High Level Group on Key Enabling Technologies

Report on Globally Competitive Manufacturing Facilities

By

Working Group 5 of the KET Sherpa team

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Executive Summary

Europe possesses a long established, strong manufacturing base that employs over 34.4 million people. This manufacturing sector represents a range of industries and companies of many different sizes. Its strengths come from a combination of a deep engineering tradition, strong academic and R&D capacity, and the proven ability of European industry to adapt to technological progress and to produce high quality products that satisfy customer needs all around the globe. However in recent years Europe has demonstrably lost ground in retaining manufacturing jobs and also has fallen behind other regions in the world in its ability to attract new advanced manufacturing companies. In recognition of this fact the KET Phase 1 report identified the 'Valley of Death' between research and development and mass market commercialisation and manufacturing of subsequent products in Europe. Working Group 5 was tasked with identifying recommendations to create a global level playing field for the Third Pillar, Globally Competitive Manufacturing Facilities, to remain in Europe (and attract new ones) and thus complete the bridge over the identified 'Valley of Death' by linking world class research and development, through pilot lines and prototyping, to global commercialisation. These recommendations were compiled from considered inputs from the members of the Working Group, inputs from other companies and Member States not within the working group, and from the Pillar 3 workshop held in Brussels on April 4th, 2011. These recommendations constitute the steps which WG5 feel are essential to cross the valley of death, and incentivise companies to make larger-scale production investments in Europe. The Return on Investment (ROI) on these investments should be made more globally competitive and attractive by providing the right framework conditions as part of an industrial innovation policy. To achieve this Europe should and can find the right mix between regulative measures, interpretation of regulation, funding and tax-related instruments.

1. Introduction

a. The mandate of Working Group 5:

Working Group 5 was mandated with identifying framework issues affecting conditions for establishing and maintaining globally competitive manufacturing facilities and manufacturing capacity in Europe. It was requested to recommend solutions that would enable private sector companies, which invest in global manufacturing in Europe, to compete internationally. This includes, amongst other recommendations, the identification of a European policy framework to create successful conditions for an equal and level global playing field.

b. The importance of Pillar 3 (Globally Competitive Manufacturing Facilities):

The deployment of Globally Competitive Manufacturing Facilities (GCMF) in Europe and the strengthening of European based manufacturing capacity and capability can be instrumental in the creation of jobs and wealth in Europe along with addressing societal challenges, and can be achieved both through the rejuvenation of existing production capacity and the creation of new facilities.

Europe hosts a manufacturing base that employs over 34.4 million people. It possesses strength through a long-established engineering tradition, strong academic and R&D capacity, and the proven ability of industry to adapt to technological progress and to produce high quality products that satisfy customer needs all around the globe. A wide variety of industries make up this strong base of manufacturing including engineering, energy, chemical, transport and communication industries, metalworking , micro and nano electronics, construction, plastics, food and beverage. Manufacturing is an important element of Europe's trade balance and extra EU trade in manufactured goods resulted in a trade surplus of 107 billion € in 2007. As an industrial sector it is characterised by a landscape of highly specialised business of which small and medium-sized enterprises (SME) account for 59% of manufacturing employment. Towards the top of this industrial pyramid, high volume advanced manufacturing facilities have been identified as being perhaps the most crucial component. These GCMF's act as an anchor tenant in a complex and valuable industrial ecosystem where start-ups, SMEs and large players can co-exist, collaborate, cooperate and grow.

Advanced Manufacturing is characterised by the following features:

- Capital intensive, knowledge intensive, technologically complex industries with complex manufacturing methods, processes and products;
- Demanding high levels of intellectual capital; and
- Requiring excellence in areas such as quality, reliability, productive, cost efficiency.

Encompassing these defining characteristics into an advanced manufacturing operation would not alone be enough to ensure that such an operation was successful. Hayes and Wheelwright proposed a "framework that indicates the various roles and associated level of performance that the manufacturing function in a company can take." [1]

[1] Baines, T. S., P. D. K. Harrison, et al. (1998). Barriers to Strategic Change in a Manufacturing Organisation. 31st ISATA complete symposium abstract volume. P. D. D. Roller. Düsseldorf, Germany, ISATA.

