way prejudge the final decision of the Commission on the work programme.

The adoption and the publication of the work programme by the Commission are expected in October 2017. Only the adopted work programme will have legal value.

Scoping paper for the Horizon 2020 Work Programme 2018-2020
Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing (NMBP)

1. Context

More than 20% of European GDP is derived from businesses selling materials, components, technologies and processes to each other. Products and services based on Key Enabling Technologies (KETs)[1] represented about 950 billion EUR or 19% of the total EU-28 production in 2013, and this is increasing. This is associated with an absolute employment of 3.3 million jobs in 2013 or 11% of all jobs depending on manufacturing.[2]

The overall approach is to serve open innovation in industry to achieve global industrial leadership. Europe needs a modernised industrial base supported by cutting-edge key enabling technologies, and it needs more companies that use these to produce breakthrough innovations in products and processes, which are radical, capable of rapid scale-up and ready for expansion in new and global markets. The role of the NMBP part is to help develop these cutting-edge technologies, stimulate new value chains and shorten the time for technology transfer, help create new business; and at the same time provide solutions to societal challenges. Open innovation will be strengthened by a step-change in societal engagement, to demonstrate the benefits of the technologies, and consider the human factor and societal needs.

The activities of this part for 2018-2020 will drive what is often referred to as the Fourth Industrial Revolution, combining digital and physical advances for innovative new products and services. The digital transformation of industry will serve to increase productivity, creativity and flexibility, reduce the reliance on energy and raw materials, minimise waste and make the most of emerging value chains. Equally, advances in KETs will improve the quality and efficiency of manufacturing and processing.[3]

NMBP will make an indispensable contribution to a further political priority, Energy and Climate Action and continue to deliver innovation for health, resource efficiency and the Circular Economy.[4] A dedicated set of activities will underpin EURICS, the 'Energy Union Research, Innovation and Competitiveness Strategy'.[5] It will also encompass substantially reinforced activities to mitigate climate change, in line with the COP21 Paris Agreement objectives.

Open science: Advanced and disruptive technologies capitalise on massive amounts of new and existing scientific data. Open data increase the innovation potential, leading to the creation of new markets where SMEs have optimal prospects.

Open to the world: Europe is a global leader in key enabling technologies, as well as in their applications to factories of the future and sustainability. This should translate into a leading voice in global debates. The international engagement in risk assessment and regulatory research will be reinforced, and a new activity on nano(bio)informatics will be explored. New

[1] micro- and nanoelectronics, photonics, nanotechnology, biotechnology, advanced materials and advanced manufacturing and processing

[2] Figures from KETs Observatory, December 2015; report available at https://ec.europa.eu/growth/tools-databases/kets-tools/sites/default/files/library/kets_observatory_second_report.pdf

[3] This part is a contribution to a new boost for jobs, growth and investment; and a connected digital single market.

[4] This part is a contribution to a resilient Energy Union with a forward-looking climate change policy.

[5] http://ec.europa.eu/smart-regulation/roadmaps/docs/2016_rtd_001_energy_union_research_strategy_en.pdf

opportunities for international cooperation, as well as emerging markets, will be explored in the areas of health, energy, climate action and the circular economy, in close cooperation with other parts of Horizon 2020.

In these activities, effective links of the technologies to the societal challenges in Horizon 2020 is a must, in exploiting fully value chains using EU-developed technologies. At the same time, it is imperative that the activities in the societal challenges address these value chains explicitly, to complete the "technology-push and demand-pull" mechanism.

The NMBP strategy for 2018-2020 is being developed on the basis of the input from the NMBP Advisory Group (report of 1 June 2016); a targeted stakeholder consultation (closed on 11 May 2016 with 65 responses); the ongoing interim evaluation of the NMBP part; lessons from the earlier Work Programmes and current projects; and the technological roadmaps of the contractual PPPs (Factories of the Future, SPIRE and Energy-efficient Buildings) as well as those of ESTHER, EMERIT, NanoFutures and EuMaT.

