

Study on the Electronics Ecosystem

OVERVIEW, DEVELOPMENTS AND EUROPE'S POSITION IN THE WORLD

Annex 6, 7 & 8

A study prepared for the European Commission
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by:



DECISION
ETUDES & CONSEIL

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1.1.1 Scope and presentation of the segment and its value chain

This part deals with both the professional and non-professional segment of the data processing market. This segment includes Personal Computers (Desktop PCs, laptops, tablets), HPC (High Performance Computing) systems, servers, and dedicated terminals.

i. PCs

Personal Computers are losing their status as the essential digital platform, which provided productivity gains, comfort and entertainment across the board from enterprises to households. During the eighties and in order to address fast growing demand worldwide, PCs joined the expanding mass-market electronics domain, with radios, audio, TVs and video, calculators and watches. Today the smartphone is becoming the essential digital hub, and the new concept of “Internet Terminals” merges smartphones, PCs, tablets, set top boxes, TVs and audio devices.

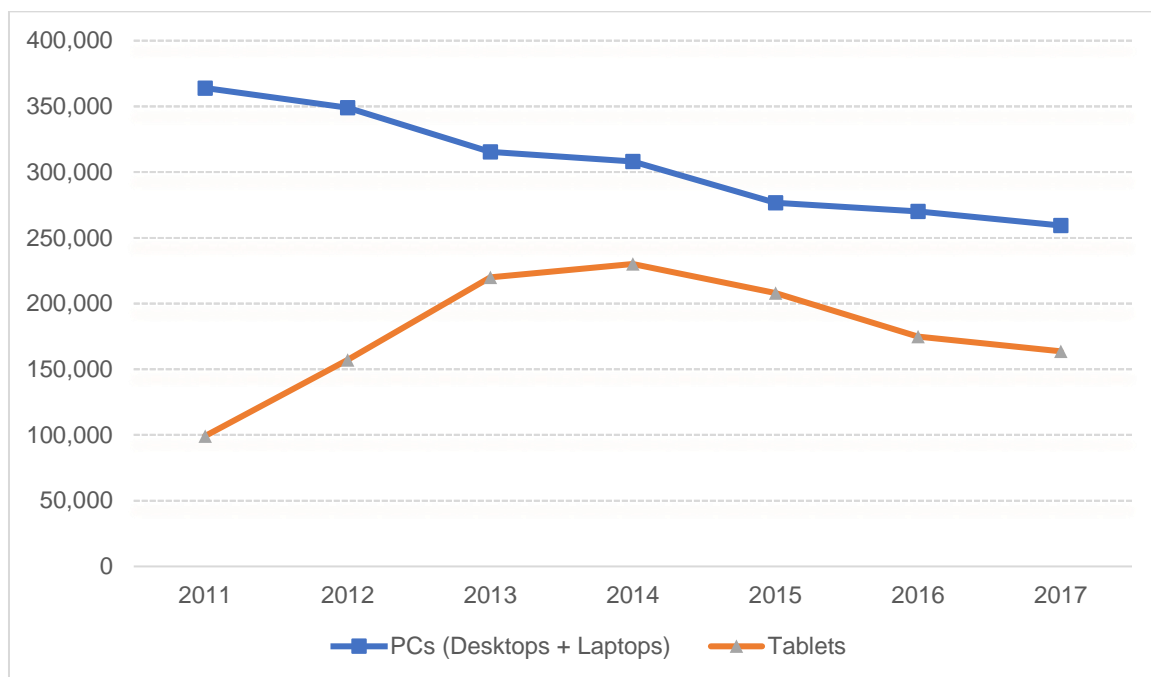
Years ago, the business market for PCs represented up to 60% of the global data processing market. However, consumer demand soon caught up with business demand, and the distinction between business and personal use has lost much of its significance today. The industry has seen price cuts, economies of scale, industrial specialisation, value chain restructuring and massive localisation in low manufacturing cost and expanding market areas. The PC industry has been the first in the electronics industry value chain to massively use sub-contracting specialists (Electronics Manufacturing Services) for motherboard assembly and, later on, for complete product design as well (Original Design Manufacturers).

Today the PC's position as central piece of the digital convergence is challenged by the smartphone. The traditional PC market (mainly desktop but also laptop) has recently entered a new and lasting trend of declining shipments in a scene marked by intensifying competition both from price competitive suppliers in Asia and from new platforms capturing an increasing share of digital services and revenues such as smartphones or tablets. The emphasis of innovation has shifted from the PC industry to the smartphone industry, with new concepts emerging, such as PC-as-a-service launched by Dell, HP and Microsoft.

Major product segments of the PC industry include:

- Desktop PCs;
- Laptops (including traditional laptop computers, and Ultramobile PCs such as Netbooks, Ultrabooks, Chromebooks, etc.);
- Digital tablets (including Hybrid PCs or 2-in-1 PCs);
- Peripherals (printers and scanners, memory sticks, disk drives, monitors, cameras, keyboards...).

Graph - PC and Tablet Unit Sales, 2011 to 2017 (thousand units)



Source: DECISION

The PC industry reached its peak in 2011, with shipments of 352.8 million units. Since then it has steadily decreased, dropping by about 90 million units between 2011 and 2017.

As well as the traditional PC industry (desktop and laptop), the digital tablet also lost against the smartphone. Despite its relatively recent emergence (from 2008), the digital tablet market peaked in 2014, only six years after its take-off, after which it declined in parallel with the rest of the PC market.

ii. Professional data processing

This section deals with the professional segment of the data processing market. The professional segment includes HPC (High Performance Computing) systems, servers, and dedicated terminals.

Medium term drivers seem solid. Europe represents 24% of the world market, but only 6% of world production. Most of the products for the low and middle ends of the servers' market are now manufactured in China but Europe still has strong assets and players such as Ingenico (a world leader in POS (Point Of Sale) terminals).

A. High Performance Computing (HPC)

The High-Performance Computing market includes *supercomputers* and *high-end technical servers*. These are high-priced and super-powerful high-performance computing machines.

HPC is now widely viewed as a key strategic factor of economic competitiveness, in the same way as scientific advances of companies and nations. Cloud services and big data also create growth opportunity for the high-end server market in addition to mobile broadband. Most of the systems are now made of clusters, and blade-based

clusters have become extremely popular due to their high price/performance level, low profile, and lower power consumption.

The strongest growth within HPC will be in the supercomputer market, particularly in China. Out of the Top 500 world's fastest supercomputers 206 (41%) are located in China, significantly more than in the USA (124 and 25%) and in Europe (95 and 19%).

In 2012, the European Commission adopted a plan to double spending on HPC to 1.2 billion euros. The majority of this amount was dedicated to the installation of additional petascale supercomputer systems. In 2013, the EU launched two 1+ billion-euro ten-year research investments (in brain functions and graphene). Moreover, in June 2018, the European Commission announces that 2.7 billion euros will be invested in order to finance projects to build and strengthen HPC and data processing in Europe.

The only significant European vendor is Atos-Bull (France), who gained significant market shares over the past few years.

B. Servers (middle and low range)

Demand increase is driven by less expensive high-density microservers who emphasize power efficiency for massive amounts of lightweight-computing tasks, such as delivering thousands of web pages to users of smartphones and other mobile systems. New microserver systems are also being aimed at a wider range of data-center applications and new cloud-computing services.

