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COVER NOTE

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date of receipt:	29 May 2017
To:	Mr Jeppe TRANHOLM-MIKKELSEN, Secretary-General of the Council of the European Union
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Subject:	COMMISSION STAFF WORKING DOCUMENT INTERIM EVALUATION of HORIZON 2020 ANNEX 2

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COMMISSION STAFF WORKING DOCUMENT

INTERIM EVALUATION of HORIZON 2020

ANNEX 2

{SWD(2017) 220 final}
{SWD(2017) 222 final}

E.6. COHERENCE

E.6.1. Internal coherence

E.6.1.1. Internal coherence of the actions implemented for LEIT ICT

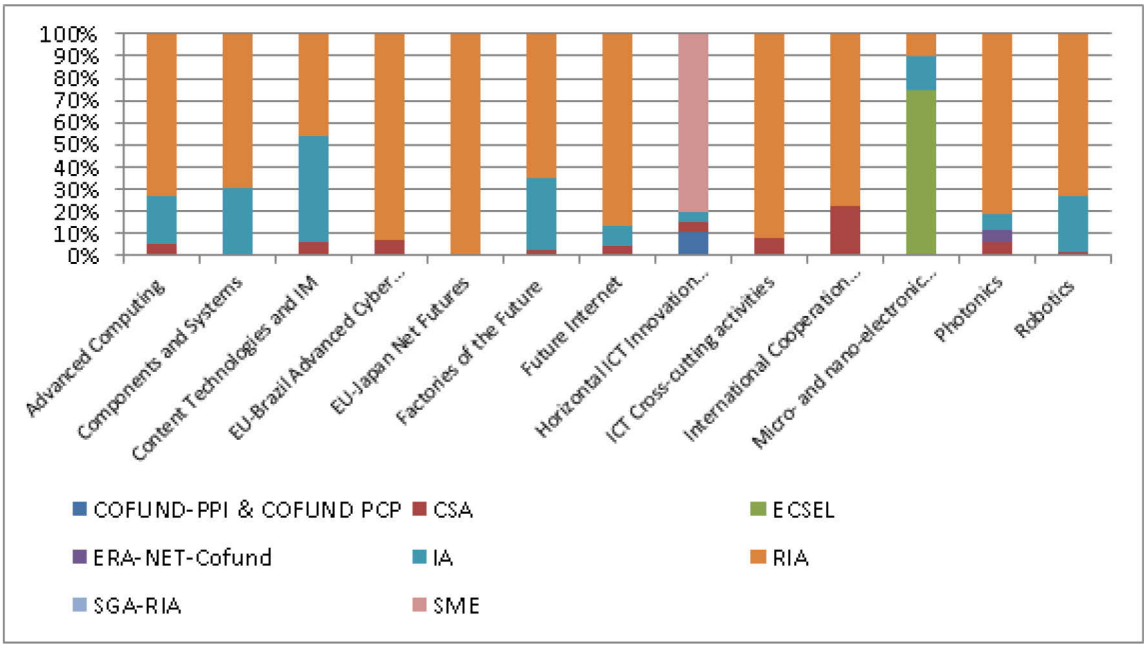
The R&I objectives of LEIT ICT are implemented mainly through RIAs (358 projects, 55% of funding) and IAs (176 projects, 34% of funding). The CSAs are 72, accounting for 3.3% of funding; 1 ERANET and 3 COFUND activities are also implemented. Projects within the Open Disruptive Innovation, implemented through the SME Instrument are very high in number (326 for Phase I; 104 for Phase II) but account for 1% and 6% of budget respectively. Pre-commercial procurement (PCP) and public procurement of innovative solutions (PPI) resulted in a low response rate and thus the use of this instrument – despite foreseen – has been limited. Examples of other instruments are: in the area of photonics an innovation incubator which provides SMEs with one-stop-shop access to photonics expertise and services for the design and prototyping of photonic or photonic-enhanced products; the use of cascading grants in the Future Internet cPPP.

Figure 95 provides an overview by line of activity of the types of actions.[1] The instruments provide a balanced and complementary approach to address the objectives:

- RIAs target disruptive research and development of leading edge technologies;
- IAs range from activities bringing together competence centres and technology supplying companies (large enterprises or SMEs) with technology using SMEs and midcaps; targeting access to technologies (design, prototyping and manufacturing), supporting demonstration activities and pilot lines, validation and testing, favouring technology transfer, industry-academia cross-fertilisation and use cases, closer-to-market research
- CSAs provide strategy support (e.g. roadmaps) and outreach (e.g. community building), but also support for the development of regional innovation strategies, promotion of skills development and take-up of technologies.
- The SME instrument (ODI) provides an additional and alternative opportunity specifically for SMEs to get funding. It offers a less complex application process, presents an option for single-company proposals and funds smaller initiatives.
- Pre-commercial procurement (PCP) and public procurement of innovative solutions (PPI) address the lack of public demand driven innovation in Europe and aim at speeding up the modernisation of the public sector.

[1] *The chart refers to data up to March 2016.*

Figure 95 - Types of actions in LEIT ICT projects, by line of activity



Source: CARSA study.

In the area of Micro-and nano-electronics (for the components and systems and micro-nano electronics area), the portfolio of research activities and agendas is coordinated with the work of ECSEL: the JU addresses mainly high TRLs (6-8) technologies with shorter term impact (2-4 years), in particular pilot lines, LEIT ICT (with more limited funding) addresses low TRLs (2-4) technologies with mid-term market impact (4-6 years). The expert panel however noted that while the investment in ECSEL to address industrial challenges is well justified, the diminishing funds in Horizon 2020 for lower TRLs raise concerns. In the area of new generation of components and systems, attention is needed to secure a steady supply of co-designed IoT components and systems and reverse an apparent trend of diminishing funding at TRLs 2-4[2]. Concerning Future Internet and 5G cPPP, they also concluded that support should also come from pre-commercial procurement and e-Infrastructures programmes.

The **SME Instrument** is coherent to the policy mix in providing a specific tailored instrument for attracting many new SMEs. Compared to other instruments the SME Instrument offers a less complex and less exhaustive application process, presents an option for single-company proposals and funds smaller initiatives. According to the expert panel however, coherence is lacking in the adequate distribution of funds between the SME Instruments and other tools, and especially in the support of excellent proposals which could not get funding through other Horizon 2020 instruments.

The experts noted that for the cPPPs to ensure translation of research outputs into industrial application a key component is **innovation across full value chains** and noted that there are no cross-cutting projects between cPPPs, e.g. Big Data and HPC.

[2] *Europe needs to invest in retaining and developing its component and systems ecosystem (from academic outputs to research and technology organisations, enterprise and manufacturing) if it is to exploit the IoT through hardware/software co-development. Support for full European value/supply chains in addition to leadership at the chip level (photonics and microelectronic) is needed to develop new sectors and businesses from advanced integrated systems.*

E.6.1.2. Internal coherence with other Horizon 2020 intervention areas

A key differentiating aspect of Horizon 2020 from previous FPs is its overall approach covering the entire range from basic research to marketable innovations. For the ICT Activities within Horizon 2020 this is achieved by combining the following elements:

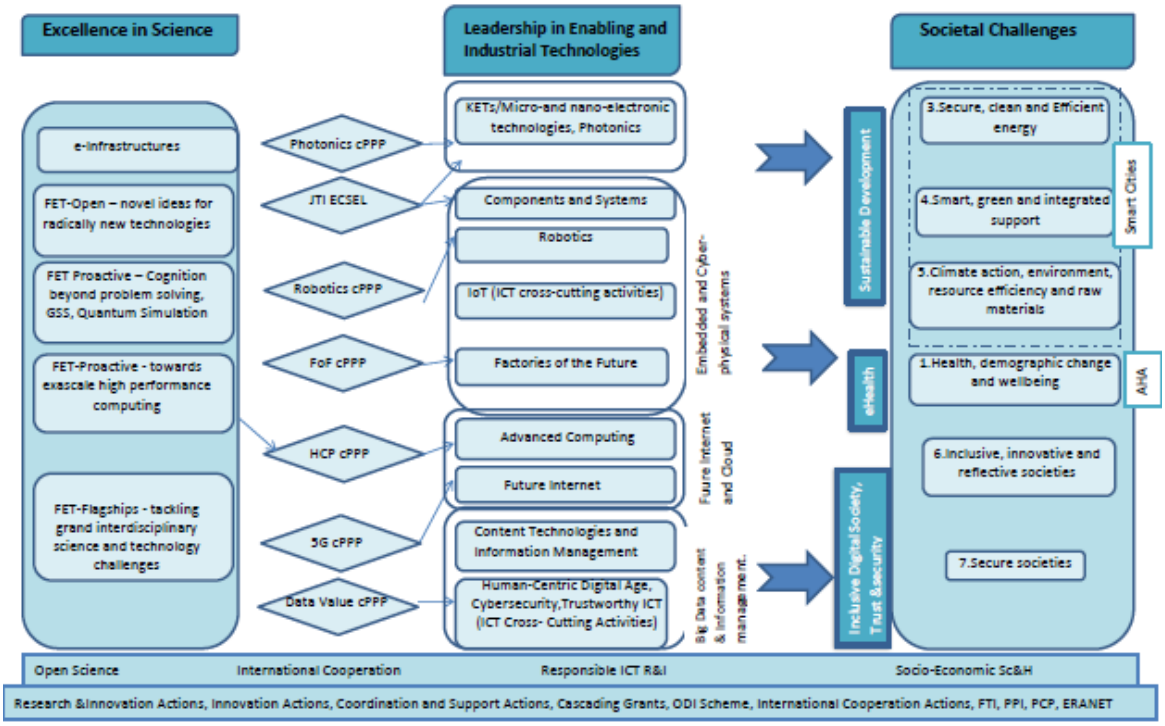
- A strong focus on the Excellent Science Priority, building on the launch of FET in FP6 and its equally successful continuation in FP7;
- A clear aim to support ICT-based competitive technologies in LEIT and to enhance growth of innovative SMEs in the ICT sector or those investing in ICT solutions, through the ODI scheme. The agenda-driven research activities and the critical mass expected to be created by the ICT cPPP initiatives are essential means to reach these objectives;
- The introduction of a new challenge-based approach to R&I, with the objective to develop ICT solutions that address concrete societal challenges related to EU priorities.

By covering the full range from basic research to technology transfer and commercialisation and through the attention paid to synergies mentioned above, Horizon 2020 ICT Activities can be considered to form part of a “holistic” approach within the framework of Horizon 2020. Complementarity and consistency of LEIT ICT with the specific pillars "Excellence Science" and "Societal Challenges" are shown in Figure 96.

Concerning coherence with other areas of Horizon 2020, it can be noted that:

- Photonics is a technology enabler in other Horizon 2020 areas;
- Robotics has also been included in three other sections of Horizon 2020: Factories of the Future (an ICT-NMBP collaboration), Agriculture (smart farming robots) and IoT Pilots (Driverless cars);
- The IOT large-scale pilots of IOT-01 form part of the cross-cutting activities under Horizon 2020 and are co-funded by SC 1 and SC 2. The implementation of the projects is being coordinated with other DGs such as DG MOVE, DG RTD and DG AGRI;
- Factories of the Future is a cPPP within LEIT NMBP;
- Cybersecurity: technological building blocks are addressed under LEIT-ICT, while SC7 focuses on specific use cases related to cyber-security and privacy;
- The HPC cPPP is implemented across FET, eInfrastructures and LEIT-ICT.

Figure 96 - Structure of LEIT ICT Activities and linkages with Excellence Science and Societal Challenges



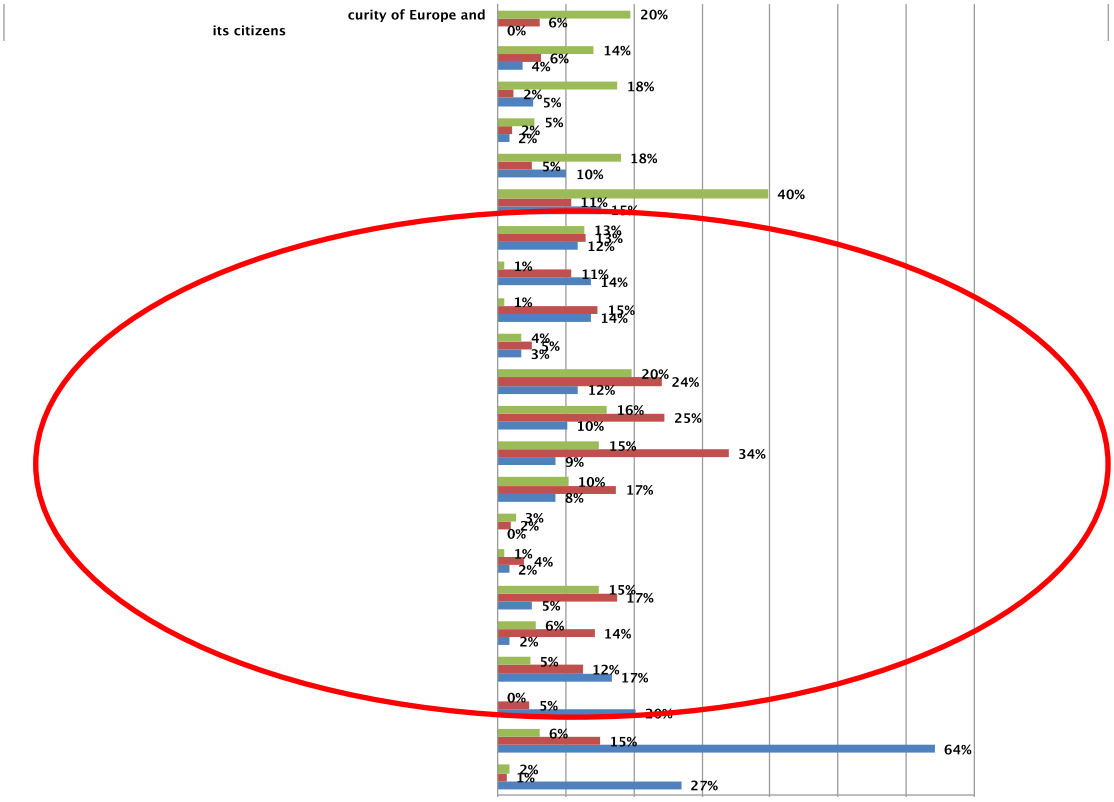
Source: EC services.

The content analysis of the project abstracts suggests that LEIT ICT projects may provide results that can be very relevant to projects in a number of topics under **Societal Challenges**. A practical application of this finding would be in guiding future clustering and information sharing activities of projects across different priority Areas.

An important indication of internal coherence is to be found in survey results, where organisations already involved in a project in a given priority are also interested in most topics of other priority areas that may correspond to different approaches to R&I. In this respect, there seems to be coherence between LEIT ICT's various components, between LEIT ICT and FET in areas such as Advanced Computing, Robotics, Photonics and Micro-and-nano-electronics and between LEIT ICT and Societal Challenges for technologies such as Robotics, ICT-Cross cutting activities and Content Technologies and Information Management. The specific areas of the Programme for which such combined approaches are more likely to occur are presented in Table 57, where are also shown observations from the abstract analysis (Keyword Analysis)[3]. The abstract analysis mainly confirms and complements the links that may exist for topics across the priority areas, in particular the links among the topics of LEIT ICT and for the ICT topics within the Societal Challenges.

[3] *The two research methods provide different, but complementary pieces of the links that may exist between a topic X of a current project and another topic Y. The survey gives a measure of the likelihood that the next project of a participant in project X could well be in topic Y that is also relevant for this participant. The abstract analysis informs that the results of a project in topic X can be very relevant for a project in topic Y.*

Figure 97 - Relevant topics for coordinators (up to 3 topics per respondent), shares (%) of coordinators within each priority area



Source: CARSA study.
Note: The survey concerned coordinators and participants of FET (Open and Proactive), LEIT ICT and ICT topics and ICT topics and projects of Societal Challenges 1, 3, 4, 5, 6 and 7.

Table 57 - Links of topics across priorities corresponding to combined interests of project participants

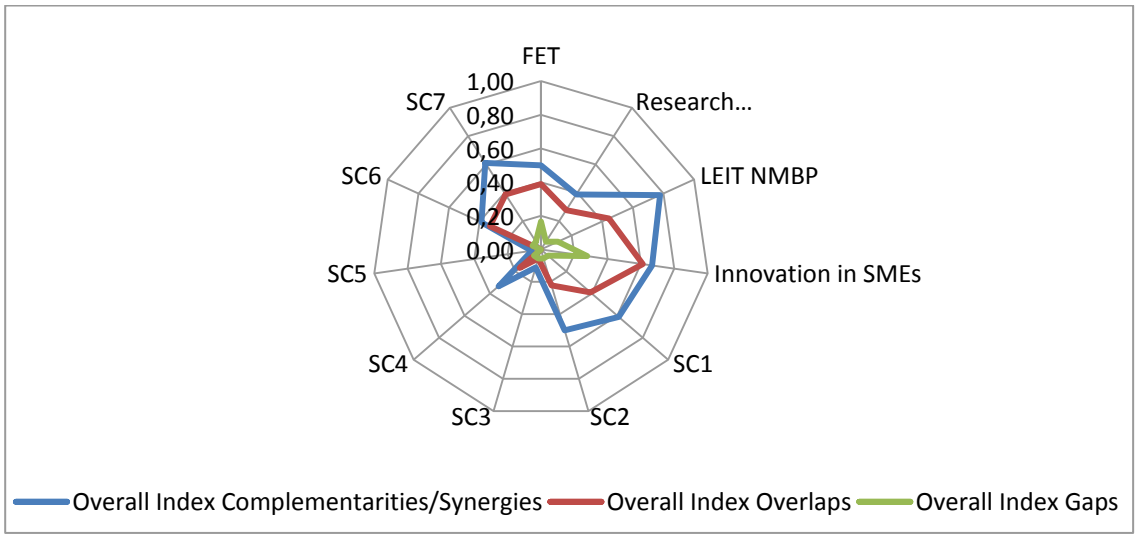
Priority Area	Survey - Relevant Topics from other Priority Areas (indicated by more than 10% of respondents)	Abstract analysis – Relevant key words pointing to topics from other Priority Areas (top 10 frequently cited in each Priority Area)
FET	**LEIT ICT**	
	Micro- and nano-electronics	
	Photonics	Photonics
	Robotics	Artificial intelligence
	ICT cross-cutting activities	Neuroinformatics
	Horizontal ICT innovation actions	
	Advanced Computing	HPC, Big data
LEIT ICT	**FET**	
	FET Open	
	Societal Challenges ICT	
	SC1 Health	Health
	SC3 Energy	
	SC5 Climate action	Environment
	SC6 Europe in a changing world	Inclusion
	SC7 Secure societies	Security

Priority Area	Survey - Relevant Topics from other Priority Areas (indicated by more than 10% of respondents)	Abstract analysis – Relevant key words pointing to topics from other Priority Areas (top 10 frequently cited in each Priority Area)
Societal Challenges ICT	**LEIT ICT**	
	ICT cross-cutting activities	
	Horizontal ICT innovation actions	
	Future Internet	Cloud
	Robotics	Robot
	Factories of the Future	

Source: CARSA study.

Results from an internal EC analysis on the internal coherence of LEIT-ICT with other Horizon 2020 specific objectives point to the prevalence of important synergies between LEIT ICT and LEIT NMBP, Innovation in SMEs, SC1 and SC7, confirming some findings shown in section 5.4.3. These synergies are due to the collaboration on the preparation of the Work Programme, the presence of ICT topics within the FoF cPPP (under LEIT NMBP), the ODI scheme implemented through the SME instrument, the ICT topics in SC1 (eHealth) and SC7 (trust and cybersecurity). Complementarities between LEIT ICT and Research Infrastructures and FET exist at the level of HPC and advanced computing. Complementarities and synergies are higher with these areas than the overlaps, which still emerged with LEIT NMBP, Innovation in SMEs and SC1. Minor gaps are also observed between FET and Innovation in SMEs.

Figure 98 - Internal coherence of LEIT ICT with other Horizon 2020 specific objectives



Source: EC services.

The above indicates that internal coherence can be improved, by establishing further and more explicit links among pillars and areas. This has been also concluded by the experts who carried out the interim evaluation of DG CONNECT Activities. Examples of such linkages to be exploited are the commonalities among HPC domain and embedded computing[4], the need for very High performance systems to achieve Big Data or machine

[4] *Commonalities can be found at the level of the elementary computing module (processor), energy consumption, the way parallelism is handled from an algorithmic aspect as well as from a programming language aspect.*

learning applications at a real scale[5], specific features related to access to supercomputers in the cloud computing domain, as well as other related functionalities like visualization of computation results stored in the cloud. For Future Internet and 5G cPPP, opportunities exist for combined actions with Smart City deployments for validation of 5G developments. Applications of Robotics are also to be further exploited in the areas of photonics, IoT, Big data, and FoF. In general, many of the cPPPs are delivering innovations applicable to advanced and future manufacturing e.g. Robotics, Photonics, and Big Data analytics. Strengthening cross-cutting activities across cPPPs is therefore essential to achieve a higher return on the funding.

E.6.1.3. Ensuring that every euro spent counts twice

The IoT constitutes the technological building block that can transform existing industries and provide new innovative solutions in a number of societal challenges. Therefore, in WP 2016-2017 a "Focus Area" was established in cooperation with Societal Challenges. The establishment of a Focus Area allows complementing technology developments with large-scale pilots, thus demonstrating actual IoT solutions in real-life settings and making it possible for providers to test user needs, user acceptance, business models and integration modalities through direct experimentation and for users to innovate their services, applications and solutions. The '**Internet of Food and Farm 2020[6]**' Large Scale Project has been granted EUR 30 million from Horizon 2020 to foster a large-scale take-up of IoT technologies in the European farming and food value chain in the next 4 years. It will consolidate Europe's leading position in the global IoT industry by fostering a symbiotic ecosystem of farmers, food industry, technology providers and research institutes and avoid fragmentation of IoT solutions. The heart of the project is formed by 19 use cases grouped in 5 trials with end users from the Arable, Dairy, Fruits, Vegetables and Meat verticals and IoT integrators that will demonstrate the business case of innovative IoT solutions for a large number of application areas. A lean multi-actor approach focusing on user acceptability, stakeholder engagement and sustainable business models will boost technology and market readiness levels and bring end user adoption to the next stage. This development will be enhanced by an open IoT architecture and infrastructure of reusable components based on existing standards and a security and privacy framework. A **EUR 6 million mid-term open call** will allow for testing intermediate results and extending the project with technical solutions and test sites.

Within the area "a new generation of components and systems", PROTEUS (AdaPtative micROfluidic and nano-enabled smart systems for waTEr qUality Sensing) mix competences from integrated smart systems area, IoT, cloud based computing, long range wireless sensors in the field of water utilities. Water management requires massive, low-cost monitoring means coping with differentiated and evolving requirements. However, the majority of multifunctional water sensors only supports predefined goals hindering interoperability, with a high cost, impeding large scale deployments. PROTEUS aims at offering x10 reduction in both size and unit function cost compared to state of the art. To this end, an increased number of functions will be integrated at a reduced cost and PROTEUS will deliver a reconfigurable microfluidic-and nano-enabled sensor platform for cognitive water quality monitoring. Upstream, high level system design addressing industrial use cases, manufacturability and cost-effectiveness,

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[5] The US Supercomputing Initiative launched by President Obama in July 2015 stresses the convergence between Big Data computing needs and more classical numerical simulations.

[6] The project, funded under Call IoT-1-2016 Large Scale Pilots, brings together 73 partners, from 16 countries, under the coordination of Wageningen University & Research. The geographical coverage will concern 18 countries.

packaging, energy budget and interfaces between building blocks, will enable consistency and efficiency of the whole approach. Downstream, system validation will be carried out at different levels: benchmarking, reliability assessment to guarantee service time, model deployments and field testing. The consortium brings together renowned actors along the whole value chain, including system integration and end users. This will contribute to post-project exploitation prepared by ensuring appropriate inclusion of business requirements within the system design.

E.6.2. External coherence

E.6.2.1. Coherence with other EU funding programmes

As mentioned above, key objectives of Horizon 2020 are to support the implementation of the Europe 2020 strategy and the priorities and initiatives of the Commission for the current programming period (2104 – 2020), including the implementation of the Digital Single Market Priority[7]. At the same time, Horizon 2020 is highly relevant to the Cohesion Policy of the EU, given that, the European Structural and Investment Funds (ESIF), the funding instruments of the EU Cohesion Policy, have a strong focus on innovation, smart growth and smart specialisation (European Commission, 2010e), with aim to ensure a more effective use of public funds, while at the same time stimulating private investment.

Analysis of ESIF data on planned ICT investments in the current programming period show 12.2 billion Euros encoded in the Thematic Objective "Enhancing access to, and use and quality of, ICT", but when ICT categories in other TOs are included, this amount almost doubles, to 21.4 billion Euros[8]. This is about two times higher than the total EC contribution for Horizon 2020 ICT-related Activities (FET, LEIT ICT, ICT in Societal Challenges), which is equal to 11.1 billion Euros. A recent study on the new provisions of ESIF[9] pointed out that coordination between the ESIF funds and other funding, including Horizon 2020, essentially focused on programming, via joint strategies and this is an area where significant progress was made; however, more effort is needed to achieve an efficient coordination of implementation. Despite existence of some examples, synergies with ESIF are still limited. Looking at specific technologies, there seems for instance to be little coherence between the Photonic actions under Horizon 2020 and the smart specialization strategies of the regions (a study released in 2015 by the EC shows that although about 50 regions have been listed by the Commission's Photonics Unit as interesting, only 9 European regions out of 276 have put photonics in central roles in their smart specialisation strategies) and national and regional funding.

Interviews carried out in the context of the support study revealed that:

- The interviewees recognised the benefits of the different types of synergies but often made reference to the difficulties of "finding one's way around the bureaucracy of ESIF", relating to administrative documentation, reporting and expense verification processes, particularly in the case of SMEs.
- There are cases where research in national programmes was a stepping-stone to FP/Horizon 2020, as well as examples of the reverse link, where FP/Horizon 2020

[7] *ICT is highly relevant for projects to be funded under the European Fund for Strategic Investments (EFSI). As discussed in Carlberg, et al. (2016), the budgetary cuts in Horizon 2020 as a result of the creation of the EFSI do not present a risk for Horizon 2020 implementation.*
[8] *Sörvik, J & Alexander Kleibrink, A. (2016). Mapping EU investments in ICT. European Commission/Joint research Centre.*
[9] *ALTUS FWC Consortium (2016).*

projects led to research funded by national programmes. In most such cases the national programme had a clear focus on research through university/private company collaborative schemes. Such funding schemes may relate to ESIF, as is the case of Greece (see text box below).

- An additional difficulty for academic organisations, more frequently encountered in cases where ESIF funding is used to commercially exploit the outcomes of an FP project, is that the research teams prefer to focus on follow-up scientific work, so other organisational units need to be involved, like Technology Transfer Offices that have a stronger focus on innovation. The success of the operation relies to a large extent on the way such units cooperate with the research teams.
- Finally, a factor that needs to be taken into account for the use of ESIF in R&I actions is enhancing the private companies demand for innovation in a given region. It was stressed by academic and private sector interviewees that particular attention should be given to support actions aiming at demonstrating the benefits associated with commercialising and applying research outcomes and their link to innovativeness and high-growth potential of companies. Such actions would help academic institutions in sharing their expert knowledge and in finding suitable business partners to develop projects with high economic and societal impact for their region.

Box 1 - Synergies Horizon 2020 and ESIF: Entrepreneurship and Innovation centre at Athens University of Economics and Business (AUEB)

A long-term objective of Athens University of Economics and Business (AUEB) was to develop efficient structures in order to support entrepreneurship and technology transfer. The steps towards the achievement of this objective are presented below, together with the source of funding:

First step: development of the Innovation and Entrepreneurship Unit (MoKE) with funding from the Operational Programme "Education and Vocational Training" under the National Strategic Reference Framework for Greece.
Second step: Funding from the Regional Operational Programme of Attika 2007 – 2013 to develop the Athens Centre for Entrepreneurship and Innovation (ACEIn), the incubator of AUEB, supporting newly established very small and small companies, operating in innovative fields, such as e-commerce, ICT and social entrepreneurship.
Third step: participation as consortium partner in the Horizon 2020 LEIT ICT project EU-XCEL. The project objective is to increase the number of ICT entrepreneurs with an EU-wide mind-set in the development of their business ideas, through specialised training, as well as with hands-on experience in different European countries. ACEIn is one of the sites used for the formal and hands-on training, which is a means for AUEB to enlarge its network of international partners, which can be used to the benefit of academic collaborations, but also to provide a European perspective to the entrepreneurship projects that receive incubation support by the Centre.

The experience gained by ACEIn staff in the area of innovative entrepreneurship enabled them to enlarge the support provided to the research teams of AUEB in this field, particularly in the areas of assessment of broader economic and societal dimensions of research projects, and of developing exploitation and dissemination plans. This largely contributed to the award of 3 more Horizon 2020 projects under Societal Challenges ICT in the period 2015 - 16. But more crucially, the capacities enable ACEIn to play a leading role in the exploitation of research and technology transfer, and, in this way, largely contribute to national initiatives aiming to stimulate innovative entrepreneurship over the next years.

Source: CARSA Study.

Other programmes

COSME and the Connecting Europe Facility (CEF) have been identified as being connected to, or impacting on, R&I activities. The Table below provides a short description of these initiatives and the (potential) areas of complementarity with LEIT ICT.

Table 58 - Potential complementarities between LEIT ICT, COSME and CEF

Initiative description	Potential complementarities with LEIT ICT
COSME aims to strengthen the competitiveness and sustainability of European Enterprises[10]. The overall budget for 2014 – 2020 is 2.3 billion Euros. Specific objectives include: • improving access to finance for SMEs in the form of equity and debt, • improving access to markets, particularly inside the EU, but also at global level, • improving framework conditions for the competitiveness and sustainability of EU enterprises, particularly SMEs, including in the tourism sector, and • promoting entrepreneurship and entrepreneurial culture.	COSME supports the creation and expansion of companies, giving particular attention to commercial activity enhanced through R&I activities of the enterprises to be supported. There are strong complementarities with the SME Instrument and other Horizon 2020 actions: an SME that received grant support (from the SME Instrument or any other Horizon 2020 action) to develop an innovation, can use COSME to obtain funding needed in the form of a loan or equity finance, for this innovation to reach the market, or to expand its market at an international level. Such synergies and complementary actions can be promoted/enhanced through the - COSME funded - Enterprise Europe Network (EEN), whose mission is to promote European programmes (and therefore, be the one-stop-shop for an SME to obtain information about Horizon 2020 funding opportunities), spread best practices and enhance trans-national business cooperation and technology and innovation partnerships on themes related to research, technology and knowledge transfer.
The Connecting Europe Facility (CEF) programme provides funds to improve trans-European infrastructure in the fields of transport, energy and telecommunications. This last field, with a budget of 1.14 billion Euros, aims to support the deployment of fast and ultra-fast broadband networks across the EU, as well as of trans-European digital services, in accordance with the principle of technological neutrality[11]. The Digital Service infrastructure (DSI) projects correspond to the largest part (870 million Euros) of the CEF telecommunications component. Their objective is to deploy trans-European digital services based upon mature technical and organisational solutions in areas comprising a wide range covering electronic identification, online dispute resolution and interoperable health services[12].	CEF telecommunications, together with ESIF are highly relevant to each other and to Horizon 2020 LEIT ICT: • Synergies between CEF and ESIF can be developed for e-government solutions and Institutional capacity and efficiency of Public Administration – such ESIF investments can have a substantially increased quality if they are designed to be interoperable with solutions in other EU countries or at EU level through alignment with CEF's DSI[13] • Projects under the Horizon 2020 LEIT ICT develop new approaches for broadband and digital services infrastructures, especially LEIT ICT[14]. CEF and ESIF can be used to ensure that outcomes of such R&I actions are used in the deployment of actual telecom networks and digital services at national (ESIF) and EU (CEF) levels.