The Hayes and Wheelwright [2]framework consisted of four stages:

1. Minimise manufacturing's negative potential: Internally neutral
2. Achieve parity (neutrality) with competitors: Externally neutral
3. Provide credible support to the business strategy: Internally supportive
4. Pursue a manufacturing-based competitive advantage: Externally supportive

At Stage 4 of the framework, "company strategy is based, to a significant degree, on manufacturing capabilities…and manufacturing plays a major role in securing strategic objectives"(Baines, Harrison et al. 1998). Companies that operate their manufacturing capabilities at Stage 4 could be called a world class or advanced manufacturer. A world class manufacturing company is "one that approaches the development of the role of manufacturing into one which fully supports the marketing strategy of the business and at the same time, provides the capability to establish a competitive advantage from the manufacturing activity itself"[3] (Sweeney 1990). It is precisely these kinds of companies, operating with manufacturing as a distinct competitive advantage, which the KET Pillar 3 seeks to attract and maintain in Europe. Their presence completes the bridge over the identified 'Valley of Death' by linking world class research and development, through pilot lines and prototyping, to global commercialisation.

c. Why urgent action is required on Pillar 3 in the EU:

With regard to KETs' strengths, one can observe that from a research and industrial perspective, Europe's assets consist of a strong research base as well as world market leadership in several KET application sectors relying, for most of them, on strong technological and manufacturing competences in large and small companies, and in production and competence networks along established and highly diverse new value chains. KETs development and deployment represent significant opportunities, in terms of opening and developing new markets (for instance new green industries) and creating new jobs if manufacturing is competitively exploited in the EU.

In today's globalised world, European manufacturing faces significant challenges. In recent times, advances in logistics, communications and transport technologies and the globalisation of supply chains have enabled the most modern manufacturing technologies to be relocated to regions throughout the world. In addition, structural challenges exist that hamper the competitiveness of manufacturing in Europe compared to emerging economies. In a global context, Europe's cost of labour and hours worked are not competitive even in the high-tech sector. In addition to this, there is the consideration of Euro (€) currency trend versus the Dollar ($) and the continuous fluctuation, in addition to energy prices, which have a significant impact on manufacturing cost-competitiveness and which are sometimes twice the cost of competitor countries and regions.

The SWOT analysis, executed in the initial assessment and reported in the KET interim report, has clearly shown that KETs development and deployment is/will be threatened if Europe does not

[2] Hayes, R. H. and S. C. Wheelwright. (1984). Restoring our competitive edge : competing through manufacturing. New York, John Wiley and Sons.
[3] Sweeney, M. T. (1990). Breakthrough to World Class Manufacturing - A strategy for the transformation. 5th International Conference on Manufacturing Strategy. Cranfield Institute of Technology.

implement successful conditions to create a global level playing field, reduce the fragmentation of its regulatory framework and Member States' policies, take appropriate measures to stimulate and to anchor globally competitive manufacturing in Europe, and reduce trade barriers. The analysis shows also the need to further reflect on the lack of appropriate financial ecosystems, along with limited financial instruments to address KETs issues and risk taking in funding large scale capacity expansions in KET production technologies.

This report prepared by the Working Group on Globally Competitive Manufacturing Facilities Installation reflects also considerations discussed in an open workshop aimed at searching for solutions for establishing competitive production capacities in Europe that are positioned to compete with international facilities, in particular those in East Asia, addressing recommendations in policy and other issues.

2. Thematic examples of sector specific issues

In this section we will provide two examples of how the current regime that has evolved regarding advanced manufacturing in Europe is affecting the ability of companies to reinvest in Globally Competitive Manufacturing Facilities.

a. Photovoltaics Case Study

In the last number of decades we have seen a growing trend to delocalise manufacturing activity out of Europe. This globalisation trend has initially affected the activity with high labour content but progressively impacted also those with high engineering content, including R&D, and this is in conjunction with a very proactive local industrial policy, particularly by Asian countries. This phenomenon is particularly visible for the KETs manufacturing. Here both photovoltaic and nanoelectronics industries represent the most visible tip of the iceberg, being the industries with longer histories, a more mature nature and large market sizes. They show that framework conditions make a difference and are playing a decisive role in attracting larger production capabilities outside of Europe.

For photovoltaics (PV), the rapid development within the last few years provides a textbook example of why it is so difficult to maintain globally competitive large-scale manufacturing in Europe. Fuelled by the attractive feed-in tariffs provided by the Renewable Energy Law, the German PV market developed about five years ago into the leading world market. In order to provide the rapidly increasing production volume, investment capital was needed in quickly increasing amounts. Such capital was offered by the Chinese government at attractive conditions. Therefore it is not surprising that production facilities in China now supply more than 50% of the world market, with large amounts of solar modules exported to Germany. As a saving grace, even those manufacturing facilities in China are based to a large extent on German production tools. In this highly automated industry, labour costs amount to less than 10% of the total PV production cost (Photon International 12/2008 p.84ff). However, the difference is the access to investment capital that has to be improved in Europe to create a more level global playing field.

b. Micro and Nano-electronics Case Study

The growing complexity of nanoelectronics technology results in exponential increases in capital spending and critical know-how. In the early days of semiconductors, Integrated Devise Makers (IDM) handled directly the entire value chain, sometimes extending their business into manufacturing equipment and materials on the one hand and electronic products and services on the other. The need to focus more on the key core competences and the availability of alternative business models (IP providers, Fabless, foundries) have induced companies to search for their best business model and to externalise or delocalise some of their activity starting from the manufacturing. This choice could be a valid one at the company level where the objective is to maximize return for their shareholders, but could be very dangerous for a country or region.