In 2013, over 70% of the market still belonged to HP, Dell and IBM, both in units and in value. IBM was rather oriented towards high-end products, while Dell targets the lower-end market segment, and HP, now n°2, lies somewhere in-between. Oracle (ex-Sun), Fujitsu and Cisco are the other much smaller actors. In January 2014, IBM announced the sale of its low-end x86 server activity for 1.7 billion euros to Lenovo, eight years after selling its PC business to the Chinese manufacturer. This transaction reinforced Lenovo's presence in data processing and data storage while IBM continues its shift from hardware to more profitable software and services. IBM's low-margin server business has posted seven quarters of losses as clients move to the cloud.

C. Dedicated terminals

The *ATM (Automatic Teller Machine)* sector is expanding in developing countries such as China and India. The leading vendors are still NCR, Diebold and Wincor. New Chinese and Korean actors are entering the market. Beyond the basic task of delivering cash, more and more new banking functions are required from these systems.

The *POS (Point Of Sales) Terminals* sector is also a dynamic market that is headed by three vendors: Ingenico, VeriFone-Hypercom, and the Chinese SZST.

Middle and low range servers, and dedicated terminals are increasingly manufactured in high market growth and low cost countries, especially in China that accounts for over 50% of world output in 2016.

Most of this production is subcontracted to large EMS or ODM companies.

1.1.2 PCs and Data processing in figures

i. Methodological note

European production is measured by Eurostat, who gathers and analyses figures from the national statistical offices across Europe, and publishes them in two distinct sources, the SBS NACE 2 statistics, which give turnover, employees, and other indicators, and the Prodcom statistics, which give production in value and quantity, as well as imports and exports.

There are differences between the Prodcom and the SBS NACE industry database:

- The SBS NACE industry statistics are “activity” statistics, i.e. they measure the activity of “statistical units” (which may be companies or subdivisions of companies) located in the EU. Units are assigned one NACE 4 digits code according to their “principal activity”, i.e. the activity accounting for the most value added (which may be less than 50% when there are more than 2 secondary activities). The whole of the activity of the unit (including secondary activities) is classified under the principal activity code. The database presents various indicators, among which turnover, value added, employees and investment;
- Prodcom data presents the value (in euros) and quantity (in units) produced in the EU in a more detailed 8 digits code (where the four first digits are the same as the NACE code), as well as import-export data. Prodcom.
- **In the figures presented by DECISION in the pyramids/overview and used to undertake comparisons with the other end-user electronic segments, the Prodcom figures have been selected as they are supposed to provide a more precise measure of the production level and location.**

Table: Data processing in Europe in 2015

	SBS	Prodcom	DECISION
Turnover or production (Billion euros)	29.1	21.9	21.9
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, DECISION Études & Conseil

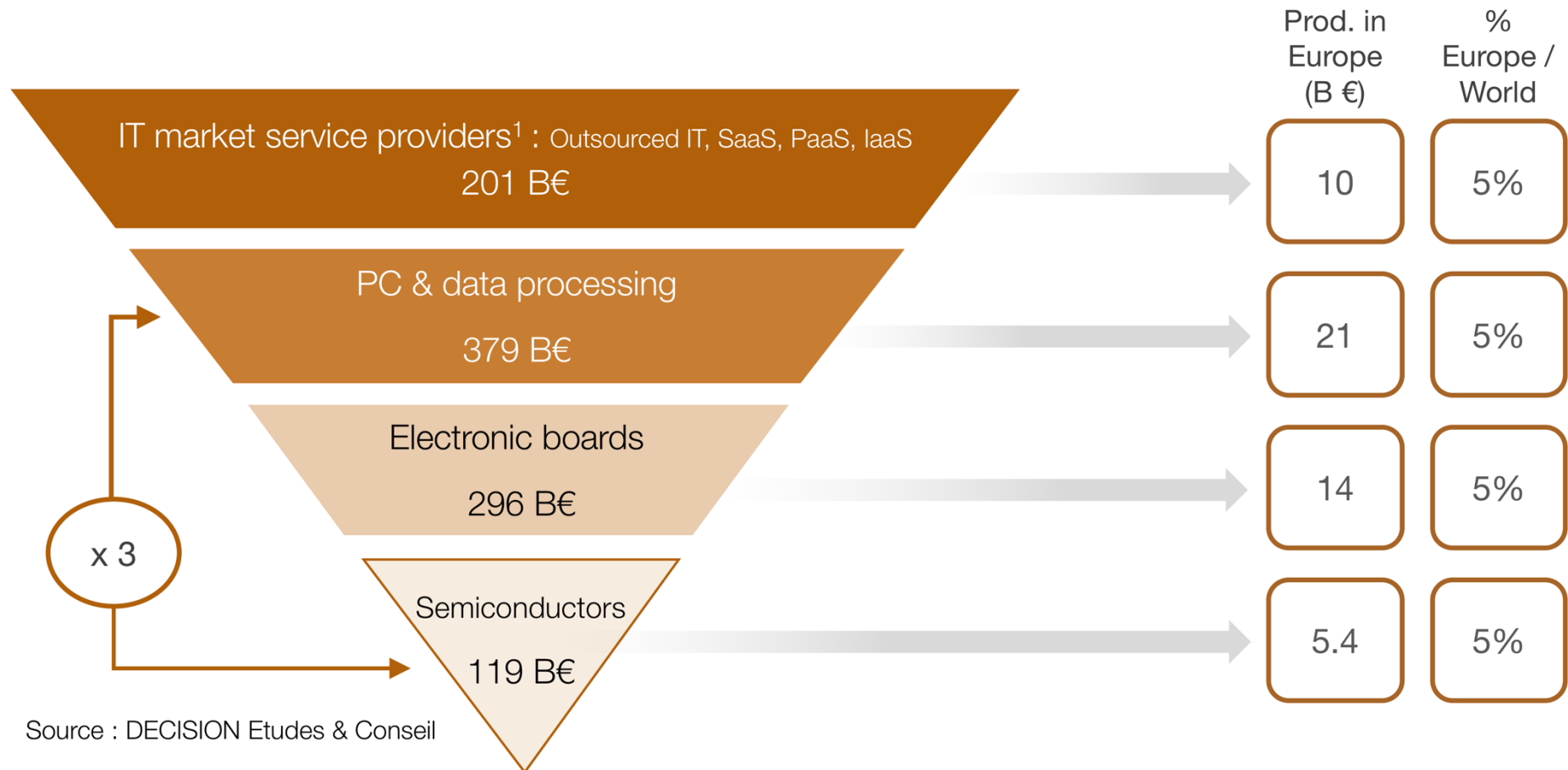
ii. The EU's position in the World

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).

