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'Advancing Manufacturing - Advancing Europe' - Report of the Task Force on Advanced Manufacturing for Clean Production

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This Staff Working Document is the result of the work carried out in 2013 by the Task Force on Advanced Manufacturing for Clean Production, a European Commission working group aimed at fostering the development and adoption of advanced manufacturing for clean production by European industry. It is aimed at providing information about existing measures relevant to advanced manufacturing that have already been implemented in recent months and upcoming actions previously endorsed by the Commission to support advanced manufacturing technologies.

1. EU MANUFACTURING: PRESENT AND FUTURE WITHIN A GLOBALISING WORLD

In 2012, the manufacturing sector in the EU was worth €7 000 billion in turnover, employed 30 million persons directly and provided twice as many jobs indirectly, the vast majority in small or medium enterprises (SMEs). It generated €1760 billion of value added (26% of the non-financial business economy)[1].

The importance of manufacturing for the EU economy is even more significant as regards its contribution to trade and innovation. Manufactured goods amount to more than 80% of total EU exports and the EU has a large trade surplus (€365 billion in 2012) in manufactured products. The manufacturing industry accounts for 80% of private Research & Development expenditure. European industry is a world leader in several manufacturing sectors, e.g. mechanical engineering, with a 37% global market share.

However, the role of the manufacturing industry in Europe has declined in recent years and the economic crisis has had severe consequences on the sector. Over 3.8 million jobs have been lost in manufacturing in Europe since the beginning of the crisis[2] and this trend has not yet abated. Industrial production is still lower than before the crisis. In real terms, the share of manufacturing in value added decreased drastically in 2008 and has not yet returned to its pre-crisis level.

[1] The largest EU-27 manufacturing subsectors in 2010 in terms of value added and employment were the manufacture of machinery and equipment, food manufacturing, the manufacture of fabricated metal products, the motor vehicle industry and the chemicals industry. Source: Eurostat, Manufacturing Statistics (April 2013).

[2] Member States' Competitiveness Performance and Implementation of EU Industrial Policy. SWD (2013) 346.

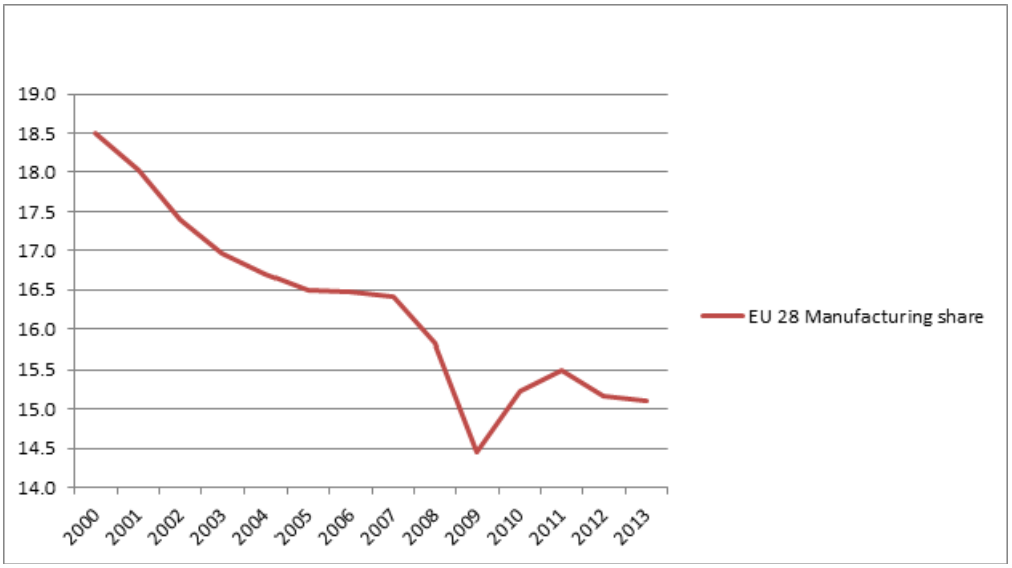

Figure 1: EU 28 Manufacturing's share of gross value added, current prices (source Eurostat)

It is a general trend in advanced open economies that the nominal share of manufacturing in value-added declines while the share of services grows. However, this trend might be enhanced by the fact that European industry faces some cost disadvantages compared to its main competitors, notably in labour and energy costs.

Labour cost divergences are expected to decrease gradually. At the same time, new technologies have the potential to change the global industrial landscape.

The increasing scarcity of resources, the availability of big data, and a trend towards mass customisation are important drivers of change for the manufacturing industry[3].

These trends have been captured by a recent foresight study[4] on the future of manufacturing which provides a vision for manufacturing by 2025. The box below provides a summary of this foresight study, while annex 1 provides an extended extract.

In 2025, there will be a fully globalised economy serving an informed and prosperous global middle class that will require personalised goods and services based on advanced manufacturing systems enabled by ICT and supplied by resource efficient and sustainable industries in Europe. In this context, three issues are particularly important for the European manufacturing industry and services.

First, consumers will increasingly demand a package of products and services tailored to meet their individual needs. The traditional model of ownership will evolve as societal and environmental pressures encourage people to demand more integrated products and services. As a result, manufacturing companies and service providers will work more closely together to build consumer-driven solutions combining products and services. Personalisation, enabled by new production technologies such as robotics and additive manufacturing will become a key driver for industry.

[3] See Business Innovation Observatory http://ec.europa.eu/enterprise/policies/innovation/policy/business-innovation-observatory/case-studies/index_en.htm

[4] A Manufacturing Industry Vision 2025, European Commission (Joint Research Centre) Foresight study, October 2013.

Second, regional and local customisation will have a major effect on how industry will operate. Diverse global markets, distributed manufacturing and an increasingly informed and prosperous global middle class will set many challenges to industry. The new global market will lead to regional diversity of consumer choice, with different regions often requiring very particular products, with different features and different pricing policies. Industry will have to respond by significantly improving its market analysis capabilities to capture consumer requirements adequately. The production of goods and services will therefore have to address mass customisation, and become localised and networked to be closer to customers, to respond to local demand, and to decrease costs.

Underpinning this will be 'Big Data'. Data will become the 'new oil'. Increasingly complex and large sets of data, supported by advanced analytical tools, will enable manufacturing firms to better understand and optimise all stages of their value chains, from design to distribution including supply chain management, production processes and marketing.

The result will be agile manufacturing, enabled by new production processes and technologies, such as additive manufacturing, software-enhanced added-value services, and ICT. Companies will create more intelligent products based on cyber-physical systems. These products will be manufactured in 'digital factories', with each part of the production process able to communicate with different manufacturing 'players', (e.g. humans, intelligent machinery, robots etc.). The value chain, with complex logistics systems able to supply, produce and distribute products flexibly, will result in a manufacturing process that is more efficient and responsive to change.

The European Technology Platform Manufuture which, since 2004 has advised the Commission to provide a vision and a roadmap for a coordinated research and innovation (R&I) in manufacturing in the EU, predicts that a new paradigm is emerging[5] with two complementary components:

- Competitive Sustainable Global Manufacturing, made up of global manufacturing industries with factories located in countries with competitive advantages (tax, labour cost, etc.).
- Competitive Sustainable Local Manufacturing, focusing on establishing local manufacturing industries, mainly where the proximity of the manufacturer to the final customer is critical.

[5] Manufuture High Level Group, 19 April 2013, Coventry.

2. ADVANCED MANUFACTURING TECHNOLOGIES FOR CLEAN PRODUCTION

'Advanced manufacturing for clean production' is understood by the Task Force as manufacturing technologies and production processes which have the potential to enable manufacturing industries to improve productivity (production speed, operating precision, and energy and materials consumption) and/or to improve waste and pollution management in a life-cycle perspective.

From a broad range of technologies both for discrete and for continuous process manufacturing[6] , the following can be taken as examples:

- *Sustainable manufacturing technologies*, i.e. technologies to increase manufacturing efficiency in the use of energy and materials and drastically reduce emissions (e.g. process control technologies, efficient motor systems, efficient separation technologies, novel sustainable process inputs, product lifecycle management systems)
- *ICT-enabled intelligent manufacturing*, i.e. integrating digital technologies into production processes (e.g. smart factories).
- *High performance manufacturing*, combining flexibility, precision and zero-defect (e.g. high precision machine tools, advanced sensors, 3D printers).

Advanced manufacturing technologies that enable clean production are seen as a key part of the new industrial revolution. For example, 3D printing allows production in much smaller quantities than is currently economically feasible, enabling low-cost customised production for new niche products and opening up new market opportunities for innovative SMEs. It is expected that tomorrow's factories will use highly energy- and material-efficient processes, employ renewable and recycled materials, and increasingly adopt sustainable business models such as industrial symbiosis[7] or others bringing together different components of the value chain, including customers, to optimise the use of materials and convert waste, heat or any other vector into useful energy.[8]

It is difficult to quantify the total market volume of advanced manufacturing, given the variety of relevant technologies. To give an indication, the global market for industrial automation solutions[9] is estimated at $ 155 billion in 2011, 35 % of it in Europe, and is forecast to reach $ 190 billion by 2015.[10] In addition, the market volume for resource-efficiency technologies is

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6 Discrete manufacturing is the production of a finished good from components, e.g. cars, machinery or semiconductors. Process manufacturing is a continuous production process of materials or chemicals (e.g. chemicals, steel, and pulp).

7 Industrial symbiosis is a systems approach to a more sustainable and integrated industrial economy that identifies business opportunities to improve resource utilisation (materials, energy, water, capacity, expertise etc). The elements of industrial symbiosis include novel sourcing of inputs, value added destinations for non-product outputs, improved business and technical processes. Redefining Industrial Symbiosis, D.R Lombardi, P. Laybourn, Journal of Industrial Ecology, vol. 16, 2012

8 A Stronger European Industry for Growth and Recovery — Industrial Policy Communication Update, COM(2012) 582.

9 Including industrial robots, sensors, valves, drives & motors, product lifecycle management systems, industrial control systems.

10 Credit Suisse, Global Industrial Automation (Global Equity Research, August 2012).

estimated at € 128 billion.[11] There are certain advanced manufacturing segments with particularly high growth, such as 3D printing, for which the global market volume is expected to increase from $ 2.2 billion in 2012 to $ 11 billion in 2021.[12]

Non-technological innovation has an essential complementary role. Design of production processes that already has clean production as an objective enables more efficient and cleaner production processes.[13] An advanced workplace organisation can also contribute to increasing the productivity and efficiency of manufacturing processes.

11 Roland Berger, Green Tech Made in Germany, update 2012.

12 Wohlers Report 2013, Additive Manufacturing and 3D Printing State of the Industry

13 For example, mass customisation requires the integration of design and manufacturing. A design-driven manufacturing environment can help to reduce time-to-market for new technologies. Design tools are important for the resource-efficient manufacturing of complex structures as underlined by the Action Plan on Design Driven Innovation, http://ec.europa.eu/enterprise/policies/innovation/policy/design-creativity/index_en.htm#h2-1. In implementation of this Action Plan, the Commission is co-financing the implementation of the European Design Innovation Platform (EDIP). The Platform aims to boost the adoption of design in innovation policies and support the creation of capacity and competencies to deliver these policies. Implementation of the EDI Platform started in January 2014 and will continue for three years.

