SUSCHEM

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Key messages:

Partnership for Impact: one of the main aspects in Horizon 2020 is the drive for Innovation. Public Private Partnerships (PPPs), such as SPIRE and BBI, are important instruments that promote competitiveness, participation of partners along the value chain and foster a networking balance between SMEs and large industries. The combination of SMEs, public partners and large companies is critical to cross the "technology valley of death". This combination should be targeted as a long term committed initiative.

Key Enabling Technologies (KETs): the chemical industry provides sustainable and innovative solutions (KETs) addressing the Societal Challenges identified by the European Commission. Innovative technologies and processes are the way to overcome the growth stagnation of the European Industry. Therefore, National Technology Platforms (NTPs) have a fundamental role positioning their geographical strengths and needs to build a strong European technological and political network.

Project Success Rates: The almost halving of the success rate compared to FP7 can be improved by more accurate call definitions with funding focused on a short list of major breakthrough innovation topics, with higher funding for more high quality projects. More precise call definitions will also enable better quality reviews.

1. SusChem and Horizon 2020

The European Technology Platform (ETP) for Sustainable Chemistry "SusChem" was established in 2004 to develop a strategy and plan for the European chemical and biotechnological industries. This strategy and plan outlined how to rejuvenate our industries through research and innovation, how this aligned with European Commission funding initiatives, in particular the Research Framework Programmes 6, 7, and subsequently, Horizon 2020, and how to most effectively improve the competitiveness and sustainability of our industries. In fact, the European chemical industry is characterized by a changing and increasingly tough global competitive landscape. The European chemicals market share more than halved in 20 years, down from 32.3 % in 1995 to 14.7 % in 2015. Moreover, very low growth rates (average of 0.3 % during the same period) were observed for the chemical sector including academia.

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We are convinced that competitiveness can bounce back via innovative, sustainable and efficient technologies and processes. In this context, SusChem plays a vital role in Horizon 2020, providing valuable input to the European Commission ranging from high level content to technology topics. An important instrument is the fourteen National Technology Platforms (NTPs) under the SusChem ETP umbrella that collect ideas and proposals from the national / regional networks and provide a link to local partners, i.e., SMEs and citizens. Moreover, SusChem is an open forum for discussion, input and communication between different players in the chemical sector and European public institutions including academia.

2. Sharper call definition for projects in Horizon 2020 and intellectual property concerns

The SusChem Key Enabling Technologies (KETs) of the chemical industry described in the Suschem Strategic Innovation and Research Agenda (SIRA) offer sustainable solutions for Societal Challenges linked to the high level priority topics of the European Commission. The innovation aspect of Horizon 2020 and the alignment of themes provide a basis for project support and funding from the chemical industry. However the Societal Challenge structure creates relatively broad calls, leading to potential disconnection between call topics and the technology developed in a project. To achieve concrete solutions for the Societal Challenges, a narrowing down the list of topics and a better consideration of KETs to approach scientific challenges is required.

SusChem supports the two-stage call approach in Horizon 2020. The feedback applicants receive from the first stage evaluation helps to strengthen, balance and complete the project proposal with specific details for the second stage. As a consequence, time and resources are saved.

Protection of Intellectual Property (IP) remains an important issue for the chemical industry, SMEs and academia. Regarding Open Science: it is important that it is applied without affecting (i) the freedom to choose whether to publish or not, and (ii) the commercial exploitation of research results. Moreover, too hasty publications may hinder IP protection via patent applications. Therefore it is essential to maintain the results as an opt-out provision.

3. The importance of SMEs and large industries participation in Horizon 2020

Horizon 2020 set out to increase the participation of industry through more innovative-oriented calls; to increase participation of Small Medium Enterprises (SMEs), and shorten the 'time to grant'. The 2014 monitoring report and recently published 2015 report reveals the following data:

	H2020 2014	H2020 2015	SPIRE (PPP) 2014 & 2015	FP7 All years
Industry participation	31% *	32.6%	59%	20 %
Participation SMEs (% of private sector)	61%	65%	26%	n/a
Time to Grant[1] (days)	224	193	178	324
EU contribution per grant (€ Million)	1.78	1.63	5.9	1.77
Project Success Rate[2]	13.6%	10.7%	16.6%	~20%

* 40% of H2020 industry participants are consultants, i.e. 1 out of 10 project participants has a consultancy background.