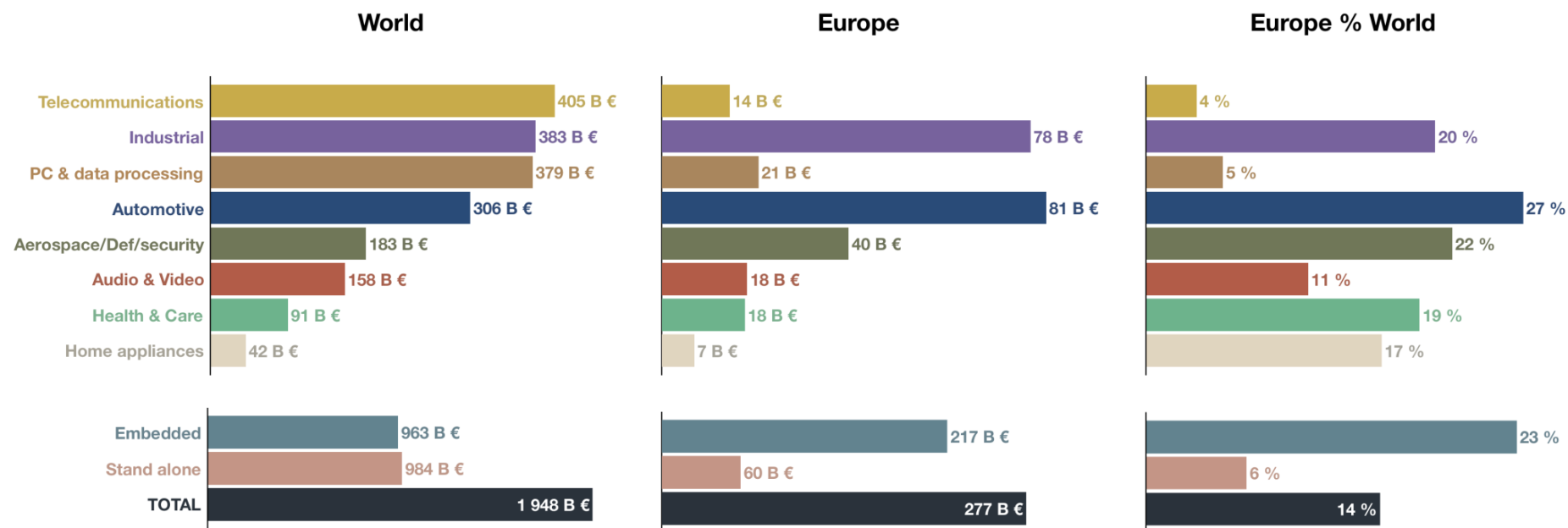
This reflects the absence of European industry in the PC and low range computer peripherals and accessories, which are an Asian speciality.

Worldwide PC & data processing 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, PC & data processing tools provide a majority of "non market services" once they are sold.

Diagrams: World and European end user equipment production in 2017 (M€)



Source: DECISION Études & Conseil

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.

Table: 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

Table: US production of Data Processing equipment (M€)

	PCs	Other computers	Storage	Peripherals & terminals	Total
2016	2 413	5 651	5 974	6 469	20 507
2015	2 303	5 960	6 704	7 523	22 220
2014	1 786	4 376	6 119	7 299	19 580
2013	1 905	4 019	6 821	8 038	20 783
2012	2 297	5 014	7 765	9 580	24 656
2011	1 703	3 302	6 181	6 967	18 153
2010	3 229	9 543	5 971	7 349	26 092

Source: US Census

Table: Japanese production of Data Processing equipment (M€)

Computers & terminals	
2016	8 621
2015	8 032
2014	8 552
2013	9 278
2012	11 722
2011	11 307
2010	13 496

Source: JEITA

Table: Professional Data Processing: World and European production in 2016 (M€)

Sub-segment	World 2016	World CAGR 2010-16	Europe 2016	Europe CAGR 2010-16	Europe % of world
PCs	241 100		2 231		1.0%
Professional Data Processing	48 100	4.8%	2 680	2.9%	5.6%
Of which					
Mainframes, high performance computing	10 000	7.6%	430	7.0%	4.3%
Servers & dedicated syst. and terminals	38 100	4.0%	2 250	2.1%	6.0%
Other equipment, peripherals, parts	80 800		15 417		19.0%
Total Data Processing	370 000		20 328		5.5%

Source: DECISION Etudes & Conseil

iii. European activity and production statistics

A. Eurostat SBS industry database

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

Table: Data processing in Europe in 2015

SBS	
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, DECISION Études & Conseil

Table: European industrial base in Data Processing by Member State (%)

Country	Turnover (%)		Employees (number)	
	2010	2015	2010	2015
Ireland	20	23	5 267	4 248
Germany	21	21	22 166	20 673
Czech Republic	19	20	6 052	5, 821
Hungary	6	7	8 041	7 500
United Kingdom	8	7	-	-
France	6	6	3 317	5 080
Italy	8	4	6 363	4 437
Poland	4	3	7 664	4 417
Romania	2	1	3 607	2 649
Portugal	1	1	985	966
Others	6	6	10 720	9 374
Total	100.0	100.0	74 183	65 165

Source: Eurostat, DECISION Études & Conseil

Table: European industrial base in Data Processing by Member State

Country	Value added (%)		Investments (M€)	
	2010	2015	2010	2015
Germany	30	30	71.6	64.2
Ireland	19	21	30.7	58.2
United Kingdom	14	16	116.9	55.3
France	5	7	13.1	7.1
Italy	7	6	-125.2	11
Hungary	5	5	13.3	29.3
Czech Republic	4	3	44.3	8.5
Poland	3	2	30.6	-3.7
Sweden	2	2	5.5	4
Belgium	2	2	5.6	6.1
Others	9	7	51.5	33.5
Total	100.0	100.0	257.9	273.5

Source: Eurostat, DECISION Etudes & Conseil

Table: European industrial base in Data Processing by Member State

Country	Value added / Turnover (%)		Turnover / Employees (k€)	
	2010	2015	2010	2015
Hungary	17	13	12 056.5	26 380.5
Ireland	18	19	12 556	18 223.8
France	15	23	9 586.8	11 136.7
Czech Republic	4	3	4 068.5	5 709
Italy	18	25	4 673.6	3 538.7
Denmark	33	33	2 978.5	1 888
Austria	43	36	94.4	494.5
Germany	27	29	303	374.7
United Kingdom	31	47	173	236.2
Spain	29	25	288.3	175.6
Others	24	21	15.3	28.8
Total	18.4	20.1	2 469.3	3 799.4

Source: Eurostat, DECISION Études & Conseil

The following graphs show the ranking of the top European Member States for Data Processing turnover, added value, investment, and employees.

The turnover in Europe of the manufacture of computers and peripheral equipment was 29.1 billion euros in 2015, growing since 2010 at a 1% growth rate.

Ireland and Germany and the Czech Republic together accounted for almost two thirds (64%) of the European manufacture of computers and peripheral equipment (~43%) with respectively 6.6 billion euros, 6 billion euros and 5.9 billion euros in 2015.

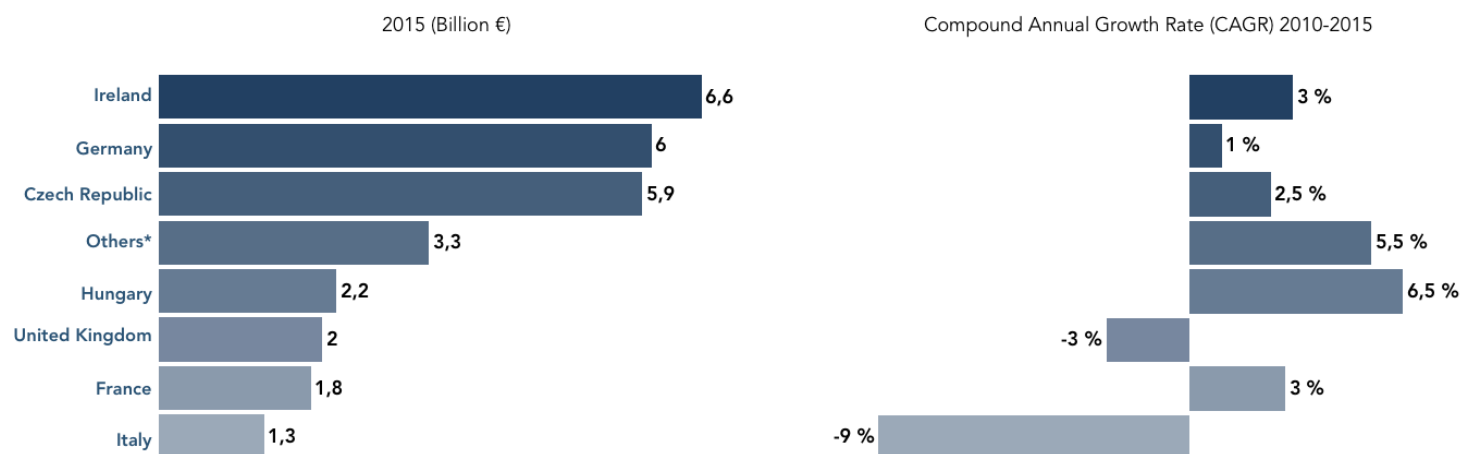
The added value created in this sector was 5.8 billion euros in 2015, growing from 2010 at 2% per annum. Germany and Ireland generated half of the added value in Europe (~51%), growing at respectively 3% and 5% per year.