Source: CARSA study.

[10] *Regulation (EU) No 1287/2013 of the European Parliament and of the Council of 11 December 2013 establishing a Programme for the Competitiveness of Enterprises and small and medium-sized enterprises (COSME) (2014 - 2020) and repealing Decision No 1639/2006/EC.*

[11] *Regulation (EU) No 1316/2013 of the European Parliament and of the Council of 11 December 2013 establishing the Connecting Europe Facility, amending Regulation (EU) No 913/2010 and repealing Regulations (EC) No 680/2007 and (EC) No 67/2010 Text with EEA relevance.*

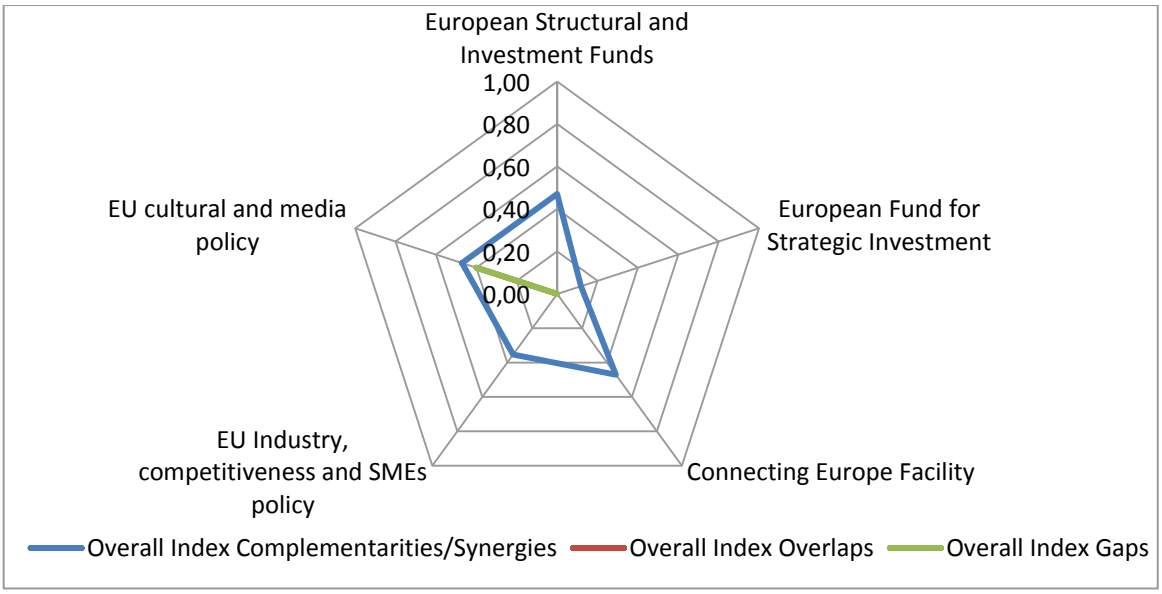
[12] https://ec.europa.eu/digital-single-market/en/connecting-europe-facility

[13] *Ferry, et al. (2016).*

[14] *Specific LEIT topics include Advanced Computing, Content Technologies and Information Management, Future Internet, Horizontal ICT Innovation Actions, ICT Cross - cutting activities and Photonics.*

As shown in the diagram below, results from an internal EC analysis of LEIT-ICT with other EU policies and programmes point to the existence of synergies or complementarities between LEIT ICT and Connecting Europe Facility activities, ESIF, the EU's Cultural and Media Policy and, to a lesser extent, between LEIT ICT and the EU's industry, competitiveness and SME policy. Very little synergies exist with the European Fund for Strategic Investment (EFSI). Minor gaps are observed between LEIT ICT and the EU's Cultural and Media Policy.

Figure 99 - External coherence of LEIT ICT with other EU policies and programmes



Source: EC services.

E.6.2.2. Coherence with other public support initiatives at regional, national and international level

Interviews with participants revealed that there are cases where research in national programmes was a stepping-stone to FP/Horizon 2020, as well as examples of the reverse sequence, where FP/Horizon 2020 projects led to research funded by national programmes. In most such cases the national programme had a clear focus on research through university/private company collaborative schemes.

The survey conducted among current participants in Horizon 2020[15] was used to assess the degree to which participating organisations benefit from opportunities and synergies with other sources of funding. Two key findings emerging from the analysis of survey responses are the following: (1) for more than 70% of Horizon 2020 participants the availability of national funding opportunities in topics related to their Horizon 2020 project is nil or low, and (2) more than 80% of Horizon 2020 participants have not applied to other national or international programmes for the particular topics of their Horizon 2020 projects.

Overall, the findings above suggest that the survey respondents had limited knowledge or experience regarding the synergies that could be developed by combining Horizon 2020 and other sources of funding. It is worth noting that university partners seem to be more active in exploiting other funding opportunities, as a larger share within this category

[15] *CARSA study*

considers availability of funding to be fair/high (40% compared to 28%, the average for all participants). Conversely, research centres have a more pessimistic view as to availability of national funding and show the lowest activity in attempting to obtain competitive funding. This may also be related to a stronger interest in other sources, such as service contracts with the private sector.

It should be pointed out that non-participants were shown to be more active in attempting to obtain funding from other sources than organisations involved in Horizon 2020: the share of non-participants that applied to national and/or international funding programmes is 33%, compared to 18% for Horizon 2020 participating organisations. The more intense involvement of non-participants can be related to a preference for continuing on national or regional programmes that are more adapted to specific needs, or for which a good track record has been already developed. Findings also suggest that Horizon 2020 participation does not seem to offer any competitive advantage for securing funding from other sources.

E.6.3. Lessons learnt/Areas for improvement

The design and implementation of LEIT ICT appears so far well suited to guarantee internal coherence among its components. The instruments cover the value chains and provide a **balanced and complementary approach** to address the objectives. Some concerns were however raised by the experts on the apparent trend of **diminishing funds in Horizon 2020 for lower TRLs** (2-4) in components and systems.

Coherence between LEIT ICT and some other areas of Horizon 2020 LEIT NMBP, Innovation in SMEs and Societal Challenges is ensured by means of regular discussions and consultations with relevant EC services on the scope and content of the relevant WPs and calls. In some cases it is also ensured by specific **calls for fostering synergies** and **joint topics**. In WP 2016-2017 a focus area in Internet of IoT with specific links to applications in Societal Challenges was also launched. Despite cross cutting opportunities are increasingly showing up in calls, they are still underexploited. Articulation within LEIT ICT (cPPPs) and between LEIT ICT-funded activities, as well as with activities from other parts of the programme could be improved, in particular through **cross-domain collaboration** and **joint-programming between the LEIT** and **Societal Challenges**.

Despite strategic alignment, there is still **scope for enhancing the complementarity of interventions under LEIT ICT** (and Horizon 2020 as a whole) **and ESIF** at the implementation level. A number of cases have been identified where research activities under national programmes act as stepping stones to Horizon 2020 projects and, conversely, where FP/Horizon 2020 projects have led to research being funded by national or regional sources. However, survey results suggest that respondents had limited knowledge or experience regarding the synergies that could be developed by combining Horizon 2020 and other sources of funding. Survey findings also suggest that participation in Horizon 2020 does not seem to offer any competitive advantage for securing funding from other sources.

E.7. EU ADDED VALUE

E.7.1. Horizon 2020 projects demonstrating EU Added Value

Efficiency: **Smart Anything Everywhere initiative** (SAE) networks several groups of competence centres across Europe that support SMEs and mid-caps to achieve product and service innovations through digital technologies with the goal to improve their

competitive position. Having a broad range of European competence centres gathered to foster innovation is effective (creating missing links, avoiding fragmentation, and realising the potential of a border-free Europe), is efficient as resources and expertise are pooled, action is better coordinated and creates synergies. The initiative consists of 4 innovation projects that conduct successful, high impact experiments in different technology areas.

Effectiveness: **RAGE** (Realising an Applied Gaming Eco-system), leverages on the opportunities offered by the non-leisure game industry (Applied Games) by developing an interoperable set of advanced technologies for various real-world contexts. The project has already 32 assets listed, described and available since August 2016 with demos available for download for interested game developers. Rage is going to launch the RAGE Ecosystem soon which includes an online social space to arrange and facilitate collaborations, and a centralised repository of a wide range of gaming software modules and services. This Ecosystem represents a great innovation vehicle to support the games industry in seizing new business opportunities. RAGE, in less than 2 years, has proven to be able to impact on the competitive positioning of thousands of European SMEs in the Applied Games market. The gaming technology assets are tested and evaluated by gaming companies in several pilots focussing on one of the Commission's high political priorities skills including digital access, communication, soft and job search skills.

Synergy: **Collective Awareness Platforms for Sustainability and Social Innovation (CAPS)** is a program which was launched in FP7. It has been the first program addressing Digital Social Innovation, encouraging new bottom up ideas exploiting hyperconnectivity and the richness of existing or emerging network technologies (social networks, wikis, IoT) to solve sustainability challenges (in environment, society, economy) in innovative manners. The projects currently running address key emerging areas in the domain of Internet economy and innovation, such as the collaborative economy, open democracy, open policy making, makers and distributed manufacturing, collaborative consumption, and citizen science. The EU action was key to create missing links and establish novel European models, for instance for the self-management of smart cities, or for the investigation of distributed architectures for decentralised data governance. By showcasing good practices in the above mentioned areas and by pioneering new funding mechanisms (e.g. cascade funding, in project CHEST) it allowed European researchers and innovators to pool resources in similar areas and to coordinate their action[16]. In terms of synergy the programme introduced some innovative requirements for consortia in order to achieve effective multidisciplinarity (presence of at least two non-ICT partners) and link to concrete action (presence of a real community of engaged citizens, for instance at local level) which proved very effective in order to leverage action in each of the emerging areas mentioned above.

E.7.2. Lessons learnt/Areas for improvement

Added value of LEIT ICT at EU level derives from trans-national cooperation, supporting bridging the valley of death and, most significantly, creating a critical mass of excellence that can compete globally. Considering the large investments needed, Europe needs to build on complementary strengths. Intervention at EU level allows getting the major stakeholders and industrial players along the whole R&I value chain into the process of actively defining the roadmap and commit to the implementation. In this

[16] *DSI dynamic mapping: www.digitalsocial.eu.*

sense, there is significant added value of implementing Horizon 2020 funding through the use of contractual cPPPs,

The development of new generations of networking technologies is one of the best possible examples where European-level intervention is justified: the standards should in fact be global, not even European. Intervention in Content Technologies and Media is important to push European Content and Media companies to more innovative scenarios, increasing their capability of innovating and acting at the European Level and to avoid fragmented scenarios on regional level.

E.8. SUCCESS STORIES FROM PREVIOUS FRAMEWORK PROGRAMMES

CoherentPaaS[17] (2013 – 2016, EC Contribution: EUR 4.95 million). Enterprises have adopted a wide diversity of databases since there is no single database solving all their needs. Many of the newer databases, so-called NoSQL databases, lack coherence guarantees that results in many issues for the end users of the services that rely on them. Additionally, these databases exhibit different data models and query languages resulting in isolated data silos. In this scenario it becomes impossible for enterprises to perform business analytics across the different databases leading to low quality and performance of the services delivered to citizens. CoherentPaaS enhances NoSQL databases with full consistency so enterprises can deliver coherent services to the end users; solves the issue of isolated data silos by providing polyglot capabilities to query across databases and delivers an ultra-scalable database with polyglot data management capabilities to deliver high quality services with full coherence to the citizens. The spin-off LeanXcale has been created to commercialize the project core results, an ultra-scalable database with polyglot capabilities. LeanXcale has been mentioned as one of the most promising start-ups by Forbes[18]

MATECAT (2011-2014, EC Contribution: EUR 2.6 million). A small consortium of 4 partners conducted research which was clearly industry-driven by the needs of the commercial partner in the consortium (Translated) and resulted in a commercial product which now successfully competes in the market. The Matecat project worked on an innovative combination of computer-assisted translation and best machine translation technology. The product is now offered to language service providers in such a way which leads to continuous improvement of the underlying technology for Translated. Matecat is becoming increasingly popular among Language Service Providers such as Welocalize, and big commercial players such as eBay.

D-CENT - Decentralised Citizens ENgagement Technologies, (2013-2016, EC contribution: EUR 1.9 million). D-CENT is a Europe-wide project including NESTA and W3C, bringing together citizen-led organisations that have transformed democracy in the past years. It helped them in developing the next generation of open source, distributed, and privacy-aware tools for direct democracy and economic empowerment. It also pioneered the development of Blockchains for the implementation of social reward schemes. D-CENT has run large-scale pilots in Spain, Iceland, and Finland through Lean UX experimentation and by leveraging existing network movements with a user-base of tens of thousands of people. D-CENT builds on some of Europe's largest experiments in direct democracy. EU action was key to create missing links (for instance, between the Open Ministry site for crowdsourcing legislation linked into parliament in Finland and the e-democracy website Better Reykjavik) and establish novel European models for

[17] *www.coherentpaas.eu*
[18] *http://www.forbes.com/sites/jasonbloomberg/2016/04/29/hunting-for-disruption-at-collision-conference/#9b2ea2e3fa3e*

democracy tools which are used by thousands of citizens across Europe, with active pilots in the cities of Barcelona, Madrid, Helsinki and Reykjavik. An investment of EUR 2 million over three years was able to generate a lasting impact, with concrete pilots in 4 large European cities, developing tools for citizen notification, collaborative policy making, electronic voting, and social currencies based on blockchains. By creating links between open democracy experiences in different European cities, D-Cent was able to leverage action (and involvement of actual political parties and citizen coalitions) and create synergies, also thanks to the unique requirements of the CAPS programme under which it was funded (multidisciplinarity, presence of real communities, usage of open source and open data solutions).

E.9. LESSONS LEARNT/CONCLUSIONS

E.9.1. Relevance

Key findings	LEIT ICT is of strategic relevance to EU R&I and it is in line with relevant objectives as well as current and evolving challenges and policy priorities
Strengths	LEIT ICT is appropriately designed for its objectives, as it constitutes a market informed pull on research A dedicated instrument for the SMEs is a successful addition to the toolbox for innovation
Bottlenecks/ weaknesses	Openness for topics and ideas of the research community is lacking to some extent, due to the prescriptiveness of calls and their timelines Evaluation criteria specific to the goals of SME growth and job creation and funding of disruptive ideas are lacking

E.9.2. Effectiveness

Key findings	Projects have a clear market orientation and societal relevance Participants expect to develop new or significantly improved commercial products and services, which suggests these could be among the key outcomes to be generated Projects funded through the SME Instrument completed contributed to the growth of highly innovative SMEs and start-ups
Strengths	cPPPs act as catalysts to ensure competitiveness of the European stakeholders in the global market Horizon 2020 forms of support to translate R&I actions into commercially viable results are well rated by participants
Bottlenecks/ weaknesses	KPIs of cPPPs lack definition on how to calculate progress and leverage factor PPPs could benefit from strategies to improve and expand a range of relevant skills, notably digital The available budget and over subscription for the SME Instrument lead to frustration over low funding rates

E.9.3. Efficiency

Key findings	Successful in attracting newcomers and engaging industry and SMEs compared with the previous programme The SME Instrument has mobilized SMEs to apply with high quality proposals, many worthy of seal of excellence.
Strengths	Participants perceive benefits from participation as exceeding costs Most participants and coordinators surveyed were satisfied with most participation-related aspects
Bottlenecks/ weaknesses	Oversubscription and difficulties in selection of best projects

E.9.4. Coherence

Key findings	The design and implementation of LEIT ICT is well suited to guarantee internal coherence among its components. The instruments provide a balanced and complementary approach to address the objectives The SME Instrument is coherent compared to other Horizon 2020 tools in providing an additional and alternative opportunity specifically for SMEs to get funding
Strengths	Cross cutting opportunities increasingly showing up in calls
Bottlenecks/ weaknesses	Opportunities for cross-domain collaboration (e.g. between cPPPs), joint programming (e.g. LEIT and SCs) and other programmes (e.g. ESIF) are underexploited In components and systems, while the investment in ECSEL to address industrial challenges is well justified, the diminishing funds in Horizon 2020 for lower TRLs raise concerns.

E.9.5. EU Added Value

Key findings	EU intervention is key in creating critical mass of excellence that can compete globally
Strengths	Innovation across value chains is key to maintain the strength of European industry sectors
Bottlenecks/ weaknesses	Infrastructure and capital intensity concentrate benefits in regional clusters There is no interaction with business angels or Venture Capitalists

F. LEADERSHIP IN ENABLING AND INDUSTRIAL TECHNOLOGIES – NANOTECHNOLOGIES ADVANCED MATERIALS BIOTECHNOLOGY AND ADVANCED MANUFACTURING AND PROCESSING (LEIT-NMBP)

F.6. INTRODUCTION

F.6.1. Context

The LEIT Pillar of Horizon 2020, which includes the NMBP part, is based on the Europe 2020 Strategy[19] which was established in 2010 to recover from the financial and economic crisis which started in 2008.

Among the seven flagship initiatives, the 'Innovation Union', 'An industrial policy for the globalisation era' and 'A resource-efficient and low-carbon economy' addressed explicitly research, technology and innovation in an industrial setting. It was acknowledged that Europe was falling behind the major competing countries and regions not only in R&D expenditure in general, but specifically with regard to private research and innovation investments.

Horizon 2020 and the part on Leadership in enabling and industrial technologies, including nanotechnologies, advanced materials, biotechnology and advanced manufacturing and processing take this successful model under FP7 further, building also on the European concept of Key Enabling Technologies[20].

The main objective of this interim evaluation was to assess the relevance, effectiveness, efficiency, coherence, and EU added value of the programme -in line with the European Commission Better Regulation Guidelines of May 2015. The evaluation looked not only at the activities of the programme and how they were implemented, but also considered how certain results were achieved (by assessing the driving or hindering factors), and, insofar as possible, what the results and impacts of these activities were. The scope of the evaluation covered all aspects related to the LEIT-NMBP programme and its activities that had taken place within this programme in the period from 2014 up to and including the first half of 2016. As the projects funded under the programme were still in their early phases, this evaluation assessed the extent to which the programme was 'on track' to achieve the intended results and impacts, and the progress made towards the overall objectives so far.

In order to guarantee a high level of technical expertise and objectivity of the analysis and conclusions, the Commission created a group of five individual experts to support and contribute to the Interim Evaluation of the LEIT-NMBP programme in Horizon 2020. The practical implementation of the evaluation was a joint effort between the European Commission and the independent expert group. The NMBP experts' tasks were especially to assist the Commission in questions related to establishing the concept and practicalities of the evaluation, contributing to data gathering (e.g. through database research, face-to-face and telephone interviews, case studies and online surveys), analysing and triangulating data, drawing conclusions and recommendations for their final report. A deeper analysis was made on the following case studies: Intellectual

[19] *EUROPE 2020 - A strategy for smart, sustainable and inclusive growth, Communication from the Commission COM(2010) 2020 final of 3.3.2010*

[20] *Preparing for our future: Developing a common strategy for key enabling technologies in the EU, Communication from the Commission COM(2009)512 of 30.9.2009*

Property Rights (IPR) strategy and exploitation, patent analysis, SME involvement and KETs-NMBP for Societal Challenges – contribution to Energy.[21]

F.6.2. Objectives of the programme and intervention logic

Based on the overall objective of Horizon 2020 (Horizon 2020)[22], the specific objectives for the pillar *Leadership in Enabling and Industrial Technologies* are laid down in Article 3.2 of Council Decision of 3 December 2013 establishing the specific programme implementing Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020).

Specific objectives of Leadership in Enabling Technologies (LEIT):

"(a) Boosting Europe's industrial leadership through research, technological development, demonstration and innovation in the following enabling and industrial technologies:

(i) information and communication technologies ("ICT");

(ii)nanotechnologies; (iii) advanced materials; (iv)biotechnology; (v) advanced manufacturing and processing; and

(vi) space;.

(b) enhancing access to risk finance for investing in research and innovation

(c) increasing innovation in SMEs

The operational objectives of the LEIT-NMBP programme are described in Annex I of Regulation 1291/2013. The NMBP programme supports four out of six Key Enabling Technologies (KETs): nanotechnologies, advanced materials, biotechnology, and advanced manufacturing and processing. The two others, micro-and nano-electronics and photonics, are included in the LEIT-ICT[23] part of Horizon 2020. The NMBP programme aims to facilitate an integrated approach to KETs. The operational objectives can be defined as follows:

Operational objectives for the LEIT NMBP programme:

- *To stimulate growth and jobs;*
- *To enhance the integration and deployment of enabling technologies by European industry;*
- *To stimulate strong private sector involvement;*
- *To enhance product competitiveness and impact;*
- *To foster cross-cutting KET activities*
- *Technology validation in an industrial environment to a complete and qualified*

[21] *The methodology of evaluation expert group (incl. list of interviews and description of all analytical tasks) is described in Experts report on methodology (January 2017, internal document).*

[22] *The overarching objective of Horizon 2020 is stated in Article 5.1 of Regulation (EU) No 1291/2013 of the European Parliament and of the Council of 11 December 2013 establishing Horizon 2020 – the Framework Programme for Research and Innovation (2014-2020) and repealing Decision No 1982/2006/EC: " To contribute to building a society and an economy based on knowledge and innovation across the Union by leveraging additional R&D&I funding and by contributing to attaining R&D targets, including the target of 3% of GDP for R&D across the Union by 2020. It shall thereby support the implementation of the Europe 2020 strategy and other Union policies, as well as the achievement and functioning of the European Research Area (ERA)".*

[23] *Information and Communication Technologies (ICT)*

system, ready or close to enter the market; and

- *To provide new opportunities to tackle societal challenges*

The LEIT-NMBP programme is a very broad funding programme which addresses many different industrial sectors with KETs and their combinations. The structure of the programme places each one of the four key enabling technologies at the same 'legal' level as ICT, while identifying one budget for the NMP areas (previously the "Industrial Technologies – NMP" theme of FP7) and one for biotechnology (previously in the KBBE theme of FP7). A global budget is indicated for all KETs together, and the programme emphasises the importance of 'cross-KET' activities.

Based on these objectives, Figure 100 presents the intervention logic of the programme in line with the European Commission Better Regulation Guidelines. This intervention logic presents the causal links between the inputs invested in the programme, and the intended outputs, results and impacts of the programme. In other words, the intervention logic reflects what human, financial and other inputs were invested in the programme on the one hand, and what was expected to happen as a result of these inputs on the other hand. The intervention logic represents the starting point for the evaluation, in that it allows the evaluation team to compare (a) what was intended to happen and (b) what actually happened based on the evidence available so far.

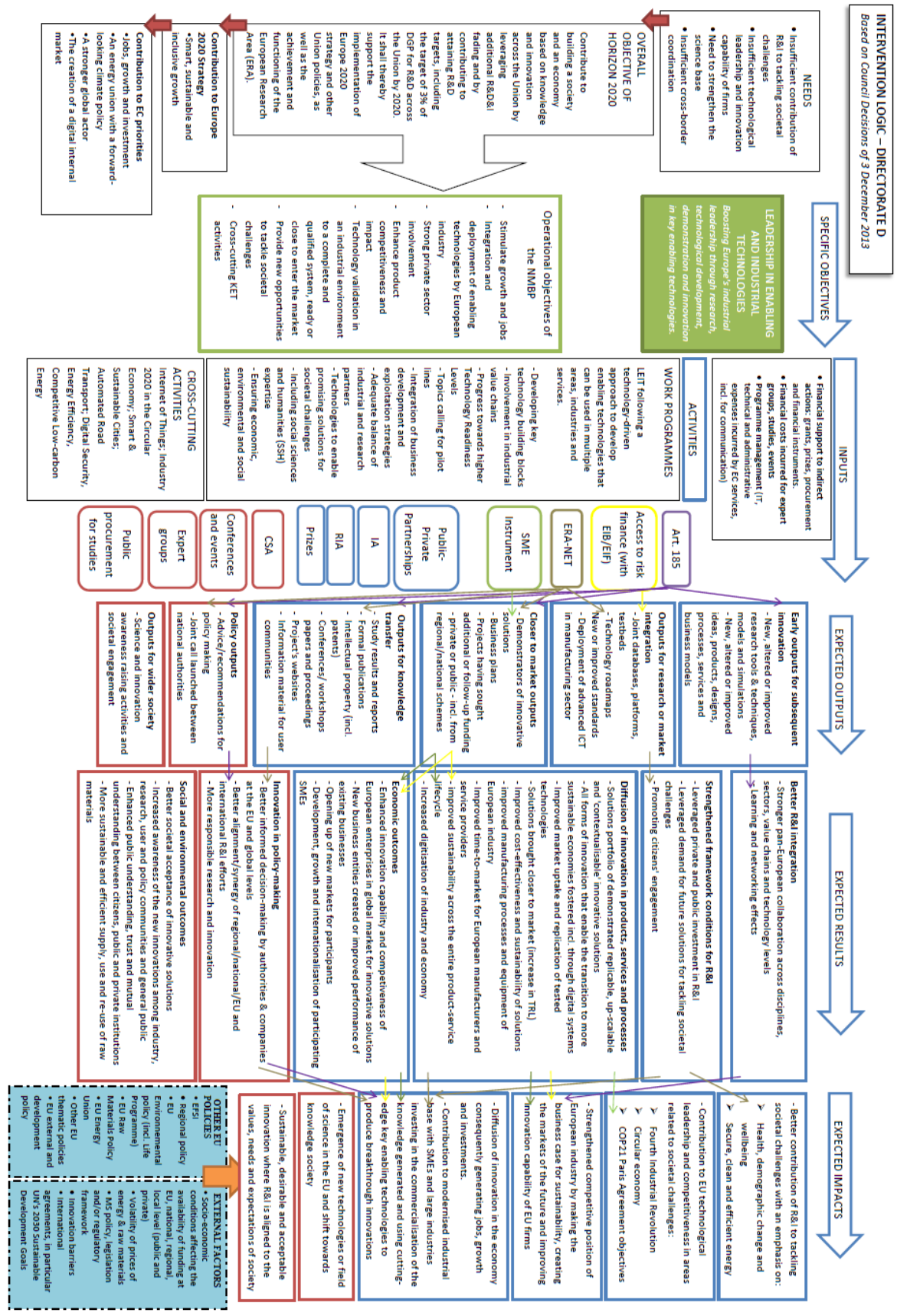
The programme focuses on priorities where the development and mastering of science and research driven technologies underpins the global competitiveness of industries and companies, with special attention to ensuring the take-up of successful results and further industrial investments. In this context, a strong industry participation (including SMEs) in projects is an aim in itself, with emphasis on activities bringing research and laboratory results to industrial development and validation. In line with the needs of industry, the NMBP programme has used primarily the research and innovation (RIA) and innovation (IA) actions to implement its objectives. Coordination and support actions (CSA) and ERA-NET (European Research Area Net) actions provide policy support in different areas across the programme. The programme concentrates on demonstrators and pilots at relatively high Technology Readiness Levels (TRLs 3-4 to 7), with the objective that successful results will allow other investors (industry, financial institutions, public programmes) to step in and take the results closer to commercialisation.

The R&I challenges are cross-sectoral and based on stakeholder input, with industry in a driving role. For a large part of the programme, this process is formalised through Partnership Agreements with contractual Public-Private Partnerships (cPPPs)[24]. The NMBP Programme makes the principal contributions to three cPPPs, Factories of the Future, Sustainable Process Industries and Energy-efficient Buildings (under "Advanced Manufacturing and Processing", with contributions from Advanced Materials); and also makes a much smaller contribution to the cPPP on the European Green Vehicles Initiative (EGVI) (from Advanced Materials). Under Nanotechnologies and Advanced Materials, a strategy for establishing pilot lines together with activities around application oriented and cross-cutting clusters to support characterisation and upscaling of (nano)materials at the service of SMEs is being pursued, having been put in place in the last two years of FP7. Finally, the programme pursues links to challenges such as

[24] *The NMBP programme contributes also to an institutional PPP, the Joint Technology Initiative for Bio-based industries for which a specific interim evaluation report is being prepared.*
Involvement of the EC in Public Private Partnerships for Research and Innovation may take either a role of Joint Technology Initiative (JTI; established on the basis of Article 187 TFEU) or Contractual PPP (cPPP). Budget for cPPPs is committed on an annual basis through Horizon 2020 calls in Work Programmes.

health, energy, energy and resource efficiency, the circular economy and climate action, and synergies with ICT and digitisation (thus supporting the so-called 4th industrial revolution).

Figure 100 - Intervention logic of LEIT-NMBP (source: Interim Evaluation 2016)



Source: Experts report on methodology (January 2017).

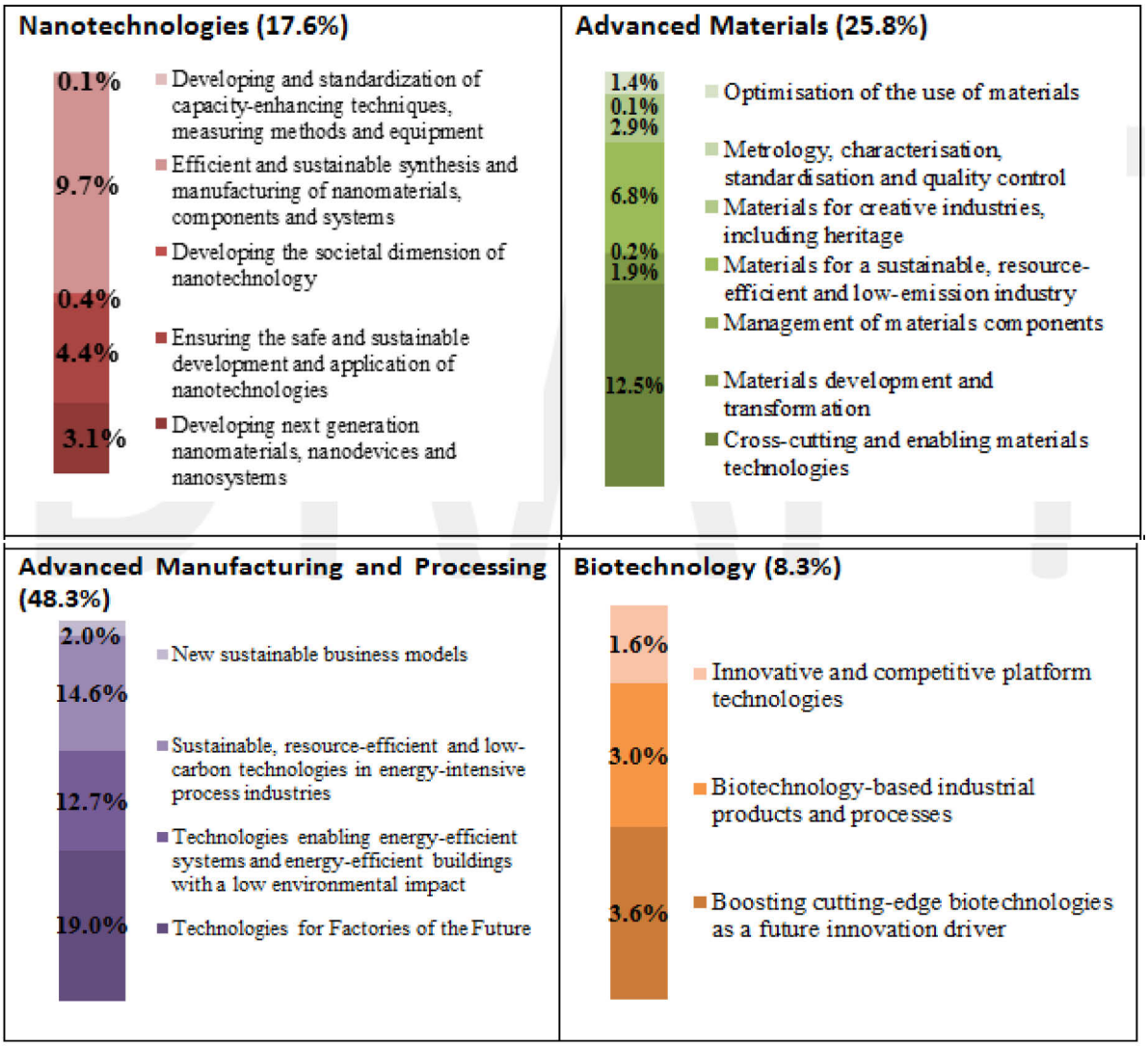
F.7. IMPLEMENTATION STATE OF PLAY

F.7.1. Overview of programme inputs and activities

As of 1 January 2017, the EU contribution allocated to the implementation of the calls included in Work Programmes 2014-2016 is EUR 1.4 billion (based on the 269 Grant Agreements (GAs) signed by 01/01/17), representing about 37% of the total budget allocated to NMBP, which is EUR 3.828 billion for the period 2014-2020.