This is as true for Europe as it is for other regions. Taking a look across the Atlantic we can observe the same debate: "In the long run, an economy which lacks infrastructure for advanced production activities and the process engineering required to support this loses its innovation capacity" is a widely held conclusion. [4]More specifically, former Intel CEO Andy Grove could easily also be talking about Europe when he stated in 2010:

"*Scaling used to work well in Silicon Valley. Entrepreneurs came up with an invention. Investors gave them money to build their business. If the founders and their investors were lucky, the company grew and had an initial public offering, which brought in money that financed growth...Wages and health-care-cost rose in the US. China opened up. American companies discovered that they could have their manufacturing and even their engineering done more cheaply overseas. When they did so margins improved. Management was happy, and so were stockholders. Growth continued, but the jobs began sputtering.... With some technology scaling innovation takes place overseas. Such is the case of advanced lithium-ion battery.... A new industry needs an effective ecosystem in which technology knowhow builds on experience, and a close relationship develops between supplier and customer. The US lost its lead in batteries 30 years ago when it stopped making consumer electronics devices. Whoever made batteries then gained the exposure and relationship needed to learn to supply batteries for the more demanding laptop PC market, and after that , for the even more demanding automotive market. US companies did not participate in the first phase and consequently were not in the running for all that followed... Each company does its best to expand efficiently and improve its own profitability. However, our pursuit of our individual business, which often involves transferring manufacturing and a great deal of engineering out of the country, has hindered our ability to bring innovations to scale at home. Without scaling, we don't just lose jobs- we lose our hold on new technologies. Losing the ability to scale will ultimately damage our capability to innovate*."[5]

It seems Europe is currently quite vulnerable to these developments and the risks are there to 'lose our hold' on nanoelectronics in and for Europe from this manufacturing perspective. This can be illustrated by looking more closely at the current situation and the impact of changes in the framework conditions in Europe. For instance:

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[4] Gary P. Pisano / Willy C. Shih: *L'urgenza di ritrovare la competitività perduta*. Harvard Business Review Sep. 2009, p. 77

[5] Business Week article ; "How America can create Jobs" July 2010

- Europe is a net importer of semi-conductor chips, with decreasing share of global semiconductor market. I.e. the volumes produced in Europe are not sufficient to satisfy a market which is already shrinking in proportion to the rest of the world.

- Production is going down and global investments in semiconductor manufacturing are now taking place largely in Asia and USA. Current analysis of worldwide production capacity shows Europe fluctuating at approximately 10% of global fab capacity, down from some 14% some years ago and losing ground on deployment of 300mm technology and future technologies. In terms of capital investment there has been a 5% decline in the past few years. Fab capacity investments in Europe between 2005 and 2010 are on the same level as Singapore (a mere 4.7% compared to 11% in the US and 20% in Japan, 23% in Taiwan, 17% in China and altogether 65% in Asia (ZVEI 2011)). Manufacturing capacity dropped up to 25% from 2005-2007. In Europe this pattern has led to the partial absence of an ecosystem of large-scale foundry & large scale assembly & testing service providers.

- Studies have shown a gap in the ROI between fabs in Europe and the rest of the world, with the main gap being the area of incentives rather than labour (as second), material or other factors. (ESIA 2005, SIA 2006, Malier 2009).

- For many business models there exists a strong link between the R&D and the manufacturing process. This is especially true for so-called More Moore [6] technologies, a point emphasized during the KETs Open Day in October 2010: *"It is not possible to have R&D for future advance production if you don't have a minimum of manufacturing. Ensuring a global competitive playing field in Europe versus the rest of the world for research, development and manufacturing R&D on advanced CMOS has to be tied up to leading edge manufacturing infrastructure"* (O. Bellezza, ST Microelectronics).

- Mastering manufacturing, the access to or in-house volume production and the need for economies of scale are common among all semiconductor players. This remains true regardless of business model or technology specialisation affecting both so-called More-Moore (which maintains a presence in Europe) and More-than-Moore (MtM where Europe maintains a very strong ecosystem[7]) semiconductor companies. Here the interdependencies remain inescapable and expertise is as vital as cost-cutting.

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[6] The micro/nanoelectronics industry has two distinct sub-categories, 'More Moore' and 'More than Moore'. These names come from a trend noted in 1965 by Intel co-founder Gordon Moore that predicted the number of transistors on a chip would double every 18 to 24 months. 'More Moore' focuses on the continued shrinking of digital physical feature sizes in order to improve cost and performance. 'More-than-Moore' focuses on incorporating functionality into devices that do not necessarily scale according to 'Moore Law', but provide value in different ways by allowing a variety of semiconductor devices to be combined on the same chip. Typical More than Moore products are integrated circuits (ICs) and multichip components used for example in the automotive, energy, security, health care and transport sectors.