In Europe, investment in the manufacture of computers was 273.5 million euros in 2015, growing 1% per year from 2010 to 2015.

Again, Germany and Ireland are the two countries where there was the most investment in the segment, with respectively 64,2 million euros and 58,2 million euros. The UK ranked just behind Ireland with investments of 55.3 million euros.

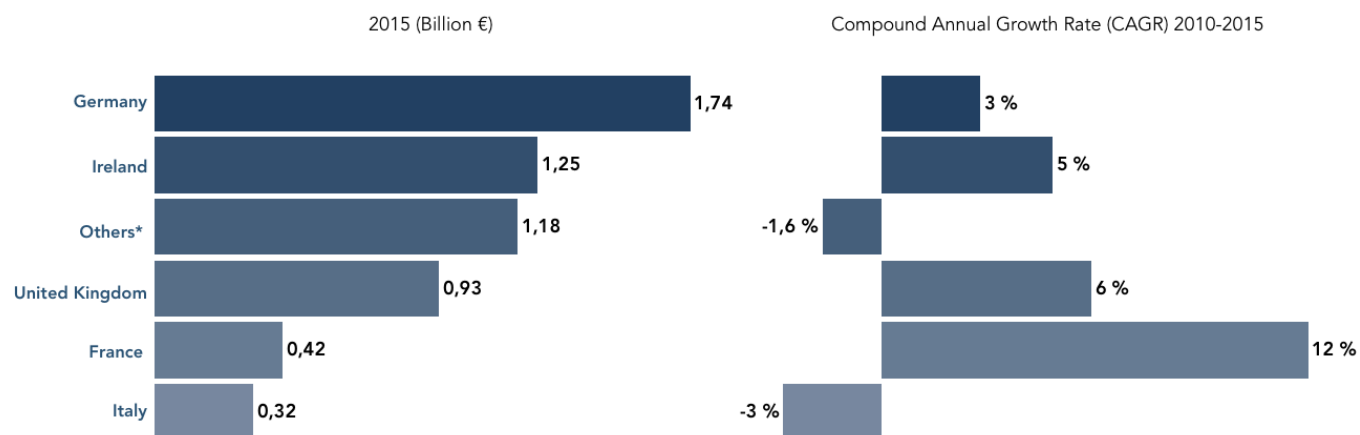
Except in France where employment grew by 8.9% per year from 2010 to 2015, all the other European Member States where data was available saw employment in the sector decline. The European Union lost 9,000 employees between 2010 and 2015. Germany was by far the largest employer in the sector (20 673), whereas Ireland only employed 4 248 people, showing a massive gap in turnover per employee (290 k€ in Germany, against 1 554 k€ in Ireland), as well as in value added per employee (84k€ in Germany, against 294 k€ in Ireland).

Diagrams: Manufacture of computers and peripheral equipment – turnover



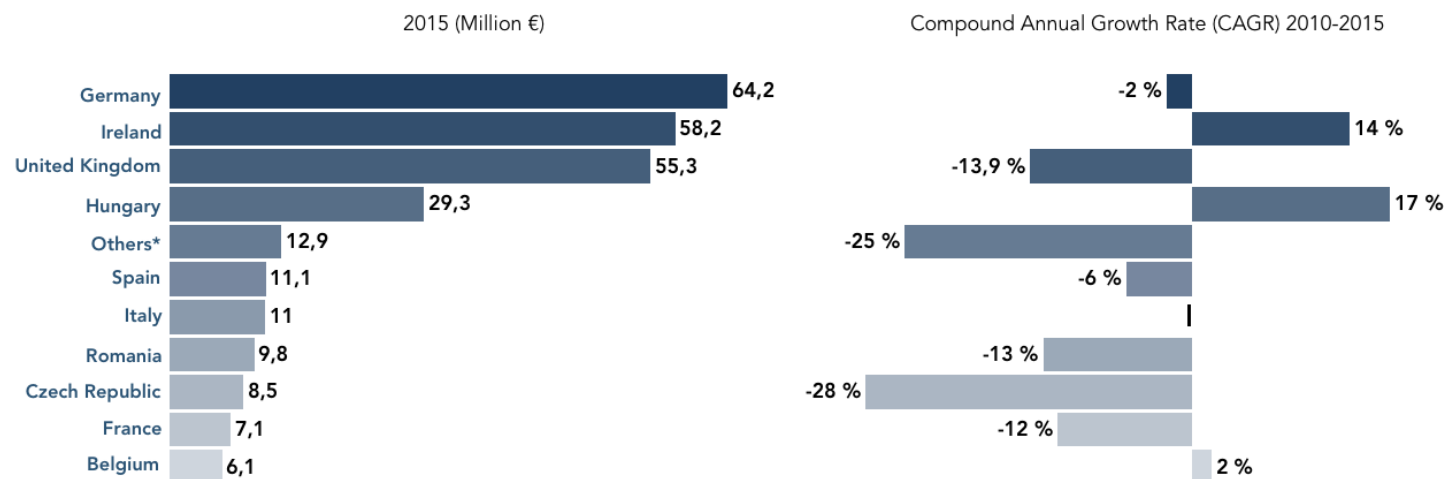
Source: Eurostat, DECISION Études & Conseil

Diagrams: Manufacture of computers and peripheral equipment – Added Value



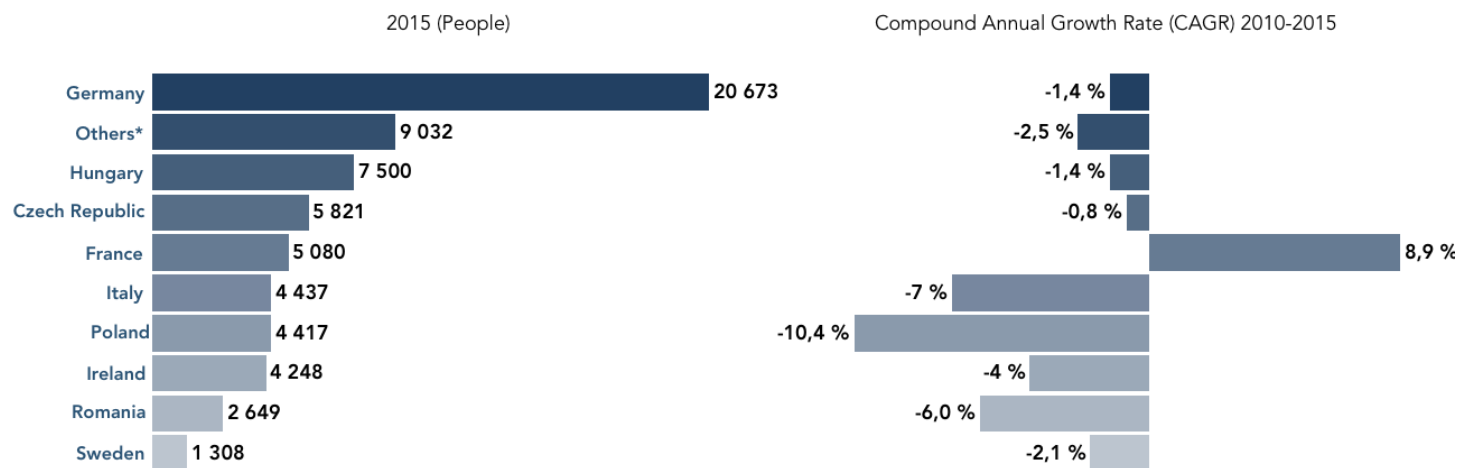
Source: Eurostat, DECISION Études & Conseil

