European Commission

Study on the Electronics Ecosystem

OVERVIEW, DEVELOPMENTS AND EUROPE'S POSITION IN THE WORLD

FINAL REPORT

A study prepared for the European Commission
DG Communications Networks, Content & Technology
by:

DECISION ETUDES & CONSEIL   CARSA

Digital Single Market

This study was carried out for the European Commission by

Decision SARL

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Abstract

This study presents the situation of the electronic value-chain (end-user electronic equipment & systems, electronic components, materials & tools…), in the world in 2017 and describes the position of the EU in terms of activity, production, main R&D and industrial players, value-chain specialization and the evolution of Europe's position since 2010.

The study describes the evolution of the production of electronics in value (euros) for all end-user sectors: Aerospace - Defense - Security, Automotive, Industrial & Medical, Health & Care, Telecommunications, Data Processing, Audio & Video and Home Appliance. Data are provided for all regions: North America, Europe, China, Japan, Other Asia/Pacific, Rest of the World (RoW) and for each year from 2010 to 2017, with forecasts up to 2022.

In many cases, the production and market of end-user platforms (cars, aircraft, defense systems, robots, industrial machinery, medical systems, etc.) are also detailed. In a broad sense of the concept, these end-user platforms are increasingly Cyber Physical Systems, that is embedded Intelligent ICT systems that make products smarter, more interconnected, interdependent, collaborative and autonomous. They provide computing and communication, monitoring and control of physical components and processes in various applications.

This study analyses the complex relations between electronic systems and Micro and Nano Electronics (MNE) value chains among the different segments (automotive, aerospace, etc.), and the purchases of microelectronics components inside and outside the EU.

In the conclusion, this study provides recommendations to support the European MNE value chain.

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- Pascal Fernandez, Vice President Global and Strategic Accounts at AVNET
- Stefan Finkbeiner, CEO Bosch Sensortec GmbH and Chairman of EPoSS
- Joost van Hees, Director Strategic Technology of ASML
- Christelle Heydemann, CEO France of Schneider Electrics
- Alain Jarre, CEO of RECIF
- Yves Jigase, Head of Programmes of ECSEL
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- Emmanuel Sabonnadière, CEO of CEA-Leti
- Roberto Zafalon, Board Member of ARTEMIS and EU Technology Programmes of STMicroelectronics

EXECUTIVE SUMMARY

Objective & Methodology

This study provides an overview of the industrial situation of the electronic value chain from Micro and Nano Electronics (MNE), to end-user electronic systems and Europe's position in the World.

End-user electronic systems are segmented in:

- Professional / Embedded systems: Automotive, Industrial & Robotics, Aerospace/Defense/Security and Health & Care;
- Consumer / Stand-alone systems: Telecommunications, PC & data processing, Audio & Video and Home Appliances.

This study defines and describes the different steps of the global electronic value chain and in particular the semiconductor value chain (I).

This study collected statistics at an international level and data were constructed on the World industrial base (II), with a focus on the European industrial base. Databases have been utilized covering all the end-user electronic systems, electronic boards, MNE electronics (in particular for semiconductors) and finally for materials, tools and equipment for semiconductors for the period 2010 to 2017, with forecasts until 2022.

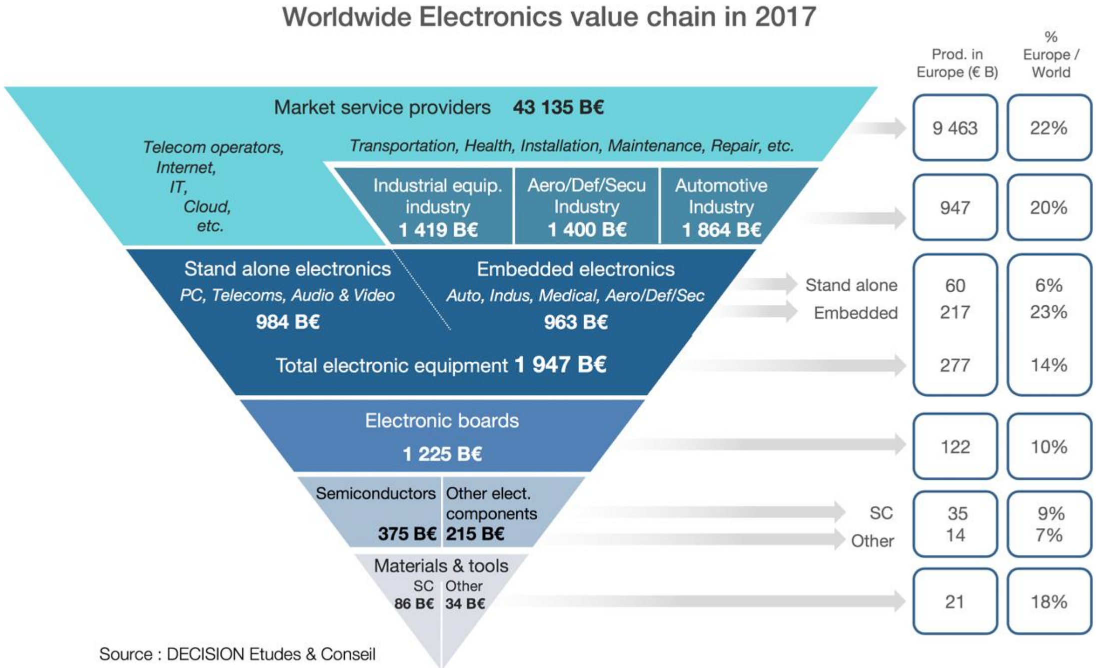
Based on these data, this study provides qualitative competitive analyses of the European MNE industrial base in the World (III), qualitative analyses on the technology and market evolution and their impact on the European MNE industrial base (IV), as well as policy recommendations in the conclusions (VI). Analyses and recommendations also relied on 24 direct interviews with the key stakeholders of the MNE sector in the EU.

An online questionnaire, gathering the answers of 50 additional key players of the electronics value chain, has also been carried out to validate the policy recommendations. The results of this online questionnaire can be found in Annex 9.

Finally, this study specifically describes the entire electronics value-chain, the share of Europe in the World and the technology and market evolutions of each end-user electronic systems' segment: Automotive, Industrial & Robotics, Aerospace/Defense/Security and Health & Care, Telecommunications, PC & data processing, Audio & Video and Home Appliances, with key findings and comparative analyses of these segments. Furthermore, each end-user value chain is briefly described, with a dedicated specific report for each annexed to the report (Eight reports for eight end-user electronic segments).

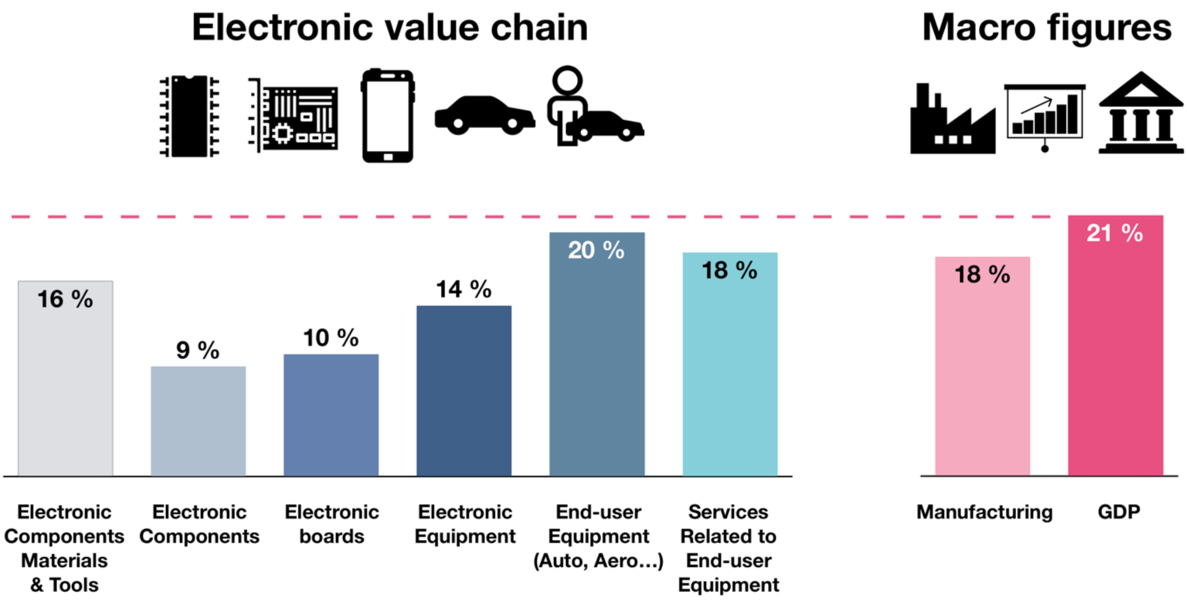
Key findings

1) Worldwide electronic value chain



The EU electronic value chain shows that Europe still holds a good share in materials and tools for the production of electronic components, though Europe's production share is lower at levels such as: electronic equipment, electronic boards and electronic components (including semiconductors).

The European share of the World production at every step of the global electronic value chain



Source: DECISION Études & Conseil

Yet, in the professional/embedded electronics segments, the EU holds very strong positions.

The relative importance of the end user segments in the European Electronics Ecosystem is significantly different from the world configuration. In Europe the leading end-user segments are industrial electronics, aerospace defense and security, and automotive electronics, whereas in the global Electronics Ecosystem the leading segments are still (but less and less) the consumer mass markets (mobile phones, PCs).

Europe's share in world production, unsurprisingly, is also highest in those segments where Europe is strongest.

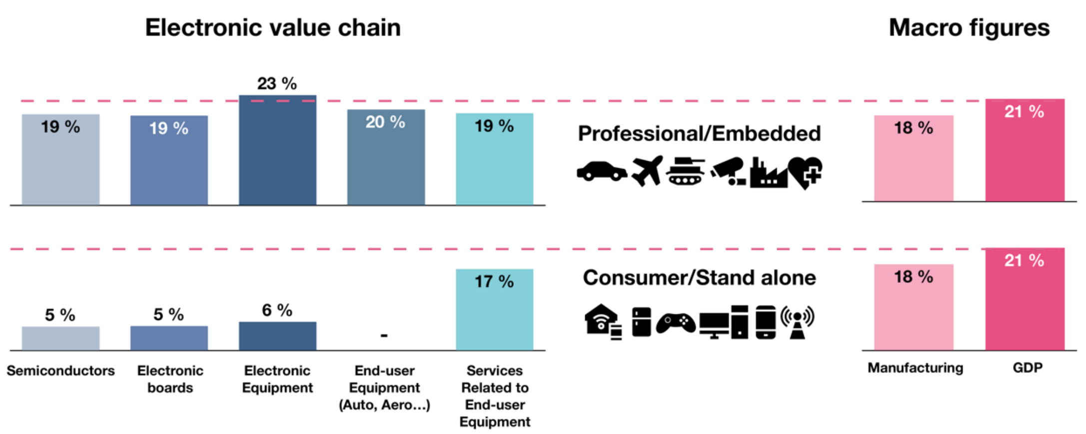
- The EU automotive industrial base is very strong. Yet, the EU automotive electronics sector is even stronger, not only in terms of high value-added activities (engineering, R&D, etc.), but also in terms of factory production. The EU produces 27% of the global automotive electronics. The EU is the first region in the world ahead of China (20%), and North America (18%);
- The EU also holds strong positions in industrial electronics. The EU produces 20% of the global industrial electronics. The EU is the second region in the world after China (24%), and ahead of North America (19%);
- The EU aeronautics/defense/security electronic industrial base is strong. The EU produces 22% of the global Aerospace/Defense/Security electronics. The EU is the second region in the world after North America (41%), but ahead of China;
- The EU has a competitive Health & Care electronics industry. The EU produces 19% of the global Health & Care electronics. The EU is the second region in the world after North America (40%), but just above China (20%).

In the stand alone / consumer electronics segments, the EU has weaker positions.

In comparison, the EU represented in 2016:

- **17%** of the global home appliances production. The EU is the second region in the world after China (37.5%) but ahead of other Asia (12.5%) and the rest of the world (12.5%);
- **11%** of the global audio & video production. The EU is the 4th (out of 6) region in the world after China (53%), other Asia (31%) and the USA (12.5%);
- **5.5%** of the global computer production. The EU is the 4th (out of 6) region in the world after China (54%), other Asia (32%) and the USA (5.5%);
- **3.5%** of the global telecommunication electronics production. The EU is the 5th region in the world after China (51%), other Asia (29%), the rest of the world (7.6%) and the USA (6.3%).

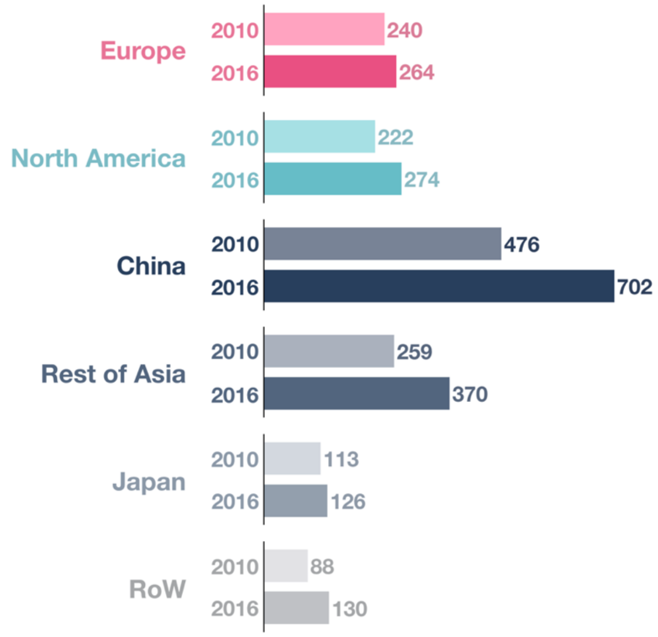
The European share of the World production at every step of the global electronic value chain



Source: DECISION Études & Conseil

The EU share of global production of electronic systems has been declining for the past six years.

World electronic equipment/system production by region (B €)

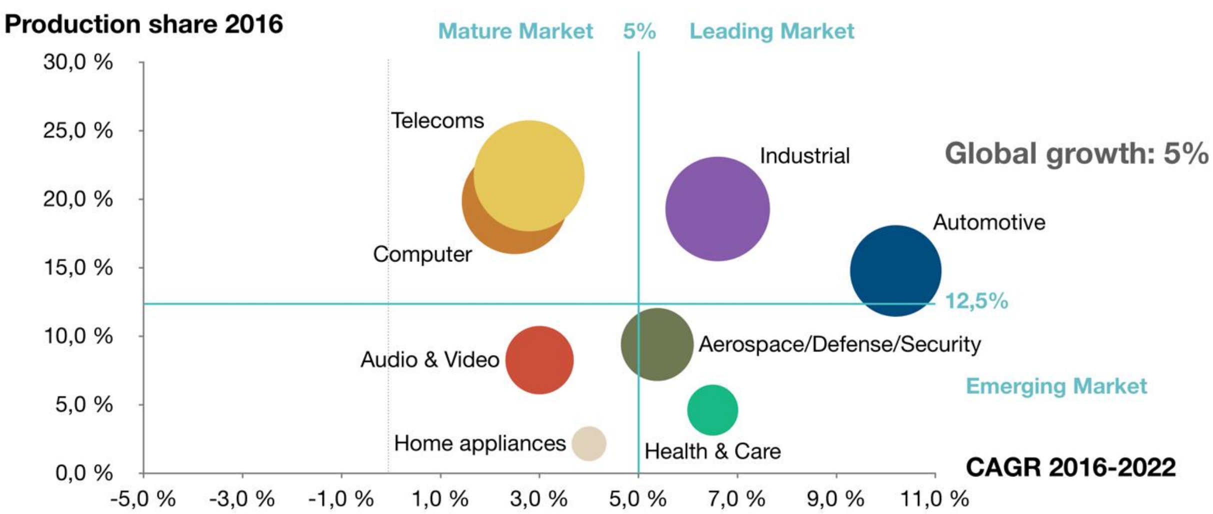


Source: DECISION Études & Conseil

Europe, the USA and Japan used to dominate the World Electronics Ecosystem, but today Asia has conquered a lion's share of mass market segments (computers, telephones, consumer audio-video), and is progressing into the more professional segments. In terms of total electronic system production, the EU is currently the 4th region of the World, behind China, other Asia and North America.

Yet, the EU is very well positioned on the end-user electronic segments with the highest potential growth over the 2016-2022 period.

Graph – World end-user segment production: Production share in 2016 (B €) & forecast CAGR over the 2016-2022 period



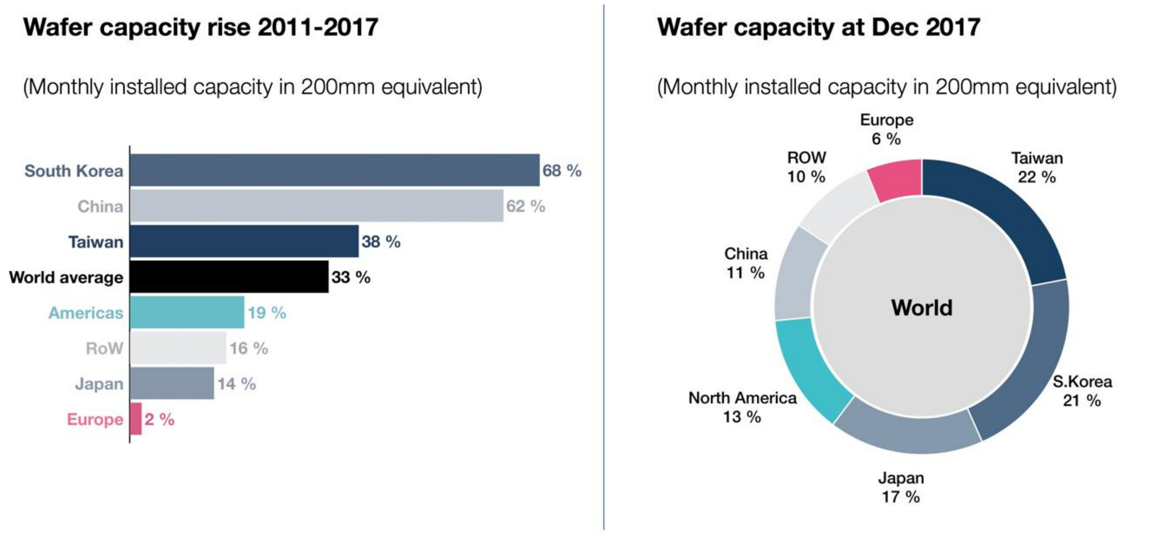
Source: DECISION Études & Conseil

2) Micro and Nano electronics

The semiconductor activity in Europe generated a turnover of 35 B € in 2017, that is slightly more than 9% of the World activity generated by semiconductor companies.

The EU production share has been declining during the last 20 years: from a peak of 22% in 1998 to 13% in 2010 and down to more than 9% in 2017. Yet, in absolute value, the EU production of semiconductor jumped from 28 B € in 2010 to 35 B € in 2017, corresponding to a compound annual growth rate of 3.8%.

In terms of monthly installed wafer capacity in 200mm equivalent, Europe represents 6% of the World.



Source: IC insights, DECISION Études & Conseil

Europe does not produce advanced semiconductor technologies anymore

- In terms of production of old technologies, the EU remain well positioned;
- On the contrary, advanced technologies (currently below 22 nm), are no longer manufactured in Europe;
- Yet, the alternative technology, namely FDSOI, is an opportunity to regain production shares in advanced technologies. GlobalFoundries already plans to build a factory of 12 nm in Dresden in 2019 using FDSOI.

Europe remains a world leader in terms of semiconductor equipment production

- ASML, based in the Netherlands and supported by research at IMEC, is a world leader in lithography with 9 B € turnover in 2017;
- SOITEC is a key player in SOI wafers and is gaining market shares thanks to its SDSOI technology;
- M + W is a world leader in advanced technology facilities with a turnover of 2 560 M € in 2017;
- Companies like ASML or AIXTRON are also gaining important market shares thanks to their deposition technologies;
- RECIF is one of the world leaders in robotic wafer handling.

Europe is a world leader in R&D, mostly due to successful European Commission supported basic research

The IMEC, the Fraunhofer Institutes and the CEA-Leti are excellent R&D centers at the cutting edge of numerous MNE technologies.

Conclusions

Enhance public aids on the EU strengths

- Emerging computing technologies: Autonomous & Cognitive (Artificial Intelligence, data analytics, neural networks, quantum computing, etc.);
- Combinations of several key enabling technologies: Industrial biotechnology, photonic, spintronics, neuromorphic chips, etc.;
- More than Moore technologies;
- Professional & embedded systems: Automotive, Industrial, Aero/Defense/Security and Health & Care.

Build a semiconductor state-of-the-art factory in the EU territory

Such a factory currently cost € 7-15 B. Apart from states, only three private actors can afford to invest in such factories: Samsung, Intel and TSMC. Those actors are not European. The best option for the EU would be to finance a EU "cooperative" factory through a public-private partnership involving the EU main semiconductor producers and R&D players: STMicroelectronics, Infineon, Bosch Semiconductor, X Fab, the Imec, the CEA Leti and the Fraunhofer Institute. FDSOI is the only technology identified as suitable for such an investment.

Set up manufacturing partnerships in MNE and in every key end-user electronic segment

Set up public-private partnerships built on the model of Airbus in order not only to enhance R&D in Europe, but more broadly:

- The support of manufacture and design;
- To condition the maintaining of strong public aids to concrete and measurable objectives in terms of:
    - Increase of the electronic equipment production in the EU territory. Through the building of new factories;
    - Increase of the employment in the EU territory. Through the building of new factories and offices;
    - Increase of the world production share of the players involved in the partnership in the related segments. Example of possible goal: Set up the world leader in terms of co-construction of autonomous trains and autonomous cars level 4 transportation networks in smart cities;
    - Protect the EU capital ownership on the players involved in the partnerships. If the players benefiting from the partnership are bought by foreign industrial or financial companies, then the initial goals can of course not be reached.

Six partnerships could be set up: An "Airbus of Chips" (regrouping EU SC producers, R&D players and SC materials and tools producers), an Airbus of Smart Automotive (Autonomous level 4 automotive coupled with autonomous trains in smart cities), an Airbus of Industry 4.0, an Airbus of Defense & Security electronics, an Airbus of 5G and an Airbus of Digital Services (a GAFAM/GAFAAT competitor).

Other recommendations

- Benchmark the Chinese and US industrial strategies;
- Set up and promote European standards and regulations;
- Develop education in engineering science, both in terms of engineers and technicians;
- Create an Observatory of the EU MNE and electronic ecosystem. There is a clear lack of hard data in Europe on automotive electronics, industrial electronics, Aerospace/Defense/Security electronics as well as Health & Care electronics. Yet, those segments are the most critical for the EU. Therefore, the EU should create an Observatory of the European MNE and Electronics ecosystem in order provide hard data updated on an annual basis.

EXECUTIVE SUMMARY (FRENCH)

Objectifs & Méthodologie

Cette étude donne une image de la situation industrielle de la chaîne de valeur électronique européenne, depuis la Micro Nano Électronique (MNE), jusqu'aux utilisateurs finals des systèmes, et de sa position dans le monde.

La segmentation des systèmes pour les utilisateurs finals est la suivante :

- Systèmes / équipements professionnels & embarqués : Automobile, Industriel et robotique, Aérospatial/Défense/Sécurité, Santé ;
- Systèmes / équipements grand public : Télécommunications, PC & informatique, Audio-Vidéo et Électroménager.

Cette étude définit et décrit les différents niveaux de la chaîne de valeur de l'électronique mondiale, et en particulier la chaîne de valeur des semi-conducteurs (I).

L'étude a recueilli des statistiques au niveau international, et a élaboré des données sur la base industrielle mondiale (II), avec un focus particulier sur la base industrielle européenne. Une base de données a été constituée, couvrant toutes les utilisations finales de systèmes électroniques, les cartes électroniques, la Micro et Nano Électronique (et en particulier les semi-conducteurs), ainsi que pour les équipements et matériaux de production des semi-conducteurs, pour la période 2010 à 2017, avec des prévisions pour 2022.

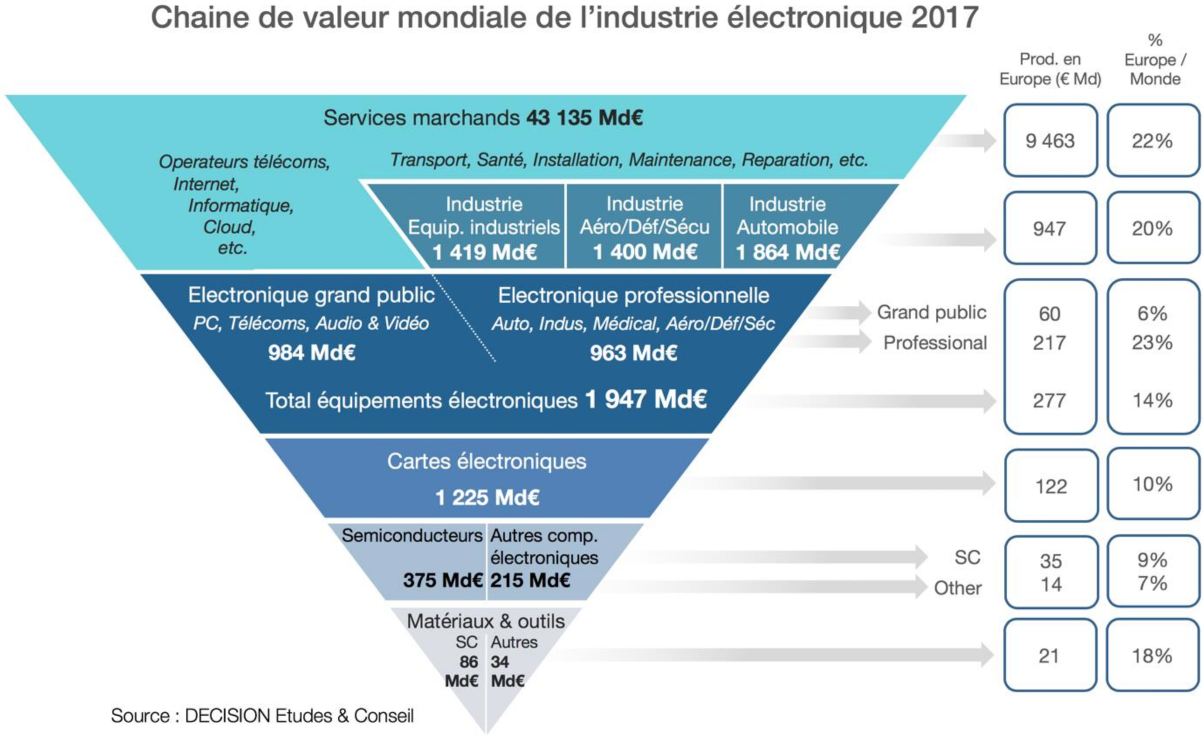
Sur la base de ces données, cette étude donne des analyses qualitatives de la compétitivité de la base industrielle de l'électronique et de la MNE européenne par rapport aux autres régions du monde (III), des analyses qualitatives des évolutions technologiques et des marchés, et de l'impact de celles-ci sur la base industrielle européenne de l'électronique et de la MNE (IV), ainsi que des recommandations en guise de conclusions (VI). Ces analyses et conclusions se sont nourries de 24 interviews directes, menées avec les acteurs-clé du secteur de la MNE dans l'Union Européenne.

Un questionnaire en ligne a recueilli les réponses de 50 acteurs supplémentaires de la chaîne de valeur électronique pour valider les recommandations formulées. Les résultats de ce questionnaire figurent dans l'Annexe 9.

Enfin, cette étude décrit de manière spécifique l'ensemble de la chaîne de valeur électronique, la part de l'Europe dans celle-ci, et les évolutions des technologies et des marchés pour chaque segment utilisateur : Automobile, Industriel & Robotiques, Aérospatial/Défense/Sécurité et Santé, Télécommunications, PC & informatique, Audio-Vidéo et Électroménager, avec les résultats-clé et des analyses comparatives entre ces segments. En outre chaque chaîne de valeur est brièvement décrite, avec une monographie consacrée à chaque segment (huit monographies de chacun des huit segments, en Annexe au rapport).

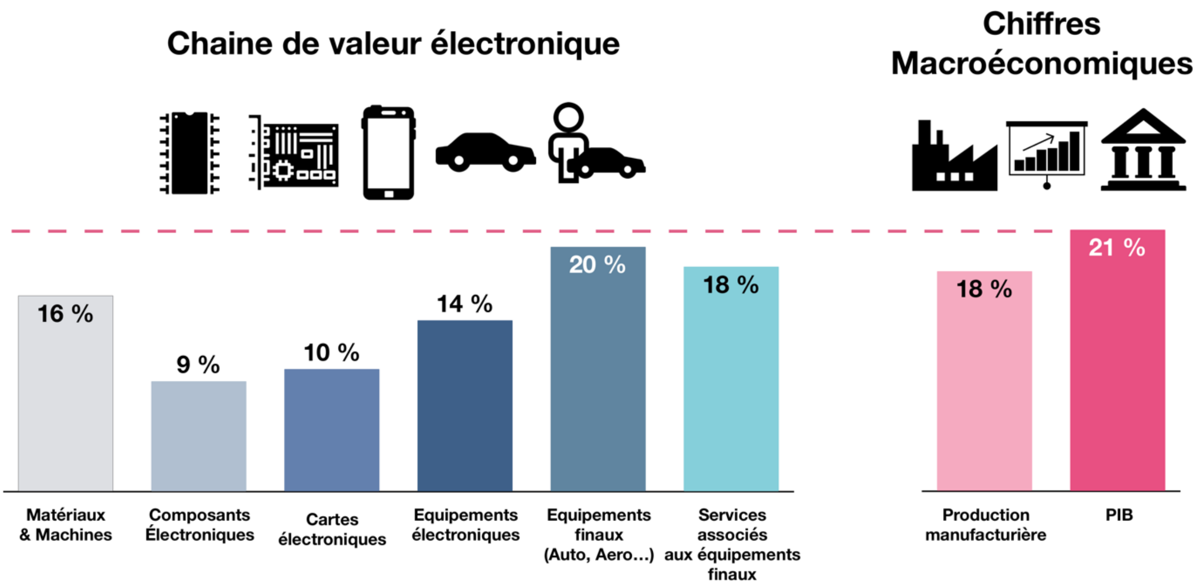
Principaux résultats

1) Chaîne de valeur de l'écosystème électronique mondial



Cette représentation de la place de l'Europe dans la chaîne de valeur de l'industrie électronique mondiale montre la place importante de l'Europe en aval (production de plateformes, véhicules et machines, production d'électronique pour ces plateformes), et en amont (équipements et matériaux pour l'industrie des semi-conducteurs). En revanche la position de l'Europe est faible sur les équipements de consommation de masse (audio-vidéo, PC, smartphones), et sur les semi-conducteurs et les autres composants électroniques.

Part Européenne de la production mondiale à chaque étape de la chaine de valeur électronique



Source : DECISION Études & Conseil

L'Europe détient des positions fortes dans les segments de l'électronique professionnelle et embarquée.

La hiérarchie par ordre d'importance des segments utilisateurs finals dans l'écosystème électronique européen diffère sensiblement de celui constaté au niveau mondial. En Europe les premiers segments utilisateurs sont l'industriel, l'aérospatial-défense-sécurité et l'automobile, alors qu'au niveau mondial les segments dominants restent les marchés de consommation de masse (téléphones mobiles, PC).

La part de l'Europe dans la production mondiale de systèmes électroniques est la plus forte là où l'Europe est également forte dans la production de plateformes incorporant ces systèmes :

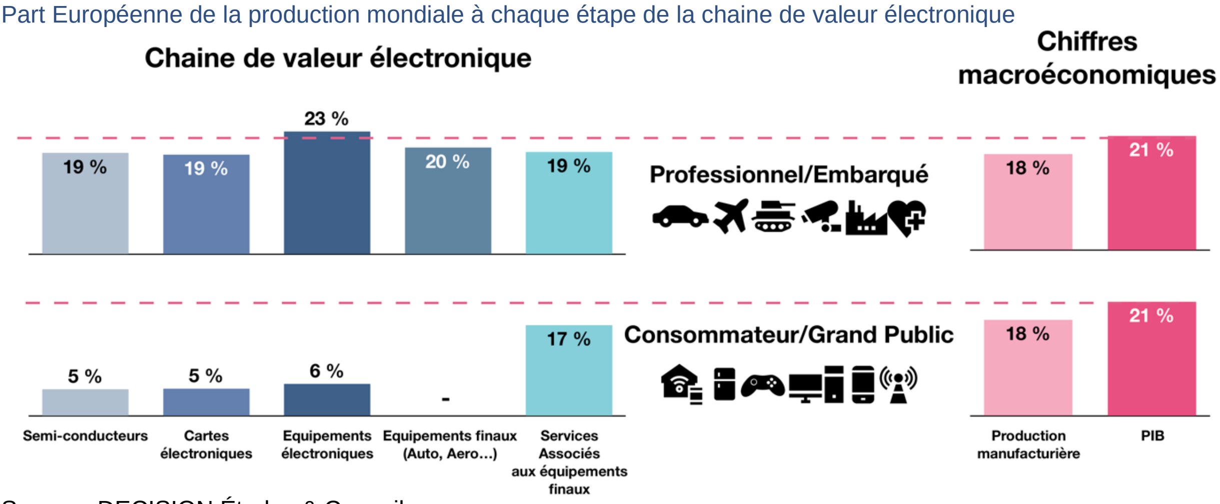
- La base industrielle européenne est très forte dans l'industrie automobile. Mais elle est plus forte encore dans l'électronique automobile, en termes d'activités à haute valeur ajoutée (ingénierie, R&D) mais aussi en termes de production. L'Europe est au premier rang mondial dans ce domaine, avec 27% de la production mondiale, devant la Chine (20%) et l'Amérique du Nord (18%) ;
- L'Europe a aussi de fortes positions dans les équipements industriels, et l'électronique industrielle. L'Europe fournit 20% de la production mondiale d'électronique industrielle, ce qui la situe au second rang mondial, derrière la Chine (24%) et l'Amérique du Nord (19%) ;
- Le poids de l'industrie aérospatial-défense-sécurité européenne est également prépondérant. C'est en Europe que sont localisés 22% de la production mondiale. Cela place l'Europe au second rang mondial, après l'Amérique du Nord (41%) et devant la Chine ;
- L'Union Européenne est compétitive dans le domaine des industries de la santé. Les pays de l'UE produisent 19% de l'électronique médicale mondiale, derrière l'Amérique du Nord (40%) et la Chine (20%).

Dans les segments des produits de consommation de masse, l'Europe est plus faible.

La part de l'Europe dans la production mondiale reste cependant forte dans l'électroménager, mais décroit dans les autres segments :

- **17%** de la production mondiale d'équipements électroménagers. L'Europe est au second rang mondial, derrière la Chine (37,5%) mais devant le reste de l'Asie (12,5%) et le reste du monde (12,5%) ;
- **11%** de la production mondiale d'équipements audio-vidéo. L'Europe est au 4ème rang mondial, après la Chine (53%), le reste de l'Asie (31%), et les États-Unis (12,5%) ;
- **5,5%** de la production mondiale d'ordinateurs. L'Europe se place au 3ème rang derrière la Chine (54%), le reste de l'Asie (32%), au même niveau que les États-Unis (5,5% aussi) ;
- **3,5%** de la production mondiale de produits téléphoniques. L'Europe se situe au 5ème rang régional mondial, derrière la Chine (51%), le reste de l'Asie (29%), le « reste du monde » (7.6%) et les États-Unis (6.3%).

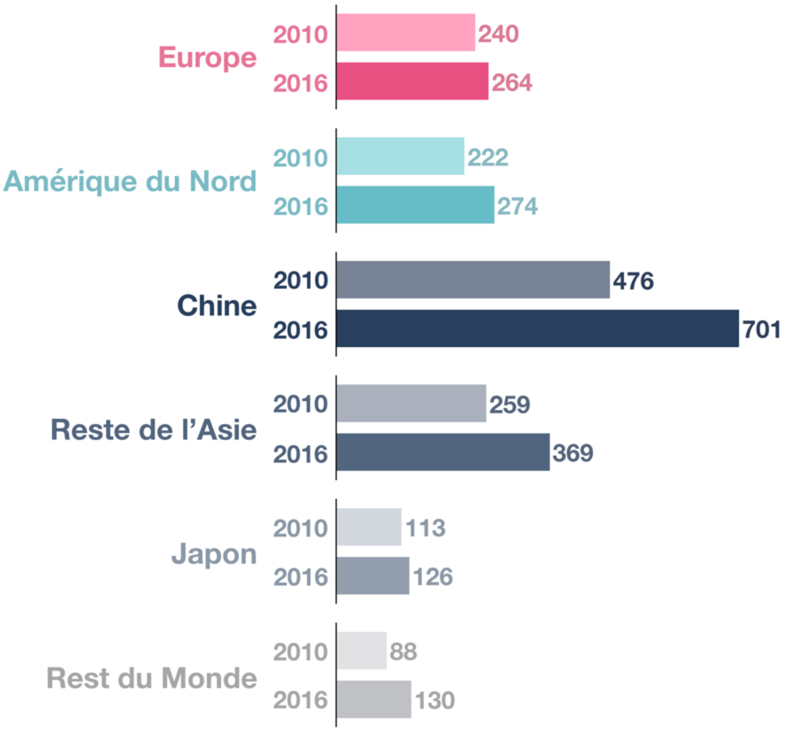
Part Européenne de la production mondiale à chaque étape de la chaine de valeur électronique



Source : DECISION Études & Conseil

La part de l'Europe dans la production mondiale de systèmes électroniques est en recul depuis les six dernières années.