[7] MtM companies have two ecosystems; one with the downstream industry (for chip design and chip integration into the downstream system), and one with the upstream industry for special materials and equipment. Most MtM companies are IDMs (Infineon, TI, NXP). Especially in Euorpe foundries are emerging (XFAB, LFOUNDRY, ALTIS, TELEFUNKEN). MtM backend facilities are spread all over the world.

- In 1998 the Commission adopted the "Multi-sectoral framework on regional aid for large investment projects". This framework was established to structure government investment across the EU, across industrial sectors, in a manner that supported job growth and sectoral market growth. It was originally authorised for three years but was extended until 31 December 2002. This Multi-sectoral framework regulated for most industrial sectors the aid intensity available to industrial sectors seeking support from their national governments to catalyze industrial growth. The average state aid intensity for large investment under the framework was about 25% of the total cost of project investment. This was less than the ceiling, which was 30 to 40%, in less developed regions. Compared to other regions outside Europe, this level of support was not competitive with places like Israel where the aid intensity reached 50%. But, it attracted larger investments in many EU regions (i.e., the automotive industry in Spain, Portugal, and Saxony; the semiconductor industry in Sicily, Portugal, Ireland, and Saxony). It is noteworthy that member states frequently did not use "the full frame" available under the Multi-sectoral Framework. They offered to investors less aid than the framework allowed. The maximum aid ceiling was relatively high, and for some member states, too expensive. For example, in Germany the limitation was due to a restriction of €0.5 Million funding per established workspace. This fact clearly underlines that the aid intensity was mainly "market driven". On the other hand, member states like Ireland previously were entitled to use EFRE budgets for incentivising large investments adequately. Despite its success in generating significant corporate investment across industrial sectors in the EU, under the Swedish Presidency in 2002, the Council decided to reduce the state aid intensity overall and to improve the transparency of decision finding.
- In the past years, there have been no global scale investments by the semiconductor industry in Europe. There were enlargements of production facilities in Dresden (Fraunhofer and AMD) and the announcement of a future upgrade of a 200mm facility to a 300mm facility by Intel in Dublin, as well as a fab site extension within Bosch in Reutlingen. The biggest activity was the enlargement of a production facility in Grenoble, in conjunction with a tangible R&D package from the French government. This was considered to be the only way to make larger investments possible in the EU and still stay competitive with non-European regions. As investments declined in the EU region, European semiconductor companies have invested in Singapore, Malaysia and China.
- State aid regime laws which are intended to ensure a level playing field only within Europe but not compared to other regions are placing restrictions on large production investments. This places global industries in Europe at a disadvantage because of our inability to compete in terms of incentives. Chapter 4.3 of the Guidelines on national regional aid for 2007-2013 (2006/C 54/08) talks about large investment projects of the type which could be used for the kind of investments required for the micro/nanoelectronics industry. Typically, the differentiation is between investments between €26M and €50M, €50M and €100M and over €100M. A typical semiconductor investment – be it for upgrading or new investment – would be well over €100M. The cost of a new Fab is €3-4 billion. The intensity of eligible support for investments depends on the region the investment is made in. The so-called 'décalage system' (or 'scaling-down mechanism') currently in place means that the higher the investment, the lesser the percentage of support that applies, therefore penalising larger investments. The range of total support in recent cases can be anything between 9% and 14% of total investment. These levels are well below other ranges of support on offer

around the world. This décalage system looks inwardly at the EU rather than outwardly in a global context in terms of competing for large scale manufacturing investments, and by penalising larger investments, and therefore job creation in Europe, it acts as an incentive to invest outside Europe.

- Besides Europe's state aid provisions and aims, Europe does not seem to be able to offer the variety of measures which are offered to companies which install production facilities in the US, Asian or Middle East countries. These include fiscal measures, such as tax exemptions for companies and their workers, tax credits in R&D, and accelerated amortisation of investments, provision of land, regular financial aid for equipment (including for production), fixed price guaranteed energy provision, attractive finance plans and aid in staff training.