A part of this budget was allocated though topics contributing to a Focus Area. These include EUR 396 million to Horizon 2020-IND-CE-2016/2017 (Industry 2020 in the Circular Economy); EUR 5 million to Horizon 2020-WASTE-2014/2015; and EUR 2 million to Horizon 2020-BG-2016/2017. There are two joint calls with LEIT-ICT: EUR 9 million to Horizon 2020-ICT-2014 and EUR 5 million from ICT to topic NMBP-13-2017. The contribution to the SME instrument is currently 6% of the NMBP budget. Two topics (NMBP-17-2014 and NMBP-8-2016) are contributions to the Green Vehicle cPPP, with a total budget of EUR 16 million.

Table 59 - Activities and allocated share of budget dedicated to the LEIT-NMBP programme for the programming period 2014-2016 (*2016 partly; these figures are excluding the SME instrument. Source: evaluation team*)



Source:LEIT-NMBP Interim Evaluation.

Table 60 - Key data on proposals per type of action for LEIT-NMBP: Number of eligible and, EC contribution requested (in million Euros) and success rates (as % of proposals submitted, and as % of budget available)[25]

Type of Action	Nr of Eligible Proposals	EC Contribution requested by Eligible Proposals (EUR million)	Nr of proposals above evaluation thresholds	EC Contribution requested by proposals above evaluation thresholds (EUR million)	Nr of Grant Agreements	Success rate count grants agreements/eligible proposals	Success rate funding grants agreements /eligible proposals
CSA	87	81.1	52	47.8	39	44.8%	41.2%
ERA-NET-Cofund	5	45.4	4	45.1	4	80.0%	81.1%
IA	685	3799.5	179	1064.1	95	13.9%	15.3%
RIA	903	4781.5	230	1318.4	133	14.7%	16.2%
Total (excl. SME instrument)	1680	8707.6	465	2475.4	271	16.1%	16.4%
SME-1	2869	143.4	536	26.8	194	6.8%	6.8%
SME-2	1091	1604.0	492	744.1	49	4.5%	4.6%
Total	5640	10455.0	1493	3246.3	514	9.1%	14.4%

Source: CORDA data, 1 January 2017, Success Rates by Type of Action (General).

The budget 2014-16 was allocated through 112 topics included in 25 closed calls for proposals for 234 Grant Agreements signed before 01/01/2017.
Two stage calls were launched in the case of seven calls with a total of 295 proposals in second stage resulting in a success rate of 29.6%, while the overall success rate of all calls (ignoring stage 1) was 16.4%.

Table 61 - Key data on signed grants per type of action for LEIT-NMBP: number, EC contribution, time-to-grant, projects' average of total costs, EC contribution in projects

Type of Action	Nr of Projects	Total Cost	Project Requested EC Contribution	Share of overall budget by Type of Action	Average Time To Grant	Nr of mail list GAs not signed within 8 months	Average of Project Total Costs Million EUR	Average of Project Requested EC Contribution Million EUR
CSA	39	35.8	33.4	2.2%	197.8	0	0.9	0.9
ERA-NET-Cofund	4	124.9	36.8	2.4%	216.8	0	31.2	9.2
IA	95	725.0	581.6	38.6%	201.8	0	7.6	6.1
RIA	133	824.4	772.4	51.2%	199.1	1	6.2	5.8
Total (excl. SME instrument)	271	1710.1	1424.3	94.4%	200.1	1	6.3	5.3
SME-1	194	13.9	9.7	0.6%	100.1	0	0.1	0.1

[25] *Stage 1s (that failed thresholds or did not submit a stage 2), Nr of proposals and EC contribution requested by proposals (Mio EUR)*

IA	497	3106.8
RIA	1023	6083.3

Type of Action	Nr of Projects	Total Cost	Project Requested EC Contribution	Share of overall budget by Type of Action	Average Time To Grant	Nr of mai list GAs not signed within 8 months	Average of Project Total Costs Million EUR	Average of Project Requested EC Contribution Million EUR
SME-2	49	106.6	74.5	4.9%	154.8	1	2.2	1.5
Total	514	1830.6	1508.5	100.0%	158.0	2	3.6	2.9

Source: CORDA data, 1 January 2017, Selected Projects and Signed Grants by Type of Action.

At the time of the interim evaluation's cut-off date of 1/1/2017, 17 projects are completed, 255 are ongoing, another 1 is currently in Grant Agreement Preparation and none are abandoned. The programme has so far been implemented mainly through RIAs and IAs. This table includes two SILC II projects.

F.7.2. Participation patterns

This section describes the main participation patterns, per call, topic, country and organisation type, newcomers, geographical distribution and international cooperation.

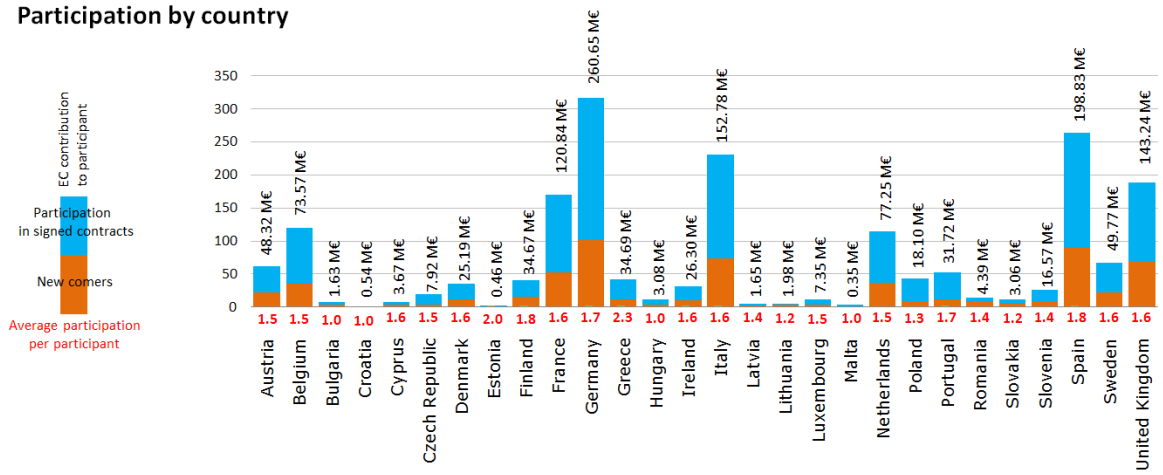
Table 62 - Key data on participation per type of organisation for LEIT-NMBP: number of participants, of newcomers, of participations, and EC contribution to participations (in million Euros). Based on RTD/D NMBP 269 (SILC II projects excluded)

Organisation Type Code	Count Participants	Nr of Newcomers in Signed Grants	Count Participations	Participant Total Cost (million EUR)	Participant EC Contribution (million EUR)
HES	266	12	627	335.0	300.0
OTH	100	36	145	41.4	34.7
PRC	1342	589	1666	775.0	628.1
PUB	76	17	117	95.1	35.7
REC	282	21	792	440.4	413.1
TOTAL	2066	675	3347	1686.8	1411.6
Explanation: Private for-profit entities (PRC); Research Organisations (REC); Higher or Secondary Education Establishments (HES); Public bodies (PUB); Other (OTH)					

Source: CORDA data, 1 January 2017, Participants and Participations by Legal Entity.

There are 675 organisations in Horizon NMBP projects, which have not participated in FP7 (and 1122 organisations not participating in FP7 NMP projects).

Figure 101 - Participation by country in NMBP: number of participants, number of newcomers, number of participations and EC contribution to participants. Based on 269 NMBP projects (SILC II projects excluded).



Source: CORDA data, 1 January 2017, Participants and Participations by EU-28 Member State.

Table 63 - Key data on participation per group of country EU-13, EU-15, Associated countries, Third Countries for LEIT-NMBP: number of participants, of project coordinators, of newcomers, of participations, and EC contribution to participations (in million Euros). Based on RTD/D NMBP 269 projects (SILC II projects excluded).

Country group	Nr of Participants in Signed Grants	Nr of Projects Coordinators in Signed Grants	Nr of Newcomers in Signed Grants	Nr of Participations in Signed Grants	Average Participations per Participant	EC Contribution to Participation in Signed Grants (EUR million)
ASSOCIATED COUNTRIES	78	12	28	119	1.5	60.9
EU-13	155	5	49	204	1.3	63.4
EU-15	1745	251	568	2891	1.7	1,285.2
OTH	88	1	30	133	1.5	2.1
TOTAL	2,066	269	675	3,347	1.6	1,411.6

Source: CORDA data, 1 January 2017, Participants and Participations by Country group.

Table 64 - Participation per type of organisation. Based on RTD/D NMBP 269 projects.

Organisation Type Code	Count Participants	Count Participations	%	Participant Total Cost (million EUR)	Participant EC Contribution (million EUR)	%	Average in participations
PRC	1342	1666	49.8%	775.0	628.1	44.5%	1.2
REC	282	792	23.7%	440.4	413.1	29.3%	2.8
HES	266	627	18.7%	335.0	300.0	21.3%	2.4
OTH	100	145	4.3%	41.4	34.7	2.5%	1.5

PUB	76	117	3.5%	95.1	35.7	2.5%	1.5
TOTAL	2066	3347	100.0%	1686.8	1411.6	100.0%	1.6

Source: CORDA data, 1 January 2017.

Table 65 - Geographical participation patterns (top 25 participants sorted by EC contribution; the arrows show trend in amount of EC contribution from FP7 to Horizon 2020)

Rank	Participant Country	Country Group	Count	%	Participant Total Cost	%	Participant EC Contribution	%	Trend FP7 to Horizon 2020
1	GERMANY	EU-15	526	15.7%	300,442,139	17.8%	260,652,393	18.5%	
2	SPAIN	EU-15	471	14.1%	225,492,030	13.4%	198,826,842	14.1%	
3	ITALY	EU-15	381	11.4%	174,393,970	10.3%	152,782,358	10.8%	
4	UNITED KINGDOM	EU-15	306	9.1%	155,309,526	9.2%	143,237,868	10.1%	
5	FRANCE	EU-15	273	8.2%	135,327,526	8.0%	120,837,240	8.6%	
6	NETHERLANDS	EU-15	173	5.2%	90,146,423	5.3%	77,245,122	5.5%	
7	BELGIUM	EU-15	183	5.5%	84,739,422	5.0%	73,572,812	5.2%	
8	SWEDEN	EU-15	105	3.1%	53,342,563	3.2%	49,767,920	3.5%	
9	AUSTRIA	EU-15	95	2.8%	56,976,681	3.4%	48,319,520	3.4%	
10	GREECE	EU-15	95	2.8%	37,095,786	2.2%	34,689,919	2.5%	
11	FINLAND	EU-15	73	2.2%	36,778,740	2.2%	34,668,279	2.5%	
12	PORTUGAL	EU-15	86	2.6%	34,503,964	2.0%	31,723,708	2.2%	
13	NORWAY	Assoc	53	1.6%	39,616,430	2.3%	31,362,532	2.2%	
14	IRELAND	EU-15	51	1.5%	28,928,659	1.7%	26,300,745	1.9%	
15	DENMARK	EU-15	56	1.7%	27,063,268	1.6%	25,186,518	1.8%	
16	POLAND	EU-13	56	1.7%	22,558,704	1.3%	18,095,425	1.3%	
17	ISRAEL	Assoc	35	1.0%	21,470,530	1.3%	16,903,883	1.2%	
18	SLOVENIA	EU-13	36	1.1%	20,221,480	1.2%	16,571,181	1.2%	
19	CZECH REPUBLIC	EU-13	28	0.8%	8,782,058	0.5%	7,916,874	0.6%	
20	TURKEY	Assoc	22	0.7%	14,305,955	0.8%	7,902,910	0.6%	
21	LUXEMBOURG	EU-15	17	0.5%	9,180,358	0.5%	7,350,924	0.5%	
22	ROMANIA	EU-13	19	0.6%	8,364,359	0.5%	4,388,280	0.3%	
23	CYPRUS	EU-13	13	0.4%	5,086,886	0.3%	3,673,518	0.3%	
24	ICELAND	Assoc	4	0.1%	4,557,781	0.3%	3,403,614	0.2%	
25	HUNGARY	EU-13	11	0.3%	4,302,659	0.3%	3,084,361	0.2%	

Source: CORDA data, 1 January 2017.

F.7.3. International cooperation

A total of 399 entities from third countries applied to the programme, within 495 project proposals. 16% of these proposals were retained for funding, involving 88 third country

participants in signed grant agreements.[26] These participants were in Argentina, Brazil, Canada, Chile, China, Japan, the Republic of Korea, Mexico, Morocco, the Russian Federation, South Africa, Switzerland, Taiwan, and the United States (US).

The Commission engaged in two specific initiatives to support international cooperation, an initiative in nanotechnology safety (nanosafety) involving mainly the US; and the Intelligent Manufacturing Systems (IMS) initiative for advanced manufacturing.[27]

F.7.4. Cross-cutting issues

The NMBP programme has so far funded 761 SMEs (with 941 participations). Innovation actions accounted for 38.6% of the budget (EUR 581.6 million), focusing on demonstration and piloting activities.

In the NMBP area, 72.5% (EUR 1 091.1 million) of the budget used so far has been allocated to sustainable development (the target for Horizon 2020 being 60%), while 32.7% (EUR 491.5 million) has been allocated to climate action, mainly decarbonisation (the target being 35%); and 0.9% (EUR 9.5 million) of the budget has been allocated to biodiversity. 16.2% (EUR 225.5 million) is related to ICT. In terms of the integration of socio-economic sciences and humanities (SSH), 10 projects are relevant, with a total EU contribution of EUR 78.4 million.

Amongst project coordinators, 27.5% are women (percentage for projects where gender of the coordinator is known). Further, the women represent 50% of members in the NMBP advisory group, 48% of evaluators (value from 2016) and 54% of expert groups.

F.7.5. Other issues related to the state of implementation

The WP 2014 included a call on 'Sustainable Industry Low Carbon II' (Horizon 2020-SILC II-2014), which led to two projects.[28]

F.8. RELEVANCE

F.8.1. Is the LEIT-NMBP programme tackling the right issues?

F.8.1.1. Problems and issues addressed by the LEIT-NMBP programme

This section presents the problems and issues that the NMBP programme sought to address when it was established. More specifically, it discusses (1) the need to recover from the economic crisis and substantially increase the R&I investments of European industry; (2) the growing role of Key Enabling Technologies (KETs) in the European economy; and (3) the significant contribution of industrial technologies in addressing European and global societal challenges.

[26] *Figure based on 273 grant agreements until end October 2016.*
[27] *Following an assessment of the IMS scheme carried out in 2015, the Commission services have decided not to renew the current agreement when it expires in early January 2018.*
[28] *AGRAL on aluminium making process and LoCO2Fe on steelmaking process*

F.8.1.2. Need to accelerate the recovery from the crisis and to increase the insufficient R&I investments of European industry

The design of Horizon 2020 was informed by the need to exit the economic crisis. Low demand in Europe, continued uncertainties about the economic outlook, relatively high prices of raw materials and energy prices, as well as continuing difficulties in access to finance for SMEs, continued to weigh down on business confidence.[29] [30] By 2012, 3 million jobs had been lost since 2008.

Figure 102 - Intervention needs

Source: Horizon 2020 Impact Assessment, Industrial Policy Communication 2012)

There is a wealth of evidence demonstrating the crucial role of R&I in the sustainable growth of productivity and in economic growth: R&I are prerequisites for the creation of more and better jobs, and increasing R&I has a positive impact on the growth of real GDP.[31] The need for strong incentives to attract more industrial investments to R&I has influenced the design of Horizon 2020, notably for the Key Enabling Technologies (KETs) in the second pillar of Horizon 2020.

An analysis of economic data shows the key role of manufacturing industry as a key player in this. The share of manufacturing in the EU-28 was 15.7% of Gross Domestic Product (GDP) in 2015.[32] Industry is a driver of the knowledge-based economy and contributes to sustained productivity improvements, which ensure competitive positioning at the right stage of global value chains. Competitiveness is a key determinant for growth and jobs in Europe and industrial competitiveness is a horizontal objective in all EU policies[33]. Manufacturing has 26.1% share in the non-financial business economy and constitutes 22.4% of employment[34], and it accounts for disproportionally large contributions to the economy's R&D intensity and trade balance. In fact, manufacturing accounts for 64%[35] of private R&D investments and over 80% of all exported goods. The strongest sectors also being technology and knowledge intensive, are machinery and vehicles which represent 42% of exported goods, while other manufactured goods and chemical products represent 23% and 16% respectively.[36] It is estimated that for every job in manufacturing, a further job is supported in related

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[29] *Industrial Policy Communication. Communication and Staff Working Document No 297 (2012)*
[30] *Impact Assessment. Commission Staff Working Paper. SEC(2011) 1427 final*
[31] *Impact Assessment Accompanying the Communication from the Commission 'Horizon 2020 The Framework Programme for Research and Innovation'. COM(2011)808final. Commission Communication "Research and innovation as sources of renewed growth", COM(2014) 339 final of 10.6.2014*
[32] *Own calculations. Data from database: World Development Indicators; last updated: 10.14. 2016.*
[33] *DG GROW: https://ec.europa.eu/growth/industry_en; United Nations Industrial Development Organisation: https://www.unido.org/what-we-do/advancing-economic-competitiveness.html*
[34] *Own calculations, persons employed by NACE Rev. 2 - 2013 value: http://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=tin00151&plugin=1 http://ec.europa.eu/eurostat/statistics-explained/index.php/Manufacturing_statistics_-_NACE_Rev._2*
[35] *Latest Eurostat data, October 2016*
[36] *EU Industrial Structure Report 2013*

business services, such as logistics, marketing or legal advice, and more than half of the jobs supported by exports[37] are related to the manufacturing industry.

Numerous reports and publications on European industry and European industrial policy[38] flagged the declining share of manufacturing in European GDP, value added and employment, and underlined the need for the EU, Member States and industry to work together on common strategies to reindustrialise and modernise European industry. Also, the European Council addressed industrial competitiveness and policy at its March 2014 meeting.[39]

Since the beginning of Horizon 2020 industrial competitiveness has been integrated in many policy areas: e.g. regional policy, trade policy, competition policy, the Single Market strategy, the Capital Union measures, as well as in the Digital Single Market and the Energy Union of the Juncker Commission. Investment and employment in the EU are slowly approaching pre-crisis levels. But concerns remain as to whether the EU is prepared for future challenges.

This is because Europe shows a structural gap in private R&D investments, compared for instance to the United States (US), together with lower productivity growth, which puts competitiveness at risk. While EU industry is the biggest R&D spender, overall output lags behind the US and other countries. US industry has been continuously increasing its share of high-tech sectors, Europe's high-tech industries have lost their weight against medium-tech industries. In addition, productivity and R&D intensity tends to be lower not only in the high-tech sectors, but also in the more mature low-tech and medium-high tech sectors.[40]

[37] *EU Exports to the World: Effects on Employment and Income, Study by the European Commission Joint Research Centre and DG TRADE, 2015; 61%, down from 70% in 1995*

[38] ***Communication from the Commission "A Stronger European Industry for Growth and Economic Recovery - Industrial Policy Communication Update", COM (2012)587 of 10.10.2012 and Staff Working Document No 297***

[39] *Conclusions (2014) https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/141749.pdf*

[40] *Industrial Policy Communication. Communication and Staff Working Document No 297 (2012).*

Figure 103 - Gross domestic expenditure on R&D

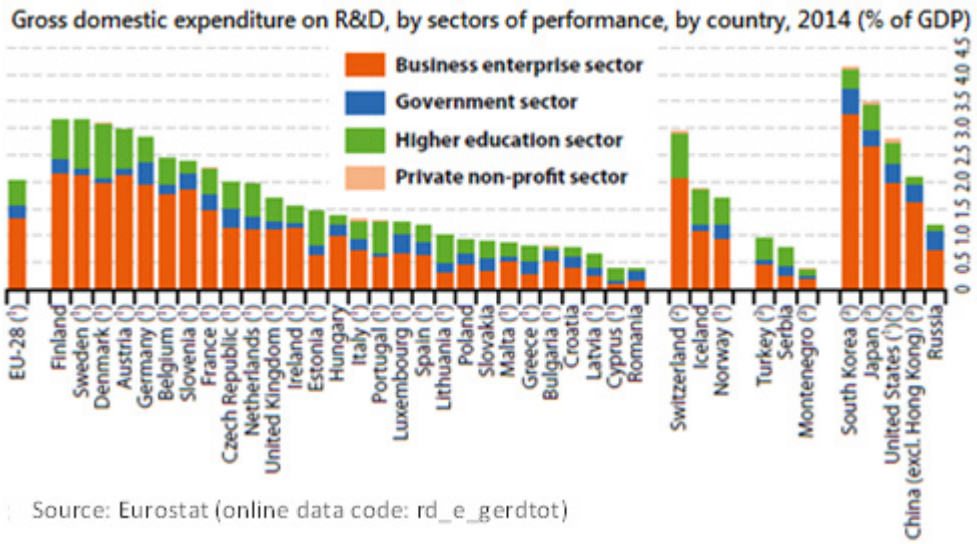
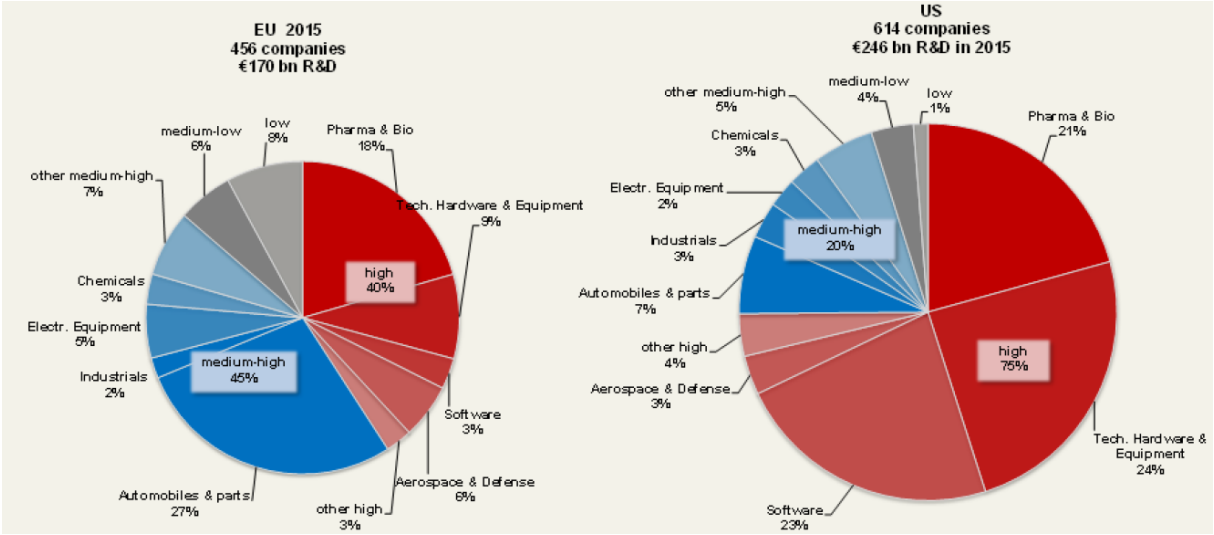
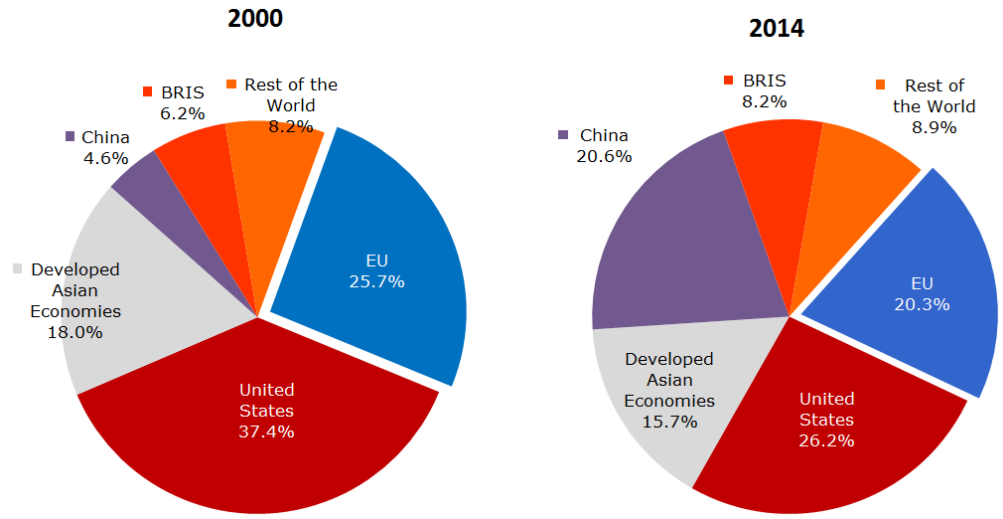


Figure 104 - Global government R&D investment



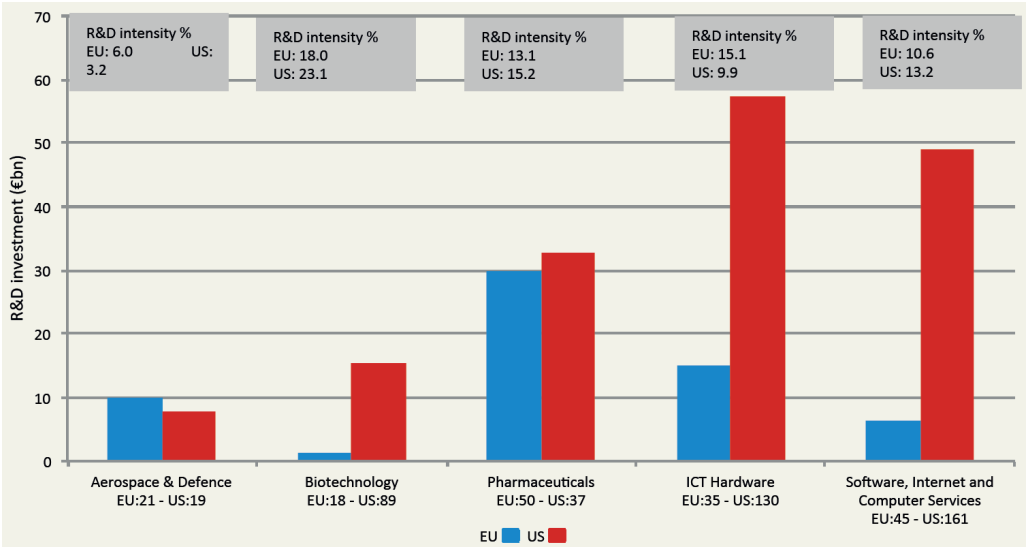
Source: European Commission, DG RTD

Figure 105 - Relative sector specialisation of the EU vs the US private sector



Source: The 2016 EU Industrial R&D Investment Scoreboard.

Figure 106 - R&D investment and R&D intensity for selected high-tech sectors EU vs US



Source: The 2015 EU Industrial R&D Investment Scoreboard.

F.8.1.3. Key Enabling Technologies: boosting the uptake of science based innovation

The industrial policy Communication[41] of October 2010 (describing the Europe 2020 flagship initiatives) brought the KETs into play. In order to boost the European economy and acknowledge the potential of the manufacturing industry, the Industrial Policy Communication 2012[42] 'A Stronger European Industry for Growth and Economic Recovery' identified KETs[43] as one of six priority action lines, together with advanced manufacturing technologies. The European KETs strategy[44] linked industry-oriented European R&I to other EU policies, highlighting the need for concerted efforts at the national and regional levels. The need for European action to foster KETs for Europe's industrial future and competitiveness was further highlighted in the Communication 'For a European Industrial Renaissance' (January 2014)[45] and a specific analysis on manufacturing was published in the report 'Advancing Manufacturing - Advancing Europe' of April 2014[46].

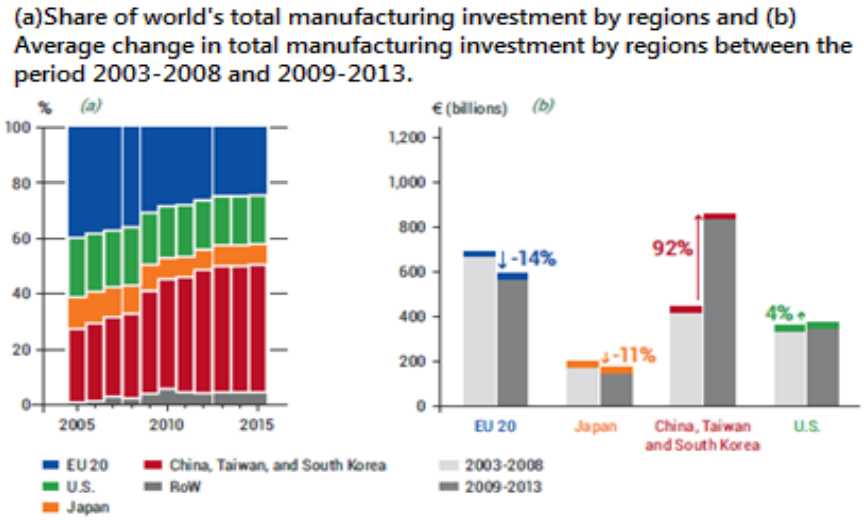
Looking at Europe's world leadership in sectors such as automotive, aeronautics, engineering, space, chemicals and pharmaceuticals, it is clear that this builds on technological leadership and entails a mastery of KETs including advanced manufacturing and processing. KETs account for 11% of employment.[47] Employment in medium and high-tech manufacturing, currently represents 37% of total manufacturing.