Production mondiale d'équipements / systèmes électroniques par région (Milliards d'euros)

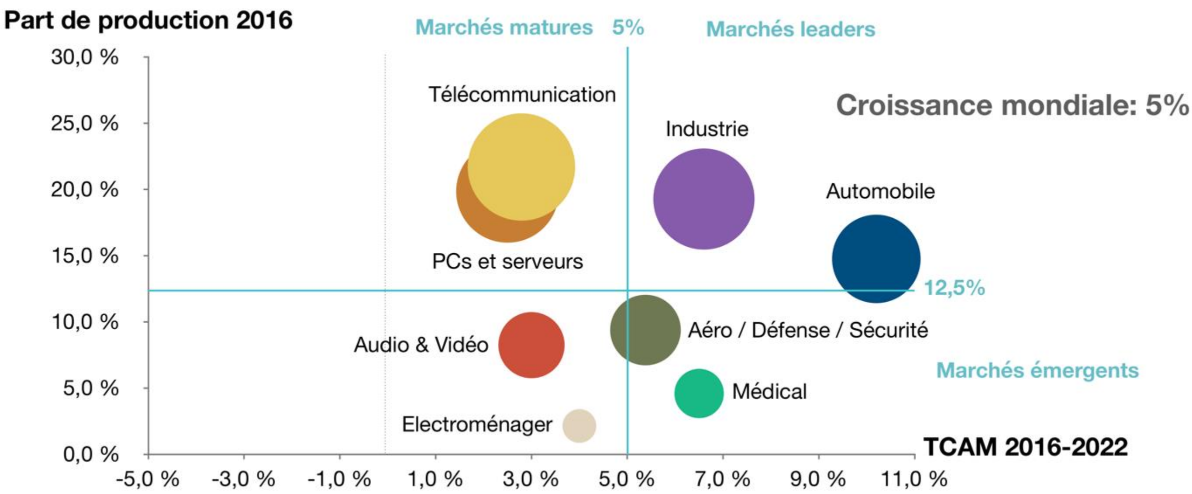


Source : DECISION Études & Conseil

Jadis les États-Unis, l'Europe et le Japon dominaient l'écosystème électronique mondial, mais aujourd'hui l'Asie a conquis la part du lion dans les segments de consommation de masse (ordinateurs, téléphones, audio-vidéo), et progresse rapidement dans les segments plus professionnels et embarqués. Pour l'ensemble de la production électronique, l'Europe se situe au 4ème rang mondial, derrière la Chine, le reste de l'Asie, et l'Amérique du Nord.

Le côté positif est que l'Europe est en bonne position sur les segments de marchés finals où la croissance devrait être la plus forte sur la période 2016-2022.

Production mondiale d'équipements / systèmes électroniques par segment : Part de production en 2016 (Milliards d'euros), et taux de croissance annuel moyen estimé sur la période 2016-2022



Source : DECISION Études & Conseil

2) Micro et Nano électronique

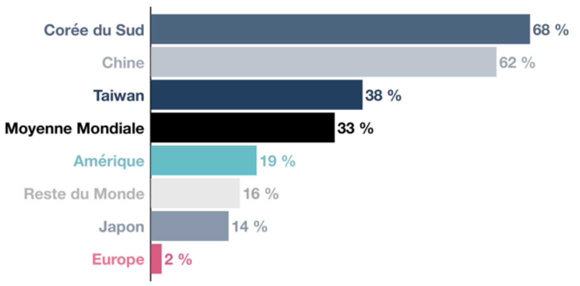
Les semi-conducteurs ont généré en 2017 un chiffre d'affaires de 35 milliards d'euros en Europe en 2017, soit légèrement plus de 9% du chiffre d'affaires mondial.

La part de l'Europe dans le marché mondial des semi-conducteurs est en recul depuis les 20 dernières années, depuis un pic en 1998 de 22%, en passant par 13% en 2010, pour tomber à 9% en 2017. En valeur absolue l'activité a toutefois augmenté, passant de 28 milliards d'euros en 2010 à 35 milliards en 2017, soit une croissance annuelle moyenne de 3.8%.

En termes de capacité de production de tranches de semi-conducteurs (en équivalent 200mm), l'Europe représente 6% du monde.

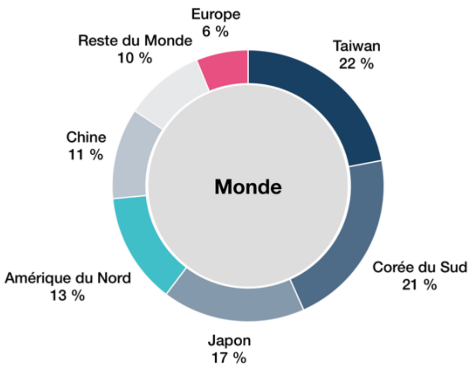
Croissance de la capacité de production de tranches de semiconducteurs 2011-2017

(Capacité installée mensuelle)



Capacité de production de tranches de semiconducteurs en Décembre 2017

(Capacité installée mensuelle en équivalent 200mm)



Source: DECISION Etudes & Conseil, IC Insights

L'Europe n'est plus présente dans la fabrication de semi-conducteurs de technologies avancées

- L'Europe reste bien positionnée dans les technologies anciennes ;
- A l'inverse, les technologies avancées (aujourd'hui moins de 22 nm) ne sont plus produites en Europe ;
- Des technologies alternatives, et notamment le FDSOI, pourraient être l'occasion de regagner des parts de marché dans les technologies avancées. GlobalFoundries prévoit de construire une unité de production de 12 nm à Dresde en 2019 en utilisant la technologie FDSOI.

L'Europe reste leader mondial dans la production d'équipements de production pour semi-conducteurs

- ASML, basé aux Pays Bas et qui bénéficie des recherches menées à l'IMEC, est leader mondial dans la lithographie, et a réalisé un chiffre d'affaires de 9 milliards d'euros en 2017 ;
- SOITEC est un acteur-clé dans les tranches SOI, et gagne des parts de marché grâce à sa technologie SDSOI ;
- M + W est leader mondial dans les installations de technologies avancées, avec un chiffre d'affaires de 2 560 millions d'euros en 2017 ;
- ASML et AIXTRON gagnent aussi des parts de marché importantes grâce à leurs technologies de déposition ;
- RECIF est l'un des leaders mondiaux de la robotique pour wafers.

L'Europe est leader mondial dans la R&D en MNE, grâce surtout au succès des programmes d'aide à la recherche fondamentale de la Commission Européenne.

L'IMEC, les Instituts Fraunhofer et le CEA-Leti sont d'excellents centres de R&D à la pointe dans de nombreux domaines des technologies MNE.

Conclusions

Renforcer les aides publiques aux points forts de l'Union Européenne

- Technologies informatiques émergentes, technologies autonomes et cognitives (Intelligence artificielle, analyse de données, réseaux neuronaux, informatique quantique, etc.) ;
- Combinaisons de plusieurs technologies-clés génériques : biotechnologies, photonique, spintronique, puces neuromorphiques, etc. ;
- Technologies "More than Moore" ;
- Systèmes professionnels embarqués : Automobile, Industriel, Aéro-Défense-Sécurité, et Santé.

Construire une usine de semi-conducteurs à la pointe de la technologie en Europe

Une telle usine coûte aujourd'hui 7 à 15 milliards d'euros. En dehors des états, il n'y a que trois acteurs privés des semi-conducteurs capables d'investir dans de telles installations, Samsung, Intel et TSMC, et ces acteurs ne sont pas européens. Dans ces conditions l'option pour l'Union Européenne pourrait être de contribuer au financement d'une usine européenne "coopérative" en partenariat avec les entreprises des semi-conducteurs et acteurs de la R&D européenne : STMicroelectronics, Infineon, Bosch Semiconductor, X-Fab, l'IMEC, le CEA-Leti et l'institut Fraunhofer. Le FDSOI est une technologie qui a été identifiée comme convenant à un tel investissement.

Susciter des partenariats de production dans la MNE et dans chaque segment de marché final critique

Mettre en place des partenariats sur le modèle d'Airbus, en vue non seulement de promouvoir la R&D en Europe, mais plus ambitieusement de :

- Soutenir la conception et la production ;
- Conditionner le maintien d'aides publiques importantes à la réalisation d'objectifs concrets et mesurables :
  - Développer la production d'équipements électroniques en Europe, en particulier dans de nouvelles usines ;
  - Développer l'emploi en Europe, notamment en construisant de nouvelles installations de production ;
  - Accroître la part de la production mondiale des acteurs des partenariats dans les segments concernés. Un exemple d'un tel objectif pourrait être de générer des leaders mondiaux européens par la co-construction de trains autonomes ou de voitures autonomes (niveau 4) et de réseaux de transport dans les villes intelligentes (Smart City) ;
  - Protéger et promouvoir le caractère européen des entreprises (part du capital, localisation du siège, de la production et de la R&D), et plus particulièrement de celles engagées dans les partenariats. Si les acteurs bénéficiant de ces partenariats étaient rachetés par des intérêts industriels ou financiers étrangers, les objectifs initiaux de pourraient plus être atteints.

Six partenariats pourraient être constitués: un « Airbus des puces » (regroupant les producteurs européens de semi-conducteurs, les acteurs de la R&D, les acteurs des matériaux et équipements de production de semi-conducteurs), un Airbus des Transports Intelligents (Voitures autonomes de niveau 4, et transports ferroviaires urbains autonomes pour les "villes intelligentes"), un Airbus de l'Industrie 4.0, un Airbus de l'électronique de Défense et de Sécurité, un Airbus de la 5G, et un Airbus des Services Numériques (un concurrent européen des GAFAM américains et des Alibaba ou Tencents Chinois).

Autres recommandations

- Étudier et s'inspirer le cas échéant des stratégies industrielles chinoises et américaines ;
- Développer et promouvoir des normes et règlements européens favorables ;

- Développer la formation en science et en ingénierie, pour accroître l'offre d'ingénieurs et de techniciens en Europe ;
- Créer un Observatoire de l'écosystème électronique et de la MNE en Europe. Il y a un manque évident de données statistiques européennes dans des domaines critiques comme l'électronique automobile, l'électronique industrielle, l'électronique pour le segment aéro-défense-sécurité, et l'électronique médicale, en particulier dans le domaine des dispositifs médicaux pour suivi à domicile. Ces segments sont pourtant les points forts de l'Europe, et sont donc critiques pour l'avenir. C'est pourquoi l'Union Européenne devrait créer un Observatoire de l'écosystème électronique et de la MNE pour fournir des données mises à jour tous les ans, suivre les principaux indicateurs, et contribuer à ce que la collecte des statistiques européennes soit mieux adaptée à ces besoins.

Description of MNE components & systems and associated value chains in Europe

1.1 The electronic value chain: from MNE to end-user systems

1.1.1 Global value chain

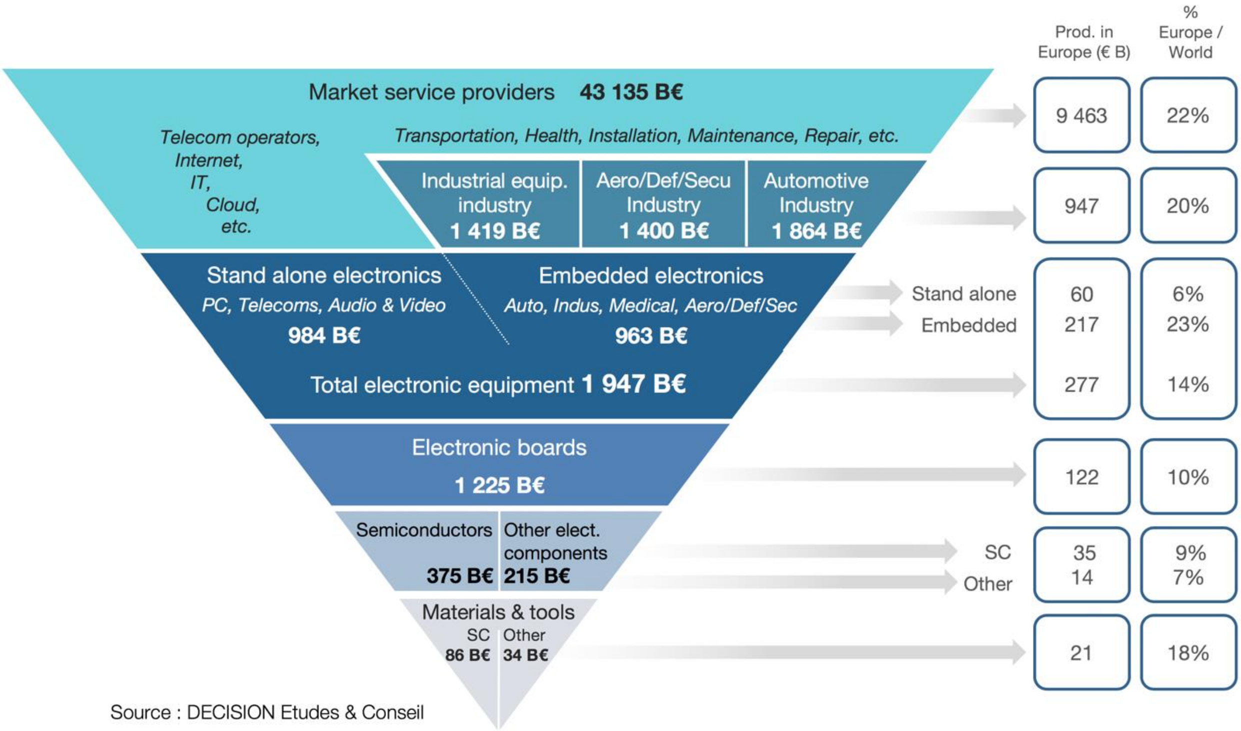
End-user segments are where Micro and Nano Electronics (MNE) capabilities become functions in products and systems.

Looking at the 2017 World Electronics Ecosystem, the largest end-user segments are those more closely related to the consumer and mass markets (communications with mobile phones, data processing with PCs, home appliances and audio-video), accounting for 984 B €. Professional electronics (Industrial, Automotive, Aerospace/Defense/Security, Health & Care), which diffuse throughout their end-user equipment, already account for 963 B € and are growing at a faster pace than consumer and mass-market electronics.

This global hierarchy is very different according to the regions of the world; there is a strong degree of international specialisation in the Electronics Ecosystem.

The following pyramid provides an overview of the electronic value chain from MNE to end-user systems in terms of production location, and position Europe at every step of the value chain.

Worldwide Electronics Value Chain in 2017

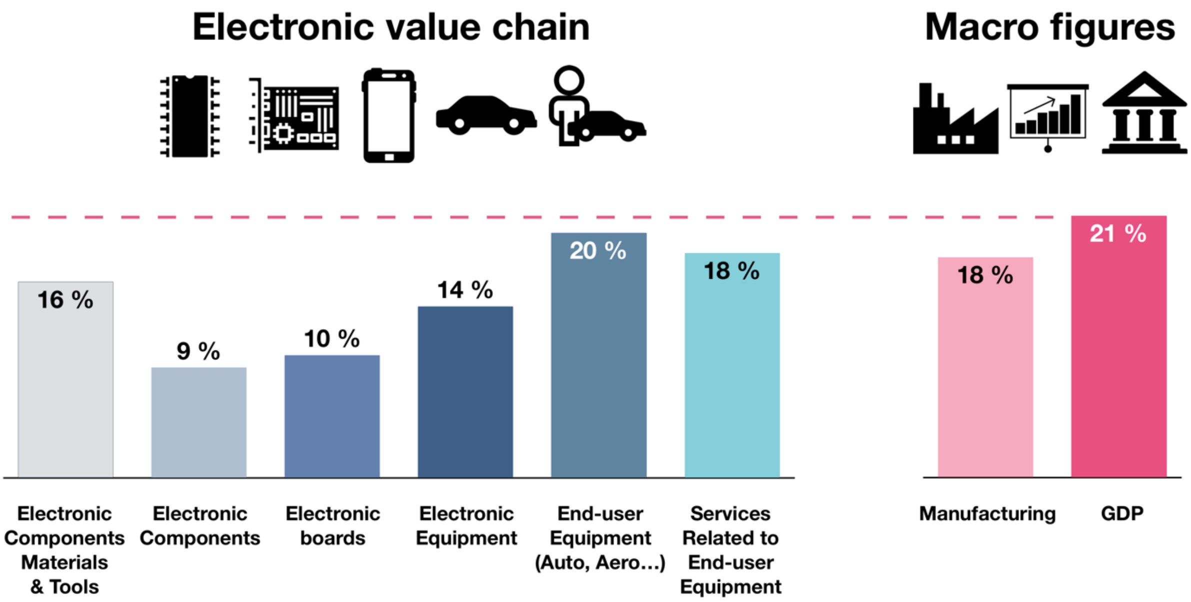


Source : DECISION Etudes & Conseil

1.1.2 The EU's position in the world

1. **The EU electronic value chain shows that Europe still holds a good share in materials and tools for the production of electronic components, though Europe's production share is lower at levels such as: electronic equipment, electronic boards and electronic components (including semiconductors).**

The European share of the World production at every step of the global electronic value chain



Source: DECISION Etudes & Conseil

2. **In the professional/embedded electronics segments, the EU holds very strong positions.**

The relative importance of the end user segments in the European Electronics Ecosystem is significantly different from the world configuration.

In Europe the leading end user segments are industrial electronics, aerospace, defense and security, and automotive electronics, whereas in the global Electronics Ecosystem the leading segments are the consumer mass markets (mobile phones, PCs). But industrial electronics, the leading segment in Europe, also comes third at the global level.

Europe's share in world production, unsurprisingly, is also highest in those segments where Europe is strongest.

- The European Union's GDP was estimated to be **€ 15.35 trillion** in 2018, representing **22% of the world GDP**.

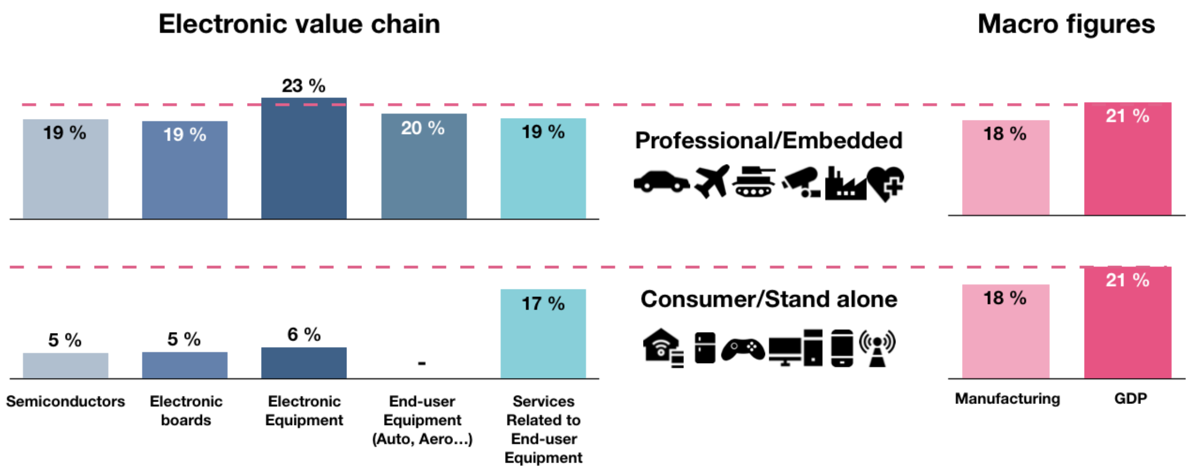
- The EU automotive sector is very strong. Yet, the EU automotive electronics sector is even stronger, not only in terms of high value-added activities (engineering, R&D, etc.), but also in terms of factory production. The EU produces **27% of the global automotive electronics**. The EU is the first region in the world ahead of China (20%), and North America (18%);

- The EU industrial electronics sector is very strong. The EU produces **20% of the global industrial electronics**. The EU is the second region in the world after China (24%), and ahead of North America (19%);

- The EU aerospace/defense/security electronic industry is very strong. The EU produces 22% of the world Aerospace/Defense/Security electronics. The EU is the second region in the world after North America (41%), and ahead of China;

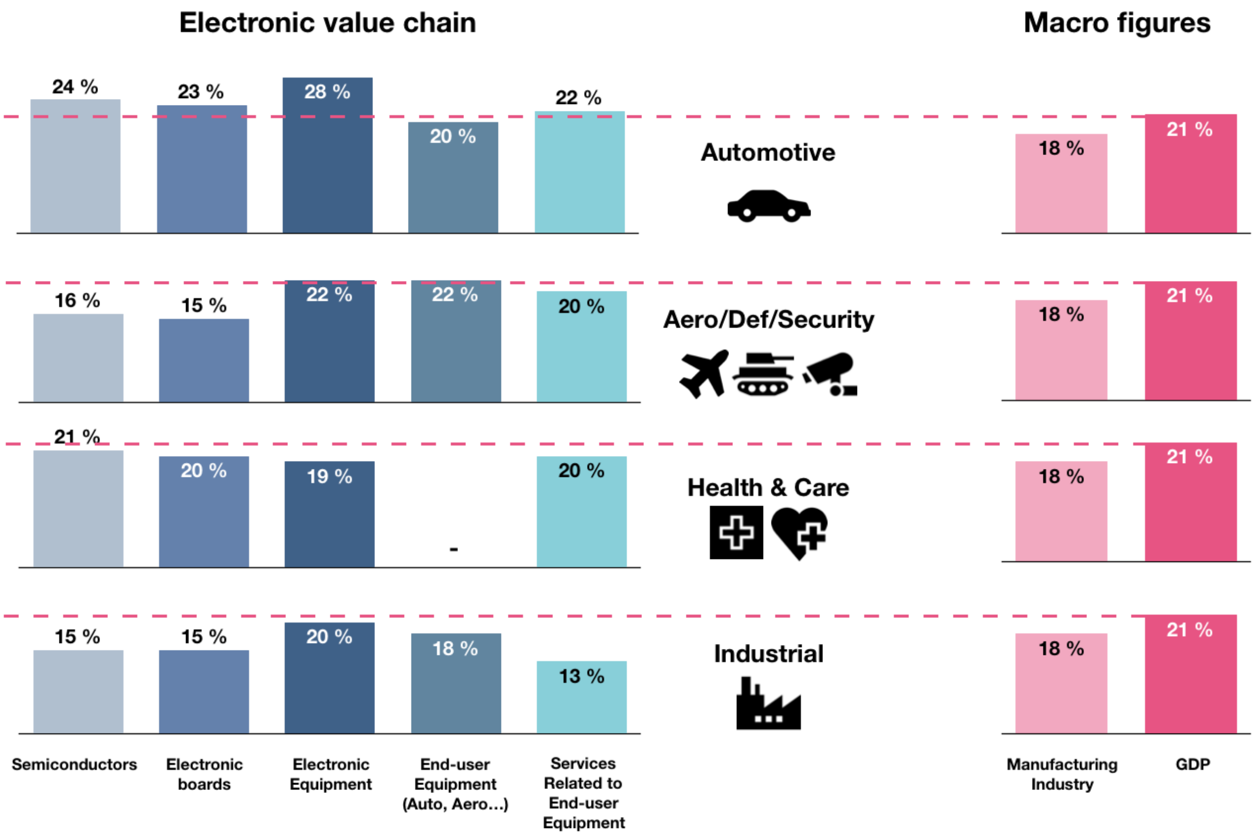
- The EU is strong in Health & Care electronics equipments. The EU produces **19% of the global Health & Care electronics**. The EU is the second region in the world after North America (40%), but just above China (20%).

Electronics value chain in 2017 – EU share of the global production between embedded and stand-alone electronics



Source: DECISION Études & Conseil

Electronics value chain in 2017 – EU share of the global production for embedded electronics systems
Source: DECISION Études & Conseil



3. In the stand-alone / consumer electronics segments, the EU has weaker positions.

In comparison, the EU represented in 2017:

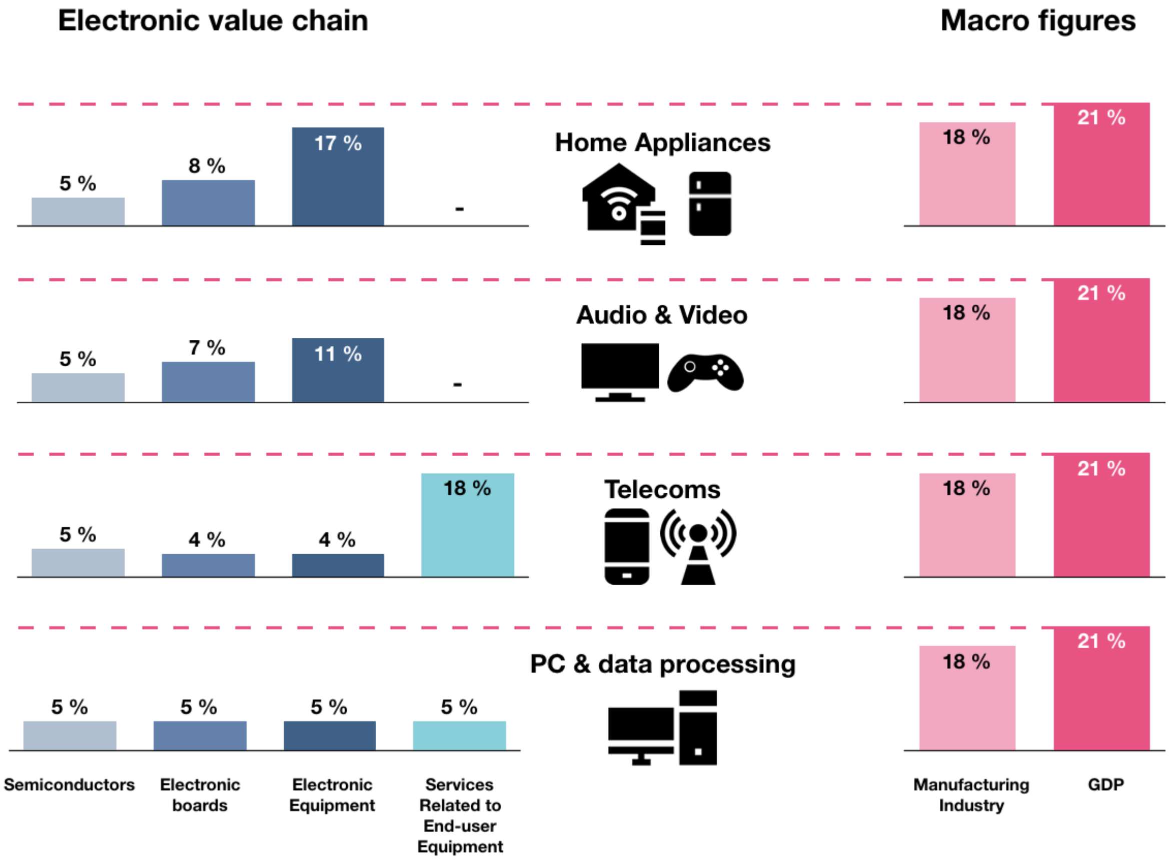
- **17%** of the global home appliances production. The EU is the second region in the world after China (37,5%) but ahead of other Asia (12.5%) and the rest of the world (12.5%). Furthermore, home appliance electronic sub-systems constitute the smallest electronic end-user segment and represent only 2.2% of the global electronic equipment production in the World;

- **11%** of the global audio & video production. The EU is the 4th/6 region in the world after China (53%), other Asia (31%) and the USA (12.5%);

- **5.5%** of the global computer production. The EU is the 4th/6 region in the world after China (54%), other Asia (32%) and the USA (5.5%);

- **3.5%** of the global telecommunication electronics production. The EU is the 5th/6 region in the world after China (51%), other Asia (29%), the rest of the world (7.6%) and the USA (6.3%).

Electronics value chain in 2017 – EU share of the global production for stand-alone electronics systems



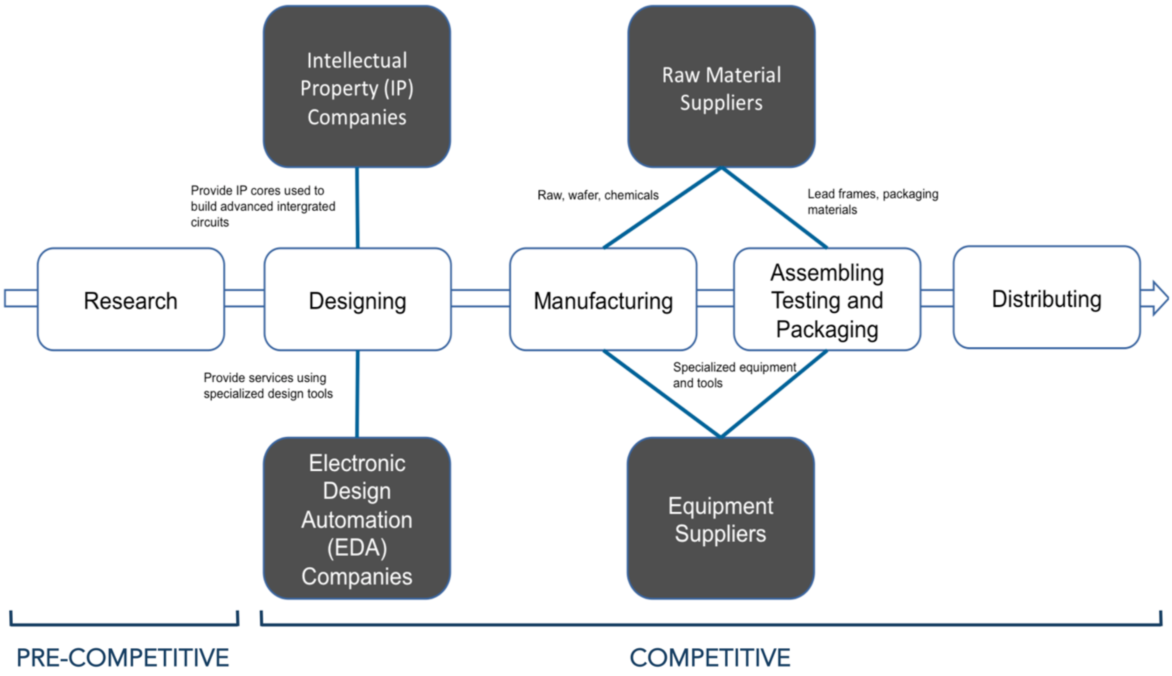
Source: DECISION Études & Conseil

1.2 The semiconductor value chain

1.2.1 Technical description

The semiconductor sector can be described, classically, as the set of activities (or players) that contribute to the design, production, packaging and commercialization of semiconductor devices. It is characterized by a set of features which today makes it unique.

Semiconductor Production Chain, Basic Elements of Value Chain



Source: SIA, DECISION Étude & Conseil

The semiconductor value chain can be briefly described as follows in four major manufacturing steps:

- **Raw wafer production**. A wafer is a thin slice of semiconductor material, such as a silicon crystal that serves as the substrate for microelectronic devices built in and over it. Wafers are formed of highly pure (99.9999% purity) single crystalline material. Their fabrication involves many complex steps and the use of several types of raw material and chemicals;
- **Front-end processing.** This refers to the sequence of operations that lead, according to the design instructions, from the wafer to the small piece of silicon (die), which, once packaged, will become a-circuit. Most modern complex chips require over 800 single processing steps including oxidation, doping or ion implantation, etching, deposition of various materials, and photolithographic patterning;
- **Back-end operations.** These operations traditionally include assembly, the final step of semiconductor devices fabrication, and testing of the resulting "chip". These operations have long been considered as the less glamorous part of the process and were early on offshored and outsourced. They are regaining favor as they have become an important part of "more than Moore" developments (multiple dies in one package);

- **The users of semiconductor devices** are either sub-system assemblers or directly the end-user equipment manufacturers. They buy products directly from manufacturers or via distributors. It is of course at this stage that any rupture in the semiconductor value chain has the main impact as the lack of a single device type can stop a whole assembly chain.

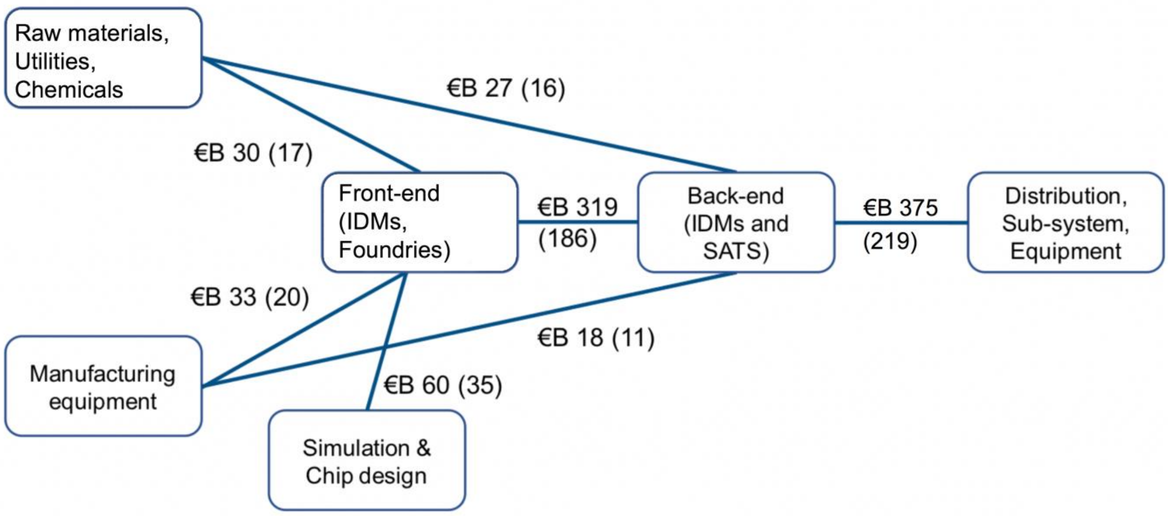
1.2.2 The semiconductor value chain in figures

Semiconductors are a critical part of the electronic value chains. Indeed:

- The contribution of semiconductor technology to the global product added value is increasing;
- The semiconductor industry is the most capital-intensive in the world (capital and R&D, expenditure represent an average 15-20% of revenues according to SIA);
- Access to electronic components is a major issue for the whole European industry and any significant disruption in the semiconductor value chain might have a severe impact;
- Steady long-term growth trend (6% over the last 20 years) and high volatility that leads to dramatic cyclical swings as shown by WSTS statistics;
- Fierce competition driven by constant, “never-ending” price decreases, due to the rapid pace of change in the market, which in turn drives a constant and strong price-performance improvement rate.

In the figure below, the numbers quoted give an idea of the sales at the various parts of the semiconductor value chain. They are estimates for 2017 (and 2010 in brackets).

Semiconductor Value Chain 2017 (2010)



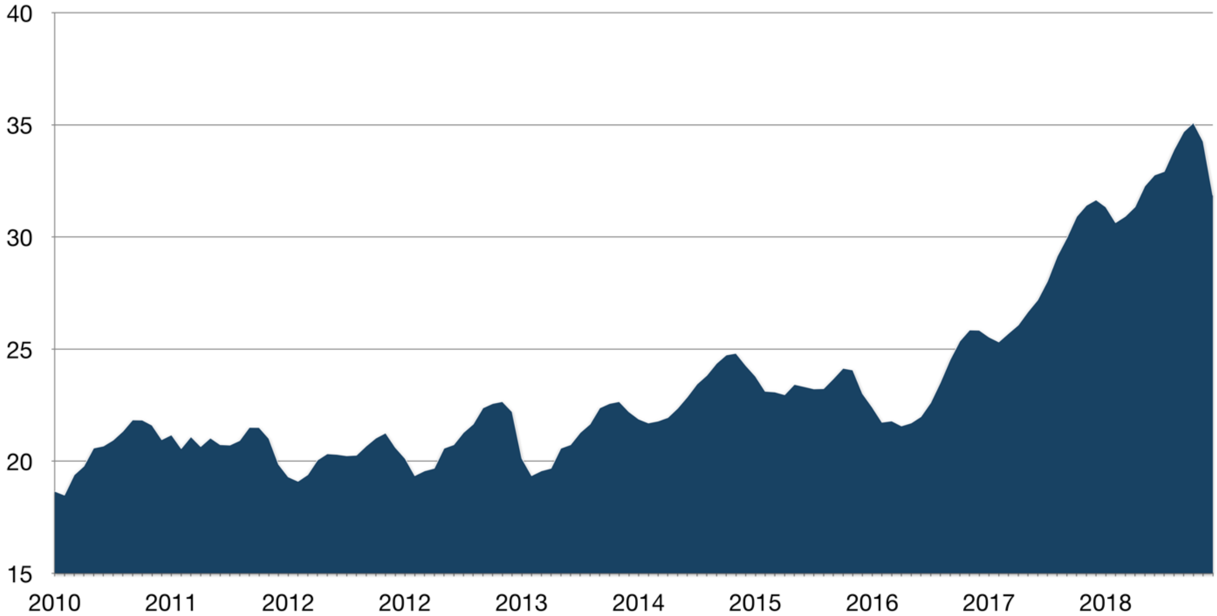
Source: DECISION Etudes & Conseil

The following table provides a breakdown of the IC Industry Metrics at the global scale.

These figures can vary significantly from one year to another. The rapid investment cycles in the semiconductor industry makes it indeed extremely volatile.

Indeed, while the creation of new electronic and equipment markets is the driving force behind the high growth trend of the semiconductor industry, it is the supply-demand imbalance that governs the year-on-year dynamics. New factories provide discrete blocks of incremental capacity and, due to their high capital cost, must be operated at full capacity. During periods of capacity shortage, firms tend to over-invest. The resulting over-capacity leads to a halting of investment until demand again exceeds capacity, whereupon the investment cycle resumes.

World Monthly Semiconductor Billings 2010-2018 (In Billion Euros, 3 Months Moving Average)



Source: WSTS, DECISION Études & Conseil

2007-2017 IC Industry Metrics

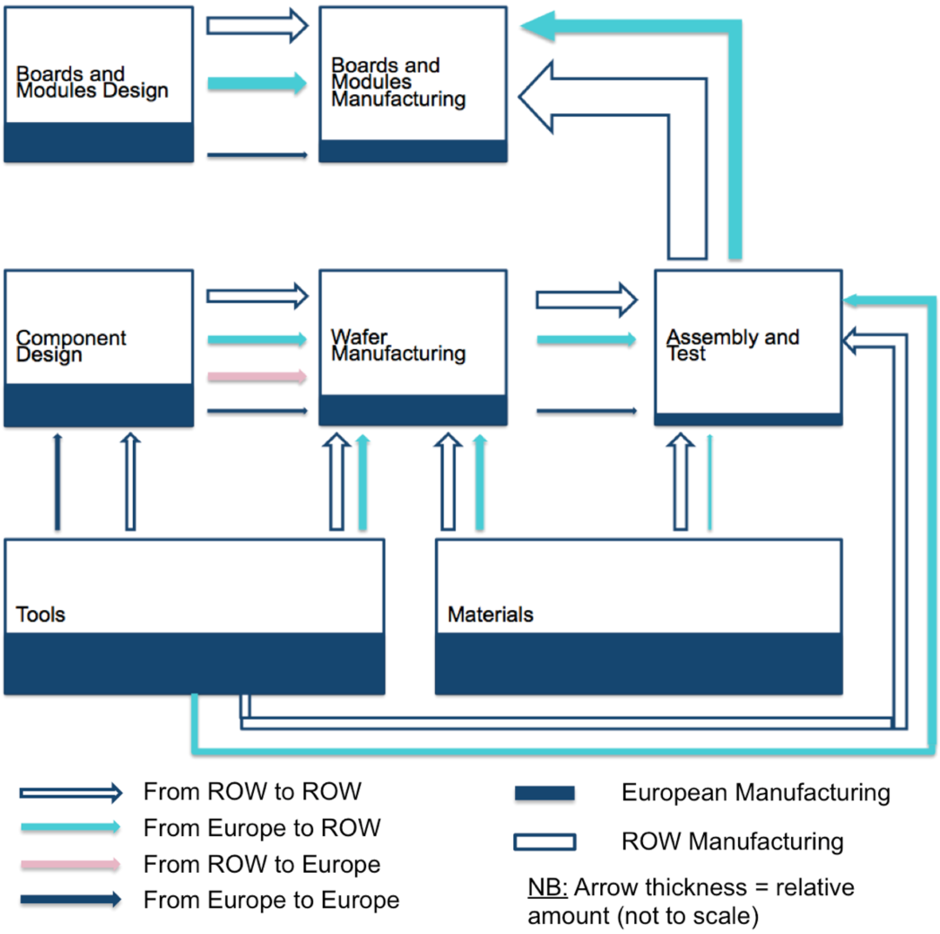
Category	2007	2016	2017	07-17 CAGR
IC Market ($B)	237.4	297.7	363.6	4.4%
IC Unit Volume Shipments (B)	156.6	252.2	288.5	6.3%
IC Average Selling Price ($)	1.52	1.18	1.26	-1.9%
Total IC Wafers* Started (M)	119.2	179.3	194.7	5.0%
IC Units Shipped per Wafer*	1,314	1,406	1,482	1.2%
IC Revenue per Wafer* ($)	1,992	1,660	1,867	-0.6%

*200mm-equivalents, Source: IC Insights

1.2.3 A fully internationalized value chain

The following diagram enlightens the following situation: from manufacturing to distribution, the market has become global and almost no product nor set of manufacturing steps is done anymore with materials, equipment, IP, and manpower coming from the same single country.