The careful selected balance between large chemical industry and SMEs is crucial to push forward Research and Innovation in Europe. SMEs play an important role in job creation, upfront innovative and sustainable technology development. Their association with the large chemical industry enables technology implementation and provides channels to the market. Therefore a balanced maintenance of public funding in H2020 for SMEs and large chemical companies is crucial to improve competitiveness in Europe.

The participation of SMEs increased in the last two years. Nevertheless SMEs still struggle with the overall complexity of Horizon 2020 and also face difficulties in joining consortia. Additional clauses that encourage the participation of SMEs are recommended. The shared-risk principle between public and private funding is very important, especially during the resource intensive demonstration phase. Consequently, speed to the market can improve.

4. Better Time to Grant and project funding

The Time to Grant (TTG) decreased in 2014. Although already better, the time to grant is still too long for an industrial partner, especially in technology priorities that evolve and change quicker than the timing of call preparation and granting. Ideally this time should be reduced by a factor of two.

[1] It represents the time between closure of a call to project granting

[2] Number of projects granted versus total number of projects submitted to a call

In 2015 the average funding per project has decreased from €1.78 to €1.65 Million. It is important to have substantial funding for basic research at lower TRLs (3 - 5), but the dilution of funding over too many initiatives represents a hurdle to bridge upfront technologies and processes over the 'valley of death'. Higher funding for innovation projects (TRL 6-8), demonstration and flagship actions for the chemical industry is necessary.

5. The impact of relative low success rates and ways to increase it

Analysing the Project Success Rate between FP7 and Horizon 2020 a drop from ~20% to 10.7% is observed. The declining success rate is a factor that prevents large industries from participating more in Horizon 2020, hindering the market penetration of new technologies, processes and products.

One reason for the halving of the success rate is the 25.5% increase in the number of proposals. One out of four high quality eligible proposals was granted in 2015, representing an increase of 40.2 % from 2014 to 2015 and reflecting positively several efforts, like SusChem brokerage events, that contribute to form, advise and instruct consortia in the delivery of high quality project proposals. Broad calls, derived from Societal Challenges, may also be a reason for low project success rates. Therefore we recommend:

- more accurate definition of the calls to improve relevance versus the priority innovations of the chemicalindustry;
- funding focused with respect to fewer topics but with the possibility to grant at least four high quality proposals;
- better and more detailed feedback on rejected project proposals.

6. Administrative costs for consortia formation has increased

Successful project proposals for Horizon 2020 calls require a precise and accurate match with the call. Moreover the cost of forming a consortium and preparing a proposal has increased compared to previous FP programmes. Active projects require a narrowly defined set of accounting rules. Unfortunately these rules do not match with the enterprise accounting platforms, e.g. SAP, which companies are using. The requirement therefore generates an extra, if not double, administrative burden.

7. Public Private Partnerships (PPPs) initiatives as long term actions beyond Horizon 2020

Public Private Partnerships (PPPs) like SPIRE and BBI are extremely important and useful instruments, performing well in their ability to fund quality projects, with high levels of success. The PPPs have the ability to combine public and private efforts, promote cross-sectorial interactions, and address cross-cutting challenges including skills, education and regulation.

PPPs should be considered a long-term action supporting the competitiveness of European industrial sectors, where innovation and its implementation (bridging 'the valley of death') require time and significant capital investments.

The chemical industry is strongly involved in and supports SPIRE in its role as key-provider of solutions for efficient processes and offering solutions for the Societal Challenges in general.

Compared to the average of €1.6 Million per project in H2020 (2015) the average funding per SPIRE project has been in the range of €6 Million enabling the demonstration of innovation and flagship actions to foster the competitiveness of European industry.

SusChem recommends the continuation of PPPs as a long term action.