Priorities and integration: the consultations identified a basic need for technology push and demand pull; the timing of the technologies developed should fit the timing of the policy priorities, in order to find quick applications. The emphasis will be in using R&D results to demonstrate new breakthrough technologies, from intermediate to high Technology Readiness Levels (TRLs), up to TRL 7. In the spirit of open innovation, a downstream part of the value chains, the technology users, will be integrated at the project stage; and a pilot activity for staged innovation will be considered. There is a continuing need to engage sources of investment beyond Horizon 2020.

Output and impact within 5-7 years: projects that reach Technology Readiness Level (TRL) of 6, that is, demonstration in an industrially relevant context, can in general reach the markets within 5 years[6] – these outcomes will be linked to the goals outlined above. The evaluation of impact will be developed further. Business-related aspects are important, including investment readiness and the regulatory environment (through innovation deals), especially in the realm of 'digitally-enabled' innovation.

Gaps and potential game changers to be taken into account: The 4th Industrial Revolution represents a key opportunity for EU industry, which has yet to be fully exploited. Opportunities include the confluence of digitisation and key enabling technologies,[7] such as additive manufacturing or connected medical technologies.

The other game changer that NMBP will exploit is the ever-closer integration of researchers and industry with other stakeholders (along entire value chains). In the innovation models pursued so far, researchers and industry interact with public support, but open innovation makes this eco-system more effective by extending it to users and society and to the financial sector.

Research Technology Organisations (RTOs) are important agents in innovation activities. Enhanced access to technology platforms for piloting projects is crucial for SMEs. More coordination is needed between the EU, national and regional R&D activities, in order to maximise the impact of these huge investments. There will be emphasis on innovation hubs, which industrial stakeholders, and especially SMEs, need to test innovations based on key enabling technologies before investing. Crucially, such innovation hubs should be extended into European MS and regions where access to RTOs and industrial innovation are poor.

[6] NB: except for medical products some device where the clinical and regulatory evaluation takes longer

[7] See, e.g., the conclusions of the World Economic Forum 2016:
https://www.weforum.org/agenda/2016/01/will-europe-lead-the-fourth-industrial-revolution/

2. Strategic orientations for 2018-2020 and translation into calls

The priorities of NMBP for 2018-2020 will address the two main policy goals outlined in the policy context: the fourth industrial revolution; and energy, climate action and the circular economy.

The overall approach requires new business models, which can fulfil the requirements of sustainability, globalised value chains, changing markets, and emerging and future industries. This requires new strategies involving accelerated approaches, to allow innovative ideas to enter the markets, with emphasis on the upscaling of prototypes as well as new supply chains.

2.1 Bringing the digital to the physical world – industrial solution revolution

(1) Nanotechnologies, Advanced Materials and Biotechnology for high added-value products and industrial value chains

This part will develop nanotechnologies, advanced materials and biotechnology, including inventive combinations of these technologies with appropriate business models, to deliver innovative products to markets and customers.

Smart materials, surfaces, structures and devices – and the technologies needed to make them – are key to the 4th industrial revolution. These are expected to have applications in most industrial sectors, such as healthcare, manufacturing, energy, transport, clean tech, infrastructure, consumer goods and security.

Activities in the biotechnology sphere will include the bioconversion of renewable resources and the production of novel, more sustainable materials, chemicals and biomolecules. It will also support optimising processes, reducing waste and reusing both waste and CO_2.

(1a) Technical upscaling and Pilot lines will build on existing research results and facilities available at centres of competence by enabling appropriate investments and product development, for market entry within 5 to 7 years. They will build up industrial value chains and strengthen networks among stakeholders for further R&D+I activities; and they will reduce technical and production development risk by increasing the knowledge intensity, especially of smaller companies and entrepreneurs. Activities will include cross-cutting issues: faster technology transfer, characterisation, reference materials and the identification of needs with regard to standardisation and the regulatory framework[8] required for the market introduction of new products. The mechanism of cascading grants will be considered for this area, as a way of enhancing openness and creating innovation hubs offering better access for SMEs to technology services.