Electronics Value Chain from materials to modules – Worldwide level



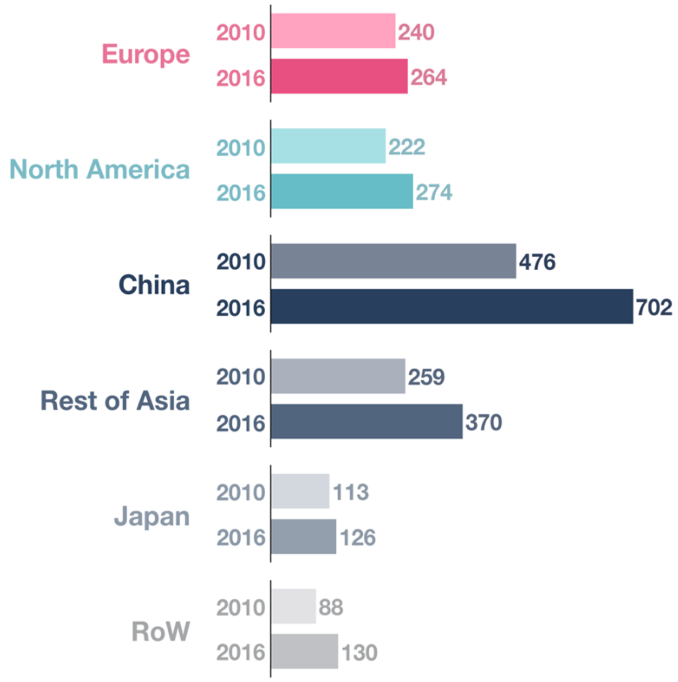
Source: DECISION Etudes & Conseil

1.3 End-user electronics systems

1.3.1 Regional trends and Europe's position in the World

Europe, the USA and Japan used to dominate the World Electronics Ecosystem, but today Asia has conquered a lion's share of mass-market segments (computers, telephones, consumer audio-video), and is progressing into the more professional segments.

World electronic equipment/system production by region (B €)



Source: DECISION Études & Conseil

As depicted in the bar chart above:

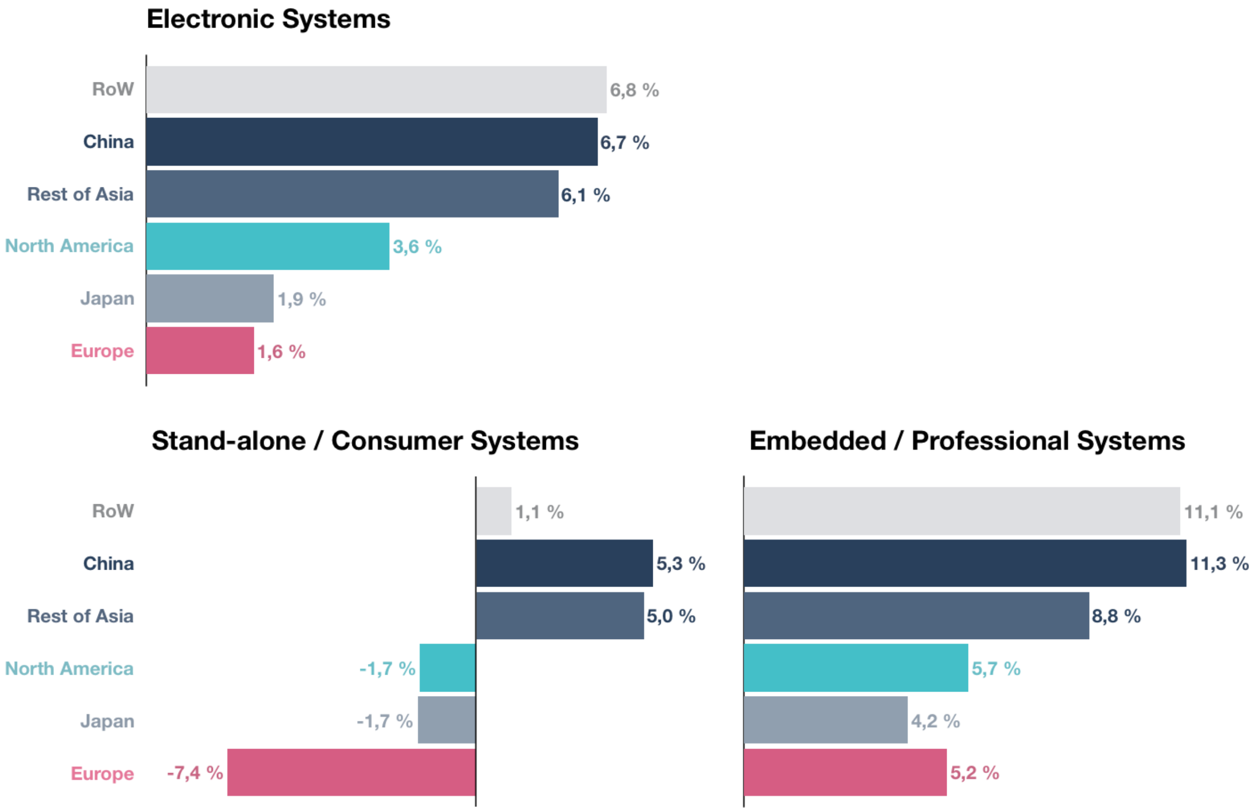
- South Asia (China and Other Asia, excluding Japan), represented 53% of the global electronics production in 2010 and represented 57% of the global electronics production in 2016, corresponding to a compound average growth rate of 6.5% over the 2010-2016 period. All regions have lost shares to the benefit of China and other Asia;

- North America recovered a significant growth after the "subprim crisis" of 2009. After falling to € 222 B in 2010, North America then succeeded to maintain and even slightly increase its shares, producing € 274 B (15% of the world total production) in 2016, corresponding to a compound average growth rate of 3.6% over the 2010-2016 period;

- During the same period, the decline of the EU-shares of semiconductor consumption cannot be overlooked: it was 17% in 2010 and 14% in 2016. The EU now ranks fourth, behind China, other Asia and North America.

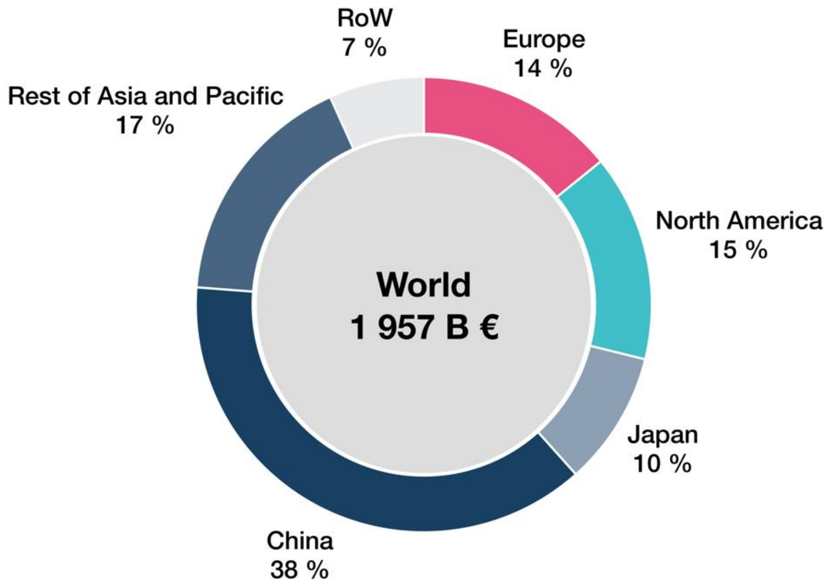
Yet, as shown in the bar charts below, the decline of the EU share of global electronic systems production is mainly due to the decline of the European production in stand-alone / consumer electronics:

2010-2017 Compound Annual Growth Rate of electronic systems production



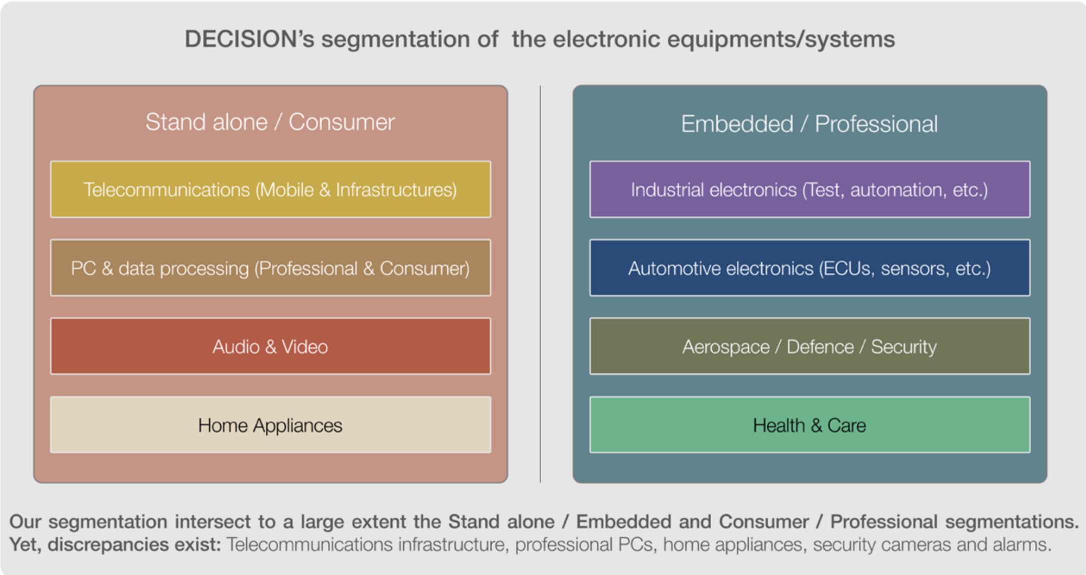
Source: DECISION Etudes & Conseil

World Production Share of electronic systems (2017)

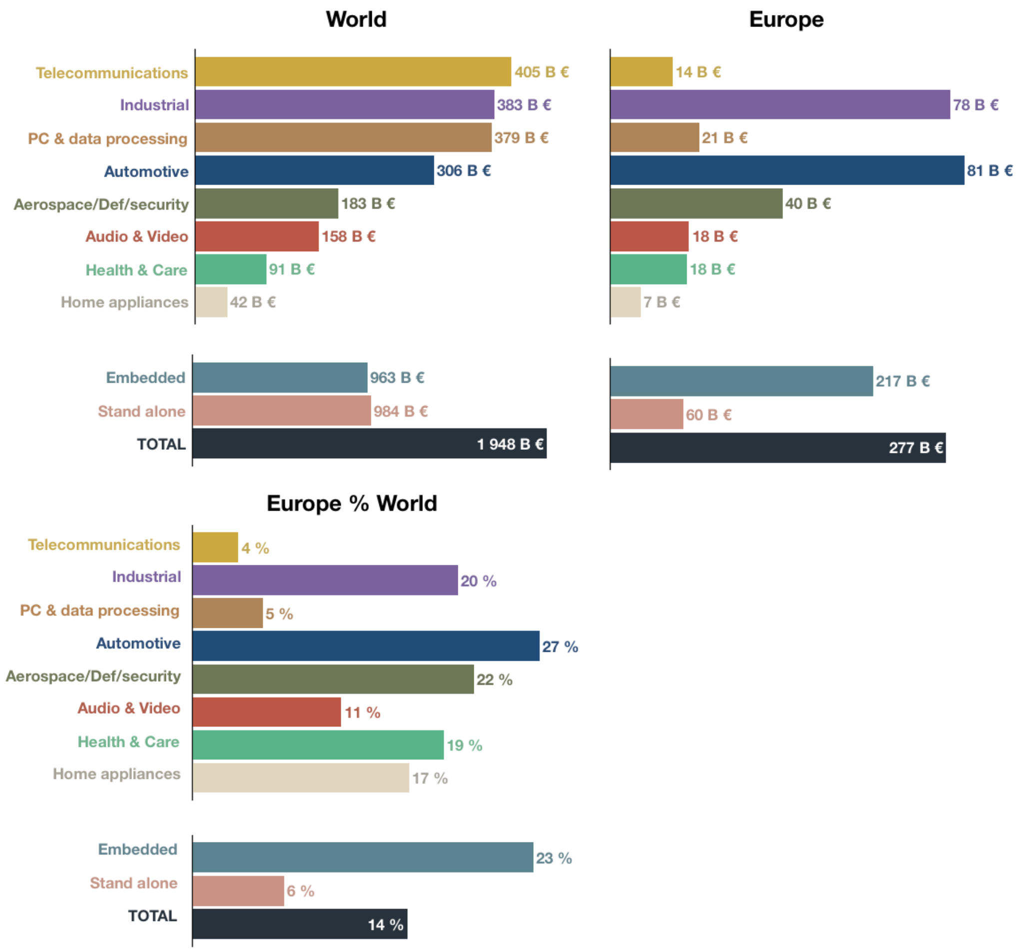


Source: DECISION Etudes & Conseil

1.3.2 Electronic systems by end-user segments

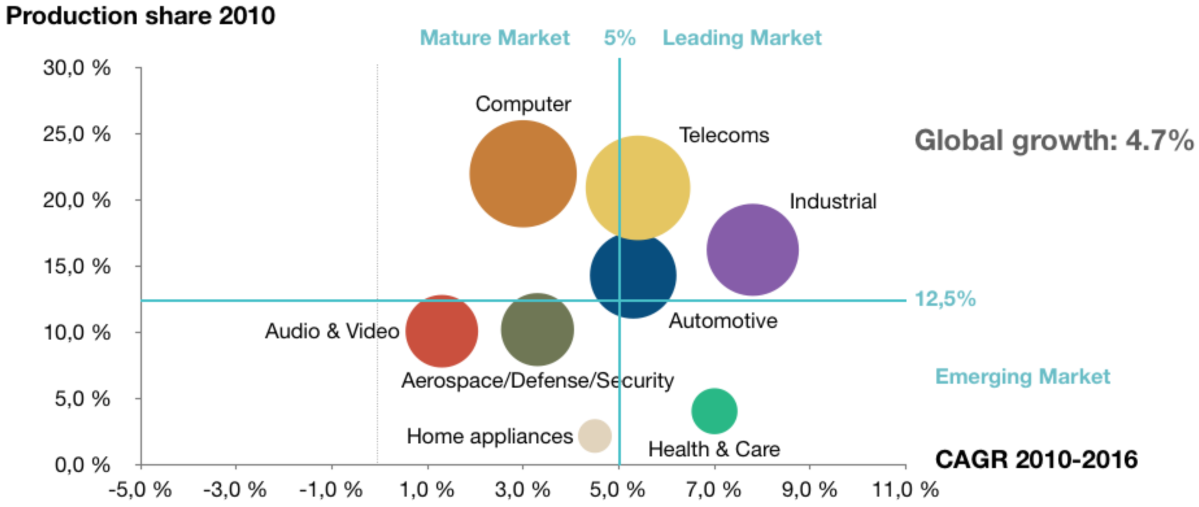


Electronic equipments/systems production by segment in 2017 (B €)



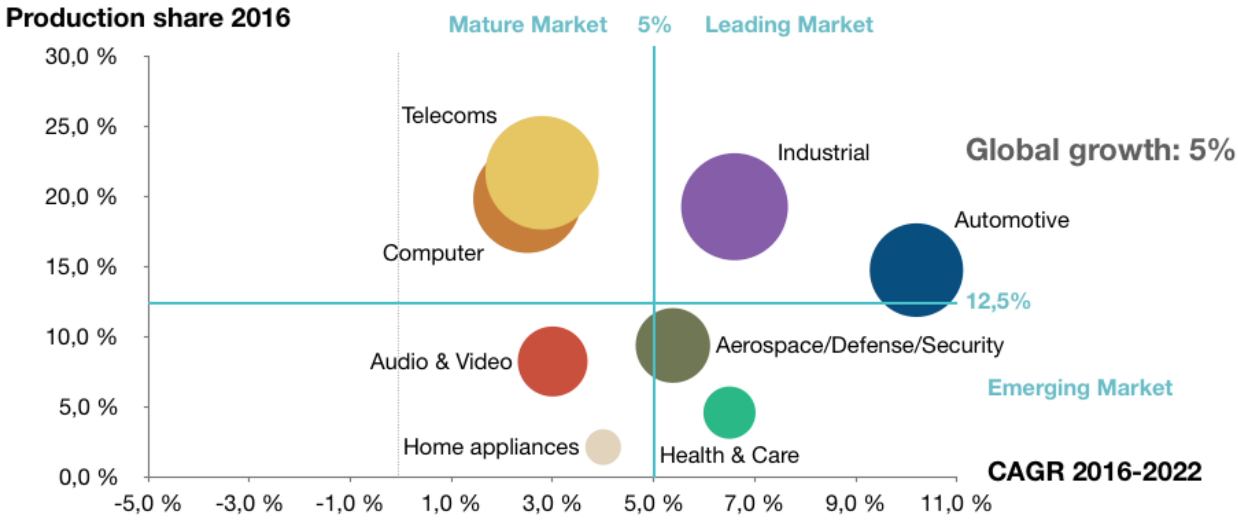
Source: DECISION Etudes & Conseil

Electronic equipments/systems by segment: Production size in 2010 and Average Growth Rate in the 2010-2016 period



Source: DECISION Etudes & Conseil

Bubble diagram – Electronic equipments/systems by segment: Production size in 2016 and Average Growth Rate in the 2016-2022 period



Source: DECISION Etudes & Conseil

1.3.3 The will of China to take the lead at every step of the global value chain

As presented in the figures above, Chinese' electronics suppliers are already key players at the global scale.

In its plan named "Made in China 2025"[1], China clearly announced its willingness to not only maintain and develop its position of electronics manufacturing strength, but also to take the lead at every step of the global electronics value chain.

In order to achieve this ambitious goal, China strives to exploit every opportunity:

- First, China uses its huge domestic market to set up Chinese leaders in every industrial segment. Indeed, this huge domestic market enables incredibly high scale-economies. Once the Chinese government reserved a great proportion of its domestic market shares to a specific Chinese company, such a company easily benefits from the required scale-economies to become a global leader in its segment. Among the policy tools used by the Chinese government to protect its domestic companies, there are:
    - The prohibition for any foreign company to buy more than 50% of the shares of a Chinese company;
    - The Chinese government is very proactive in terms of regulations to fight against pollution (including CO_2 and NOx emissions). Yet, the Chinese government usually provides the technical specifications of such new regulations to foreign producers only 3 months before their entry into force. The Chinese government provides the technical specifications to Chinese producers significantly earlier in order to give them competitive advantages.
- Second, China uses the power of attraction of its huge domestic market to set up joint ventures in China with as many foreign companies as possible. Indeed, since 1994, foreign group moving to China must to form joint ventures in which they cannot hold more than 50% of the shares, the other 50% being hold by Chinese shareholders. This legal structure has many advantages for China:
    1. It allows Chinese players to accelerate technology transfers;
    2. It allows Chinese players to impose the set-up of engineering offices, R&D offices and regional headquarters in China;
    3. It leaves the door open for an eventual future redemption of the rest of the shares by Chinese players.
- Third, on every segment, once Chinese players gained sufficient negotiation power at the global scale upward the value chain, they thrive to progressively impose Chinese suppliers at the bottom of the value chain.
- Finally, China is not only implementing strategies to take the lead on the supply chain from the top. China already took the lead on the supply chain from the bottom (raw material production) and is using this leading position as an asset. In September 2017, the European Commission published "the 2017 list of Critical Raw Materials for the EU"[2]. This document insisted on the fact that:" China is the most influential

[1] See the report made by the European Union Chamber of Commerce in China on the "Made in China 2025" plan.

[2] Communication from the commission to the European Parliament, the Council, the European Economic and Social Committee and the committee of the regions on the 2017 list of Critical Raw Materials for the EU, Brussels, 13.9.2017, COM (2017) 490 final.

country in terms of global supply of majority of critical raw materials, such as rare earth elements, magnesium, tungsten, antimony, gallium and germanium among others (…) The risks associated with the concentration of production are in many cases compounded by low substitution and low recycling rates." A great amount of such critical raw materials is essential in the electronics industry and China uses its monopoly position to sell some resources up to 20% more expensive to its foreign customers. To the extent that the USA filed a complaint in 2016 before the World Trade Organization (WTO), accusing China of "disadvantaging US producers". In addition, since the early 2000s, Beijing has reduced exports of various materials, such as molybdenum, fluorine, magnesium or yellow phosphorus. These maneuvers place Western manufacturers in a dilemma: should the production tools be maintained permanently in their current locations, with the associated risk of shortages coming from China? Or is it necessary to relocate to China in order to benefit from unlimited access to raw materials? Cheap labor from inland areas, the low cost of capital - driven in part by a policy of devaluation of the yuan - and the strong potential of the Chinese market have already convinced many of them to relocate to China.

In other words, China combines three elements to take the lead of the global electronics supply chain:

- Key positions at the bottom of the supply chain thanks to materials and equipments manufacturing;
- Key positions at the top of the supply chain thanks to its huge domestic market;
- Smart and very proactive industrial policies.

For instance, China is particularly proactive in terms of electric battery production. In 2015, the "Made in China 2025" plan made automotive electric battery itself an industrial priority. China is expected to produce 80% of commercial batteries sold in the world by 2020. The aim of China is not only to sell batteries to the world but to use its position of world leader in terms of electric battery production to progressively become the world leader in terms R&D, engineering and production of electric vehicle. Among the 10 world first producers of battery electric vehicles (BEV), 6 are already Chinese: BYD, Shanghai Automotive Industry Corporation (SAIC), Dongfeng Motor Corporation, Geely, FAW Group and Beijing Automotive Industry Holding Co. Brussels announced October 11, 2017 the creation of a European Battery Alliance to counter the Chinese lead.

1.3.4 The attempts of the United States to tackle Chinese' rise

For a few years now, the United States has become aware of the threat that represent the development of China at every step of the electronic value chain. The trade reforms undertaken by the President since early 2019 are a consequence of this awareness. A list of 5 745 Chinese products (including a large share of electronic products), has been set up by the USA. It represents an amount of $ 200 B to compare with the total amount of the USA importations: $ 505 B in 2017. These products will be taxed at a rate of 10% until January 1st, 2019. Thereafter, tax rates should rise up to 25%. The USA is adopting the same policy as the one set-up in the 1980s by Ronald Reagan towards Japan that was at that time on its way to become the first country in the world (in terms of GDP). The USA successfully imposed drastic raises of tax rates (up to 100%), on a large number of Japanese products (mainly electronic products: cameras, camcorders, etc.). Under the current American pressure, the Chinese government already proposed several concessions, among which the possibility for foreign companies to hold more than 50% of the shares of a Chinese company (proposal made in May 2019).

1.3.5 The fifth level: USA & China, beyond the electronics value chain

The USA launched a strategy that consists of going for what the Americans consider is the key to mastering the ecosystem, the fifth level of software and services[3], with dominant companies (Google, Amazon, Facebook, Apple, Microsoft, etc.).

The conquest of this level, together with a strict preservation of American ownership and headquartering of equipment and most of all of MNE companies considered critical have ensured up to now the dominant position of the USA in the world electronics ecosystem and MNE value chain.

Asia is however following the same path. Alibaba, the Chinese equivalent of Amazon, had revenues of € 33 B in 2017, up 58% from 2016, with its activity for the moment almost entirely situated in China. This compares with Amazon revenues of € 156 Bn. Tencent, the other major Chinese internet services company had 2017 revenues of € 32 Bn.

Europe, on the other hand is less visible on this level, except for the major legacy telecoms operators, such as Orange, BT, Deutsche Telekom, etc. with differentiating size and activity spread.

[3] That is the fifth level of the value chain: Level 1 (Material and tools), Level 2 (Semiconductors, passive components, others), Level 3 (Electronic boards), Level 4 (End-user electronic equipment), Level 5 (Associated Software and services).

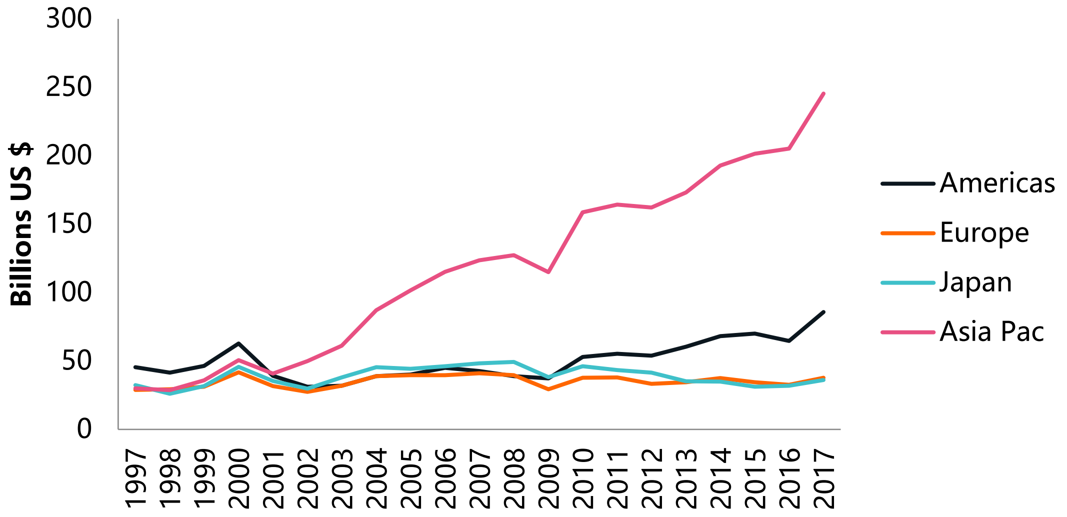
European industrial activity in MNE: a quantitative analysis

1.1 The global view and Europe's position

To estimate the evolution of the SC production, DECISION uses the WSTS billings data. **European semiconductor production represented around 35 B € in 2017**, i.e more than 9% of the world global SC output.

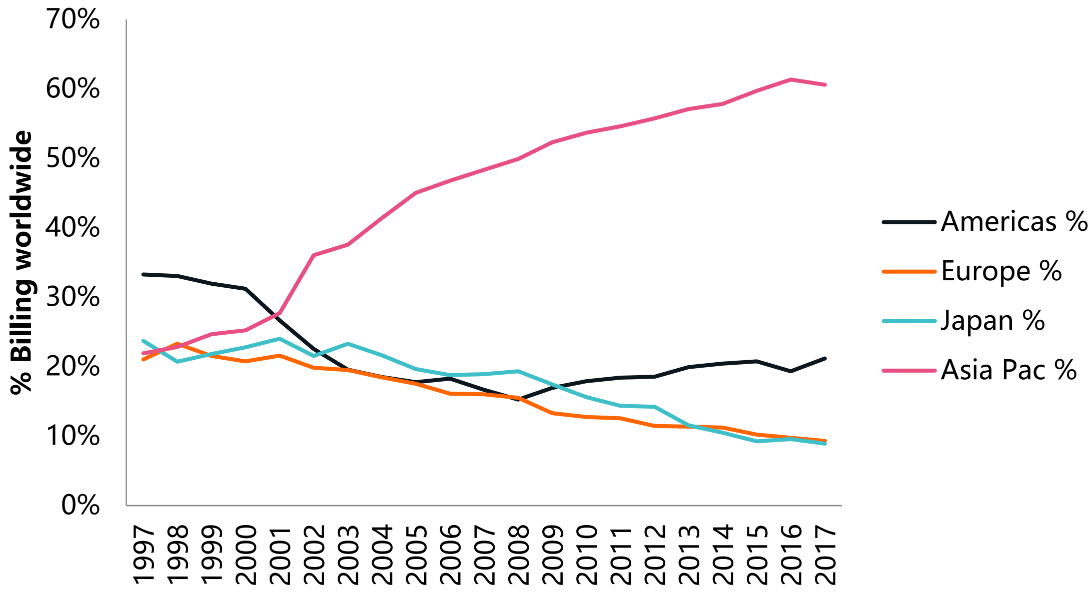
This figure is close to the production of semiconductors in the EU given by Prodcom (Eurostat), which corresponded to 32 B € in 2017, i.e. 8.5% of the World production.

World Semiconductor billings by region 1997 – 2017 (in value)



Source: WSTS 2017

World Semiconductor billings by region 1997 – 2017 (in %)



Source: WSTS 2017

According to the previous charts:

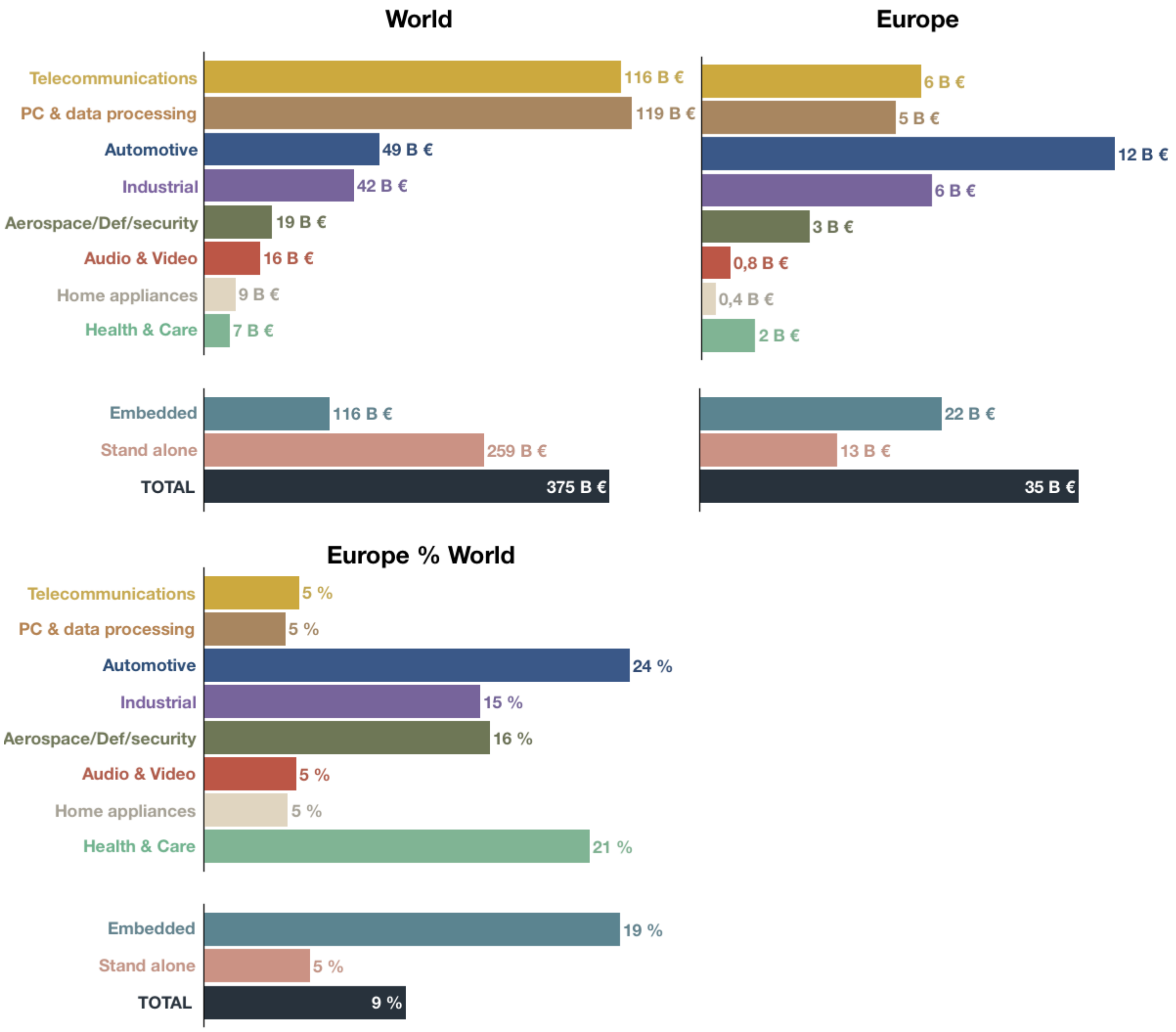
- The surge of electronic manufacturing in Asia-Pacific has been impressive since 2001. Semiconductor billings rose from 23% in 1997 to 61% of the world total in 2017. All regions have lost shares to the benefit of Asia-Pacific;

- America recovered a significant growth after the economic crisis of 2008. After falling from 33% in 1997 to 18.5 % in 2004, America then succeeded to maintain and even slightly increase its shares, representing 21% of the global billings in 2017;

- During the same period, the decline of the EU cannot be neglected, where Europe represented 9.3% of the world billings in 2017. The EU now ranks sixth, behind Taiwan, South Korea, Japan, the USA and China. The EU drift during the last 20 years shows: from a peak of 22% in 1998 to 13% in 2010, it is now down to around 9% in 2017.

- However, in absolute value, the EU semiconductor billings jumped from 28 B € in 2010 to 35 B € in 2017, corresponding to a compound annual growth rate of 3.8%.

Comparison of the European and the World semiconductor production by end-user segment in 2017 (B €)



Source: DECISION Etudes & Conseil

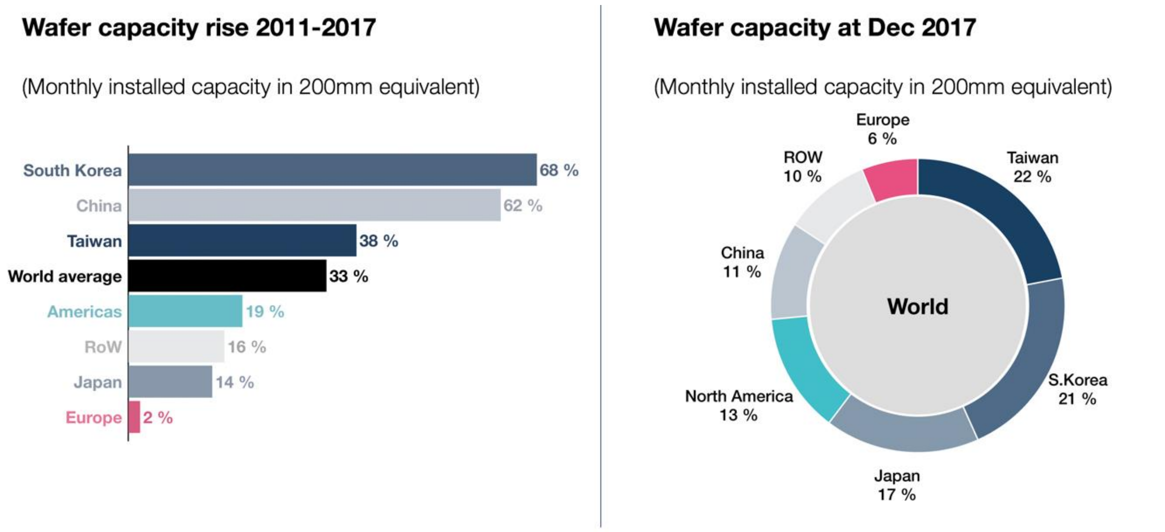
1.2 Wafer fab capacity: Europe's position in the world

1.2.1 Overall capacity

Europe's share of the wafer fab capacity for IC manufacturing is decreasing with an expected 5.3% share of world manufacturing capacity forecast by 2022, which would represent only 65 % of the value of the 2010 share (that was 8.1%).

Nevertheless, the 200mm fabs have been fully expanded in Europe thanks to the second-hand equipment market and only some semiconductor devices are able to take advantage of the cost saving generated by wafer size. As a consequence, **200m wafer fabs will still be profitable in Europe for a few years on devices like display drivers, microcontrollers, RF and analog products, specialty memories, MEMS and even 3D IC like MEMS & companion chips**. In Europe, new 200mm fabs have even been launched recently or refurbished after transfer of the former production to 300mm.

Globally, by geographic region, Europe is down to **6.2 % of the worldwide manufacturing wafer capacity in 2017**, against 8.1 % in 2010, and Asia is now up to 71.3%.



Source: IC insights, DECISION Etudes & Conseil

Forecast 2017-2022 monthly installed capacity shares – by geographic region

Country	2016	2017	2018*	2019*	2020*	2021*	2022*
ROW	10.1%	9.5%	9.6%	9.4%	9.7%	9.3%	9.2%
Europe	6.4%	6.2%	5.7%	5.4%	5.4%	5.4%	5.3%
China	10.8%	10.8%	12.5%	15.0%	15.6%	17.0%	17.1%
N. America	13.4%	13.2%	12.5%	11.7%	11.3%	11.1%	11.1%
Japan	17.1%	17.0%	16.8%	16.3%	16.3%	15.9%	16.1%
S. Korea	20.9%	21.3%	21.3%	20.9%	20.1%	19.9%	19.7%
Taiwan	21.3%	22.0%	21.6%	21.4%	21.6%	21.4%	21.6%

The large increase of China share is due to the progressive start of the high number of wafer factories that are launched according to Chinese program on semiconductors: The building of 26 new wafer fabs have been launched there in 2017 (source SEMI)

Source: IC insights

1.2.2 Capacity per wafer size

Analyzing the capacity per wafer size, **the majority of European capacity is in 200mm**. In 2017, Europe handled 7.6 % of the world 100/150mm capacity, 14.4 % of 200mm and 2.6 % of 300mm. These shares were respectively 11.2 %, 12.4 % and 4 % in 2010. This means that Europe has almost abandoned the manufacturing of advanced digital technologies[4] on the European soil.

The main consequence in the short to medium term will be that the corresponding technology knowledge and know-how will disappear from Europe. Design efficiency is closely linked to this technology knowledge and to the proximity between IC designers and manufacturing, and so the result will either be that the design of advanced digital products by the European companies will be made in Asia, or that the European companies will stop manufacturing advanced digital products.