3. Recommendations from the Working Group and the Workshop

To establish globally competitive manufacturing facilities and overcome the final and most difficult step in crossing the valley of death, Europe needs to make production investments in Europe – especially larger-scale ones - more globally competitive and attractive by providing the right framework conditions which can act as investment incentive for KETs as part of an industrial innovation policy. To achieve this Europe should find the right mix between regulative measures, interpretation of regulation, funding and tax-related instruments.

a. Instruments

i. Freeing above all larger-scale KETs investments to go where they make most sense; i.e. make re-investment incentives in existing competitive areas/ clusters/ ecosystems more attractive. This can be done by removing the geographical obligations of state aid in Europe for KETs. One particular instrument would be an effective smart specialization initiative which could potentially provide leverage for KETs, incorporating more ERDF funding for innovation (and therefore KETs), more effective combination of other public funds (CIP, FP) and more use of financial instruments (VC, loan guarantees). Smart specialization strategies should be applicable to the EU territory as a whole, not only to disadvantaged regions.

ii. Demonstrate a clear political commitment by all EU institutions regarding the critical importance of the production/manufacturing side of KETs as a vital element to ensure growth and global competitiveness in and for Europe. This can be done through statements at all levels from the HLG to Member State authorities.

iii. Make state aid rules more effective. This can be done by making full and better use of current state aid possibilities such as cross-border cooperation, projects of European interest Art. 107 3b/c, the upcoming R&D&I review or applying a matching clause to production.[8]

iv. Support KETs clusters/ ecosystems. Here there is a need to distinguish between technology clusters/ecosystems and knowledge clusters/ecosystems to optimize the benefits for the specific KETs. Various KET value chains may differ in their business models or in terms of financing, timing and volume. Some may need high funding volumes with shorter pay-back times; some would benefit more from quicker decision times, appropriate skills and / or infrastructure. A distinction can be made by focusing on measures and instruments which can attract investments to existing competitive ecosystems for technology clusters/ecosystems and by focusing on measures and instruments such as cross-border cooperation for knowledge clusters/ecosystems as part of an effective EU cluster policy[9].

b. Inputs – Financial

i. To provide a financial environment targeted towards the needs of KETs, able to provide rapid access to capital at low cost and support capital investment. The focus should be on providing availability of loan guarantees and how to make it easier to carry the risk of larger-scale investments. This can be done by supporting an enhanced EIB RSFF programme with new innovation and/or KETs specific provisions and a focus on longer term viable solutions. One measure could also be based on a success-dependent return ('earn-out' clause such as French cinema case) structure where access to a funding basket is combined with a reimbursement commitment with higher reimbursement in the case of success; i.e. a loan/grant mixture.

ii. Enabling private & public funding to also target the upgrading of existing plants and new investments; mostly definable as larger-scale investments. This can be done by making state aid rules more flexible and driven by

[8] The **Community framework for state aid for R&D** (2006/C 323/01) describes the matching clause for R&D under Art: 5.1.7. **as follows:** "In order to address actual or potential direct or indirect distortions of international trade, higher intensities than generally permissible under this section may be authorized if – directly or indirectly – competitors located outside the Community have received (in the last three years) or are going to receive, aid of an equivalent intensity for similar projects, programmes, research, development or technology. However, where distortions of international trade are likely to occur after more than three years, given the particular nature of the sector in question, the reference period may be extended accordingly. If at all possible, the Member State concerned will provide the Commission with sufficient information to enable it to assess the situation, in particular regarding the need to take account of the competitive advantage enjoyed by a third-country competitor. If the Commission does not have evidence concerning the granted or proposed aid, it may also base its decision on circumstantial evidence."

[9] See also annex

overall European competitiveness and innovation capabilities. In particular the current decalage system is an active disincentive for any larger-scale investments and should be phased-out for KETs or its logic reversed to the more a company is prepared to invest in Europe in globally competitive production installations, the more it should be supported

iii. Enabling funding to also target 1st-in-kind plant investments. This can be done by supporting the proportionally higher engineering costs during the learning phase and during the manufacturing science implementation as part of the investment required (capital & costs) to start a production and first installations into the market. A form of subsidization which could cover up to 50% of additional costs should be aimed for. Here short-term targeted support is more effective than long-term subsidies.

c. Inputs – Taxation

i. To find a more targeted way of using tax-related measures which are conducive towards Pillar 3 issues. This can be done by presenting to Members States a benchmarking of the most effective tax-related measures such as accelerated depreciation of equipment, R&D tax credits, tax rebates to cut energy costs and recommending the use of these.

ii. The use of tax-related measures for a determined period of time; in particular corporate taxation as part of an investment incentive. This can be done by implementing a progressive framework of taxation rules across the EU. This would strengthen the functioning of the Single Market as a driver of innovation, and remove barriers for technology-based businesses. The EU should review on an ongoing basis successful tax measures that have supported innovation and technology development, and the adoption of new technologies, with a particular focus on KETs, and report on these annually to Member States.