3. FOSTERING THE COMPETITIVENESS OF EUROPEAN MANUFACTURING INDUSTRY

The European Commission has taken action to reverse the declining role of industry. The Industrial Policy Communication Update of October 2012[14] established clear objectives for the industrialisation of Europe. Investment measured in terms of gross fixed capital formation is expected to increase from 18.6% of GDP in 2011 to 23% by 2020. Investment in equipment is expected to grow from 6-7% to 9% of GDP by 2020 to introduce new technologies and increase productivity. This should contribute to the overall aim of raising industry's contribution to GDP.

Advanced manufacturing technologies are crucial for simultaneously reaching the industrial policy aspirational goal of 20% GDP share of industry and the Europe 2020 objectives of a 20% emissions reduction and a 20% increase in energy efficiency by 2020.

In this context, the European Commission established the Task Force on Advanced Manufacturing for Clean Production at the beginning of 2013 to 'foster the development and adoption of Advanced Manufacturing for Clean Production technologies by European industry'. Advanced manufacturing technologies have been identified as a priority action of industrial policy[15] as they are of a cross-cutting nature, providing a crucial input for process innovation in any manufacturing sector[16]. The ultimate objective is to increase the competitiveness of the EU's manufacturing industry as a whole. This message has been strengthened by the recently adopted Communication "For a European Industrial Renaissance"[17] which enlarged the scope of the Task Force so as to cover the integration of digital technologies in the manufacturing process in the light of the growing importance of the industrial internet and the use of "big-data" in the manufacturing process.

The Task Force coordinates efforts with regard to advanced manufacturing in relevant Commission services.[18] During 2013, the Task Force consulted with EU Member States, industry and other stakeholders. The Task Force held a public hearing on 19 March 2013 and a series of workshops on 27 May 2013.[19] A final public hearing was held on 9 October 2013. A dedicated online consultation was open from March to June 2013.

Investment in advanced manufacturing technologies will lead to process innovation in manufacturing industries and will enable the manufacturing of new products. On the one hand, advanced manufacturing technologies have been identified as one of the Key Enabling

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14 A Stronger European Industry for Growth and Recovery — Industrial Policy Communication Update, COM(2012) 582.

15 Other identified priority action lines are: i) clean vehicles; ii) bio-based products; iii) sustainable construction ; iv) smart grids and v) key enabling technologies.

16 A process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.

17 COM (2014) 14

18 The Task Force is led by DG Enterprise and Industry, with participation of DG Research & Innovation, Joint Research Centre, DG Education & Culture, DG Communications Networks, Content & Technology, DG Competition, DG Employment, Social Affairs & Inclusion, DG Energy, DG Regional Policy, DG Trade, and Secretariat-General.

19 Summaries of discussions are available at http://ec.europa.eu/enterprise/policies/industrial-competitiveness/amt/index_en.htm.

Technologies (KETs)[20] necessary to produce KET-based products[21]. On the other hand, the scope of the Task Force on Advanced manufacturing technologies for clean production further encompasses all production solutions that can improve the productivity or resource efficiency of manufacturing production both in traditional sectors and emerging industries.

EXAMPLE: In spite of higher labour costs in Europe, a Spanish fashion manufacturing and retail chain became a world leader with flexible manufacturing and a high degree of automation of the production process.[22] It has created 30 000 new jobs between 2008 and 2012.

Individual EU Member States have also adopted strategies on advanced manufacturing. An enhanced coordination both among Member States and between national initiatives and EU initiatives seems, however, necessary to maximise the impact of such strategies.

EXAMPLES: Germany follows the agenda Industry 4.0 to use the potential of cyber-physical systems ('the Internet of Things') to maintain industrial leadership.[23]
The UK has undertaken a growth review on advanced manufacturing and launched the Advanced Manufacturing Supply Chain Initiative funding R&D and skills development as well as the High-Value Manufacturing Catapult.[24]
Finland's innovation agency Tekes focuses R&D&I support in manufacturing to ICT-enabled manufacturing and sustainable manufacturing.[25]
France has included factories of the future and robotics among the 34 initiatives for reindustrialisation.[26]

Annex 2 provides further details on national initiatives.

The European Union is not the only advanced economy taking policy measures to promote the development of advanced manufacturing technologies. In 2011, U.S. President Barack Obama launched the Advanced Manufacturing Partnership to improve the competitiveness of U.S. manufacturing industry.[27] In 2012, Mr Obama announced a $2.2 billion investment in advanced manufacturing research and development (R&D) and $1 billion for a National Network of Manufacturing Innovation.[28]

20 A European strategy for Key Enabling Technologies – A bridge to growth and jobs, COM(2012)341. Advanced manufacturing technologies for Key Enabling Technologies (KETs) are one of the six KETs prioritised by the European Commission. Other KETs are photonics, nanotechnology, advanced materials, nano/microelectronics and industrial biotechnology.

21 See annex 1 to Communication 'A European strategy for Key Enabling Technologies – A bridge to growth and jobs' COM(2012) 341 final

22 'Flexible Manufacturing & IT Makes Zara the World's Largest Fashion Retailer', Enterprise Efficiency, January 2013.

23 http://www.bmbf.de/en/19955.php.

24 http://news.bis.gov.uk/Press-Releases/Advanced-manufacturing-supply-chain-fund-to-create-thousands-of-new-jobs-6887c.aspx. In addition, the UK has undertaken a foresight project on the future of manufacturing: http://www.bis.gov.uk/foresight.

25 http://www.tekes.fi/en/community/Home/351/Home/473.

26 http://www.redressement-productif.gouv.fr/nouvelle-france-industrielle.

27 President's Council of Advisors on Science and Technology, Report to the President on Ensuring American Leadership in Advanced Manufacturing (2011); President's Council of Advisors on Science and Technology, Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing (2012).

28 White House Press Office, Fact Sheet — Advanced Manufacturing Initiatives to Drive Innovation and Encourage Companies to Invest in the United States, 17 July 2012.

4. TASK FORCE ACTION LINES

In order to foster the development and adoption of Advanced Manufacturing for Clean Production technologies by European industry, the Task Force has focused so far on three main lines of action:

1. Accelerating the commercialisation of advanced manufacturing technologies.
2. Removing obstacles to demand for advanced manufacturing technologies.
3. Reducing skills shortages and competence deficits.

This report identifies measures that have already been implemented in recent months and describes tools which are at disposal to support advanced manufacturing technologies.

4.1. Faster commercialisation of new advanced manufacturing technologies

Research and development is a key driver of innovation in advanced manufacturing and Europe is a major producer of knowledge in advanced manufacturing. However, European's share of global patent applications in advanced manufacturing[29] has decreased from 31% in 2000 to 25% in 2010, while East Asia's share of global patent applications has increased from 25% in 2000 to 46% in 2010.[30]

Continued investment in R&D for advanced manufacturing technologies is of prime importance for the competitiveness of manufacturing industry in the EU. In Horizon 2020, the EU Framework Programme for Research and Innovation in 2014-2020, a significant part of the budget (17.6%) will be dedicated to promoting leadership in enabling and industrial technologies, including advanced manufacturing technologies.[31]

However, investment in R&D is a necessary, but not a sufficient condition for industrial leadership. It is not the excellence in research, but the commercialisation of research results on the market that generates turnover and jobs in industry. In general, Europe suffers from weak industrial exploitation of new technologies stemming from research undertaken in the EU, mainly due to the current low growth prospects and insufficient exploitation of the potential of the single market.
Industry participation in research programmes plays an important role in improving the industrial exploitation of research results.

To this end, the industry-led European Technology Platforms (ETPs) continue to play a significant role as a channel of external advice that can help the Commission take industry needs into account in the process of implementing Horizon 2020. Furthermore, the ETPs will now focus on identifying the pathway to commercial deployment of research and provide strategic insights into market opportunities and needs.

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29 Patent applications in advanced manufacturing for key enabling technologies (KET) based products.

30 European Competitiveness report 2013, SWD(2013) 347

31 Horizon 2020 funding for "Leadership in enabling and industrial technologies" also includes nanotechnologies, advanced materials, biotechnology, information & communication technologies, cross-cutting KETs and space technologies.

4.1.1. Promoting public private partnerships to enable faster commercialisation

Public Private Partnerships (PPPs) seek to develop, fund and implement research and innovation agendas enabling innovative technologies to get faster[32] to market. In PPPs industry has direct input into the preparation of the work programmes in areas defined as of high industrial relevance. Best conditions and contractual commitments are put in place to enable commercialisation of research results by European manufacturing industry as they benefit from a preferential access to research results for exploitation.

Therefore, the European Commission provides financial support for market oriented pre-competitive research and development and innovation (R&D&I) in advanced manufacturing via the following PPPs[33]:

- The '**Factories of the Future**' [34] PPP was launched in 2009, constituting a €1.2 billion part of the European Economic Recovery Plan. So far, 150 R&D&I projects have been initiated including the full spectrum of discrete manufacturing[35]. This covers the processing of raw materials until the delivery of manufactured products to customers, across many sectors, covering both, large-volume and small-scale production, dealing with issues such as supply chain configurations, robotics, mobile and virtual factories, material processing and handling, customer-driven design and production, energy efficiency, emissions reductions, new processing technologies, upgrading of existing machines and technologies, including the use of ICT. The first technologies funded by 'Factories of the Future' are now market ready, e.g. additive manufacturing of high-tech metal products with close-to-zero waste or hybrid roll-to-roll/sheet-to-sheet manufacturing for OLED lighting foils.

  The Commission services will continue to support the contractual PPP on 'Factories of the Future' in Horizon 2020[36] with an indicative budget of €1.15 billion for the period 2014-2020, driving R&I to develop advanced manufacturing technologies and systems for discrete manufacturing, notably in ICT for resource-efficient factory design, adaptive and smart manufacturing equipment and systems (incl. robotics and mechatronics) and high-tech manufacturing processes (incl. 3D printing and micro scale structuring).[37]

- Following industry consultations, the Commission services have assessed the impact of a potential PPP in sustainable process industries. As a result, a new contractual PPP called **SPIRE** (Sustainable Process Industry through Resource and Energy Efficiency) was established for advanced manufacturing technologies for continuous

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32 Public-private partnerships in Horizon 2020: a powerful tool to deliver on innovation and growth in Europe, COM(2013)494.

33 http://europa.eu/rapid/press-release_IP-13-1261_en.htm

34 http://ec.europa.eu/research/industrial_technologies/ppp-in-research_en.html

35 Discrete manufacturing is the production of a finished good from components, e.g. cars or semiconductors.

36 Contractual Arrangement setting up a Public-Private Partnership in the area of Factories of the Future, signed on 17/12/2013

37 European Factories of the Future Research Association, Factories of the Future 2020 – Strategic Multi-Annual Roadmap, June 2013.

process manufacturing[38] with an indicative budget of €900 million for the period 2014-2020[39]. The objective is to develop new technologies and solutions for the process industry to reduce energy intensity by up to 30% and the use of non-renewable primary raw materials by up to 20%.[40] SPIRE brings together cement, ceramics, chemicals, engineering, minerals and ores, non-ferrous metals, steel and water sectors. These process industries are highly dependent on resources (energy, raw materials and water) in their production and advanced manufacturing technologies are necessary to make the industries more competitive and sustainable.