Regional capacity by wafer size at Dec 2017 (monthly installed capacity in 200mm equivalent)

Wafer Size	Taiwan	S. Korea	Japan	N. America	China	Europe	ROW	Total
300 nm	2,878	3,308	1,778	1,494	1,097	308	942	11,805
200 nm	916	508	820	693	679	713	626	4,954
<= 150 nm	187	38	481	198	175	100	146	1,326
Total	**3,982**	**3,854**	**3,078**	**2,385**	**1,951**	**1,121**	**1,714**	**18,084**

Source: IC insights

Regional capacity by wafer size at Dec 2017 (monthly installed capacity in 200mm equivalent)

	≤ 150 mm	200mm	300 mm	Total
ROW	11%	13%	8%	10%
Europe	8%	14%	3%	6%
China	13%	14%	9%	11%
N. America	15%	14%	13%	13%
Japan	36%	17%	15%	17%
S. Korea	3%	10%	28%	21%
Taiwan	14%	19%	24%	22%

Source: IC insights

This will have 2 main other consequences:

- First the independence of Europe regarding advanced technologies (spatial, military, avionics, but not only) will disappear;
- Second, in the medium to long term, capacity to design and produce technologies based on legacy processes (analog, HF, and so on) may also progressively disappear as their evolution that is based on "re-use" of advanced logic processes will no more be available.

As of today, the 200mm capacity is likely largely dedicated to analog/mixed signals and microcontrollers, within IDM fabs or pure play foundries.

[4] Advanced technologies currently correspond to technologies below 22 nm.

At the end of 2017, 300mm wafer fab capacity accounted for 65% of the total installed fabs; capacity for 200mm wafers was 27% of the total.

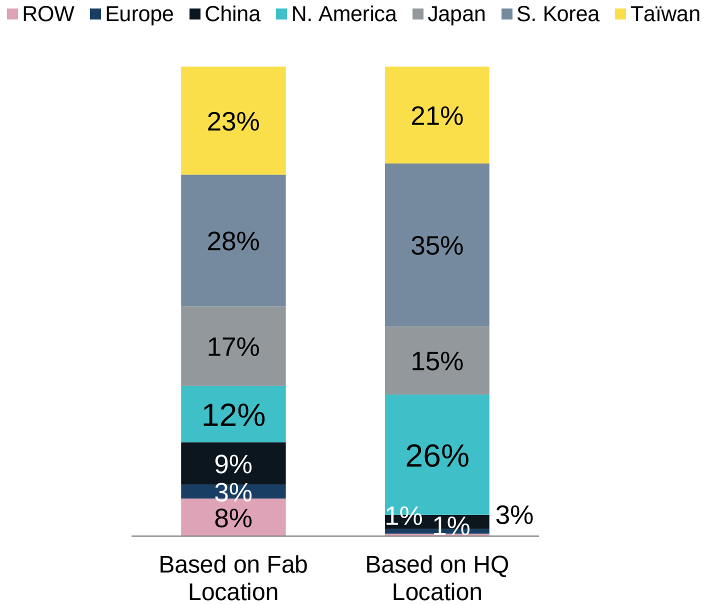
Almost 3/4 of the capacity of 300 mm is in the hands of the 5 biggest manufacturers, giving them an enormous power in the semiconductor market. Furthermore, the capacity of each of those fabs is huge (mega fabs) and they are equipped in a modular way, each module having a capacity up to 60,000 per month. Well managed, this generates an incredible manufacturing efficiency and a large manufacturing cost advantage.

One can rank the companies according to their total capacity on 300mm wafers (including IC + Optoelectronics/Sensors-actuators/Discretes). Looking at this ranking, the largest European company (STMicroelectronics) is only 18th with 0.4% of the global capacity, the 1st is Samsung with 22.5% of world capacity. The 2nd European company (Infineon) only ranks 23rd with 0.2% of world capacity.

Out of the top 10 companies in this ranking, 4 solely or primarily make memory chips, and 5 are pure play foundries.

It is interesting to compare the wafer capacity based on Fab location and on Headquarters location:

Comparing 300mm Wafer capacity based on Fab location and Headquarters location (5.5M* Wafers, December 2017)



*Includes 300mm capacity for O-S-D devices from Sony, Infineon and Samsung

Source: IC insights

This shows a strong imbalance between Fab and headquarter location for the USA and Europe: positive for the USA (Production based on HQ location > Production based on Fab location), and negative for Europe (Production based on HQ location < Production based on Fab location).

This also shows the very low presence of European companies in 300mm, and consequently in advanced digital technologies. The majority of 300mm wafers manufactured in Europe are made by Intel and Global Foundry.

1.2.3 Capacity per process technology

Key findings

- **European companies tend to specialize mainly on Bipolar, power, and BCD and "old MOS" technologies that don't require advanced processes capabilities;**
- **In MOS, Europe is almost not present on advanced technologies below 40nm, although it is within these below 40nm technologies that the major part of the growth within the next 5 years will take place.**

Regional capacity by Process Technology as of Dec 2017 (Monthly installed capacity in 200mm equivalent)

Process	Taiwan	S. Korea	Japan	N. America	China	Europe	ROW	Total
MOS	3,874	3,759	2,796	1,981	1,732	753	1,414	16,31
BiMOS/BCD	66	60	128	244	151	224	140	1,013
Bipolar	11	34	141	116	68	141	160	672
III-V	31	0	13	44	0	2	0	90
Total	**3,982**	**3,854**	**3,078**	**2,385**	**1,951**	**1,121**	**1,714**	**18,084**

Source: IC insights

Regional capacity by Process Technology as of Dec 2017 (Monthly installed capacity in 200mm equivalent, %)

Country	III - V 0,09M	Bipolar 0,67M	BIMOS/BCD 1,01M	MOS 16,31M	Total 18,08M
ROW	-	24%	14%	9%	10%
Europe	3%	21%	22%	5%	6%
China	-	10%	15%	11%	11%
North America	48%	17%	24%	12%	13%
Japan	14%	21%	13%	17%	17%
S. Korea	-	5%	6%	23%	21%
Taiwan	35%	2%	7%	24%	22%

Source: IC insights

According to IC Insights, in 2017 the very large majority (90.2%) of wafers are manufactured on MOS processes, then 5.6 % of WW capacity is devoted to BiMOS/BCD, 3.7% is Bipolar and 0.5% is III-V.

If we compare to 2010, the MOS ratio is almost stable (it was 90.6%), the BiMOS/BCD has increased (it was 4.6%), Bipolar has decreased (it was 4.8%) and the III-V is now measurable, thanks to the pervasion of this technology in the consumer market.

As we said before, the MOS technologies are globally made on the larger substrates (mainly 200 and 300mm); Bipolar is made on 100 to 150mm wafers and BiCMOS/BCD for Mixed signal and high voltage that used to be manufactured on 150mm have largely moved to 200mm and are beginning to be produced on 300mm.

Below is the capacity by process and region.

If we look at the capacity per processes installed in Europe and the trend from 2010, it appears that:

- The capacity in MOS has not changed since 2010 (still 753 Kwafers/month) while the global MOS capacity has grown by a factor of 1.46;
- BiMOS/BCD has grown by a factor of 1.27 while the global BiMOS/BCD capacity has growth by a factor of 1.8;
- Bipolar has growth by a factor of 2.09 while the global Bipolar capacity has growth by a factor of 1.12;
- Among the 753 K wafers corresponding to the European MOS production capacity, the 2 fabs of Intel Ireland and Global Foundry Dresden account for 259 K.

This clearly shows how European companies tend to specialize mainly on Bipolar, power, and BCD and "old MOS" technologies that don't require advanced processes capabilities.

If the production is split by minimum geometry, the regional capacity becomes:

Regional capacity by Minimum Geometry as of Dec 2017 (Monthly installed capacity in 200mm equivalent)

Geometry	Taiwan	S. Korea	Japan	N. America	China	Europe	ROW	Total
<20 nm	427	2,259	1,312	675	441	79	402	5,594
< 28 nm - ≥20 nm	1,035	788	263	293	234	54	183	2,85
< 65 nm - ≥28nm	756	261	136	136	279	171	327	2,236
< 0.2µ - ≥65nm	1,274	392	611	611	620	257	379	4,007
≥0.2µ	490	155	756	756	377	560	423	3,397
Total	**3,982**	**3,854**	**3,078**	**3,078**	**1,951**	**1,121**	**1,714**	**18,084**

Source: IC insights

Regional capacity by Minimum Geometry as of Dec 2017 (Monthly installed capacity in 200mm equivalent, %)

Country	≥ 0.2µ	<0.2µ - ≥65nm 4.01M	<65nm - ≥28nm 2.24M	<28nm - ≥20nm 2.85M	<20nm 5.59 M	Total 18.08M
ROW	13%	13%	15%	6%	7%	10%
Europe	17%	6%	8%	2%	1%	6%
China	11%	16%	13%	8%	8%	11%
N. America	19%	12%	14%	10%	12%	13%
Japan	22%	15%	6%	9%	23%	17%
S. Korea	5%	10%	12%	28%	40%	21%
Taiwan	14%	32%	34%	36%	8%	22%

Source: IC insights

These tables show again that in MOS, Europe is almost not present on advanced technologies below 40nm, although it is within these below 40nm technologies that the major part of the growth within the next 5 years will take place.

1.2.4 Capacity per product type: Europe strong in analog and foundry

Regional capacity by Product Type as of Dec 2017 (Monthly installed capacity in 200mm equivalent)

Product	Taiwan	S. Korea	Japan	N. America	China	Europe	ROW	Total
Memory	806	2,784	1,602	504	675	18	544	6,934
Analog	13	66	399	569	97	381	91	1,616
Logic	1	423	425	196	0	102	59	1,206
Micro	3	11	248	478	0	148	145	1,033
Foundry	3,076	310	267	589	1,143	309	613	6,306
Other	82	259	138	49	36	163	262	989
Total	**3,982**	**3,854**	**3,078**	**2,385**	**1,951**	**1,121**	**1,714**	**18,084**

Source: IC insights

Regional capacity by Product Type as of Dec 2017 (Monthly installed capacity in 200mm equivalent, %)

Country	Memory 6.93M	Analog 1.62M	Logic 1.21M	Micro 1.03M	Foundry 6.31M	Other 0,99M	Total 18.08M
ROW	8%	6%	5%	14%	10%	27%	10%
Europe	1%	24%	9%	14%	5%	17%	6%
China	10%	6%	-	-	18%	4%	11%
N. America	7%	35%	16%	46%	9%	5%	13%
Japan	23%	25%	35%	24%	4%	14%	17%
S. Korea	40%	4%	35%	1%	5%	26%	21%
Taiwan	12%	1%	1%	1%	49%	8%	22%

Source: IC insights

The EU's strengths

Analog and Foundry are the two-product types for which Europe preserves its top positions. Looking at the regional capacity per product type shows that Europe is mainly present in analog, micro and foundry that globally account for 74.8 % of Europe manufacturing capacity.

- In terms of **Analog**, Europe holds 24% of the global capacity. Europe is therefore the third region (3/7), in terms of analog capacity, after North America (35%) and Japan (25%). The main end-user segments of analog products are indeed the professional electronic segments were Europe holds a great position. From 2010 to 2017, Europe's capacity in analog has been multiplied by 1.42 while the total capacity worldwide has been multiplied by 1.43, showing that Europe has maintained its world share in this product family;

- In terms of **Foundry**, Europe's production capacities are still ahead of Japan with 5% of the global capacity. Yet, Europe is already the sixth region (6/7) in terms of foundry capacity after Taiwan (49%), China (18%), Rest of the World (10%), North America (9%) and South Korea (5%).

The good news is that as shown in the bar chart below, compared to the forecasted 6% global growth rate of capacity needed from the demand side for the next 5 years, the expected growth rate for analog and for foundry is 7%. One of the goals for Europe should thus be at least to maintain and increase its position in the analog and foundry markets.

Market CAGR of Major Product Categories (2017-2022F)

Source: IC Insights

Regarding other semiconductor types:

- Europe has just maintained a niche market capacity in memories, decreasing from 49,000 wafers /month in 2010 to now 18,000;
- Europe's capacity in logic has also decreased from 170,000/month to 102,000 during the same period. Europe capacity on micro has also strongly fallen from 311,000 wafers /month in 2010 to 148,000 now. Foundry capacity, thanks to Global Foundry, increased during the same period from 99,000 wafers/month to 309,000.

The competitive position of the European MNE industrial base in the World

1.1 Structural evolutions of the world competitive landscape

1.1.1 Fragmentation and internationalization of the value chain

The competitive landscape of MNE industrial players have been impacted in the past decades by two major trends:

- **Fragmentation**: Industrial actors being more and more specialized in specific steps of MNE production.
- **Internationalization**: The different steps of MNE production being made in different regions of the world.

In-house offshoring of semiconductor assembly and testing started very early in the globalization process (Fairchild was the first company to move its assembly to Hong-Kong, in 1961). Chip production offshoring (by U.S. companies) started later in the 1970s but for different reasons. Yet, most experts identify the real start of the fragmentation of the semiconductor value chain in the early 1980s when the fabrication segment separated from the design segment, leading to the emergence of fabless firms.

The root cause of such specialization was the high cost of entry into the semiconductor industry, leading to the development of Electronic Design Automation (EDA) tools (1981) and of pure-play foundry fabs (the companies MOSIS and TSMC were created respectively in 1981 and 1987). With the arrival of EDA companies, Independent Device Manufacturers (IDMs) were able to outsource not only the computer-aided-design (CAD) tools they were developing themselves, but also some of their designs to a new breed of companies, the “design houses”. In turn, design houses started developing products of their own as the demand from IDMs was not steady, thus creating the first fabless companies and looking for companies to produce their products. The first foundries were laboratories or small companies only able to produce prototypes and small volumes.

In the 1990s, the emergence of the so-called “system-on-chip” methodology led to the disintegration of the design part of the value chain into EDA and Intellectual Property (IP)[5] providers and design houses. The fragmentation of design undermined the prevailing opinion that off-shoring production of semiconductors was not a relevant business issue given that design, as the high value-adding part, remained in the country of origin.

During the last 2 decades the long-term trend in fragmentation of the semiconductor value chain has continued (especially at the design level). There are four main reasons for this:

1) Cost reductions by moving production to “low labor cost” countries;
2) Migration of consumer goods production to Asia, encouraging the move of related semiconductor production towards Asia;
3) Perpetual high pace of technological change, inciting companies to focus on core competencies;
4) The rising costs of building and equipping fabs;

[5] In electronic design a semiconductor intellectual property core, IP core, or IP block is a reusable unit of logic, cell, or chip layout design that is the intellectual property of one party. IP cores may be licensed to another party or can be owned and used by a single party alone.

1.1.2 Fab-light is the way to fabless

The beginning of the 21th century has seen the emergence of the “fab-light” model due to the increasing cost of building state-of-the-art fabs, which today are only affordable by a handful of IDMs (Intel, Samsung, Toshiba, Renesas, etc.) and foundries (TSMC, UMC, Global Foundries, SMIC, etc.). Fab-light refers to the move by a large number of companies from the ‘fab’ model of a full IDM manufacturer towards an intermediate model where they act as an IDM for only part of their sales and as “fabless” for the rest (i.e. by outsourcing production to a foundry).

As mentioned by an industry leader “fab-light is a cashless strategy”, as it is a way for an IDM to avoid investing in new manufacturing plant. Financial pressure from shareholders worried by insufficient results has triggered this successful short-term financial strategy in most companies, as seen in Europe with Infineon, NXP and to a lower degree STMicroelectronics.

However, there is a good case for the assumption that “fab-light is the way to fabless”. The products that are manufactured by foundries for IDMs are state-of-the-art and require the latest manufacturing facilities. Over the years, these products become commodity products and the older fabs become obsolete. The fab-light IDMs will close the obsolete plants and will most probably not have the cash (because, in the meantime they will have lost the human resources, know-how and equipment) needed to build state-of the-art new ones, so they are likely to become at least partially fabless and to focus on niche market on which they are able to produce.

1.1.3 Towards a less fragmented value chain?

However, the rise of new Chinese semiconductor suppliers, and the lessons from recent earthquakes and other disasters raise the question of whether a less fragmented value chain pattern may emerge in the future.

The literature and recent dramatic events in Japan highlighted the fragmented and therefore weak points of the value chain:

1. Raw materials (used for manufacturing raw wafers, then in the transformation of wafers into chips, and again in the assembly phase) are critical in the process and are only produced in few places. They include silicon, germanium, gallium and boron;
2. The fabrication of raw wafers is complex and involves a large number of different materials and process steps. In addition to this complexity (and potential disruption in the raw materials, utilities and chemicals supply chain), over 50% of production comes from Japan (source: SIA 2014) and Taiwan is coming up fast;
3. As far as (pure-players) foundries (that is companies with manufacturing plants but no design capabilities) are concerned, the main issue is their concentration in Greater China, i.e. Mainland China and Taiwan. This is a concern knowing that state-of-the-art production processes are highly concentrated in foundries, in companies producing memories, such as Samsung, Hynix,Toshiba and Intel.

1.2 The competitive position of Europe

Most parts of the semiconductor value chain are now located outside Europe

During the 1990s, Europe saw growth in new fabs but since then the flow has reversed, and the region fell significantly behind in semiconductor manufacturing during the last decade. Old fabs closed with few new ones opening to replace them. The reason is that European semiconductor companies have mostly adopted the fab-light approach.

Such offshoring and outsourcing are part of the history of the semiconductor industry and not specific to one region. Furthermore, the internationalization of the value chain has never been considered as a problem by corporations. Nevertheless, offshoring and outsourcing leads on the mid-term to a loss of human resources, industrial know-how and key equipment needed to build state-of-the-art new factories if needed in the EU territory. Besides, it places the EU in a weak position towards the producing countries in a period of political tensions and therefore constitute a limitation of the EU's sovereignty.

Moreover, the fact that the capability to manufacture on advanced technologies[6] disappears in the EU represent a direct loss of competitivity for the EU MNE ecosystem. This means that production of advanced technologies will remain in the hands of foundries and the remaining full-fab IDMs (it is to be noted that “cooperative” foundries - supported by several companies- is a possible development that would be likely to fuel the large movement of consolidation in the industry).

Europe remains a world leader in terms of semiconductor equipment production

ASML, based in the Netherlands and supported by research at IMEC, is a world leader in lithography with 9 B € turnover in 2017.

SOITEC is a key player in SOI wafers and is gaining market shares thanks to its FDSOI technology.

M + W is a world leader in advanced technology facilities with a turnover of 2 560 M € in 2017.

Companies like ASML or AIXTRON are also gaining important market shares thanks to their deposition technologies.

RECIF is one of the world leaders at robotic wafer handling.

Europe is a world leader in R&D, mostly due to successful European Commission supported basic research

The Imec, the Fraunhofer Institutes and the CEA Leti are excellent R&D centers at the cutting edge of numerous MNE technologies.

[6] Currently corresponding to below 22 nm.

1.3 Key players of the MNE global Value Chain

Semiconductor players' sales at every step of the SC value chain in 2016

Segment	Company	Country	Sales
SC suppliers	Intel	USA	€ 54.1 B
	Samsung	South Korea	€ 10.1 B
	Qualcomm	USA	€ 15.4 B
	SK Hynix	South Korea	€ 14.7 B
	Broadcom	USA	€ 13.2 B
	Micron Technology	USA	€ 13 B
	Texas Instruments	USA	€ 11.9 B
	Infineon	EU	€ 9.4 B
	NXP Semiconductors	EU	€ 9.3 B
MEMS suppliers	Bosch	EU	€ 1.2 B
	STMicroelectronics	EU	€ 0.8 B
	Texas Instruments	USA	€ 0.7 B
	Avago	USA	€ 0.7 B
	InvenSense	USA	€ 0.4 B
Manufacturing equipment	ASML	EU	€ 7.0 B
	Lam Research	USA	€ 6.1 B
	Tokyo Electron	Japan	€ 5.8 B
	KLA Tencor	USA	€ 3.0 B
	SCREEN Semiconductor Sol	Japan	€ 1.7 B
	Advantest	Japan	€ 1.3 B
	Teradyne	USA	€ 1.3 B
	Hitachi High Technologies	Japan	€ 1.1 B
SC Materials	Applied Materials	USA	€ 9.4 B
	ASM	EU	€ 0.9 B

Source: DECISION, company reports

1.4 Semiconductor producers

1.4.1 Top players in wafer capacity

In 2017, Samsung ranks first in semiconductor wafer capacity, in world semiconductor sales, and in world semiconductor buying.

Regarding wafer fab capacity, Europe used to have three companies among the top 10 in terms of installed capacity in 2006. In 2017, there was only one company ranking 10th (ST), the next two ranking 13th and 17th (NXP however is no longer a European headquartered company). The world leader's wafer capacity is 5.5 times larger than that of the leading European company (in 2010 the ratio was only 2.2).

Wafer Capacity leaders at Dec 2017 (Monthly installed capacity in 200mm equivalent)

2017 Rank	2016 Rank	Company	Region	Dec 2016 Capacity (Kw/m)	Dec 2017 Capacity (Kw/m)	Yr/Yr Change	Share of Worldwide Total	Inclusion or Exclusion of Capacity Shares from Joint Venture Fabs
1	1	**Samsung**	S. Korea	2,549	2,810	0,1	15.5%	
2	2	**TSMC**	Taiwan	2,005	2,237	0,12	12.4%	+SMC, +Vanguard
3	3	**Micron**	N. America	1,558	1,604	0,03	8.9%	+IM Flash
4	4	**SK Hynix**	S. Korea	1,463	1,578	0,08	8.7%	
5	5	**Toshiba/SanDisk**	Japan	1,389	1,513	0,09	8.4%	
6	6	**Intel**	N. America	736	781	0,06	4.3%	+IM Flash
7	7	**GlobalFoundries**	N. America	706	749	0,06	4.1%	+SMP
8	8	**UMC**	Taiwan	606	651	0,07	3.6%	+Mie Fujitsu
9	9	**Texas Instruments**	N. America	553	584	0,06	3.2%	
10	10	**STMicroelectronics**	Europe	481	510	0,06	2.8%	
11	11	**SMIC**	China	366	424	0,16	2.3%	
12	12	**Powerchip**	Taiwan	313	361	0,15	2.0%	
13	13	**Infineon**	Europe	248	278	0,12	1.5%	
14	14	**ON Semiconductor**	N. America	247	264	0,07	1.5%	+Aizu Fijitsu
15	15	**Huahong Grace**	China	238	245	0,03	1.4%	+Huali Microelectronics
16	16	**Renesas Electronics**	Japan	236	245	0,04	1.4%	
17	17	**NXP**	Europe	215	201	-0,06	1.1%	+SSMC
18	18	**Vanguard**	Taiwan	165	185	0,12	1.0%	-TSMC
19	19	**TowerJazz**	ROW	151	157	0,04	0.9%	+TPSC
20	20	**Nanya Technology**	Taiwan	135	153	0,13	0.8%	
21	21	**Panasonic**	Japan	133	139	0,04	0.8%	+TPSC
22	25	**China Resources**	China	112	127	0,13	0.7%	
23	22	**Macronix**	Taiwan	121	125	0,04	0.7%	
24	23	**Fujitsu**	Japan	120	125	0,04	0.7%	-ON, -UMC
25	25	**DB HiTek**	S. Korea	112	116	0,04	0.6%	
		Others	-	**1,912**	**1,925**	**0,01**	**0,11**	
		Total		**16,870**	**18,084**	**0,07**	**1**	

Source: Companies, IC insights

1.4.2 Top semiconductor vendors

Top Ten Semiconductor vendors (Billion €)

2017 rank	2016 rank	Company	Country	2017 revenues	% Share	2016 Revenue	% Share
1	2	Samsung	South Korea	61 216	14.6	40 104	52.6
2	1	Intel	USA	57 712	13.6	54 091	6.7
3	4	SK Hynix	South Korea	26 300	6.3	14 700	79.0
4	6	Micron Technology	USA	23 062	5.5	12 950	78.1
5	3	Qualcomm	USA	17 063	4.1	15 415	10.2
6	5	Broadcom	Sing/USA	15 490	3.7	13 223	17.1
7	7	Texas Instruments	USA	13 806	3.3	11 901	16.0
8	8	Toshiba	Japan	12 813	3.1	9 918	29.2
9	17	Western Digital	USA	9 181	2.2	4 170	120.2
10	9	NXP	Europe	8 651	2.1	9 306	-7.0
		Others		**174 418**	**41.6**	**157 736**	**10.6**
		Total market		**416 720**	**100.0**	**343 514**	**22.2**

Source: Gartner

1.4.3 Top semiconductor buying companies

Top 10 Semiconductor buying companies by SC design TAM Worldwide (Millions of USD)

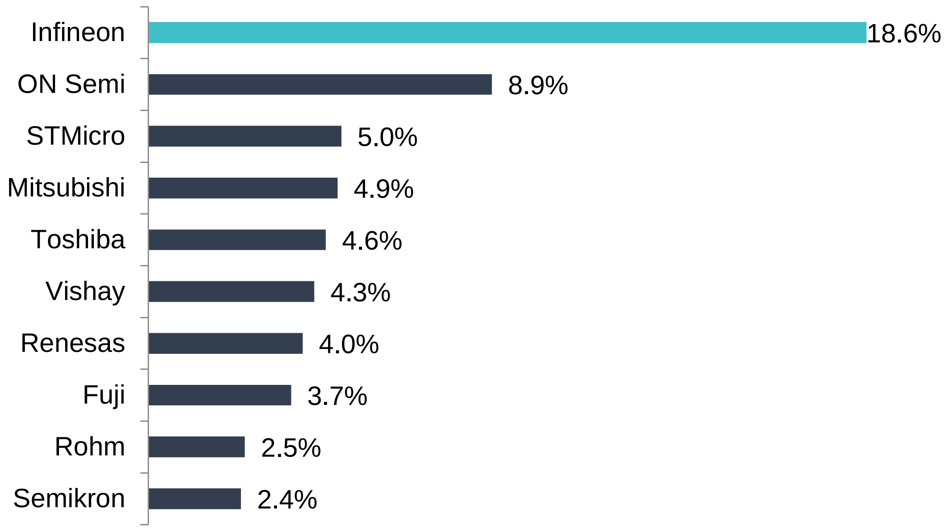
2017 rank	2016 rank	Company	2017 revenues	2016 revenues	2017 Market Share (%)	Growth (%)
1	1	Samsung Electronics	43,108	31,426	10.3	37.2
2	2	Apple	38,754	30,39	9.2	27.5
3	3	Dell	15,702	13,544	3.7	15.9
4	4	Lenovo	14,671	13,384	3.5	9.6
5	5	Huawei	14,259	10,792	3.4	32.1
6	7	BBK Electronics	12,103	6,411	2.9	88.8
7	6	HP Inc.	9,971	8,906	2.4	12.0
8	8	Hewlett Packard Ent	7,199	6,124	1.7	17.5
9	11	LG Electronics	6,537	5,162	1.6	26.6
10	13	Western Digital	6,21	4,47	1.5	38.9
		Others	**251,206**	**212,906**	**59.9**	**18.0**
		Total	**419,72**	**343,514**	**100.0**	**22.2**

Source: Gartner

1.4.4 Semiconductor markets where EU players are world leaders

Power discrete and modules – Global market shares 2017

Total market in 2017: $18.7 bn

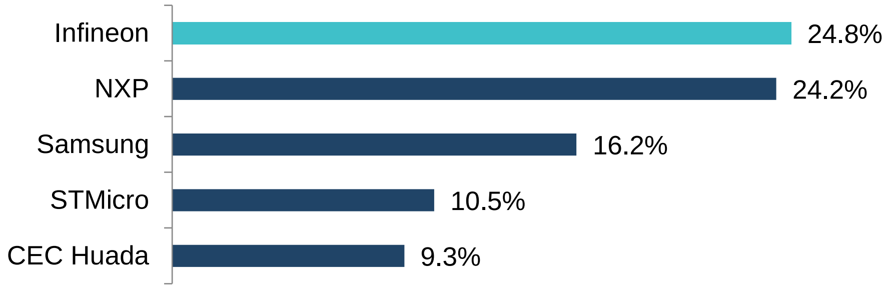


Source: Infineon, IHS Markit

On Power discrete and modules, Infineon is the World leader and ST Microelectronics ranks third in a global market of $18.7 B in 2017.

Microcontroller-based Smart Card ICs

Total market in 2016: $2.79 bn



Source: Strategy Analytics

On microcontroller based smart cards IC's, Infineon (n°1), NXP (n°2) and ST (n°4) cover 59.5 % of a world market estimated at $ 2.79 B.

Leading Analog IC Suppliers ($M)

2017 Rank	Company	2016	2017	% Change	% Market share
1	Texas Instruments	8,536	**9,900**	16%	18%
2	Analog Devices*	3,790	**4,310**	14%	8%
3	Skyworks Solutions	3,205	**3,710**	16%	7%
4	Infineon	3,030	**3,355**	11%	6%
5	ST	2,519	**2,930**	16%	5%
6	NXP	2,430	**2,415**	-1%	4%
7	Maxim	1,900	**2,025**	7%	4%
8	ON Semi*	1,335	**1,800**	35%	3%
9	Microchip*	819	**940**	15%	2%
10	Renesas*	810	**915**	13%	2%

*Includes sales from acquired companies in 2016 and 2017

It should be noted that this product category is the one that is forecasted to have the highest growth rate in the next 5 years.

Source: IC Insights, company reports

The 2017 $ 54.5 B market on analog products is more spread, nevertheless Europe is relatively well positioned with Infineon, ST and NXP.

Technological and market development and their impact on the European MNE industrial base

1.1 Key findings

- In terms of production of old technologies, the EU remains well positioned;
- On the contrary, advanced technologies are no longer manufactured in Europe;

Yet, the alternative technology named FDSOI is an opportunity to regain production shares in advanced technologies. There is a dichotomy between advanced technologies (MPU / MCU), and older technologies in Europe.

In terms of production of older technologies, the EU remain well positioned in particular thanks to the size and the growth of the industrial, automotive and aeronautics/defense/security end-user segments.

On the contrary, advanced technologies are no longer manufactured in Europe (except for the design and for a few very specific advanced technologies), so that Europe will soon become dependent of Asia regarding these technologies (leading to sovereign risks, climatic risks like earthquake, etc.). Since the 22 nm node, Intel, followed by all the companies willing to follow the More Moore path, have indeed introduced the FinFET technology to assure an increasing speed and density on all processor types. The European companies have not been able to follow this path, which generated a stall in Europe on the More Moore axis who is the main market driver, in particular for consumer electronics markets. The manufacture of advanced technologies is also leaving the EU because of the lack of public investment to support the manufacture of such technologies compared the US and Asia (in particular China). Yet, in terms of capital ownership, the EU players are still well positioned on advanced technologies: Infineon, STMicroelectronics, NXP and XFab. As a consequence, the middle-term risk only concerns the production of advanced technologies in Europe but do not concerns the know-how (patents, skilled-jobs, design, etc.).

The alternative technology named FDSOI is an opportunity the regain production shares in advanced technologies. An alternate technology named FDSOI has been developed in Europe, mainly by SOITEC/LETI/STM which has been implemented in Samsung and Global Foundry. It has some advantages compared to FinFET (mainly power consumption and a certain ease in manufacturing on photolithography) but also some drawback (mainly speed and density and up to now a quite low acceptance and support from the SC community).This technology is presently used in very low volume compared to FinFET but is said to present great interests in automotive and 5G. FDSOI is presented by his supporters as a possible path for Europe to regain market share in advanced technology.

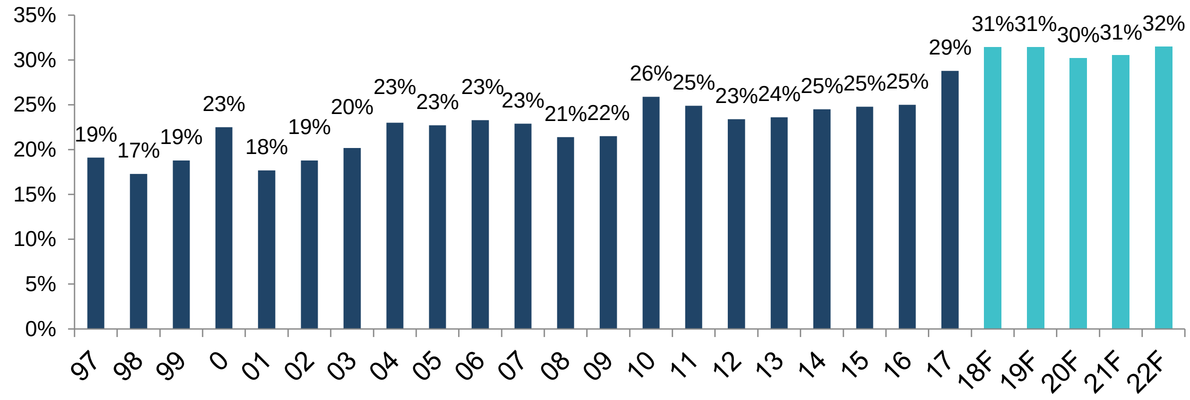
1.1.1 Global semiconductors' growth drivers

i. A growth ever more driven by the pervasive effect

Semiconductor content in equipment is growing as intelligence is increasingly embedded in modern devices and appliances. It has grown from 2% in the 1960s to 20% in the 2000s and is approaching 25% today in 2017. **The pervasive use of semiconductors across many economic sectors is essential, has been and will continue to be the main driver of SC market growth**. The driving force of the industry is changing over time. Today semiconductor technology contributes to individual productivity through mobile devices and multimedia, robotics, artificial intelligence. The next wave of applications will be in societal needs like health, energy, transport and security.

ii. A growth driven by an ever more rise of electronic systems' SC content

Electronic system semiconductor content past evolution and forecast



Source: ST Microelectronics, TI, IC Insights

Historically, the driving force behind the higher average annual growth rate of the semiconductor industry as compared to the electronic systems market is the increasing value or content of semiconductors used in electronic systems. With global unit shipments of cellphones (-1%), automotives (3%), and PCs (-1%) forecast to be weak in 2018, the disparity between the moderate growth in the electronic systems market and high growth of the semiconductor market is directly due to the increasing content of semiconductors in electronic systems.

While the trend of increasing semiconductor content has been evident for the past 30 years, the big jump in the average semiconductor content in electronic systems in 2018 is expected to be primarily due to the huge surge in DRAM and NAND flash ASPs and average electronic system sales growth this year. After slipping to 30.2% in 2020, the semiconductor content percentage is expected to climb to a new high of 31.5% in 2022.

The trend of increasingly higher semiconductor value in electronic systems has a limit. Extrapolating an annual increase in the percent semiconductor figure indefinitely would, at some point in the future, result in the semiconductor content of an electronic system reaching 100%. Whatever the ultimate ceiling is, once it is reached, the average annual growth for the semiconductor industry will closely track that of the electronic systems market (i.e., about 4%-5% per year).

1.1.2 The growth of more than Moore devices is an opportunity for the EU

Some ten to fifteen years ago, the split between ‘More Moore” and “More than Moore” became increasingly apparent, both in type of circuits and in type of applications. This resulted in two development directions:

- **The “More Moore” approach** characterized by following the Moore law (speed and transistor density doubling every 2 years), dedicated to speed and computation power;

- **The “More than Moore” approach** characterized by diversification of the applications (analog, RF, Passives, HV/Power, sensor/actuators, Biochips and so on).

More than Moore technologies are generally implemented using the process steps and the equipment that have been developed formerly by More Moore technologies, so they are less demanding in “state of the art” technologies and they use equipment and facilities already (at least partially) amortized. As a consequence, the knowledge on More Moore technologies need to have been built or acquired beforehand. Yet, the large majority of the remaining semiconductor facilities and fabs existing in Europe are now dedicated to More than Moore technologies.

Naturally More Moore and More than Moore technologies can be (and are) combined to produce higher values systems, etc. This of course implies the capability to master both.

1. More than Moore technologies are a strong driver of growth of wafer demand over the 2017-2023 period

Although around 81% of the volume[7] of end user markets are served by advanced CMOS devices (that is More Moore devices), the remaining 19 % of More than Moore devices are a strong driver of growth of wafer demand over the 2017-2023 period.

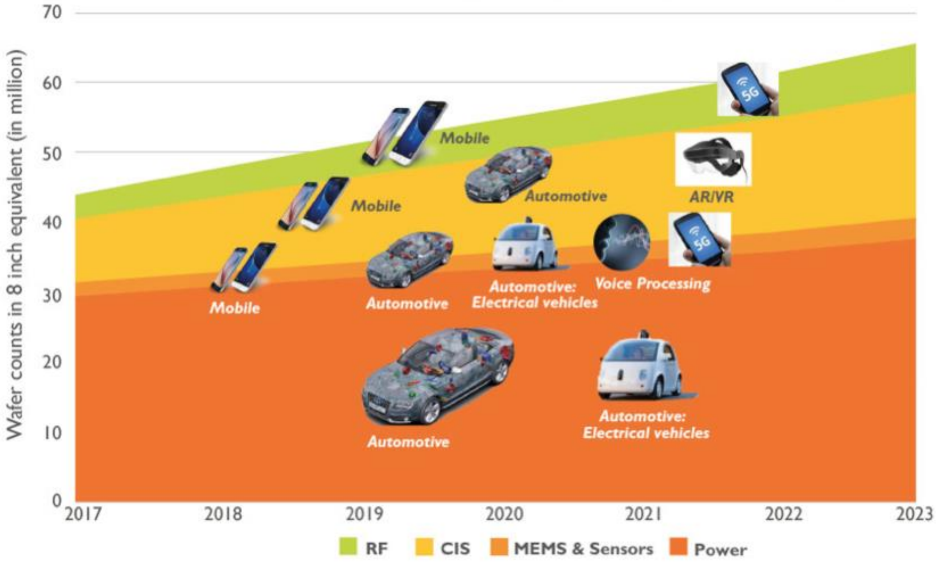
More than Moore devices should represent more than 66 million 8-inch equivalent wafers by 2023. As shown in the figure below, more than Moore devices will drive a strong growth of wafer demand (with a 7% CAGR over the 2017-2023 period according to Yole Development).

This growth of the need of wafers for More than Moore will be fueled by 5G and mobile, voice processing, artificial intelligence, motor drives, smart automotive and the automotive industry (see the graph below).

[7] DECISION Etudes & Conseil’s estimates

Overall wafer demand from 2017 to 2023

Breakdown by More than Moore device (in 8-inch eq)



Source: Wafer Starts for More than Moore Applications, Yole Développement, March 2018

2. On the demand side, the EU is well positioned in More than Moore technologies

The EU is very well positioned on the professional end-user segments (automotive, industrial, health & care), that are very consuming in terms of More than Moore devices.

3. On the supply side, the EU is well positioned in More than Moore technologies

On the supply side the EU holds strong positions in More than Moore technologies (RF, MEMS, Power Semiconductors as well as low power CMOS technologies like FD-SOI). For instance, 2 out of the 3 world leaders in MEMS production are European (ST Microelectronics and Bosch).

