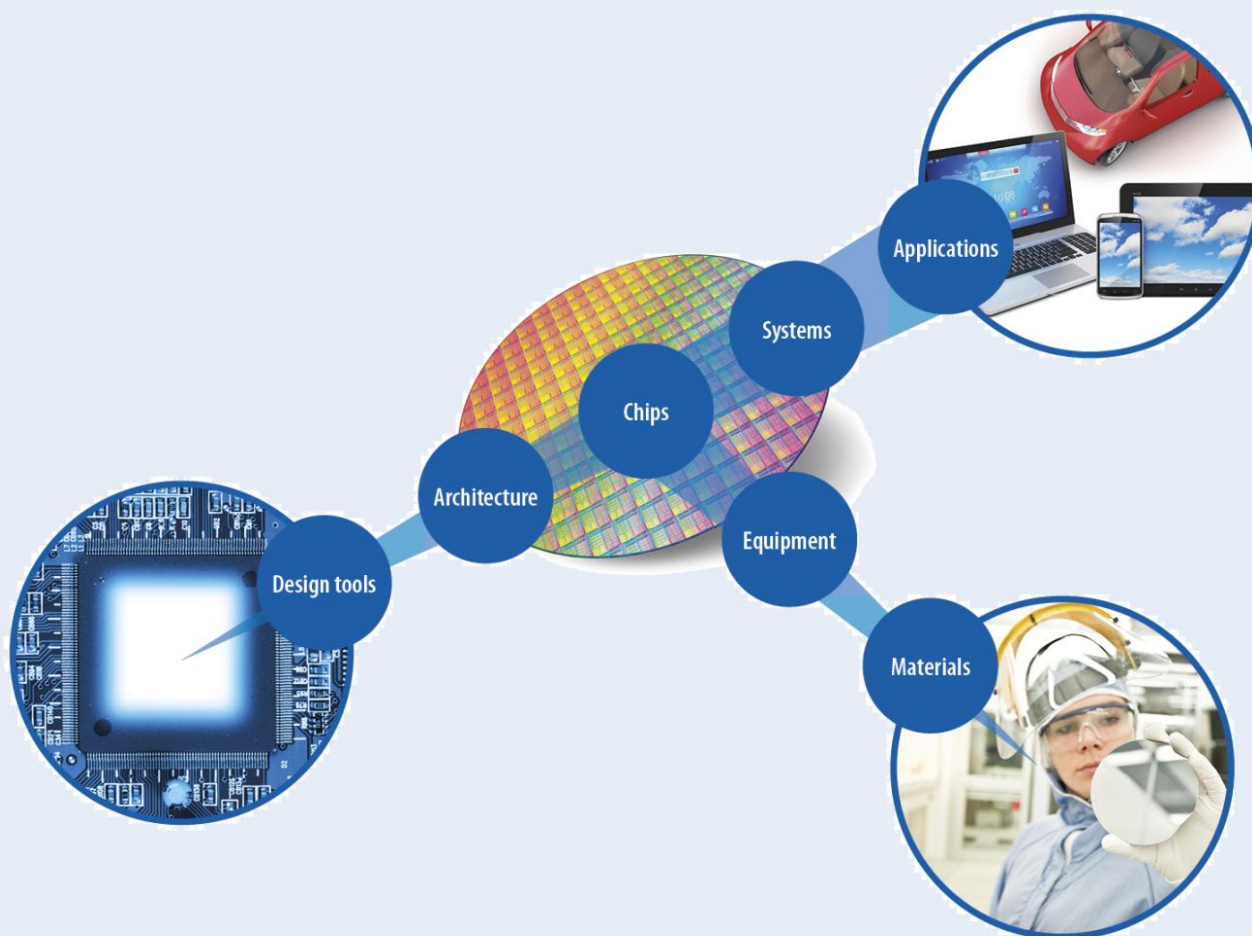




A European Industrial Strategic Roadmap for Micro- and Nano-Electronic Components and Systems

A report to Vice President Kroes by the
Electronic Leaders Group

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Date 30th January 2014

I. Executive Summary

Today, semiconductors and their value chains¹ underpin innovation and competitiveness in all major sectors of the economy. In Europe, the semiconductor ecosystem itself employs approximately 250,000 people directly. More than 800,000 people work on the integration of components into systems, applications and services across Europe, and more than 2,500,000 are employed in the complete components value chain. Overall, micro- and nano-electronic components and systems enable the generation of at least 10% of GDP in Europe and the world.²

To improve the future prospects of the industry and its related technologies and value chains in Europe, the Electronic Leaders Group (ELG) accepted the challenging goal launched in May 2013 by Neelie Kroes, Vice President of the European Commission (EC) – ***to double the economic value of the semiconductor component production in Europe by 2020-2025.***

To achieve growth requires competitiveness in new and existing markets. The ELG has identified three areas of opportunity for high demand growth which have a good fit with European strengths and skills:

1. Existing areas where Europe is strong and there is above average growth in the electronic content e.g. automotive, energy, industrial automation and security.
2. New high growth areas, in particular Internet of Things (IoT), where industry in Europe is well positioned to benefit from the development of anticipated "SmartX" markets.
3. Markets in the changing landscape of mobile convergence which constitute opportunities to be captured e.g. by maintaining leadership in the design of low power processors and growing leading edge semiconductor manufacturing.

The ELG with the help of the EC, has developed an action plan to reverse the decline in EU semiconductor production and target a doubling by value in the 2020-2025 timeframe. This is based on a two-pronged approach of demand-pull and supply-push:

- **Demand accelerators**
 - Launching a high profile initiative on "Smart Everything Everywhere" in order to ride the next Internet wave by integrating networked electronic components and systems in any type of product, artefact or goods. This will be done by setting up a number of excellence and competence centres, the establishment of zones of full scale testing of novel applications as well as lighthouse projects to deploy innovations in areas such as Autonomous Mobility and Smart Personal Companion.
- **Preparing and strengthening the supply chain**
 - Strengthening the chip industry in Europe by focusing on fuller utilisation, expansion and upgrading of existing fab capacities as well as potentially new facilities and new forms of cooperation in production. Future capacity will be aligned to anticipated demand growth.

¹ (ranging from materials and equipment to components design all the way to chip-manufacturing)

² Cf. The Joint Statement of European business organizations on the occasion of the 21st EU-Japan summit, 12. November 2013 (<http://pr.euractiv.com/pr/joint-statement-european-business-organisations-occasion-21st-eu-japan-summit-101452>)

- Building on its strong equipment and materials industry, Europe will continue to invest to prepare for the next generation of materials and equipment in order to support production on 300mm wafer and the transition to next-generation 450mm wafer.
- Creating an initiative on chip design and architectures aimed at strengthening the design and fabless industries and enabling them to cooperate with European partners. It will commence with specific measures to provide better access to manufacturing facilities for design SMEs and to support the development of multidisciplinary skills.
- Reinforce cooperation across the innovation eco-system and provide SMEs with easier access to Europe's world class research technology organisations.
- Support ground-breaking technology development that strengthens competence and knowledge in Europe and maintains industry at a leading edge.
- **This will be accompanied by**
 - Investments in training and education and initiatives to provide on the job up-skilling.
 - Initiatives on patents, business issues and reducing barriers to closer cooperation as well as standards, improvements and commonality in methodologies, and access to EDA tools especially for SMEs.