8. Recommendations

- Have a substantial coverage of topics in lower TRLs (Technical Readiness Level 3 – 5) and few topics at demonstration and pilot levels (TRL > 7) with appropriate levels of funding.
- Strengthen the PPP concept as a long term committed initiative; increase their attractiveness towards the large industry by higher funding for more flagship-oriented projects.
- Focus the H2020 programme on fewer/bigger topics related to Europe's strengths that can receive more funding to enable mission focused Flagship Project(s) for the chemical industry.

- Focus on fewer topics but funding at least four high quality proposals, allowing a holistic approach for a specific scientific challenge.
- To achieve a better participation balance in Horizon 2020 between large industries, SMEs, academia, and Member States (including EU-13 Member States) an improvement of call topic selection is strongly required.
- Earlier publication of call topics allowing possible partners to align themselves with their business planning.
- All the calls for proposals should be based on a two-stage process: this would allow a simplification of the workload of the involved consortia. Criteria: (i) the time for evaluation of the first stage should be faster with a shorter deadline between stages one and two; (ii) the coherence between the evaluations in both phases can be improved.
- Better and more precise feedback for rejected projects is highly desirable.
- Horizon 2020 is an important R&I funding mechanism, but overall may represent only a portion of total R&I funding/support available in the EU through other programmes and/or member state instruments. A better integration between different funding mechanisms is highly desirable.
- We need high-level support in the Member States and the European Parliament to achieve the rejuvenation of the process industry in Europe.

9. Preliminary impact of selected FP7 and Horizon 2020 projects

The following section translates into more concrete terms the relevance and impact of actions taken in Horizon 2020. Five fields were chosen taking into consideration aspects such as process industry, circular economy, and energy efficiency amongst others. Examples are given highlighting the impact of the selected projects.

Water Management

Water is a scarce resource and a key element for the development of our society and economy. The continuing increase in urbanization and agricultural production, combined with the demands from the new, emerging industries, plus the need to preserve biodiversity and the environment, put high demands on water management.

The chemical industry is a significant water user and an important solution provider of innovative products, technologies and services that enable more sustainable water management. Water is used in the chemical industry for many purposes including processing, washing, and diluting, heating and cooling, and transporting product. To deal with critical challenges, such as the need to reduce water use, wastewater production and energy use, the FP7 funded **ChemWater** project developed a vision and roadmap. Subsequent FP7 funded innovation projects like **E4Water** and **DemoWare** followed this roadmap and took technology concepts (TRL3-4) developing these into industrial pilots (TRL 7-8). The six industry pilots in the E4Water project demonstrate 40-80% reduction in fresh water uptake; 30-100% reduction is wastewater production; up to 20% energy use reduction; and capability to recover resources from water and returning them to the primary process. In addition, the ten industry pilots in **DemoWare** demonstrate cross-sectorial industrial symbiosis in re-use of treated wastewater; and the re-use of treated industrial wastewater for agricultural purposes. The breakthrough results of the DemoWare project are recognized by the Environmental Leader's project of the Year 2015 award. The Horizon 2020 funded **INSPIREWater** started recently. The project is leveraging the learnings from earlier and related projects to further enhance the concept of integrated water management, industrial symbiosis and closeloop re-use of water.

These EU funded projects demonstrate results and impact in the chemical and related process industry sectors in terms of 'fit for purpose' water management; effectively decoupling industrial activity from the use of fresh water. To extend this impact to the most recent developments in the chemical industry two major development routes forward are identified: (I) a closer interaction between chemical production and industrial water treatment processes and (II) combining digitisation in industrial water management with digitisation in the process industry.

Catalysis and Processes

As chemistry is an enabling industry for most of the seven societal challenges in Horizon 2020, it has to anticipate the changing needs of society, and be able to create wealth (value growth, jobs) by ever increasing its efficiency and ability to transform materials, use a broader range of raw materials and deliver innovative solutions. **Catalysis** and advanced catalytic processes account directly or indirectly

for about 20-30 % of world GDP. Catalytic technologies are ensuring that raw materials and energy are used efficiently in the production of various industrial large scale and specialty chemicals, plastics and fuels. Combined with reactor design, catalyst technologies provide one of the most important sources of technology-based efficiency improvement potential. Around 90% of chemical processes use catalysts for efficient production. Moreover, catalysts and advanced process technologies enable the use of a growing number of alternative raw materials such as biomass, natural gas, gaseous effluents, or waste and secondary streams from other industries as chemical and energy feedstock's, and are used to clean emissions from industrial processes and combustion engines to limit the impact on our environment. As a root of chemical efficiency, catalyst and advanced process technologies are highly innovative and able to deliver on the specific challenges that the chemical industry has to overcome.