4. The EU still holds great capacities in old technologies (150 and 200mm wafers), that represent more than 60% of More than Moore total wafer consumption[8] in 2017

Below is a breakdown of wafers size by More than Moore applications[5] :

- Most of the demand for 300mm wafers is driven by CMOS Image Sensors Back Side Illumination;
- Most of the demand for 200mm wafers is fueled by CMOS Image Sensors, followed by power devices;
- Most of the demand for 150mm wafers is fueled by power devices followed by MEMS and RF devices;
- The decline of 100mm wafers is due to the transition to 150 mm for BAW ceramic RF devices.

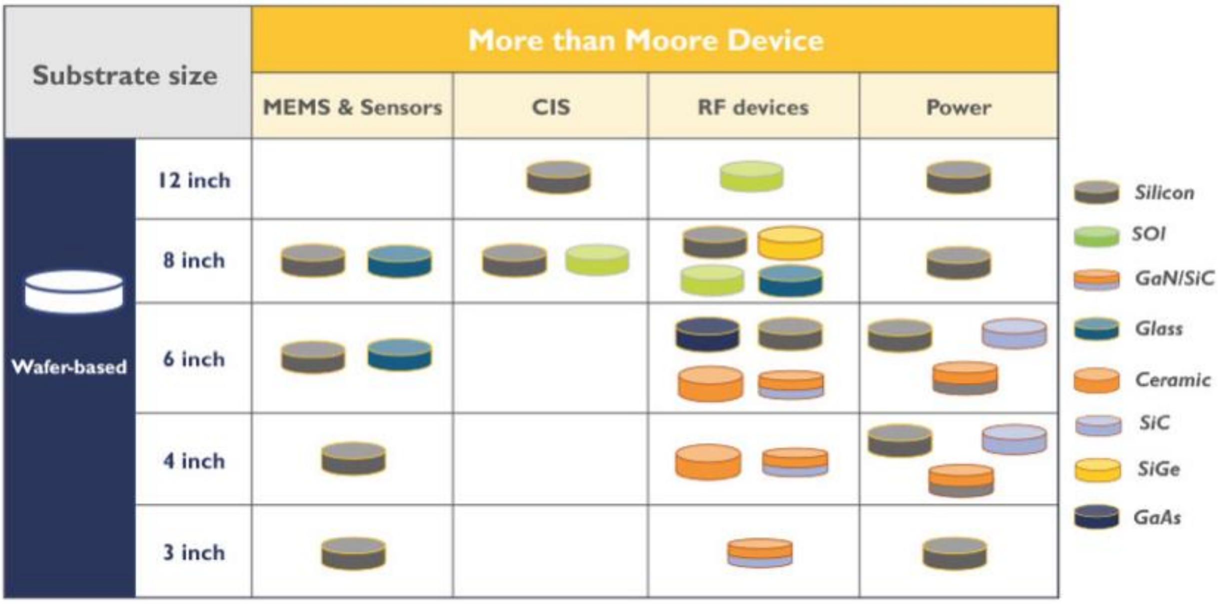
5. The rapid growth of More than Moore devices is therefore an opportunity for the EU

[8] According to Yole Développement.

1.1.3 The emergence of new substrates in More than Moore devices is an opportunity for the EU

As shown in the table below, even if the very large majority of the wafers used for More than Moore devices are still in silicon, other substrates types are appearing in line with the new functionalities and applications generated by the needs of higher integration**.**

Substrate type used by More than Moore wafer size



Source: Wafer Starts for More Than Moore Applications, Yole Développement, March 2018

The growth in volume of these substrates on technologies which are manufactured in Europe and for which European manufacturers remain quite solid is also an opportunity of development for the EU.

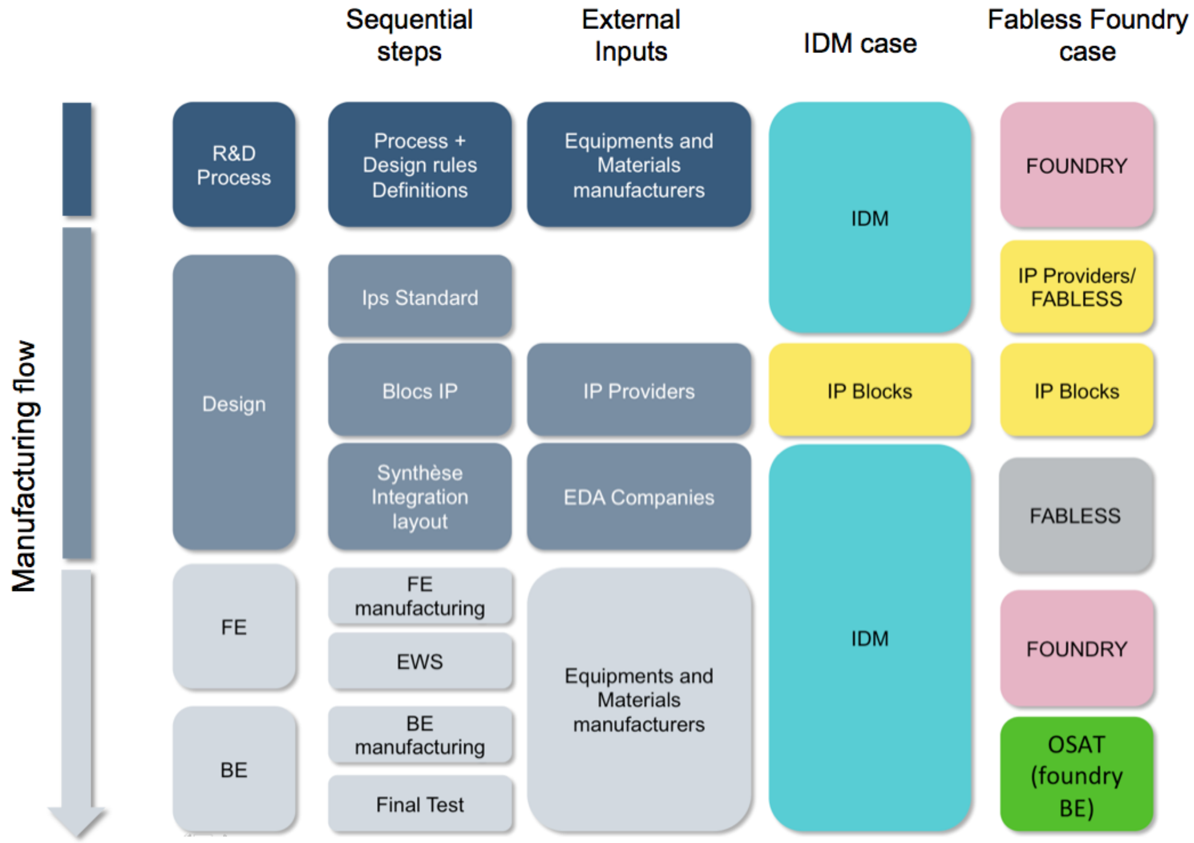
- In terms of SOI substrates, the European company SOITEC is the world leader with an annual revenue (fiscal year 2017-18) of € 311 M;
- On top of More than Moore substrates, SOITEC has developed a technology named FDSOI, presented as an alternative to advanced CMOS FinFET (More Moore) that may have a significant impact in automotive and communication (5G).

1.2 Technical and market development at every step of the semiconductor value chain

The manufacturing flow, with the sequential steps and the externals inputs is shown below for an IDM or for a Fabless/foundry case.

These steps and external inputs are needed whatever the type of semiconductor device (or circuit) required and manufactured. The differences between the technologies/processes or between the device types that are the outcome of the manufacturing process are due to the specifications and characteristics of the materials used (including wafers) and to the specifications and usage of the equipment along the different process steps.

Sequential step description



Source: DECISION Etudes & Conseil

1.2.1 Wafer production

i. Wafer technology – State of play

The main process steps to manufacture a semiconductor wafer are:

- Deposition / Oxidation / thermal treatments;
- Photolithography;
- Etching (bath or plasma or reactive ion etching);
- Chemical vapor deposition (with or without plasma);
- Ion Implantation;
- Chemical mechanical polishing (CMP);
- Plus, a lot of handling, control and test operations.

ii. Wafer market evolution

In 2017 :

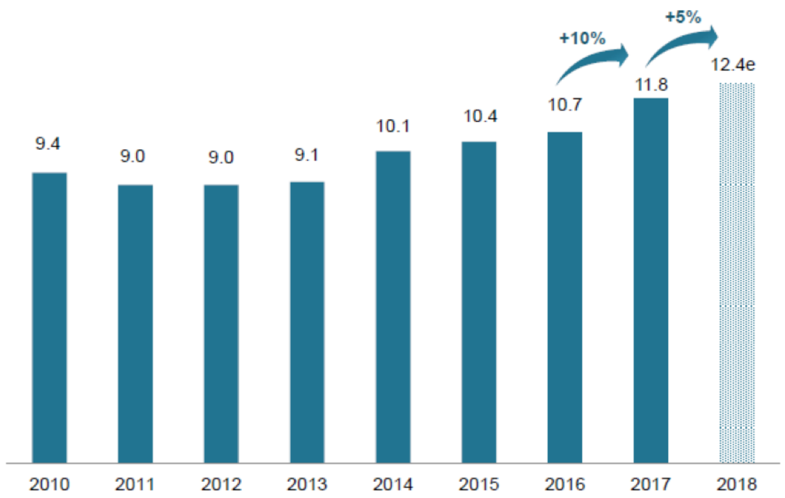
- The quantity of wafers started for IC manufacturing (mainly More Moore devices) is estimated to almost 195 million 8 inch equivalent (source: ICinsight);

- The total semiconductor wafer market is estimated at 8.7 B US$ (7.7 billion €) (source SEMI, Siltronic).

The demand is growing, mainly on 300mm wafers. However, whereas the growth of semiconductor chip revenue and physical silicon area produced are closely related, the silicon revenue has ceased to grow with semiconductor revenue since about 2011. The very large growth of demand in 2017 may partly explain the present tight supply situation, and the rising prices.

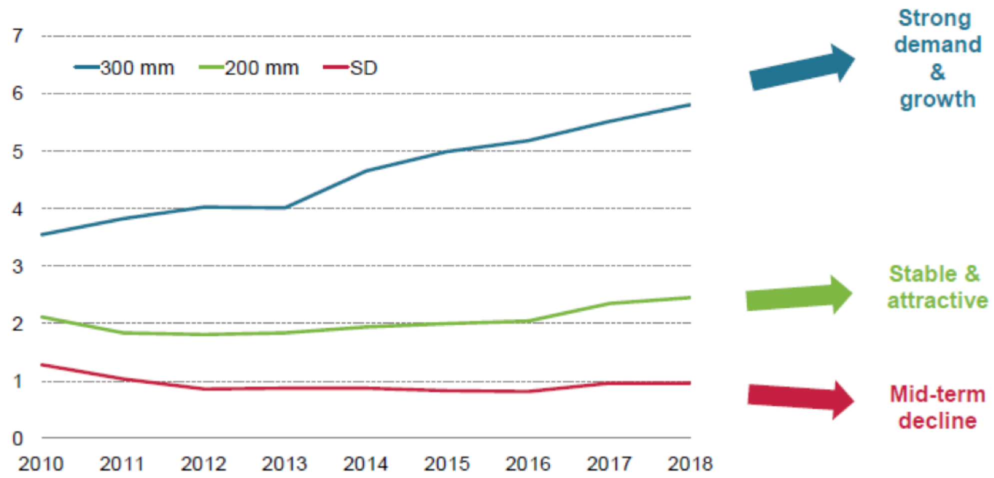
As shown in the two figures below, the global silicon wafer demand is rising at fast paces (+10% in 2017), and this growth is driven by 300mm.

Silicon wafer demand, in bn in^2



Source: SEMI (Silicon Area until 2017), HIS Markit Technology (Semiconductor Silicon Demand Forecast Tool, Q2'18 Update, Estimate 2018)

Development of total wafer demand per diameter

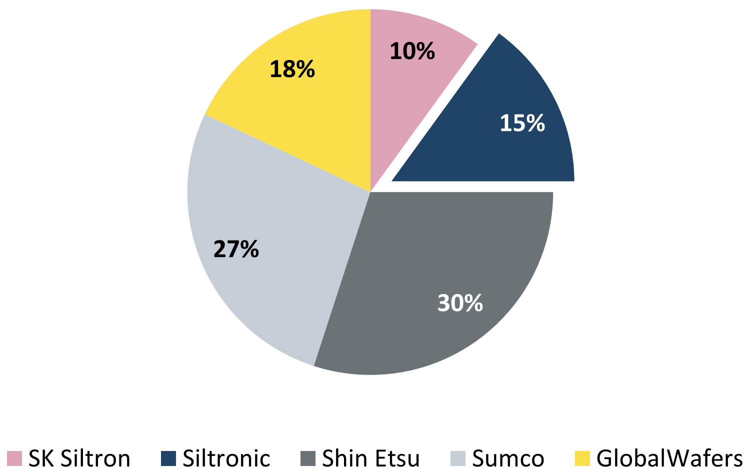


Source: SEMI up to March 2018

The quantity of wafers started for More than Moore devices, including MEMS & sensors, CIS (CMOS Image Sensor), and power (along with RF devices) reached almost 45 million 8-inch equivalent wafers in 2017 (source Yole).
This is consistent with a global amount of 230 million 8 inch equivalent estimated by IHS, due to double counting on some analog products.

iii. Wafer – Company positioning

Pie chart - Top 5 wafer producers serve more than 90% of market accros all diameters



Source: reported company revenues FY 2017, converted to USD million

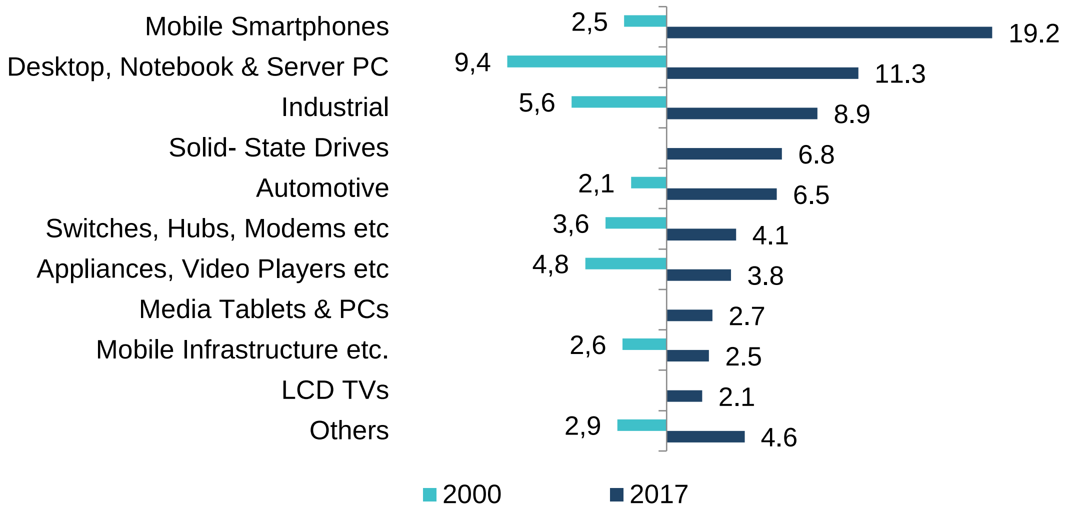
Another wafer producer, OKMETIC, specialised on 150 and 200mm wafers specific to MEMS, sensors and discrete/analog is based in Finland and owned by National Silicon Industry Group (China) since 2016.

OKMETIC claims to be the seventh largest silicon wafer manufacturer in the world.

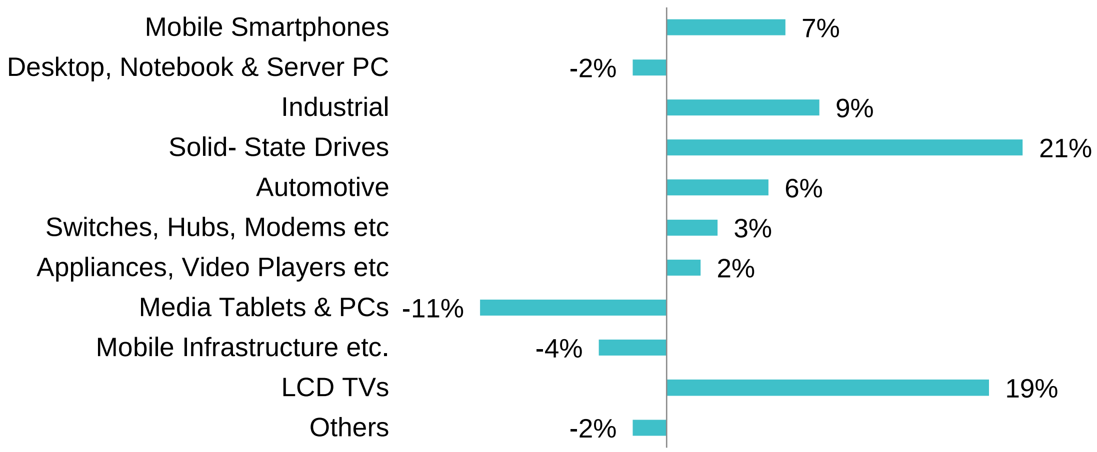
iv. Wafer demand by final market

The wafer demand by final market is shown below:

Bar chart - Wafer Demand 2000/2017, in bn cm2



Bar chart - Growth rate 2017-2018



Source: HIS Markit Technology (Semiconductor Silicon Demand Forecast Tool, Q2'18 Update)

Over the past 20 years, the silicon wafer industry has consolidated from more than 20 suppliers in the 1990s to only five large players today. Those 5 wafer manufacturers supplied more than 90 % of the market, among which the European company Siltronic accounted for 15 %[9].

[9] Source : company reports

1.2.2 Gas and materials

On top of the base wafers, the semiconductor manufacturing is using numerous other materials:

- Gas: oxygen, nitrogen, hydrogen, ammoniac, chlorine, silane, phosphine, diborane, arsine, numerous "precursor" gases, etc.;
- Liquid reagents: Hydrogen peroxide, sulfuric acid, Hydrofluoric acid, ammonium fluoride, hydrochloric acid, phosphoric acid, different salts, solvents, photosensitive resins, photo reagents, primers, etc.;
- Ultra-pure water;
- Polishing slurries: various mix of abrasive particles and chemical etchants;
- Packaging materials: ceramic and epoxy substrates, flexible substrates, gold wires, aluminum wires, glues, resins, molding components, frames, tin, lead, copper.

According to SEMI, total wafer fabrication materials and packaging materials accounted for $27.8 billion and $19.1* billion, respectively, in 2017. In 2016, the wafer fabrication materials and packaging materials markets logged revenues of $24.7 billion and $18.2 billion, respectively, for 12.7 percent and 5.4 percent year-over-year increases.

Wafer fabrication and packaging materials (Bn$)

	2016	2017	% Change
Wafer fabrication materials	24.7	27.8	12.7
Packaging materials	18.2	19.1	5.4
Total materials	42.9	46.9	9.3

Source: SEMI

This means that the total of materials, out of substrates, accounted for $38,2 billion.

The market per region is indicated below.

Homogeneous to the decrease of his production capacities, Europe became the lowest market, accounting for 7,2% of the total market.

2016 and 2017 Regional Semiconductor Materials Markets (US$ Billions)

Region	2016	2017	% Change
Taiwan	9.20	10.29	12%
China	6.80	7.62	12%
South Korea	6.77	7.51	11%
Japan	6.76	7.05	4%
Rest of World	5.39	5.81	8%
North America	4.87	5.29	9%
Europe	3.03	3.36	11%
Total	**42.82**	**46.93**	**10%**

Source: SEMI, April 2018

1.2.3 Semiconductor manufacturing equipment

Semiconductor manufacturing is highly dependent of very advanced and complex manufacturing equipment that is produced worldwide by a very small number of companies.

During the last 20 years, the number of suppliers available per process technology/step has drastically reduced due to the reduction of the number of semiconductor companies present in the market and the always more stringent specifications per process step. It appears that now it remains only more or less 1 or 2 manufacturing equipment suppliers available for each step/technology.

This again is becoming a high strategic risk for Europe which have lost the great majority of manufacturing equipment suppliers.

Nevertheless, the good news is that the undisputed company leader in photolithography for advanced CMOS processes, covering all technologies from 0,5µ to 5 nm is the European company ASML.

The ranking of the top 7 semiconductor equipment companies is indicated below.

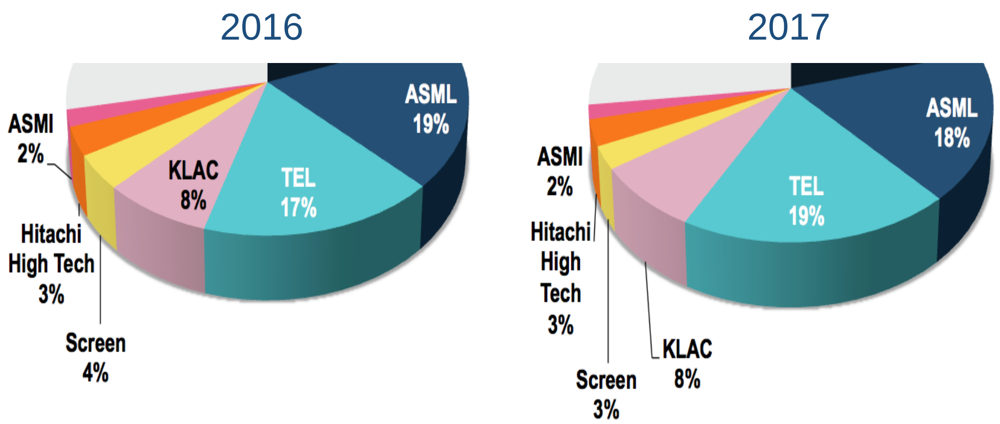
It shows that there are 4 big companies (including ASML) that dominate the market with revenues at least 5 time the ones of the followers. The second European company, ASM International just follows with a revenue 2017 of 737 M€.

Top semiconductor equipment manufacturers by Revenues ($Million)

Company name	CY 2016	CY 2017	% Change
Applied Materials	7,737	10,097	30.5%
Lam Research	5,213	7,838	50.4%
ASML	5,061	7,256	43.4%
Tokyo Electron	4,667	7,283	56.1%
KLA - Tencor	2,129	2,998	40.8%
Hitachi High Tech	937	1,039	10.9%
Screen Semiconductor	1,128	931	-17.5%
Total	**26,872**	**37,442**	**39.3%**

Source: IC Insights

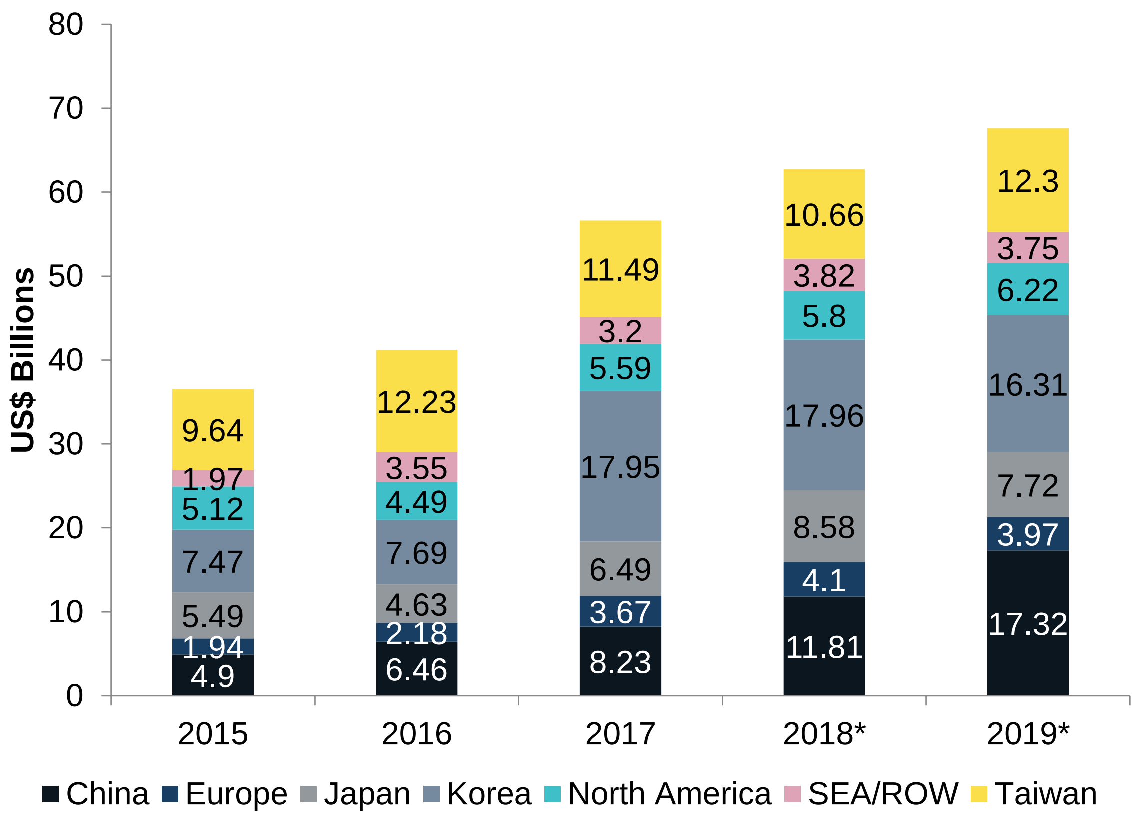
Semiconductor Equipment Market by market shares 2016-2017 YTD



Looking to the semiconductor equipment market shown below, one can see that Korea, Taiwan and China are at top in a 2017 market of 56,62 B$ that is forecasted to grow to 67,58 B$ in 2019 with an increasing demand in China.

In %, European demand stay flat and low, around 6% of worldwide investments.

Semiconductor Equipment Production by region 2015-2019



Country	2015	2016	2017	2018*	2019*
China	4.90	6.46	8.23	11.81	17.32
Europe	1.94	2.18	3.67	4.1	3.97
Japan	5.49	4.63	6.49	8.58	7.72
South Korea	7.47	7.69	17.95	17.96	16.31
North America	5.12	4.49	5.59	5.8	6.22
SEA/ROW	1.97	3.55	3.2	3.82	3.75
Taiwan	9.64	12.23	11.49	10.66	12.3

*Estimated
Remark: New Equipment, Totals may not add due to rounding
Source: The Information Network

1.2.4 Design

The design of a chip that once was entirely done by the IDM who developed the technology is now split in different parts:

- The basic transistors and component's model (i.e. spice model) provided by the company who develop and master the technology;
- The IP blocks developed and provided by IP providers like ARM (now Japan);
- The synthesis, simulation, integration and layout supported by EDA (Electronic Design Automation) also referred as ECAD (Electronic Computer-Aided Design), thanks to tools provided by EDA companies like Cadence (US), Synopsis (US), Mentor (Germany). Embedded software's are also created and verified during this step, thanks to the tools provided by the EDA suppliers.

The ecosystem of the semiconductor IP market consists of IP designers and vendors such as Arm Limited (ex UK, now Japan), Synopsys (US), Cadence (US), Imagination Technologies (UK), Ceva (US), Lattice Semiconductor (US), Vivante (US), Kilopass Technology (US), Atmel (US), Intel (US), Rambus (US), Mentor Graphics (Germany), Renesas Electronics (Japan), Ememory Technology (Taiwan), Silab Tech (India), Open-Silicon (US), Dream Chip Technologies (Germany), TansPacket (Norway), Achronix Semiconductor (US), Sonics (US), Xilinx (US), CORTUS (France), Digital Blocks (US), Dolphin Integration (France), and EnSilica (UK).

In the present time, ARM (Japan), Synopsys (U.S.), and Imagination Technologies (U.K.) are the three major market leaders contributing the largest market share in the semiconductor IP market space.

Top 10 global companies – Semiconductor IP market

Rank	Company	2015	2016	Growth 2015-2016
1	ARM (Softbank) Synopsys	1,368.1	1,647.6	20.4%
2	Synopsys	395.1	447.0	13.1%
3	Imagination Technologies	232.0	182.2	-21.5%
4	Cadence	120.3	108.6	-9.7%
5	Ceva	59.5	72.7	22.2%
6	Verisilicon	60.2	66.2	10.0%
7	eMemory Technology	34.6	37.7	9.0%
8	Rambus	24.6	32.2	30.9%
9	Lattice (Silicon Image)	29.4	29.1	-1.0%
10	Kilopass Technology	26.5	29.1	9.8%
	Top 10 Vendors	**2,530.3**	**2,652.3**	**12.6%**
	Others	642.5	2,652.3	16.2%
	Total	**2,992.8**	**3,386.0**	**13.1%**

Source: DECISION Etudes & Conseil

The semiconductor IP market is expanding at a tremendous growth rate both in terms of market size and popularity worldwide mainly because of large scale adoption of third-party silicon IP cores in diverse application sectors such as computer and peripherals, mobiles and tablets, telecom infrastructure and networking technologies, automotive, aerospace, and defense.

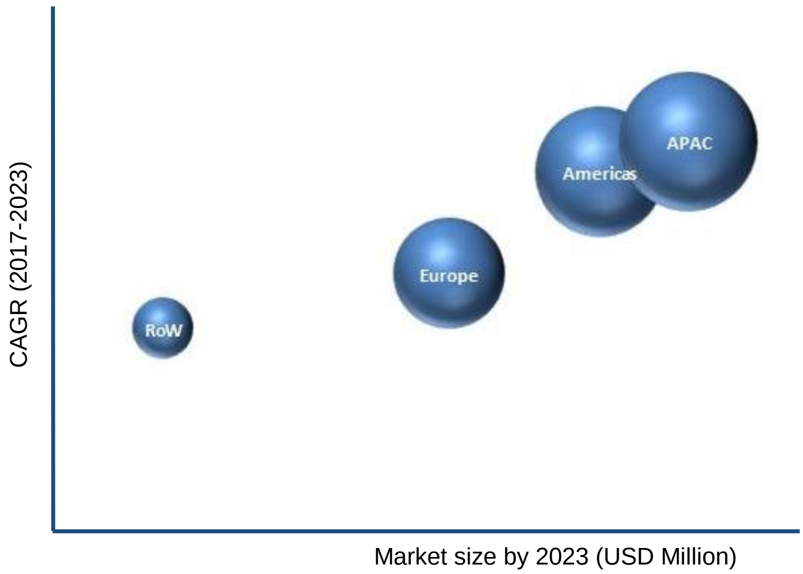
In the past few decades, the semiconductor IP market's value chain has grown to encompass a vast network of players involved in various segments. There have been tremendous changes in the landscape of the semiconductor IP industry's ecosystem with several developments in market segments such as open source IP vendors, IP core developers, IP aggregators, IP licensing vendors, and IP Customers including fab, fabless, foundry, and IDM players. The Semiconductor IP Market is growing in both the Integrated Circuit (IC) IP and System-on-Chip (SoC) IP sub-sectors.

IP block market covers all the digitals designs but is far smallest for power and analog products design where companies favors internal and proprietaries solutions that are there differentiators.

New startups with niche product offerings are also growing at a fast rate to capture tremendous opportunities offered by the semiconductor IP market worldwide. The escalating market applications and ever-increasing adoption of third-party IP cores by semiconductor companies are expected to surge the demand of semiconductor IP solutions globally.

The semiconductor IP market was valued at USD 4.44 Billion in 2016 and is projected to reach USD 6.22 Billion by 2023, at a CAGR of 4.87% between 2017 and 2023. The factors such advancement in multicore technology for consumer electronics, increasing demand for modern SoC designs, rising chip design cost and expenditure and growing demand for connected devices are driving the growth of this market.

Semiconductor IP Market, by Region, 2023 (USD Billion)



Source: MarketsandMarkets Analysis

Europe, thanks to Arm, Imagination Technologies is clearly having a strong leadership in the IP block market (DECISION estimates the European market share to be above 45%). On the EDA side, Mentor - Siemens (Germany) is one of the top 3 leaders together with Cadence (US) and Synopsys (US).

Top 3 worldwide leaders – EDA side

Company	Revenue 2017	Notes
Synopsys	$ 2 725 M	Include IP block revenues
Cadence	$ 1 949 M	Include IP block revenues
Mentor - Siemens	$ 1 280 M	

Source: DECISION Études & Conseil, Companies annual reports

1.2.5 Front end manufacturing

Manufacturing of all IC's, including power IC's and MEM's, and of discrete SC is made in clean rooms. Size of the clean room determine the capacity, from some hundred m² for the smallest ones used for R&D with production capacity of some hundred wafers/week (100 to 200mm diameter), to giant ones (Giga fabs) with cleanroom area over 160000 m² able to produce more than 25K 300mm wafers/week like the fab 18 from TSMC presently in construction in Taiwan or like the SMIC 38K 200mm wafers/week in construction (expansion of an existing fab) in Tianjin, northern China (source: companies).

Building of advanced wafer fabs is complex, with the coordination of numerous specialized companies covering building structures for very large areas without pillars, multilevel floors, antivibration waffle slab floors, air conditioning and air treatment, exhaust systems, gas management and ultrapure piping, chemical management with ultrapure piping, wafer transfer systems, operational safety due to hazardous gas and chemicals used in quite high quantities, earthquake protection rules, etc.

The European company M+W Group (now Exyte from August 2018) is one of the worldwide leaders in wafer fab engineering.

It must be noted that after having run 10 years + on advanced technology, wafer fabs are easily reused for other technologies/processes that are perfectly in concordance with the capabilities of the facilities and of the tool set. The result of this is that the companies having run and depreciated building and toolset on advanced technologies are winning a clear economic advantage versus the ones that have to set up new facilities to manufacture products that are not sate of the art (analog and RF technologies, power, MEMs, etc.).

1.2.6 Back end manufacturing

At the end of wafer manufacturing, the chips present on the wafers are tested one by one and then transferred to "Back end" where each die is processed to create the final packaging.

For the las 15 years or so, a lot of different processes have appeared toward the very diversified packaging types, from the old DIL (Dual in line) or single die discrete packages to a large spectrum of very complex multi-die packages. This comprise a large variety of 3D technologies to realize "systems in packages", thanks to different types of multi-die wiring (for memories), bumping processes and TSV (Through Silicon Vias) technologies.

Many features of the features available in today systems (automotive, consumer, healthcare, etc.) are only possible thanks to advanced packaging technologies.

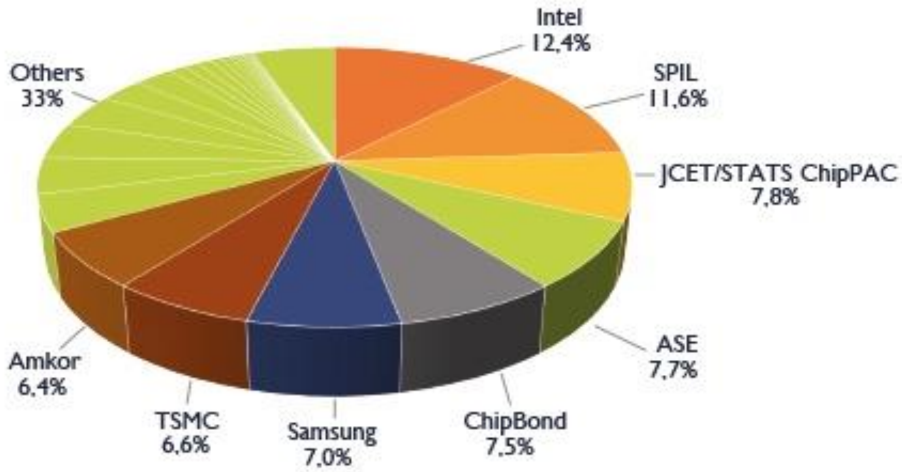
Part of the assembly market is covered by the IDM companies that have their own assembly plants.

Regarding Europe, ST and Infineon have each a Back-end site in Europe (Malta for ST and Germany for Infineon), all other back end activities are done either in their Asian facilities or in OSAT.

The big remaining part of worldwide assembly is done through OSAT (Outsourced Semiconductor Assembly and Test) companies.

The below diagram show this tendancy for advanced packaging:

Advanced packaging wafer share by manufacturer



Source: Status of the Advanced Packaging Industry 2017, May 2017, Yole Développement

The total Assembly and test market were 54 B$ in 2016 (source: anysilicon) and is estimated at 60 B$ in 2017 according to DECISION.

There are over 300 IC packaging companies worldwide and 10 main players are covering the majority of the subcontracted market, no one is located in Europe.

Top 10 worldwide companies – IC packaging

Ranking	Name	Production – M€- 2016	Production – M€ - 2017 (Estimated)	Growth
1	ASE	4,896	5,215	7%
2	Amkor Technology	3,894	4,055	4%
3	JCET	2,874	3,256	13%
4	SPIL	2,626	2,679	2%
5	PTI	1,499	1,999	33%
6	TSHT	823	1,055	28%
7	TFME	689	913	33%
8	KYEC	623	674	8%
9	UTAG Group	689	673	-2%
10	ChipMOS	568	600	6%

Source: Anysilicon

Comparative description of the World and European value chains by end-user electronic system

1.1 Industrial electronics, a traditional European stronghold

- **The second largest user segment in Europe, and third largest in the world**

Industrial electronics are the second largest end user segment in Europe, and a segment where Europe's position is particularly strong. In 2017, European production represented 20% of the world market, well over the average for all end user segments (14%), and Europe ranks second in the world for the manufacture of industrial electronics, behind China, but ahead of the USA and Japan.

Two European companies are world leaders (Siemens and ABB) in this field, and with Schneider three European companies are among the top five. Inside the EU, Germany is by far the leading country.

The synergy between end user segment and component supply is particularly efficient in this field. The three large European semiconductor manufacturers (Infineon, STM and NXP) are among the top ten suppliers of analog ICs. Analog ICs correspond to a very large share of the industrial market (47%), far above their modest share in the total IC market (15%). The same is true of discrete devices.

- **Strong growth in the past, should continue**

The global market for industrial electronics has grown at 7.8% per year over 2010-2016, and this strong growth should last during the coming years, pulled by innovation (Industry 4.0, etc.) and the strong demand in Asian countries, as well as by the shift to renewable energies (wind and solar power).

This global growth is very unequally distributed by regions. The "historic" regions are losing market shares, and Asia, growing very fast, is gaining.

European production of industrial electronics has grown at 3.7% over 2010-2016, falling back in market share in the world from 25% in 2010 to 20% today. In contrast US production has grown at 6.4% during the same period, whereas Japanese production has shrunk by 4% per year.

- **China becoming leading manufacturing country**

Chinese industrial electronics production has grown very fast over the recent years, at rates close to 20%. China is now the first country for industrial electronics manufacturing, slightly ahead of Europe.

China has now about 21% of the world industrial electronics market. This share should be compared with the place of China in the world.

Country / Region comparisons

	China	Europe	The USA	Japan
Share of world Industrial electronics production	24%	20%	19%	12%
Share of world GNP	15%	21%	24%	6%
Share of world population	18%	7%	4%	<2%

Source: DECISION Etudes & Conseil, Eurostat, United Nations, World Bank

This shows how China is fast rising to occupy a rank consistent with its size, and has in fact already developed industrial electronics, an essential instrument of productivity and competitivity, beyond its share in world GNP or population.