41 An Integrated Industrial Policy for the Globalisation Era Putting Competitiveness and Sustainability at Centre Stage, Communication from the Commission COM(2010) 614 final of 28.10.2010
42 COM(2012) 582 final
43 In 2009, the Commission adopted the concept of Key Enabling Technologies (KET) in the Communication 'Preparing for our future: Developing a common strategy for key enabling technologies in the EU', Communication from the Commission COM(2009)512 of 30.9.2009. Subsequently, the first High-Level Group on Key Enabling Technologies developed recommendations which inspired the Communication on the European KETs Strategy of 2012.
44Communication A European strategy for Key Enabling Technologies – A bridge to growth and jobs, COM(2012)341 final of 26.6.2012 – see also the Report of the first KET High-level Group
45 COM(2014) 14 final
46 Report of the Task Force on Advanced Manufacturing for Clean Production, SWD(2014) 120 final of 19.3.2014
47 KETs Observatory, European Commission, December 2015

Europe has more than a 35% share in production machinery and production volume of products highly dependent on KETs represents more than 19% of total EU-28.[48]

KETs are behind the special functionalities and performance of "intelligent" and "smart" products and processes.[49] But they involve considerable technological and financial risks, and to realise their potential it is necessary to "cross the valley of death". [50] To reach the higher technology readiness levels relevant to industry, there is a need for pilot lines and scale-up, which often goes far beyond normal risk-taking. This is especially true for SMEs, which are often not catered for adequately by Europe's financial institutions[51].

Figure 107 - Manufacturing investment



Source: KETs HLG final report, June 2015.

The KETs High Level Group of 2013-2015 looked at the entire industry ecosystem for innovation and assessed its strengths, weaknesses and changing context in Europe. The final report calls for coordination between innovation and industrial policies across the EU, with a focus on translating KETs into marketable products and services. According to this analysis, public intervention needs to focus on higher technology levels, with industrially relevant demonstrators and pilot lines, and their validation in view of going further towards industrial deployment and market introduction, at which point private investors are willing to invest and take risks. The report of the High-level Group also emphasises a need to fund demonstrators and pilots of strategic significance and to ensure that SMEs get access to the relevant technologies. What makes the need for action urgent is that Asia and the US are moving forward quickly, exposing Europe's weaknesses more than before. Asian economies (China, Japan, South Korea and India) are gaining ground.[52] And China has been rapidly increasing its share in global patenting. In the US, manufacturing is being reinforced to regain competitiveness, also through

[48] *Eurostat based figures from 2015.*
[49] *KETs Observatory, European Commission, December 2015.*
[50] *KETs are nanotechnology, micro-nanoelectronics, advanced materials, photonics, industrial biotechnology and advanced manufacturing systems. The Commission based the KETs selection following the screening of the common high-tech areas and strategies at Member State level. The selection criteria included their economic potential, their value adding and enabling role as well as their technology and capital intensity regarding R&D and initial investment costs. (COM(2009)512): "Preparing for our future: Developing a common strategy for key enabling technologies in the EU".*
[51] *EIB study on Access to finance for KETs, March 2015; See also Section 7.2 on external coherence with financial instruments*
[52] *"Asian companies continued to show substantial R&D growth." The 2016 EU Industrial R&D Investment Scoreboard. JRC, 2016.*

public sector measures. Advanced technologies including production technologies, and the increasingly important digital technologies and systems, have become core issues of government policies around the world, promising benefits from growth, sustainability and jobs. The concern of the KET High-level Group is that Horizon 2020 and other instruments are insufficient to leverage private investment and are not achieving critical mass and impact for industrial investments.

F.8.1.4. Support to Societal Challenges: Sustainability and clean production as a business opportunity

Many societal challenges will require technological solutions, which KETs can provide[53]: examples include battery chemistry to support energy storage and e-mobility, advanced manufacturing, lightweight materials, medical technologies for personalised diagnosis and therapy, smart factories and supply chains, and customised and localised production. Across the industrial sectors, including in construction, KETs are enabling significant reductions in greenhouse gas emissions and in the use of energy and raw materials.[54]

As the Horizon 2020 Impact Assessment noted, investment in applied research focusing on societal challenges would generate the quickest and broadest societal and economic returns, which would in turn meet most explicitly the short- to medium-term concerns of Europe's citizens, Member States and the EU. For example, strong growth is expected in the world markets for clean production technologies, with size expected to double from some EUR 380 billion in 2007 to 765 EUR billion by 2020.

Given the importance of the processing industry as a supplier for other industries in many value chains, and its contribution to the economy and employment, the benefits of reducing costs such as raw materials, feedstock and energy are clear. The circular economy is a related opportunity.[55] Other important markets, such as water efficiency and waste water treatment, are expected to grow by 6-11% annually.[56]

Buildings are the highest energy consumer in Europe[57] and a main contributor of CO2 emissions.[58] Therefore, it could become one of the key contributors to EU decarbonisation efforts, with new solutions for building design, materials and processes as well as insulation, energy provision or heating and cooling relying on KETs.

F.8.2. Flexibility to adapt to new scientific and socio-economic developments

While the general needs and problems in the fields that this programme addresses have remained the same, significant developments are confirming the relevance of the programme and underline the need for intervention.

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[53] *An example of current project: http://www.helis-project.eu/*
[54] *KETs Observatory. DG Growth, December 2015, p. 23.*
[55] *Ellen McArthur Foundation: Economic and business rationale for an accelerated transition. 2013*
[56] *Frost&Sullivan 2012: Membrane-based water and wastewater revenue forecast for Europe.*
[57] *Climatic change, with the increase of ambient temperature, undoubtedly affects the built environment and leads to a significant increase in energy consumption in the building sector.*
[58] *S.-N. Boemi et al. (eds), Energy Performance of Buildings. Springer International Publishing Switzerland 2016, p. 95.*

F.8.2.1. Global competition for manufacturing and accelerating KETs innovation

While the real-term increase in value added in manufacturing suggests that the EU as a whole has maintained its competitiveness in this sector[59], the share in global manufacturing has continued to decrease[60]. Global trade has been expanding much faster than intra-EU trade. In addition, the ever more dynamic global markets adopt technological developments rapidly, creating a challenging environment. EU manufacturing exports are gradually being replaced by products from emerging industrial powers in the traditional high-income markets of North America and Europe. This trend is likely to determine the dynamics of world trade in the future and the EU's opportunities for export expansion.[61]

The urgency to act is further demonstrated by recent developments in the machine tool industry, one of the key KETs application sectors: the European share in global production dropped from 44% in 2008 to 33% in 2010, to the advantage of Asian competitors, namely China (including Taiwan) and Korea. These lower-cost countries are rapidly upgrading their technological base and improving productivity through investments in advanced automated production systems. Although Europe's share of production rebounded to 40% in 2014, and the industry has shown stable production levels during the last four years, this is still not enough to reach parity with the US and Asia-Pacific.

As a consequence, there is a need to provide short- to medium term opportunities for growth and job creation, and there is a need to mitigate the risk of loss of knowledge, because R&D and manufacturing are intricately linked and often take place in close proximity to each other.
The NMBP programme therefore addresses areas of key relevance for advancing the manufacturing industry and creating opportunities for investments in Europe ("re-industrialisation").

F.8.2.2. Industry trends: The "4th Industrial Revolution", digitisation and servitisation

Digitisation is changing the manufacturing landscape and the race to adopt digitisation (commonly referred to as the fourth industrial revolution) is already under way among companies in Europe, the US and Asia. This shift in manufacturing will affect producers' entire value chains, from design to after-sales service. In order to achieve the necessary global usability and cross-system consistency, international standardisation in industrial automation will play an important role and is pursued as a matter of priority.[62] The association implementing the cPPP Factories of the Future[63] released "Factories 4.0 and Beyond" in September 2016, an update to its roadmap showing how to realise the benefits of the Fourth Industrial Revolution, including through new types of skills and customisation, while building on past and present achievements.[64]

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[59] *Study "EU Structural Change 2015", Report by the European Commission DG GROW*
[60] *In terms of manufacturing value added, EU lost its first position as the main manufacturing producer in the World. In 2014, EU is still far from the pre-crisis levels. Data from database: World Development Indicators, retrieved 11/11/2016.*
[61] *Study "EU Structural Change 2015", Report by the European Commission DG GROW*
[62] *German Standardization Roadmap Industry 4.0. Deutsche Kommission Elektrotechnik, Eletronik, Informationstechnik, 2016.*
[63] *European Factories of the Future Research Association (EFFRA)*
[64] http://www.effra.eu/roadmap/application.projects.all.php

The fourth industrial revolution brings opportunities for new materials, nanotechnologies and advanced manufacturing[65], and will also transform environmental and energy technologies. Global sales in emerging application markets (currently without visible sales) are forecast to be worth nearly EUR 700 million in 2019. The top 10 emerging technologies identified by the World Economic Forum in 2016 include five technologies directly related to the NMBP portfolio: nanosensors and the internet of nanothings; next-generation batteries; two-dimensional materials; perovskite solar cells; systems metabolic engineering.

Another example of digitisation in manufacturing is Additive Manufacturing (AM), the process of making objects from 3D model data by adding materials layer by layer (as opposed to the traditional, "subtractive" manufacturing). The technology has matured through EU projects and is now ready for broader deployment in some sectors, while much R&I work is needed to broaden the applications. Although European regions face strong competition from Israel, the US and Japan in plastic AM and hybrid manufacturing, as well as from China in emerging areas such as bioprinting, they are world leaders in areas like metal AM, selective laser melting and biomedical AM research. One NMBP project is already developing fully personalised bionics and smart prosthetics to improve a quality of lives of mobility-impaired people. Nevertheless, some value chain segments are missing or could be strengthened in Europe, such as high-end metal powders or food printing, and the European AM landscape remains fragmented.[66] In order to address the latter for example, the 'Business models and industrial strategies supporting novel supply chains for innovative product-services' Coordination and Support Action has been placed in the 2017 Work Programme.

The manufacturing industry has become increasingly service focused. This is explained by the increasingly blurred product-service boundaries, the outsourcing of R&D functions, and the need to remain competitive in a world economy where more goods are being produced in developing countries offering lower costs of production. Firms previously focussed on straight manufacturing increasingly position themselves as "solution providers", often based on using advanced technologies in their products and digital and data based services. Customisation or after-sales services are examples. In some areas, business models are changing, e.g. from sales to leasing relationships with customers. On the other hand, higher labour costs in Europe may be offset by improvements in productivity and resource efficiency, and the development of high-tech products and services.[67]

The feedback from current projects during the interim evaluation regarding the envisaged outputs and impact does not reflect the importance of these developments.

F.8.3. The relevance of NMBP in addressing European objectives

F.8.3.1. Industry relevance and jobs, growth and investments

The LEIT-NMBP programme is expected to contribute to the creation of jobs, growth and investments. Mastering the KETs determines the competitiveness of companies on the growing markets for KETs based products. These advanced technologies do not only make existing products and processes "better" ("next generation" products and

[65] *Klaus Schwab, The Fourth Industrial Revolution, 2016*
[66] *Identifying current and future application areas, existing industrial value chains and missing competences in the EU, in the area of additive manufacturing, July 2016.*
[67] *The Interaction of Resource and Labour Productivity. Sustainable Europe Research Institute, December 2015.*

processes) but they have the intrinsic potential to provide new solutions to needs, and create new markets.[68]

Products and services based on KETs[69] represented about EUR 953.5 billion or 19.2% of the total EU-28 production in 2013, and this is increasing.[70] 25% of European GDP added value[71] is derived from industry (incl. construction) Machinery & transport equipment and other manufactured goods represented 64.5% of EU-28 exports in 2015 and it represents 82% when included chemicals & related products. Industry remains an important economic sector and the industries served by NMBP, and their users, are an important part of the European economy in terms of employment and competitiveness.

The European economy and industry are also facing rapid changes due to the need to address climate change and reduce pollution and waste.
The NMBP programme helps industry to face these challenges through new relevant technologies underpinning new solutions, products, processes and services. It funds projects to further develop and demonstrate enabling technologies across sectors and applications. In line with European policies as well as with Europe industrial strengths it also fosters enabling technologies to achieve specific policy objectives. For example in the energy, construction and transport sectors, projects address the next generation of high-performance energy technologies for energy storage, energy generation and energy efficiency, as well as the reuse of CO2 and the optimisation of the use of resources in the process industry.

F.8.3.2. Sustainable and clean production: Energy Union and Climate policy and the Circular Economy

As noted above, the NMBP programme is expected to make significant contributions to a sustainable and clean industry. The importance of concentrated efforts in these areas is underlined in the Strategic Energy Technology Plan (SET-Plan), the Commission proposal for the revision of the Energy Performance of Buildings Directive, the industrial policy emphasis on supporting and decarbonising "energy-intensive industries". These all refer to research and innovation as an ongoing and necessary action line, including the PPPs.

The "Accelerating Clean Energy Innovation" communication[72] encompasses reinforced activities to mitigate climate change, in line with the COP21 objectives. Many of the activities needed to reach the goals of the Energy Union and climate action are in areas served by NMBP. In early 2016, NMBP supported 107 projects that developed advanced materials and nanotechnologies for energy applications. These projects enable a wide range of energy applications, as shown in the table below.[73]

Figure 108 - Overview of NMBP projects for energy applications

[68] *KETs observatory. DG GROW, May 2015.*
[69] *micro- and nanoelectronics, photonics, nanotechnology, biotechnology, advanced materials and advanced manufacturing and processing*
[70] *KETs Observatory, European Commission, December 2015.*
[71] *A figure for euro area countries from 2015. https://www.ecb.europa.eu/mopo/eaec/html/index.en.html*
[72] *COM (2016 763) of 30.11.2016*
[73] *Case study Contribution of NMBP to the Energy Societal Challenge.*

Generic	Thermo-electrics	Solar	Fuel cells	Hydrogen	Biofuels	Gas turbines	Oil and gas	Electrical power	Wind	Wave	Coal	Nuclear	Energy	Modelling	Energy storage	Energy efficient	Energy efficient
5	1	19	3	2	8	2	1	1	9	4	2	1	6	3	21	16	9

Source: European Commission, internal analysis DG RTD.

Furthermore, NMBP aims to demonstrate the economic and environmental feasibility of the circular economy approach while supporting the re-industrialisation of the EU. In this regard, the Sustainable Process Industries (SPIRE) initiative, addressing eight key European industrial sectors, is expected to enable a more efficient use of resources, such as raw materials, water and energy (including renewables); high-tech and eco-efficient production facilities and materials; and minimising and re-using waste, including CO2. The industry is currently examining the potential of an Important Projects of Common European Interest (IPCEI) on CO2 reuse.

F.8.3.3. Health

The NMBP programme supports KETs (nanotechnologies, biomaterials and biotechnology) for healthcare, including personalised diagnostics and therapies. These technologies reflect the paradigm shift from the symptomatic treatment of diseases towards predictive, preventive, personalised, participatory, precision medicine and care, offering new opportunities to increase the efficacy of healthcare while reducing costs to patients and healthcare systems. A key issue is to help SMEs translate their ideas into marketable products. Therefore the NMBP programme includes specific actions to help SMEs mature and validate their technologies to be ready for clinical trials including support for upscaling through pilot lines.

F.8.3.4. The Digital Single Market - Digitising European Industry

In the Communication "Digitising European Industry"[74] the Commission outlined its plans to foster the development and uptake of digital technologies and systems in European industry. Building on the convergence of digital technologies, this is not only a matter for the digital industry (the providers of digital solutions), but for all sectors of the economy. The process of bringing national programmes together and identifying the scope of joint actions has started. Initiatives such as digital innovation hubs and digital platforms, e.g. for "smart, connected factories", are directly related to the NMBP programme and in particular to the Factories of the Future and SPIRE initiatives. Also the European Cloud Initiative,[75] creating an infrastructure for sharing data to underpin open science, and a Communication on ICT Standardisation priorities are a part of this package.

F.8.3.5. Open Innovation

More than 20% of European GDP in 2013 derived from businesses selling materials, components, products and technologies to each other. In the NMBP programme, open

[74] *COM(2016) 180*
[75] *European Cloud Initiative - Building a competitive data and knowledge economy in Europe", COM(2016) 178 of 19.04.2016*

innovation is reflected in the composition of consortia involving large industry, SMEs and researchers and in particular industrial users. There are also many examples where authorities and end-users are involved, as well as a broader constituency of practitioners representing social sciences and humanities.

An ongoing NMBP project, E4Water, is leading the way in open innovation in industry, tackling the unsustainable use of water. This project brought together more than 200 stakeholders from industry, academia, the public sector and end-users. This collaboration has developed solutions with a direct impact on the environmental and water footprint of industry, by dramatically reducing contaminants in waste streams from industrial parks that participated in the project. The success lies less in the technologies and more in the transfer of knowledge between industrial stakeholders, public authorities and end-users.[76]

F.8.4. Addressing specific stakeholder needs

F.8.4.1. Industry and SMEs

The programme appears highly relevant to industry and SMEs, in helping them sustain and boost their leadership in KETs. The current participation rate of industry is 49.8%, a four points increase from 45% in FP7, at which time this participation rate was significantly above average. The participation of industry in cPPP projects has reached almost 60% in the first years of Horizon 2020. In budgetary terms, the share of industry rose by 8.5 points, from 36% in FP7 to 44.5% in Horizon 2020. The activities involve 54% of newcomers to the programme (compared to 33% of newcomers to Horizon 2020 overall), of which 87% are from industry, and roughly half are SMEs. The SME participation rate is 36.2% of distinct participants[77]. Within the contractual PPPs, 77% of project participants are not members of the corresponding industrial associations, showing the openness and relevance of this mechanism in addressing the needs of industry.

Project coordinators described the LEIT-NMBP programme as extremely relevant, especially in relation to scaling up and further developing technology to higher technology readiness levels (TRLs).[78] The survey conducted for this evaluation saw a response rate of 77%,[79] while the ex-post evaluation of the predecessor programme in FP7 reached a return rate of 40%. Project coordinators interviewed as part of the case study on SME involvement noted that the NMBP programme was especially relevant to them as it funded their innovation, and allowed them to collaborate with important partners and participate in front-end research.

Stakeholders[80] considered the thematic fields well defined and topical. At different TRLs, and depending on the specific challenges addressed, the relevance of the programme is seen in the cooperation of partners across the 'triple (or quadruple) helix', that is industry, universities (and Research and Technology Organisations - RTOs) and governments, with citizens where relevant. Another important feature for stakeholders was the possibility to bring new developments closer to the market and to validate the achievements in an industrial environment while still staying in a precompetitive environment. They see the value of the programme in terms of a strategic and longer-term perspective. In the words of one interviewee, "the long-term relevance is here".

[76] *www.e4water.eu*
[77] *Excluding SME instrument*
[78] *Response from the online survey of NMBP project coordinators, June-July 2016*
[79] *Return rate of 77% counts for RIA/IA projects, while the small sample of CSA projects reached 59%.*
[80] *From interviews with stakeholders*

Interviews with a sample of companies from the NMBP field[81] showed interest in the programme calls for different reasons. Established companies and big industries are less interested in the funding and they join the consortia for cooperation to conduct demonstration/piloting activities. This is intended to accelerate the market introduction/commercial uptake of innovation and to reduce financial and technical risks associated with innovation. On the other hand, start-up companies from this field identified access to research funding and the funding rates as the main reason for their submissions. While the interviewed start-up and growing companies have expressed no doubts in participating in the future LEIT-NMBP calls, established companies and big industries have been more hesitant and emphasised concerns regarding the number of hours required for a preparation of such participation. The relevance of the programme and the funding opportunities (meaning published calls) received a positive response among the interviewees. Also, they noted that the Programme objectives are relevant to the beneficiaries' problems and market needs.

A point that stakeholders often made was the balance between industry and academia. They indicated that industrial players are interested in higher TRL projects, whereas academia tends to be more interested in lower TRL projects. What is interesting is that external stakeholders as well as programme coordinators had different perceptions of the extent to which the programme was actually relevant to industry. A few stakeholders noted that in practice the programme still benefits academia and research organisations more than industrial actors. However, as noted above, the industrial participation has increased. Further, a recent analysis shows that out of the 67 companies in Deloitte's FAST 500 list which participated during the last four years in FP7, the ICT and the NMP programmes attracted about half of them. This shows the importance of ICT and NMBP to fast- growing companies.

F.8.4.2. Stakeholder involvement in priorities and topics

Another important aspect related to relevance is the way in which underlying roadmaps and priorities of the programme are defined. The Horizon 2020 regulation requires programme priorities to be set in liaison with stakeholders from all sectors concerned.

Desk research and interviews with EC project officers confirmed that the priorities relating to nanotechnology, advanced materials and advanced manufacturing and processing are aligned with the priorities of external stakeholders. The primary mechanism for stakeholder feedback are the relevant European Technology Platforms (ETPs). These are "industry-led fora, recognised by the Commission as key actors in driving innovation and EU competitiveness". ETPs develop R&I roadmaps for action at EU and national level (to be supported by public and private funding); encourage industry participation; and organise dissemination and information events.[82]

Table 66 - European Technology Platforms consulted for the LEIT-NMBP programme

European Technology Platforms

[81] *Nine interviews with high management of companies (R&D directors, Chief Operation Officers, CEO, Head of Innovation department) from the NMBP field conducted in February 2017.*
[82] *Source: Website European Commission on the Innovation Union. Retrieved on 28 September 2016, from: http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=etp.*

EUMAT-Advanced Engineering, Materials and Technology	Industrial Safety (ETPIS)
ETP SMR-Sustainable Mineral Resources	Future Textile and Clothing
ESTEP-European Steel Technology Platform	Forestry Technology Platform
Nanofutures	ConXept
Nanomedicine	ECTP-European Construction Technology
ETP for Sustainable Chemistry	Manufutures

Source: Interim Evaluation LEIT-NMBP.

A structured and formalised relationship with stakeholders has been established through the agreements with the respective associations of the contractual Public-Private Partnerships. Their Partnership Boards advise the Commission on priorities and topics. The subsequent calls are fully open to all interested stakeholders.

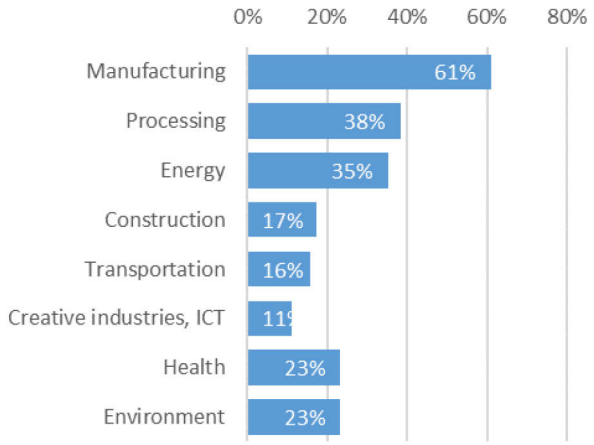
Biotechnology is the only area where inputs have not been gathered in a structured way via the ETPs. Instead, these are gathered on an ad hoc basis, notably during the recent NMBP public stakeholder consultation process[83], and from the NMBP Advisory Group

Some new advisory mechanisms have emerged, notably EMERIT for materials for energy and ESTHER for medical technologies.

F.8.5. Other issues related to relevance

The survey of coordinators confirmed that the NMBP programme covers many different industries in terms of the applications of the results. Many results are cross-sectoral in nature, intended to be used in several different industries. With regard to the areas of application, the manufacturing sector was identified most frequently by project coordinators (61%), followed by process industries (38%), the energy sector (35%), health and environment (both 23%); construction (17%), transportation (16%) and creative industries/ICT (11%).

Figure 109 - Intended sectors of application of the solution

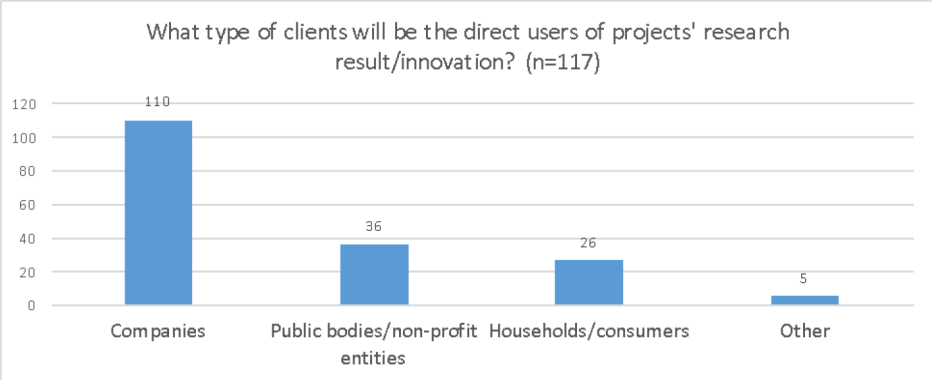


Source: project coordinators survey, N=116, July 2016.

[83] *In total, 30% of the contributions of the stakeholder consultation were on biotechnology. Source: Information provided by the European Commission (RTD.D).*

The survey of project coordinators sheds also light on the direct users of the research and innovation results of the projects. Companies (including the consortium members themselves) are the main client group of the solutions developed. Approximately a third of the project coordinators indicated that public bodies and non-profit entities were also direct users of their results, and a fourth of respondents mentioned consumers and households.

Figure 110 - Direct users of the projects' research results and innovation



Source: project coordinators survey, July 2016.

Coordination and Support Actions (CSAs) typically cluster activities or develop recommendations for research and innovation. Asked about the direct users of the CSA results, project coordinators pointed to public bodies (16), policy makers and private companies (both 14), followed by the broad public (6) and civil society (3).

F.8.6. Lessons learnt / areas for improvement

The relevance and importance of a framework programme part dedicated to key enabling technologies and industry is supported by extensive literature on the competitive position and innovation capacities of industry in Europe. The key issues are to advance industry in areas which drive and underpin their competitiveness and new products, processes and services. The higher technology readiness levels have attracted higher industry participation and there is evidence for the need to specifically support growth and scale-up of start-ups and SMEs.

The programme also makes an effort to contribute to European policy objectives. It aims at capitalising on the opportunities presented by the global challenges of climate action, energy the circular economy and health by including specific topics or relevant sustainability requirements for the expected impact of funded activities across the board, as demonstrated also in the significant contribution to the Focus Area "Industry 2020 in the Circular Economy" in the Work Programme 2016-17.

While the period of two years since the launch of this programme is relatively short, the surveys and interviews[84] conducted for this interim evaluation confirmed the validity of the initially identified problems and needs, as well as the continued relevance of the programme objectives.

Even though the problems and needs have not fundamentally changed in the last few years, recent developments once again show the relevance of the programme. One of

[84] *Project coordinators, stakeholders including Member States representatives, Commission staff*

these developments is the increasing importance of KETs for industry (as indicated by the findings of the KETs High Level group of 2013-2015 and the KETs Observatory). Another development relates to the fourth industrial revolution, digitisation and the shift to services.

The NMBP programme was found to be relevant not only to industry, but also to the academic world and people in general. Rankings of future technologies also show the innovation potential of combining and converging technologies, for example bio-based technology with nanotechnology and "classical" chemistry for advanced materials. At the "enabling" level, this is addressed through a "cross-KET" approach, for example converging nanotechnology, advanced materials and bio-materials, including advanced manufacturing[85].

The challenge is to make the best of the available budget, to position the Work Programmes and actions well in relation to industry strategies, and to achieve the hoped for leverage of private investment. This calls for attention to technology trends, as well as to the needs of start-ups and SMEs. A key issue is the scaling-up of developments, for which complementarity with other instruments and sources of funding and finance is essential.

F.9. EFFECTIVENESS

F.9.1. Short-term outputs from the programme

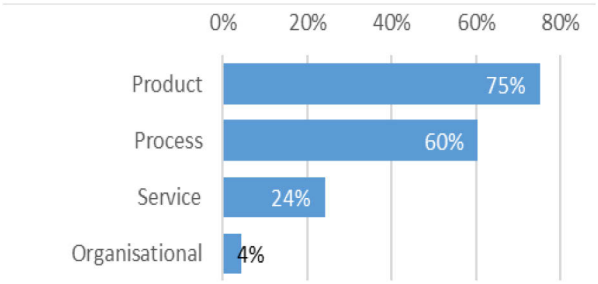
The envisaged outputs of the projects show the industrial relevance of the programme and projects. Research and Innovation Actions and Innovation Actions, making up 92% of projects, are aimed at testing and demonstrating new materials, biotechnologies, manufacturing technologies and processes through demonstrators or pilot lines (TRL 4-7). Particularly relevant are demonstrators on technology integration in an industrial environment, for example those from the dedicated Pilot Lines call, which include also open access pilot lines for SMEs. In the first two years of Horizon 2020, 24 projects containing pilot lines were approved, receiving a combined grant of EUR 138 million. For the 2016-17 Pilots, a grant of EUR 80 million has been allocated. 58% of pilot line participants are from industry; 34% are SMEs receiving EUR 44 million in funding. At the time of writing, a total of 77 pilot lines have been developed within the 24 projects.

Innovation outputs

The project coordinator survey confirms the findings with regard to market-oriented innovation outputs: 75% of the relevant projects aim at developing a new product (confirmed for Factories of the Future projects in the Innovation Radar pilot completed in 2016); 60% a new process; and 24% a new service. The proportion of projects which target organisational or business model innovation is smaller, only 4%.

Figure 111 - Type of the innovation

[85] *For example in the area of Organic LED in actions from a joint call with the ICT Programme in the Work Programme 2014-15.*



Source: Project coordinators survey, July 2016.

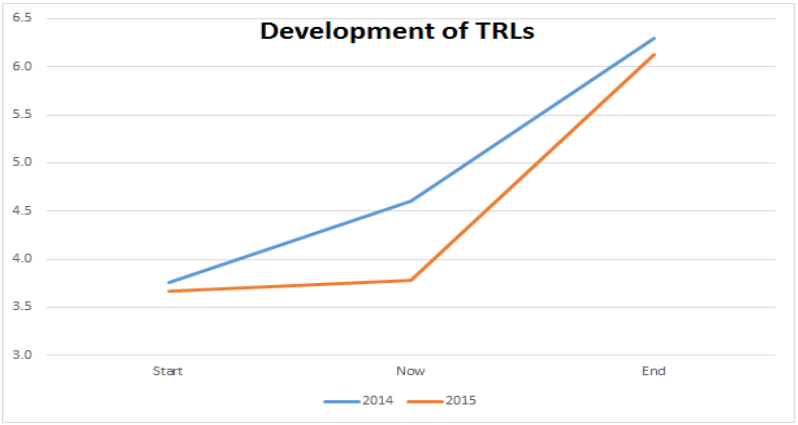
Development of new knowledge and related learning effects are amongst the most frequent outputs to be achieved (new knowledge was mentioned as a most basic outcome by 67% of the projects). The interviews with coordinators showed that when it comes to private partners, acquiring new knowledge constitutes a decisive economic factor. An even more significant finding is that it was asserted in interviews that the effects on learning are of particular benefit to SMEs. Regulation activities, standardisation and norms accounted for about 11% of the expected outputs from the sample. This aspect could be potentially important if one considers the opinions expressed by some interviewees about how important such issues may be for commercialisation success.

Progress on Technology Readiness Levels (TRLs)

The LEIT-NMBP programme addresses mainly higher TRLs in order to move research and laboratory results towards industrial development and validation, with a view to subsequent industrialisation and commercial deployment, if successful.

The main conclusion from the analysis of projects (survey of coordinators) shows that for each of the four technology areas a very clear progression up the TRL ladder can already be observed at an early stage.

Figure 112 - Indication of TRL in project at the start, current and expected



This includes a subset of projects from the survey(69 from 2014, 63 from 2015), where TRL levels were indicated.

Source: project coordinators survey, July 2016.

The main conclusion from the analysis shows that for each of the four technology scientific fields a very clear progression up the TRL ladder can already be observed at an early stage.

The projects closest to the market are predominantly found in advanced manufacturing; and as expected they are Innovation Actions more often than Research and Innovation Actions. Also, the survey showed that radical innovations are often found in projects with low TRLs. Being closer to the market also suggests that the results are exploited

earlier, typically within three years from the end of the project (confirmed in the Innovation Radar pilot for Factory of the Future projects with 61% of the innovations due to be introduced in the market within three years). Respondents commented that in some cases an overall TRL is assigned to a project, with certain components being at lower or even higher levels. Interviews showed also that academics and industry tend to rate TRLs in different ways, leading to sometimes different opinions and perceptions as regards industry requirements and criteria to define "maturity". Sometimes the integration of fairly mature technologies entails significant development, and the overall TRL will be lower in such cases.