- The Commission has also established a **Robotics PPP** under Horizon 2020[41]. In particular, this PPP is aimed at: (i) helping to increase the level of industrial commitment to invest in robotics in Europe; (ii) strengthening industrial leadership all along the value chain by promoting wide-scale cooperation and greater integration across the whole R&I value chain; (iii) acting as catalyser for enhancing synergies between EU-robotics initiatives and national robotics strategies and (iv) creating the right conditions for accelerating Europe's innovation process and time to market.
- In addition, of close relevance to advanced manufacturing, the Commission has set up a **Photonics PPP**[42] and a joint technology initiative, Electronic Components and Systems for European Leadership (ECSEL) [43] with the aim of securing industrial leadership for laser systems for production, and electronics design and manufacturing capabilities, respectively, through the development of advanced techniques applied to the automation process.

The participation to PPPs and to the calls to implement them will remain open to new business participants including SMEs during the implementation of Horizon 2020[44].

The Task Force has been consulted in particular on the strategic roadmaps 2014-2020 of Factories of the Future and SPIRE to ensure that appropriate measures are included to ensure dissemination and commercialisation for the successful exploitation of research results.

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38 Process manufacturing is a continuous production process of materials and chemicals (e.g. chemicals, steel, and pulp).

39 Contractual Arrangement setting up a Public-Private Partnership in the area of Sustainable Process Industry through Resource and Energy Efficiency (SPIRE), signed on 17/12/2013

40 SPIRE Roadmap, 2013.

41 Contractual Arrangement setting up a Public-Private Partnership in the area of Robotics, signed on 17/12/2013

42 Contractual Arrangement setting up a Public-Private Partnership in the area of Photonics, signed on 17/12/2013

43 ECSEL is building on the successes of the past joint undertakings ENIAC and ARTEMIS which demonstrated the strength of aligning strategies at European, national/regional and industrial level around common objectives to invest in future growth. Through the public-private partnership ENIAC, over the period 2011-2013, 19 manufacturing pilot lines received nearly 2 billion euro combined financing; the European funding of nearly 300 million euro has been complemented by 261 million euro national funding and leveraged over 1.4 billion euro industrial contribution..

44 SME involvement is a monitored priority. See final assessment of the research PPPs in the European Economic Recovery Plan. Factories of the Future, Energy-efficient Buildings, European Green Cars initiative page 40 (http://bookshop.europa.eu/en/final-assessment-of-the-research-ppps-in-the-european-economic-recovery-plan-pbKI0213270/) "PPPs have been successful in increasing the overall participation of SMEs compared with the overall FP7 programme. However, further work needs to be done to increase SME participation."

The synergies among PPPs and Joint Technology Initiatives (Factories of the Future, SPIRE, Robotics, Photonics, ECSEL) could benefit from further strengthening. The possibility to work in partnerships with multi-stakeholder communities could be used to go beyond designing R&I strategies and tackling other common issues, such as investments in production and business creation, skills development, trade issues.[45]

4.1.2. Bridging the gap between research and the market in advanced manufacturing

Horizon 2020 provides the opportunity to bridge the gap between research and its exploitation. Europe-wide demonstration of advanced manufacturing technologies (e.g. Living Labs, small-scale projects as well as large-scale demonstrator projects) addressing users in various industries will further strengthen commercialisation.

Information dissemination, brokerage and technology transfer of project results could be used more systematically. The Enterprise Europe Network provides facilities and services for such activities.

Besides, the **European Technology Transfer Office (TTO) Circle**[46] could play an important role in commercialisation. The Circle operates as a laboratory for the exchange of best practice in technology transfer, mainly among public research organisations. A number of the Circle's member organisations have vast, diversified IP portfolios, including technologies that may be highly relevant for advanced manufacturing. There is therefore an opportunity to connect technologies emerging from the Circle with the technology needs of European industry. Contact between industry and technology transfer offices could then be facilitated via the organisation of technology brokerage events.
The Commission services are working closely with the European TTO Circle and other TTOs, to ease the commercialisation of research results by public research organisations in advanced manufacturing technologies.

In addition, the Commission, together with Member States and industry, is currently in the process of strengthening the Strategic Energy Technology Plan[47], the EU energy research and innovation strategy to pool resources and capacities to accelerate innovation in the energy system and bridge the gap between research and the market. This process includes the development of an Integrated Roadmap to foster innovation in the field of energy, to support EU industry and reinforce the industrial value chains of low carbon energy technologies. In this field, advanced manufacturing can contribute significantly to cost reductions, increase in process efficiency and quality of outputs.

Similarly, the Commission services encourage R&I policy on national and regional level to include measures to facilitate the commercial exploitation of new advanced manufacturing technologies and technology transfer from the lab to the marketplace.

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45 An example is the Airbus of Chips initiative (http://ec.europa.eu/commission_2010-2014/kroes/en/content/helping-europe-lead-electronics)

46 The European TTO Circle brings together the technology transfer offices of some of the most prominent European Public Research Organisations.

47 COM(2013) 253 – 'Energy technologies and Innovation'

4.2. Removing obstacles to demand for advanced manufacturing technologies

The European producers of advanced manufacturing technologies currently have a strong position on the global market thanks to the quality of their products.[48] Latest figures show that the EU is the global market leader with a global trade share in advanced manufacturing technologies of 38%[49]. For example, in robotics and factory automation, the global market share of EU producers is around 50%[50] and in process automation around 30%. EU manufacturers of advanced manufacturing technologies face strong demand, particularly from users in other regions. For example, for industrial robots, the largest markets are Japan, China and the US, while only 25% of sales of industrial robots are in Europe[51]. Some 44% of European machine tools are exported outside Europe, particularly to Asia, which accounts now for more than 60% of world sales in machine tools.[52]

As part of its trade policy, the EU strives to reduce tariff and non-tariff barriers to trade, including in advanced manufacturing technologies at multilateral, plurilateral and bilateral level, including in the Free Trade Agreements with its trade partners.
Recently, in January 2014, the EU and another fourteen World Trade Organisations Members, including the US and China, launched a new initiative in the WTO to eliminate tariffs and to address some other barriers to trade in the so called "environmental products", i.e. those that contribute to the achievement of environmental and climate objectives.[53].

That said, while exports to third countries can be an important driver of demand, there are also risks attached to relying only on exports. First, the interface between producers and users is considered crucial for technology development. If the users of new technologies are exclusively in other regions, Europe may risk losing its ability to innovate in the longer term.[54] Second, exports of advanced manufacturing technologies are an indicator of the competitiveness of European producers of advanced manufacturing technologies, but a wider impact on the EU industry requires broader market uptake of advanced technologies in Europe.

Low demand in the internal market is a constraint on deploying advanced manufacturing technologies also in Europe. Facing continued uncertainty and sluggish growth, many firms have held back new investment in equipment, which has dropped below the 2006-08 level in all but one Member State.[55] Demand for machine tools in the EU has dropped from €18 billion in 2008 to €12 billion in 2012.[56]

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48 European Competitiveness Report 2013, SWD(2013) 347.

49 KETs Observatory, https://webgate.ec.europa.eu/ketsobservatory/kets-deployment/indicator?sort=ASC&order=Time&geo=EU28&indicator=Market%20share%20in%20total%20exports

50 International Federation of Robotics, World Robotics 2012.

51 International Federation of Robotics, World Robotics 2013

52 Competitiveness of the European Machine Tool Industry, CECIMO, 2011.

53 http://trade.ec.europa.eu/doclib/docs/2014/january/tradoc_152095.pdf ; http://trade.ec.europa.eu/doclib/press/index.cfm?id=1017

54 Evidence from a US perspective in President's Council of Advisors on Science and Technology, Report to the President on Ensuring American Leadership in Advanced Manufacturing, June 2011.

55 Member States' Competitiveness Performance and Policies 2013, SWD(2013) 346.

56 Source: CECIMO.

More investment in equipment by EU businesses would be needed to bring advanced manufacturing technologies into the factory floors and plants of Europe.

According to the stakeholders consulted by the Task Force[57] the main obstacles for European manufacturers purchasing advanced manufacturing technologies are problems in access to finance, low awareness and low prioritisation of process innovation and energy efficiency investments.

In addition, other framework conditions have the potential to negatively affect investment in advanced manufacturing technologies: administrative procedures, fiscal incentives for investment, the energy prices or macroeconomic confidence. However, these framework conditions are not specific to advanced manufacturing and go beyond the scope of this report.

Demand for advanced manufacturing can be stimulated via several instruments, varying from regulation and support to testing and deployment activities and the purchasing power of public authorities via public procurement.

Advanced manufacturing and clean production solutions may also be required to address societal challenges in some of the European Innovation Partnerships[58.] Therefore these European Innovation Partnerships can also contribute to stimulating the demand for advanced manufacturing.

4.2.1. Strengthening the cooperation with the European Investment Bank

Although stresses in financial markets have calmed down, in some countries access to finance remains a problem for SMEs.[59] Manufacturers in many parts of Europe do not have sufficient financial resources to optimise their industrial production by purchasing advanced manufacturing equipment.

The European Commission and the **European Investment Bank (EIB)** have taken important steps to improve conditions for access to finance.
Following the capital increase agreed by the European Council in 2012, the EIB will increase its lending for 2013-2015 by up to EUR 60 billion thereby unlocking up to EUR 180 billion in additional investment across a set of critical priorities such as innovation and skills, SME access to finance, resource efficiency and strategic infrastructures. Among the EIB's €123 billion approvals since 2000 in support of the knowledge economy, more than €33 billion were used for the application and diffusion of innovation, including deployment of break-through technologies, with a specific focus on KETs.

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57 The Task Force held a public hearing on 19 March 2013 and a series of workshops on 27 May 2013. A final public hearing was held on 9 October 2013. A dedicated online consultation was open from March to June 2013. See also Business Innovation Observatory, Advanced Manufacturing – New Manufacturing Engineering, 2013.

58 European Innovation Partnerships follow a challenge-driven approach, focusing on finding solutions to societal challenges and building competitive advantage in key markets, http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=eip.

59 Member States' Competitiveness Performance and Policies 2013, SWD (2013) 346.

EXAMPLE: EIB is providing support to a leading integrated Italian energy group with activities in the chemical sector, to support the conversion of an old loss-making petrochemical site located in Sardinia into a modern green chemistry production plants and R&D site. It is a flagship project based on the deployment of innovative process and product technologies.[60]

The Commission and the EIB are working together closely on blended risk-sharing instruments leveraging the EU budget with EIB lending capacity. A new financial instrument has been developed under Horizon 2020 which will cover a broad range of products targeting SMEs (via venture capital, equity and guarantees, counter-guarantees), as well as mid-caps and larger entities via EIB investment loans, which can help fill the market gap in financing the deployment of advanced manufacturing technologies in the EU industry.

In addition to supporting deployment of innovative technologies, energy and resources efficiency investments remain a high priority through intermediary banks. For example the EIB supports investments identified by approved energy audits in SMEs, mid-caps and large industry.

In parallel, the possibilities for non-bank financing[61] for investment in advanced manufacturing equipment could be further explored as an alternative to loans. The Commission has come forward with a reflection document on how to improve the financing of long-term capital goods in the European economy.[62]

Furthermore, the Commission signed on 27 February 2013 a Memorandum of Understanding with the EIB in respect of their cooperation on KETs. In this context, the EIB signed in 2013 credit lines for €1.3 billion in the area of advanced manufacturing technologies[63].