This should continue, as the Chinese government has an active policy of further developing industrial electronics, and in particular robotics, in line with the Made in China (MiC205) program. The objective of the Chinese government is to sell a total of 100 000 domestically produced industrial robots by 2020. In 2017, on the Chinese market of 87 000 robots, 27 000 were from Chinese robot suppliers, and 60 000 from foreign robot suppliers. A sign or an effect of this policy is the acquisition in 2016 of KUKA, a leading German robotics company, by the Chinese household appliance and HVAC giant Midea.

• Strong positions of European companies on the world markets

The European Siemens is by far the leading global supplier of industrial electronics, with around 10% of the world market, and is present on all the sub-segments. The second is the European ABB, who acquired GE Industrial Solutions in 2018, thus ending the American company's involvement in the segment. Schneider Electric is the third major European player, ranking fourth in the world, after the American Honeywell, and before the Japanese Mitsubishi.

The European Bosch is also a leading player with its Bosch-Rexroth subsidiary specialized in motion control, which ranks ninth among world players.

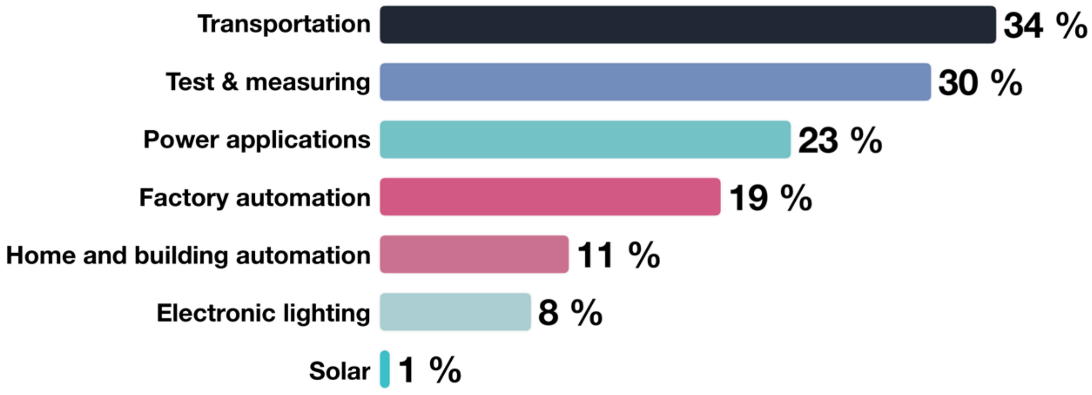
Other significant European players are Danfoss, Legrand, Rohde & Schwartz, Heidenhain.

• Many differentiated applications, products, systems and value chains

Measuring and testing is the largest segment in industrial electronics, followed by industrial automation (robots, drives, motion control, numerical control, and other control). This comprises a large variety of products and systems, some of which in new developing fields such as Industry 4.0 or smart metering.

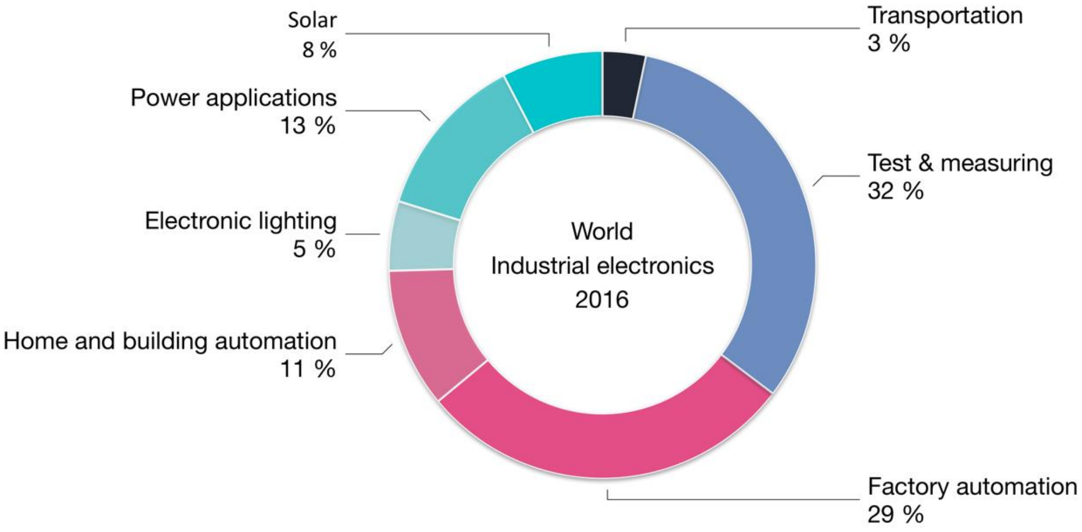
The share of European production is high for the whole segment (20%), but unequal in the sub-segments. In particular home and building automation, which includes a lot of HVAC controls, is less developed in Europe.

European share of the world in industrial electronics segment production



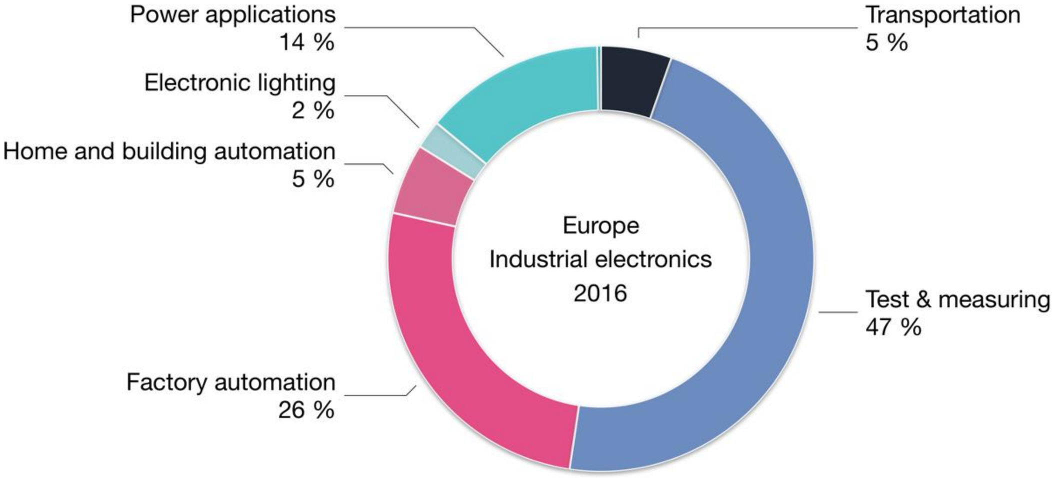
Source: DECISION Etudes & Conseil

Industrial electronics: segment share in the world 2016



Source: DECISION Etudes & Conseil

Industrial electronics: segment share in Europe 2016



Source: DECISION Etudes & Conseil

Industrial electronics production by region B €

Region	2010	2016	2010-2016 CAGR
Europe	59.6	74.3	4%
The USA	48.3	69.9	6%
Japan	56.2	44.0	-4%
China	30.9	87.6	19%
Other Asia	20.4	42.9	13%
RoW	14.6	40.7	19%
World total	**229.1**	**359.3**	**8%**

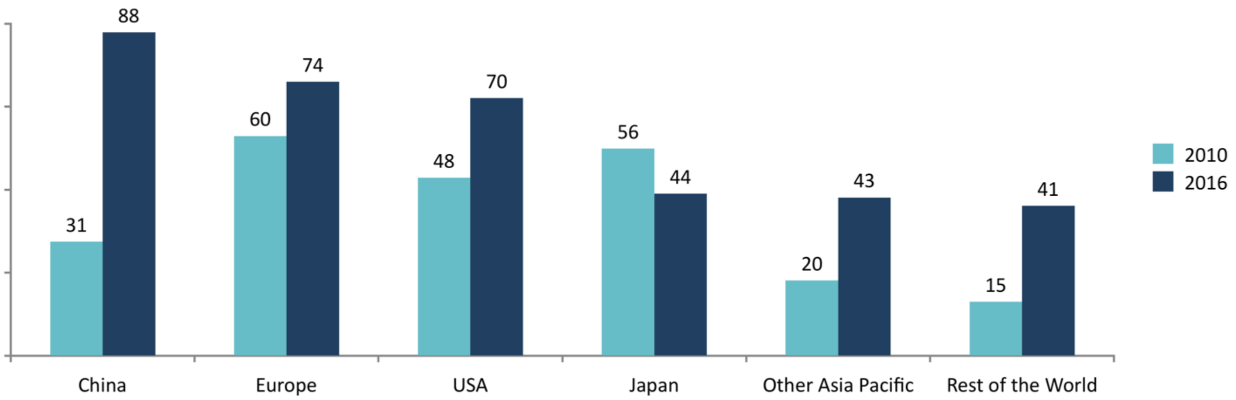
Source: DECISION Etudes & Conseil

Industrial electronics production by segment B € in 2016

	World	Europe	Europe share
Factory automation	103.0	19.4	19%
Of which robots	*36.2*	*3*	*9%*
Home and building automation	38.0	4	11%
Test & measuring	115	34.9	30%
Power applications	45.0	10.2	22%
Solar	27.5	0.2	1%
Electronic lighting	18.9	1.6	9%
Transportation	11.8	4	33%
Total	**359.2**	**74.3**	**20%**

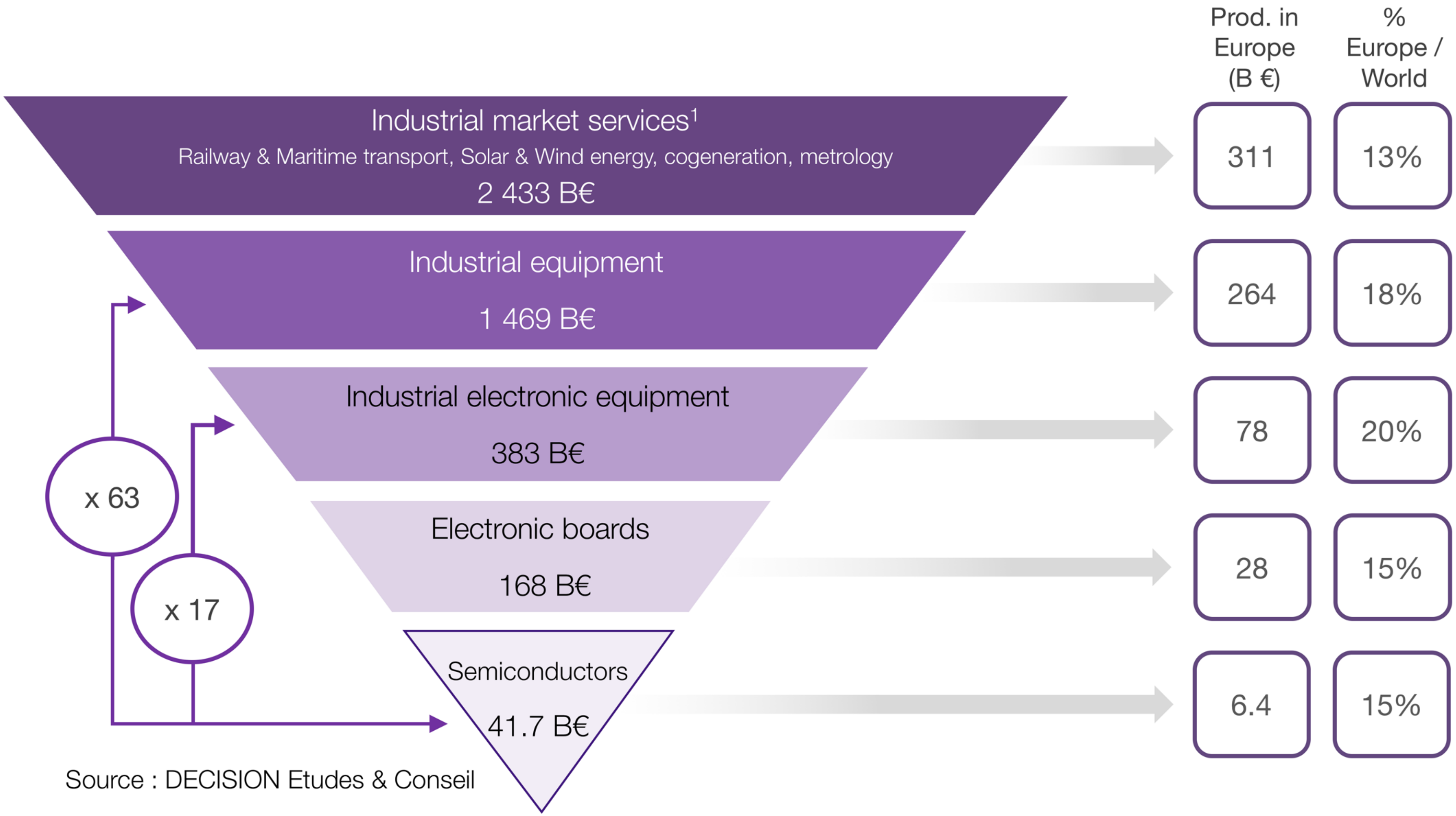
Source: DECISION Etudes & Conseil

Industrial electronics production by regions (B €)



Source: DECISION Etudes & Conseil

World Industrial & Robotics electronics value chain in 2017



Source : DECISION Etudes & Conseil

[1] The services measured in this diagram only corresponds to the "market services", that is the services produced for sale on the market at a price intended to cover production costs and to provide a profit for the producer. Yet, industrial equipment provide a majority of "non market services" once they are sold.

1.2 Aerospace/Defense/Security

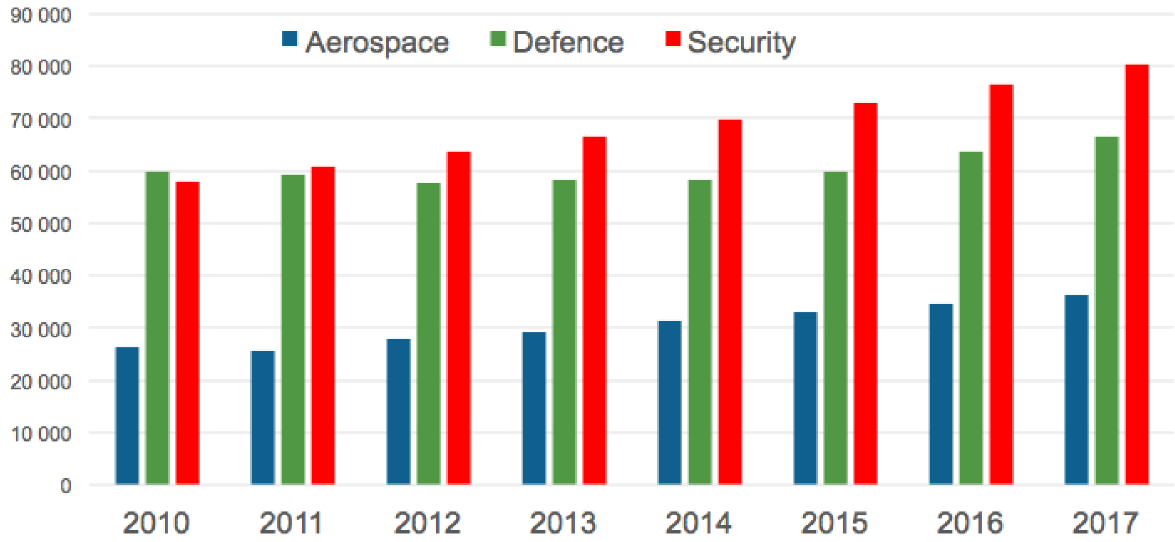
Like the automotive industry, the aerospace and defense industries are made up of a complex supply chain ranging from parts and components to general supplies and commodities, electronic systems, and complete assemblies (aircraft, ships, etc.). Historically, this industry developed in Europe, in the USA, in Japan and in the USSR. Both technology and production have remained strongly concentrated in these areas (except in Japan), despite a developing industry in emerging countries such as China, India, Brazil or Israel. The sequels of World War II and American military leadership during the Cold War led to a dominant position of American industry worldwide. Today, this dominance is challenged by Europe, as shown by the success of Airbus in civil aviation and by the emerging powers like China in the defense sector.

Over the past years, the success of the European Airbus Commercial Aircraft, Airbus Helicopters (ex. Eurocopter) and Arianespace on civil markets consolidated Europe as the worldwide number one or two supplier of civil platforms. Over the past 30 years, Airbus managed to raise as the undisputed rival of Boeing transforming the market from a monopoly situation into a duopoly. With only 42 deliveries and 13% of market share in 1985, the European-based maker managed to catch up and to overtake its historic competitor Boeing and now claims more than 50% of the market. Airbus succeeded from 2012 to 2017 to deliver more planes than its American competitor. Like Airbus, its subsidiary Airbus Helicopters has achieved the same success by being for several years now, the worldwide leader in the civil helicopters market segment.

On the defense side, the industry is heavily fuelled by the growth of US military expenditure. The wars in Iraq and Afghanistan have reinforced the North American territory as the leading production region of defense equipment but with the withdrawal of its troops on these theatres of operation, the USA lowered their military expenses. Furthermore, the economic crisis of 2008 led to budgetary cuts in defense spending in all western countries. Therefore, like the US, Europe faced a sluggish domestic defense market, which led to a fierce competition between the US and Europe to promote their defense equipment and win export markets. Besides the quality of its own products, the European defense industry will have to show flexibility in this competition: product adaptation and technology transfer are its specific advantages.

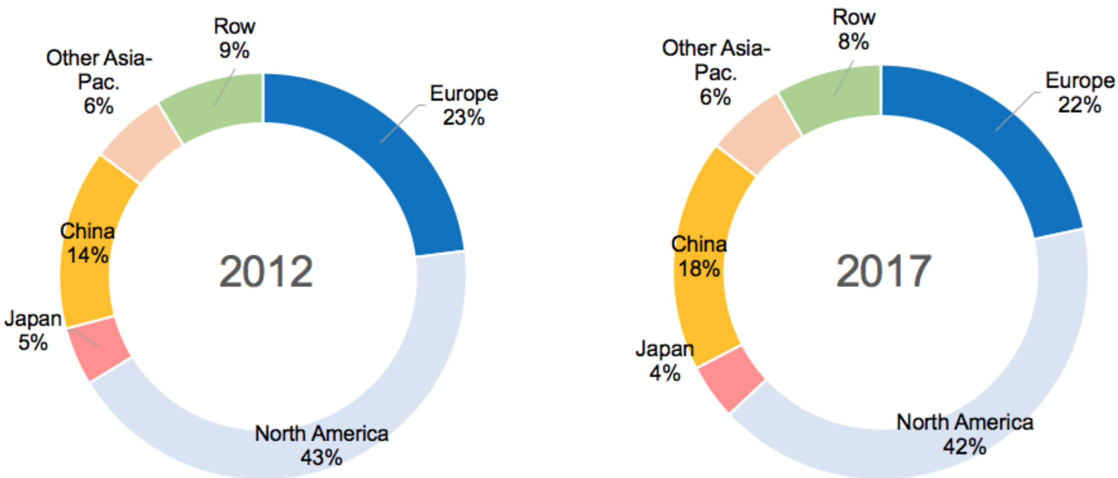
About the Security industry, the structure of the value chain production is not as regionally concentrated as for the Aerospace and Defense one.

Evolution of Aerospace – Defense – Security electronics equipment production by segment from 2010 to 2017



Source: DECISION Etudes & Conseil

Aerospace – Defense – Security electronics equipment production breakdown by region in 2012 and 2017



Source: DECISION Etudes & Conseil

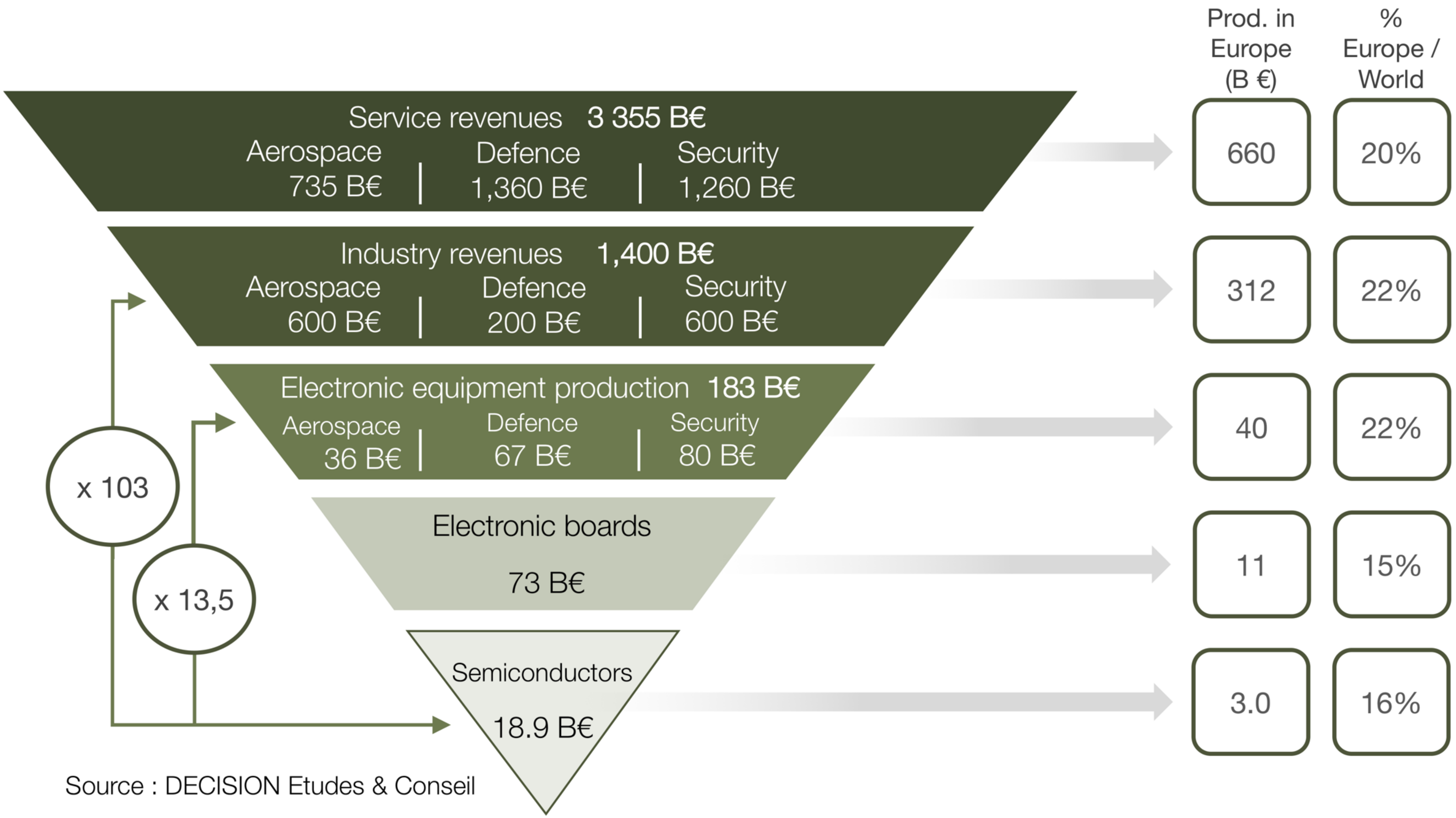
Aerospace and defense electronic systems are designed close to their final assembly location, i.e. Europe and the USA. In 2012, Europe represented 23% of world production (including security electronics). Combined with North America, the two regions accounted for two-third of total world production in 2012, a share that diminished slightly to 64% in 2017 due to decreasing budgets in the military segment whereas other countries like China and India have fast-growing markets and are engaged in dynamic policies to build larger local industries.

In 2017, the world market/production for electronic aerospace, defense and security systems was 183.2 billion Euro, of which 36.2 billion Euro for aerospace systems, 66.6 billion Euro for defense systems, and 80.3 billion Euro for security systems. Civil systems for marine and land transport applications are included under the “industrial and medical electronics” chapter.

With an average annual rate of 5.5% for the 2017-2022 period, growth in world demand for aerospace, defense and security electronic systems is more dynamic than the previous period 2012 to 2017 (+4.2%) and performed better than the electronics industry globally. All the aerospace – defense - security segments will grow faster over the 2017 - 2022 period than over the 2012 - 2017 period. Aerospace electronics will grow at 5.4 % per year on average from 2017 to 2022 (compared to 5.3% from 2012 to 2017). Defense electronics production should go up significantly over the next five years (+5.3% compared to a mere 2.9% from 2012 to 2017) du increasing investment in military budgets worldwide. Security electronics on its side should experience an average annual growth of 5.7% worldwide till 2022 compared to 4.8% over the 2012 – 2017 period.

With 4.6% of expected growth from 2017 to 2022 (compared to 2.9% between 2012 and 2017), the prospects for European electronics production are rather favourable. This is because the European military industry should benefit from increasing defense budget dedicated to the procurement of equipment from European countries after many years of budgetary cuts in the major defense-spending countries. In addition, excellent prospects in civil aeronautics driven by a continuing growth of the electronics content in civil aircraft with the arrival of a “more-electric” new generation of aircraft as well as continuing satisfactory aircraft delivery levels pulled by fast-growing demand in world air passenger traffic, especially in Asia and the Middle-East will drive civil airborne electronics equipment production in Europe.

World Aerospace – Defense – Security electronics value chain in 2017



Source : DECISION Etudes & Conseil

1.2.1 Focus on Aerospace

The electronics for the aerospace sector is composed of:

- Civil airborne systems: including avionics electronics (communication, navigation, radars, flight control, aircraft management systems, etc.), electronic control units embedded into aircraft sub-systems (engines, landing systems, etc.), In-Flight Entertainment electronics, disseminated electronics and power electronics;
- Military airborne systems: Fire & arms systems, cockpit, navigation, instruments, communications and other aircraft embedded systems;
- Civil space: Satellite and rocket embedded electronic systems for civil purposes;
- Military space: Satellite and rocket embedded electronic systems for military purposes.

Analyses

- In 2017, the EU production (million euros) of aerospace electronics accounted for 32% of the global production. Thus, in 2017, the EU was the second largest producing region in terms of aerospace electronics after North America (42%);
- Production of airborne systems (encompassing both civil and military application) in Europe grew at 6.5% per year on average between 2012 and 2017 (above the worldwide trend of 5.6%) driven by excellent perspective in the civil on-board electronic production. This trend should continue in Europe with a forecasted annual growth of 5.9% till 2022;
- Europe is even the first electronics production area for the civil airborne systems with 42% of the world production (5.5 billion euros). The excellent market positions of Airbus and the European aircraft equipment suppliers (Safran, Thales, Liebherr, Rolls-Royce, etc.) drive the on-board electronic production on the European territory. All those players are well positioned to address the More-Electric Aircraft (like the Boeing B787 and the Airbus A350), which are new generation of jetliners fitted with higher contents of electronics. In addition, the European civil airborne electronics industry also benefits from the worldwide increasing demand in new aircraft;
- Military airborne systems represented an electronic production valued at 12.3 billion euros in 2017 with Europe accounting for 26% of this global production (behind the US with 55%). However, thanks to increasing defense budgets and strong performance at exports, the segment should outperform the US in terms of CAGR over the 2017 – 2022 period with 4.7% of growth (compared to 4.0% for the US);
- European space electronics production worldwide is estimated at 2.9 billion euros in 2017 and is the second highest worldwide (behind the US). A segment which should grow at 3.0% till 2022 below the world trend of 4.2% due to lack of military contracts.

1.2.2 Focus on Defense

The electronics for the defense sector is composed of:

- Military communications and naval & ground systems gathering all defense and government dedicated communication systems: tactical, mobile, all ground civil & military government radar & air traffic management or surveillance, all communication, commandment & electronic defense systems for combat or support ships and submarines;
- Missiles electronics, which encompasses embedded missile electronics (without launchers, pads, etc.).

Analyses

- In 2017, with 16.8 billion euros the EU production of defense electronics accounted for 25% of the global production. Thus, the EU was the second largest producing region in terms of aerospace electronics after North America (41%);
- From 2012 to 2017, the production of electronics dedicated to the defense sector grew at a slow 2.9% worldwide. Europe did not perform well with 0.7% of growth over the period. Like the US (with 1.5% growth), Europe suffered from harsh budgetary cuts in defense spending in France, the UK, Germany and Italy, which were partially offset by exports successes;
- On the other hand, emerging countries from Asia and China especially carried on developing their own defense industry and increased their defense electronics production simultaneously. Chinese production of electronics equipment for defense boomed from 7 billion euros in 2012 to 11.6 billion euros in 2017 (i.e. a CAGR of 10.4% during the period).
- Till 2022, growth should be back in Europe thanks to the rise of equipment procurement in all major European countries. A 4.3% growth on average in the defense electronics production from 2017 to 2022 is forecasted. Europe should remain the second largest production zone of defense electronics equipment in 2022.

1.2.3 Focus on Security

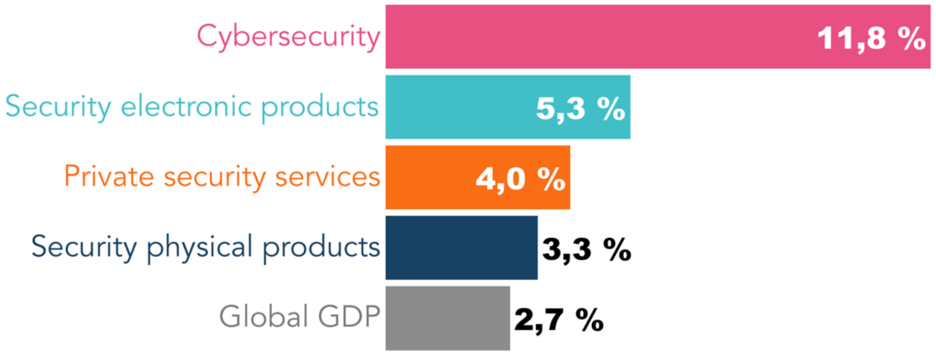
The security sector is composed of:

- Physical security products (police, customs and fire brigades' vehicles, coastal surveillance boats, customs aircraft, helicopters, etc.);
- Electronic security products (CCTV cameras, fire alarms, intrusion alarms, surveillance radars, detection equipment, etc.);
- Cybersecurity software and services (that is electronic software);
- Private security services (Guarding, CCTV, investigation, etc.).

The electronic security sector is composed of electronic security products (hardware) and cybersecurity software and services.

- Security is currently one of the global industries that generates the highest growth.
- This high growth is driven by the growth of cybersecurity and the growth of the security electronic products.

World – Compound annual growth rate 2013-2016



Source: DECISION Études & Conseil

<u>Analyses</u>

- In 2017, the EU production (factory-fate figures, million euros), accounted for 14.5% of the global production. In other words, in 2017, the EU was the third region in terms of security electronics production (hardware only), after North America (43%) and China (24%);
- In other words, the global production of electronics equipment dedicated to security is clearly led by the USA that concentrates 35% to 40% of the global production;
- China is the global challenger with 24% of the global production and a very high growth (in particular linked to the rise of the public torture market in China: electric chairs, tasers, electric shock batons, etc.). The expected average CAGR of China is 9% over the 2017-2022 period;
- Asia as a whole (that is China, Japan and rest of Asia & Pacific), represented 18% of the global production in 2012, represents 34% of the global production in 2017 and is expected to represent 33% of the global production in 2022;
- The USA are therefore expected to remain the global leader in terms of electronics equipment dedicated to security until 2022 (with 38% of the global production in 2022);
- Israel, considered in the figures of the rest of the world, is also a significant competitor at the global scale with 8% to 10% of the global production shares.

1.3 Automotive electronics

1.3.1 The Global view

Market Size

Automotive electronics production represented 306 billion euros in 2017[10], that is 16% of the world electronic production[11]. In other words, Automotive is the fourth global electronic market in 2017 after telecommunication (€ 405 M, 21%), industrial (€ 383 M, 20%) and data processing (€ 379 M, 19%).

Growth

Automotive electronics production registered a strong compound annual growth rate (CAGR) within the 2012-2017 period compared to the other electronics applications (Audio-Video, Home appliances, Data processing, Telecommunications, Aerospace/Defense/Security, Industrial/Medical), with a CAGR of 6%. Automotive electronics benefited from the third highest CAGR after Health & Care (10% CAGR), and the industrial segment (7.6% CAGR).

Furthermore, automotive electronics production is expected to register the highest CAGR within the 2017-2022 period compared to the other electronics applications, with an estimated CAGR of 10%[12].

As a consequence, automotive is expected to represent € 493 B by 2022 and to outreach the telecommunication and the PC & data processing segments by 2022-2025.

The global automotive electronics production is driven by two main factors:

- The world automotive production in unit, driven by emerging markets, benefits from significant growth with an estimated average annual growth rate of more than 3% over the 2017-2022 period;
- The average percentage of electronics in the added value of an automotive will also benefits from high growth over the period 2017-2022 (5% CAGR). Its main driver will be Advanced Driving Assistance Systems (ADAS) but also Infotainment and the main beneficiaries of this growth will be embedded software developers.

Automotive IC is the end-user application that is growing the fastest with 13.4% compound annual growth rate over the period 2016-2021. Although automotive IC sales only represent 7.7% of total IC sales in 2017 (far less than computer, communications and consumer applications), this market is expected to account for nearly 10% of total IC sales in 2021, which would make it the third-largest end-use application for ICs, slightly ahead of the consumer segment.

[11] DECISION Études & Conseil
[12] DECISION Études & Conseil, IC Insights

1.3.2 EU key indicators and position in the world

Automotive

In 2017, the automotive industry provided between 2 and 2.5 million jobs and generated 371 B € in the EU. 80% of the growth in this industry is expected to occur outside the EU but will benefit to the EU's actors.

In 2017, the automotive services provided between 5.5 million jobs and generated 572 B € in the EU.

In other words, the EU automotive sector (industry and services) contributes directly to almost 6,5% of the EU's GDP.

Automotive electronics

In 2017, the automotive electronics sector provided 1 162 000 jobs and generated a turnover of € 145 B in the EU. In other words, the EU automotive electronics sector contributes directly to 1% of the EU's GDP.

- With 28% of the world global output in 2017, Europe is the leading region in automotive electronics production;
- In 2017, the automotive electronics sector provided 307 000 high skilled jobs in engineering offices, R&D offices and headquarters. These skilled jobs generated a turnover of € 55 B in the EU;
- In 2017, the automotive electronics sector provided 855 000 jobs in factories. These jobs generated a turnover of € 91 B in the EU;
- In 2017, 40% of the automotive electronics turnover was generated by firms whose principal shareholders were headquartered in an EU member state, which makes the European Union by far the first region at the global scale regarding that criterion before Japan (24%) and North America (16%). In comparison, in 2017, 39% of the automotive electronics turnover was generated by firms whose principal shareholders were headquartered in Asia (China, Japan and other Asia & Pacific), less than in the EU;
- The European automotive IC consumption represented € 9 B in 2018.

2017 – Automotive Electronics – EU key indicators

	Eurostat SBS industry database - 2015	DECISION - 2017
Turnover (€M)	34 400	**145 500**
Number of employees	238 408	**1 162 000**
Added value at factor costs (€M)	7 900	**38 505**
Net investment in tangible assets (€M)	1 300	**6 336**

Remark: The Eurostat SBS industry database figures corresponds to the characteristics of the companies in Europe when more than 50% of their turnover is dedicated to the "Manufacture of electrical and electronic equipment for motor vehicles". In other words, the figures of the Eurostat SBS industry database constitute a very indirect estimation of the European automotive electronics production and clearly provide a clear underestimation of the real European automotive electronics production.

Source: DECISION Études & Conseil

1.3.3 Competitive analysis

Four leaders at the global scale

- In 2017 at the global scale, the automotive electronics production was clearly dominated by four countries: China (18%), the USA (13%), Japan (12%), and Germany (10%). Their cumulated turnover accounted for 53% of the global turnover in 2017;

- For already more than 10 years, China has been the first country in terms of automotive electronics at the global scale. In 2017, China’s turnover represented 18% of the global turnover and almost 20% of the people employed in the world in automotive electronics. China is the first country in terms of automotive electronics factory production, but China is also the fourth country in terms of automotive electronics engineering, R&D and supporting function with 12,3% market shares against 17,4% for the first country (Japan).

The predominance of Germany in the EU

- In 2017 and for decades, the EU automotive electronics production have clearly been dominated by one country: Germany. Germany’s turnover in automotive electronics accounted for 37% of the EU total turnover in 2017. Besides, 32% of the people employed in the EU automotive electronics industry in 2017 were located in Germany.