The project **SYNFLOW** has developed and successfully demonstrated the concept of catalytic process design to provide continuous catalytic flow-processes with superior process performance and clearly identifiable business advantages for small to medium scale chemical and pharmaceutical manufacturing. The concept of the SPIRE project **PRINTCR3DIT** is to employ 3D printing to boost process intensification in the chemical industries by adapting reactors and structured catalysts to the specific requirements of the reaction. The utilization of the concept of 3D printing will significantly improve the resource utilization of reactor and catalyst manufacture, and thereby lower energy consumed (< 15%) in processes. **TERRA** aims to develop a tandem electro-catalytic reactor with great potential advantage of saving resources and energy by intensifying the process. In **ADREM** Page 5 of 6 catalytic reactor engineering, catalyst design and process control will address the domain of resource and energyefficient valorization of variable methane feedstocks to C2+ hydrocarbons.

ICT/Digitisation and Processes

From new forms of production including modeling of processes and materials to new business models the chemical industry is about to go through a revolution by taking full advantage of what **digital technologies** have to offer. Such engagement is expected to have a particularly high impact in **modernizing Europe's production and R&D capabilities** and would position the European chemical industry ahead in the race for **competitiveness and sustainability**.

The European chemical industry strongly contributes to the European economy by transforming raw materials into intermediates as a basis for manufacturing industries and end-user products. **Digitization is present in all aspects of the chemical industry** as it is essential throughout its value chains, from logistics, process design and new materials development, planning, plant operations, plant safety, monitoring and maintenance of factory equipment to marketing/sales and customer integration.

Important project examples include the **F3 Factory** project's results demonstrating the advantages of operating **modular continuous plant processes** that are more economical and sustainable than current operations and only possible by digital process control and online analytics.

The project **MORE** introduced and successfully deployed in several industrial pilots **real-time resource efficiency indicators** that can be efficiently used in daily operations and are computed based upon the processing of real-time data that is available in the monitoring and control systems. Such efforts strongly contribute to improve resource efficiencies by providing model-based real-time decision support to plant operators and plant managers.

Built on the F3 Factory concept, the SPIRE project **CONSENS** is advancing the continuous production of highvalue products that meet high quality demands in flexible intensified continuous plants by introducing novel **online sensing equipment and closed-loop control** of the key product parameters. Applied in industry, the outcomes of the projects could result in significant cost savings and reduction of CO2 emissions (176,000 t/y), less consumption of solvents in pharmaceutical and specialty industry, and in the important acceleration in the development of new products (2x faster additional innovations and 2x shorter times-to-markets).

The Horizon 2020 funded SPIRE **CoPro project** started recently; the project is leveraging learnings from past and related projects to further enhance the concept of **process monitoring and optimal dynamic planning**, scheduling and control of plants, industrial sites and clusters under today's dynamic market conditions.

These project examples are just the starting point to further deploy digitizing the chemical industry. By unfolding the full potential of high speed connectivity, the

internet of things, cloud computing, optimization through the use of big data extensively applied in all stages of R&D and the manufacturing chain, the chemical industry will create new high-skilled jobs, reduce its consumption of resources and energy in the manufacturing phase, increase its production capacity and continue to create those innovative products which a changing society needs.

Sustainable Bioeconomy

Many sectors (agriculture, forestry, marine, chemicals and materials, energy, food) can be made more competitive and sustainable through the development of the bioeconomy via an integrated systems approach, which will provide very significant opportunities for new innovations, more sustainable value chains, jobs and economic growth.

The **European industrial biotech and chemicals industries** increasingly stimulate **bio-based production** and the conversion of renewable biological resources and associated waste streams. Moreover, it enables the entire bioeconomy value chain from feedstock availability to the biorefining of biomass into **bio-based chemicals and materials** that can be used in plastics, paints, adhesives, lubricants, cosmetics, pharmaceuticals and many more applications.