4.2.2. Integrating advanced manufacturing in regional strategies when appropriate

Structural funds 2014-2020, in particular the European Regional Development Fund (ERDF), are a source of funding for the deployment of advanced manufacturing by companies in European regions. Structural funds allow co-funding for the rejuvenation of factories and advanced manufacturing.

In the recent past, structural funds have already played an important role in upgrading the manufacturing capacity of European regions, as shown by the example below:

EXAMPLE: With a contribution from ERDF funding, the University of Sheffield (South Yorkshire, UK) has created the Advanced Manufacturing Research Centre (AMRC) to develop a cluster of industry-focused manufacturing R&D centres and supporting facilities in their region. The AMRC model is based on close collaboration with industrial partners to identify and resolve problems in advanced manufacturing. The centre grew rapidly and, with further ERDF funding, opened the 4500 square metre AMRC Rolls-Royce Factory of the Future in 2008. Recent developments include an extension to the Factory of the Future for the expanded AMRC Composite Centre and a Knowledge Transfer Centre to present new manufacturing technologies to businesses.

60 Increasing lending to the economy: implementing the EIB capital increase and joint Commission-EIB initiatives, Joint Commission-EIB Report to the European Council, June 2013

61 For example, investment vehicles with long-term objectives and non-traditional sources of finance.

62 Green Paper on Long-term Financing of the European Economy, COM(2013) 150. See also Presentation on 'Non-bank financing for SMEs & Investment Needs' at Advanced Manufacturing Workshop in May 2013.

63 Presentation by EIB at High-Level Group on Key Enabling Technologies on 29 January 2014

To maximise the ERDF[64] impact towards smart and sustainable growth, under the 2014-2020 programming period, the ERDF rules provide for investments to be concentrated on four key thematic objectives: (1) innovation and research, (2) the digital agenda, (3) support for and SMEs and (4) low-carbon economy. This means that for more developed regions more than 80% of the total ERDF resources at national level are to be allocated to two or more of these objectives, for transitional regions 60%, and for less developed regions 50%[65].

The possibility to invest in '*advanced manufacturing capabilities and first production, in particular in key enabling technologies and diffusion of general purpose technologies'* is included under thematic objective 1 on research and innovation. However, as a precondition for the use of the funds the needs for such investments would have to be included in the smart specialisation strategy[66].

Regions interested in modernising and rejuvenating their manufacturing sectors could benefit from including in their Operational Programmes a horizontal line on advanced manufacturing. Wherever advanced manufacturing is part of the national or regional strategy for smart specialisation, industrial stakeholders and regional authorities can work together to plan interventions in advanced manufacturing.
The Smart Specialisation Platform already includes a number of regions with a key interest in advanced manufacturing, in various industry sectors such as automotive, process industries, machinery or furniture[67].

In line with the Industrial Policy Communication[68] the Commission continues providing a platform to assists EU countries and regions to develop, implement and review their national and regional research and innovation smart specialisation strategies. In the platform all interested parties can consult these strategies, including how advanced manufacturing aspects are integrated. Workshops with regional and industry stakeholders on advanced manufacturing and smart specialisation are organised in 2014[69].

4.2.3. Promoting process innovation and clean production technologies

Even when the financial conditions for investing exist, manufacturers tend to prioritise investment in product innovation more than in the production process. Surveys show that product leadership is seen by 58% of businesses as a main source of competitive

64 See Articles 4-5 of the ERDF Regulation 1301/2013

65 In addition, 'promoting energy efficiency and renewable energy use in enterprises' is included as an investment priority under thematic objective 4 on low-carbon economy. For this objective there is also further concentration of ERDF fund of 20%, 15% and 12% for the more-, transitional and less-developed regions, respectively.

66 Smart Specialisation is a strategic approach to economic development through targeted support to Research and Innovation. It is a process of developing a vision, identifying competitive advantage, setting strategic priorities and making use of smart policies to maximise the knowledge-based development potential of any region. It is an inclusive, bottom-up 'entrepreneurial discovery' process that involves a broad range of stakeholders (e.g. businesses, technology and competence centres, universities and public agencies, science and business parks, civil society, etc.).

67 See the online Eye@RIS3 searchable database at: http://s3platform.jrc.ec.europa.eu/map

68 COM (2014) 14

69 Regional Innovation Monitor, RIM+, http://ec.europa.eu/enterprise/policies/innovation/policy/regional-innovation/monitor/

differentiation, while process leadership only scores 32 %.[70] The limited financial resources of manufacturing companies are usually invested in production or development that generates immediate revenue. Investment in process innovation and resource-efficiency has a lower priority and is perceived as not generating immediate revenue. There is a risk, however, that under-investment in process innovation leads to obsolescence of the production process, reducing the future competitiveness of businesses and not allowing companies to adjust to the new trends in manufacturing[71.]

Therefore, initiatives to promote industrial awareness and investment into clean production technologies should be strengthened.

SPIRE, which represents a strong industrial commitment and aims specifically to develop technologies for improving resource and energy efficiency in the process industries, is a good example of this kind of initiatives.

Existing measures could be replicated at national level, e.g. or in other Member States. This is the case for example of the EU grant scheme Sustainable Industry Low Carbon (SILC), and of a set of national policies promoting sustainable business models for the manufacturing industry.

The **Sustainable Industry Low Carbon (SILC)** scheme launched by the EU under the Competitiveness and Innovation Framework Programme (CIP) supports European manufacturers in finding technological and non-technological innovation measures that help energy-intensive manufacturing reduce its greenhouse gas emissions while maintaining competitiveness.
The first phase, SILC I, seeks to foster the uptake of existing cost-efficient low-carbon solutions. Industrial projects implement such solutions and disseminate the results for replication within and/or across relevant industrial sectors.[72] The Commission services proposed to continue the SILC initiative with a second phase, SILC II, to be funded under Horizon 2020[73], with a focus on possible breakthrough solutions that require large-scale pilot and demonstration programmes and validation prior to their industrial implementation. SILC II could seek long-term measures to be developed by wide consortia involving all the main players in a given sector/technology.
The SILC initiative, by funding replication and demonstration activities, is a spur for industry to engage in innovative solutions to make low-carbon manufacturing a reality.

National policies in Member States to **promote sustainable business models** can also help to raise awareness in industry of the importance of sustainable process innovation and thereby trigger demand for advanced manufacturing technologies. A best policy practice exchange project run for the European Commission[74] brought together policy practitioners from across

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70 IDC Manufacturing Insights: 'The Factor and Supply Chain of the Future' (2012). Several industry representatives reported this also in the Advanced Manufacturing for Clean Production Workshop.

71 A Manufacturing Industry Vision 2025, European Commission (Joint Research Centre) Foresight study, October 2013 and annex 1.

72 On-going projects cover industrial sectors such as ferroalloys (production of ferro-silicon), pulp and paper (production of tissue paper), ceramics (production of tiles) and glass (production of flat glass). Additional sectors may likely be covered in the future by new projects.

73 Horizon 2020 Work Programme 2014 – 2015 - 5. Leadership in enabling and industrial technologies - ii. Nanotechnologies, Advanced Materials, Biotechnology and Advanced Manufacturing and Processing

74 IDEA Consult, 2013.

the EU to share their experiences on policies that worked well and might be transferable to other regions. Two examples are provided below.

EXAMPLE: Green Labs DK supports the development of advanced clean technology by establishing large test facilities, developing pilot projects and demonstrating their viability, and facilitating market entrance. It is strongly market-oriented and aims to support the creation of competitive enterprises by helping them to commercialise as well as develop advanced technology.

EXAMPLE: More than 1 000 industrial companies participated in the U.K's National Industrial Symbiosis Programme (NISP), which by promoting the collaboration of different organisations has been able to reap very substantial benefits, both economic (£100 million) and environmental (3.4 million tonnes CO2 reductions) through the coordinated use of materials, energy, water and/or by-products and the sharing of assets, logistics and expertise.

Member States could consider how initiatives such as SILC replicated at national or regional level can stimulate the uptake of existing and economically sound manufacturing solutions in various industrial sectors, taking into account State aid rules.

The Commission services are taking the necessary steps to ensure that demonstration projects on new business models and process innovation are in principle eligible for funding under LIFE[75] funding, and where relevant, under Horizon 2020.

In its recent Communication 'A policy framework for climate and energy in the period from 2020 to 2030'[76] the European Commission recognises that particular emphasis should be put on accelerating cost reductions and market uptake of low carbon technologies, including low carbon industrial processes across a range of sectors. This should focus, among others, on scaling up investments in large scale demonstrators. The concept of an expanded NER300 system[77] will, therefore, be explored by the Commission as a means of directing revenues from the ETS towards the demonstration of innovative low carbon technologies in the industry and power generation sectors.

4.2.4. Strengthening industry' involvement in the implementation of the Energy Efficiency Directive

The Energy Efficiency Directive[78] is an example of how the regulatory framework can promote more efficient production processes stimulating opportunities in creating markets for advanced manufacturing.

Continued efforts to improve energy efficiency through EU energy policies and implementation at national level can further help compensate existing price disparities among the EU major trading partners.

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75 Regulation No 1293/2013 of 11 December 2013 on the establishment of a Programme for the Environment and Climate Action (LIFE) and repealing Regulation (EC) No 614/2007

76 COM(2014) 15

77 NER300 is a funding programme for innovative low-carbon energy demonstration projects. It is funded from the sale of 300 million emission allowances from the new entrants' reserve (NER) set up for the third phase of the EU emissions trading system (EU ETS). The scope of the current NER300 system includes demonstration of environmentally safe carbon capture and storage and innovative renewable energy technologies.

78 Directive 2012/27/EU on energy efficiency.

Significant opportunities in productive investment and increased efficiency in manufacturing production will arise from the implementation of this Directive. More efficient process technologies can bring significant savings and increase productivity in different industrial sectors.[79] The Directive requires Member States to come forward with comprehensive national programmes to mobilise investment to deploy energy efficiency solutions across the whole energy chain, including in industry, but also in buildings and energy networks.

In particular, the requirement to make widely available and facilitate the implementation of energy audit in industry and SMEs should become a powerful driver of investment in energy efficiency. Large enterprises will be required to carry out energy audits first by 5 December 2015 and at least every four years from the date of the previous energy audit. This obligation is coupled with the possibility for Member States to set up programmes to encourage the implementation of audit recommendations.

Gains from energy efficiency in the operation and production process could be made more visible as lack of information may lead to cost-effective investments being missed. In particular, energy audits are a powerful tool to capture and monitor the effectiveness of energy efficiency or other clean production processes and should become a real driver to attract investment in industry. Dedicated information channels on programmes and initiatives undertaken in Member States and at EU level to implement the Energy Efficiency Directive, in particular on energy audits and the efficient heating and cooling in industrial processes (e.g. cogeneration, waste heat recovery) will be put in place.

4.2.5. Innovative incentive schemes in advanced manufacturing in line with EU State Aid rules

Public authorities can stimulate, when necessary, the uptake of advanced manufacturing with support schemes, taking into account State aid rules.

To strengthen demand for ICT-based advanced manufacturing technologies, the European Commission piloted **'ICT Innovation for Manufacturing SMEs' (I4MS)**[80] - an instrument to stimulate the take-up of advanced technologies by manufacturing SMEs. EU grants support the testing in real production conditions of existing advanced manufacturing technologies (e.g. robot solutions, high-performance cloud-based engineering simulation, intelligent sensor- and actuator-based equipment and innovative laser applications) to promote their up-take in the manufacturing industry.