(2) Governance - New ways of engaging with society

An effective and informed dialogue with all stakeholders and broader society is an essential element of safe, responsible and effective governance of nanotechnology, advanced materials and biotechnology and their applications. The aim is to enhance public confidence, societal engagement and encourage the uptake of new technologies (especially by SMEs) in an open innovation eco-system.

This governance will deal with long term, global issues: integrating knowledge and technology for human potential (more creative, productive and inclusive, better learning, active ageing); life security (sustainability, health, safety); and assessing technological and business risks. There is a need to communicate risks and benefits effectively. Social Sciences and Humanities (SSH) and foresight will make crucial contributions to this area.

[8] E.g. Free Flow of Data, liability questions, access and ownership of data

The approach to open innovation for industry will be complemented by a large *inducement prize* (10-15M€) in a challenge to be developed.

(2a) Science-based risk assessment and regulatory aspects

New technologies potentially offer significant benefits and at the same time raise concerns about potential risks. In the case of nanomaterials, the fast evolution of the market is not matched by equal progress in the regulatory framework, resulting in the lack of regulatory clarity. This hampers the uptake and exploitation of products and materials involving nanotechnologies and may become a major barrier to innovation. Nanotechnology products have to be developed safely and sustainably, both for public protection and for innovation to meet societal needs. This is expected to be an important market enabler for the European manufacturing industry. Besides accurate quantification of any risk in regulatory terms, advances in this area may also deliver safety-by-design protocols and methods that would bring management of this risk to equal levels as for other known risks.[9]

(2b) Computational modelling for the development of key enabling technologies: With the recent growth in available computational power, predictive multi-scale modelling has the potential to become an integral part of value chains providing economic advantages for all manufacturing industries, by enabling new solutions and supporting technology transfer. This is one of the key application areas of High Performance Computing (HPC) and closely linked with the Digital Single Market (DSM) strategy as a driver for growth. Activities will focus on meeting the modelling needs of industrial end-users, accompanied by relevant translator services, metrology, instrumentation, standardisation as well as support tools for business decision.

(3) The Factories of the Future (FoF) initiative will help EU manufacturing enterprises, including SMEs, to adapt to global competitive pressures by deploying the necessary digital and key enabling technologies to support a broad range of sectors, while taking full advantage of the Fourth Industrial Revolution. It will help European industry to meet the increasing global consumer demand for greener, more customised and higher quality products through the transition to a digitally enabled, demand-driven industry with less waste and a better use of resources. The priorities will be the digitisation of industry including SMEs; additive manufacturing; human-centred manufacturing, such as better human-machine interfaces and attractive work environments; interconnection of systems for lifecycle management; customer-focused added-value manufacturing through the linking of products and processes to innovative services.

(4) Medical technologies for healthcare (ESTHER) will offer promising opportunities for economic growth, arising from the convergence of activities related to industrial medical technologies. These comprise *inter alia* nanotechnology, biotechnology and genomics, biomaterials, micro/nano and printed electronics, communication technologies, modelling and scaled-up advanced manufacturing. To harness this potential, combined research and innovation efforts will be required between these various disciplines, along with all aspects of the healthcare industry, regulators and patient representative groups. Innovative and complex, but cost effective healthcare products for diagnosis and treatment will become available to patients. Capturing these opportunities needs a combination of substantial public and private commitments at all levels.