The action plan builds notably on the experiences gained in public-private-partnerships, such as the ENIAC Joint Technology Initiative that engaged more than €1.8 Billion of co-investments in pilot lines and pilot projects³ in 2012-13. Co-investments are therefore also planned for the next decade spanning from R&D&I to first production facilities in line with state aid rules. These can take the form, when appropriate, of Important Projects of Common European Interest. Part of that investment is to be done within the new ECSEL Joint Technology Initiative with a total planned budget of at least €5 Billion in the next seven years⁴.

³ €250M by the EU, €300M by the Member States and more than €1.2B by the private sector.

⁴ €1.2B from the EU, €1.2B from the Member States and at least €2.4B from industry to cover the whole value chain from components to embedded systems.

II. Introduction

On 23 May 2013, the European Commission announced an EU-wide strategy for micro and nano-electronic components and systems, with the objective to reverse the declining European share of this market, and to ensure that Europe makes the best of this technology to boost innovation, growth and jobs creation across the economy. The strategy highlights the main policy actions that should be undertaken. It refers to the vision document⁵ endorsed by the CEOs of the main companies in the sector indicating industry's willingness to invest and create jobs in Europe.

An Electronic Leaders Group (ELG) was set up in September 2013 to develop an industrial roadmap in cooperation with a wide Stakeholder Engagement Forum representing the main actors in Europe in the whole sector value chain. The present roadmap is the result of the work of this Group.

III. A clear target to steer efforts

During the 1990s, the European share of semiconductor production steadily increased to more than 15% of world production⁶. In the last decade, it has fallen back to below 10% due to several interrelated trends, including:

- The share of investment in Europe has decreased in semiconductor manufacturing;
- New fabs were increasingly built in Asia as the manufacturing of electronic products shifted to that region;
- Semiconductor companies increasingly moved to a fab-light business model for business reasons.

Whilst electronics has become increasingly powerful, it is predominantly embedded (i.e. hidden) and thus invisible to the consumer. Yet it has become the basis of innovation and value creation across the majority of sectors, products and services. This makes the chip design and manufacturing ecosystems, along with their supply chains, central to the health of Europe's economies.

Although the various electronics value chains do not have to be co-located, their close proximity does lead to greater opportunities for innovation and the development of multidisciplinary skills, with spin-off to other value chains throughout the economy. Moreover, electronics will be central to the sustainability and dependability of our societal fabric as health, energy and transport systems to security, education and leisure. Therefore, maintaining Europe as a key player in the creation and manufacture of electronic systems is essential for jobs, economic growth and for preserving strategic autonomy and security.

Figure 1 shows the electronic system value chain and its breakdown into sub-systems, components and their materials, along with the value and market share won by Europe. Virtual sub-systems and components (which may include a substantial software component) make a significant contribution, span the value chain more broadly, but are difficult to quantify directly because they do not

⁵ "Innovation for the Future of Europe: NANOELECTRONICS BEYOND 2020". CATRENE & AENEAS, November 2012.

⁶ EECA-ESIA based on WSTS, SEMI, HIS, Barcelona 29/11/2013

normally appear as items on the bill of materials, and are usually treated as amortised NRE (Non-Recurring Engineering) costs.

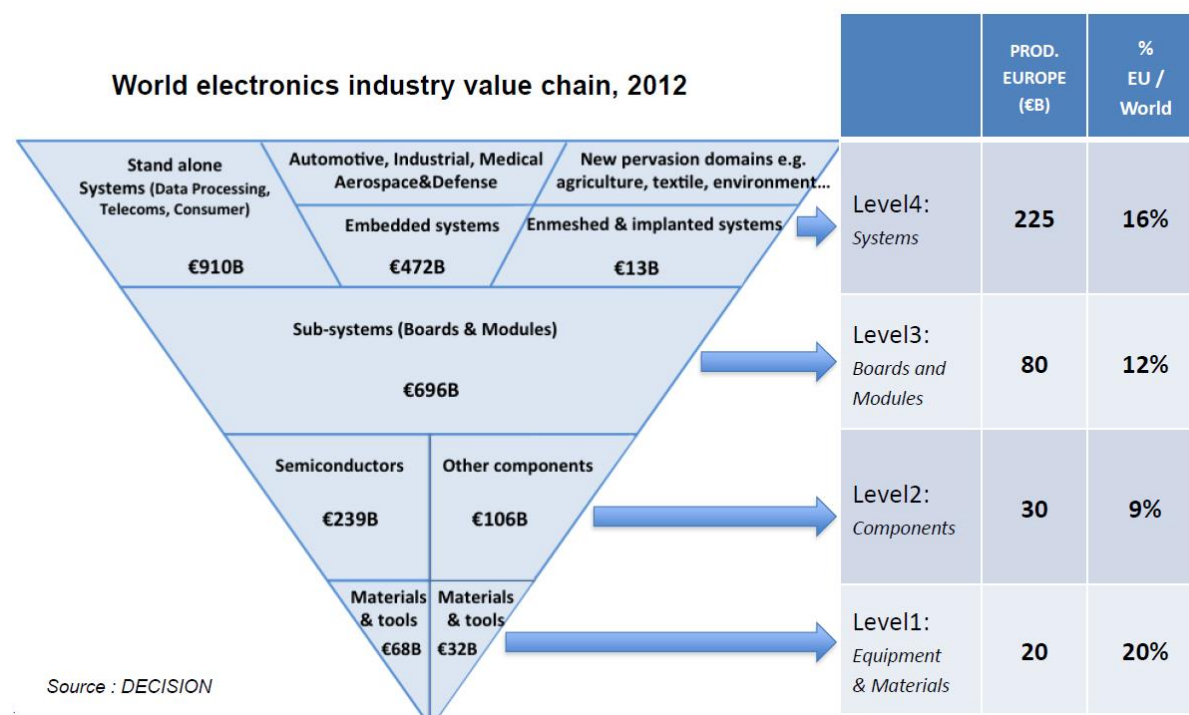


Figure 1: Europe in the electronics value chain

The industry in Europe has a 20% share at level 1 (equipment and materials); a 9% at level 2 (semiconductors and other components); a 12% at level 3 (subsystems) and a 16% share at level 4 (systems) with a significant share (~30%) in the embedded systems sub-sector – which is a current European strength.

The ELG accepts the challenging goal launched in May 2013 by Neelie Kroes, Vice President of the European Commission – **to double the economic value of the semiconductor component production in Europe by 2020-2025.**

Such an ambitious target can only be attained by addressing the whole value chain which links semiconductor production, upstream supply chains (material, equipment, design and architectures), downstream system integration as well as the complementary supply chains of component and IP providers. To achieve the 'doubling in Europe' objective will require increasing the value and quantity of semiconductor production, but also the demand for it.

Similarly, the target cannot be achieved by addressing existing markets alone. Therefore new markets need to be captured. For new markets, Europe's semiconductor component providers need to be well connected to the global electronic systems integrators, and the other component and sub-system providers in the electronic system value chain. Figure 2 shows the main relationships between the various parts of the value chain in the creation of electronic systems.