Diagrams: Manufacture of computers and peripheral equipment – Investments



Source: Eurostat, DECISION Études & Conseil

Manufacture of computers and peripheral equipment – Employees



Source: Eurostat, DECISION Études & Conseil

B. Production in the European Data Processing Industry

The Eurostat Prodcom database provides detailed production figures for the Data Processing industry. Prodcom production figures differ from SBS NACE figures because Prodcom takes into account the production of companies in each product, whereas in the SBS figures the whole company turnover is counted in the sector which represents the main activity of the company and is not counted if it is not the company's main activity.

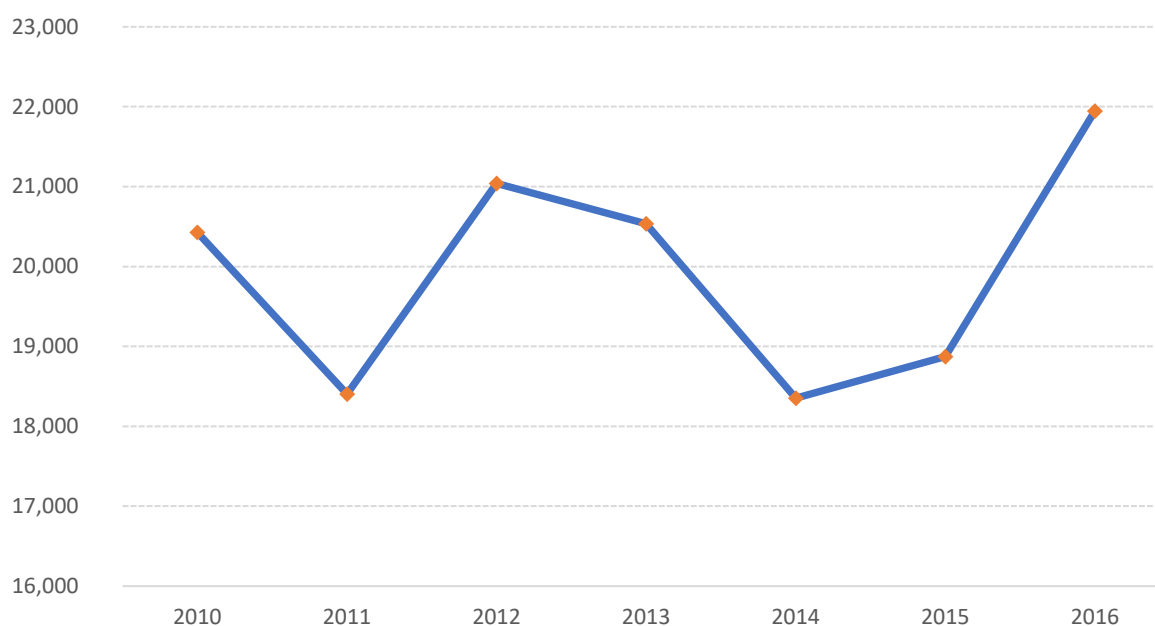
Table: Prodcom – Data Processing equipment: European Production in Value (M€)

	Total	PCs	Peripherals	Storage	Terminals & other	Parts
2010	20 425.8	5 684.1	2 717.2	2 422.4	4 937.4	4 664.7
2011	18 402.9	3 351	2 711.8	2 429.3	5 732.1	4 173.7
2012	21 041.3	3 459.9	2 863.2	4 553.5	5 902.7	4 262
2013	20 533.9	3 009.4	2 544	6 066.1	5 226.6	3 687.7
2014	18 352.9	2 971.6	2 333.4	4 094.6	5 682	3 271.3
2015	18 872.1	2 328.2	2 250.7	6 150.9	5 625.7	2 516.6
2016	21 945.9	2 230.9	2 414.7	5 365.6	9 546.1	2 388.2

Source: Eurostat, DECISION Études & Conseil

In 2016 European data processing equipment production was 21.9 billion euros, up from 20.4 billion in 2010.

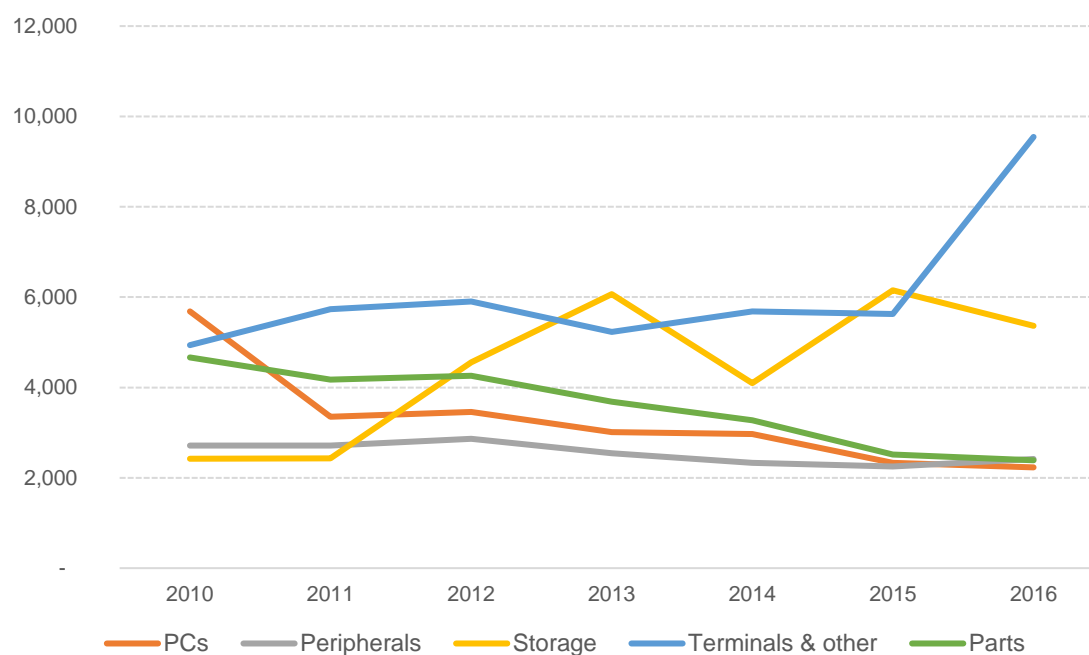
Graph: European data processing equipment production (M€)



Source: Eurostat, DECISION Etudes & Conseil

In Europe, data processing equipment production has evolved very irregularly during the recent years, with however a downward trend since a peak in 2012. This irregularity reflects the irregular evolution of storage and memory products, as well as strongly differentiated trends for the various product groups. Storage, terminals and other data processing products are on a growth trend, peripheral equipment is rather stationary, whereas PCs and parts and accessories have strongly declined.