A summary of the Commission services' experience on how to stimulate demand of advanced technologies for manufacturing for testing technologies in production-like environments in line with EU State aid rules (annex 3) is available to interested Member States and regions and will be further disseminated via the Smart Specialisation Platform. While the Commission

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79 Processes technologies are estimated able to bring substantial saving potentials of 16-21% by 2035 in the German paper industry via innovative process technologies Fleiter, et alii. (2012): Energy efficiency in the German pulp and paper, Energy, 40 (1), pp. 84-99.). A substantial saving potential of about 14% until 2035 in the German energy-intensive industries could be reached via more efficient process technologies as argues by Fleiter, T.; Schlomann, B.; Eichhammer, W. (eds.) (2013).

80 €77 million funding over the period 2013-2016. In total, about 200 SMEs are expected to take part in I4MS with more than 150 innovation experiments over the next 3 years. The innovation of the initiative is that only half of the experiments have been defined at the time of launch. There is plenty of opportunity for interested companies to apply for being part of the action through responding to open calls. For additional information see http://i4ms.eu/

services' experience is limited to ICT-based advanced manufacturing technologies, similar support schemes could be developed for the testing of other advanced manufacturing technologies.

The Commission continues the 'ICT Innovation for Manufacturing SMEs' initiative under Horizon 2020[81] to accelerate the uptake of advanced manufacturing technologies and networking with national and regional initiatives and to explore synergies with the EIB lending schemes.

The Commission services encourage Member States and their regions to take into consideration the experience of the European Commission in supporting demand for advanced manufacturing technologies, should they wish to set up funding schemes to support advanced manufacturing.

Public procurement of innovative solutions is a powerful tool to support the demand for innovation. Government procurement can drive the uptake of innovation, providing lead customers for innovative businesses. There is a growing commitment in the EU to exploit the potential of public procurement to be a driver of innovation. In the area of advanced technology products, businesses in several Member States consider government decisions a driver of technological innovation[82]. It is estimated that the public sector accounts for 2% of EU demand for machinery and equipment (€16 billion).[83] Using this public purchasing power for innovation procurement could stimulate market uptake for advanced manufacturing technologies.

Public procurement of innovative solutions supporting advanced manufacturing for clean production could be considered for inclusion in future work programmes of Horizon2020.

The priorities of Industrial Policy are taken into account for the programming of actions under the Competitiveness and SME Programme (COSME). In this context, the need for additional measures to accelerate the adoption of advanced manufacturing in Europe to the extent that market forces do not deliver and in a way that does not distort the market process could be assessed.

4.2.6. Applying technology-neutral internal market legislation

The market uptake of new technologies requires a **coherent, stable and predictable regulatory framework** so that companies have an incentive to invest in new technologies. The regulatory framework, if predictable, technology-neutral and with stable and ambitious medium-term targets, can provide an important stimulus both for innovation and for the uptake of innovation, particularly in energy-efficient and resource-efficient technologies. To accelerate market uptake, it is important to address potential obstacles in the regulatory framework appropriately.

To identify potential obstacles, the Commission services have undertaken a thorough screening of the internal market legislation for industrial products, including a broad

81 http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/2188-fof-09-2015.html

82 European Public Sector Innovation Scoreboard 2013

83 http://ec.europa.eu/internal_market/publicprocurement/docs/modernising_rules/cross-border-procurement_en.pdf.

consultation with industry. The results indicate that the EU legislative framework, being technology-neutral and not regulating technical specifications, is not an obstacle to process innovation in manufacturing. As the production process is not regulated, the legislation allows sufficient flexibility for the deployment of advanced manufacturing technologies. However, with regard to additive manufacturing, there are some open issues concerning IPRs, and market surveillance.
The Communication "A vision for the internal market for industrial products" concludes that the Internal Market legislative framework has in built responsiveness to adapt to change and presents a vision to achieve a more integrated internal market based on rationalising the existing regulatory framework. In order to avoid any unnecessary barriers for the timely take-up of new technologies and market introduction of innovations, the Commission has committed to taking into account innovation and technological developments in the elaboration of any new proposals in the internal market for industrial products.[84]

Beyond internal market legislation, the Commission has taken further action with the Regulatory Fitness and Performance Programme (REFIT) to ease the regulatory burden on businesses. REFIT demonstrates the Commission's commitment to provide a clear, stable and predictable regulatory framework in all policy fields.[85]

Concerning future EU legislation the European Commission is committed to evidence based policy making and performs detailed ex ante assessment of new proposals. In this context, the impact on technological development and innovation is assessed, whenever relevant, among the economic impacts in Impact Assessments[86].

4.2.7. Enhancing cooperation with European standardisation organisations on advanced manufacturing

Standards can also play an important role for market uptake and diffusion of advanced manufacturing technologies. To deliver a standard just in time when a new technology is ready to be launched on the market, better interaction between research & development and the standardisation process is required. For example, existing standards could be extended with performance evaluation protocols of products under development.

To ensure standardisation activities enhance competitiveness and innovation in advanced manufacturing, the Commission has adopted an annual Union Work Programme for European standardisation for the first time in 2013 to execute planning of activities in this field.[87] Its implementation in advanced manufacturing will be regularly monitored. In parallel, the European Standardisation Bodies, CEN and CENELEC, are also addressing the issue of the advanced manufacturing standardisation potential via the STAIR platform[88].

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84 COM(2014) 25, A vision for the internal market for industrial products.

85 COM(2013) 685 "Regulatory Fitness and Performance (REFIT): Results and Next Steps". New fitness checks will be launched, inter alia, on waste policy and chemicals legislation not covered by REACH.

86 Impact Assessment Guidelines: http://ec.europa.eu/governance/impact/commission_guidelines/docs/iag_2009_en.pdf . Furthermore the "capacity to innovate" is among the three components of Competitiveness Proofing: http://ec.europa.eu/governance/impact/key_docs/docs/sec_2012_0091_en.pdf

87 COM(2013) 561.

88 Standardisation, Innovation and Research, http://www.cencenelec.eu/research/innovation/PolicyContext/stair/Pages/default.aspx.

Cooperating world-wide on common research topics through activities on standardisation and interoperability issues helps to ensure win-win situations by capturing market developments globally and fostering the participation of European companies in global value chains.[89]

Within the framework of Regulation (EU) No 1025/2012 on European standardisation the Commission services will work closely with standardization organizations in Europe to systematically address results of screenings and foresight exercises on advanced manufacturing in their work programme. The Commission services will work with the standardization organizations in Europe to identify and address standardization gaps taking into account the work of the Task Force on Advanced Manufacturing for Clean Production and the annual Union Work Programme for European standardization.

4.2.8. Implementing State aid modernisation

Other framework conditions, such as rules governing **possibilities to grant State aid in the EU** are of high relevance as investment in advanced manufacturing technologies implies high costs, high risks and a slow return on investment.
It is important to improve awareness as regards the possibilities State aid rules offer to making contributions to boost demand for advanced manufacturing technologies.

On 8 May 2012, the Commission set out an ambitious State aid reform programme in the Communication on **State aid modernisation.**[90] The modernisation has three main, closely linked objectives: (i) support smart, sustainable and inclusive growth in the context of budgetary restrictions; (ii) focus enforcement on cases with the biggest impact on the internal market; (iii) streamlined rules and faster decisions.

Within this context, the Commission is currently reviewing different State aid frameworks:

- The new Framework for State aid for **Research & Development & Innovation (R&D&I)** will enable public support to address market failures that may hamper the financing of R&D&I in Europe. In line with the Europe 2020 objectives, the review seeks to support sustainable growth and contribute to the quality of public spending by discouraging aid that does not bring real added value and distorts competition. It is expected to improve the design of compatibility rules, and to include some adjustments on the scope and definitions in order to improve legal certainty.

  A public consultation on the revised R&D&I Framework has taken place.

- The new **General Block Exemption Regulation** (GBER) is expected to significantly extend the forms of aid that can be put in place by Member States without being subject to the notification obligation as long as they comply with established conditions. The new GBER should give Member States more flexibility for implementing R&D&I aid, for example by doubling the notification thresholds for different categories of R&D aid, including experimental development, and by

89 An example of international collaboration on manufacturing is the EU participation to IMS (Intelligent Manufacturing System). More information at www.ims.org

90 COM (2012) 209.

introducing new categories of exempted innovation aid. A public consultation on the draft GBER has taken place.

- The **Guidelines on State aid to promote risk finance investments**, recently adopted[91], provide the framework to ensure that in case of market failures SMEs, but also small and innovative mid-caps have proper access to finance, as envisaged in the COSME programme, for instance. This will help companies overcome the most critical stages of their life cycle – the so called “valley of death" they have to cross to bring new products and ideas to the market, including those in advanced manufacturing.

- The **Guidelines on regional State aid** for 2014-2020[92] allow, for example, the possibility of granting regional aid to large undertakings in the case of diversification of existing establishments into new products or new process innovations.

With regard to demand outside Europe, the issue for EU businesses and particularly for SMEs is to overcome obstacles for internationalisation. The Commission is strengthening the support available to European SMEs for doing business outside Europe[93]. At the same time, the Commission services continue to promote international convergence in legislation and technical standards for industrial products to give greater access for EU industry to key emerging markets where there is high demand.[94]

91 OJ C 19, 22.1.204, page 4.
92 COM(2013) 3769.
93 Further information at http://ec.europa.eu/enterprise/policies/sme/market-access/internationalisation/ .
94 COM(2014) 23.

4.3. Skills shortages and competence deficits in advanced manufacturing

The 2013 Global Manufacturing Competitiveness Index shows that the quality and availability of a country's skilled workforce, including researchers, scientists, and engineers, and the resulting ability to drive innovation, is the most important driver of manufacturing competitiveness.[95]

To strengthen Europe's position in advanced manufacturing and clean production technologies a sufficient supply of particular skills and competences is needed. Technological changes automating repetitive tasks will concentrate job creation in highly-skilled occupations[96] which can respond in a flexible way to new market opportunities and the new increasingly complex nature of products and production processes. Demonstrating increased reliance on higher level skills, a recent study carried out by the UK Commission for Employment and Skills details a number of areas in which skills supply and development will be needed:[97]

- Technically competent workers at craft and operative levels;
- Leadership and management skills;
- Market assessment skills of senior managers alongside skills associated with regulatory compliance;
- Supply chain management skills;
- Research and development skills and design skills.

Shortages in skills and competence deficits are mentioned by industry as one of the barriers to wider uptake of advanced manufacturing technologies in Europe[98] as the capacity to take-up new technologies relies on a highly qualified workforce. Advanced manufacturing stakeholders reported concern about skills shortages in ICT and engineering, limited dialogue with education and training institutions both in academic curricula and in vocational training programmes[99].

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95 Deloitte, 2013 Global Manufacturing Competitiveness Index. http://www.deloitte.com/assets/Dcom-Global/Local%20Assets/Documents/Manufacturing/dttl_2013 %20Global%20Manufacturing%20Competitiveness%20Index_11_15_12.pdf.