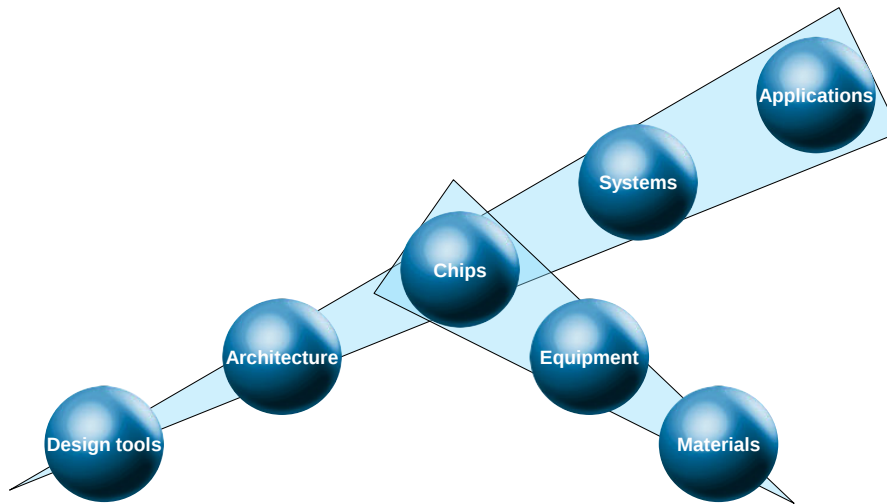


Figure 2: Semiconductors at the heart of the European value chain

Maximising the number, scope and integration of the European businesses involved in the global value chains of electronic systems will be beneficial overall to European competitiveness and its economy; a loss of European parts of global value chains will produce a “technology lag” slowing the ability to capitalise on innovations leading to new products and markets.

Today, European microelectronics employs 250,000 people with close to 2,500,000 people in its full value chain; it represents about 8% of the industrial jobs, and contributes 10% of European GDP⁷.

IV. Current Industry Situation

IV.1 Total market growth at 5-6% per year on average

Figure 3 shows that the worldwide demand for semiconductors continues to increase at a rate of 9% in volume and 5-6% in value.⁸

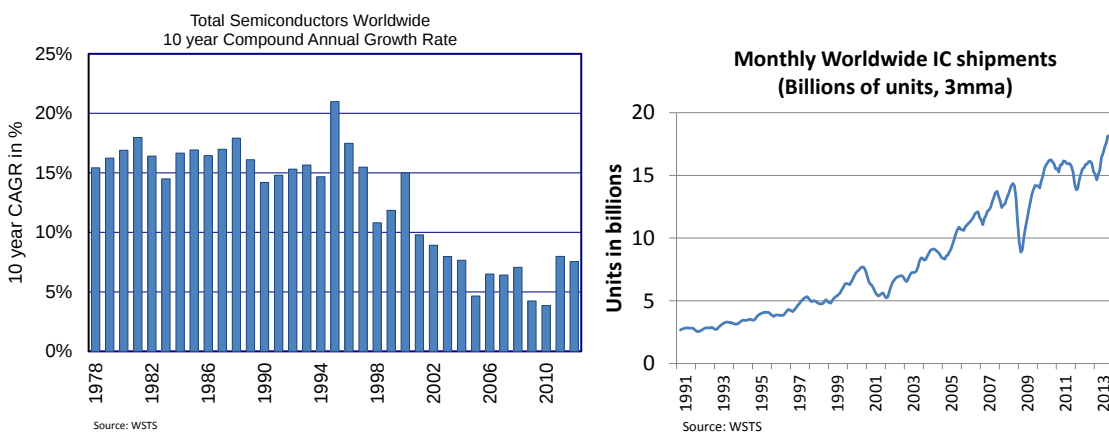


Figure 3: Semiconductor world market⁹

⁷ EU, IDC, Destatis, Roland Berger, as presented to ARTEMIS and ITEA2

⁸ Historically the growth over the last decade has dropped to 5-6% by value, but the current predictions for the next few years are lower e.g. 4.1% for 2014 and 3.4% for 2015.

⁹ EECA-ESIA after WSTS Barcelona 29/11/2013

IV.2 Despite strengths in vertical markets the share of production in Europe is declining

Semiconductor manufacturing in Europe is based in a large number of sites, though high volume manufacturing of leading edge technologies is centred on a few clusters (Figure 4). The annual output in equivalent 200mm wafer starts per months in Europe for the last three decades is shown in Figure 4 (inset). This shows a steady growth over two decades, but output peaked in 2005 and is now in decline.

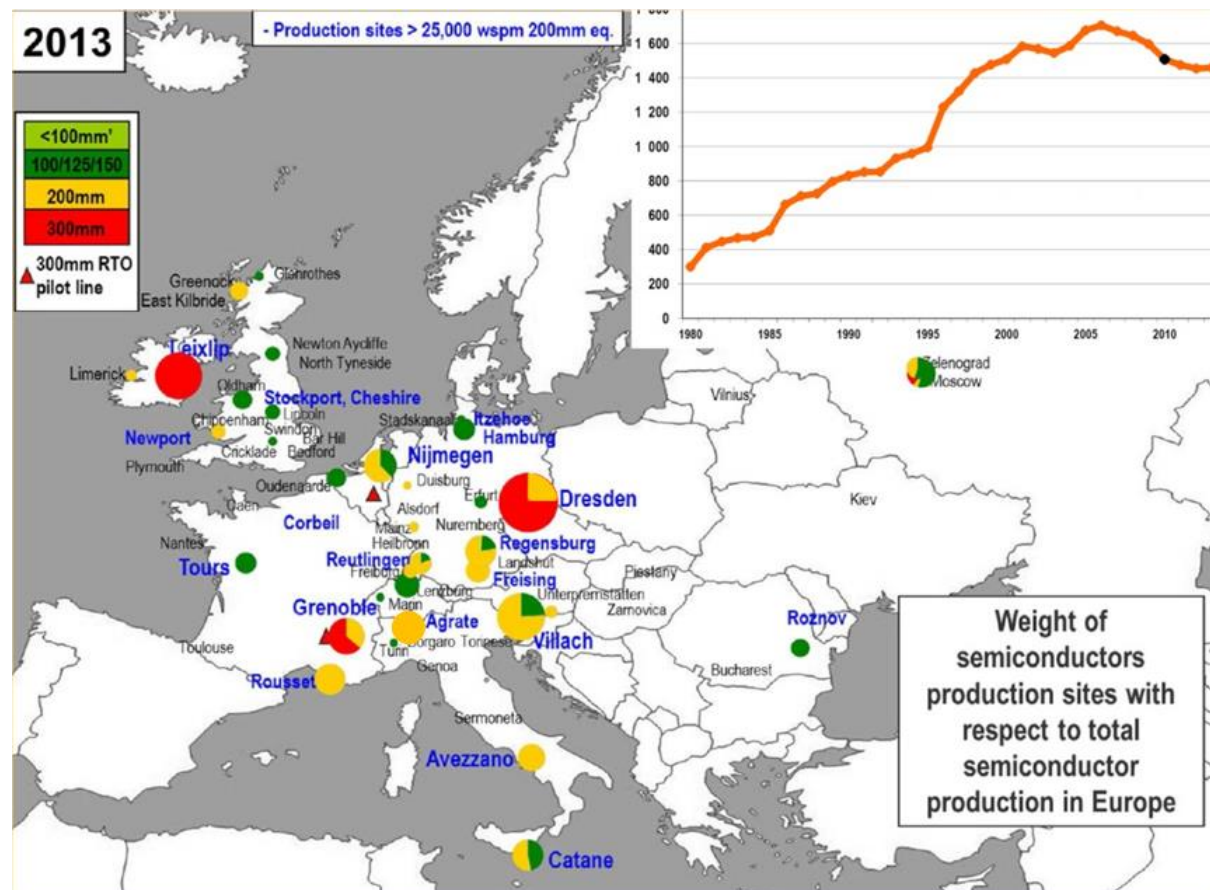


Figure 4: Snapshot of semiconductor manufacturing landscape in Europe in 2013; [inset – evolution of semiconductor manufacturing landscape in Europe from 1980 to 2013]. (Source: Gartner, Yole, SEMI)

Despite a decrease of its share in world production in the last five years, Japan remains the world number one producer of chips (measured by country of fab location) with more than 22% of world production (see figure 5). South Korea and Taiwan have grown as semiconductor powerhouses with 18% and 17% of world production respectively and increasing for South Korea. China and Singapore have seen the largest growth in the last five years. Whilst the USA has seen a significant decrease in production capacity down to 13 % in 2012 (USA based companies still have more than 50 % of world market, but a large part of the actual fabrication is done outside the USA). With a modest decline during these years, Europe is now just below 9%.