- In 2017, in terms of engineering offices, R&D offices and supporting functions, Germany’s turnover in automotive electronics accounted for 49% of the EU turnover and 43% of the jobs within the EU;

- Furthermore, for decades, Germany’s policy has consisted in outsourcing low-cost jobs dedicated to automotive production in a few east European countries (Poland, Czech Republic, Slovakia, Austria and Hungary), in order to rise its competitiveness, the profitability of its companies and its ability to export. Germany benefits not only from its geographic proximity with these countries, but also from the high similarities in terms of languages and culture. As a result of this strategy, Germany and its hinterland (Poland, Czech Republic, Slovakia, Austria and Hungary), accounted in 2017 for 56% of the EU’s total automotive electronics turnover (€ 51 B) and for 53% of EU’s total automotive electronics jobs (with 428 736 jobs) in terms of factory production;

The will of China to take the lead at every step of the global value chain

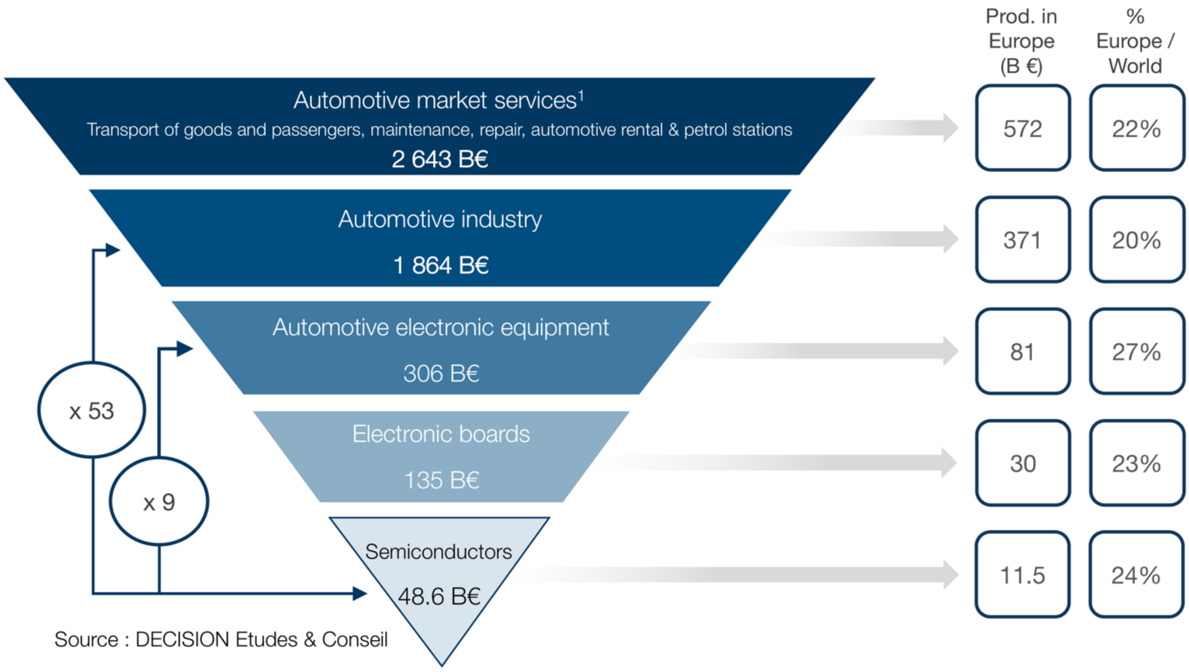
China combines three elements to take the lead of the global automotive electronics supply chain:

- Key positions at the bottom of the supply chain thanks to materials and equipments manufacturing;

- Key positions at the top of the supply chain thanks to its huge domestic market;

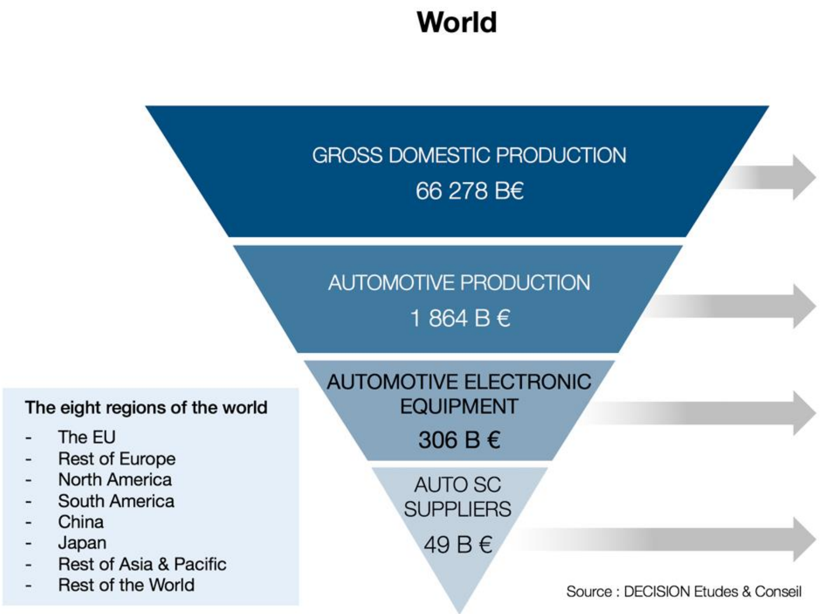
- Smart and very proactive industrial policies (including protectionism).

World Automotive electronics value chain in 2017



[1] The services measured in this diagram only corresponds to the "market services", that is the services produced for sale on the market at a price intended to cover production costs and to provide a profit for the producer. Yet, industrial equipment provide a majority of "non market services" once they are sold.

World Automotive electronics value chain in 2017



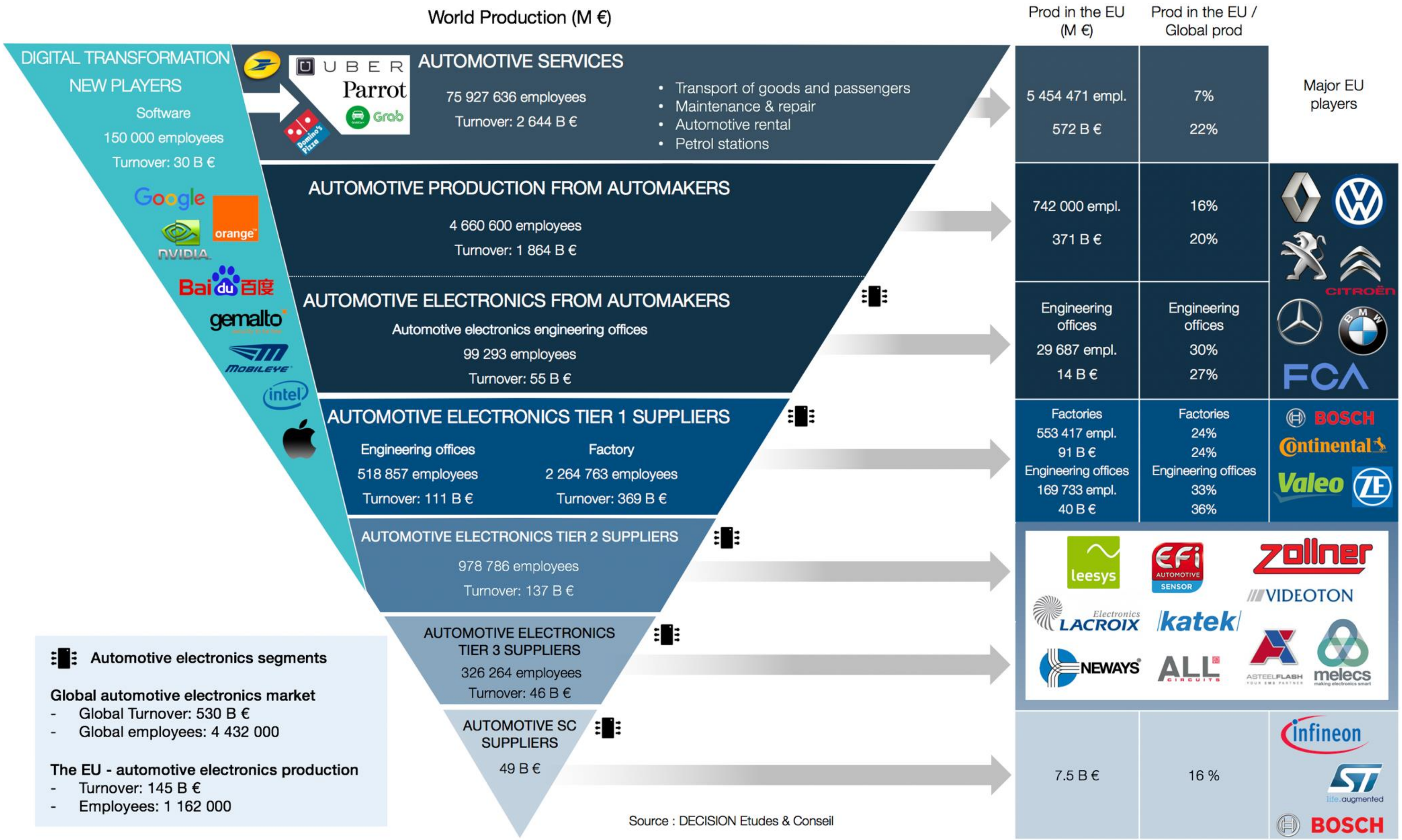
Ranking of the EU

Criteria	Share of the EU	Rank of the (/8)
GDP	21%	2nd (after North Am)
Assembly location	20%	2nd (after China)
Capital ownership	35%	1st
Factory production	25%	1st
Engineering / R&D / HQ offices	33%	1st
Capital ownership	40%	1st
Capital ownership	16 %	3rd (after North Am & Rest of Asia)

Source : DECISION Etudes & Conseil

DECISION ETUDES & CONSEIL

Automotive electronics value chain in 2017



Source : DECISION Etudes & Conseil

1.4 Home Appliances

Domestic appliances are the last end-user segment for MNE and other electronic components in terms of production in Europe. European production of domestic appliances was 7 billion euros in 2017, and the industry employed around 42 500 people.

Yet, it is a segment where Europe is strong, with 17% of the global production, and four European companies among the top ten. The Europeans Bosch and Electrolux rank second and third, behind the American world leader Whirlpool. And in the global domestic appliance top 15 the European Miele ranks 10th, the European small appliance specialists SEB, Philips and Dyson respectively 9th, 13th and 15th.

Nonetheless the Chinese industry has become the largest in the world, with companies among the world leaders who are developing their own brands after having long sold through OEM under the historic European or other brands. The largest, Haier and Midea, rank 4th and 5th, before the Koreans Samsung and LG.

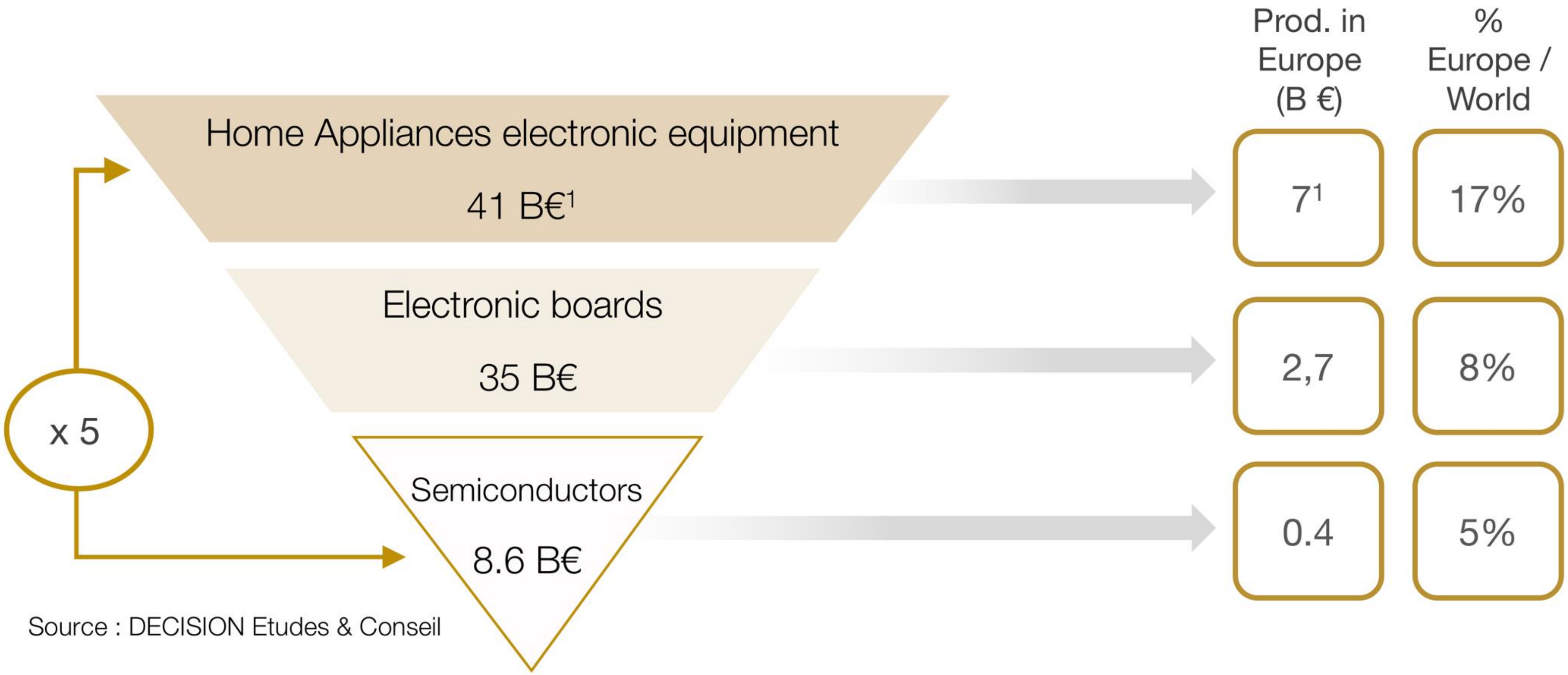
Domestic appliances do not have a very high semiconductor content (about 5% today). This means that in this segment 1 billion euros of semiconductors can leverage nearly 20 billion euros of equipment production, and over 125 000 jobs. And increasingly the functions enabled by the semiconductors in the appliances are what drives the growth of this industry.

World production of electric domestic appliances (M€)

	2010	CAGR 2010-2016	2016	% share of the world	CAGR 2016-2022	2022
Europe	25 362	1.1%	27 141	17.0	2%	30 398
USA	11 556	6.8%	17 167	11.0	3%	20 257
Japan	15 869	-0.2%	15 726	9.5	2%	17 613
China	40 000	7,0%	60 000	37.5	9%	92 400
Other Asia	15 000	4,9%	20 000	12.5	10%	32 000
Rest of World	15 000	4,9%	20 000	12.5	7%	28 400
Total World	**122 814**	**4,5%**	**160 034**	**100.0**	**5.1%**	**221 068**

Source Eurostat Prodcom, US Census, JEMA, DECISION estimates

World Home Appliances electronics value chain in 2017



Source : DECISION Etudes & Conseil

[1] Home appliances are traditionally considered as “electronic equipments”. Therefore, the figures provided in the final report correspond to the “home appliances” as a whole. Yet, in order to be more precise, the figures indicated in this diagram as well as the figures considered in the total value of electronic equipments correspond to the share of the value of home appliances precisely corresponding to the electronic sub-systems.

1.5 Audio & Video

Audio & Video electronics has for a long time become an Asian domain of excellence. Asian countries accounted for three quarters of world production in 2016, and Asian companies (South Korean, Chinese and Japanese) have acquired a quasi-monopoly on television production as well as on other audio and video products, although in these more diverse and innovating fields European companies in particular still hold significant shares of the market.

The domination of Asian companies does not mean all their production is located in Asia. A number of Asian companies (in particular Samsung and LG) who hold large shares of the European market have production facilities in Europe. This is probably why European production of Audio & Video electronics, although it has strongly decreased since 2010, remains relatively strong (11.3% of the world total) compared to Japan (3.6%) and the USA (1.5%).

Since the decline of traditional CRT technology in favour of flat panel TVs, Europe has become a marginal player in the TV industry production. Some Asian TV manufacturers have set up state-of-the-art flat panel modules and assembly facilities in Eastern Europe (Slovakia, Poland, Hungary, Czech Republic, Bulgaria…) in order to serve the European market.

World production of audio & video electronics (M€)

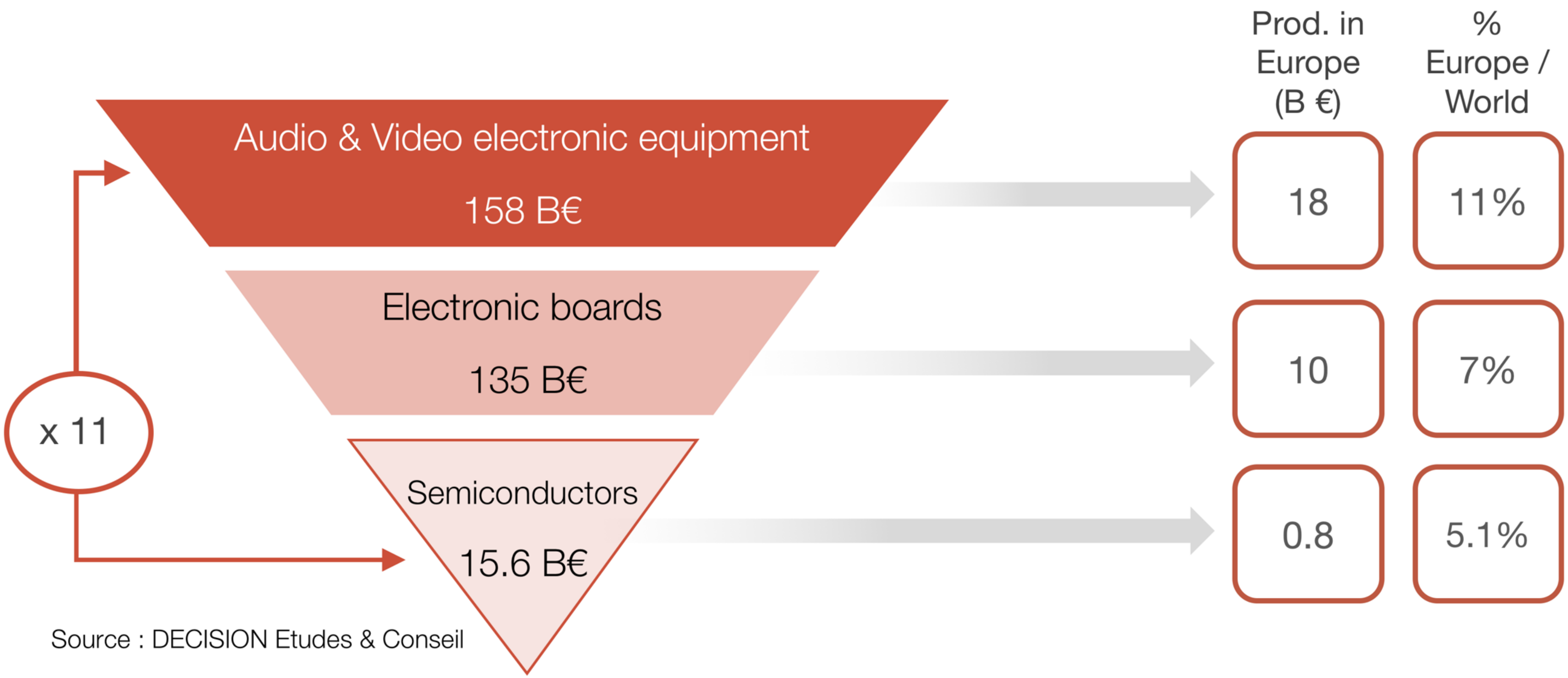
	2010	2016	2022	% share 2016	CAGR 2010-2016	CAGR 2016-2022
Europe	30.1	17.9	18.0	11.1	-0.8%	0%
The USA	1.7	2.4	4.2	1.5	-0.2%	9.6%
Japan	20.6	5.4	5.1	3.4	-20%	-0.1%
China	50.0	85.0	98.6	53.1	10%	2.5%
Other Asia	34.1	43.1	57.1	26.9	7.8%	4.8%
Rest of World	5.5	6.1	8.5	3.8	6.3%	5.6%
Total World	**142**	**160**	**192**	**100.0**	**2.8%**	**3.1%**

Sources: Eurostat Prodcom, US Census, JEITA, DECISION estimates

TV production analysis

With 25% of the global production in 2016, Europe continues to represent a large and attractive production region for TV suppliers. However, the European share of the global production has been steadily declining since 2010 (29%) and is expected to decline further until 2022, as Asian consumption develops and captures market share against developed economies. The new 4K TV sets will influence purchasing behaviours in Europe but the market for UHD will develop progressively, in close relation to the price decrease. The TV replacement cycle induced by the switchover to digital terrestrial broadcast started around 2010 and is still going on. In the EU analogue switch-off was in 2012, and throughout most of the world it should be completed after Russia (2018) and Brazil (2023). Consequently, a significant share of the flat screen TV installed base is still quite recent. A significant "natural" replacement cycle is not expected in Europe before the end of the decade.

World Audio & Video electronics value chain in 2017



Source : DECISION Etudes & Conseil

1.6 PC & data processing

PC & data processing equipment is the third largest end user segment at the world level (and was the second segment until 2016), with 20% of the world electronic equipment production in 2017.

Yet, with 7.4% of the European electronic equipment production in 2017, PC & data processing only ranks fourth out of eight in Europe (far behind the three first segments).

In spite of a very slight decline, production of Data Processing equipment in Europe has remained remarkably stable since 2010, when compared to Japan and the USA. Once undisputed master of the computing scene, today the US data processing production has dwindled to roughly the same level as Europe. And production in Japan is still severely decreasing.

However, Europe, Japan and the USA combined account for no more than 14% of data processing equipment production in the world. This reflects the near monopoly positions taken by Asia, and in particular first by Taiwan, and now by China who today accounts for about half of the world production.

World production of Data Processing equipment (B€)

	2010	2016	% share 2016	CAGR 2010-2016
Europe	**22.4**	**20.6**	**5.5%**	**-1.6%**
USA	26.1	20.5	5.5%	-3.9%
Japan	11.9	10.6	2.9%	-2.0%
China	170.0	200.0	54.1%	2.7%
Other Asia	69.6	108.6	29.4%	7.7%
Rest of World	10.0	10.0	2.7%	0%
Total World	310.0	370.3	100%	3.0%

Sources: Eurostat, US Census, JEMA, DECISION estimates

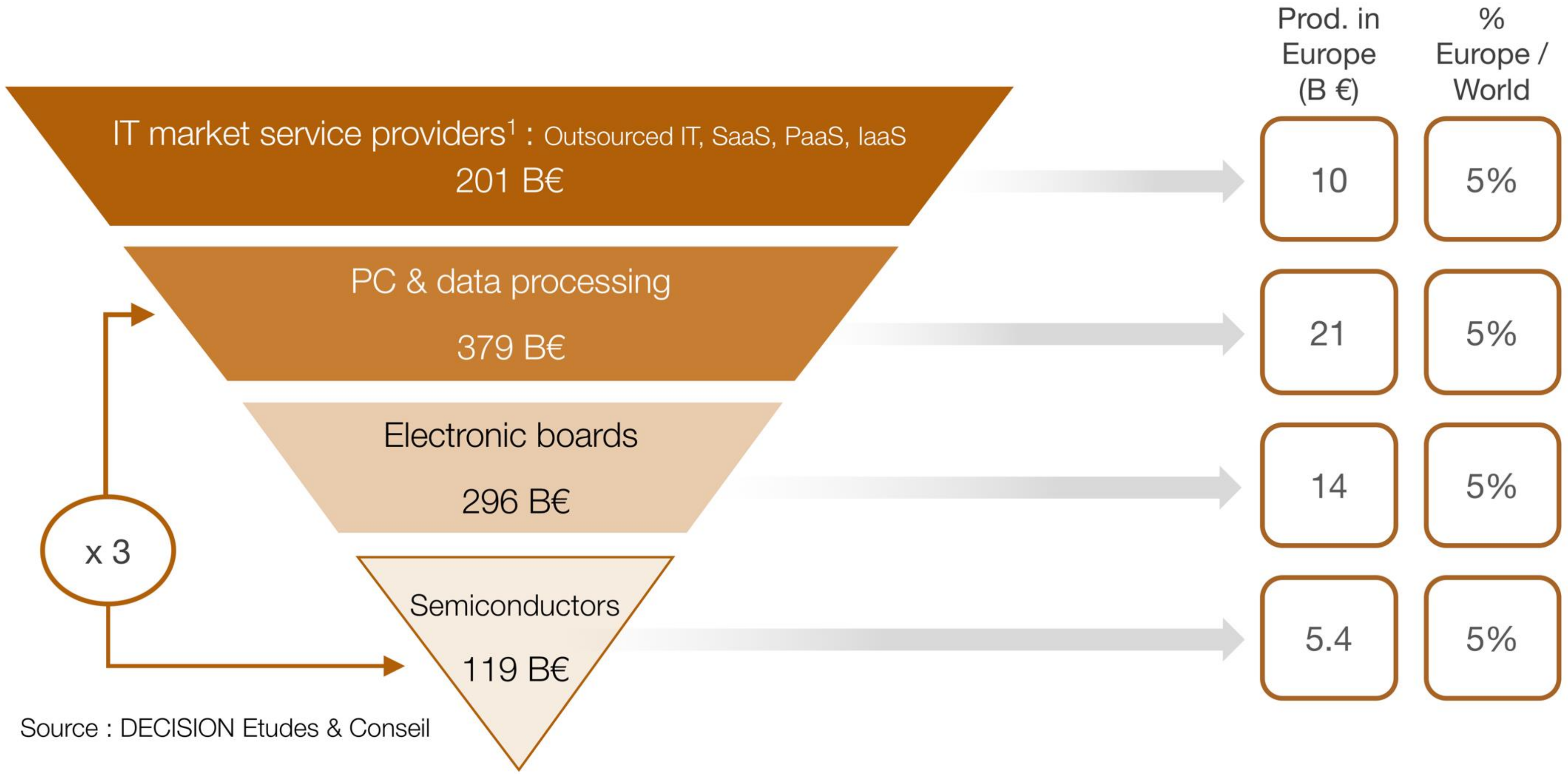
Activity statistics shown in this title are given in the Eurostat SBS (Structural Business Statistics) database for the NACE code 26.20.

Data processing in Europe in 2015

2015	Eurostat SBS Industry database
Turnover or production (Billion euros)	29.1
Value added (Billion euros)	5.8
Employees (number)	65 165
Investment (Billion euros)	0.3
Value added/turnover	20%
Investment/value added	3%
Turnover/employees (euros)	445 409

Source: Eurostat SBS Industry database

World PC & data processing electronics value chain in 2017



Source : DECISION Etudes & Conseil

[1] The services measured in this diagram only corresponds to the "market services", that is the services produced for sale on the market at a price intended to cover production costs and to provide a profit for the producer. Yet, PC & data processing tools provide a majority of "non market services" once they are sold.

1.7 Telecommunication

- **Market overview**

Telecommunication equipment manufacturers supply hardware, software and services mainly associated to mobile but also fixed networks. Telecommunication infrastructures constitute the backbone of every economy, enabling economic development and innovation.

The telecommunications infrastructure market is highly concentrated and competitive. And this concentration has increased over the past years following the consolidation of telecom services that took place after the liberalization of national telecommunication markets.

With users demanding always more mobility, performance and flexibility, carriers faced increasing competition. In order to win greater agility and flexibility, carriers had no choice but to build more interconnections within large-scale carrier networks. Thus, an ecosystem of services providers and peers is emerging.

Today, Network Functions Virtualizations (NFV) and Software Defined Networking (SDN) help carriers' networks to transform, enabling the telecommunication industry to prepare for 5G and IoT networks.

- **Market Drivers**

The telecom market has been driven by several factors:

- The expanding demand for mobile communication
- Digital transformation enabling higher data transfer rates
- Semiconductors
- Security
- Power consumption

- **World Production & Key Players**

Production of communications equipment in Europe has more than halved since 2010, and the same is true of infrastructure equipment. The USA have succeeded in more or less maintaining their production, although all "historic" telecommunications equipment manufacturing countries or regions have been dwarfed by the surge of production in Asia and in particular in China.

World production of all communications equipment (in billion euros)

	2010	CAGR 2010-2016	2016	% share 2016
Europe	31,8	-12%	14,5	8%
USA	29,9	-1%	28,4	32%
Japan	14,7	-11%	7,5	7%
China	148,14	8%	230	61%
Other Asia	69,132	8%	110	25%
Rest of World	35,528	-5%	25,5	6%
Total World	**329,2**	**4%**	**415,9**	

Sources: Eurostat Prodcom, US Census, JEITA, DECISION estimates

Infrastructure equipment is about one fifth of the total communications market, handsets or other terminal equipment accounting for the remaining 80%

Telecom infrastructure and network equipment suppliers (in billion euros)

Company	Country	2012	2016	2017	Growth 2016-2017
Huawei	China	21.2	71.2	77.3	9%
Cisco	USA	35.8	49.3	48.0	-3%
Nokia (including Alcatel-Lucent)	Finland	27.8	21.8	20.5	-6%
ZTE	China	7.2	13.8	14.3	4%
Ericsson	Sweden	26.2	11.3	13.0	15%
Samsung	South Korea	4.0	5.0	5.4	8%
NEC Corporation	Japan	6.9	5.6	4.5	-20%
Juniper Networks	USA	2.5	2.3	2.3	-0.4%
Fujitsu	Japan	2.8	2.1	1.9	-10%

Source: DECISION, from companies' annual reports

The top ten telecommunications infrastructure suppliers are predominantly Asian (China 2, Japan 2, South Korea 1), followed by the Americans (2 companies) and the 2 Europeans in the top 5.

In the Carrier Networks Segment, market leaders are Huawei (#1) followed by the European Nokia (#2) after the acquisition of the equipment manufacturer Alcatel-Lucent in 2016. Ericsson is ranked (#3), before the Japanese NEC (#4) and the Chinese ZTE (#5).

In the Telecoms Software Systems and Services segment, the major suppliers are predominantly US-based with the undisputed market leader Cisco followed by Fujitsu (#2) and Juniper Networks (#3). Ericsson and Huawei are also growing rapidly on this segment.

- **Telecommunication infrastructure production in Europe**

Production of communications equipment in Europe has more than halved since 2010, and the same is true of infrastructure equipment. The USA have succeeded in more or less maintaining their production, although all “historic” telecommunications equipment manufacturing countries or regions have been dwarfed by the surge of production in Asia and in particular in China.

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Table – World production of all communications equipment (in billion euros)

Region	2010	CAGR 2010-2016	2016	% share 2016
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Total World	**329,2**	**4%**	**415,9**	**100%**

Sources: Eurostat Prodcom, US Census, JEITA, DECISION estimates

Table – Communications equipment: European production in value (in billion euros)

Year	Total	Infrastructure	Handsets	Broadcasting	Parts
2010	**28 813**	12 872	9 009	4 230	2 700
2011	**25 839**	12 915	6 697	3 627	2 600
2012	**23 393**	14 418	3 000	3 269	2 705
2013	**13 208**	6 011	1 700	2 682	2 812
2014	**11 866**	5 862	849	2 392	2 761
2015	**11 896**	6 463	290	2 577	2 564
2016	**12 314**	6 638	342	2 333	3 000

Source: Eurostat, DECISION

- **News**

- In 2017, Nokia started manufacturing “5G-Ready” multiband base stations in a production site in India. AirScale base stations, Nokia’s leading technology, convinced several countries. The Finnish company said this is the first triple band radio. 700MHz, 3.6GHz, 26GHz are the three bands that have been selected by Europe in order to launch the 5G network. Nokia and T-Mobile are leading the nationwide 5G networks in the USA. Nokia will provide transport network and future 5G networks in China as well. They also use the beamforming technique and massive MIMO antennas.

- Korea Telecom and Ericsson, during the 2018 Olympic Games, plan to use beamforming technology that will enable mmWaves transmissions to spread optimally in both urban and rural areas.

- Qualcomm has created the 5G modem IC Snapdragonx50, continuing to be a mobile industry leader by reaching mobile Internet speeds of 1GB/s. The Snapdragonx50 chip will be able to reach higher Internet speeds when the 5G network will be rolled out entirely, according to the American company. This modem fits to smartphones equipped with 2 antennas.

- The leading Chinese telecom equipment suppliers Huawei and ZTE are investing heavily in R&D and are developing technologies for 3GPP's Phase 2 release of 5G specifications. They focus on New Radio Network and network architecture solutions leading to massive connections for machines and IoT or autonomous vehicles.

Key messages:

Telecom infrastructure suppliers are facing a similar revolution to the one that affected the computer industry in the 1990s with the generalization of IP-based digital communications. From a supplier perspective, the impact is massive and multi-dimensional:

- *Manufacturing*

On the manufacturing side, the commoditisation of infrastructure equipment combined with the competition of low-cost players is pushing to more sub-contracting to EMS by traditional OEMs.

This trend to outsource an increasing share of production to EMS is not new to the telecom industry but will be amplified in the coming years due to the technological shift towards all-IP based network solutions.

Cisco for example, coming from the computer industry, is particularly performing in the telecom market with a fabless industrial model.

- *R&D*

As far as R&D is concerned, the pressure will continue to be strong on new product development and increasingly concentrated on software development rather than hardware.

Due to the higher complexity and heterogeneity of network architecture, OEMs will have to develop innovative eco-systems gathering content producers, start-ups and service companies in order to provide comprehensive solutions responding to market needs.

- *Integration*

In a commoditised telecom equipment industry, the competitive advantage of traditional OEMs no longer relies on their capacity to develop and produce equipment, but on their capacity to integrate equipment from different vendors in order to provide comprehensive solutions to their clients.

In such a context services and applications (security, multimedia, billing, intermediation, network maintenance and upgrade, etc.) take an increasing role in the global value proposition of infrastructure suppliers.

- *Network Virtualization*

Carriers will also outsource more and more network management operations to their equipment suppliers, which will temporarily put pressure on OEMs to reorganize these operations and increase their productivity.

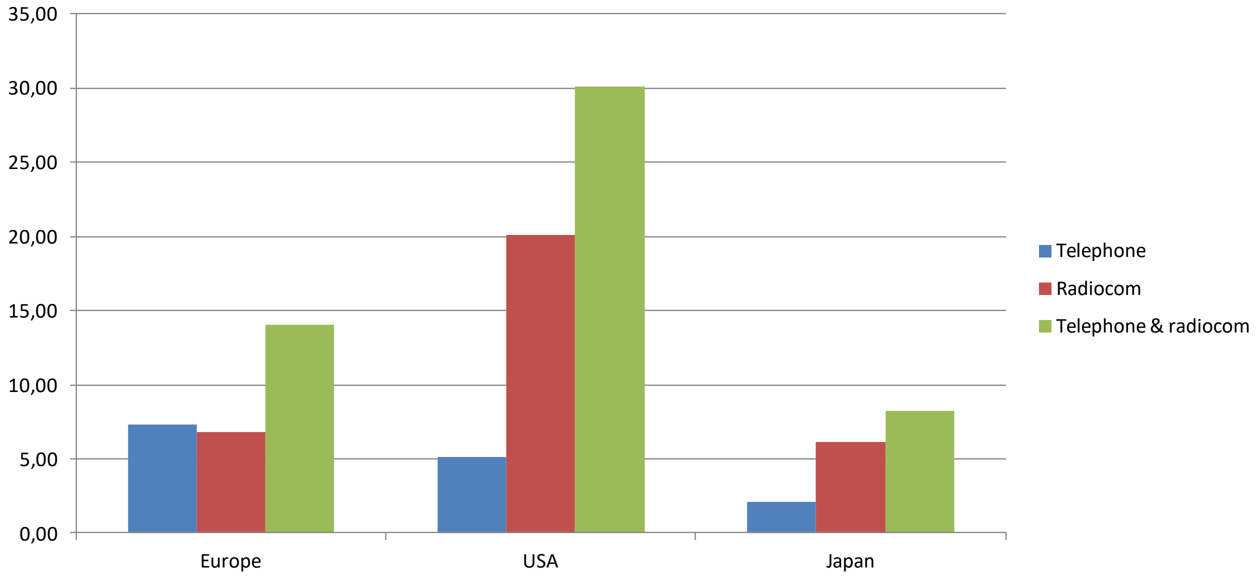
- This new organisation will open new opportunities for players who could target specific economic or industrial sectors, fulfilling particular needs proper to the industry needs.

- There may be new intermediaries in the value chain, positioned downstream of network operators. They could play the role of bundlers and repackagers for industries or economies. In order to optimize the efficiency of such a new value chain, operators and new entrants will gain at synchronizing their services to enhance connectivity services for specific industries.

- New actors upstream in the value chain could emerge as well for mobile networks. Operators could see an opening in dense urban areas where networks have to support a growing densification of the network. Investing in 5G infrastructures for specific sectors, traditional operators could be in competition with these new entrants.

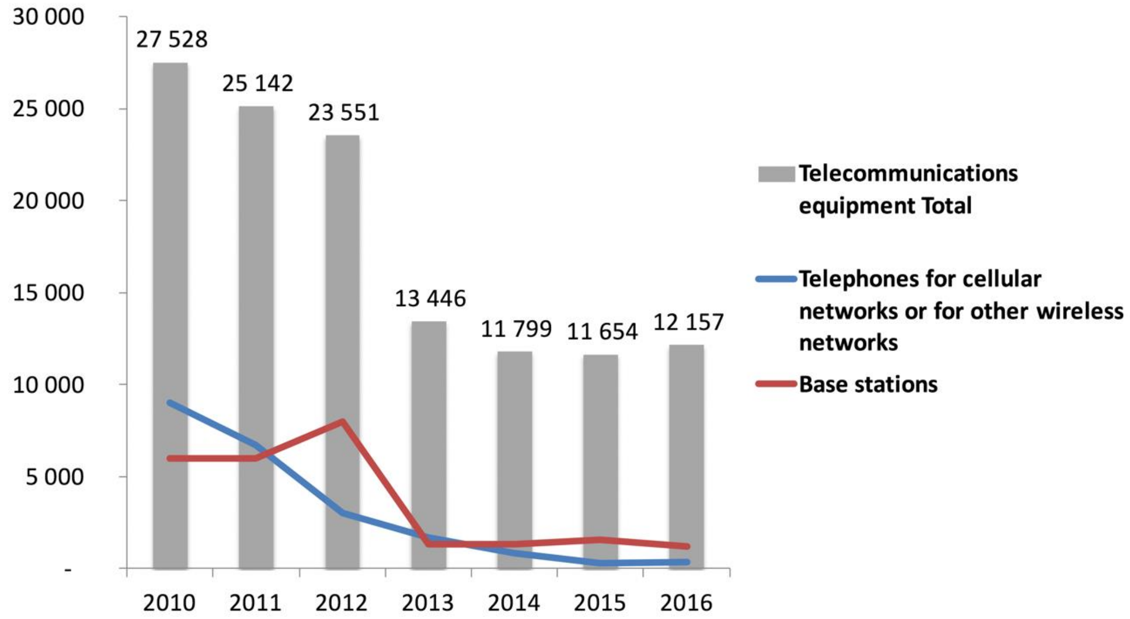
- The overall competition will be led by the orchestration of services and network (NFV and SDN), delivering the most efficient and fast connectivity.