Graph: European data processing equipment production (M€)



Source: Eurostat, DECISION Etudes & Conseil

1.1.3 Company positioning

i. PCs

Table: PC market shares by units (without tablet sales)

2017 Rank	Manufacturer	Country	2017 Market share (%)	2010 Market share (%)	2010-2017 Market share evolution
1	HP		21	17.9	+3.1
2	Lenovo		21	9.7	+11.3
3	Dell		15	12	+3
4	Asus		8	5.4	+2.6
5	Apple		7	-	-
6	Acer		6	12.9	-6.9
-	Others	-	22	42.1	-

Source: Gartner (April 2018)

Three of the six top PC vendors are American (HP, Dell and Apple), and the other three are Asian, one Chinese (Lenovo) and two Taiwanese (Asus, Acer).

The American vendors however do not manufacture their hardware in the USA, where PC production is minimal, but in Asia. Activity in the US is mainly focused on system design and software.

Europe has no significant presence in the industry. The last European PC manufacturer is the German Wortmann AG who still produces desktop PC, laptops and tablets

ii. Professional data processing

The global HPC market can be estimated at 4.1 billion euros in 2016. It is the high-end professional market segment and has entered a growth period from 2008. Players include HP, Cray, IBM and Oracle, SGI, in the USA, plus Nudt and Sugon-Dawning in China, Hitachi, NEC and Fujitsu in Japan, and Bull in Europe. Used by government agencies, major companies from the defence industry, and universities, this segment is not dependent on overall economic conditions.

The world's fastest supercomputer in 2018 was from the American vendor IBM (Summit) followed by the Chinese NRCPC (Sunway TaihuLight) and another supercomputer IBM (Sierra). Several non-US companies intend to increase their market share in the fast-growing supercomputers segment, such as the Japanese NEC and Fujitsu, the French Bull-Atos, and of course the Chinese companies.

Table: Distribution of supercomputer sites by country in 2018

Country	Number of supercomputers	% of the top 500
China	206	41.4
USA	124	24.9
Europe	95	19.1
Japan	36	7.2
S Korea	7	1.4
Canada	6	
India	5	
Australia	5	
Russia	4	
Others	10	
Total	498	100

Source: TOP500

In November 2014, it was announced that the United States was developing two new supercomputers to exceed China's Tianhe-2 as world's fastest supercomputer. The two computers, Sierra and Summit, will each exceed Tianhe-2's 55 peak petaflops. Summit, the more powerful of the two, will deliver 150–300 peak petaflops.

On 10 April 2015, US government agencies banned selling chips from Nvidia, to supercomputing centers in China as "acting contrary to the national security... interests of the United States"; and banned Intel Corporation from providing Xeon chips to China due to their use, according to the US, in researching nuclear weapons – research to which US export control law bans US companies from contributing " The Department of Commerce refused, saying it was concerned about nuclear research being done with the machine."

On 29 July 2015, President Obama signed an executive order creating a National Strategic Computing Initiative calling for the accelerated development of an exascale (1000 petaflop) system and funding research into post-semiconductor computing.

According to TOP500 out of the top five supercomputer vendors, three were Chinese and two American.

Table: Top five vendors by system quantity (June 2018)

Vendor	Country	Systems
Lenovo	China	117
Hewlett Packard	USA	79
Inspur	China	68
Sugon Dawning	China	55
Cray	USA	53

Source: TOP500

1.1.4 Technological and market development

i. PCs

A. From PCs to smartphones

Globally the technology in the PC industry is driven by the Moore's law for semiconductors, which focuses on miniaturisation of the Integrated Circuits and of the computers themselves (apparition of the microcomputers in the 1980s, etc).

Then, in the late eighties and early nineties, the first laptops appeared which revolutionised the computing technology and radically changed the way consumers perceived computers. The next big revolution in the industry came from the emergence of the smartphone and of digital tablets in 2010. Innovation was parallel in the hardware through components (chips, screens, etc.) and software (OS, etc.), with Intel, Microsoft and Apple confirming and conforming to Moore's Law.

Now smartphones are becoming the essential digital hub. This has led to a considerable reshuffling of the markets, industries and players concerned. New players have appeared in semiconductors, and the positions of historical actors are fragilized.

B. Processors: more power, more graphics, less energy

The main innovation in hardware will come from processors (MPUs) and their leaders Intel, AMD and Samsung. In 2018, AMD and Intel have planned to release processors that will double computer capacities. The need of mobility required by consumers pushed the PC makers (and therefore semiconductor manufacturers not only to improve device power but also to work on other features like reducing component power consumption, etc.).

Intel is still the world leading player in the processor market by strictly following Moore's law: and developing ever more powerful chips for PCs. However, Intel passed up the chance to enter the smartphone and tablet industry by designing low-consumption ICs dedicated to these products. As a consequence, Intel (61 billion USD of turnover) who remained the undisputed worldwide leader over the past three decades, was overtaken by Samsung in 2017 (65,6 billion USD of semiconductor turnover).

Intel now faces the competition of new actors like Qualcomm who have based their strategy on chipsets dedicated to the mobile market. Other fabless companies like Apple (who are not originally semiconductor manufacturers) decided to develop their own semiconductors by using specific architectures designed by the English-based company ARM) and to sub-contract production to foundries based in Taiwan like TSMC.

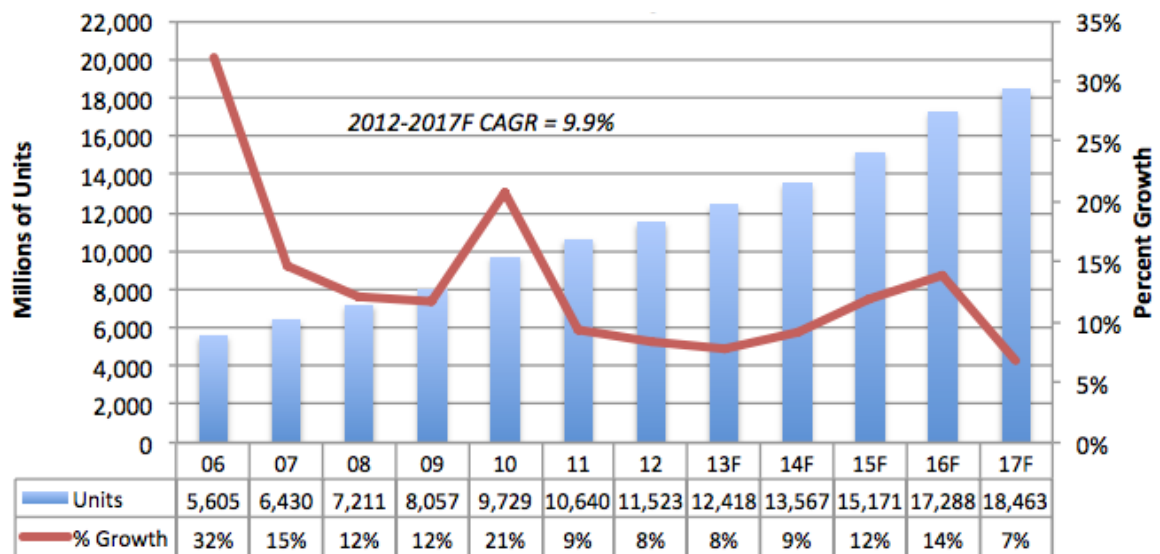
Other manufacturers entered the market with low-consumption processor solutions like ARM (acquired by Softbank in 2017). Thanks to the competition between the CPU manufacturers, research and development in the sector is going well. Intel's research and development budget was more than 13 billion USD (20% of its turnover, showing a desperate effort to make up for missing the smartphone market) whereas the same year Samsung only spent 6.3% (surprisingly little). AMD and Intel are both working on a hybrid processor which they hope will be a real game changer for the industry (officially labelled as 'Intel 8th Generation Core with Radeon RX Vega M Graphics'). Intel and AMD are in competition in the CPU market (Intel being the world leader) but AMD is the only one that makes high-end graphics hardware (as does Nvidia).