In terms of value generated from the whole supply chain including design, equipment, and material as well as from fabless and virtual components activities, Europe's share of value produced in 2012 is between 10 and 11% of world market as shown in Figure 1.

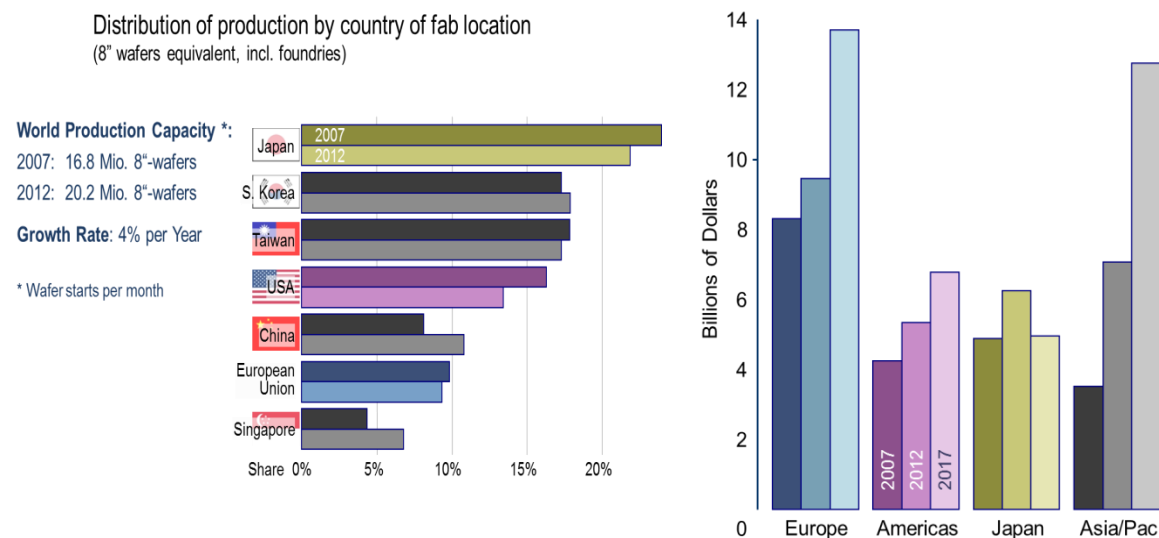


Figure 5: Distribution of production world wide

Figure 6: Share of Automotive Semiconductors 2007 /2012 /2017

Europe has strengths in vertically integrated markets, such as automotive (see figure 6), energy, security and smartcards, a leading position in new markets such as sensors, MEMS, is strong in virtual components and low power processors, and in the supply of equipment, materials and IP (Intellectual Property) into the value chain.

The key concern is that with vertically integrated supply chains (and sub-chains) becoming more important, it is necessary for all parts of the supply chains in Europe to be strong to ensure sustainable business in the region and thereby economic growth.

V. Future and Emerging Markets

V.1 Different market growth perspectives across sectors

Digital technology has been increasingly democratised; initially it was driven by the military, then by enterprises and now by individuals. But we now are poised at the start of a new wave where the cost and ease of connectivity has reached a point where anything can be connected to everything. The Internet of Things (IoT), with its underlying cyber physical components, promises to provide a new level of connectivity, intelligence and capability to all sectors. This will also create a significant potential for change in the nature and mix of products, but also in their creation, marketing and support.

Strong market drivers for this are, for example, automotive, e-health, and emerging areas such as Smart Homes, Smart Cities, security, CO₂ and energy reduction and intelligent transport systems. These align well with Europe's strengths identified in Section IV. Predominantly these vertical markets will be enabled by enterprises providing horizontal (cross-cutting) technologies and capabilities to the electronic systems integrators with the silicon vendors being pre-eminent. The opportunity for much of this to be drawn into Europe is real.

Table 1 shows the estimated growth for a number of new and emerging markets, led by immediacy. Together this represents about two thirds of the anticipated growth in semiconductor components over a 5 year period.

Table 1: 5 year revenue growth 2010-2015 €B (source: iSupply, McKinsey)

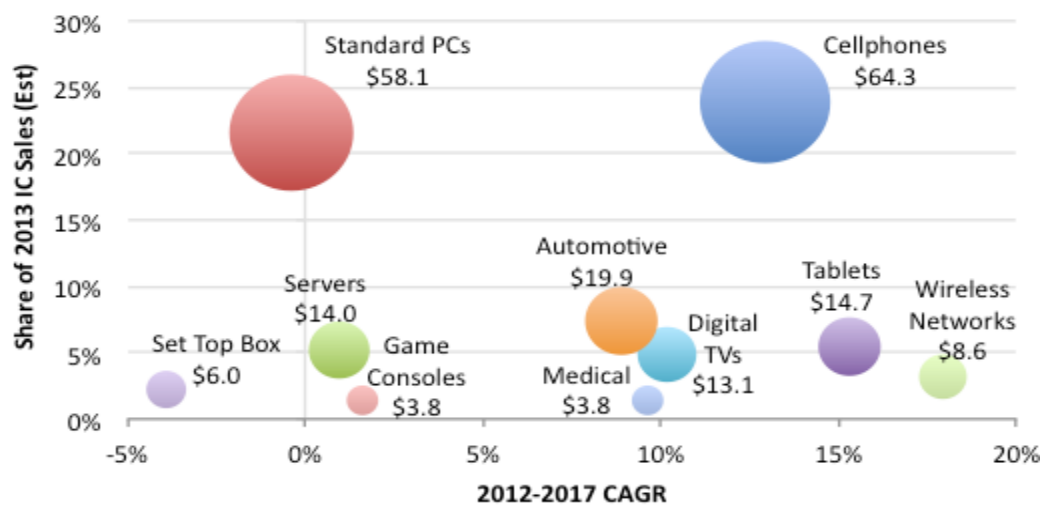
	Cloud Computing	Mobile convergence	*Immediacy	Next generation wireless	Security Standards	Energy Efficiency	Total
Memory (volatile)	-0.15	0.44	0.15	1.25	N/A	N/A	1.69
Memory (nonvolatile)	2.94	7.58	0.81	1.84	0.00	0.07	13.25
Micro-components	1.18	-0.15	4.71	1.47	0.88	1.40	9.49
Logic	0.59	2.87	2.58	3.97	0.00	0.07	10.08
Analog	-0.59	1.32	1.32	1.62	N/A	0.07	3.75
Discretes	0.07	1.03	0.44	0.66	N/A	0.15	2.36
Optical	0.15	1.84	1.69	1.32	N/A	2.21	7.21
Sensors	-0.07	0.52	0.07	0.59	N/A	0.15	1.25
Total	4.12	15.60	11.78	12.73	0.88	4.12	49.09

* Immediacy is smart health monitoring, RFID, real time, IoT etc

V.2 Market drivers

Mobile, wireless, Immediacy (Internet of Things, Smart objects etc) are driving market developments. Europe has strengths in micro components, logic and analogue, discretes, MEMS and sensors - their design, production, integration and support. When taken in conjunction with the target market sectors identified, and adding in next generation wireless where Europe also has technical strengths and could be in a position to lead, this represents a significant part of the opportunity for growth.