2.2 Post-COP21 action, Energy and the Circular Economy

(5) The Sustainable Process Industries (SPIRE) initiative, addressing eight key European industrial sectors, will enable a more efficient use of resources (raw materials, water etc.) and energy (including renewables); high-tech and eco-efficient production facilities and

[9] this work contributes also to better regulation for innovation

materials; and minimising and re-using waste, including CO_2. Through industrial symbiosis between the eight industrial sectors but also throughout their value chains, SPIRE is looking at integrating, demonstrating and validating systems, technologies and business models that will build up a true European industrial renaissance and will contribute to addressing societal challenges linked to climate action, energy, the circular economy and smart cities. The priorities for the period 2018-2020 will be in adaptable processes able to use different feedstocks and alternative energy sources; innovative processes leading to CO_2 reduction and valorisation as new feedstock, in particular for energy-intensive industries; new methods including digitisation and modelling for process optimisation; and new approaches to water as feedstock and energy source.

(6) The Energy-efficient Buildings (EeB) initiative will turn energy efficiency into a sustainable business, fostering EU competitiveness in the construction sector on a global level. The construction sector has a crucial impact on climate and energy, as buildings account for 40% of the total energy consumption and are responsible for 36% of greenhouse gas emissions in Europe – while the replacement rate of the existing stock is very small (1-2% per year), and the renovation rate is still insufficient (1% per year). The construction value chain represents about 8.2%[10] of the EU-28 GDP, provides 23 million jobs of which 11.5 million direct jobs in the non-financial business and consists mostly of SMEs (95%). It is on a path to decarbonise the European economy by 2050 in line with the Energy Union strategy, which entails reductions in CO_2 emissions by 90% and in energy consumption by as much as 50%. This is a unique opportunity for sustainable business growth, based on affordable, high-quality products and services, including digitisation, for both new and refurbished buildings, meeting current and future regulation.

The strong participation of public authorities is a must and will be promoted, as they own and regulate a large part of the building stock at European level.

(7) EMERIT (Energy Materials for Europe – Research & Industry innovating Together) will focus on providing advanced materials and nanotechnologies to help implement the European energy policy. EMERIT will accelerate the development and uptake of advanced materials solutions in low-carbon energy applications along the entire value chain, from the development and fabrication of advanced materials in Europe to their market adoption in energy applications. EMERIT aims to reduce costs and improve performance of promising low-carbon energy technologies. The approach takes into account consumers and market factors, successful diversification of energy sources, increasing the share of energy production from renewables, decentralising energy production, development of flexible energy storage and decarbonisation of fossil energy sources.

A particular contribution will be to *Electric Green Vehicles*, and the capture and storage of energy. Next-generation electric vehicles will be based on new overall designs, new lightweight materials and in particular on new and improved means of sustainable energy storage. These play an important role also in stationary applications and the full integration of storage devices into the energy system (with associated benefits for grid stability and flexibility). The EURICS strategy covers these aspects, strongly based on the new integrated SET plan (and its actions 1, 2 and 7) and the Strategic transport research initiative STRIA. There is a strong emphasis on electrochemical storage, whilst all other options are considered (chemical, electrical, mechanical and thermal), as well as advanced upscaling and manufacturing techniques.

[10] *The European construction value chain: performance, challenges and role in global value chain*, 2016.

Industrial Solution Revolution, including	Activities (1), (2), (3) and (4) (including FoF cPPP)	[11]
Focus area 'Digitising and transforming European industry and services'	*By bridging the digital and the physical worlds, this focus area will address at the same time the digitisation of industry and open innovation.*	Contributions from LEIT-ICT, Space, SCs 1, 2, 4, 6
Focus area 'Building a low-carbon, climate resilient future'	Activities (6) and (7) and parts of activity (5), linked to low-carbon energy, electric green vehicles and energy efficiency (including EeB and SPIRE cPPPs)	Contributions from LEIT-ICT, Space, SCs 1-5
Focus Area 'Connecting economic and environmental gains – the Circular Economy'	Parts of activity (5) (SPIRE cPPP)	Contributions from LEIT-ICT, SCs 2, 3, 5

[11] This table does not reflect the arrangement of the various activities into calls.