96 Cedefop forecasts that the share of high-qualifications jobs will increase from 29% in 2010 to almost 35% in 2020. The share of jobs employing those with medium-level qualifications will remain very significant, at around 50%. And the proportion of low skilled jobs will fall in the same period from 20% to less than 15%: http://ec.europa.eu/education/news/rethinking/sw373_en.pdf.

97 http://www.ukces.org.uk/publications/er48-sector-skills-insights-advanced-manufacturing.

98 IDC Manufacturing Insights: The Factory and Supply Chain of the Future (2012).

99 The Task Force held a public hearing on 19 March 2013 and a series of workshops on 27 May 2013. A final public hearing was held on 9 October 2013. A dedicated online consultation was open from March to June 2013. See also "Assessment of impacts of NMP technologies and changing industrial patterns on skills and human resources", Report for the European Commission, 2012

4.3.1. Addressing skills shortages in advanced manufacturing

An important **mismatch between supply of and demand** for ICT skills crucial for ICT-based advanced manufacturing is observed as the demand for ICT practitioners is growing at a rate of 3% per year in the EU while there is a decrease in the number of ICT graduates.[100]

Advanced manufacturing stakeholders can get involved in the multi-stakeholder partnership called "the Grand Coalition for Digital Jobs"[101] and become associated with targeted actions around training, mobility, digital entrepreneurship, qualifications recognition and the attractiveness of ICT careers.

European data shows[102] engineering is among the top three bottleneck occupations on the European labour market.
The development of mobility instruments for EU students, learners in vocational education and training, and workers has potential to address skills mismatches and shortages effectively. Persistent skills shortages, particularly in engineering, have a potential to be addressed in **mobility schemes** organised by European Employment Services (EURES)[103]. Schemes such as '**Your First EURES Job**' could be highly relevant for young graduates.

4.3.2. Strengthening links between industry, education and training institutions

Links between education and training, on the one hand**, and industry**, on the other, could be usefully improved via enhanced partnerships between education, training providers and industry. In this context, the Task Force highlighted the role of structured partnerships such as **Knowledge Alliances** and the **Sector Skills Alliances**[104]**.** Advanced manufacturing has been included as eligible sector for funding under the relevant calls for proposals[105].

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100 http://ec.europa.eu/education/news/rethinking/sw373_en.pdf.

101 https://ec.europa.eu/digital-agenda/en/grand-coalition-digital-jobs-0

102 European Vacancy and Recruitment Report, 2012.

103 EURES (European Employment Services) is a cooperation network designed to facilitate the free movement of workers within the European Economic Area. Switzerland is also involved. Partners in the network include public employment services, trade union and employers' organisations. The network is coordinated by the European Commission. The main objectives of EURES are: to inform, guide and provide advice to potentially mobile workers on job opportunities as well as living and working conditions in the European Economic Area; to assist employers wishing to recruit workers from other countries; and to provide advice and guidance to workers and employers in cross-border regions.

104 Knowledge Alliances are structured partnerships between businesses and higher education institutions to stimulate, develop new and innovative ways of delivering and using education and knowledge. They aim to foster excellence and innovation and create new multidisciplinary curricula to promote skills such as entrepreneurship, real-time problem solving and creative thinking. Sector Skills Alliances bring together vocational education and training providers, stakeholders from the same economic sector, research institutions and authorities or bodies responsible for certification/qualification or professional orientation with the objective of: (1) tackling skills gaps, enhance the responsiveness of initial and continuing vocational education and training (VET) to sector-specific labour market needs, (ii) creating new sector-specific vocational programmes, to develop innovative ways of vocational teaching and training and to put the EU wide recognition tools into practice.

105 Erasmus + Programmes, Knowledge Alliances and Sector Skills Alliances, https://eacea.ec.europa.eu/erasmus-plus/funding/knowledge-alliances-sector-skills-alliances-eacs1113_en

To bring together the worlds of higher education, research and business, the European Commission originally proposed creating a new **Knowledge and Innovation Community (KIC) on Added-Value Manufacturing** in 2018. In response to demand from stakeholders, it has recently been decided to bring the launch forward to 2016[106]. The KIC will inter alia offer a forum for the promotion of multidisciplinary skills, which are particularly needed for the combination of different key enabling technologies.

Timely preparation by stakeholders for the KIC on added value manufacturing would be helpful to ensure a proper implementation of this KIC.

The Task Force also underlined that **lifelong learning**, whether formal, non-formal or informal, as well as the validation of is learning outcomes[107], is highly important to ensure the supply of a skilled workforce. Employers could also be incentivised to invest in the training of workers. For this, a clearer picture of future skill needs and of current investment would be welcome. In this context, it would be useful that skills issues continue to be discussed by the representatives of European employers and employees in the relevant European Sectorial Social Dialogue Committees. [108] In addition, the **Sector Skills Councils[109]** could be a place to identify specific skills needs for advanced manufacturing and promote them in training and lifelong learning.

4.3.3. Promoting the diffusion of workplace innovation in advanced manufacturing

Advanced manufacturing technologies also change the jobs and skills required. To attract highly skilled people to manufacturing and to make the most of the skills of the workforce, advanced manufacturing needs advanced workplace organisation in which employees can use and develop their knowledge, skills and creativity to the full. The introduction of a new production process may demand innovations in how work is organised.

Workplace innovation has to provide advanced solutions for manufacturing industry, based on the newest technologies. Virtual reality and side laboratories, where employees can perform extra research and experimentation, not connected with their daily tasks, are examples of combining advanced manufacturing technologies and advanced workplaces. Furthermore, workplace innovation can help companies to enhance competitiveness by using the innovativeness and creativity of all employees. The Commission has established the

106 Commission Decision 1312/2013 on the Strategic Innovation Agenda of the European Institute of Innovation and Technology (EIT): the contribution of the EIT to a more innovative Europe

107 See the Council Recommendation on the validation of non-formal and informal learning of 20 December 2012, inviting Member States to set up arrangements for the validation of non-formal and informal learning by 2018.

108 To date, Sectoral Social Dialogue Committees have been established in 43 sectors of the European economy, including seven committees in the manufacturing sectors. These sectors cover 145 million workers, i.e. over three quarters of total employment in the EU.

109 European Sector Skills Councils are established by the main sectorial stakeholders on the demand and supply side of skills: employer representatives, employment services, trade unions, and education and training providers. The social partners play a major role in their formation. They provide a focal point at sector level for improving skills intelligence, highlighting skills mismatches and bottlenecks and for shaping the educational and training offer. They will also facilitate peer-learning at national level by creating a European platform of exchange between labour market actors, skills intelligence observatories and education and training providers active in the sector.

European Workplace Innovation Network (EUWIN)[110] to exchange good practices and promote workplace innovation.
The Commission has included workplace innovation aspects in the R&D&I programmes for advanced manufacturing[111]. Explicitly including R&D on human-centred manufacturing could enhance the active and innovative role of people in factories and could contribute to design the workplaces of the future.

110 http://ec.europa.eu/enterprise/policies/innovation/policy/workplace-innovation/euwin/index_en.htm

111 http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/2183-fof-04-2014.html

5. CONCLUSIONS

The Task Force has so far focused on short-term deliverables. The wide range of actions identified in this report demonstrates the added value of coordinating policies at EU level. The line of action on advanced manufacturing has been explicitly welcomed by the European Parliament[112]. The Task Force could also address the issues negatively affecting the demand and to support companies' transition towards a more competitive and clean manufacturing and a more resource efficient production model.

A structured dialogue between Member States, regional governments, industry and Commission services on topics of advanced manufacturing could contribute to raising public awareness about the imperative to modernise industry in view of assuring an advanced and clean manufacturing production in Europe.

In 2014 the Commission services continue the partnership with Member States, Regions and industry to discuss potential measures in the medium-term that would have an even stronger impact on the development of advanced manufacturing technologies and would contribute to substantial improvements in the productivity and competitiveness of EU manufacturing industry.

[112] European Parliament Resolution of 15 January 2014 on reindustrialising Europe to promote competitiveness and sustainability

ANNEX 1: A MANUFACTURING INDUSTRY VISION 2025

Annex 1 provides a summary of "Manufacturing Industry Vision 2025", a foresight study conducted by the Joint Research Centre of the European Commission, October 2013

The foresight study has adopted an exploratory approach to develop the Industrial Landscape Visions 2025. The Vision was built with experts and stakeholders during interactive workshops. The vision of the industrial landscape in 2025 was based on the analysis of the importance and the potential impact of the societal, technological, economic, environmental and policy (STEEP) drivers on industry. The ILV 2025 was supported by desk analyses and review of existing research and literature on current and future trends of manufacturing at both the European and global levels. Literature on long-term trends and analysis on future developments of society was also consulted. The ILV 2025 is qualitative and aims at identifying a desirable and plausible future. The vision is the starting point for strategy building and to identify possible policy actions.

In 2025 there will be a fully globalised economy serving an informed and prosperous global middle class that will require personalised goods and services based on advanced manufacturing systems enabled by ICT and supplied by European resource efficient and sustainable industries.

There will be a fully globalised economy…….

In 2025, the world's economy will be fully **globalised**, with the global market expanded to include the mature economies of the BRICS[113] countries. The 'next 11'[114] countries will be reaching economic maturity and other countries, such as Ethiopia, Kenya and Uganda undergoing rapid industrialisation. As a result, **competition for markets** will become fiercer. New industrial players from emerging and newly emerged industrial economies will fight for market share with multi-nationals and companies from traditionally industrialised countries, including the EU.

This will drive companies to constantly **seek innovation** to develop a competitive edge for new products and services, and to adopt more efficient operations. **Smart and interoperable infrastructures[115]** will underpin industrial competitiveness and innovation including smart energy grids and intelligent transport systems.

To take advantage of new opportunities, industries will fundamentally change their **business models**. Over time, service-type functions will have a larger share in manufacturing companies' activity. The ratio between service-type activities and production in advanced economy is changing, service activities could account for more than 50% of manufacturing

[113] Brazil, Russia, India, China and South Africa

[114] Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, Philippines, Turkey, South Korea, and Vietnam.

[115] Energy, transport, water, data, knowledge and financial infrastructure.

employment in the future[116]. Companies will create global manufacturing structures that seamlessly operate collaboratively around the world. They will be flexible and agile to produce products and services designed to meet the local requirements of a target region. This will result in a **disaggregation of the supply chain** with **increased localisation of production** to address local requirements, and to reduce transport and distribution costs. This approach will be enabled by new production technologies, such as additive manufacturing, as well as by production automation and vastly improved information and communications technologies.

Environmental and social pressures will contribute to changes in manufacturing business models. **Corporate social and environmental responsibility** will become a core element of corporate strategy, with reporting and accounting requiring companies to address environmental and social rules.

Overall, these developments will introduce **a new era of manufacturing**. Manufacturing companies will need to be highly agile, networked enterprises that use information and analytics, as skilfully as they employ talent and machinery, to deliver products and services to diverse global markets.

….serving an informed and prosperous global middle class…..

The **global population** is approaching 8 billion people partly due to an increase in life expectancy. This creates a prosperous global middle class with large new potential markets based upon growing middle class in the mature economies of the BRICS countries and the increasing economic maturity of the 'next 11'. About 1.8 billion have joined the global consuming class in Asia and Africa alone since 2013. However, at the global level the distribution of income varies across countries and within different regions of the same country. The distribution of income has become more unequal, with patterns differing significantly among different population groups.