A complementary analysis is summarised in Figure 7, showing the projected growth rates and market sizes.



Source: IC Insights

Figure 7: Value of IC end use markets (\$B) and growth rates

A positive aspect is that Europe's recognised areas of strength are in the areas with highest growth potential. But whilst it is apparent that components for automotive have potential for above average growth, it is less obvious that providers into wireless and mobile convergence will also see good growth, as totally new market opportunities emerge - markets which cannot be tracked today, because they do not exist yet.

VI. Development of the Supply Side

Figure 8 shows the evolution of costs of a silicon CMOS production facility against technology nodes. It shows the steep increase in the cost of factories as technology moves. The elevated cost of doing this explains why less than 25 companies world-wide made the investment in the transition from 200mm to 300mm compared to 65 for the transition from 150mm to 200mm, as shown in figure 9.

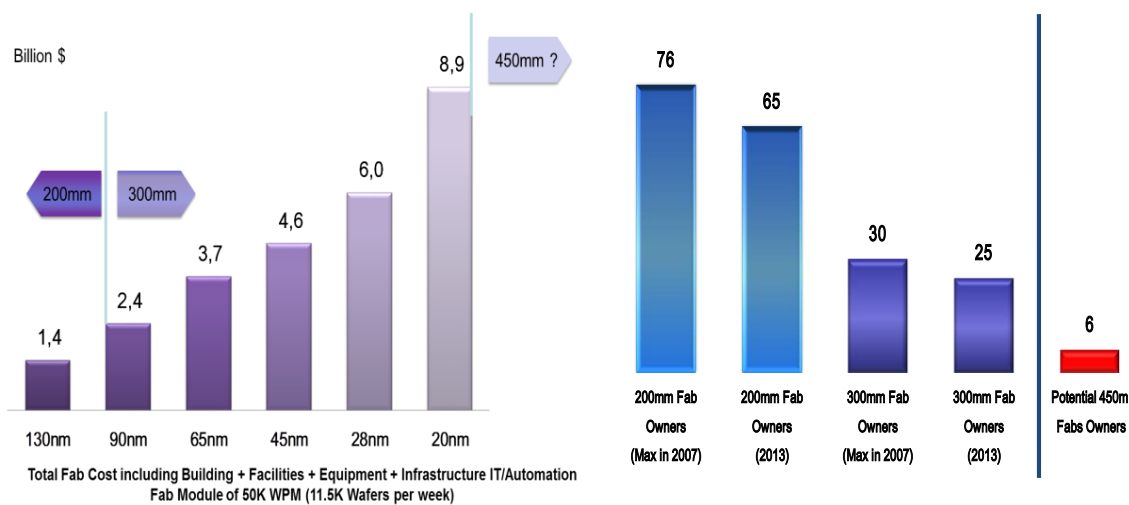


Figure 8: Total Fab cost

Figure 9: Companies with 200mm and 300mm fabs (IC Insights 2/13)

The continued reduction of unit costs requires a move to smaller geometry processes and eventually to 450mm wafer size. As a result, a very limited number of companies will be in the position to make the necessary investments. Thus the competition will be intense, and Europe will need to have compelling incentives and other assets, such as a strong ecosystem and a highly educated workforce.

It is worth remembering that even to maintain the current position, future investments in Europe will have to match those in the rest of the world; to extend the position will require further investments in line with expected demand.

In order to get some estimate of the **level of investments** needed to double value from semiconductors in Europe by fab capacity alone, an economic model based on average revenues per fab and a mix of technology indicates that capacity equivalent to 250,000 wafers/month (300mm equivalent) would need to be added – requiring tens of billions of Euros (see figure 8). This provides an indication of the sheer size of the challenge. Thus, whilst increasing Europe's fab capacity will clearly form a part of delivering of the doubling objective by 2020-2025, it cannot be achieved by that factor alone.

Within the lifetime of a fab, there is continual investment; shrinks, technology modifications etc. improve yields and thus the value of the output continually and significantly, providing an increase in capacity.

VII. What needs to be done and what can be done?

VII.1 A combined market-pull-supply-drive strategy to optimise impact

Competitive manufacturing capabilities in Europe are needed to serve global markets. A strong local demand helps to start a local ecosystem, and leads to productive relationships with customers. In this way, innovations arise faster and are transformed more quickly to commercial successes; in turn these bring rapid benefits to the rest of the economy and society. Similarly, early adoption provides a competitive advantage in addressing global markets.

It is therefore essential that the roadmap for electronics in Europe addresses both the way for Europe to lead the demand for innovative components and systems for the benefit of its citizens and businesses as well as the way to prepare for a strong supply industry to meet the emerging and growing demands from within and outside of Europe.

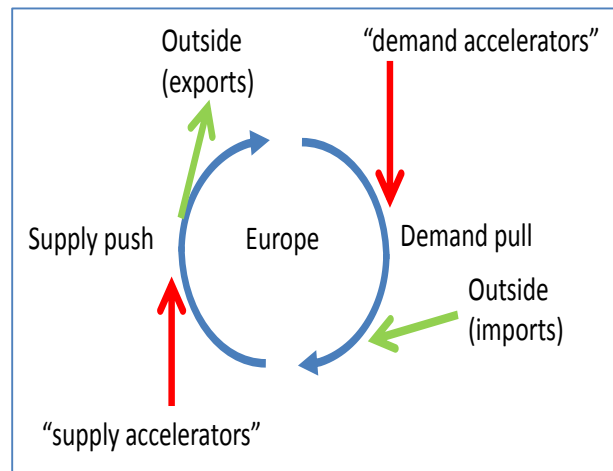


Figure 10: Demand/supply economic circle

The supply push and demand pull sides complement each other (see fig. 10). “Accelerators” on the demand and supply sides increase economic activity. Obviously, there are also “inhibitors”, such as a lack of standards and a skills shortage, on both the demand and supply sides and actions to overcome these are required.

It is vital to the whole of Europe’s society and economy that Europe maintains and extends its technical strengths, to be in position to effectively exploit the next waves of innovations enabled by electronic systems. With more than 30% of the world market, Europe is one of the largest markets for systems, and a concerted European vision, coupled with coordination, will enable its industry to take advantage of these opportunities and a European lead market will drive demand worldwide.

Key market opportunities for Europe are split into three areas:

1. Existing system areas where Europe is strong and there is growth above the average¹⁰ in the electronic content e.g. automotive, energy and industrial automation – the target is to double the current production value by 2020-2025.
2. Emerging system areas where Europe has strong competences and advantages, such as Internet of Things (IoT), and the development of SmartX including smart homes, intelligent

¹⁰ The historical growth rate for the semiconductor industry over the last decade has dropped to 5-6%; the prediction for future growth for the next few years is lower.

transport, smart cities, e-health, security standards, energy efficiency, etc.) – the target is to capture 60% of this market.

3. The changing landscape of mobile convergence where there is high risk/high reward – target to win a significant portion of the growth in mobile and wireless, where leading edge semiconductor manufacturing is driven by More Moore. Combined with advances in More than Moore, the target is to reach 20% of its projected growth.

Based on Europe having 9% of the worldwide market for silicon in 2013 (\$27B) and the worldwide market projected to be \$400B in 2020, a target of 18% (doubling from 9%) is \$72B of revenue by 2020. This is measurable, but it is not the whole story; a similar level of growth will be required in the system related value-chains (the demand side) to enable it to be achieved.

To achieve this, Europe would have to win most of the anticipated growth in any one of these areas to reach the required target growth. Focusing on any single area is unlikely to deliver the overall growth objective, so a portfolio approach is a safer strategy.