By combining the two firms' know-how, the firms develop and will start to produce a unique chip that will be thinner and more powerful. The real innovation is that this chip will be the combination of a processor and a graphics card. By connecting various elements, it will provide high-speed data transfer between all of its high-performance subsystems. It will be possible to fit into a very thin and very performing laptop (at least as powerful as gaming laptop which are the most powerful laptops in the market). The chip offers some of Intel's and AMD's fastest and more advanced technology and provides high-speed data transfer between all of its high-performance subsystems. This chip is not only interesting to gamers. It would allow people to work on very energy-consuming applications like video editing, 3D video, etc.

C. Storage: towards solid state

While CPU manufacturers are developing more and more powerful chips, storage solution manufacturers have to develop technologies that can follow. Historically, the HDD (hard disk drive) technology has always been used in the computing segment. The Top 3 HDD manufacturers are Western Digital (USA), Seagate (USA) and Toshiba Memory (USA since its take-over by a consortium led by Bain Capital, associating Apple, Dell, Seagate, SKHynix, and Kingston in a joined consortium). However, the flash technology, a market initiated by Toshiba and now dominated by Samsung (South Korea), with the SSD (solid-state drive) technology, is very efficient and has been commercialised for many years.

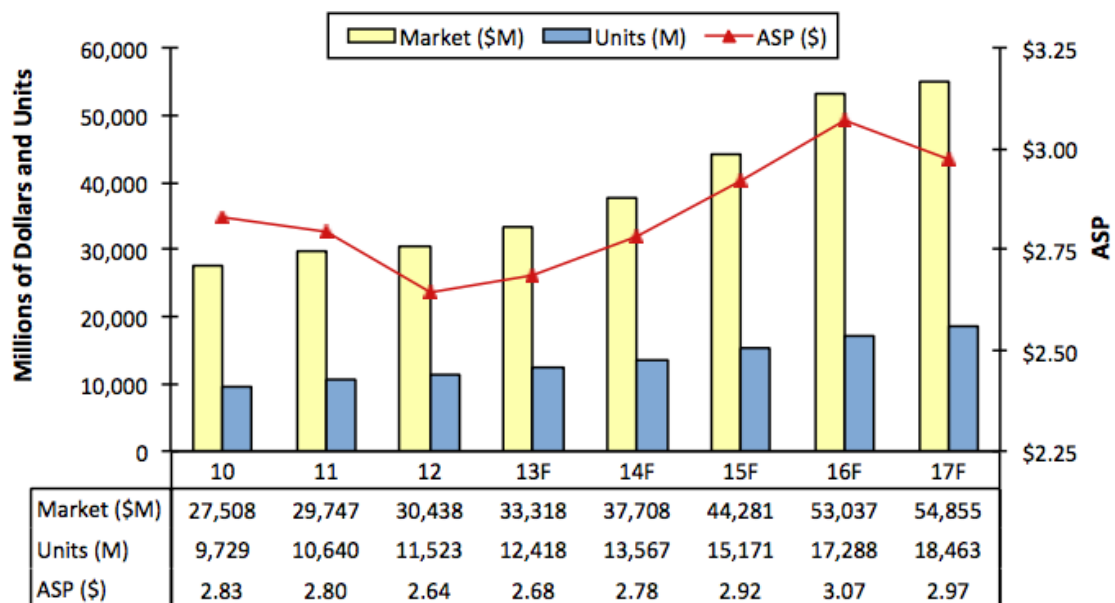
Diagrams: Total Flash Memory Unit Growth



Source: IC Insight

While HDDs are electromechanical data storage devices that use magnetic storage, SSDs are semiconductor storage devices mounted on a circuit board. After the HDDs, the computer market is ready to use SSDs, with the flash technology storage solution enabling them to match the new generation CPUs with adequate memory storage power. SSD drives are now faster (in terms of writing speed), thinner and more resisting (SSDs have no moving component so they are not affected by shocks which is a good thing because consumers want more and more mobile devices). SSDs only have advantages comparing to old generation HDD. They have high read and write performance, are shock resisting (no moving components), have low power consumption (no motors unlike HDDs), are smaller (the regular sizes are 2.5" and 3.5" only because manufacturers wanted SSDs to replace HDDs even in terms of space but SSDs could be smaller), lighter and silent.