Global migration will also increase, and will continue to be driven by political and economic factors plus increasingly by population imbalances and environmental factors. This will also result in increased **urbanisation**, especially in emerging industrialised countries, as people seek to find work. Factories with zero environmental impact will have a key role in this urbanisation trend as they become integrated into urban society.

In the vast majority of global regions, an **ageing and dwindling society** will have effects on demand for products and services, with new markets arising to serve older populations. Improved quality of life and advanced health care will enable some senior segments of the population to work longer, often contributing to addressing a skills shortage problem.

In parallel, **consumer behaviour** will also evolve. Consumers, especially in more affluent, mature economies, will increasingly choose products on the basis of their **social and environmental impact** rather than on price alone**.** This will be driven by the fact that there is increased awareness of the **ethical issues** surrounding product production. **Consumer choice**

[116] 'Manufacturing the future: The next era of global growth an innovation' November 2012, McKinsey Global Institute.

will be better informed thanks to the widespread use of social networking. This will result in the **social ranking of products and services.**

…..requiring personalised goods and services…..

An informed and prosperous global middle class will drive consumer requirements for goods and services**.** The traditional **model of ownership** will evolve as societal and environmental pressures encourage people to demand more integrated products and services. As a result, manufacturing companies and service providers will work more closely together to build consumer-driven solutions combining **products and services**.

In many cases, consumers' requirements will go one stage further. Consumers will increasingly demand a package of products and services tailored to meet their individual needs. **Personalisation**, enabled by new production technologies, such as robotics and additive manufacturing, will become a **key driver for industry**. This will change the relationship between consumers and manufacturers, with consumers being much more active in their relationship with companies, and being much more closely involved in the entire production chain. Personal choice will also define the manner of purchase and delivery. Far fewer goods and services will be purchased or leased from traditional shops on the high street. On-line personalised services will be increasingly used, with companies storing individuals' personal preferences and measurements and new visualisation technologies used to aid selection. A greater variety of delivery mechanisms will also be used, ranging from automated drones through to dedicated courier services.

Regional and local customisation will also have a major effect on how industry will operate. Diverse global markets, distributed manufacturing and an increasingly informed and prosperous global middle class will set industry many challenges. The new global market will lead to **regional diversity of consumer choice**, with different regions often requiring very particular products, with different features and different pricing policies. Industry will have to respond by significantly improving its market analysis capabilities to be able to capture consumer requirements adequately. Regions will also need to prepare for and embrace this challenge and whilst working together with industries, academia and civil society, develop Smart Specialisation Strategies that aim to concentrate the available resources for research and innovation (including from the EU Cohesion Funds) on their comparative advantages, needs and possibilities for the creation of cross-European value chains.

… based on advanced manufacturing systems enabled by ICT …

To address the globalised economy and the regionalisation of markets, companies will implement production chains that will be geographically spread around the world, connected by advanced ICT. These will require ever more **sophisticated logistics systems** to, produce and distribute products.

More complex value chains will be available to deliver highly personalised products and services. Companies will increasingly rely on intelligent, automated and **integrated logistic tools**. They will also increasingly rely on **asset tracking** software enabling the real-time monitoring of materials and products to ensure their recovery and multi-level management. .

The use of such tools will enable better coordination of production activities and ensure good process reliability, short delivery times, reduction of stocks and low production costs.

The production of goods and services will be more **localised** and closer to customers, to respond to increased demand for customisation/personalisation and to decrease costs. Globally, companies will be required to engage in regionally based operations to fulfil local demand. This **distributed manufacturing** will be enabled by new production processes, such as additive manufacturing, software-enhanced added-value services, and new ICT technologies allowing the digital interconnectivity of different parts of the production process.

Companies will also seek to assure the **flexibility of their supply chain** and the fast re-configurability of their production lines (e.g. through self-adaptive and modular machine tools and robots) to meet changing consumer requirements. However, the regional customisation of demand will mean that the production system will become more fragmented. Companies will therefore practise **'hybrid manufacturing'**, incorporating a mix of production processes located in both high-cost and low-cost countries according to geographic advantages and based upon a wide range of factors (labour costs and skills, infrastructure, regulation, policy, materials, market demand, etc.) enabled by technological developments, especially in the ICT field.

Different business models will be developed to cope with the complexities of a global market. Clusters of partners offering specialised services will form in certain geographical locations, based on similar technological skills, a common interest in a nearby source of raw materials or shared energy schemes. These partners will act as an **'ecosystem'**, applying industrial symbiosis, feeding off each other in the value chain, and enabling the 'cross-fertilisation' of technology.

The need for efficiency, and the realisation of an increasing scarcity of natural resources, will drive some companies to seek full control of their value chain through **vertical integration**. Enabled by new technologies, the entire value chain will be controlled by individual companies from the supply of raw materials through to the selling of products and services.

To be competitive many companies will apply **holistic design**, taking into account the entire life cycle of products and services. This holistic approach, enabled by new design technologies, will address all aspects of products and services, from the requirements of consumers, to their environmental impact and their cost. Other design techniques will also be applied. Consumers will be much more closely involved in design and prototyping of products and services. New practices, including **social and open innovation**, will be implemented to maximise consumer input and innovation.

Materials will remain one of the critical factors for the competitiveness of any advanced manufacturing company. The scarcity of many important materials will continue to push the development of new, advanced materials. These will provide industry with increased functionality, lower weight, lower environmental burden, and energy efficiency. **Smart, multifunctional materials,** able to change properties according to environment (e.g. temperature, pH, light, magnetic field, etc.) will become increasingly available, and will

enable the development of new, advanced and environmentally friendly products, often based on organic, non-toxic, non-harmful synthetic materials, which can be used endlessly in different product cycles to enable a waste-free manufacturing system that can even protect and enrich ecosystems. **New technologies**, arising from nanotechnologies and associated nano-materials, will underpin these developments.

Major developments in technology are underpinning manufacturing industry today. This has been greatly helped by the **global diffusion of technologies**, thanks mainly to the widespread use of ICT. There has also been widespread **convergence of technologies** that has enabled increasing production of multifunctional products.

Considerable development will take place to ensure the **interoperability** of technologies**,** as this will be key to providing integrated solutions to industrial advancement and to societal challenges. **Key Enabling Technologies** (KETs) will continue to be developed and deployed. They provide indispensable technology bricks that enable a wide range of product applications, including those required for developing low carbon energy technologies, improving energy and resource efficiency, tackling climate change or facilitating healthy ageing.

Ubiquitous computing has already become pervasive, connecting all aspects of daily life, ranging from industrial processes to the Internet of Things and cloud-based computing. Developments in **artificial intelligence** will increasingly drive automation in production processes and form the basis for new products, such as automated, driverless cars and intelligent, hand-held mobility management systems.

Data will become the 'new oil'. Increasingly complex and large sets of data ('Big Data') with the Internet of Things will enable manufacturing firms to better understand and optimise all stages of their value chains, from design to distribution, including supply chain management, production processes and marketing. To cope with the huge amounts of data, **analytical techniques** will have to be developed, with the data protected by resilient **security systems**, and moderated by stringent and transparent **data privacy** regulation.

These developments will enable the **'digital factory',** a network of digital models, methodologies, and applications used to integrate the planning and design of manufacturing facilities with the manufacturing process itself. The digital factory concept focuses on an integrated planning and monitoring process that includes product design, process planning, and planning and implementation of the operation, making the manufacturing process more efficient and responsive to change.

The increasing use of technology, especially automation technology, will make future manufacturing processes **less labour intensive**, but nevertheless requiring an increasing number of **highly qualified staff**. Combined with **advanced robotics,** it will enable manufacturing processes to become much more efficient, and result in close to fault-free production. Robotics will advance to the point where **humans and robots work in harmony** on the plant floor thanks to personalised machine-to-user interfaces and human-like robot

behaviour and features (e.g. humanoid design, voice recognition, natural language, gesture understanding).

To improve productivity and to attract the best workers, factories will focus on the **well-being of workers** (e.g. through human-centred factory design) and their better integration with technologies, machines and systems (e.g. through personalised user interfaces, enhanced ergonomics, etc.). Many workers will also follow **more flexible working practices**, especially as ICT technologies develop, making it possible to have your 'office' constantly accessible globally.

….supplied by European resource efficient and sustainable industries

The effects of **climate change** will become more evident, **natural resources** will be increasingly scarce and **energy demand** will increase globally. This will have considerable impacts on manufacturing as environmental and societal concerns develop, and costs of materials and energy increase. **Life cycle approaches** will be applied to minimise waste, and maximise efficiencies. There will be significant efforts to **reduce the environmental impact** of production and consumption. This will focus on **preserving energy**, **minimising waste**, **re-cycling and re-using** products and their parts, and high demand for the use of energy efficient products.

The business models of companies will be further refined by society's demand for a **'circular economy'** (i.e. the 'triple-zero' objectives: zero waste, zero net energy cost and zero environmental impact). This movement will be enhanced as companies seek savings to become competitive in the global market. Firms will invest in services and technologies to achieve their 'triple zero' objectives. They will also invest in technologies for managing the disassembly and de-manufacturing of materials, parts, products and even factories, as well as the recovery of trace elements, to foster end-of-life reuse, remanufacturing and recycling. Companies will make their business models 'environmental-friendly' as a marketing strategy to seek commercial advantage (e.g. sustainable packaging and re-manufacturing).

Environmental and societal pressure will also encourage **eco-innovation,** resulting in the development of innovative products and services that will reduce environmental impact, enhance resilience to environmental pressures, or achieve more efficient and responsible use of natural resources. Eco-industries will become a growing sector in 2025.

Underpinning this effort will be a continuing move to **de-carbonise the energy supply,** requiring the use of multiple, different renewable energy sources supported by a new energy infrastructure able to receive and provide energy from multiple energy sources — the so-called **smart grid**. The development of a smart electrical power grid infrastructure, combining ICT and energy supply technologies, will enable factories to optimise their energy flows, acting as both energy providers and users. Contributing to this, the results of the manufacturing process (such as heat and waste) will increasingly be used as sources of energy, enhancing the energy balance of many factories, and making them **energy self-sufficient** and **carbon neutral**. **New energy storage facilities** will also enable factories to adjust energy flows according to their needs off-the-grid.

ANNEX 2: NATIONAL INITIATIVES ON ADVANCED MANUFACTURING

The German Initiative 'Industry 4.0'

The term 'Industry 4.0' denotes the fourth industrial revolution, a term coined by an Industrial Working Group set up by the German government. The first industrial revolution consisted of *mechanisation driven by steam power*; the second industrial revolution used *electric power to drive mass production*. The third industrial revolution followed with production *automation, enabled by the use of electronics and IT*. The fourth industrial revolution is considered to be driven by the internet, particularly the blending of the real and the virtual worlds and the so-called *Internet of Things*.

The initiative considers that industrial production in the future will be characterised by a strong customisation of products with highly flexible (large series) production, extensive integration of customers and business partners in business and value-adding processes, and in linking of production and high-quality services leading to so-called hybrid products.

'Industry 4.0' was conceived under the German government's High-Tech Strategy, focusing on information and communication technologies. It was then developed further to include production research and the user industries. The initiative builds on European strengths in (software-intensive) embedded systems, particularly in the car industry and engineering. So-called Cyber-Physical Systems are becoming increasingly important in this context, e.g. through the networking of embedded ICT systems both with one another and with the internet.