VII.2 Preparing the supply – capacity building.

The cost of the next generation fabs is so large that there will be a very limited number worldwide and few companies will have the ability to fund such an undertaking by themselves. As indicated in Section VI tens of billions of euros would be needed to be invested in fabs to double the value of silicon manufactured in Europe.

As direct investment at that scale is unlikely, new business models may be required. One potential scheme might be co-investments, including where customers may invest in their own wafer suppliers to alleviate potential issues. Another could be the collaborative use of existing or new facilities – which may need to serve several companies to use the capacity to the full.

The economics of chip production is such that fabs need to be operated close to full capacity to be viable. So close alliances within existing fabs going beyond the established concepts of IDM (Integrated Device Manufacturer), fab-less, fab-light, IP-provider, suppliers and foundry, may be the catalyst for this. The principle of closer alliances applies throughout the value-chain where capital intensity or other market scarcity represents a bottleneck or limitation. Figure 11 shows the range of manufacturing models and the trade-offs between investment, security of supply and control.

A different situation exists in the equipment and material area of the value chain; in some areas European companies are in leading positions. This segment is directly or indirectly responsible for an estimated 100,000 high level jobs in Europe, and feeds on an extensive network of knowledge from institutes and universities. This segment has a very high added value while it mainly sells its products in Asia, and many European SME's contribute to the output.

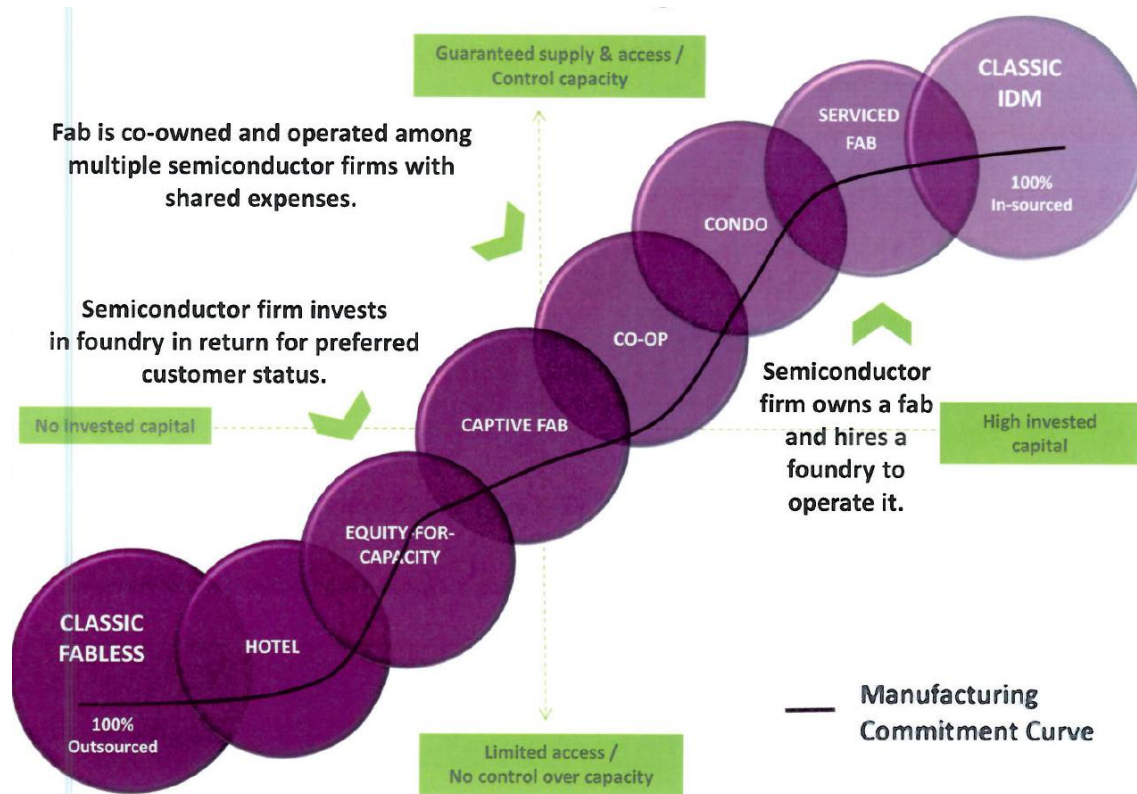


Figure 11: Alternative Manufacturing Models (Source: B.Silver, SEMI-ISS Europe 2013)

Europe must also build on its complementary strength in material, equipment, chip design and fabless activities, and system integration. 20% of the production of equipment and material is currently done in Europe and there is growth potential. Leadership and strengths of this network is an opportunity not only for this sector growth but to leverage the competitiveness of the EU downstream value chain, for example:

- Advanced materials provide a path for breakthroughs and strong differentiation in silicon applications (Si-based, SOI, strain Si)
- Advanced equipment and technologies for high end digital application (EUV)
- Large band gap materials (III-V, GaN, SiC) and related equipment are the foundation of cutting edge technologies for efficient energy; this is a huge opportunity for More than Moore applications and societal challenges such as power, electric and hybrid cars, for energy management and savings, for efficient and smart lighting, low consumption radiofrequency components for mobile
- Equipment and materials suppliers are major contributors to the value chain and form an important part of the ecosystem to attracting and support new manufacturing capacity.
- In view of the long term 450mm challenge, leading equipment and materials providers must maintain their R&D&I efforts to be ready when the global need emerges.

VII.3 Preparing the supply – differentiating factors

For Europe's component businesses (virtual and physical) to be strong, they must build on their strengths and utilise the strengths of Europe's centres of excellence and RTOs¹¹. They must also build world class products which can be delivered internationally, whilst culturing local networks to benefit from their proximity. They also have the opportunity to form enterprises to address higher-value chains and sub-chains in the system products.

By working in closer cooperation and connecting the parts of the value chain (partnering), development can be made concurrent, lowering the risk, reducing time to market and improving the chances of success. European enterprises and national authorities need to identify and build value chains (and sub-chains) to be more than the sum of the parts. It will:

- Take strengths and become world pre-eminent in many and larger parts of the electronic system value-chains.
- Ensure world markets can be accessed as easily as possible.
- Help businesses see and seize the global market opportunities for their skills.

VIII. Delivering with concrete actions and commitments

Actions are planned to follow three main tracks – accelerating demand, providing supply and production capabilities and capacity across the supply chain, and enhancing the framework and infrastructure.

Track 1: Demand accelerators

In addition to pursuing and reinforcing initiatives already launched to maintain Europe's lead in important market sectors for electronics such as the European Green Vehicle Initiative for the automotive sector, Factories of the Future or the Smart Cities and Healthy Ageing initiatives, the ELG recommends two main initiatives to be started in 2014:

1. T1.1 Leadership in innovation in emerging markets

- **T1.1.1 A high profile initiative on "Smart Everything Everywhere"** that enables Europe to take the lead in IoT development world-wide. The main goal is to step up Europe's innovation capacity by the development of technologies and methodologies to support the integration of networking and intelligence into any type of end product, artefact or goods. This will provide Europe with reinforced means to significantly raise its competitive edge across the economy and to address its key societal challenges. The initiative is based around the following concrete actions:
- **T1.1.2 Set up a number of excellence and competence centres** to be the coordination heart for business, industry and academic activities in the field of SmartX/IoT. Each will establish its own top class R&D&I capabilities, and will be charged with inclusion of other research centres within its region, and with coordination with the other excellence and competence centres, to form a virtual excellence centre to span Europe. They will cover skills extending from chip design to embedded software and cyber physical systems and offer a one stop

¹¹ Research and Technology Organisations

shop for low-tech or non ICT industries wishing to embrace the opportunities that SmartX/IoT provides. Financial support should come from H2020 including the ECSEL JTI as well as from national and regional R&D&I budgets including from the European Structural funds.