Standardisation

The survey of projects showed a 16% contribution to regulation and standardisation/norms as part of the output. This figures has been compared with an internal analysis, where the 179 NMBP projects (including CSA projects) in Horizon 2020 (as of June 2016), 26 have submitted detailed plans on standardisation in their work packages. These 14.5% resulting from the internal analysis are comparable with the 16% from the survey. Projects deal with standardisation mainly by referencing standardisation bodies and specific standards relevant to their field of endeavour.

The projects consider three options regarding standards:

1. To try to make the outcomes of the projects fit into existing regulation and standardisation codes;
2. To amend or extend existing standards to accommodate new products that emerge from the projects;
3. To create entirely new standards for new products.

Business Plans

The NMBP work programme has set out specific requirements with regard to an initial description of the business plan already at proposal stage (or, in 2016-17, the business case and exploitation strategy). Apart from the general move to higher TRLs and the introduction of the pilot line concept, this specific requirement has probably been the most noteworthy new element in Horizon 2020 for consortia and projects.[86] Questions submitted to the helpdesk and feedback from the proposal evaluation process[87] show that this requirement is galvanising new efforts from the programme applicants.

In the interviews and in the survey, the prevailing opinion was that dealing with business plans at the end of the projects would be too late to be effective. A total of 140 projects (78% in June 2016) have made provisions for business or exploitation plans as dedicated work packages, to further develop initial business plans during the project.

The project coordinators confirmed in the survey that developing the business case is important to them: 33% already conducted a market analysis more detailed than in their original application, and 59% planned to do so. Only 9% did not intend to undertake a market analysis. The findings are similar concerning the preparation of a detailed business plan for the exploitation of the results: 25% had already done it or were preparing it at the time of the survey, and a further 69% were planning a business plan in the course of the project, and only 6% did not intend to prepare a detailed business plan. To draw attention to this key issue and to ensure that it was addressed properly, workshops on business plans were organised by the Commission for partners in the pilot line projects.

[86] *See Introductions to the Work Programmes 2014-15 and 2016-17*
[87] *Observers reports (not published)*

Barriers to innovation

The survey of projects revealed that the main barriers to full effectiveness of the project perceived are still technological (73 respondents, 58%). This is a characteristic of applied research rather than close-to-market innovation or commercialisation projects. Issues with current regulation and standards were a barrier for 43% of the projects. Current regulations may not support the development of the new technologies, leading to risks. Direct risks arise from the uncertain outcome of clinical studies and regulatory authorisation (notably for biotechnology and health-related developments), and indirect risks from delays in successful market entry. All these are possible barriers which need to be considered in risk assessments.

Some of the typical barriers for projects oriented towards commercialisation arises from difficulties in market entry. These include the customer acceptance of the new solutions; access to a sufficient pool of end users; and overcoming various other obstacles created by competitors, public procurement practices etc. This type of barrier was the third most common in the survey, identified by 53 respondents (42%). As expected, the market entry barrier is more relevant to IA than RIA projects, that is for projects envisaging shorter-term exploitation. This observation is consistent with studies describing barriers to innovation, notably the valley of death in the area of KETs. A study by the European Investment Bank (EIB) on Access to Finance for KETs companies shows that many KETs companies, especially small and middle-sized ones, struggle or fail to obtain adequate debt financing, hampering their uptake of new technologies. Despite the favourable conditions of the market, the banking sector does not meet the specific needs of many KETs companies, because of a general aversion to risk, but also because of a lack of knowledge of the KETs sectors.[88]

The interviews also touched upon business plans or market analyses for newly developed solutions. Several interviewees explained that the quality of the business plans and the level of exploitation were heavily influenced by several factors: the Technology Readiness Level; the consortium partners involved; and the engagement and support of the project officer. Interviews confirmed that projects with higher TRLs are more likely to exploit their results in the near future, as mentioned in the Innovation Pathways Study.[89]

Dissemination activities

The programme calls for significant communication and dissemination activities in the projects. These may be essential for commercialisation and for facilitating the necessary regulatory changes – but also to help distribute the knowledge generated by publicly funded projects amongst stakeholders who might be interested in them. The survey of coordinators revealed that the dissemination is mostly through non-peer reviewed and non-academic journals (80% and 62% respectively). Project websites and conferences provide additional dissemination opportunities (34% and 17% respectively).

Projects may address different groups of stakeholders, and their dissemination and communication strategy (where one exists) must target the most relevant groups and determine how these will be reached. For instance, some projects have incorporated social media into their communication mix, while all projects have a dedicated website.

A well thought-out dissemination strategy will be instrumental in addressing prospective customers in areas where market entry is difficult because of concerns with new products (e.g. the construction market where there is a certain inertia in opening up to innovative

[88] http://www.eib.org/attachments/documents/innovfin_access_to_finance_conditions_kets_en.pdf
[89] *How to convert research into commercial success story? KMU Forschung Austria, 2013.*

approaches, and where the designer community, consultant engineers and architects, should be addressed effectively)[90]. Some projects expect to receive help from the cluster in which they participate. In certain projects a specific partner in the consortium has a dedicated role with regard to dissemination and communication.

F.9.2. Expected longer-term results from the programme

Most of the 115 surveyed projects funded under NMBP aim at some commercial exploitation of their innovation results. Only eight RIA or IA projects failed to provide a plan to commercialise the results (this question was not put to CSA projects).

Leveraged private and public investment in R&I

About a quarter of projects (26%) have already invested additional funds – not initially budgeted – to pursue their exploitation objectives. This is in line with the programme expected outputs as stated in the intervention logic (closer to market outputs). The additional investments overwhelmingly came from private sources, but public funds were also drawn upon by a minority of projects. As one would expect, projects that have already exploited some or all of their results, or where the chances for exploitation are very good in the opinion of respondents, were more likely to have invested into additional commercialisation activities. On the other hand, no correlation was detected with the starting TRL of the project.

The question regarding the intention to invest additional funds to commercialise results probably came at too early a stage. Only 9% of the respondents said that they do not plan to mobilise additional funds to invest in exploitation. The question also highlights the need for public follow-up funding: less than a third (29%) plan to rely exclusively on private funds for further commercialisation activities, while 62% plan to add public funds to the mix (with 2% relying entirely on public funding). This is discussed further in chapter 7 on the coherence of the programme.

In the case of the contractual Public-Private Partnerships (cPPPs), which account currently for 45% of NMBP project funding, further industrial investments beyond the projects arise from the explicit commitments made by the private side. In the latest progress reports, the respective cPPPs show leverage factors between 1.5 and 3.5, on the basis of a methodology accounting only for current investments and discounting future investments. Counting on the fact that larger investments are not forthcoming at the very early stage of technology development, a leverage factor of 4-5 could be expected for successful projects in the SPIRE and FoF initiatives.[91]

Diffusion of innovation in products, services and processes

Observing the types of innovation that result from the surveyed projects, the high proportion of process innovations (over 80%) pointed towards positive longer-term results. This is also true of service innovations (found in a about a quarter of all projects), indicating that these will play a role in the current tendency in European industry to introduce services.

Several interviewees among the programme participants dealt with the time to market and the introduction of innovations in the market as a direct result of the funded projects. According to them, the issues of exploitation and customer engagement were insufficiently addressed during the project. On the other hand, the responses of project coordinators showed that 75% aim to develop a new product, 60% a new process, and

[90] *Interim Evaluation of the Horizon 2020 NMBP programme. Results of the online survey report. October, 2016.*
[91] *Progress monitoring reports for SPIRE, FoF and EeB 2015.*

24% a new service. Referring to a survey of participants of completed FP7 projects, 60% reported that they had developed a new or significantly improved product, and half reported that such a product had already been introduced at the market by the time of the ex-post evaluation.

Economic results

Estimations on the economic impact of the programme should be undertaken carefully. Generally, expected economic outputs from the LEIT-NMBP projects include job creation, reduction of the EU dependency on raw materials and goods (oil, rare earth, fuels, chemicals etc.), and a shorter time to demonstration at pilot or industrial scale.

A recent report on exploitation activities for selected FP7 projects in the field of nano-medicine concludes that out of the thirty results considered, 24 key exploitable results were exploited. Twelve of these were products, eleven were patents and one was a service.[92] A 2013 study on how research can be turned into commercial success found that the involvement of industry in R&D consortia increases the success rate of market-oriented exploitation. In terms of tracing the path of this exploitation, a distinction can be made between time-limited funding programmes and the permanent structures that specifically undertake technology transfer.

Studies assessing the links between public R&I expenditure and socio-economic impacts found that while there is a broad range in possible effects, the impact of public investments is positive.[93] In terms of social impacts, a recent review of more than 20 studies concluded that, for every EUR 1.2 million spent on energy efficiency, approximately 23 jobs are directly supported in the energy efficiency industry.[94] The reporting from FP7 projects in the NMBP points to an average of five additional jobs created per project.[95] cPPPs have to report on the creation of new types of high-skilled jobs and they report regularly (e.g. reporting of the EFFRA association). The NMBP projects have reported a wide range of results regarding new high-skilled jobs, the highest average being in FoF, with 3.5 new types of jobs per project. EeB projects currently report 0.8 jobs per project (in Horizon 2020), with 1.6 in FP7.

Novelty of innovations

The NMBP portfolio is dominated by projects that are somewhere in the middle of the road in terms of their ambition, described as ‘substantial modifications’ to existing technologies (57%). Project officers considered that a further 24 projects (21%) bring ‘incremental improvements’, while the remaining 22% were seen as ‘radical novelties’. The innovation ambition is somewhat higher in RIA projects and among projects with lower TRLs. Interestingly, projects coordinated by a private company are also associated with a higher level of innovation ambition than the ones led by a higher education institution or a research institute. In the Innovation Radar pilot with FoF projects 53% of the innovations identified were described as 'obviously innovative' and 23% 'very innovative', in line with the above figures.

The NMBP portfolio has a fair share of projects that are new to the world or at least the EU (41%)[96]. The remainder (59%) is somewhat less novel, mostly a combination of

[92] *Analysis on the exploitation of results and impact of the FP7 selected projects in the field of nanomaterials. META, May 2016.*
[93] *E.g. The Economics of Research (analysis for Denmark in life sciences), Novo Nordisk Foundation, Apil 2016, FP7 ex-post evaluation*
[94] *CIS on Revision of Energy Efficiency Directive, 2016*
[95] *A CORDA based review of the reported project outputs from projects funded under FP7.*
[96] *Project coordinators were asked if the research/innovation in the projects is new to the world/ to specific sector/country or the EU/to specific company or organisation.*

existing technologies and their adaptation to another application area or sector, or to the specific production processes of a company (new to the company).[97]

Overall the programme appears to address ambitious mainstream issues coming from the roadmaps, with leaders (further analysed in 5.3) at the forefront. The degree of 'radical' innovation seems to be a matter of individual project ambition, can be related to the expected impacts in topics, or is inherent in the technology (e.g. nano-medicine, biotechnology). This suggests a potential to open the programme to emerging issues and markets and to involve new types of stakeholders with emphasis on transformation of high TRLs for industrial applications. This effort makes the technologically still challenging innovations practicable for the industry.

Open Science – Open Data

Most NMBP participants operate in the Business to Business (B2B) arena, with 94% of project coordinators mentioning other companies as the direct users of the projects' results.

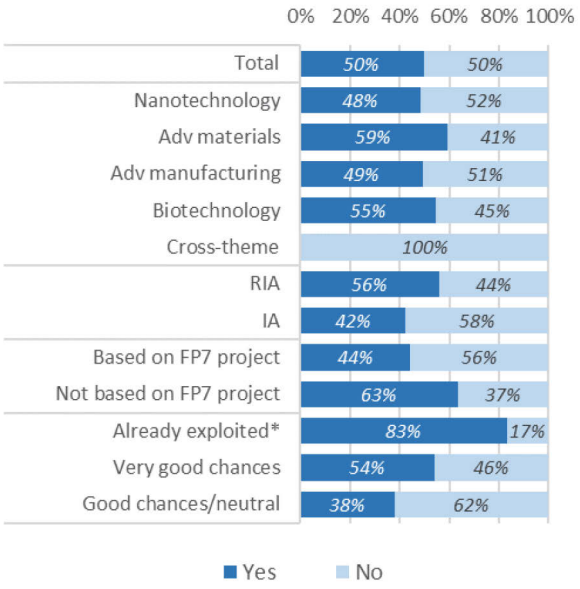
In this regard, there are significant challenges in maintaining open access to the data produced in projects and there is a question as to who owns the data or should have access to them, as they move along value chains. RECODE, an FP7 project on open access to research data, noted that different stakeholders see the path to open access differently, depending on whether they are funders, project researchers, disseminators, curators or end users. This results from conflicting value chains, and parallel and disconnected processes. A key issue is the disconnection between the current discipline-specific practices, and the growing demands of funding bodies for open access to research data. 50% of project coordinators reported they used Open Access data in their work.

Open data access is more significant for RIA projects and for projects that are not based on results from prior projects. Also, projects with partially exploited results showed a much stronger tendency to use Open Access data, than projects that had not reached this stage. Out of the 67 respondents who had not yet used Open Access data, 21% thought that their project could benefit.

The Commission committed itself to running a flexible pilot on open research data (ORD Pilot). The pilot aims to optimise the access to, and the re-use of, research data generated by Horizon 2020 projects. Projects not covered by the scope of the pilot can participate (opt in) on an individual and voluntary basis. While the average across Horizon 2020 of projects choosing the 'opt-in' option was 12%, the same average reached 17% for NMBP projects (mainly thanks to the strong participation among FoF and EeB projects, above 20%).[98]

[97] *Survey of project coordinators, July 2016*
[98] *Horizon 2020-EeB-2014: 31%; Horizon 2020-FoF-2014: 21%.*

Figure 113 - Use of Open Data in Horizon 2020 NMBP projects



Source: project coordinators survey, July 2016)
** Moderately strong association (Cramér's V 0.2667)*

Patents

Patents are one of the most common indicators of innovative output of research and innovation projects. An independent case study of the patenting history of project participants was performed as part of this interim evaluation process. The basic premise was that past patenting activity would be one of the factors influencing the likelihood to patent project results in the future. The study, focused on the field of nanotechnology, revealed that all the projects considered have at least 1 participant with patenting experience, on average projects have 3 members with experience and the maximum is 10.[99] The number of nanotechnology patents previously filed by beneficiaries of projects granted in the nanotechnology field varies considerably. The minimum is 2 patent applications per project consortium, the maximum is 825 and the average 180. At the level of individual participants it is worth noting that of all the 400 consortia members listed in the 38 projects analysed, 87 have patenting experience, and this is with an average of 34 patent filings in a skewed distribution with a minimum of 1 and a maximum of 519 patent filings per participant.

The analysis also shows that patents previously filed by beneficiaries of ongoing projects display specific features compared to patents previously filed by non-beneficiaries. In fact, patents filed by beneficiaries tend to be: i) more radical (i.e. they draw on knowledge from some areas to build applications in other areas); ii) more closely related to science (i.e. they cite more literature other than patents); and iii) more likely to seek protection outside Europe, needing time to explore market potential (i.e. filed at European Patent Office via the Patent Cooperation Treaty).

[99] *Projects considered include all nanotechnology Horizon 2020 NMBP running projects as of May 2016 (a total of 38 projects), with starting dates between December 2014 and June 2016. Information on the patenting experience of participants was obtained by matching the names of project participants with valid PIC (400) and the names of the key staff listed in the project descriptions (1502) to the names of EPO patent applicants (more than 12000 distinct names) and inventors (48812 distinct names) listed in all 24950 patent applications filed at EPO between 1978 and 2015 in the field of nanotechnology. Patent information comes from the EPO Worldwide Patent Statistics Database (PATSTAT) in its version of May 2016, where analysis is limited to patents filed at the European Patent Office (EPO). Patent applications in nanotechnologies are identified by using the CPC class B82Y99. More details available in the Patent Analysis report carried out by expert Catalina Martinez (CSIC-IPP)*

Ongoing nanotechnology projects in NMBP seem to be therefore very likely to produce patents and, even if this remains a working hypothesis, project beneficiaries may build their projects on patents that are more radical and have a stronger connection with scientific research than those of other players in the field.

More broadly, preliminary results of ongoing projects in all NMBP areas show 15 applications for patents, of which five have already been awarded; and one application for a trademark, which has also been awarded.

In addition to the patent analysis in nanotechnology, a separate case study on IPR strategy and exploitation based on information from a small selection of NMBP projects was also carried out.[100] This case study, based on interviews and a review of secondary information, found project beneficiaries well aware of the fact that patenting and IPR protection are key in some of the fields covered by the programme. Interviews also revealed that, although patenting is never the aim in itself, and what matters is to bring the project results as close to the market as possible, knowledgeable beneficiaries regularly carry out patent searches to ensure freedom to operate, and understand the trade-offs between secrecy and patenting, and between openness and protection. The project coordinators consulted on IPR issues as part of this interim evaluation agreed on the fact that 'trust' is the most important element to prevent IPR related conflicts, together with having clear and transparent rules in the consortium agreement. This is the main reason why the IPR governance structure was agreed right at the beginning, generally by using expert advice.[101]

Spin-offs and publications in projects

The review of reported project outputs from FP7 (with a sample comparable to the current NMBP programme[102]) found that 76 spin-off companies had their origins in these projects. With an average of 1.4 spin-off per project, the NMBP area is a leader compared to other areas of FP7.

The current number of reported publications is almost 300 with more than 150 publications in conferences or workshops and 69 peer-reviewed publications (followed by chapters in books, dissertations etc.).

Improved cost-effectiveness and sustainability of solutions

For 70% of the project coordinators, cost savings[103] were an expected benefit. Corporate Social Responsibility (CSR) was mentioned as a sought-after outcome by 28% of the respondents, and it counts especially for projects that seek to apply the innovation in the environmental sector (48% of all projects). 9% mentioned other, more indirect expected outcomes, including lower energy and raw material consumption and a reduction in the

[100] *The case study was mainly based on: 1) interviews to project coordinators and project officers and materials related to three innovation actions starting in 2015 and ending in 2019, with total project costs between 7 and 9 Million Euro in the fields of nanotechnology and biotechnology; and 2) interviews with Exploitation Strategy and Innovation Consultants (ESIC) to get an overview of their role as IPR advisors in ongoing and concluded FP7 NMP projects. When relevant, information was also taken into account from interviews to project coordinators and project officers and materials related to the three other projects selected for the case study on SME involvement. The latter include two innovation actions starting in 2015 and ending in 2018, with total project costs between around 6 and 7 Million Euro in nanotechnology and information technologies, and one research and innovation action in biotechnology starting in 2015 and ending in 2019 with 9 Million Euro in total project costs.*

[101] *For the three projects analysed more in depth in the case study of IPR strategies (in the fields of nanotechnology and biotechnology), as well as for the three other projects analysed for the SME involvement case study (in the fields of nanotechnology, information technologies and biotechnology).*

[102] *A review of the reported project outputs from projects funded under FP7, comparable to NMBP (and comparison with other thematic areas under FP7). The data was taken from CORDA. It is acknowledged that the data is not complete: certain projects did not report on the (final) outputs by the time of the data was extracted (end of May 2016)*

[103] *Although not necessarily savings in in-house production, but in certain cases at their consortium partners*

use of critical raw materials. All these outcomes are foreseen in the intervention logic of the programme as expected results under 'Diffusion of innovation in products, services and processes'. Nevertheless, the proportion of Corporate Social Responsibility seems high and wasn't as such expected by the intervention logic. This category could have been understood by projects coordinators as a broad category including issues such as improved sustainability across the entire product-service lifecycle or all forms of innovation that enable the transition to more sustainable economies, which are foreseen by the intervention logic.

F.9.3. Progress towards attaining the specific objectives of NMBP

This section identifies the extent to which the available budget and instruments contributed to achieving the specific objectives. To fulfil its goals, the NMBP programme is using systematically the concept of Technology Readiness Levels (TRLs), and stresses the importance of business cases and exploitation strategies in enhancing impact. Virtually all funded activities are developed on the basis of industrial roadmaps addressing complete value chains.

To foster cross-cutting KET activities:

'Cross-cutting KETs' activities integrate different KETs and reflect the interdisciplinary nature of technological development. Such integration represents another vital activity in Horizon 2020 and 35% of the budget allocated to KETs went to integrated projects in 2016.

Technology validation in an industrial environment to a complete and qualified system, ready or close to enter the market:

In the case of the three contractual PPPs covered by the NMBP part, the roadmaps come from the respective industrial associations, EFFRA for Factories of the Future, A.SPIRE for the Sustainable Process Industry, and the E2B Committee of ECTP[104] for the Energy-efficient Buildings. Two of these cPPPs existed before the start of Horizon 2020 (being a part of the EU economic recovery plan of 2008), while the Sustainable Process Industry started at the beginning of Horizon 2020.

In the case of Advanced Material and Nanotechnologies, the following principal roadmaps are used: NANOfutures, NanoSafety Cluster, European Materials Modelling Council, Science and Technology Roadmap on Catalysis for Europe; and International Technology Roadmap for Semiconductors 2013. Starting in the late years of FP7, the approach to these areas has been made systematic and has focused increasingly on industrial roadmaps (e.g. NANOfutures is a cross-cutting European Technology Platforms initiative, which started in late 2010).

In the case of Biotechnology, the priorities originate from the EuropaBio association. Before the start of Horizon 2020, industrial biotechnology was not an explicit priority, as a key enabling technology, although related activities were pursued in some of the FP7 themes. The biotechnology activities in the NMBP programme focus on intermediate TRLs, given that the deployment is mostly in the societal challenges and in the BBI (Bio-based Industries) initiative.

To provide new opportunities to tackle societal challenges:

[104] *The E2B Committee gathers together large companies, SMEs, research centres, academic institutions and relevant stakeholders interested in RTD in energy efficient buildings and districts.*

The following preliminary data on key performance indicators (KPIs) are available from the monitoring of the cPPP projects of Horizon 2020:[105]

- The number of new technologies per project is 1.8 for SPIRE, 2.4 for EeB, and more than 6 for FoF;
- The reduction in energy use varies between 15% for FoF and 37% for EeB;
- The reduction of CO2 emissions is 48% for EeB, 15% for SPIRE, and 16% for FoF;
- The potential reduction in the use of materials resources is 20% for SPIRE, and 19% for FoF;
- Demonstrators and prototypes have accounted for 40% of the FoF budget;
- There were 2.9 demonstration sites per project amongst 19 EeB projects; and
- 25 % of SPIRE project results will be taken up for further investments.

To stimulate strong private sector involvement:

The evaluation also considered the characteristics of industrial participants in the NMBP programme. The patent analysis in nanotechnology mentioned in the previous section found that Philips is the leader amongst beneficiaries, followed by the German companies BASF, Evonik and Merck. These companies have significantly higher numbers of patent fillings than the other participants. The Web of Science citation index in the area of nanoscience and nanotechnology, shows that the same firms are at the top of the EU28 rankings.[106] BASF is currently the private participant with the largest participation in the NMBP programme, with an overall EU contribution above 5 million Euro in seven projects. Philips and Evonik have been the main private participants in the NMP theme of FP7. Thomson Reuters 2016 list of Top 100 global innovators includes 19 European innovators and 13 of these participate in the NMBP programme.[107]

Additionally, many SMEs are seen as successful innovators and are amongst the biggest private participants in the programme. In the Innovation Radar pilot, 35% of the innovators identified are SMEs. One example is Alacris Theranostics GmbH, a German company specialising in omics data for drug development and personalised medicine, which won awards and published several articles in the last two years. Another innovative participant is Lithoz GmbH, an Austrian company specialising in ceramic materials and additive manufacturing systems, which also won multiple awards and cooperates with international universities. An example of an SME benefiting from the free circulation of labour is IRIS (Innovacio Recerca Industrial i Sostenible SL), an SME founded in 2007 in Spain by two Irish engineers, which specialises in improving industrial processes with new technologies.

F.9.4. Progress towards the overall Horizon 2020 objectives of LEIT NMBP

F.9.4.1. Fostering excellent science in scientific and technological research

LEIT-NMBP serves science by translating its results into industrially relevant knowledge and taking it further towards higher technology readiness levels and industrial

[105] *Progress Monitoring Reports 2015 for EeB, FoF and SPIRE.*
[106] *Sorted by times cited (position): Philips (1.); BASF (3.); Evonik (19.); Merck (20). Sorted by citation impact: Philips (9.); BASF (13.); Merck (15.).*
[107] *This list is not limited to private companies.*

applications. According also to the operational objectives of the NMBP programme one would not expect many project outputs related to excellent science as the programme is rather industry oriented. However, "knowledge generation" is at the top of the output expectations and the current number of reported publications is almost 300 with more than 150 publications in conferences or workshops and 69 peer-reviewed publications (followed by chapters in books, dissertations etc.).

A 2010 report of the OECD[108] argues that in certain fields (e.g. nanoscience and nanotechnology) cooperation with academia is crucial, especially for smaller companies, and helps sourcing new knowledge. The experience from FP7[109] shows that large firms typically publish with universities (confirming other studies that indicate that they are relatively more active in basic research as compared to SMEs), while SMEs publish more often with RTOs (which are more application-oriented than universities). Also a 2011 report on the UK collaborative R&D programme[110] found that collaborations between innovative business and academic partners had a positive impact on innovation.

F.9.4.2. Spreading excellence and widening participation

The different background of participants influences their perceptions of the steps in the process of transferring ideas to the market. This can lead not only to a different understanding of the market and relations with investors, but also to different expectations regarding the exploitation of results. Industrial partners have in mind products for the market, while academic partners are interested in publications or new fundamental knowledge.[111] RTOs translate basic research results into relevant industrial applications, which is particularly important for medium-tech SMEs (large firms have R&D capacities and work directly with universities). In this way, RTOs play an important role in technology transfer and the development of regional clusters.

Previous research[112] showed that the level of scientific activities related to NMBP in EU-13 countries are similar to those of many EU-15 countries, therefore a higher participation from EU-13 countries would help exploit that potential (the low participation rates of the EU-13 have persisted in FP6 and FP7 and the first years of Horizon, see Table 65). However, EU-13 countries are in the process of directing their basic research towards applications and at the same time researchers are moving from a more science-oriented to a more market-oriented outlook. This process may take several years before it results in ways of approaching market-relevant research similar to those of the EU-15 universities and research organisations.[113]

F.9.4.3. Boosting innovation, industrial leadership, growth, competitiveness and job creation

As set out in the intervention logic, the programme aims at boosting and strengthening the competitive position of European industry through outputs which would generate jobs, growth and further investment. Special emphasis is given to industry needs and to the importance of SMEs and their needs for collaborative research and innovation to

[108] *OECD (2010) The impact of nanotechnology on companies. OECD. Paris.*
[109] *FP7 ex-post evaluation of the NMP programme*
[110] *Evaluation of the Collaborative Research and Development Programmes. PACEC, 2011.*
[111] *Analysis on the exploitation of results and impact of the FP7 selected projects in the field of Nanomaterials. May, 2016.*
[112] *Ex post evaluation and impact assessment of funding in the FP7 NMP 2015; Mapping the regional embeddedness of the NMP programme 2016*
[113] *Ex post evaluation and impact assessment of funding in the FP7 NMP area. European Commission, 2015.*

develop and take new technologies and solutions towards the commercialisation of the generated knowledge.

The current progress in programme implementation and expected results show a positive picture with regard to this specific objective of Horizon 2020 which is at the heart of the NMBP programme itself. Key indicators for this are industry and SME participation in the programme, together with industrial demonstrators, using technology readiness levels as a proxy to estimate the progress towards the envisaged industrialisation and market introduction of innovation based on project results. While estimations should be viewed with caution at this stage, the survey of ongoing projects showed that an order of 90% of projects envisage or consider the exploitation of project results within 3 years after the end of projects. The FP7 ex post evaluation report for NMP mentions that by that time, 34% of survey respondents had already put new products or services on the market.

The focus on higher TRLs and demonstrators is crucial and the data confirm that the programme is attracting more industrial participants. As mentioned earlier, 45% of the EU contribution went to companies in Horizon 2020, compared to 36% in FP7. The share of company participations increased to 50% across NMBP, reaching 59% in the cPPPs. As long-term economic impacts are difficult to assess at this stage, one has to look at industrial participation as a measure of future impact.

Statistics show that at least 50% of industrial participants are SMEs.

A deeper analysis found that SMEs are important in consortia. In many of the projects funded in the first two years of the NMBP programme, SMEs are in charge of the protection, diffusion and commercialisation of results: 53% are engaged in the 'marketing of IP and searching partners for exploitation'; 44% in 'protection of IP'; 36% in 'full scale exploitation and use'; and 34% in the dissemination of project results and outreach. The main research and development tasks (and the generation of IP) are the most important role for SMEs in 21% of the projects.

The NMBP programme aims to develop innovation ecosystems more favourable to SMEs. The topics of the NMBP calls are designed to address specific market needs and aim to bridge the gap between research and innovation. The choice of partners in the NMBP consortia, including SMEs, needs to be carefully thought out, as they need to provide complementary expertise which will enable to bring the research results as close to the market as possible. SMEs applying for NMBP funding need to prove that they are integrated in a value chain with their partners.

The interviews showed that past collaborations are the most common origin of consortia, nevertheless, when the expertise needed to match a topic is not available in the pool of former partners, matchmaking events and conferences (often organised by the Commission) are a very good networking opportunity for SMEs.[114] One of the coordinators interviewed explained the rationale for building consortia that involve large and small firms: *"large firms want to collaborate with SMEs because they do not have the expertise, or the funds to start from zero in a new field. SMEs develop the techniques and large firms make the production scalable."*

The case study showed that the sustainability of the innovation ecosystems supported or developed by the programme is a matter of concern for some SMEs. European projects are the largest source of funds for many European high-tech firms, more so in countries

[114] *Nevertheless, some interviewees were concerned about participation 'usual suspects' and possible entry barriers for newcomers.*

which have reduced national R&D funding as a result of the financial crisis.[115] As one interviewee argued, *"Projects only last 3-4 years. SMEs want short term gains, they need to survive, and these big projects help them a lot, but once the project finishes they have nothing. It would be good to have some funding between projects, to maintain the SMEs alive. Otherwise, once the project is finished, the SMEs involved will focus on the short term to survive and will not develop the product further."* The SME instrument could be helpful in providing the longer-term funding that is needed. However, in the calls of 2014 and 2015 of the SME Instrument, 87% of the selected SMEs were newcomers to Horizon 2020, which suggests that not many SMEs use the instrument as a follow-up of other FP projects. It would be useful to monitor the use of other funding opportunities by SMEs taking part in NBMP projects once they end (e.g. the InnovFin instruments dedicated to SMEs[116]).

F.9.4.4. Addressing the major societal challenges

Regarding societal challenges, the exploitation of health related projects was introduced in the previous section and contributions to energy related projects in chapter 4 on relevance. A closer observation of participation patterns showed that 12% of NMBP participants are involved in the Health programme and 8% are involved in the Energy programme. Other activities, in e.g. the EeB initiative, aim to reduce carbon footprint, which significantly contributes to the achievement of major policy objectives. Similarly, in the FoF initiative, there are demonstrators of environmentally-friendly technologies, reducing energy consumption in robotic lines

A case study forming part of the evaluation of the Energy programme found that the NMBP programme should be understood as an enabler, rather than a supplier.[117] Further comments on internal coherence with societal challenges are dealt with in the Coherence chapter.