To tackle the barriers to greater innovation in the bioeconomy through the development of sustainable chemistry and industrial biotech, the FP7 funded project **BIO-TIC** provided an interesting roadmap for addressing technical and non-technical hurdles in Europe. Three main aspects were analyzed in depth: potential market developments; research and development needs; and regulatory and non-technological aspects. The learnings acquired by this and previous projects are being leveraged throughout H2020. Several different initiatives towards the uptake of the bioeconomy began during the period of Horizon 2020. In particular the **Bio-based industries PPP (BBI)**: a €3.7 billion dedicated programme to leverage capital markets and additional private and public funding in the bioeconomy. It focuses on feedstock supply, biorefineries, as well as markets and policy development. As an example, the first BBI-funded flagship project **FIRT2RUN** focuses on the chemical and biochemical conversion of vegetable oils for the production of value-added chemicals. The holistic and integrated view of the project allows the use of feedstock that does not compete with feed and food and also take into consideration the sustainable valorization of side-products and energy efficiency.

Also the **contractual PPP SPIRE** enables research and development in the area of the bioeconomy. Moreover, the push in adopting **models of collaboration** between different players along the entire value chain will open up new chances to strengthen bio-based industries. Bio-based industry is a key enabler of the **Circular Economy**. Demonstration projects such as **AgriMax** and **Funguschain** focusing on the minimization, valorization, and use of agro waste will be important milestones.

The different initiatives in the bioeconomy started in H2020 are already showing an impact in the chemical and biotechnological industries in Europe, i.e. the creation of new value chains, stronger links between up- and downstream players, and cross-sectorial collaborations via industrial symbiosis models. To support these initiatives a long term incentive is required through orchestrated funding systems attracting also private investments to further implement the bioeconomy. SusChem has actively supported synergies between these instruments, such as SPIRE and BBI.

Materials for Energy

Innovations from the chemical sector in the area of **advanced materials** play a vital role in increasing competitiveness and environmental performance. The European chemical sector has a strong track record of developing innovative high performance materials and it considers of high importance the impact achieved by European projects. There are many examples of materials projects linked to the challenge of a cost competitive implementation of clean energy in Europe. This area is an example where a wide variety of advanced materials is required and a significant number of new materials have been developed through funded FP7 research projects showing how the framework programme instrument is key for SusChem's research community (SMEs, public as well as industry partners) and what impact materials development has across sectors.

For example, building on results of **SuperLightCar** (FP6) and **ELVA** (FP7) projects, the **ENLIGHT** (FP7) project developed innovative lightweight fibre-reinforced polymer materials and their respective manufacturing technologies, for medium to high volume production electrical vehicles, aiming at reducing the weight of major weight contributing modules. The project achieved up to 50% weight reduction compared to modules in commercially available vehicles, while complying with performance, manufacturability, cost effectiveness and footprint reduction targets, thus increasing the potential commercial viability of the technologies. Furthermore,

the project's OEM partners (original equipment manufacturers) jointly enjoy a 54% market share in EU-27, and 24% worldwide, ensuring wide exploitation of project results. In terms of material technologies, the project further developed fibre reinforced composites with bio-based matrix PA410 (EcoPaxx) and bio-based polyolefins. Furthermore the project outcomes will be used in the H2020 funded project ALLIANCE.

The second example in the area of energy storage is the FP7 project GREENLION dedicated to the improvement of battery cell materials and components, optimised module design as well as advanced production methods (Advanced manufacturing processes for low cost greener Li-ion batteries). This project succeeded in reducing cost while at the same time expanding environmental compatibility of Lithium-Ion batteries without decreasing performance characteristics like safety or energy density compared to state of the art cells. On the materials side, the technology to manufacture aqueous-based electrodes and avoid the use of organic solvents was developed (new patented high capacity anodes and a temperature stable separator membrane).

The challenge is being further addressed by the chemical industry through various currently running H2020 projects for batteries materials development, including eCAIMAN and FIVE VB amongst others, which demonstrate that an overall high impact is to be expected in the area of materials solutions for energy storage (Li-ion, but also other complementary technologies).

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