d. Inputs – Talent

i. Education and skills are an asset for Europe, but the attraction of technical education is decreasing. Specific initiatives can help cultivate the skills Europe will require in the future:

ii. Support initiatives for stimulating awareness and appeal for maths, engineering, technology and science, at 10-18 years age,

iii. Launch specific ERASMUS calls, focused on KET areas,

iv. Through student grants, support international cooperation between Masters in Electronics and nanotechnologies, as well as the residence of students from such masters within European RTOs (Research and Technology Organizations),

v. Support European trans-national initiatives for specific training of workers in the field

e. Market Pull

i. Enhance the role of public authorities in market-pull initiatives. This can be done by the increased use of pre-commercial public procurement, with public authorities acting as 1st adopters. Also linking products with relevance for the community and European strategic goals such as societal challenges more closely can act as market-pull incentive. Reinforcing Europe 2020 and focusing on KETs as providers of solutions for societal challenges would provide an important support also in this respective.

f. Institution Decision Making

i. Speed-up decision-making for support projects. This can be done by setting a target of 6 months for decision-making procedures for KETs projects which stimulate and secure globally competitive manufacturing in Europe. Decisions regarding specific state aid should not take more than 2-3 months compared to the current 12 months. The various administrative steps for setting up (i.e. planning and building) a manufacturing facility could be organized more efficiently by adopting a more parallel process with a possible one-stop-shop rather than the current step-by-step linear/sequential manner of operating.

ii. Adopt recommendations as a package rather than a selective choice between them. Recommend on a regular KET HLG review process starting in spring 2012 to monitor progress on the actions done.

g. Global Level Playing Field

i. Work towards establishing a global level playing field especially and fair global conditions for pillar 3. This can be done by making more use of existing EU trade defense mechanisms, reinforcing environmental standards, quality control, certification, labeling & standards, use of local content regulation to counter those used in other regions, a 'made in Europe campaign'.

4. Summary

In conclusion, in the last decades we have seen a growing trend to delocalise manufacturing activity out from Europe. This globalisation trend has initially affected the activity at high labour content but progressively impacted also the one with high engineering content, including R&D and this in conjunction also of a very proactive local industrial policy in particular by Asian countries. Losing manufacturing for companies could be a possible solution if it focuses purely on its core competence or localises its manufacturing in a more favourable country. The risks for a country or a region are however far higher if it loses its manufacturing capability. Not only does this mean the loss of job creation opportunities, but more importantly what is at stake is its capacity to further innovate. This threat is valid for Europe and in particular for KETs. To counterbalance this trend, EU and EU Member States should and can act and introduce an industrial innovation policy based on a mix of framework conditions as described in detail in our recommendations. This is a blueprint which would allow smart local players to be globally competitive players, as well as attracting future FDI into Europe.

5. Appendices

a. Appendix 1

Readiness levels in Manufacturing

Several hundred steps and the inclusion of large numbers of materials are typically required in a modern day advanced production plant. Equally typical is that customers today ask for finished high quality products with a guarantee of supply continuity on top of the 'normal' reliability guarantee of supplying the product with the same features and characteristics over time. To meet these expectations companies need to qualify both process and sourcing **beyond** the technology readiness (PLR) preparation which is being used as a tool for Pillar 2.

The use of readiness levels to describe system maturity has become an increasingly recognised element of the development of technologies for future products in many global organisations. The implementation of new manufacturing capacity can also benefit from such an approach. Here below we are described a model define and in use in Rolls-Royce that has been identified as a good practice by the UK Aerospace Design and Manufacturing National Technical committee and that we consider valid as well for most of KETS technology.

The United States Department of Defence (DoD) have probably been most active, certainly of all government bodies, in defining a manufacturing readiness standard. The DoD approach essentially consists of a series of Manufacturing Readiness Levels (MRLs) designed to provide visibility against a number of relevant "threads" (covering design , materials , manufacturing , quality , production , process capability and control , cost and funding and industrial base) Ten MRL stages have been identified , the first three being pre-conceptual. The remaining stages require reviews at each gate to confirm capability and identify the risks for progression to the next stage. MRL10 focus on continuous improvement.

The MRL approach is essentially assessment driven, as might be expected of a methodology being proposed by a customer organisation rather than a direct manufacturer.

Manufacturing Capability Readiness Levels (MCRLs) in Rolls-Royce was initially developed to support Trent !000 turbofan for the Boeing 787, and is now routinely used to support implementations of manufacturing technology and applied to its internal and external supply chain.

Phase	MCRL	State of development
Phase 3 Production ramp-up	9	Fully production capable process qualified on all parts over extended period (all business case metrics achieved)
	8	Fully production capable process qualified on all parts over significant run lengths
	7	Capability and rate confirmed via economic run lengths on production parts
Phase 2 Pre-production scale-up	6	Process optimised for capability and rate using production equipment
	5	Basic capability demonstrated using production equipment
Phase 1 Technology assessment and proving	4	Process validated in laboratory using representative development equipment
	3	Experimental proof of concept completed
	2	Applicability and validity of concept described and vetted, or demonstrated
	1	Process concept proposed with scientific foundation

Level 1 to 4 represent the technology assessment and proving phase. This is traditionally a time consuming phase of research activity and generally spans the entire development process, from a concept though to demonstration.