The societal challenges which have been addressed explicitly in the NMBP programme are:

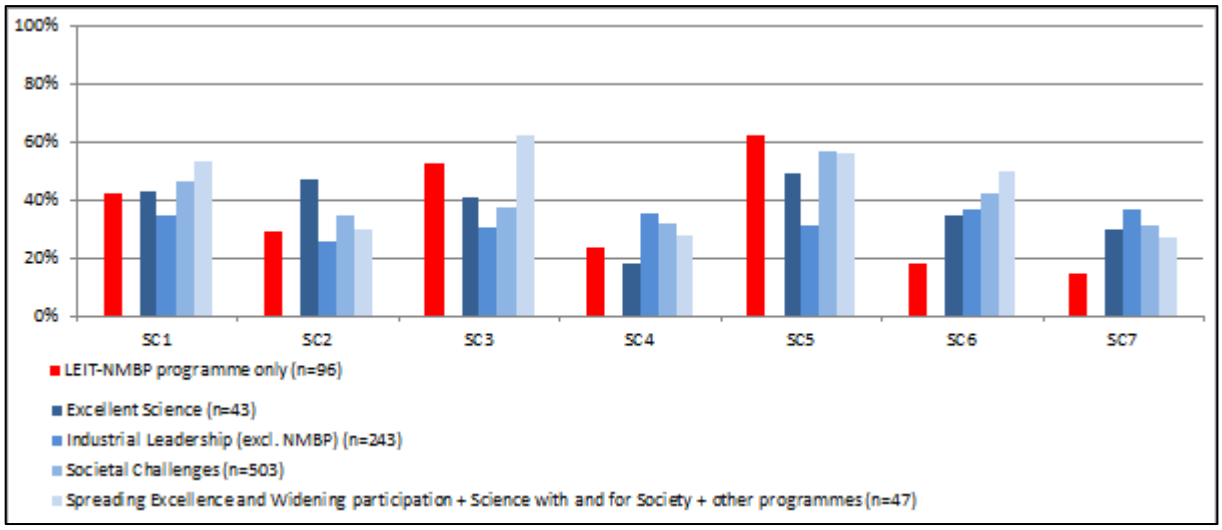
- Healthcare applications have been addressed in a set calls and topics on biomaterials for health and nanomedicine. These activities have direct links to the activities in personalised medicine in the respective societal challenge.
- Energy applications have been addressed in another set of topics, covering advanced materials and nanotechnology for energy applications. These include renewable energies, as well as storage and distribution.
- Energy-efficiency is addressed in the cPPPs on energy-efficient buildings (EeB), as well as some of the topics in the cPPPs on sustainable process industries (SPIRE) and Factories of the Future (FoF).
- Applications in transport have been addressed through contributions to the cPPP on Electric Green Vehicles cPPP (EGVI), covering lightweight materials and next-generation batteries.
- The bio-economy is addressed by the biotechnology topics in the NMBP programme. In comparison to the Bio-Based Industries initiative (BBI), the biotechnology activities of the NMBP programme address more upstream developments (including synergies and some demonstration).

[115] *While some interviews stated that in certain countries (as e.g. Germany), it is easier companies to obtain funding from the national government.*
[116] *http://www.eib.org/products/blending/innovfin/products/index.htm*
[117] *Case study: Contribution of NMBP to the Energy Societal Challenge.*

- Marine-related applications ('Blue Growth') have been addressed by some of the topics in advanced materials.
- Climate action is addressed in the cPPPs on energy-efficient buildings (EeB) and on sustainable process industries (SPIRE). In both cases, this involves decarbonisation through energy efficiency, and in the case of SPIRE it involves also direct reductions of greenhouse gas emissions in process industries.
- Environmental protection has been fostered in the dedicated activities on nanosafety.
- The preservation of cultural heritage has been addressed by one topic in advanced materials.
- Resource efficiency and the circular economy have been addressed by the cPPPs on sustainable process industries (SPIRE) and on factories of the future (FoF). In the case of SPIRE this includes the re-use of carbon dioxide and industrial symbiosis.

Beneficiaries were asked to assess the expected impact of their project on societal challenges in the next ten years. According to the results, NMBP projects are expected to contribute especially to Societal Challenge 5 - Climate action, environment, resource efficiency and raw materials (62%) and Societal Challenge 3 - Energy (53%), and less so for Societal Challenge 7 – Secure societies (15%) and Societal Challenge 6 – Europe in changing world (18%).

Figure 114 - Share of projects in Horizon 2020 sections which are expected to have a wider impact on societal challenges in the next ten years



Source: EAV survey, PPMI, 2016.

There were quite significant differences between NMBP in general and the subgroup of cPPPs, as shown in the table below. The specific difference with regard to SC3 and SC5 can be explained by the objectives and scope of the cPPP on Energy-efficient Buildings and SPIRE. The difference for SC1 relates to the importance of health/medical applications in nanotechnology/advanced materials.

Table 67 - Share of projects in Horizon 2020 sections which are expected to have a wider impact on societal challenges in the next ten years

Horizon 2020 Programme part	SC1	SC2	SC3	SC4	SC5	SC6	SC7
Industrial leadership							
NMPB (n = 96)	42%	29%	53%	23%	62%	18%	15%
Subtotal within NMPB: PPP projects (n=32)	*26%*	*7%*	*70%*	*20%*	*68%*	*23%*	*10%*

Source: EAV survey, PPMI, forthcoming

F.9.5. Early success stories

Since the programme is at a relatively early stage, the following projects should be considered as promising examples rather than success stories. Such technically promising projects can be compromised by a number of non-technical issues (e.g. business performance of partners).

The aim of **Metafluidics (RIA; 8.8 million EUR; June 2015 – May 2019)** is to integrate a range of technologies into a platform designed to identify genes of interest among all the genomes present in an environmental sample (also known as metagenomes). This platform will be used for green bioenergy conversion, bioremediation, food chemistry and other industrial applications, and will showcase technologies with the potential to create new EU and global standards in the field of metagenomics.

This is particularly attractive for providers of innovative enzymatic solutions, including the partners Novozymes, the world's largest producer of enzymes based in Denmark; Bio-Iliberis R&D, a Spanish SME dealing in enzymes for bioremediation; and Prozomix, a UK-based SME that has a 10% market share in the sector of enzymes for sustainable chemistry. The new user-friendly collection of bioinformatic tools will make the processing of metagenomic data available to all potential users, helping them discover useful genes.

Nanotechnology applied to medicine (nanomedicine) promises more effective and better targeted drugs, with reduced side effects for patients, but these nanopharmaceuticals are still at a very early stage of development. The aim of **NanoPilot (RIA; 6.3 million EUR; January 2015 – December 2018).** is to establish a flexible and adaptable pilot plant for nanopharmaceuticals. It will provide specific tools and services to SMEs and researchers to validate their technologies and to be able to produce nanopharmaceuticals of sufficient quantity and quality to enter clinical testing. Not only does this help to overcome R&D challenges, but it also offers a solution to the high cost of manufacturing (e.g. clean rooms and special equipment), as well as compliance with regulatory requirements. Three different applications show the flexibility of the planned facility: the treatment of dry eye syndrome, a HIV nanovaccine and a drug for the treatment of painful bladder syndrome. The pilot line will be validated in the project and will continue its certified services after the project, for further drugs and diseases. The consortium includes the operator of the pilot line, an SME, two university institutes which develop the nanopharmaceuticals, and a specialist institute on nanosafety.

The aim of **SteamBio (IA; 7 million EUR; February 2015 – January 2018)** is to increase the value of bio-derived source materials that are currently underused, by demonstrating an innovative mobile superheated steam process in fields and forests. This

process will convert agro-forestry residues into stable feedstock for biochemical and bioenergy uses. The ultimate aim is to replace mineral-derived coal, oil and gas with renewable source ingredients, the risk being that the players in the existing supply chains (linked to fossils) may eventually adopt different materials. Biochemical production currently accounts for approximately 100 billion EUR per year, still much less than the size of the chemicals market as a whole, about 3 trillion EUR. The project is committed to demonstrating the economic viability. The six SMEs involved all expect to benefit from the work, through a wider and cheaper raw material base and new end users.

F.9.6. Lessons learnt/ Areas for improvement

- The programme appears on track with regard to relevant indicators. There is the right focus on business to business areas where science and research based developments determine competitiveness at global level
- The evidence reveals an emphasis in established industries (e.g. manufacturing and processing), which need to transform themselves in order to improve their sustainability and maintain competitiveness, in response to digitisation and the policies for energy and climate action. The degree of innovation can mostly be described as "substantial", with a smaller part that can be described as "radical". There is a strong integration of new technologies into the existing industrial environment, which also represents potential for innovation. Leaders participate in the programme. This is in line with the objectives of this part of Horizon 2020.
- There is a strong participation of SMEs.
- Consortia based on trust are indispensable for generating common knowledge and IPR strategies.
- The targeted outputs are mostly related to products and processes, and to a lesser extent to services. The role of the latter should be examined.
- The monitoring and follow up of industrially relevant outputs are important.
- Future strategies need to consider specific support for projects to allow further exploitation. These include links to potential investors and access to finance and other funding sources.
- Guidance is needed to capitalise on results relevant to policy, including notably standards and regulations (which can act either as barriers or as potential competitive advantages).
- The possibility should be considered of opening the programme to emerging and new priorities and stakeholders.
- Possible action should be considered to address the participation of the EU-13, which has been consistently low throughout FP6 and FP7 and in the first years of Horizon 2020.

F.10. EFFICIENCY

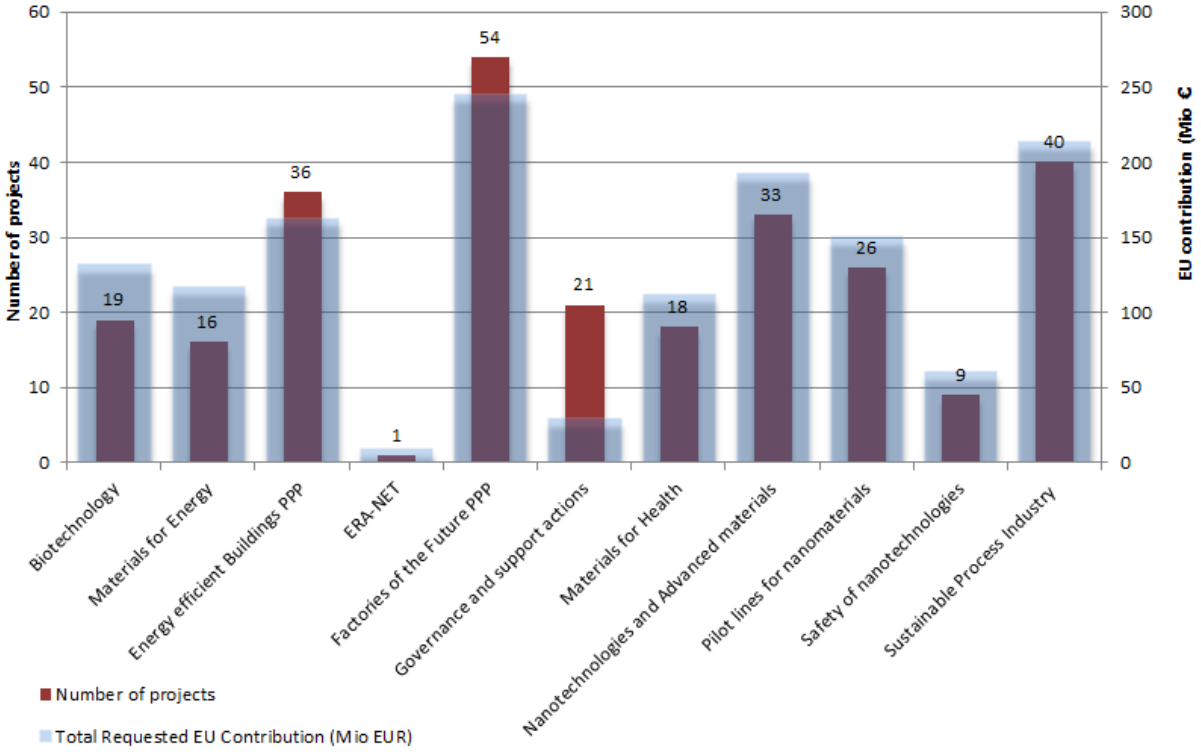
F.10.1. Budgetary resources

The NMBP programme is managed by DG RTD. The SME Instrument and the SILC II call of 2014,[118] as well as the bottom-up FTI activity, are implemented by the Executive Agency for SMEs (EASME). The programme has an operational budget of EUR 3.83 billion for 2014-2020[119]. By January 2017, EUR 1.4 billion has been allocated to grants under calls of the programme including SILC II; and EUR 84.2 million has been allocated to the SME Instrument, and EUR 20.2 million to the pilot for Fast Track to Innovation.[120] A budget of EUR 2.2 million has been dedicated to public procurement, and EUR 6.1 million to evaluators and monitors. Finally, EUR 3 million has been dedicated to an inducement prize (which will close in January 2018).

The pro-rata contribution of the EU budget to the European Fund for Strategic Investments **(**EFSI**)** it reduced the total budget of the NMBP programme by EUR 160 million. The operational budget in NMBP (excluding the part allocated to biotechnology) remains practically the same as in the NMP theme of FP7.

All areas outlined in the Specific Programme for NMBP have been covered already by the calls in 2014-16 (Figure 117). The balanced use of the budgetary resources depicts also in the fact that at least three projects have been realised within each topic.[121]

Figure 115 - Number of projects and requested EU contribution per Work Programme Area



Source: internal analysis.

[118] *For these two projects EASME reports to DG GROW.*
[119] *Under responsibility of DG RTD Directorate D to be allocated to different actions, as compared to the administrative budget.*
[120] *Both implemented through the EASME.*
[121] *When excluding CSAs, the average is 3.1 funded project per R&D topic.*

The annual budgets were executed as planned and without difficulties, with regard to both commitments and payments, facilitated by the way in which the calls, grant signatures and payments were planned. A notable feature in the case of the NMBP programme is that about half of the budget is allocated through two-stage calls while the other half through single-stage calls; this allows a balanced spread of the workload in the year.

A little more than half of the funding was allocated to Research and Innovation Actions (133 projects, 57% of the R&D topics and 51% of the total budget); a close second were Innovation Actions (95 projects, 43% of the R&D topics and 39 % of the total budget). The rationale is explained in detail in section 7.1.

As a key aspect of simplification in Horizon 2020, funding rates across the Framework Programme were harmonised,[122] in order to simplify and accelerate grant preparation and management. However, the NMP theme of FP7 already had a comparatively short time to grant in its final years, and the NMBP programme made in 2016 additional efforts bringing TTG indicator below 190 days.

For NMBP, the application of a single funding rate has led to an average funding rate of 83% across the programme, compared to 69% in FP7 (when lower funding rates applied to industry). Some of the leverage within projects has been lost. The overall project size in terms of budget has increased by 5.6% compared to FP7. On the positive side, the overall industrial participation (including SMEs) has increased, thus attractive funding, simplification and the emphasis on industrial needs seem to have borne fruit in attracting industry, as well as new players, to the programme (33% newcomers).

The Commission is monitoring the investments of project participants in developments/ exploitation beyond the projects. This is done for the contractual PPPs and will be done also for pilot lines, but relies on voluntary information and studies. Comments from the Advisory Group and the Programme Committee, as well as feedback from industry, would suggest that lower funding rates should be considered, especially for large industry. There is also a consensus in industry that it is not necessarily the project size that determines impact; the requests for large-scale demonstrators should be seen in the context of needs in different industrial sectors.
The projects and quality proposals were analysed by type of call (with the same calls aggregated across years) to avoid distortions arising from the very different numbers of submissions to each call. The budgets and the amount of requested EC contribution is typically somewhat lower for selected projects (an exception are the two-stage calls). The difference is striking for the CSA calls.

A significant finding is that both projects and quality proposals are very rarely coordinated by an organisation from the EU-13: only 3% of proposals meeting the quality threshold (but not funded) were led by an EU-13 coordinator, and only 2% of projects. At the same time, their share among proposals not meeting the quality thresholds was 6%. It seems that the chances of getting scored favourably, and especially getting funded are significantly lower than for proposals submitted by coordinators coming from the EU-15 or from an Associated Country. In line with the previous, the average share of EU-13 organisations among unsuccessful projects is higher under most call types than among funded projects.

[122] *Generally 100% of incurred costs are reimbursed for Research and Innovation Actions and Coordination and Support Actions, and 70% for Innovation Actions (with 100 % for non-profit entities,), in all cases including a flat rate of 25% for indirect costs.*

A proposal coordinated by a 'newcomer' (an organisation that did not participate in FP7) has a slightly lower chance of being selected, even though its quality is good enough to pass the threshold (7% of projects are led by a newcomer, versus 10% of the quality proposals that were not selected).

F.10.2. Programme's attractiveness

F.10.2.1. Mobilisation of stakeholders

The participation pattern of NMBP projects in Horizon 2020 is taken as an indicator that the programme is on track. As intended, it has attracted a significant share of industrial participation, even higher than in FP7[123] (49.8% compared to 45.4%); and industrial participants account for a significantly higher share of funding (45% compared to 36%). When considering individual participants rather than participations, the share of industry (including SMEs) is even higher at 64.9%. The participation of newcomers (33% being new to the Framework Programme, and 54% new to NMBP in Horizon 2020) is encouraging.[124]

The presence of Research and Technology Organisations (RTOs) is striking. While only 13.6% of individual participants, they account for 29.3% of the budget. Leading European institutes in the NMBP areas figure among the top beneficiaries, have the largest share among project coordinators and have more participations on average (2.8) then industry (1.2).[125] This reflects their pivotal role as intermediaries between research and industry, and their support for SMEs in terms of testing infrastructure and access to technology services. The existence of RTOs in a region also seems to be a motor for the R&I and industrial performance of that region.[126]

The shift in project participation patterns has been observed with respect to main sector of activity. The number of project coordinators went up for industrial participants with a striking increase in manufacturing sector, where the share of coordinators increased from 7% in FP7 to 17% in Horizon 2020.

A relatively fast conclusion of the grant agreement has been a much appreciated feature of the NMP programme in the last years of FP7. In Horizon 2020, NMBP has seen record short times to grant. At present the average time to grant for NMBP stands at 197 days, which is 19% shorter than the statutory 8-month period, and better than the average for Horizon 2020,[127] and also some Joint Undertakings. In the survey of coordinators the grant preparation procedure (88%), the short time to contract (86%), as well as regular and ad-hoc support from the Commission (82%), were the most universally acknowledged features of implementation. Only one out of 269 GAs was not signed within eight months.

However, there is criticism regarding the participant validation process and associated complicated and time-consuming procedures. Implementing a contract amendment seemed to be especially onerous. A change of a partner during grant preparation can be managed only with the support of the project officer, in addition to the Research Executive Agency (REA) in charge. The validation of newcomers to Horizon 2020 can also take much time.

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[123] *Industry participation in FP7 was already above the programme average.*
[124] *See also Section 4.4 Addressing specific stakeholder needs - 4.4.1 Industry and SMEs*
[125] *See also section 3.2 Participation patterns*
[126] *See the study "Mapping the regional embeddedness of NMP projects"*
[127] *It is about equivalent with the time to grant of the Research Executive Agency (REA) and longer than the EASME*

Project coordinators appreciate the more efficient electronic communication and procedures and the updated Participant Portal, which is deemed to be much easier to use than with FP7. The continuous reporting platform is deemed to work well. There are however critical remarks on the IT support in the early years of Horizon 2020 (e.g. on the tool for project monitoring, reporting and amendments, SYGMA); errors on the Participant Portal; or onerous processes and insufficient explanations (notably with regard to contract amendments). Helpdesk answers were often difficult to follow.

Other comments on the efficiency of programme implementation were:

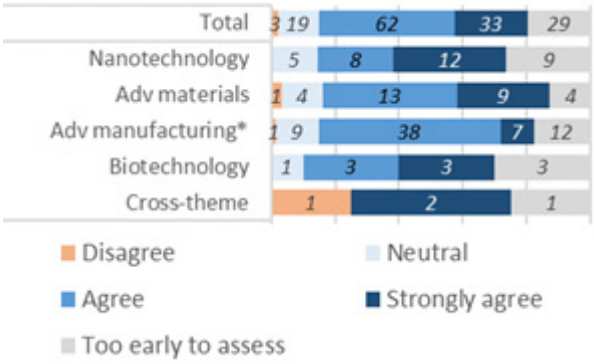
- Call deadlines are spread out over the year, making it hard to plan. Many call deadlines come immediately after vacation periods. There is relatively little time between first- and second-stage submissions.
- The scope of topics is sometimes too vague and at some other times overly specific.
- There are too many requests to participate in surveys and to supply information.
- The approach to ethical issues appears bureaucratic.
- The reporting requirements can be unclear. It is difficult to provide the concrete data on impact requested, especially at the early stages of the project.

The new financial rules (e.g. accounting for direct costs and overheads) and the simpler budget structure (no activity types, and a unique rate for indirect costs) were acknowledged. There were some critical remarks on reporting requirements.

Finally, there is criticism from some proposers who find the feedback on rejected proposals too generic.

Notwithstanding the criticism of some shortcomings[128], on the whole project coordinators seem to be satisfied with how the programme is implemented. Most project officers have a positive view on the efficiency of project management. More than half, 62 of the respondents (53%) said that they agreed with the statement.

Figure 116 - Agreement with the project being managed efficiently



Source: project coordinators survey, July 2016)

The key issue for stakeholders[129] is oversubscription – that the low success rates discourage researchers from participating. The overall success rate in NMBP calls from 2014 to 2016 was 16.1% (excluding the SME instrument), while the average in Horizon

[128] *Survey of project coordinators, July 2016*
[129] *Survey of project coordinators, July 2016*

2020 is 11.6%, which should be compared to 26.4% in the NMP theme of FP7 (and 22.4% in the calls for the cPPPs of 2009-2013). In particular industry expressed disappointment in the cPPPs, highlighting the significant effort and cost for preparation, in relation to the chance to get funding, especially in topics with broader formulations.

Nevertheless, it must be noted that those proposals that reach all evaluation thresholds see an average success rate of 58.7 % (and at least 50% for most calls). The set up of calls allows competition between topics in order to ensure that the best proposals overall are selected for funding. The proportion of proposals reaching all thresholds ranges from less than 20% to 67% (not taking ERA-NET and CSA calls into account). In the NMBP programme a frequent cause for failing to reach the thresholds is a low score against the impact criterion[130], frequently related to poor business cases and outline business plans in the proposals.

To mitigate oversubscription, the NMBP programme uses two-stage calls (with short first-stage proposals) for the more open areas. First-stage evaluations are fully remote, allowing resources to be optimised.

The programme has a strong on-line presence, and engages in extensive communication activities and in efforts to mobilise and network stakeholders, too numerous to outline here. The NCP network of the programme is particularly active. The programme supports successive EU Presidencies in organising major conferences[131] (1,000 participants or more over 2-3 days):

- April 2014 – Greece: Industrial Technologies 2014 in Athens
- October 2014 – Italy: LET'S Act! Leading Enabling Technologies for Societal Challenges in Bologna
- June 2015 – Latvia: the EuroNanoForum in Latvia
- November 2015 – Luxembourg: Manufuture in Luxembourg
- June 2016 – Netherlands: Industrial Technologies 2016 in Amsterdam
- October 2016 – Slovakia: ReInEU – Reindustrialising Europe – Bratislava
- Planned June 2017 – Malta: EuroNanoForum in La Valletta
- Planned November 2017 – Estonia: Manufuture in Tallinn

F.10.2.2. Geographical dimension

The top five Member States in terms of participation (by EC contribution) in the NMBP programme (Germany, France, Italy, Spain and the UK) are also those with the biggest share of manufacturing to value added of manufacturing in the non-financial economy.

Analyses of the NMP theme of FP7 show a low participation of EU-13 countries. For industrial technologies this is an issue of particular interest, because many of these countries have significant industrial contributions to their economies, above the current EU average of 15% (and the majority of participations from the EU-13 come in fact from industry). Their share of the NMBP funding in Horizon 2020 is 4.5%, higher than the 4% share in FP7. However, they account for 7.5% of participants, lower than the 9% in FP7. It is noteworthy that these figures are comparable to the share of the EU-13 in the EU's Gross Domestic Expenditure in R&D (GERD), which is 4%. Poland, Slovenia and the Czech Republic remain at the top of the EU-13 participation.

Clear policies and strong support at the national and regional levels can make a difference in bringing new players into EU projects. While some Member States are very

[130] *For Innovation Actions the Impact Criteria is weighted higher (1.5) in relation to Excellence and Implementation.*
[131] *Funded from Horizon 2020 through Coordination and Support Actions*

active in terms of stakeholder engagement, this is not the case in countries with weaker participation, notably the EU-13. The Commission is considering various strategies to increase the participation of EU-13 stakeholders in Horizon 2020 (for example opportunities can be created through the prioritisation of R&I in the regional programmes).

International cooperation in NMBP relied on the general opening of Horizon 2020; on explicit highlighting in the text of some topics; and on the well-established cooperation in nano-safety, mainly with the US (which operates only through the synchronisation of related projects). The EU contribution to international partners was EUR 2.4 million; the international partners' own expenditure was EUR 9.6 million.[132] Switzerland, a former associated country, accounted for a further EUR 60 million in own expenditure. The main areas of international cooperation are nanosafety, medical technologies, materials for energy and advanced manufacturing. Some of the international cooperation was not in topics where it was explicitly encouraged. While overall this level of international cooperation could be considered low, feedback from the stakeholders confirms that the NMPB project participation in general strengthens their opportunities and access to international markets.[133]

F.10.2.3. Cross-cutting issues

F.10.3. Cost-benefit analysis

The implementation of the NMBP programme and project management are carried out by DG RTD, Directorate D for Industrial Technologies. Only the contributions to the SME Instrument, the Fast Track to Innovation (FTI) and SILC II projects are managed by an Executive Agency, the EASME.

Feedback from coordinators highlights the important role of project officers. Timely communication and a good understanding of the projects and their subject matters are considered important. Proposal evaluation remains a key task of project officers.

An important element for the quality of programme implementation is the project monitoring system. An efficient monitoring system is in place, and most projects deliver as expected. However, the monitoring system represents a break from the FP7 practice of close and continuous monitoring, including the support of Project Technical Advisers (PTAs). For Horizon 2020, the approach is more arm's-length, involving project officers and monitors (more than 300 monitors were contracted in 2016), and considerably fewer site visits and face-to-face contact with the project coordinators. It focusses on monitoring and is more limited in terms of following technologies and policies than it was in FP7.

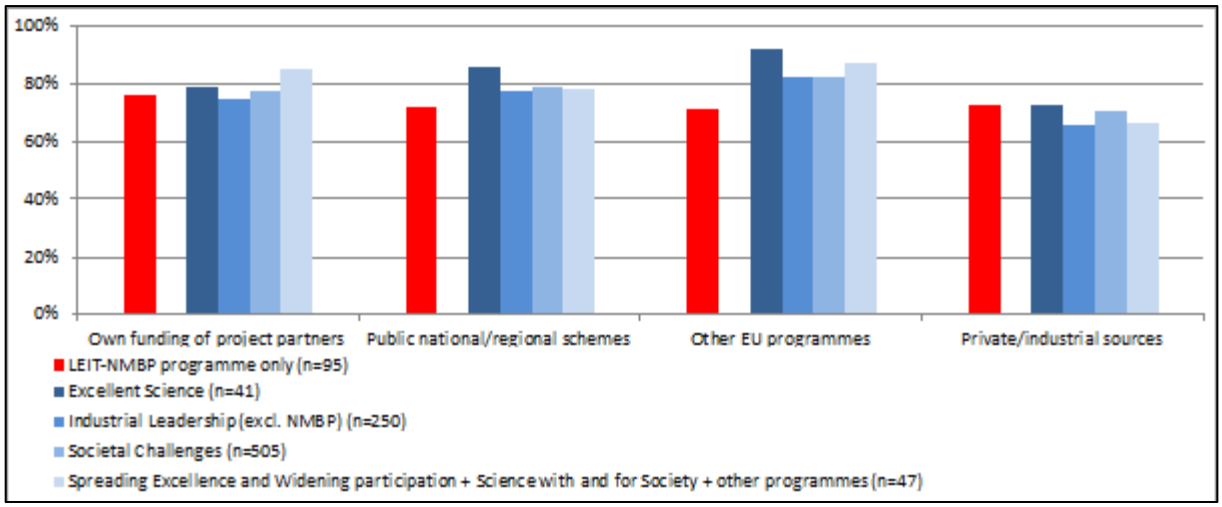
The new system was expected to require fewer resources on the Commission's side (in terms of staff numbers and the resources spent on PTAs). But project officers see the risk of decreasing quality and reliability in the follow-up of projects. On the other hand, one may expect that the more competitive selections could lead to projects requiring a lighter approach to monitoring.

In terms of complementary funding, the survey results show that almost half of the NMBP beneficiaries also used their own funding or the funding of project partners (49%). Another 45% also had funding from national or regional schemes, 39% had

[132] *Based on 273 Horizon 2020 NMBP GAs.*
[133] *See Section 8.1 European Added Value*

private or industrial funding, and 33% also received funding from other EU programmes (for complementary projects). These results have to be completed by project coordinators survey, which distinguished between mobilised and planned investment. Already mobilised additional investments within the consortium come overwhelmingly from private sources. The importance of public funding is indeed higher when asked about further investment planned for the commercialisation of projects, where less than a third (29%) plan to rely exclusively on private sources.

Figure 117 - Share of beneficiaries who expect to secure additional R&D funding for their projects in the future (by funding source)



Source: EAV survey, PPMI, 2016.

F.10.4. Lessons learnt/ Areas for improvement

More than half (56%) of surveyed coordinators see major differences between the implementation of Horizon 2020 and FP7. Notwithstanding specific criticism, coordinators are on the whole satisfied with the implementation.

The main concern is that success rates are too low, discouraging researchers and industry from participating. Hence, it may be appropriate to consider more two-stage calls.

With regard to the drafting of the Work Programme, it is important to consider carefully the ways in which scope and expected impact are defined. As competitors are also heavily investing in KETs and manufacturing, speed is becoming an issue, to which the programme responds through its "time to grant" which fully respects the eight months and is significantly shorter for example for cPPPs. With regard to expected impact, in particular the expected business cases and exploitation strategies, the guidance has already been substantially revised for the Work Programme 2016-2017, but it is too early to gauge the stakeholders' views on the 2016 calls.

It is important, in the case of demonstration projects, to consider a significantly lower funding rate for industrial partners. Even though this may compromise the simplification efforts, more or larger projects could be funded in this way, and more leverage and industrial commitment could be secured.

Synergies and alternative funding sources, including national and regional programmes, is particularly important and a high priority for the NMBP programme.[134]

In addition, the survey of coordinators suggests a number of improvements:

- Improving the administrative support, including for new project coordinators.
- Courses to help prospective proposers address the requirements of the NMBP programme.
- Improving the monitoring system in specific ways.

Particular attention should be paid to innovation related activities in projects, such as business plan development, input to standardisation, securing finance or other support to capitalise on project results. The survey confirmed a need for a systematic and specific support for exploitation, such as the ESIC[135] scheme of the NMP theme of FP7 and the early years of the NMBP programme. The response may include the Innovation Radar, and possible support through well targeted services, which would not diminish the obligations of project participants ("Exploitation booster").