Along with increased automation in industry, the development of intelligent monitoring and autonomous decision-making processes is particularly important to steer and optimise both companies and entire value-adding networks, almost in real-time. The aim is to develop completely new business models and tap the considerable potential for optimisation in the areas of production and logistics.

Other factors include new services in important areas of application — such as mobility, health, climate and energy, as identified in the German High-Tech Strategy. 'Industry 4.0' thus covers manufacturing, services and industrial design. One focus is on intelligent production systems and processes and the realisation of distributed and networked production sites. Under the heading 'Smart Production', there will be a stronger focus on intra-company production logistics, human-machine interaction and the use of 3D manufacturing.

The initiative is funded with up to €200 million, mainly through the Federal Ministry of Education and Research (BMBF) and the Federal Ministry of Economics and Technology (BMWi).

Source: *http://www.bmbf.de/en/19955.php*

Finnish Programmes

Finland supports R&D and innovation activities via its funding agency Tekes, which grants around EUR 600 million a year to innovative projects aimed at generating new know-how and new kinds of products, processes, and service or business concepts. Its main target group consists of SMEs seeking growth in internationalisation. In this group, young growth companies in particular receive Tekes funding targeted at businesses. In its strategy, Tekes has specified focus areas (implemented largely via Strategic Centres for Science, Technology and

Innovation — SHOK) in which Finnish companies and research have significant potential. Tekes grants nearly half its funding to these areas. The focus areas related to manufacturing (annual funding of approximately EUR 150 million) are:

(1) Business in global value networks

(2) Renewing services and production by digital means (new ICT-enabled business processes, knowledge and information-based business concepts, connecting the real and the virtual worlds)

(3) Natural resources and the sustainable economy (energy & raw material efficiency, renewable energy solutions, sustainable solutions for mineral resource use and water consumption).

Source: http://www.tekes.fi/en/community/Home/351/Home/473

UK initiative on High Value Manufacturing

The UK Government aims to increase the role that manufacturing plays in the growth of the economy, by helping to create an environment that will encourage companies to commercialise more of the world-class output of the UK science base through manufacture here in the UK. This will include emerging technologies where the UK is scientifically strong and has the potential to make a global impact through manufacturing. These include composite materials, plastic electronics and industrial biotechnology.

Our High Value Manufacturing strategy and the Future Landscape Study, which underpins this strategy and was prepared for us by the Institute for Manufacturing (IfM) in Cambridge identified many of the areas of potential which are addressed by our programme of activities in the coming period.

We have identified five strategic themes where there is strong potential for innovation in high value manufacturing to make a difference across multiple sectors and generate wealth for the UK:

- Resource efficiency
- Manufacturing systems
- Integration of new materials with manufacturing technologies
- Manufacturing processes
- New business models

Our investment programmes will set out to support industry in developing these national competencies, through feasibility studies and collaborative research and development competitions, and through the High Value Manufacturing Catapult. In this regard, the High Value Manufacturing Catapult, which opened for business in October 2011, will continue its development to provide a transforming resource to accelerate the commercialisation of new and emerging manufacturing technologies.

Source: https://www.innovateuk.org/high-value-manufacturing

Advanced Manufacturing Initiatives in the US

So far, US programmes relating to manufacturing covered basic S&T and support to commercialisation (mainly through the Manufacturing Extension Program — annual budget USD 128 million). Recent intense discussions involving the White House, however, have led to a decision to launch a network of regional manufacturing innovation institutes, the National

Network of Manufacturing Institutes (NNMI), which will cover the crucial in-between area of *applied R&D*.

In his budget for fiscal year 2014, the US President proposed creating a network of up to 15 regional Institutes for Manufacturing Innovation (IMIs). Funded by a proposed one-time USD 1 billion investment, the NNMI responds to a crucial competitiveness challenge and threat to future prosperity: closing the gap between research and development (R&D) activities and the deployment of technological innovations in domestic production of goods.

To jumpstart the NNMI in 2013, existing funds from four federal agencies were used to launch a pilot institute. In less than a year, the pilot attracted 76 members and co-funded seven collaborative projects — the President tasked the Departments of Defence and Energy to initiate competitions for three IMIs, again with existing funds. Together, industry partners, state and local agencies, foundations and others will co-invest with the federal government in each IMI. A strong partnership between industry and local or regional stakeholders is required for federal efforts to serve as a catalyst for advanced manufacturing. The emphasis of the NNMI is on advanced manufacturing.

IMIs, each with a technology focus that leverages and expands the industrial, research, and institutional strengths of the region, will be a central element. Each IMI will be designed to catalyse collaboration and maximise shared infrastructural resources. The focus of each institute will be unique, determined through a competitive application process, but all IMIs will concentrate on adopting, refining, and applying promising emerging technologies.

The NNMI and its regional IMIs will have a scale and focus that are unique, and they will be built on concepts of a strong public-private partnership. The institutes and the entire network will be industry-led. They will be designed and implemented in partnership with industry (companies large and small, established and start-up), academia, non-profit organisations, and states, with the aim of investing in and accelerating development of cutting-edge manufacturing technologies with industrially relevant applications. Over a specified period, each IMI will become a self-sustaining technical centre of excellence.

The NNMI program will be managed by the interagency Advanced Manufacturing National Program Office. Participating agencies include the Department of Defence, Department of Energy, Department of Commerce's National Institute of Standard and Technology, NASA, the National Science Foundation, Department of Education, and other agencies.

Source: http://manufacturing.gov/advanced_manufacturing.html

ANNEX 3: KEY FEATURES OF A COMMISSION'S FUNDING SCHEME TESTING ADVANCED TECHNOLOGIES FOR MANUFACTURING IN PRODUCTION-LIKE ENVIRONMENTS

This annex summarises the main features of a promising EU funding scheme recently piloted by the European Commission, called **ICT Innovation for Manufacturing SMEs** (I4MS), for the benefit of regions that may wish to consider putting in place a similar model with EU funds — if necessary and appropriate — and **duly taking into account State aid rules.**

The added value of the initiative implemented by the European Commission is **i) to lower the costs and risks linked with being first users or early adopters of new advanced technologies** with the potential of gaining a competitive advantage and **ii) to cross the gap from research prototypes to successful market adoption by experimenting with new business models** which are commercially sustainable.

Scope of the programme

The scope of the programme is to run experiments to test existing innovative technologies in production-like conditions to favour their up-take in manufacturing industry. Technologies could include e.g. advanced robot solutions, high-performance cloud-based simulation services; intelligent sensor-based equipment and innovative laser applications.

The programme supports the fast adoption of advanced solutions that are expected to have a particularly high impact on modernising manufacturing capabilities in a region, transferring these technologies to new industrial applications.

To increase the impact of the programme beyond direct benefits to the participants, experiments have included **competence centres** and innovation multipliers. These are instrumental for **SME actors to expand their activities** and provide several services to the SMEs involved.

Within the programme, SMEs benefited through 1) direct participation as partners in experiments, and played a key role in driving their respective experiments and 2) technology and competence transfer by getting access to technologies, competences, a pool of ‘best practices’, and services of the partners in their respective experiments.

Type of experiments

Experiments mostly targeted innovation at multiple levels of the value chain. For example, in the activities the European Commission has piloted on simulation services, innovation and consequently partnership was addressed at three levels: (1) Users: one-stop shopping access to simulation services, including expertise and cloud resources; (2) Software suppliers: software porting on the cloud and experimentation with new business models; (3) High performance computing (HPC) resource providers: establishment of a commercially-sustainable European cloud of HPC resources. On the first two levels, SMEs play a key role and map well into the above categories.

The experiments covered the key sectors of industrial application and the most relevant areas of evolving manufacturing equipment. The assessments helped manufacturers to identify economic leverage and bridge the technological gap of the novel technology and targeted industrial solutions in areas such as:

- Robustness / reliability / performance
- Identification of implications in the up and down-streams of the manufacturing process
- Interfacing between systems (competing or addition of new elements)
- Universality of equipment/components (Plug and play aspects)
- Cost/time/resources for integration
- Modularity of components
- Safety – implementation within European regulations
- Bringing solutions from other areas that could help reduce costs or improve safety
- Green technologies – resource efficiency

Equipment chosen for assessment had to fulfil a set of prerequisites, such as not being commercially available or already prototyped and having a clearly identified industrial user.

Experiments were of two types:

(1) **Experiments to support suppliers**, in particular SMEs, of new or enhanced equipment, tools, processes, or methodologies and their use in production-like environments;

(2) **Experiments to support first users**, or early adopters, in particular SMEs, to get access to knowledge, training, prototyping, manufacturing, design, or engineering services

In the Commission model, experiments could be proposed by a small consortium, including relevant actors in the value chain depending on the technology to be implemented.

It was important to cluster the experiments around c***ompetence centres***, which added significant value along two dimensions. While supply-side SMEs are supported in collaborating with users outside their ecosystem, sector, or region and get access to new markets, demand-side SMEs get access and competences beyond what their local research and service partners can offer.

In the Commission's experience, the partnership of users, suppliers and competence centres in any experiment was led by alignment of the commercial interests of the participants and can potentially result in a long-term business relationship. Therefore, the set-up of experiments and partnerships along the value chain should be considered as a key element of the initiative.

Examples of competence centres

- Austrian Institute of Technology (AIT), Foresight & Policy Development Department, Austria
- VTT Technical Research Centre of Finland
- Institute of Industrial Technologies and Automation (ITIA-CNR), Italy
- Fraunhofer Gesellschaft, Germany
- TERATEC, France

Beneficiaries

The model used by the Commission could be beneficial both for companies providing new manufacturing technologies and for companies interested in applying them. Users can reduce the risk of being an early adopter of advanced technology with the potential of gaining a competitive advantage, while suppliers can broaden their user or application base by 'bringing them customers'. The focus is on downstream activities such as systems integration, testing and validation under realistic manufacturing conditions.

- **Companies in the manufacturing sector** (including SMEs) either as users or as technology suppliers
- Service providers, technology/application experts;
- System integrators;
- **Innovation intermediaries** competent in manufacturing to maximise the impact of the experiment to address the needs of companies. Work should be focused around stimulating the exploitation of synergies across technology domains, industrial sectors and — most important — European regions; sharing ideas, best practices and experiences; and linking the activities to existing regional innovation clusters and networking activities such as the Enterprise Europe Network of the European Commission.
- **Competence centres** with the role of providing coordination and common services to the experiment: dissemination, access to infrastructure, brokering of new users, influencing standardisation, and administrative support. They can be centres already in existence or created for a specific new technology.

Selection process and evaluation criteria used by the Commission

The call seeks new experiments that will be used to test currently available advanced manufacturing solutions. In order to not discourage SME participation, the call proposal should be as light as possible.
The individual budgets for the new experiments will not be fixed and applicants can ask for smaller or larger amounts in their bids.
The basic principles which govern the European Commission's calls are: excellence, transparency, fairness and impartiality, confidentiality, efficiency and speed.

Reference and contacts

The pilot initiative recently launched by the European Commission is called ICT **Innovation for Manufacturing SMEs** (I4MS). More information can be found on the website.

Website: http://cordis.europa.eu/fp7/ict/computing/home-i4ms_en.html

For more information, contact: CNECT-A3@ec.europa.eu