- **T1.1.3 Establish zones of full scale testing of new and emerging discoveries in SmartX/IoT fields.** These go beyond simple labelling but include a comprehensive investment in equipping and upgrading infrastructures, homes, offices, transport systems, schools, hospitals, factories, etc. They require public-private partnerships involving the ICT supply chain and industries like engineering, energy, construction, health, tourism, financial, etc. By 2017, 5 city centres or large public locations will deliver an agreed new and challenging service based on SmartX/IoT technologies. This will be achieved by building on the existing smart cities European Innovation Partnership and the Energy Efficient building initiatives in Europe.
- 2. **T1.2 Launching a set of "lighthouse projects" to develop, test and deploy innovations in essential areas of key importance to Europe.** Europe must reinforce its competitive edges gained by developing and making the best use of electronics in areas like automotive, energy and security. Complementing initiatives such as those already launched for electric vehicles or smart grids, ambitious innovative initiatives in areas like Autonomous Mobility, Smart Personal Companion, etc. should be launched. These will be EU-wide initiatives that help focus R&D&I to be supported as part of H2020 and ECSEL JTI and at national or regional level. The lighthouse projects must include regulatory and other measures to unlock any barrier and facilitate large scale deployment. It is essential to involve the whole value chain in these projects, mainly user industries and end users, as well as legal, ethical and financial stakeholders.
- 3. **T1.3 Win a significant portion of the growth in the largest sector, mobility.**
 - T1.3.1 Identify the strength of the EU ecosystem in solutions for mobile devices and strengthen the collaboration across the value chain to consolidate and build on this
 - T1.3.2 Develop EU-wide initiatives that help focus R&D&I to be supported as part of H2020 and ECSEL and at national or regional level.

Track 2: Preparing the supply, raising production capacity and capability across the value chain

A four pillar plan is proposed:

1. T2.1 New silicon production capability and capacity.

To double production by value would require the capacity equivalent to the volume of 70,000 wafer starts per month (300mm equivalent) to be added every two years. However, capacity must be matched to demand. The existing markets in which Europe has strengths have a mixture of technology requirements, and new and emerging markets also imply a mixture of requirements. In addition, there is a need to provide better access for SMEs and early production.

Building on ENIAC achievements:

- In 2012 investments in five pilot lines and pilot projects included €115M from FP7, €130M from the Member States (MSs) including regions and €500M from industry.
- In 2013, 9 pilot lines and pilot projects are supported including extension of the ones launched in 2012, with €165M from FP7, €160M from Member States and €750M from industry.

- T2.1.1 A first focus for doubling production by value is to make full use of, and expand existing production facilities in response to a higher demand for European manufactured silicon. As demand grows, spare capacity will be utilised and investments in new, and expansion of existing, production capacities will be required. At that time, the investment in new production facilities within existing fabs may be shared. The mix of products emerging in new markets will dictate the technology requirements, which in turn provide the specification of the fabs required to be constructed in subsequent years. They will provide the business justification for their investment. A step increase in demand is envisaged for low power high performing components, mobile, sensors or energy related markets; options such as multi-platform and multi-technology solutions may be one of the ways to meet this demand. These developments will be catered for by the most appropriate fab investments – where cost effective extensions or upgrades to existing facilities may provide a faster means of matching the supply to the demand.
- T2.1.2 Taking into account the leverage that micro- and nano-electronics production has on the whole economy, the public side needs to provide a focused package of incentives to share the risk with the private sector to assist in the accelerated growth required to reach the doubling objective. Independently of this, the public authorities will have to make significant efforts, at the scale which is competitive with worldwide practice, to expand existing and attract new investments to Europe. Europe has much to offer - the proximity of state of the art knowledge on IC manufacturing, a wealth of creative and technological knowledge, and last, but not least, stable ground¹².
- T2.1.3 Building on its assets, including its strong equipment and materials industry, Europe will continue to invest to prepare for the next generation of production materials and equipment for diversified needs including production in 300mm and the transition to 450mm. It will be ready to host new investments as markets develop and technology progresses in the coming decade.

Investments will also need to cover the whole system supply chain from material and equipment to design, architectures and fabrication, including physical and virtual components and their technologies, but also the opportunities and needs of the large SME communities.

New forms of public support

Building on successes in co-investments in public-private partnerships such as the ENIAC JTI, public incentives will have to include support to R&D, support to pilot lines and support to first innovative production facilities as well as incentives in line with state aid rules. Part of the public financing has to come through a focused package, **preferably as Important Projects of Common European Interest (IPCEI)** involving EU support through H2020 (ECSEL for R&D&I including pilot lines), structural funds (for investments in first production), and regional and national investments as matching funds (both within ECSEL and structural funds). Total public investment in such a package will need to exceed one billion euro to be competitive with other regions worldwide.

¹² Many fabs elsewhere are located in areas prone to unpredictable natural conditions – typhoons, tsunami, earthquakes etc.

Additionally, the EU will work to encourage the development of de-facto standards (eventually leading to formal standards) where such a lack might inhibit or slow the creation or adoption of new technologies and/or systems in Europe.

2. T2.2 An Ecosystem Initiative

To complement this, Europe will work on reinforcing its electronics design industries and fabless semiconductor companies including those involved in the development of virtual components applicable to end systems.

- Starting on this path, an initiative on design focusing on SMEs and mid-size companies that are extremely competitive in Europe today will be prepared starting in 2014 with support from H2020 and possibly within ECSEL. This initiative will aim at opening new opportunities and involving the user industry at large to develop and strengthen links to make innovative ideas emerge. More than capital investments, what counts here is the development of the right and multidisciplinary skills. Focus will be on tightening the links between design and manufacturing in Europe.

3. T2.3 Reinforcing cooperation across the innovation eco-system

Research underpins the technologies and methods which are used by businesses throughout the value-chains of electronic systems. Businesses use this knowledge to create more efficient, higher quality, more capable, more cost-effective and more globally competitive products; closer cooperation in R&D&I thus contributes directly to global competitiveness.

- T2.3.1 Europe is recognised to have the world's best public research and technology centres in micro and nano-electronics components and systems. This is a key asset to build on. These centres form the core of regional industrial clusters that attract private investment and skills from all over the world. It is essential to maintain their level of excellence and build on it to strengthen competitiveness. By specialising and cooperating these centres are and continue to be robust engines of innovation in the sector.
- T2.3.2 The ELG recommends that the cooperation is reinforced between the main research and technology centres (e.g. LETI, IMEC, FhG, VTT, Tyndall), the independent expertise existing in universities all over Europe and along the whole application ecosystem. Furthermore, it is recommended that SMEs in particular should have easy access to Regional Technology Organisations (RTOs) to encourage rapid transfer from idea to product. This will help develop new business models to deal with increased digitalisation and globalisation and the closer cooperation required to have integrated supply/value chains.
- T2.3.3 Reinforce the supply chain eco-system and synergy with equipment and materials, use the innovation and differentiation brought to leverage European competitiveness. Strengthen the SME participation in the supply chain network.