Communications equipment production 2016 (Bn €)



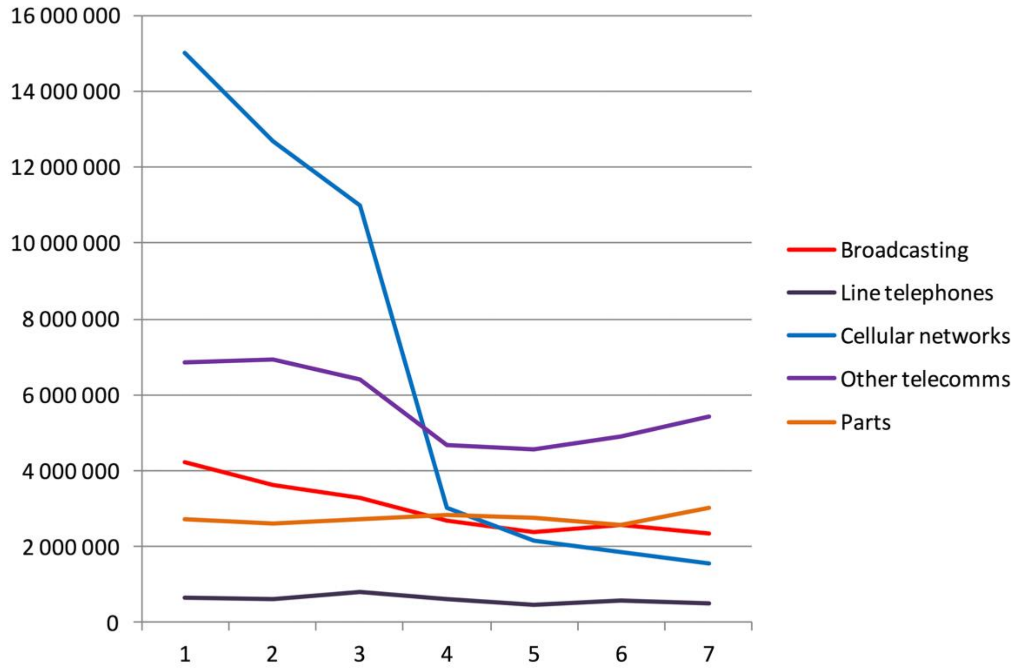
Source: DECISION Études & Conseil, Eurostat, US Census, JEITA

European Telecommunication Equipment Production (Million €)



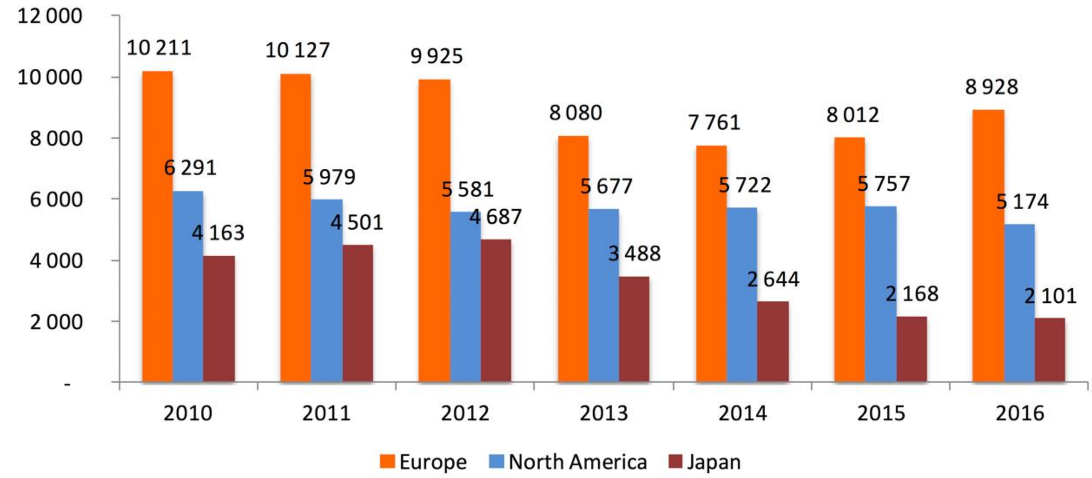
Source: DECISION Études & Conseil, Eurostat

European Communication Equipment Production (K €)



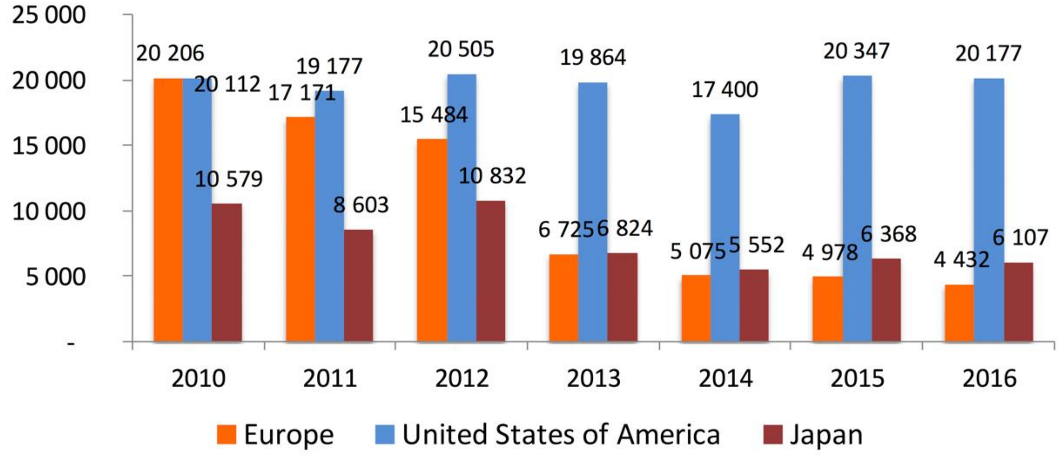
Source: DECISION Études & Conseil, Eurostat

Line Telephone Equipment Production in Value (Million €)



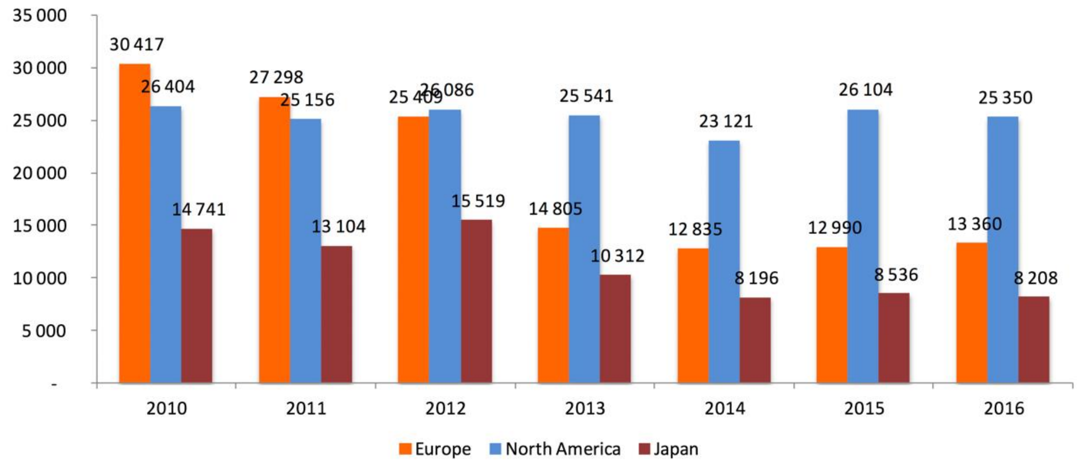
Source: DECISION Études & Conseil, Eurostat, US Census, JEITA

Radiocommunication Equipment Production in Value (Million €)



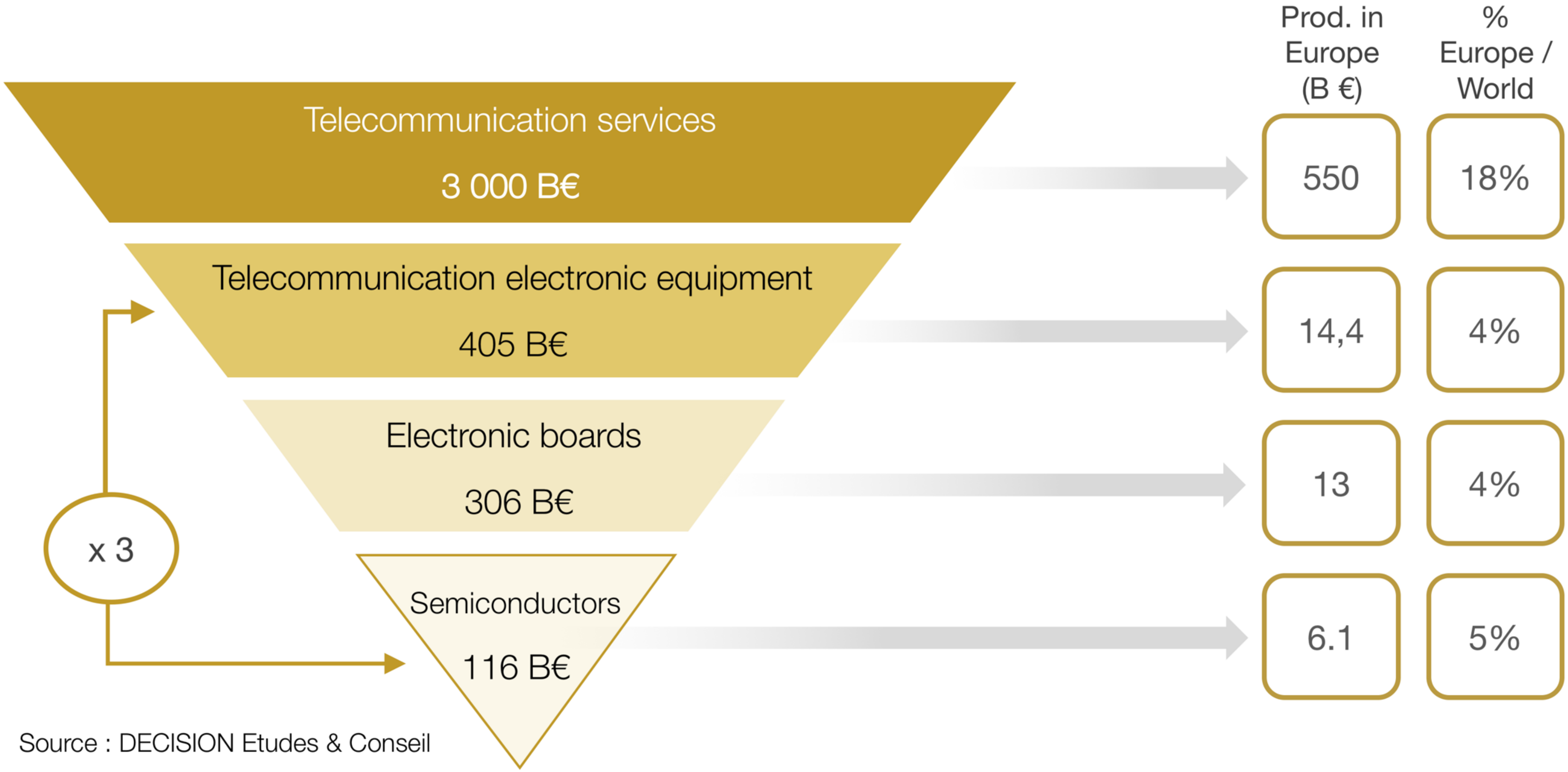
Source: DECISION Études & Conseil, Eurostat, US Census, JEITA

All Communication Equipment Production in Value (Million €)



Source: DECISION Études & Conseil, Eurostat, US Census, JEITA

World Telecommunication electronics value chain in 2017



Source : DECISION Etudes & Conseil

1.8 Health & Care electronics

Healthcare electronics are a very particular market, largely dominated by health organisations (hospitals, clinics, social security and insurance) who are the customers, the operators, and who often finance patient expenses.

Health & Care is forecast to be the "next Automotive market" in terms of electronic equipments, that is the next "leading electronic equipments market" (Automotive is already the fourth biggest market with 16% of the global electronic equipments production in 2017 and has the highest growth forecast over the 2016-2022 period with almost 10%/year).

Health & Care is still a much smaller market with only 91 B € in 2017 (4.7% of the global electronic equipment production, that is the 7th market in terms of size, just above home appliances), but benefited from a high growth of 7% per year over the 2010-2016 period and will continue to benefit from a high growth over the 2016-2022 period (6.5%/year on average).

- The "professional" sub-segment (90% of the total) is driven by better health facilities in Asia, Latin America, and Africa;
- The "consumer" sub-segment (10% today, very fast growing) is driven by the IoT and connected wearables, and the coming e-health.

The USA dominates this segment with 41% of global production, and leading global companies (Medtronic, GE Healthcare).

Europe is well positioned in terms of electronic equipments dedicate to Health & Care with 19% of the world production in 2017 (comparable to China's production size). Europe has indeed leading global companies (with Philips and Siemens) well established in the institutional markets. In Europe healthcare electronics production was 18 B€ in 2017, and the industry employed over 40,000 people. Finally, electronic equipments dedicated to Health & Care represented 6,5% of the European production value of electronic equipments in 2017.

Yet, the Chinese healthcare industry is growing very much faster.

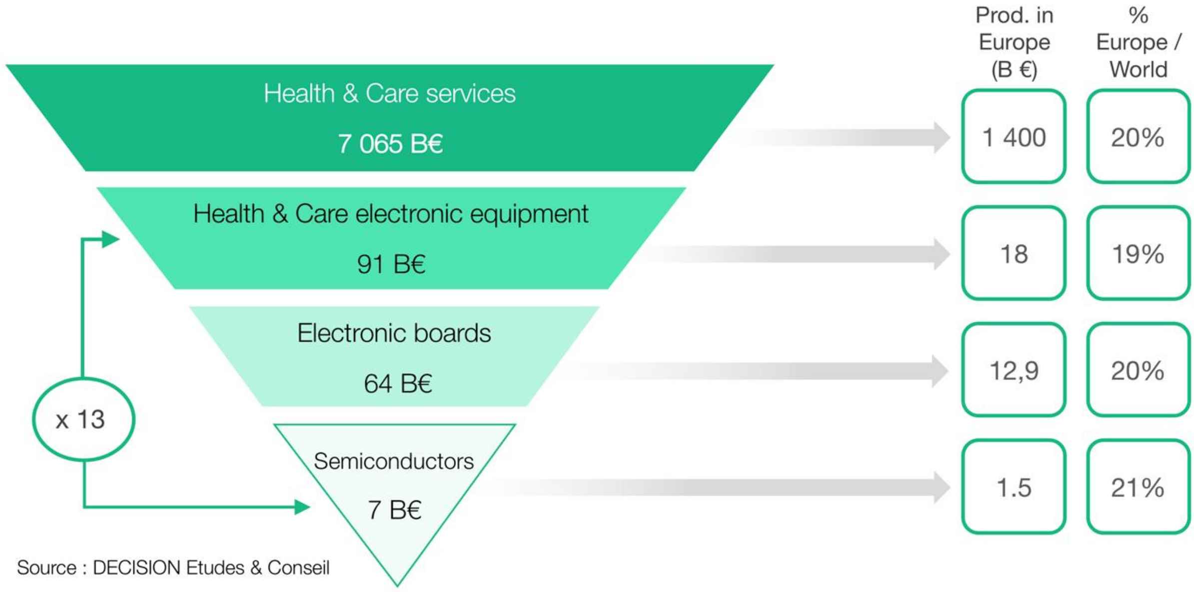
Japan is very present, but mostly on its domestic market, and less in the rest of the world.

World production of professional healthcare electronics

M €	2010	2016	CAGR 2010-2016
Europe	13 000	16 555	4.1 %
The USA	26 035	35 148	5.1 %
Japan	6 514	7 960	3.4 %
China	8 023	16 635	12.9 %
Other Asia	1 897	4 425	15.2 %
Rest of the World	1 653	4 425	10.5 %
TOTAL World	**57 122**	**85 726**	**7 %**

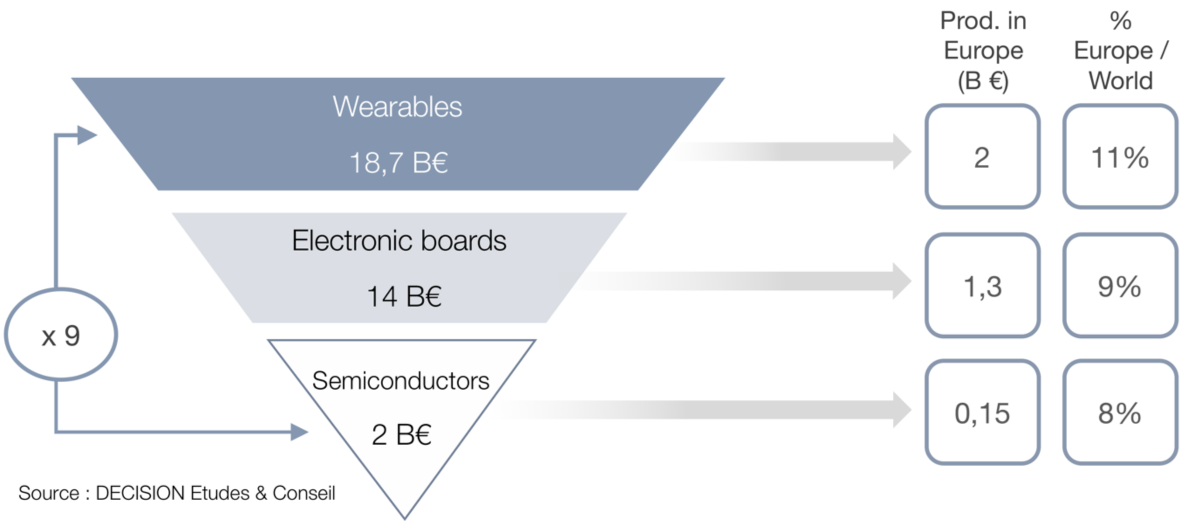
Source: DECISION Études & Conseil, Eurostat, US Census

World Health & Care electronics value chain in 2017



Source : DECISION Etudes & Conseil

World Wearables electronics value chain in 2017



Source : DECISION Etudes & Conseil

Conclusions

1.1 Enhance public aids on the EU strengths

1.1.1 Maintain public aids on More than Moore technologies

The EU is strong in embedded/professional electronic components & systems production: Automotive, Industrial, Aerospace/Defense/Security and Health & Care. These markets are the most promising in terms of size and growth over the 2016-2022 period.

Therefore, the EU should maintain and improve public aids on More than Moore technologies (MEMS, NEMS, sensors, analog). Indeed:

- These More than Moore components are mainly used in embedded/professional electronics;
- The EU holds strong position in More than Moore technologies. For instance, 2 out of the 3 world leaders in MEMS production are European (ST Microelectronics and Bosch).

1.1.2 Enhance public aids on emerging computing technologies

Innovation drivers seem to move downstream the electronic value chain towards end-user systems as Cyber-Physical Systems and Smart Systems are being impacted by emerging computing technologies:

- Emerging “autonomous” or “cognitive” technologies: using artificial intelligence (AI) applications, data handling and data analytics, predictive analysis, neural networks and deep learning, quantum computing, etc.
- An increasing number of combinations of several key enabling technologies such as industrial biotechnology, integrated photonics, spintronics, neuromorphic chips, etc.
- 5G, Cybersecurity, etc.

The EU is a World leader in terms of R&D micro and nano-electronics but also in terms of electronic systems and software.

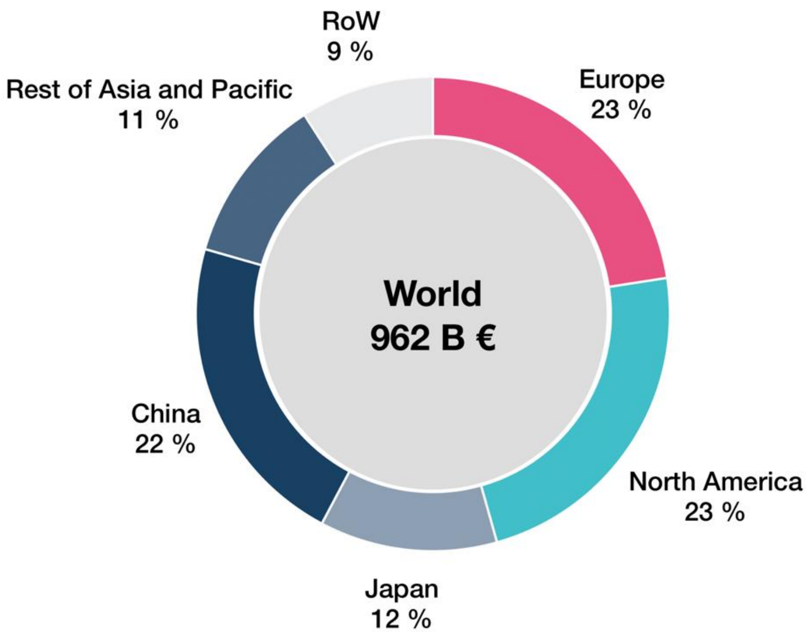
Therefore, the EU as the opportunity to support the R&D and test of these emerging computing technologies. Indeed, the key innovators in these emerging computing technologies will be the world industrial leaders of tomorrow’s large markets generated by these technologies.

1.1.3 Focus public aids on professional & embedded electronic applications

The EU is strong in embedded/professional electronic components & systems production:

- Industrial & robotics;
- Automotive;
- Aerospace/Defense/Security;
- Health & Care.

World Production Share 2017 – Embedded / Professional electronics



Source: DECISION Études & Conseil

These markets are the most promising in terms of size and growth over the 2016-2022 period.

1.2 Build a semiconductor state-of-the-art factory in the EU territory

Started decades ago, the trend of fragmentation and internationalization of the MNE supply chain led the EU semiconductor producers to progressively offshore their SC factories outside the European Union in the attempt to become at least partially fabless and to focus on niche markets on which they are able to produce (professional electronics markets). Simultaneously, the great decrease of the EU's market shares in terms of production of consumer electronics (PC, telecoms, audio/video, etc.), discouraged private SC producers to invest in advanced technology fabs in the EU territory (below 22 nm). To the extent that:

- The EU is the last region of the world in terms of monthly installed capacity in 200mm equivalent. In 2017, the EU monthly installed capacity in 200mm equivalent represented only 6% of the global capacity, way behind Taiwan (22%), South Korea (21%), Japan (17%), North America (13%), China (11%) and even the rest of the world (9,5%);
- EU semiconductor factories are specialized on old technologies (above 22 nm). EU companies tend to specialize mainly on bipolar, power, BCD and "old MOS" technologies that do not require advanced processes capabilities.

The disappearing of the capability to manufacture advanced technologies in the EU represents a direct loss of competitivity for the EU MNE ecosystem. This means that production of advanced technologies will remain in the hands of foundries and the remaining full-fab IDMs.

Moreover, if such strategy is worthwhile for the EU's private companies, it is not for the EU's sovereign states. The absence of semiconductor advanced technologies' factory in the EU territory place the EU in a weak position towards the producing countries in a period of political tensions and therefore constitutes a limitation of the EU's sovereignty.

The solution would be to build a semiconductor state-of-the-art factory. Such a factory currently cost € 7-15 B. Apart from states, only three private actors can afford to invest in such factories: Samsung, Intel and TSMC. Those actors are not European. The best option for the Europe would be to create an EU "cooperative" factory involving the EU main semiconductor producers and R&D players: STMicroelectronics, Infineon, Bosch Semiconductor, X Fab, the Imec, the CEA Leti and the Fraunhofer Institute. This would in turn be likely to fuel the large global movement of consolidation in the industry.

FDSOI is the only technology identified as suitable for such an investment.

- Indeed, the EU's players are the world leaders regarding this technology: it has been developed in Europe, by the cooperation between SOITEC/LETI/STMicroelectronics, and has been implemented in Samsung and Global Foundry;
- Moreover, it has some advantages compared to FinFET (mainly power consumption and a certain ease in manufacturing on photolithography) but also some drawback (mainly speed and density and up to now a quite low acceptance and support from the SC community);
- Finally, this technology is presently used in very low volume compared to FinFET but is said to present great interests in automotive and 5G.

FDSOI is presented by his supporters as a path for the EU to regain market share in advanced technology.

1.3 Set up manufacturing partnerships in MNE and in every key end-user electronic segment

The objective would be to set up public-private partnerships built on the model of Airbus. Indeed, the aim of this partnership would be not only to enhance R&D in Europe, but more broadly:

- The support of manufacture and design;
- To condition the maintaining of strong public aids to concrete and measurable objectives in terms of:
    - **Increase of the electronic equipment production in the EU territory**. Through the building of new factories;
    - **Increase of the employment in the EU territory**. Through the building of new factories and offices;
    - **Increase of the world production share of the players involved in the partnership in the related segments**. Example of possible goal: Set up the world leader in terms of co-construction of autonomous trains and autonomous cars level 4 transportation networks in smart cities;
    - **Protect the EU capital ownership on the players involved in the partnerships.** If the players benefiting from the partnership are bought by foreign industrial or financial companies, then the initial goals can of course not be reached.

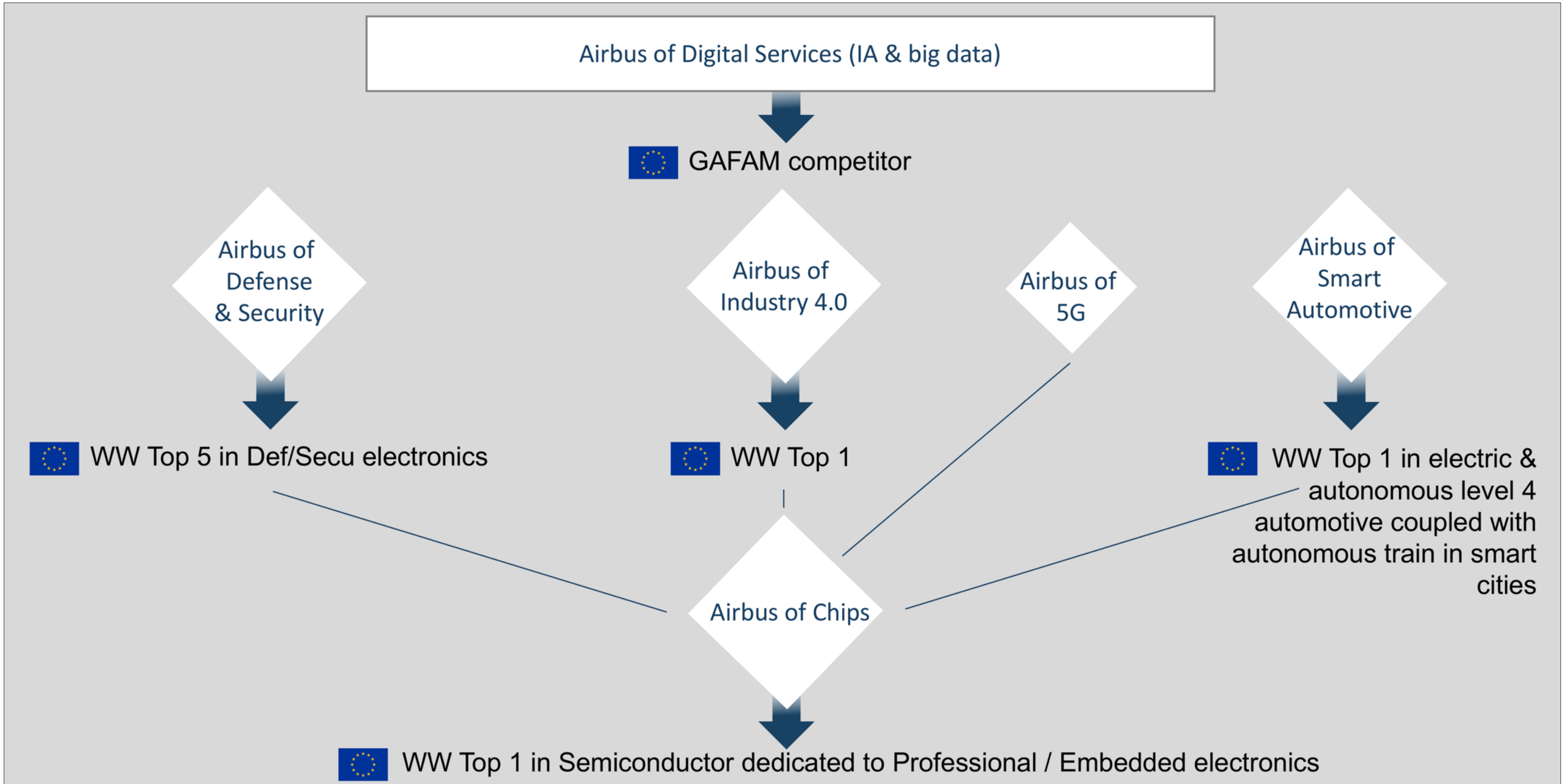
The most promising end-user segments in terms of market size and potential growth are (ranked by potential electronic production size):

- Automotive electronics;
- Industrial electronics;
- Defense & Security electronics:
- Health & Care electronics;
- Telecommunications (5G).

The EU is very well positioned on each of these end-user segments.

Health & Care is a very promising market. Yet, at the moment the EU producers' ecosystem is very fragmented. Nonetheless, designing an Airbus of Health & Care could be useful.

Finally, there would be a necessity for the EU to benchmark the US strong players at the level of digital services (GAFAM/GAFAAT), that support the entire US electronic value chain from the top of the value chain. Yet, the EU is currently very weak in terms of digital services players and setting up a EU player that would be a GAFAM/GAFAAT competitor is a first goal already very ambitious



Source: DECISION Etudes & Conseil

1.3.1 Set up an Airbus of Chips

- **What is the main justification of such an Airbus of Chips?**

1. The amount of investment required for the production of a semiconductor factory are remarkably significant. Indeed, a factory of semiconductor advanced technologies (that is below 22 nm), currently cost at least 5 B € and up to more than 10 B €;

2. The amount of investment required is constantly rising among the years. Indeed, the technologies required to build and operate a semiconductor factory of advanced technologies today (<22 nm), are significantly more complex and therefore costlier than the technologies required to build and operate a semiconductor factory of advanced technologies decades ago (> 22 nm);

3. As a result, manufacturers are reluctant to make such investments if they are not backed up by sufficient guaranteed volumes for a satisfactory return on investment. Yet, one of the main characteristics of the semiconductor market is its high volatility with a constant alternation of oversupply and under supply periods, linked to the periodic intervention of investments in production capacity;

4. These three factors explain why currently only three private companies in the world can afford to build a semiconductor factory of advanced technologies (<22 nm) alone: Intel, Samsung and TSMC. None of these companies are EU-owned. As a consequence, there is need for the concentration of the EU companies and players in this sector if the EU is to remain competitive.

- **What would be the form of such an Airbus of Chips and the EU actors involved?**

Set up a public-private partnership between public bodies (the EC, member states), the main EU private semiconductor companies:

  - Semiconductor producers: Infineon, ST Microelectronics, Bosch Semiconductor, XFab, etc.

  - Semiconductor materials and tools producers: M + W, SOITEC, Aixtron, Recif, etc.

  - Main EU R&D players: Imec, Fraunhofer institutes, CEA Leti, etc.

NXP, ASML and GlobalFoundries could also be involved in this public-private partnership as a large share of their activity and production is located in the EU territory. Furthermore, NXP and ASML are headquartered in Europe.

1.3.2 Airbus of Defense & Security electronics

- **What is the main justification of such an Airbus?**

Although the EU holds strong positions in this segment, the US are the world leaders and China is rising at fast pace.

- **What would be the form of such an Airbus and the EU actors involved?**

The possible stakeholders of such a collaboration would be: The Thales/Gemalto group, Leonardo, Atos, Ericsson, Smith detection.

The set-up of an Airbus of Defense & Security electronics is capable of forming part of the construction of a European Defense structure.

- **What would the goals of such an Airbus?**

The precise goal of such an Airbus of Defense & Security electronics is yet to be defined, but several options are possible: a global collaboration in very fields, a focus on cyber-security or a focus on Identification/authentication issues (Thales/Gemalto is already the world leader in this sub-segment).

1.3.3 Airbus of Industry 4.0

- **What is the main justification of such an Airbus?**

Launch a dynamic of concentration and collaboration of the EU players to face the rise of China.

- **What would be the form of such an Airbus and the EU actors involved?**

The possible stakeholders of such a collaboration would be ABB, Schneider, Bosch, Siemens…

- **What would the goals of such an Airbus?**

Set up a world leader in electronics dedicated to Industry 4.0.

1.3.4 Airbus of smart automotive

- **What is the main justification of such an Airbus?**

The EU is the first region of the World on almost every criterion: Automotive capital ownership / Electronic equipment production, R&D and capital ownership… But the automotive electronics industry is forecast to grow at an average growth rate of close to 10%/year over the next decade. Furthermore, the drivers of such a growth are disruptive, that is these drivers consist in new technologies therefore involving new players. The first driver is ADAS (Advanced Driver Assistance Systems leading to autonomous vehicles), based on new sensors and new software, therefore involving new players (Mobileye, Intel, etc.). The other main driver is the electrification of powertrains (leading to full electric vehicles), based on new powertrain and therefore involving new players (Chinese players in particular for rare earth and batteries at the moment). As a consequence, is the EU do not set up a clear strategy to support its leaders in the right direction, the EU players' market share could decrease very significantly in a single decade.

- **What would be the form of such an Airbus and the EU actors involved?**

The EU players that could be involved are numerous:

- Automakers: Renault-Nissan-Mitsubishi, Volkswagen, PSA, Daimler, BMW, Fiat-Chrysler, etc.
- Automotive electronics tier 1 suppliers: Bosch, ZF, Continental, Valeo, Hella, Faurecia, Leoni AG, etc.
- Emerging players: Dyson (electric vehicle), etc.

Currently, the two natural trends of automotive electronics are leading to the invention and the set up an individual plug-in fully-electric and full autonomous (level 5) car, without any innovation in terms of transportation networks (road network).

The idea would be to invest in a different direction:

1. Remain at the autonomous level 4 without investing a lot to reach the autonomous level 5.
    a. Level 4 means here: A network of fully autonomous car but driven by a single AI that run the car network in a closed environment (in a principle similar to autonomous train). This technology is already mastered in the EU.
    b. Level 5 means here: A fully autonomous car driven by a self-sufficient AI integrated fully into the car and able to face any possible situation in an open environment without any foreign intervention. This technology is not mastered by any player in the world and there is currently no guaranty that this technology will be mastered sometime. Experts currently postpone to 2030/2040 the emerging of the innovations required to master such a technology.
2. But build an offer of “Smart mobility in Smart cities” built on the combining of:
    a. Autonomous cars level 4 in closed environment networks;
    b. Autonomous train networks;
    c. Public bodies involved in smart cities.

    The required technologies to build such an offer are already mastered by the EU players. Yet, the challenge would be to develop a combined offer of Smart City Architecture combing autonomous trains players and autonomous cars players to build the first world leader of “Smart mobility in Smart cities” that could sell its service offers to cities around the world.

- **What would the goals of such an Airbus?**

Set up the world leader in terms of co-construction of autonomous trains and autonomous cars level 4 transportation networks in smart cities.

1.3.5 Airbus of 5G

Although it is already late to undertake actions in 5G, the EU still benefit from very significant players in telecommunications (Ericsson and Nokia-Alcatel in particular), that should enable the EU at least to preserve production shares in terms of 5G infrastructures installation.

1.3.6 Airbus of Digital Services (IA & big data)

- **What is the main justification of such an Airbus?**

The US are using their leaders of digital services (GAFAM) to support their electronic equipment industry. China is adopting the same strategy with Baidu, Alibaba, Tencent, Xiaomi…

The EU is the only world player with a comparable size to that of China and the US in terms of population and wealth. Therefore, the EU has the structural capability to set up a similar strategy.

- **What would be the form of such an Airbus and the EU actors involved?**

The EU is currently very weak in terms of digital services players. The players identified as possible stakeholder of an Airbus of digital services are the following:

Name of the company	Turnover 2017 (M €)	Segment
Cap Gemini	13 000	IT consulting
Atos	13 000	Software development & IT consulting
Sopra Steria	3 800	IT consulting
Avast	653	Software & antivirus development
OVH	320	Cloud computing services

- **What would the goals of such an Airbus?**

To set up an EU player that would be a GAFAM / GAFAAT competitor.

1.4 General recommendations

1.4.1 Benchmark the Chinese and US strategies

Over the 2010-2016 period, China and the USA are the two main players that benefited from the highest growth of electronic equipment/systems production (with respective compound annual growth rates of 6.7%/year and 3.6%/year).

Therefore, if the EU is to preserve its production shares and the market shares of its players, in particular from the rise of China, the EU needs in the first place to benchmark the Chinese and US strategies, that is to put the state (that is the national states and the EU commission) back above the markets and the private companies (domestic and foreign). It means that the EU strategy needs to be developed and set up with the willingness to ensure a long-term positive development (not only economic, but also ecologic and social) for the 28 members states citizens and not only from the point of view of significant private companies, without fear of disturbing private markets (often leaded by foreign companies).

Those are the strategies of the United-States and China. It implies to:

- **Set up a proactive capital-ownership policy**. Such a policy consists in proactively influencing the capital-ownership of domestic and foreign companies in order to protect and enhance the EU's interests with three axes:

  1. Prohibiting when necessary the purchase of EU owned companies by foreign investors. For instance, Wolfspeed (subsidiary of Cree, US owned company), has acquired Infineon AG Radio Frequency (RF) Power Business for approximately € 345 million in March 2018. Yet, in 2016, Infineon thrived to purchase Wolfspeed for $ 850 million but this deal had been prohibited by the USA (through the Committee on Foreign Investment in the United States);

  2. Supporting and/or leading the purchase of foreign companies that have been identified as having key capabilities, know-how and/or patents and that may be complementary with EU owned capabilities, know-how and/or patents. An example of such as strategy has been the attempt of Qualcomm (supported by the USA), to purchase NXP in 2017 and 2018;

  3. When it proves possible, prohibiting the purchase of a foreign company by another foreign company when such a merger would lead to the set-up of a too powerful competitors for EU players. An example of such a strategy has been the political blockage by China of Qualcomm's $44 billion deal for NXP.

- **Being able to enhance smart protectionism to ensure the set-up and/or the maintaining of EU leaders inside the EU market**. With 500 Million wealthy citizens, the size of the EU market is comparable to the size of the Chinese domestic market and the US domestic market. Therefore, the EU has the structural capability to set up the same strategies as China and the USA: that is to use its huge domestic market to set up EU leaders in every industrial segment using smart protectionism rules.

  One of the best examples of smart protectionism tool is the **combined use of standardization, certification and prescription**. Standardization consists in defining a list of technical characteristics regrouped in a “standard”. Certification consists in setting up a public authority whose role is to analyze the products of private companies in order to determine if a specific product can be considered as being part of a standard. Finally, prescription consist in imposing to public and/or private organizations the use of products that have been considered has being part of a specific standard by the certification authority. Why can the combined use of standardization, certification and prescription be useful to protect the EU’s interests? Because the European players are among the most competitive players of the world in terms of R&D, patents and know-how, but often face difficulties to compete foreign players on the single criteria of the price. Promoting European standards at the forefront of technological innovation and imposing those standards to the European actors is a very efficient way to indirectly provide competitive advantage to the EU providers and thereby to “reserve” the EU market to EU suppliers.

  The use of **contracts to equip public services with EU-owned solutions** is another example of smart protectionism.

- The Chinese example demonstrate the importance of maintaining independent capacities of production and know-how at every step of the value chain in order to remain a key player on any type of electronic segment. The EU should focus on **regaining significant and independent production capacities in particular at the level where the EU is weak: raw materials and SC foundry**.

1.4.2 Set up and promote European standards and regulations

Set up and promote European standards and regulations, in order to enable fast and large emerging technologies deployments in European end-markets and then worldwide ones, as the GSM standard did.

1.4.3 Develop education in engineering science

Many industrial bring to the fore the lack of electronic technicians and engineers in the EU territory. According to the Commission ICT Monitor, in 2017, 80 000 electronics related open vacancies. Among these 80 000 vacancies:

- 64 000 open vacancies of electronic engineers;
- 16 000 open vacancies of electronic technicians.

Developing education and training in science, technology and engineering, and in particular in the key domains of artificial intelligence, big data, and industry 4.0, where Europe lacks manpower with the qualifications and skills required at all levels of the value chain.

1.4.4 Create an Observatory of the EU MNE and electronic ecosystem

There is a clear lack of public statistical data in Europe on:

- Automotive electronics;
- Industrial electronics;
- Aerospace/Defense/Security electronics;
- Health & Care electronics.

Yet, those segments are the most critical for the EU. On the contrary, segments in which the EU's position is very weak are much more precisely measured: mobile phones, audio & video, PCs, etc.

Therefore, the EU should create an Observatory of the European MNE and Electronics ecosystem in order to:

- Provide more relevant data based on the precise study on the players in the EU;
- Provide data that would be annually updated.

European Commission

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