MCRL5-6 is termed pre-production and sees the transfer of the process onto production standard equipment. The phase ends with the sealing of a development process via a demonstrated strategy for control of key process variables.

MCRL7-9 is the phase of activity from completion termed Ramp-up and can be through of a verification, consolidation and sustainment phase. The process and its mode of operation should not change substantially during this phase of activity.

MCRL7 represents the demonstration of the process during early stages of production. There should be no major process change during this stage. If such a change becomes necessary, the process MCRL should be reassessed, as the changes will need to be confirmed by repeat MCRL review at a lower level. Production is expected to take place within the production location and be run by the operations team.

MCRL8 represents the demonstration of the process during early, but statistically significant volume production. There should be no major process change during this stage. If a change becomes necessary. a reassessment and demotion to a lower MCRL may be required. Initial volume production confirms that the process will support production without significant corrective action.

MCRL9 represents the demonstration of the process during volume production over an extended period. Again, there should be no major process change during this stage. If such a change becomes necessary, a reassessment and demotion to a lower MCRL may be required. Volume production confirms optimal production without significant corrective action.

New factory and process qualification has become a key requirement by many users in several domains starting from defence to aerospace, and ending to communications and automotives., and tools like MCLRs are becoming more and more popular in advance technology manufacturing.

b. Appendix 2

The Pillar 3 Workshop of April 4, 2011 brought together over 40 experts from all the KETs, the European Commission, Regional authorities and EU Member States to discuss and recommend actions which could strengthen Europe's 3rd Pillar. Many of the ideas are integrated directly into the recommendations and into this report.

Common themes from the WG5 workshop

- Is advanced manufacturing in EU still a viable option?
- How can we create Global level playing field?
- How does the EU keep and strengthen existing EU based advanced manufacturers?
- How to attract emerging opportunities?
- What are the pre-conditions for success?

J.M.Chery (STM) presentation themes

- Funding requirements for Investment in Pilot Lines
  - Different mixes of matching funding
  - Different matching methodologies
  - Different matching %s
- Unique funding requirements for Investment in Pillar3 Lines
  - Access to low cost capital
  - Changes in rules regarding depreciation
- Manufacturing is a science - if you lose the capability, it won't come back
  - Must build solid eco-systems
  - Support strategies with regional suppliers
  - Have partnerships with customers for prototyping, ramp-up
  - Train and retain manufacturing science talent

M.Nitzsche (Solarworld) presentation themes

- Must have consistent business development policies
  - In order to support R&D
  - In order to support start-ups
  - In order to support clusters
- Local Content regulations
- Support Grid Expansion
  - Funding to reach grid parity in EU
- Issue of harmonisation of subsidies in EU
- Huge competition from China - free land, energy, interest free loans
- In Europe there is a lack of qualified engineers
- Currently a lack of funds for capacity expansion

- We must enforce fair compliance globally on standards e.g. safety
- Foster closer partnerships between Industry and R&D

E. Westkämper (Fraunhofer IPA) presentation themes

- Better instruments to support deployment
- Support investment in 1st of kind plants
- Get political support
- Smart regulation

G. Katzler (Osram) themes

- How can Europe provide high quality work force?
- Concentrate on high tech, innovative production.
- Support R&D on manufacturing to gain competitive advantage
- Support set-up of pilot Lines
- Use public procurement to favour EU products
- Marketing campaign to promote products 'made in EU'
- Push regulations on energy efficiency and quality of light
- Subventions
- Proposal on public procurement on recyclable
- Automation alone not the answer to lowering labour cost
- Location of choice depends on many criteria

B. Cannon (Intel) themes

- Manufacturing is a creator of large scale employment and has a 3-5X multiplier effect
- Symbiotic relationship with R&D; Manufacturing acts as innovation engine
    - Fab facilities are living labs
- Scaling is hard but necessary
- Leverage Taxation - flexible state aid and taxation rules
- Leverage existing expertise – grow and sustain clusters, pick and support winners
- Foster cooperation with SMEs, and amongst industries
- Leverage Education to create skilled human capital for current & future needs e.g. 450mm
    - Create desire in young people for tech jobs and innovation

M. Lemonier (France) themes

- New proposal needed to replace subsidies/loans
- Grant with cash payback proportional to success

J.F. Clerc (CEA) themes

- Support clusters
- Manufacturing has a multiplier effect on employment

H.Gruber (EIB) themes

- Risk sharing finance facility
- Scaled RDI versus Innovation cycle
- 2011-2013 : additional tranche under discussion
- 2014 on financing: include innovation; use of regional funds

c. Appendix 3

Integrated KET approach – value chain types **Technology and knowledge based clusters**

The trend towards forming centres of excellence or poles of competitiveness based on common interests and capabilities enables IP generation, ensures competitive differentiation, captures new market opportunities, provides strong support for developing new application and allow to stay in the competitive race. These clusters , built on the networks created under public-private partnerships, along with regional competence clusters connected to local players from large scale multinationals and SMEs as well as to research institutes and universities, offer an ideal breeding ground for developing new opportunities. Such ecosystems enable new initiatives in lead markets thanks to the proximity of research and development to production capabilities, stimulating cross fertilisation and openness to innovation while protecting IPR of players involved.