4. T2.4 Actions for a sustainable future

To contribute to market share in 2020, the technologies have to be here today, but guided research for production beyond 2020 is also needed. Candidate technologies/development tracks include:

- Examples expected to see an impact on exploitation before 2020 – very low power technologies and methodologies, high performing low power digital technology based on SOI, photonics integration, 3D / multilayer silicon, language, compiler, debug chains for highly parallel systems, reuse and legacy, new non-volatile memory technologies
- Examples expected to see first impact on exploitation after 2020 - Organic materials, organic semiconductors, Gallium Nitride, reliable systems on unreliable components
- T2.4.1 Some of these technologies have already been in progress for a long time, whilst others have seen mainstream applications emerge very rapidly e.g. in lighting, wireless base stations, or user interfaces, which development is critical for their future success and widespread. Organic semiconductors may have good potential in the areas of IoT and eHealth. Switches could move into the optical domain, and there may be advances in III-V technologies.

Track 3: Enhanced Framework and Infrastructure

Standards, improvements and commonality in methodologies, access to EDA tools, access to High Performance Computing (for modelling, simulation and verification) are necessary to enable the closer cooperation that vertically integrated supply chains require. All businesses and SMEs in particular, need to have access to interoperable tools and conform to the same standards as their customers in the value chain, to enable them to cooperate in the ecosystem.

As well as specific actions covering R&D and technical advances, complementary activities are required to support the development and strengthening of the ecosystem including:

- T3.1 Investment in people is a critical activity - the pool of relevant skills has to be increased. Develop a through-life education ethos for engineering, with formal and informal methods. Analyse the European value chain to better shape industrial and governmental policies and target support at the weak points in the value chain.
- T3.2 Support for patenting, export control, standards, WTO regulations and counterfeit - barriers to closer cooperation.
- T3.3 Assisting start-ups, and mid-sized industries to grow; businesses to adopt best-practice methods and procedures applicable to their global customer-base.
- T3.4 The Internet and ICT are necessary for effective communication and business. For the growing area of IoT, national and international infrastructure connections must be resilient and secure, and able to keep pace with the continually escalating growth.

Europe will be established as having the full value chain for the targeted markets and market sub-segments, and thus be attractive as for a focus for global inward investment for these markets.

IX. Action plan – Timetable

Matching technology developments, market drivers and capacity building is extremely challenging, and so a clear and effective means of monitoring progress and adjusting the direction of focus and developments during the implementation of the strategy will be required.

Action	Ownership	Start	End
Track 1: Demand accelerators			
T1.1. Leadership in innovation in emerging market segments Focus H2020/ECSEL on identified markets and notably IoT/SmartX		2014	2020
T1.1.1a Elaborate a “smart everything everywhere” strategy	Industry with relevant stakeholders	2014	2015
T1.1.1b Launch a policy initiative on "smart everything everywhere"	EC	2015	2016
T1.1.2 First call on excellence and competence centres in Smart X/IoT in H2020	H2020/ECSEL	2014	2020
T1.1.3 Calls on zones of full scale testing of Smart X/IoT technologies in H2020/ECSEL (to be followed by subsequent calls in H2020 and/or ECSEL)	H2020/ECSEL	2015	2020
T1.2. Launch of lighthouse projects in areas of European strengths Focus on ground breaking projects in H2020/ECSEL		2014	2020
Launch of first two initiatives e.g. autonomous mobility, smart personal companion or 2020 factories	ECSEL/H2020	2014-15	2020
T1.3. Win a significant portion of the growth in the largest sector, mobility			
T1.3.1 Identify strength of the EU ecosystem in solutions for mobile devices	Industry with relevant stakeholders	2014	2015
T1.3.2 Support of targeted actions in H2020/ECSEL	H2020/ECSEL	2015	2020
Track 2: Supply and production capabilities and capacity across the value chain			
T2.1. New silicon production capacity and capability			
T2.1.1 Extend the European supply by extending existing fabs to match capacity to demand	Industry/EC/Member States & Regions	2016-17	
T2.1.1 Evaluate and, if necessary, build new multiplatform/multi-technology fabs to match capacity to demand	Industry/EC/Member States & Regions	2016-2019	
T2.1.2 Maintain and attract new investment in Europe through public incentives covering R&D&I to first production (using the IPCEI mechanism)	EC/Member States & Regions		
T2.1.3 Continue to lead the development of manufacturing tools and materials for diversified needs including 300mm and the transition to 450mm.	Industry/Member States & Regions/EC support	2016-17	
T2.2. An Ecosystem initiative			
Develop design capability of and in SMEs and mid-size companies possibly through support in H2020/ECSEL	Industry – in particular SME's	2014	
Support the fabless sector to improve EU innovation in components		2014	
T2.3. Reinforcing cooperation across the innovation eco-system			
T2.3.1 Reinforced coordination between the main RTOs, universities across the eco-system	RTOs and universities	2014	

T2.3.2 Easy and affordable access of SMEs to existing technological competences	RTOs with support from EC/Member States & Regions	2014	
T2.3.3 Reinforce the supply chain eco-system and synergy with equipment and materials technologies to leverage European competitiveness; strengthen the SME participation in the supply chain network.	Equipment and materials industry		
T2.4. Actions for a sustainable future Support to new technologies			
T2.4.1 Identify technology developments enabling markets for the longer term	Relevant roadmapping initiatives such as ENI2	2014	2016
T2.4.1 Include the support to these technology developments in H2020 and/or ECSEL and/or EUREKA and/or national level	Relevant support programmes	2015	2020
Track 3: Enhanced framework and infrastructure			
T3.1 Skills development; develop policies to address other weaknesses	EC/Member States & Regions and industry with the strong involvement of academia	2014	2020
T3.2 Support to a better regulatory environment including patenting, export control, standards, WTO regulations and counterfeit	EC with input from industry including through relevant associations	2014	2020
T3.3 Support to the growth of start-ups and mid-sized industries	EC/Member States/EIB/Venture Capital	2014	2020
T3.4 Ensure secure and effective internet, especially for IoT	Member States & Regions/EC	2014	

X. Conclusion

An ambitious plan has been set out for a fast moving industry that is the driver of a significant part of Europe's industrially generated wealth. The target of a doubling of the economic value of the semiconductor component production in Europe by 2020-2025 is extremely ambitious. Given that it has to be tied to market demand, and there is a significant lead time in building capacity, this target is achievable in the 2020-2025 timeframe. With a clear ambition, the collaboration, focus and rate of progress will turn from a declining share to an improving and greater share.

The European semiconductor industries and the associated electronic system community, announce their immediate intent to work together with the support of the EC and Member States and the Regions to deliver a real growth of market share for Europe in this area.

Annex 1 – List of ELG members

- Ben Verwaayen, Chairman
- André-Jacques Auberton-Hervé, CEO of SOITEC
- Carlo Bozotti, CEO of STMicroelectronics International NV
- Rick Clemmer, CEO of NXP
- Hubert Lakner, Chairman of the Board of Directors of the Fraunhofer Group Microelectronics
- Mike Muller, CTO of ARM Ltd
- Reinhard Ploss, CEO of Infineon
- Eamonn Sinnott, Intel Vice President Technology & Manufacturing Group and General Manager Intel Ireland
- Jean Therme, Director of Technological Research of CEA
- Luc van den Hove, CEO of imec
- Peter Wennink, CEO of ASML
- Rutger Wijburg, CEO of Globalfoundries Dresden

Annex 2 – List of ELG sherpas

- Patrick Bressler, Fraunhofer Group Microelectronics
- Gabriel Crean, CEA
- Jens Drews, Globalfoundries Dresden
- Rob Hartman, ASML
- Leonard Hobbs, Intel Ireland
- Roger de Keersmaecker, imec
- Nelly Kernevez, SOITEC
- Norbert Lehner, Infineon
- Ian Philips, ARM Ltd
- Thierry Tingaud, STMicroelectronics International NV
- Fred van Roosmalen, NXP