F.11. COHERENCE

F.11.1. Internal coherence

F.11.1.1. Internal coherence of the actions implemented for NMBP

In line with the needs of industry, the NMBP programme has used primarily the research and innovation (RIA) and innovation (IA) actions to implement its objectives. The strategy targets technology readiness levels (TRLs) from 3 to 7, the focus being in the range from 5 to 6. The highest levels in this range are reserved for cases where there is a strong industrial commitment, hence innovation actions (with a lower funding rate of 70% for industrial partners) have been used for demonstrators and pilot lines. In the contractual public-private partnerships (cPPPs), which account for roughly half of the NMBP budget, the same logic has been applied, while further industrial investments beyond the projects arise from the commitments made by the private side. In the latest progress reports, the cPPPs show leverage factors between 1.5 and 3.5, when accounting only for current investments and discounting future investments.

Coordination and support actions (CSAs) are used for a variety of policy purposes: coordination of R&D in certain key areas, such as nanotechnology safety, advanced materials and eco-design; communication and societal engagement; speeding up the exploitation of project results in the cPPPs; facilitating combined funding for R&D activities; and organising Presidency conferences. Public procurement was used for a number of studies, such as the monitoring of nanotechnologies and the potential of frugal innovation; and to provide specific services for the exploitation of results to project consortia. While there is no overlap with current R&D topics and projects, it is clear that some of the questions and issues pursued by the current generation of CSA and public procurement actions could be implemented also as part of mainstream R&D projects. One example is the exploitation support to project consortia.

[134] *See section 7.2.1 Coherence with other EU funding programmes, in particular 7.2.1.2 Synergies with ESIF – Smart Specialisation as a priority*
[135] *Exploitation Strategy and Innovation Consultants.*

ERA-NET co-fund actions (see also section **Error! Reference source not found.**) are typically used where there is sufficient interest from national and regional funding agencies. One action was introduced in 2014-15, and is the only one already running, and three more were included in the Work Programme of 2016. While a number of ERA-NETs address areas where also the NMBP programme has launched calls (advanced materials including materials for energy; nanomedicine; manufacturing and biotechnologies), the ERA-NETs typically implement fairly broad transnational calls and according to currently available evidence (which comes mainly from similar actions funded under FP7), they typically attract SMEs that would not necessarily participate in collaborative projects of Horizon 2020. This deserves further analysis, as in this case the question of possible overlaps with the SME Instrument arises.
Finally, the NMBP programme includes an inducement prize for materials for clean air (which will close in early 2018).

F.11.1.2. Internal coherence with other Horizon 2020 intervention areas

In order to fulfil its primary objective, the emphasis in the NMBP programme is on pilots and demonstrators (more than in FP7). Lower TRLs and scientific research are addressed in biotechnology and regulatory research on nanosafety. The KETs, in particular nanotechnology and advanced materials, are addressed in the European Research Council (ERC) and in Marie Skodowska Curie Actions (MSCA), as well as in Future and Emerging Technologies (FET). ERC projects have been surveyed on an ad hoc basis to identify developments that could be taken over in the NMBP programme, especially in the fields of nanotechnology and advanced materials. So far, this exercise has not led to new topics in NMBP. Beyond this, there is no systematic monitoring and there are growing gaps between NMBP in the industry pillar and the more upstream activities typically funded by the science pillar. Closing the gap on the NMBP side is a matter of budget availability and no systematic attempt has been made so far. In the case of FETs, efforts were made while developing the Work Programme 2016-2017 to include certain NMBP priorities in the FET Proactive part, which represent more upstream (i.e. low-TRL) aspects in nanotechnology and advanced materials, such as bottom-up construction.[136] As regards the specific programme on research infrastructures it has so far not reflected explicitly the needs of industrial users, although such explicit support (translating open science to open innovation and access to technology for SMEs) is expected in WP 2018-2020. So far, open access pilot line projects (with access for SMEs) are funded in the LEIT NMBP programme.

As regards the coherence with InnovFin KETs need considerable investments to reach high TRLs, and to support upscaling and deployment. The EIB and EIF instruments play a special role in financing KETs. In February 2013 the Commission signed a Memorandum of Understanding with the EIB to promote access to finance for KETs, followed by an increase of 60% in the lending to KETs-related projects.

The importance of risk finance is further demonstrated by the fact that the NMBP areas account for roughly 30% of the signed amounts under the Horizon 2020 InnovFin from 2014 to mid-2016.

In general, however, access to finance for KETs is very limited, in particular for small and fast growing SMEs immediately after the start-up period.

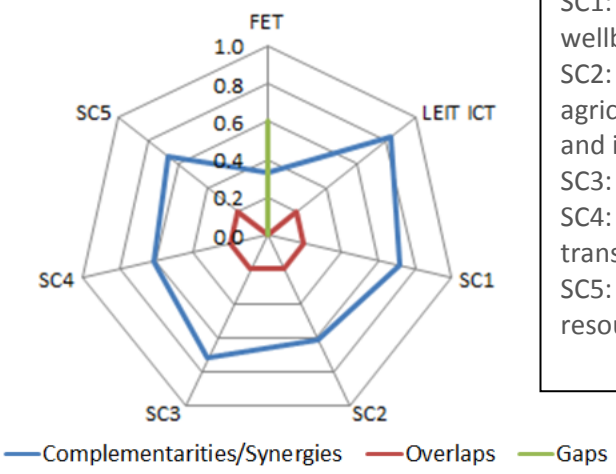
[136] *The relevant areas in FET Proactive are: intra- and inter-cell biotechnologies; bio-electronic medicines and therapies; cognitive neuro-technologies; hybrid opto-electro-mechanical devices at the nano-scale; ecosystem engineering; complex bottom-up construction.*

An EIB study on the subject proposes potential solutions to improve access to finance. An estimated 10,000 SMEs base their business on the development and commercialisation of KETs, but many innovators and research-driven newcomers find it hard to raise growth capital to develop their businesses. The study shows that it is not enough to have risk-sharing financial products to resolve the financing needs of KETs companies. These companies are often not aware of these opportunities, and many need expert financial advice to become investor-ready. Similarly, bankers often lack an understanding of new technologies and of their market potential, and hence shy away from such investments. A follow-up study by the EIB will examine the way in which investors assess risk in KETs projects.

Regarding the coherence with the societal challenges pillar of Horizon 2020, the LEIT-NMBP programme has supported activities with applications in specific societal challenges, as well as activities of a more general nature with a variety of possible applications and addressing various industrial sectors. The choices arise from industrial roadmaps. These roadmaps try to identify value chains and address the most promising ones.

An initial effort has been made to include in the societal challenges references to applications of key enabling technologies, notably in transport and in raw materials resource efficiency. The NMBP programme made a substantial contribution to a focus area entitled 'Industry 2020 in the Circular Economy', reflecting a combined effort to make sustainable industry and the circular economy a reality. However, the various contributions in this focus area were not developed jointly, compromising its effectiveness in terms of synergies. A more systematic effort is now under way to develop such links in the last Work Programme, through participation in focus areas (on climate action including energy and on the circular economy); by developing shared narratives (in the expected impact statements); and by clustering projects addressing the same challenges.

Figure 118 - Internal coherence of LEIT NMBP with other Horizon 2020 specific objectives



SC1: Health, demographic change and wellbeing
SC2: Food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bioeconomy
SC3: Secure, clean and efficient energy
SC4: Smart, green and integrated transport
SC5: Climate action, environment, resource efficiency and raw materials

Source DG RTD survey, October 2016.

As the graph and the text above show, there is a high degree of internal coherence with the other Horizon 2020 specific objectives. The high coherence with LEIT-ICT shows the explicit effort to apply what has been developed by the ICT programme.

F.11.2. External coherence

F.11.2.1. Coherence with other EU funding programme

Horizon 2020 seeks to build synergies with other European funds and financing instruments. The Financial Regulations of 2014-2020 EU programmes contain cross-references to promote synergies in the use of the EU funds. Rules laid down for the European Structural and Investment Funds (ESIF), Horizon 2020 and other EU programmes foresee to ensure coordination, synergies and complementarities among founds. This is an important component of the policy and funding strategy for NMBP, and a key issue in the European KETs Strategy. KETs and industry are spread across Europe, with KETs specific strengths and weaknesses in Member States and regions.

The synergies with other funding instruments are crucial for the effectiveness of public funding in bridging the "valley of death" and bringing R&I results to the markets.

Furthermore, links between activities at European level and national or regional strategies and programmes have already been developed through previous framework programmes, and there are now successful examples of follow-up investments for FP7 project results supported by regions.[137]

F.11.2.2. ERA-NET actions and synergies with Member States' programmes

ERA-NET actions have been a means to link Member States programmes with European priorities, with a number of initiatives spanning FP7 and Horizon 2020. They provide interesting examples of leverage for EU funding.[138]

For example, the MANUNET II[139] FP7 ERA-NET (closing in 2016) has involved 13 countries and 14 regions. It triggered investments of 190 million Euro in 180 projects on advanced manufacturing, involving 500 SMEs. The M-era.Net[140] action in the area of advanced materials, started under FP7 and has been relaunched in Horizon 2020. Overall, the NMBP calls 2014-2016 mobilised more than 30 funding agencies from more than 20 countries, including third countries, offering a total budget for projects of around 95 million Euro, including the EU contribution. The national programmes tend to offer additional possibilities to SMEs, typically for lower TRLs (levels 3 to 5) and in areas that benefit from trans-national collaboration.

ERA-NETs also provide a framework for cooperation, and where regions participate, they are now a test-bed for the "Seal of Excellence". However, this relies on the availability of funds: where no national budget is available for a given research area, a country/region cannot participate. The "Seal of Excellence" is a promising tool for regional complementary funding, a point also made by regional stakeholders in the NMBP Mapping study.[141]

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[137] *See presentation S2P company, Workshop on Industrial Technologies for Regional Growth (12 April 2016), http://ec.europa.eu/research/index.cfm?pg=events&eventcode=84126F94-DA32-A7AB-04E4A5A79F49FFE6*

[138] *For more information on ERA-NETs see the specific evaluation report – will be published in November 2016.*

[139] *http://www.manunet.net/ Participating countries: Estonia, Finland, France, Germany , Iceland, Israel, Luxembourg, Portugal, Romania, Slovakia, Spain, Switzerland and Turkey; regions: Asturias, Basque Country, Cantabria, Castile and León, Catalonia, Franche-Comté, Lower Austria, Navarra, Nord-Pas de Calais, Northern Ireland, Piedmont, Tuscany, Wallonia and Western Greece*

[140] *https://m-era.net/*

[141] *Study "Mapping the regional embeddedness of the NMP programme", INNOVA+ - TNO – ZEW, 2016.*

F.11.2.3. Synergies with ESIF – Smart Specialisation in KETs as a priority

Synergies with the European Structural and Investment Funds are of particular interest for KETs and the NMBP areas. According to the EYE@RIS3 database, the majority of European regions have declared KETs as a priority.[142] For the great majority this relates to manufacturing and industry.

An analysis of FP7 in the NMBP areas[143] showed that most regions have participated as much as one would expect from their level of activity: regions with more R&D resources tend to participate more. The main factors for high performing regions are the track record and level of specialisation, but also the level of regional expertise. In this context, the creation of regional research centres, some of which were established in the 80's and 90's to diversify incentives to innovation, appears to pay off.[144]

This supports the current NMBP strategy to promote demonstrators and pilot lines specifically to support SMEs in validation and scale-up activities.

The NMBP Work Programme 2014-2015 encouraged proposers to address possible synergies and more than 20 topics were considered relevant. In the NMBP Work Programme 2016-2017, reference to synergies was included in the 'LEIT Introduction', and typically applied to topics for pilot lines and demonstrators at relatively high Technology Readiness Levels, for which synergies with regional funding is one possible way of enhancing impact. The Work Programme encourages proposers[145] "where possible… to actively seek synergies with, and possibilities for further funding from other relevant EU, national or regional research and innovation programmes (including ESIF), private funds or financial instruments." It is important to bear in mind that such synergies are not an evaluation criterion for proposals. They should be seen as a way to increase project impact and to help capitalise on public investments. The possibility of additional funding, whether from ESIF or from other sources[146], helps make a case for the business planning beyond the project.

More than half of the NMBP project coordinators[147] (53%) are aware of national and regional funding opportunities. Out of these, however, only seven mentioned that they or other partners in the projects have secured such funding. All of them applied to an open call.

National programmes mentioned included: a grant of the Ministerio de Economia y Competitividad (Spain); short-term financial support by the University of Zagreb (national funding) for equipment; ECHO project grant from the Netherlands Organisation for Scientific Research (NWO); COST grants Action CM1303 ("System Biocatalysis"); proof of concept grant from European Research Council (ERC-2015-PoC); German BMBF Batterie 2020; Innovate UK, TKI Urban Energy; Swedish Energy Agency – Biomass fuel program etc.

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[142] EYE@RIS3 and Study " Analysis of Smart Specialisation Strategies in Nanotechnologies, Advanced Manufacturing and Process Technologies Smart Specialisation and KETs, Inno-Group, Innova and SQW, 2015

[143] *Study "Mapping the regional embeddedness of the NMP programme", INNOVA+ - TNO – ZEW, 2016. No significant differences between NMBP technology areas were detected, therefor these results are considered relevant also for Horizon 2020.*

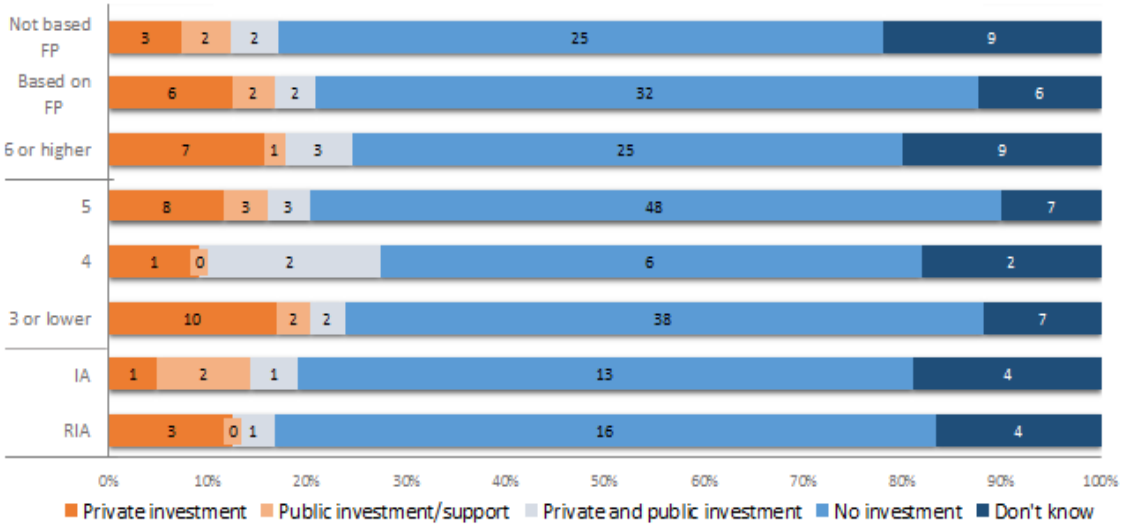
[144] Study "Mapping the regional embeddedness of the NMP programme", INNOVA+ - TNO – ZEW, 2016

[145] *'LEIT Introduction' of the Horizon 2020 Work Programme 2016-17, see also for 2014-15; This wording has been extensively discussed also in the Programme Committee.*

[146] *E.g. private industry funding, financing instruments from banks including the EIB and EIF instruments under InnovFin and the EFSI, national funding programmes etc*

[147] *Survey of project coordinators, June - July 2016.*

Figure 119 - Further investment induced since start of the project (N=116)



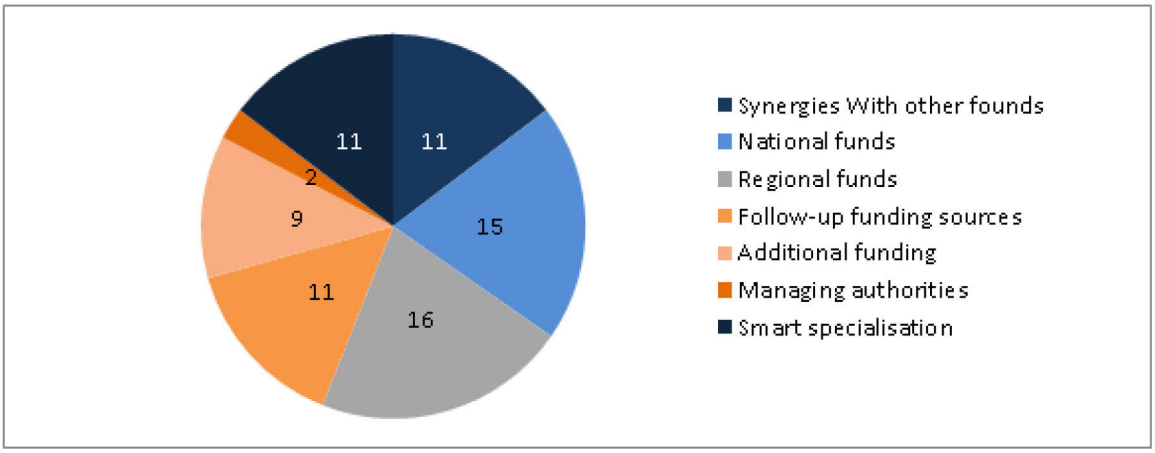
Source: project coordinators survey, July 2016. The question asked: Since the start has your project induced further investment (beyond the match funding budgeted) within the consortium?

Not many projects have explored all the possibilities that exist at European, national and regional level. A big issue is the lack of awareness of the programmes best suited to a stakeholder's research activities.

On a positive note, cPPPs such as Factories of the Future, which are mirrored by a number of national platforms, have links to regions, one example being the Vanguard[148] regional initiative; this leads to a greater knowledge of investment opportunities in regions.

Identification and analysis of the synergy cases at project level is a complex task. A keyword analysis was done on a sample of 29 project proposals under the LEIT NMBP programme, in particular related to the pilot lines calls. Key-words used: synergies with other funds; national funds; regionals funds; follow-up funding sources; additional funding; managing authorities; smart specialisation.

Figure 120 - Synergies among Funds- key word analysis



Source: Proposals from the pilot projects 2014-2015.

[148] http://www.s3vanguardinitiative.eu/*http://www.s3vanguardinitiative.eu/*

More than half of the project proposals analysed clearly state reference to synergies with other funds (ESIF, National or Regional). Some projects list synergies under project main objectives or under the business plan to outline financial arrangements including possibilities for cumulative funding, with relevant National/Regional research and innovation programmes and/or European Structural and Investment Funds in connection with smart specialisation strategies.

Out of 29 selected Project Proposal, 10 project proposals intended to look for follow-up funding sources in order to o support the subsequent investments in actions or specific project results during the project implementation phase.

Project partners look for additional funding opportunities, either in the framework of Horizon 2020, ESIF and also nationally and regionally in about a quarter of the project proposals analysed. In particular Smart Specialisation Strategies (S3) will be taken into account in order to expand the knowledge generated by the projects and the main results.

Finally, 100% of the project proposals provide a detailed list of on-going projects already financed under the EU, National or Regional funds that allow synergies and the possibility of mutual promotion.

Example of Synergies at project level

IZADI-NANO2INDUSTRY project: bringing together funding from Horizon 2020 and ESIF in a research and innovation project.

The involvement in FP6 and FP7 projects of consortium partners from IZADI-NANO2INDUSTRY have helped them demonstrate their effectiveness for enhancing materials and manufacturing processes performance up to a certain level tested in intended environment (TRL 5). IZADI-NANO2INDUSTRY project proposes different solutions based on KETs such as nanotechnology, advanced materials and advanced manufacturing. The project aims to implement the master-batches, the master-pellets and the nanostructured powders in three innovative PILOTS, developed and installed at three existing production plants that will effectively manufacture real components (B-pillar, Swash plate and Valve plate) integrating safe-by-design approaches into the developments stages. IZADI-NANO2INDUSTRY is an industry driven project with up to 44% of the budget devoted to SMEs. It proposes solutions that will generate new market opportunities for European Automotive, Construction and Agricultural Machinery sectors. IZADI-NANO2INDUSTRY project is supported by the government of the regions where the PILOTS will be installed. The project addresses an innovation action that is in line with the Basque Country, Lombardy and Emilia-Romagna region's RIS-3 Smart Specialization Strategy.

After the project completion, IZADI-NANO2INDUSTRY partners will co-develop the final product with customers to adapt results of the project to specific needs and get industrial readiness level.

Source: IZADI-NANO2INDUSTRY project proposal.

In interviews for this evaluation, some very positive examples of regional coherence emerged, but it is difficult to assess whether this may be generalised. For instance, some regional programmes (e.g. in Catalonia) are mirroring the NMBP priorities and include additionally aspects of regional specialisation. This is promising in terms of complementarity effects.

However, some Member State delegates were of the opinion that synergies with ESIF do not work well. ESIF is more risk averse, and its implementation varies from region to

region. Another issue is whether deserving proposals that could not be funded under Horizon 2020 can be implemented through other funding programmes.

Regarding follow-up funding, local innovation agencies do not necessarily have strategies to deal with NMBP-funded projects and few projects are selected for follow up. A further question is how to design practical implementation mechanisms to ensure coherence. Companies are not necessarily clients of innovation agencies, or they may have already used up the national funding allowed by state aid rules (block exemptions). Better and more specific guidance from the Commission is called for. For successful coordination within Member States a very solid strategic base is required. The Basque region in Spain is a positive example of having a clear R&I vision and appropriate priorities. The main opinion of stakeholders is that coherence at EU level is better than at national and regional levels. At the same time, stakeholders point out that it is much more difficult to assess coherence at regional level with confidence.

Beyond the implementation of Horizon 2020, DG RTD participates actively in the work of the Commission with the regions, regarding the implementation of Smart Specialisation strategies and Operational Programmes. KETs have been a main priority area of the Knowledge Exchange Platform.[149] A series of dedicated workshops since 2014 brought together representatives of regions, industry and RTOs, and allowed them to exchange best practices and to explore new opportunities for activities.

The importance of KETs and the need to modernise industry has further led to the setting up by the Commission of a Smart Specialisation Platform for Industrial Modernisation (S3P-Industrial Modernisation), in June 2016, aiming to foster cooperation of regions and create a pipeline of investment projects.
Notwithstanding certain practical issues regarding the combination of financing instruments, the NMBP programme can be considered a good example of following up on the commitment to develop synergies with other public support instruments.

F.11.2.4. Synergies with ESIF – European Territorial Cooperation and INTERREG

The European Territorial Cooperation (ETC) provides a high coherence between Thematic Objectives, partnership requirements and synergies with EU instruments outside Cohesion Policy, such as for example Horizon 2020, COSME and LIFE+.

INTERREG has three types of programmes: trans-national, transnational[150,] and interregional. The analysis took into consideration related calls for proposals, application forms and projects financed with a direct connection with KETs. Due to geographical coverage (28 EU Member States, Norway, Switzerland), also Interregional Cooperation programme INTERREG EUROPE was included in the analysis: the programme is a policy learning programme for European public authorities promoting the exchange of experience and the transfer of good practices between players at all levels in Europe.

Among the 15 Transnational Cooperation Programmes, 13 have been selected for a special analysis of the thematic objective Research and Innovation (all Programmes except Caribbean Area and Amazonian Area). Some programmes design specific actions to promote synergies with other European Union Instruments and have funded projects

[149] *Launched in October 2015 by Commissioner Carlos Moedas and the President of the Committee of the Regions, Mr Markku Markkula*
[150] *Transnational cooperation, known as Interreg B, involves regions from several countries of the EU forming bigger areas. Interreg B covers 15 cooperation programmes. It is delivered through the European Regional Development Fund (ERDF) with EUR 2.1 billion for the period 2014-2020.*

relevant for KETs. Synergies can be created through information exchange, institutionalised cooperation between programme authorities, events at European level or even common processes during implementation; in some cases synergies are promoted in Programme documents (Applicants Guidelines, standard Application forms etc) and for these, projects need to include a description of how they aim to achieve complementarity and synergies with other EU instruments.

Applicants have to describe the coherence and complementarity with other Union instruments of relevance for the topics addressed by the proposals and with national policies and funding instruments, within the application form, giving evidence of the added value brought by transnational cooperation, in particular with regard to Horizon 2020, COSME, LIFE, the Connecting Europe Facility, Creative Europe and Erasmus for all. Multi-annual and annual work programmes as well as guidelines developed within these instruments shall be considered by applicants when submitting proposals.

Specific sections of the Cooperation Programmes (CPs) give an overview on the principles followed for implementing the programme in a complementary and coordinated manner with other relevant EU and National instruments and funds in accordance with the principles of subsidiarity and proportionality[151].

Concerning the possible inclusion of the KETs within the regional planning documents for INTERREG Programmes, the CPs are not focused precisely on KETs but on thematic objectives. KETs may be included in Thematic Objective 1- Research and Innovation.

Example of synergies at Programming level

INTERREG CENTRAL EUROPE 2014-2020: three key measures for coordination with different EU instruments

The Central Europe transnational programme defines three key measures for coordination with different EU instruments. Firstly, when submitting proposals, applicants are asked to describe coherence and complementarity with other Union instruments, highlighting the added value of transnational cooperation. Secondly, programme authorities seek exchange with and advice from Commission services and other European and national institutions involved in the instruments. Thirdly, communication tools and measures make the programme results available to thematic stakeholders of other EU instruments. This includes the direct involvement of national contact points for these EU instruments in events organised by the transnational programme.

Sources: Cooperation Programmes INTERREG CENTRAL EUROPE 2014-2020.

Synergy examples emerged in the past programming period and such synergy development is expected to gain strength in the current programming period 2014-2020 as a result of enhanced policy design. Identification of the synergy cases is a complex, especially because the majority of projects financed under INTERREG Programmes are in an initial stage of advancement, however, some of the more promising projects financed under INTERREG Programmes (identified thanks to the effective cooperation of managing Authorities and Joint secretariats) can provide inspiration for future synergies.

[151] *REGI Committee – Review of adopted European Territorial Cooperation Programmes (Study), Chapter 3 (pages 51-62)"Synergies between ETC Programmes and other planning instruments" EP, DG for Internal Policies, Policy Department B Structural and Cohesion Policies (2016); Desk research carried out for the Interim Evaluation of the LEIT-NMBP programme*

Example of synergies at project level, starting in the programming period 2007-2013

NANOFORCE Project - Nanotechnology for Chemical Enterprises – how to link scientific knowledge to the business in the Central Europe space.[152]

The main objectives and key achievements of the NANOFORCE Project are perfectly in line with the LEIT-NMBP Programme. The NANOFORCE Project, funded under the INTERREG CENTRAL EUROPE Programme 2007-2013, aimed at better integrating sciences, industries, finance, management and public authorities for the sustainable development of nanotechnologies in Central Europe, by creating a homogenous geographic area where research centres, companies, professionals and competent authorities can realize nano-products in a responsible way. The added value of the transnational cooperation is rooted in a transnational network of cluster management organisations, innovative companies and venture capitalists in the nanotechnology field. It will continue to contribute to enhancing the competitiveness of chemical industries by reducing the existing disparities in high-tech development of the chemical sector in the involved countries. There are plans for a follow up proposal to be submitted in one of the next calls (Horizon 2020 or CE), showing that the NANOFORCE project could be considered as an example for creating a springboard for the further development of regions and their industries.

Example of synergies at project level in the programming period 2014-2020

INNO INFRA SHARE Project - Sharing strategies for European Research and Innovation Infrastructures[153]

This partnership, covering 8 European regions with common RIS3 priorities, shares the goal of exploiting local assets and investigating business models for long term sustainability taking into account also possible synergies of 2014-2020 funds (e.g. ESIF and Horizon 2020). The objective of the project is to improve the accessibility and the exploitation of local Research and Innovation infrastructure (RII) assets by SMEs, including in the areas of Key Enabling Technologies (KETs). Mutual learning across regions and the improvement of innovation capabilities through usage strategies for Research and Innovation Infrastructures can facilitate innovation in the domains covered by the Smart Specialization Strategies, with impact on research and innovation, digital agenda and support to SMEs thematic objectives. The expected project results could lead true synergies among Horizon 2020 and ESIF.

The Project has just started but has the potential to become a knowledge platform that will underpin possible future project proposals to be funded also under Horizon 2020. Some partners involved in the project have previous experience in Horizon 2020 and this can make the difference in project design and in planning synergies.

[152] *Source: http://www.nanoforceproject.eu/; Application Form*
[153] *Source: http://www.interregeurope.eu/innoinfrashare/; Application Form*

NUCLEI Project - Network of Technology Transfer Nodes for Enhanced open Innovation in the Central Europe advanced manufacturing and processing industry.[154]

This initiative builds on the basis that the European Union's most important automation and mechatronic industries are located in central European regions. The NUCLEI Project, funded under the INTERREG CENTRAL EUROPE Programme 2014-2020, aims to change the obsolete innovation management model from a "local-based" technology scouting approach to a transnational pool of knowledge that supports advanced manufacturing innovation beyond regional borders. Synergies are mostly related to combine the NUCLEI market intelligence approach, underpinned by regional industrial clusters and R&D performers, with frontrunner EU projects in mechatronics and automation, addressing also standardisation and system interoperability. The aim is to create a broad and collaborative environment, initially tested by 100 companies from 7 regions, in order to increase linkages with innovators outside the project regions, increase R&D expenditure and patent applications, and accelerate time-to-market of R&D concepts (from EU-funded research & central European labs to companies).

F.11.2.5. Coherence with new financial instruments (InnovFin and EFSI)

KETs need considerable investments to reach high TRLs, and to support upscaling and deployment. The EIB and EIF instruments play a special role in financing KETs. In February 2013 the Commission signed a Memorandum of Understanding with the EIB to promote access to finance for KETs, followed by an increase of 60% in the lending to KETs-related projects.

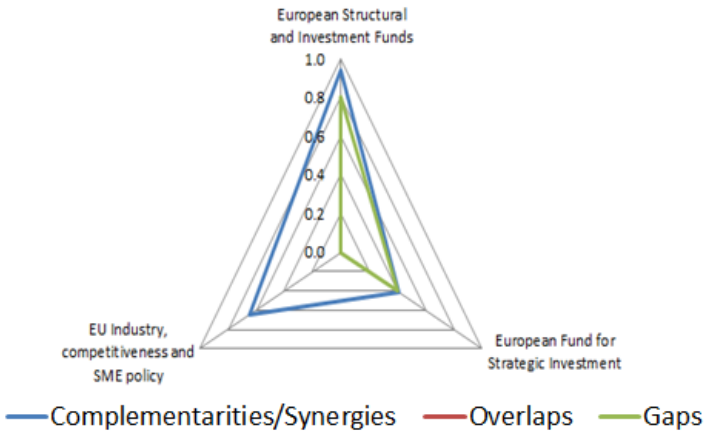
The importance of risk finance is further demonstrated by the fact that the NMBP areas account for roughly 30% of the signed amounts under the Horizon 2020 InnovFin from 2014 to mid-2016.

In general, however, access to finance for KETs is very limited, in particular for small and fast growing SMEs immediately after the start-up period.

An EIB study on the subject proposes potential solutions to improve access to finance. An estimated 10,000 SMEs base their business on the development and commercialisation of KETs, but many innovators and research-driven newcomers find it hard to raise growth capital to develop their businesses. The study shows that it is not enough to have risk-sharing financial products to resolve the financing needs of KETs companies. These companies are often not aware of these opportunities, and many need expert financial advice to become investor-ready. Similarly, bankers often lack an understanding of new technologies and of their market potential, and hence shy away from such investments. A follow-up study by the EIB will examine the way in which investors assess risk in KETs projects.

[154] *Source: http://www.interreg-central.eu/Content.Node/NUCLEI.html; Application Form*

F.11.2.6. Results of DG RTD internal assessment of external coherence with other EU policies / programmes



Source DG RTD survey, October 2016.