The success of innovation clusters is becoming a favoured policy of local authority in ASIA in supporting the local creation of global champions. Whereas previously the clustering primarily was initiated by large companies in a giver region, the driving force in forming these centres of excellence or poles of competitiveness increasingly appears to be led by national and local authorities seeking to attract global players through local investment and tax incentives while providing the right infrastructures and ecosystems. More and more local authorities are targeting the opportunity for creating jobs, attracting skills and maximising IP generation and return. In top of this the trend toward making new IP operational by grouping suppliers and end-users clusters, centres of excellence and/or consortia has become an important condition for gaining access to new market.

Various KET value chains may differ in their business models or in terms of financing, timing and volume. Some may need high funding volumes with shorter pay-back times; some would benefit more from quicker decision times, appropriate skills and / or infrastructure. *A distinction can be made by* focusing on measures and instruments which can attract investments to existing competitive ecosystems for technology clusters/ecosystems and by focusing on measures and instruments such as cross-border cooperation for knowledge clusters/ecosystems as part of an effective EU cluster policy.

Recommendation: EC agreements with the regions for regional funding should systematically include the obligation to also strive for cross-border cooperation

Specific role for Smart Specialisation:

Especially in pillar 2 and 3 where decisions are targeted at higher investment in specific locations, the European added value should be guided by the smart specialisation policy. This implies tailor made solutions depending on the technologies and the value chains. This ranges from local cluster formation / geographical proximity up to trans-European cooperation, to unify the most suitable actors and to achieve critical mass.

As examples illustrating this are:

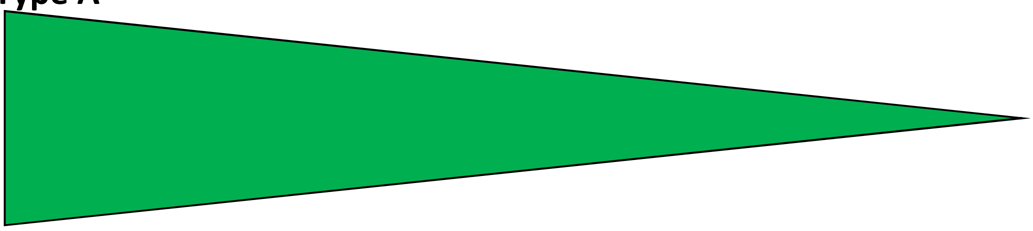
- For Industrial Biotechnology, the feedstock and/or the localization R&D facility determines the often decentralised location of the pilot/demo project
- For Nanotechnology or Nano-/Microelectronics the pilot (Pillar 2) has to be located close to the next step of the specific value chains being for example a device manufacturer or automotive manufacturers.
- Nevertheless, for certain other value chains and technologies and for Technological research (Pillar 1), a EU wide network of excellence is needed ,while the geographical proximity of the next step in the value chain might be a less critical issue

This slide has been taken from Working Group 2’s presentation as the themes expressed resonate very well with the Working Group 5 opinion on value chains.

Integrated KET Approach – value chain types:

Processing --→Consumer

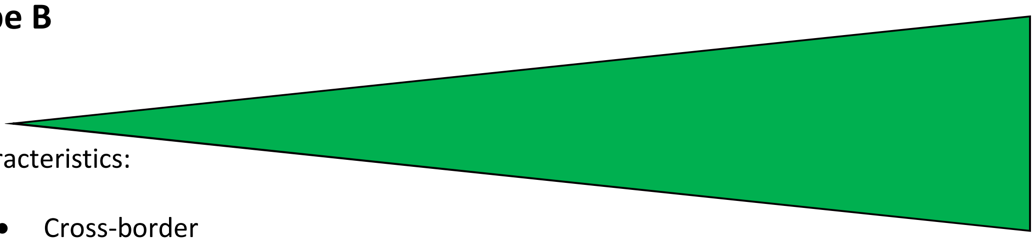
Type A



Characteristics:

- Cluster
- Financing needs 10^9 – 10^{10} €/ shorter payback
- Major needs at value chain end
- Value added at end

Type B



Characteristics:

- Cross-border
- Financing needs 10^9 – 10^{10} €/ shorter payback
- Major needs earlier in the value chain
- Value added more upfront