F.11.2.7. Coherence with other public support initiatives at regional, national and international level

National and regional funding opportunities across the EU are diverse. An analysis done as part of the coordination and support action EU-GREAT[155] [156] showed an impressive inventory of national and regional funding opportunities relevant to large-scale R&I NMBP related initiatives. The analysis identified numerous funding instruments throughout Europe at national, regional or even local levels. Among the examples mentioned: FIRI2016 (Finland), FUI (Fond Unique Interministerial) (France), Sectoral R&D programmes (Poland), and Mobilisation Programmes and Demonstrator projects (Portugal). Some of these national and regional programmes are partially supported by ESIF, but managed at national or regional level.

In addition, the new instrument addressing Important Projects of Common European Interest (IPCEI) is noteworthy. The main goal is to mobilise public support for the first industrial deployment of major R&D projects.

F.11.3. Lessons learnt/Areas for improvement

The analysis of internal and external coherence shows that in terms of structure the choice of instruments is coherent and complementary. A wide range of opportunities exist, which do not overlap and can in principle be mutually reinforcing. In terms of the synergies though, there is room for improvement. This applies both to internal synergies within Horizon 2020 activities, and to external synergies between Horizon 2020, other sources of public funding, and financing mechanisms. The opportunities for improvement lie mainly in coordination and information efforts, rather than the design of individual programmes. Current ERA-NETs can fulfil this role to some extent, by supporting coordination and complementarity between national research programmes.

[155] http://eu-great.com/
[156] *EU-GREAT, Deliverable D5.2-Report overview of funding mechanisms*

F.12. EU ADDED VALUE

F.12.1. EU Added Value in the LEIT-NMBP programme – three practical examples

This section presents three practical examples of projects that demonstrate the EAV of the NMBP programme. They were selected to show various kinds of European added value within the programme. The selected projects present efficiency, effectiveness and synergy.

DRIVE (RIA; 8.8 million EUR, June 2015 – May 2019) is a good example of the opportunities that the programme can provide to a societal challenge, health in this case. It aims to improve pancreatic transplant therapy for diabetes mellitus. Partners are developing a minimally invasive way to maintain donated pancreatic islets (the parts that play a role in diabetes) in recipients who would otherwise need frequent injections. More specifically, they intend to insert the islets into small capsules, create a fold in the lining of the recipient's abdomen and establish the capsules inside this "pocket". A successful islet transplant reduces patients' burden considerably by freeing them of the obligation to work out how much insulin they need and to administer accordingly. The private partners forecast considerable future growth.

Manutelligence (RIA; 4.8 million EUR; February 2015 – January 2018) is a prime example of a merger between the digital and physical worlds, typical of the fourth industrial revolution. Its vision is smart, social and flexible production with high value-added services fulfilling EU sustainability goals. The project aims to improve product and service developments in multiple markets or industries by digitally connecting all parts of their value chains right down to the customer. Funded under the Factory of the Future cPPP, the objective is to enable product designers to develop holistic views on the lifecycle of their creations by gaining access to relevant product and market data from multiple sources. A key aspect of Manutelligence is therefore to merge the current design, manufacturing and Product Lifecycle Management systems with those derived from the emerging Internet of Things. Consequently, these vastly increased information resources will enable manufacturers to develop new innovative services based on their existing products and to create tailored services based on product usage information and customer's wishes while eliminating resource waste in the process. Regarding Innovation policy, the project shows the importance of creating new potential manufacturing systems to increase the competitiveness of EU industry.

MATChING (IA; 11.8 million EUR; March 2016 – August 2019) tackles the sustainable management of water resources. Power generation is a sector requiring large amounts of water: cooling water for energy production accounts for 45% of total EU water use, second only to agriculture. The project demonstrates technologies for reducing the use of water in thermal and geothermal power plants (30% and 15% reduction, respectively). Advanced and nano-based materials will be used to improve the technologies behind cooling towers, steam condensers, cooling water circuits and water conditioning, to reach economically viable water consumption and facilitate market uptake. To increase the available water supply at reasonable costs, alternative water sources will be exploited and different membrane technologies will be used to re-cycle municipal and process waters. Demonstration will take place in partner-owned industrial sites.

F.12.2. Other issues related to EU added value

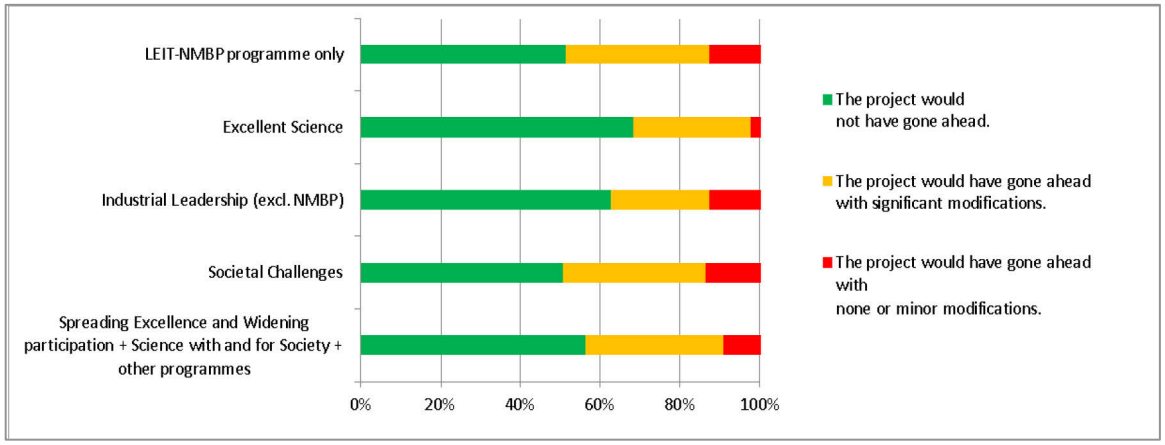
The European Added Value (EAV) is an assessment on whether objectives can be better achieved by European action. This section explores the additional value that results from the programme, compared to what could be achieved by Member States at national, regional, or local levels. The evidence is based on two main sources: The primary source of information is from a large survey (conducted by PPMI) on the EAV of different Horizon 2020 programmes and initiatives. This study allows not only to assess the perceived added value of NMBP in detail, but also to compare these outcomes to other programmes and initiatives. The secondary source comes from data on EAV collected in the evaluation of the NMBP programme.

F.12.2.1. EAV - Project continuity without EU funding

A key aspect of EAV is the concept of project additionality, that is the capacity of the project beneficiaries to carry out the same or very similar projects without EU funding. If Horizon 2020 projects could be fully implemented without EU funding, this would imply a crowding out of investment. Conversely, full project additionality and EAV is achieved in cases where Horizon 2020 projects would not have gone ahead at all without EU funding.

Based on the findings of the EAV survey, it seems that the NMBP projects had clear additionality. Just over half of the NMBP projects (51%) would not have gone ahead without EU funding. And only 13% of the NMBP projects would have gone ahead with no or minor modifications. About a third (35%) of projects would have gone ahead, but with significant modifications. These outcomes are similar to the average outcomes under the Societal Challenges pillar and some other parts of Horizon 2020, but somewhat lower than those for the programmes of the Excellent Science pillar and the other parts of the Industrial Leadership pillar.

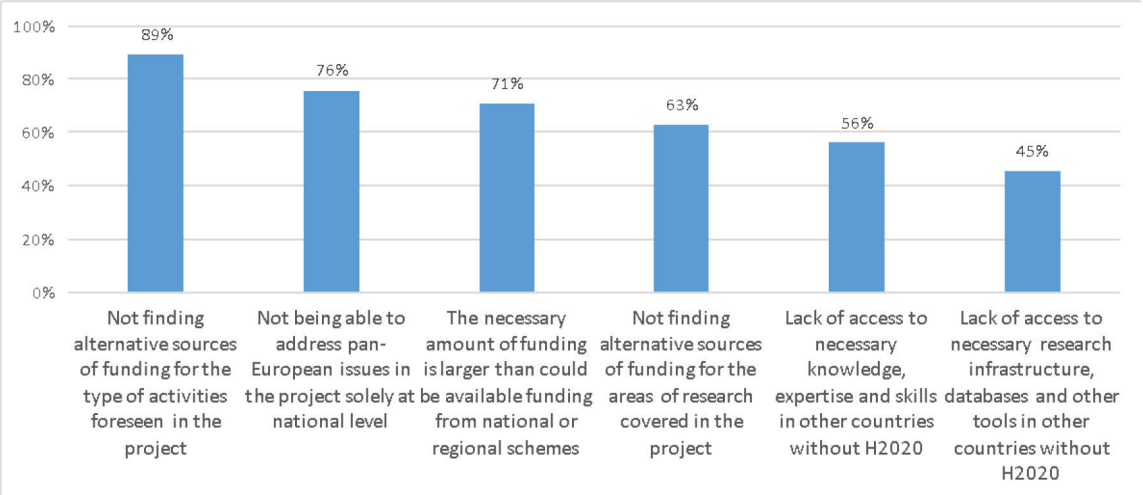
Figure 121 - Continuity of Horizon 2020 projects had they not received EU funding



Source: Survey of a representative set of Horizon 2020 project coordinators performed within the following study: PPMI, "Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020)", forthcoming.

The most common reason for projects not going ahead without EU funding is that the project coordinators would not have found alternative sources of funding for key activities in the project. Another common reason for significant variations is that the projects would not have been able to address pan-European issues, as shown in the figure below.

Figure 122 - Most relevant reasons for not going ahead in the project – NMBP (n=49)



Source: Survey of a representative set of Horizon 2020 project coordinators performed within the following study: PPMI, "Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020)", forthcoming.

A large proportion of those respondents who indicated that their project would have gone ahead, indicated that the project would have been financed from the consortium's own funds (84%) or from national and regional schemes (80%).

A large proportion of those respondents who indicated that their project would have gone ahead with modifications, indicated at the same time that their project would have had a different timeframe (82%) or a more limited scope (78%), that is more limited areas, subjects or ambition. Additionally, more than half of these respondents considered that their project would have had fewer partners, or different types of partners. As a consequence, these projects would most likely not fulfil the standards and requirements expected under Horizon 2020.

These findings are in line with the feedback received from NMBP project coordinators, who on the whole considered that there was a clear EU added value in the NMBP programme. The respondents suggested that if only national programmes were available, cooperation would have been much less efficient and effective. Moreover, they felt that learning effects would have barely taken place. One of the very positive effects of the NMBP programme in terms of added value is that it brings industry and research together on the European scale. This increases the ability of companies to collaborate with RTOs and universities from other Member States and Associated Countries. This was particularly the case for companies located in smaller countries.

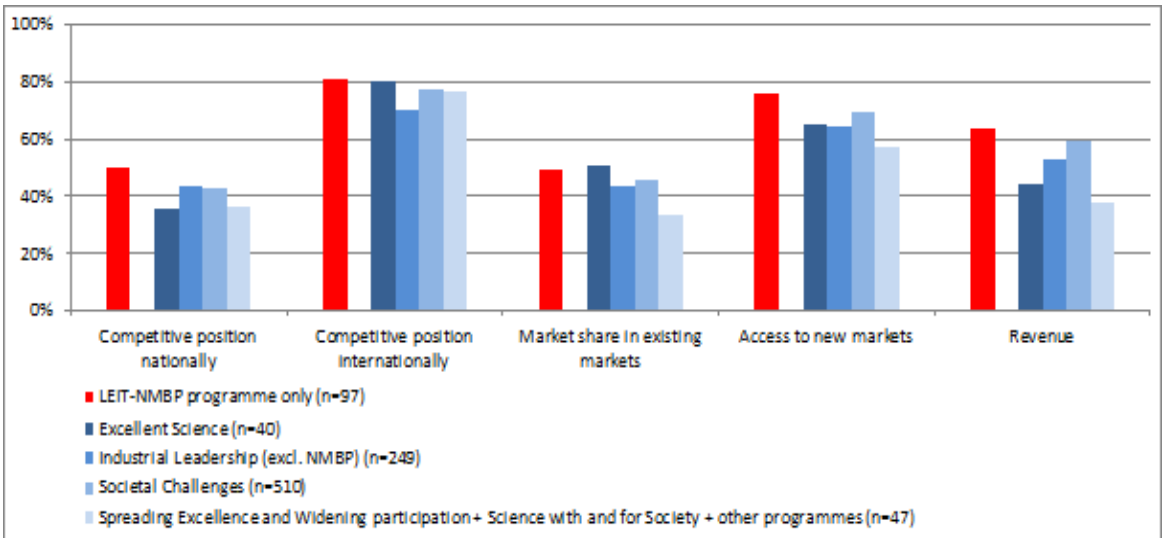
There were various reasons for the inclusion of more partners, or different types of partners, in NMBP projects. Networking was one of them, bringing with it the opportunity to be updated on the state of the art of technologies and other developments. This may radically transform some sectors and lead to more cross-cutting and hybrid technologies. In addition, even though the sectors in question are often traditional and dominated by fairly large companies, the consensus was that SMEs were always needed for bringing new ideas and business models. In other words, the projects supported by the programme help to create a European ecosystem that "does not exist elsewhere in the world".

Beneficiaries of Horizon 2020 projects were also asked about a hypothetical situation in which, instead of Horizon 2020 support, they received a similar amount of national or

regional funding and their consortium went ahead with the project. In this scenario, 59% of NMBP projects would have developed less understanding and knowledge in new areas; 58% would have less access to infrastructure and equipment; 53% would have fewer scientific capabilities; and 52% would have fewer technological capabilities. These findings were very much in line with the feedback received through the interviews and case studies conducted as part of this evaluation.

NMBP project partners clearly indicated that the EU funding helped them to enhance their competitive position internationally (81% for NMBP in general, and 93% for the cPPPs). What stands out in the results is that NMBP projects also benefited to a greater extent than other areas in relation to access to new markets (76%), increasing revenues (64%) and enhancing their competitive position nationally (50%). These positive results with regard to competitiveness and access to new markets confirm the added value of the NMBP programme in particular.

Figure 123 - Share of project and consortium partners for whom commercial advantage would have decreased had they received national / regional instead of Horizon 2020 funding

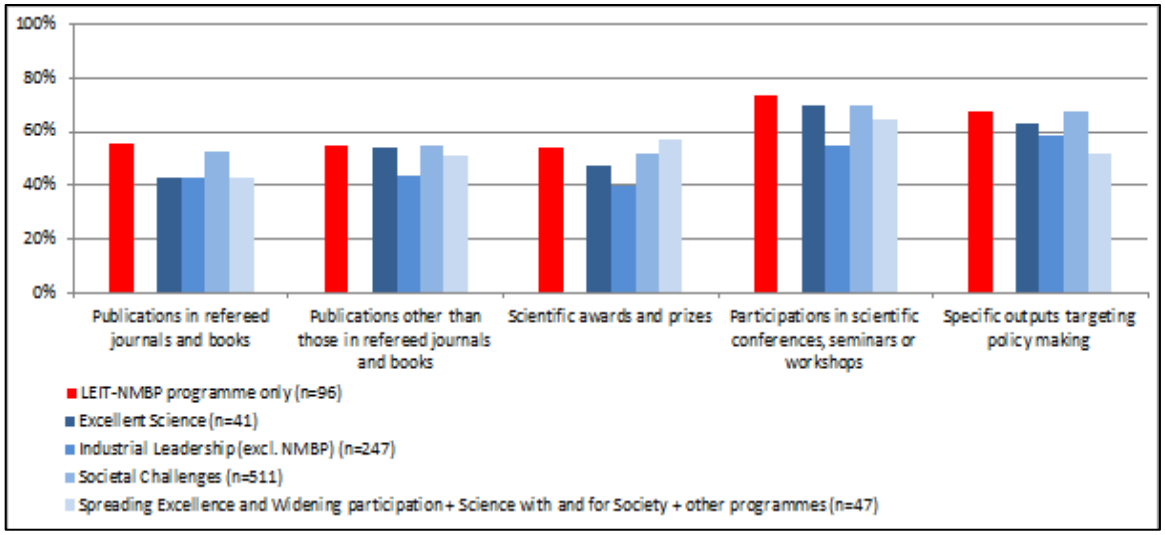


Source: Survey of a representative set of Horizon 2020 project coordinators performed within the following study: PPMI, "Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020)", forthcoming.

F.12.2.2. EAV – Research outputs

Beneficiaries were also asked to comment on the EAV in relation to the project outputs. Many indicated that especially the dissemination activities (i.e. participation in conferences, seminars and workshops) would have been more limited without the EU funding. 74% of the NMBP beneficiaries felt that this participation would have decreased under national or regional funding. The EAV was also relatively large for outputs linked specifically to policy making: 67% of NMBP beneficiaries felt that there would have been fewer policy-related outputs under national or regional funding.

Figure 124 - Share of project and consortium partners for whom scientific/research outputs would have decreased had they received national / regional instead of Horizon 2020



Source: Survey of a representative set of Horizon 2020 project coordinators performed within the following study: PPMI, "Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020)", forthcoming.

As shown in the table below, the findings on the EAV of research outputs are even stronger when looking at the NMBP cPPPs only.

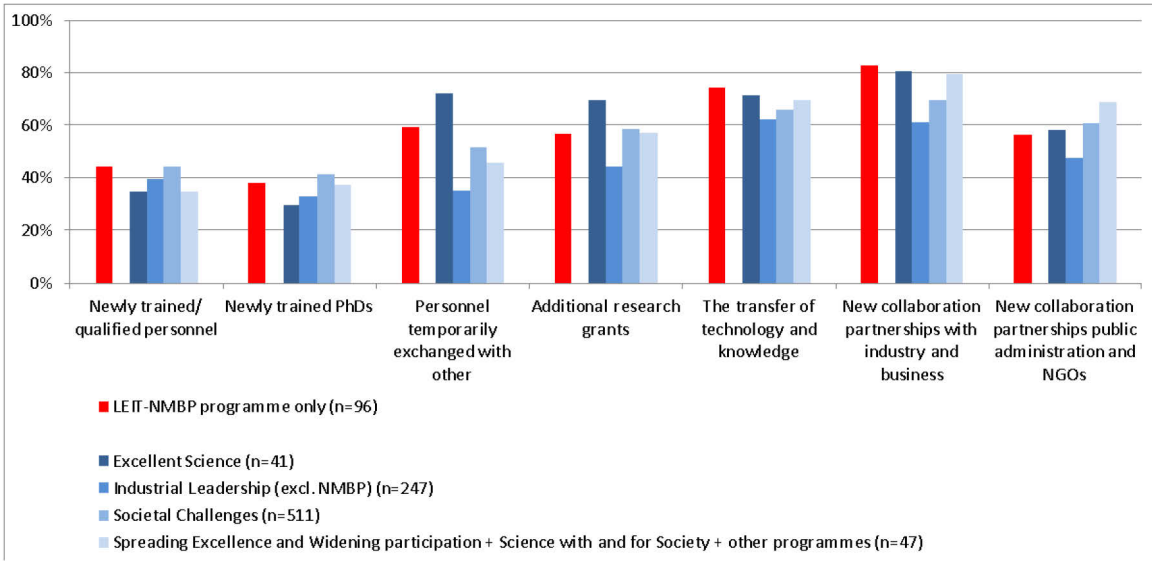
Table 68 - Share of project and consortium partners for whom their scientific / research outputs would have decreased had they received national / regional instead of Horizon 2020 funding – NMBP versus PPPs only

Horizon 2020 Programme part	Publications in refereed journals and books	Publications other than those in refereed journals and books	Scientific awards and prizes	Participations in scientific conferences, seminars or workshops	Specific outputs targeting policy making
Industrial leadership					
NMPB (n = 96)	55,1%	54,9%	53,8%	73,6%	67,0%
Subtotal within NMPB: PPP projects (n=31)	*63,2%*	*75,9%*	*41,5%*	*86,6%*	*75,3%*

Source: Survey of a representative set of Horizon 2020 project coordinators performed within the following study: PPMI, "Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020)", forthcoming.

Another set of questions analysed the extent to which the research capacities of beneficiaries would have decreased had they received national or regional funds. The underlying trend is that there would be a significant decrease in the research capacities, particularly with respect to new collaboration partnerships with industry and business (83% in NMBP, and 87% in the cPPPs) and the transfer of technology and knowledge (74% in NBBP, and 89% in cPPPs). The EAV was less clear in relation to newly trained or qualified personnel (44%) and newly trained PhDs (38%), although compared to the other programmes, NMBP scored slightly above average for these aspects.

Figure 125 - Share of project and consortium partners for whom research capacity outputs would have decreased had they received national / regional instead of Horizon 2020 funding



Source: Survey of a representative set of Horizon 2020 project coordinators performed within the following study: PPMI, "Assessment of the Union Added Value and the Economic Impact of the EU Framework Programmes (FP7, Horizon 2020)", forthcoming.

F.12.3. Lessons learnt

- Access to new partners: a clear aspect of added value was in the networks that the programme supported (76% of respondents) and the ability of projects to attract the right researchers and other key staff (63%). The aspect of networking was also reflected in the fact that, without the LEIT-NMBP programme, there would have been a significant decrease in the research capacities, especially in relation to new collaboration partnerships with industry and business (83%) and the transfer of technology and knowledge (74%).
- Access to new markets: a remarkable feature of the NMBP programme is that participants benefited to a greater extent than other areas in relation to access to new markets (76%), increasing revenues (64%), and enhancing their competitive position nationally (50%).
- Availability of funding: a key aspect of added value which respondents have highlighted was the scarcity of funding at the national and regional levels. A large number of respondents also indicated that they would not have been able to address pan-European issues.
- Attracting additional financial resources: A majority of NMBP beneficiaries indicated that they expected to secure additional R&D funding for their projects in the future. 76% expected to secure more funding from project partners, 72% from public national or regional schemes, 72% from other EU programmes, and 72% from private or industrial sources. It would be interesting to follow-up the extent to which these expectations are realised in the future.
- Contributions to Societal Challenges: Lastly, NMBP projects are expected to make significant and unique contributions addressing societal challenges, notably climate

action, environment, resource efficiency and raw materials (62% of NMBP projects) and energy (53% of NMBP projects).

F.13. SUCCESS STORIES FROM PREVIOUS FRAMEWORK PROGRAMMES

Among the many success stories from completed FP7 projects, three have been selected as examples of outstanding success in tackling several societal challenges, in heralding socio-economic change, and in providing EU added value:

RetroKit (10 million EUR; September 2012 – August 2016) tackled the problem of very low retrofitting rates in Europe's buiding fabric. It developed multifunctional, modular, low cost and easy-to-install prefabricated modules, contributing to EU 2030 energy reduction commitments. The solutions that the project developed were applied to three different residential buildings, located in three different climate zones in Madrid (ES), Frankfurt (DE) and Piteå (SE). The project brought multifunctional envelope (façade and roof) elements into the construction industry, opening doors for mass customization. The project developed special solutions dealing with aspects of heating, ventilation, cooling, electricity (photovoltaics) and digitisation. The key factor is the the technical box incorporating heating and cooling systems as well as utilities infrastructure (ducting, piping) installed on the existing façade. Multi-family residential buildings dating between 1945 and 1980 represent more than half of the European building stock. Such buildings account for 65% to 80% of the total energy consumption of buildings in the EU. Because of their age, most of them now require retrofitting or refurbishing. The key advantage of RetroKit is that interventions (even window replacements) are executed from the outside with only minor disturbance to residents. The toolkit includes a Decision Support System (DSS), which is a web application that will help the user to select the technologies to integrate in the modules for their specific building and configure the related characteristics. The RetroKit toolbox can evaluate the new energy demand, energy savings, environmental benefits and payback time. A significant impact is already ensured for the project, thanks to the commitment of the owners of the demonstrator buildings (municipality of Madrid, ABGnova and Pitebo) to reproduce the RetroKit solution in several of their buildings.

The **Oli-PHA (4 million EUR; June 2012 – May 2015)** project's goal was the biotransformation of olive mill wastewater for the production of high-value products, such as polyhydroxyalkanoate (PHA) biopolymers for food and cosmetic packaging. The treatment also allows the recovery of polyphenols that can be further used as anti-oxidant additives in cosmetics or active packaging. The bio-based polymer addresses growing consumer demand for environmentally friendly products, while contributing to the reduction of industrial wastewater environmental impact. Project participants from Mediterranean countries, Spain, Italy and Greece, shared their knowledge in addressing this shared issue.

FIBLYS and its direct follow-on project, **UnivSEM (5 million EUR; April 2012 – March 2015)**, are enabling researchers and businesses to make the best use of nanotechnology. The projects achieved major breakthroughs in advanced tools, by creating an instrument that is able to see, touch and sense on the nanoscale level. The instrument targets the markets for electron microscopy, which is a relatively broad market spanning microelectronics, materials research and quality control in production. Another major potential market is that of hybrid devices that combine inorganic and organic materials. Traditional analytical tools can handle inorganic materials, but UnivSEM added the ability to monitor and analyse organic materials that was lacking. The radical advance that this tool for nanotechnology brings is that it enables operators to use for the first time just one machine to carry out a range of processes which previously

required separate pieces of equipment each one costing millions of euros. This also saves time since samples do not have to be moved between devices and set up again each time.

F.14. LESSONS LEARNT/CONCLUSIONS

F.14.1. Relevance

The relevance of, and necessity for, the NMBP part – dedicated to key enabling technologies[157] (KETs) and industry – is supported by extensive literature on the weaknesses of Europe in industrial investments in R&I and high-tech; the growing importance of KETs; and the competitive position and innovation capacities of industry in Europe. There is a need to cross the "valley of death"; secure support for growth and scale-up; exploit and further develop Europe's strengths in KETs in the face of heavy global competition for new markets; and capitalise on the opportunities presented by the global challenges of climate action, energy, the circular economy and health.

The NMBP programme responds to this by positioning itself well in relation to industrial strategies, in particular with regard to the needs of SMEs, and by paying particular attention to leveraging private investments. As many other factors come into play when it comes to the industrialisation and commercialisation of the results, the programme relies also on the coherence and complementarity with other instruments, for example sources of funding and financing to scale up the developments.

The problems and needs have not changed fundamentally in the last few years, and recent developments such as the "fourth industrial revolution", the increased attention to the potential of digital technologies for manufacturing and in industrial applications, and the shift to services have added weight to the relevance of the programme.

Industry has responded with higher participation rates than in FP7, 49.8% for the programme and close to 60% in the cPPPs. The SME share in individual participations is as high as 36.2%. There are 54% of newcomers to the programme, of whom 87% are from industry. The programme remains highly relevant to the academic sector, notwithstanding its reduced participation.

The relevance to society at large arises from the applications of KETs in energy efficiency and renewables, the circular economy, medical technologies and healthcare, or studying the needs of people in relation to automation in manufacturing.

F.14.2. Effectiveness

The programme appears on track with regard to relevant indicators. The focus is on business to business areas where technological developments determine competitiveness at global level. The targeted outputs are mainly new products (75%) and processes (60%), and to a lesser degree services. The role of services should be examined as these are becoming increasingly blurred with manufacturing. Demonstrators and prototypes account for a significant part of the activities, for example 40% of the budget of the Factories of the Future cPPP.

There is no doubt about the intentions of the consortia to exploit their results, with the majority envisaging this within one to three years after the end of the project. About one quarter of projects seem to have attracted additional funding. Projects worth EUR 138

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million in funding involve the up-scaling of advanced materials and nanotechnologies through pilot lines. Standardisation is found in 16% of projects. The cPPPs add to the effectiveness of the programme by mobilising industrial stakeholders for European objectives, developing common roadmaps, and committing themselves to further investments.

The evidence shows a predominance of established industries (e.g. manufacturing and processing), which need to transform themselves in order to improve their sustainability and maintain competitiveness, in response to digitisation and new policies on energy and climate action. The degree of innovation is mostly substantial, with elements of radical innovation. New technologies are being integrated into the existing industrial fabric, where there is much potential for innovation. This is in line with the objectives of the NMBP part. Industrial leaders and SMEs alike participate in the programme.

Experience has shown how important it is to monitor and follow up any industrially relevant outputs. It is particularly important to capitalise on results relevant to policy, including standards and regulation (which can act either as a barrier or as a potential competitive advantage). Thought should be given to specific support for projects to allow further exploitation. This includes links to potential investors and access to finance and other funding sources. A study by the EIB on access to finance for KETs is already available; and a follow-up study started recently looking at due diligence and risk assessment carried out by banks and aiming to address information asymmetries on advanced technologies.

The possibility of opening the programme to emerging and new priorities and stakeholders should be considered.

F.14.3. Efficiency

Programme implementation is well on track and the simplification has led to higher interest of industry including SMEs. The LEIT NMBP programme has been successful in increasing the participation of newcomers, in particular from industry.

The time to grant respects the 8-month limit and is significantly below in many cases, as for the cPPPs. The overall budget for NMBP excluding the biotechnology part and the contributions to the SME Instrument is practically the same as that of the NMP theme under FP7.

The main concern is that success rates are too low, discouraging researchers and industry from participating. It may be appropriate to consider more two-stage calls (currently used for about a half of the topics).

While the average funding rate has increased in Horizon 2020, there is a strong case for a lower funding rate for industrial partners in demonstration projects. Even though this may somewhat compromise simplification, it would allow more projects or larger projects to be funded, and secure more leverage and a stronger industrial commitment.

With regard to the drafting of the Work Programme, it is important to consider carefully the ways in which scope and expected impact are defined; and whether the requirements and guidance with regard to business cases and exploitation are being understood fully by the stakeholders. There seems to be a need for a systematic and specific support for exploitation, such as the ESIC scheme for FP7 NMP projects, confirmed by the use of the "Exploitation booster" pilot under Horizon 2020 by NMBP projects (including cPPPs).

Possible action should be considered to enhance the participation of EU-13 partners, which has been consistently low throughout FP6 and FP7 and in the first years of Horizon 2020.

The role of project officers is much appreciated. New coordinators and SMEs need specific administrative support.

F.14.4. Coherence

The NMBP programme shows a very strong internal coherence in particular with the ICT programme and a number of Societal Challenges. In practice, key enabling technologies have a strong presence in the European Research Council (ERC) and in Marie Skodowska Curie Actions (MSCA), as well as in Future and Emerging Technologies (FET). However, there is no systematic monitoring and there are growing gaps between NMBP in the industry pillar and the more upstream activities typically funded by the science pillar. Closing the gap on the NMBP side is a matter of budget availability and no systematic attempt has been made so far.

Coherence with national programmes is reflected in the ERA-NETs which support coordination and complementarity between national research programmes, with Horizon 2020 NMBP and some involve an important international cooperation dimension.

Particularly important is the coherence and synergies with other funding and financing instruments such as regional and structural funds (ESIF). There are several encouraging examples of strong regional interest in KETs and the NMBP areas, while there is still scope for making Horizon 2020 and ESIF funding more complementary at the implementation level; and a need for better coordination and information exchanges.

F.14.5. EU Added Value

Supporting collaboration across borders is the most prominent aspect of the programme's added value - projects attract the "right" researchers and other key staff to work together Without the NMBP programme, there would have been a significant decrease in research capacities, especially in relation to new collaboration partnerships of industry and business with academia and the research community and the transfer of technology and knowledge.

Another remarkable feature of the NMBP programme is that participants benefited to a greater extent than other areas in relation to access to new markets, increasing revenues, and enhancing their competitive position.

A key aspect of added value for stakeholders was the scarcity of funding at the national and regional levels or the need for additional funding. A large number also indicated that they would not have been able to address pan-European issues without the funding.

NMBP also brings a clear added value to Societal Challenges: NMBP projects are expected to make significant and unique contributions of pan-European relevance addressing societal challenges, notably climate action, energy, the environment, and resource and energy efficiency. Also policy objectives under the Digital Single Market are more effectively addressed under a European umbrella.

European programmes such as NMBP allow resources to be concentrated to those priorities that can be tackled better at a European or global level.