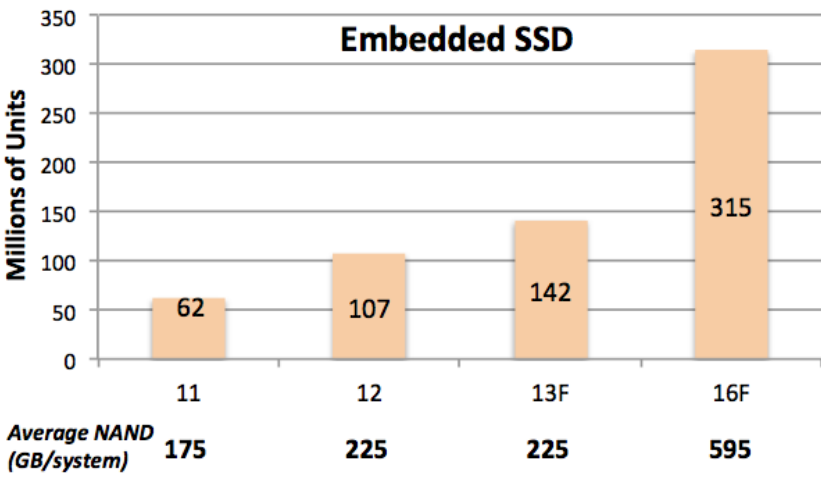
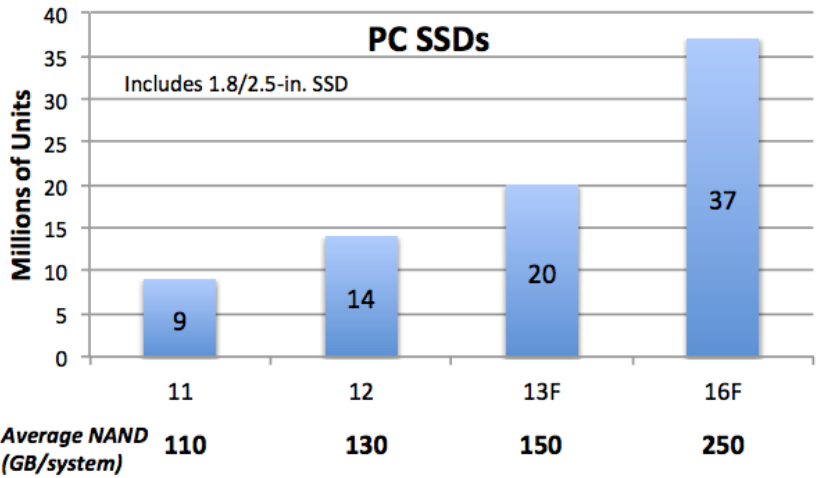
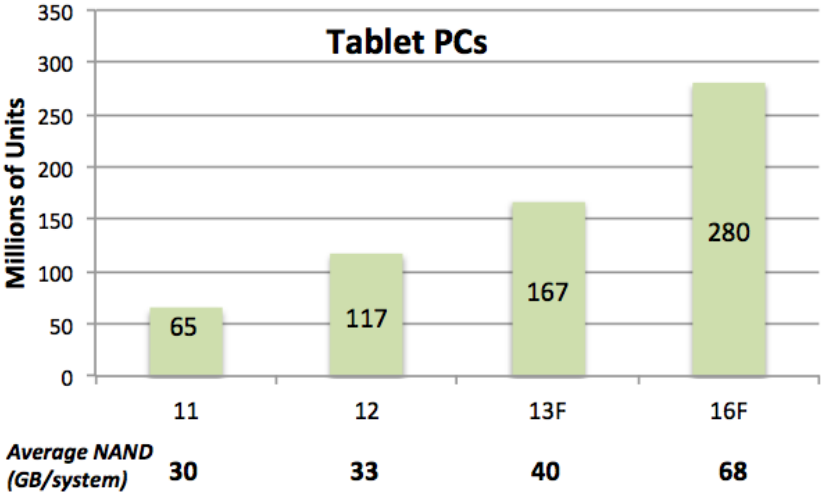
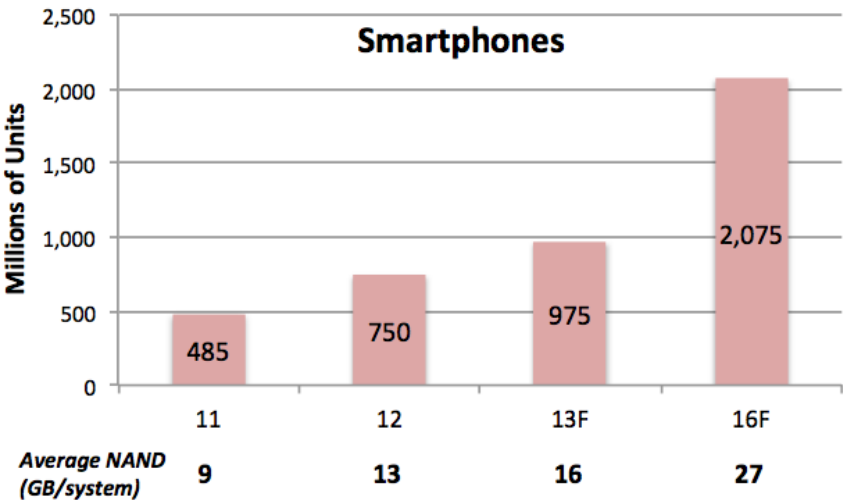
Diagrams: Flash Memory Market History and Forecast



Source: IC Insights

The problem is cost. The technology is expensive but extensive use of flash memories in tablets and smartphones has helped reduce prices by increasing quantities.

Diagrams: Key Growth Drivers for NAND Technology



Source: SanDisk, IC Insights

Cost is why PC and laptop manufacturers only fit computers with 128GB or 256GB SSDs (the 512GB SSD are much too expensive to be set on large audience computers). Due to its popularity, shortages are expected (SSDs are also used in smartphones and digital tablets which represent a large part of the demand), and the prices could fly up at the same time. Nevertheless, HDD manufacturers are developing new technologies in order to recover their market shares.

Simultaneously, technology like HAMR (heat-assisted magnetic recording) and MAMR (micro-wave magnetic recording) are being developed (and ready to be put on the market according to manufacturers) by the two mastodons of the HDD industry, Seagate and Western Digital. Without going into details, these new technologies would allow to exponentially increase the storage capacity of hard drives. This is really interesting for computing companies.

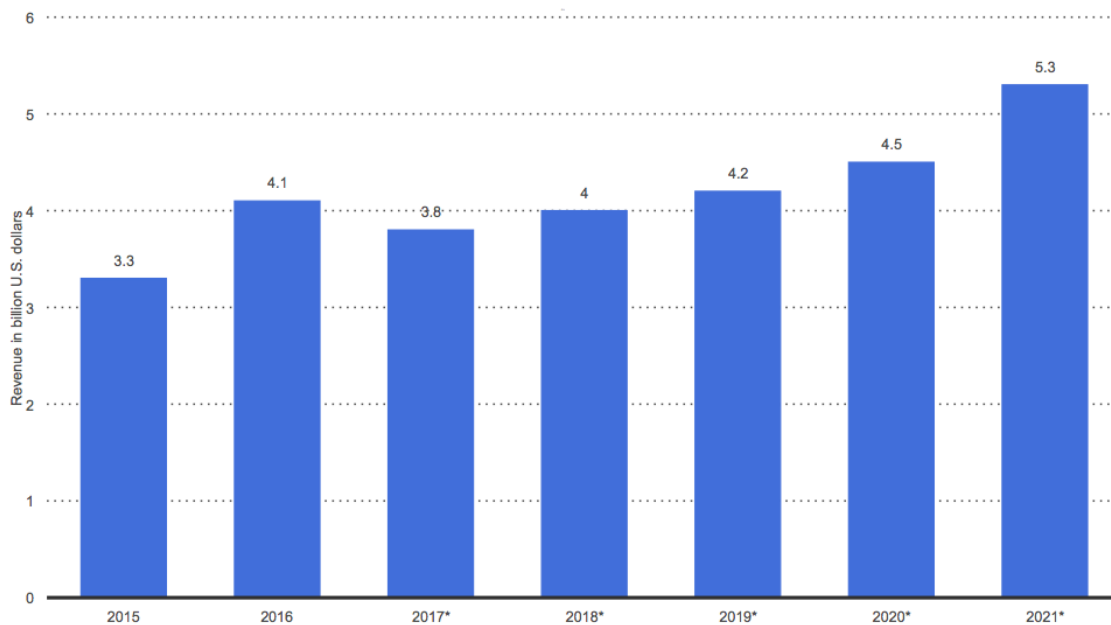
Indeed, due to the overall decrease in computer shipments, companies are redesigning their business models and one of the solutions is cloud computing. In the computer industry, all companies are thinking about developing their cloud services. The development of HAMR and MAMR technologies would allow them to maximise their profits. First, they will continue to offer computers and laptops with those more expensive SSDs (with which they gain more profits than with HDDs), and then, those SSDs being limited in storage capacity, companies will offer subscription to cloud services to their client. Such cloud services would be made possible thanks to the new data centres that will be build using HAMR or MAMR technology. This could be an opportunity for Europe. Indeed, all storage solutions are produced in Asia, but the data centres could be built in Europe providing there were companies to offer the cloud services and data centres.

Other hardware innovations are also expected. In terms of connectivity, the generalisation of the Bluetooth 5.0 will radically change the perception of data exchange between users. Indeed, the range is now 200m (4 times the Bluetooth 4.0's range) and the transmission rate is now 4 Mbytes/second (which is two times faster than Bluetooth 4.0) without consuming more energy. The Bluetooth 5.0 improves interoperability and coexistence with wireless technologies. Mobile device battery life will also increase in years to come.

ii. Professional data processing

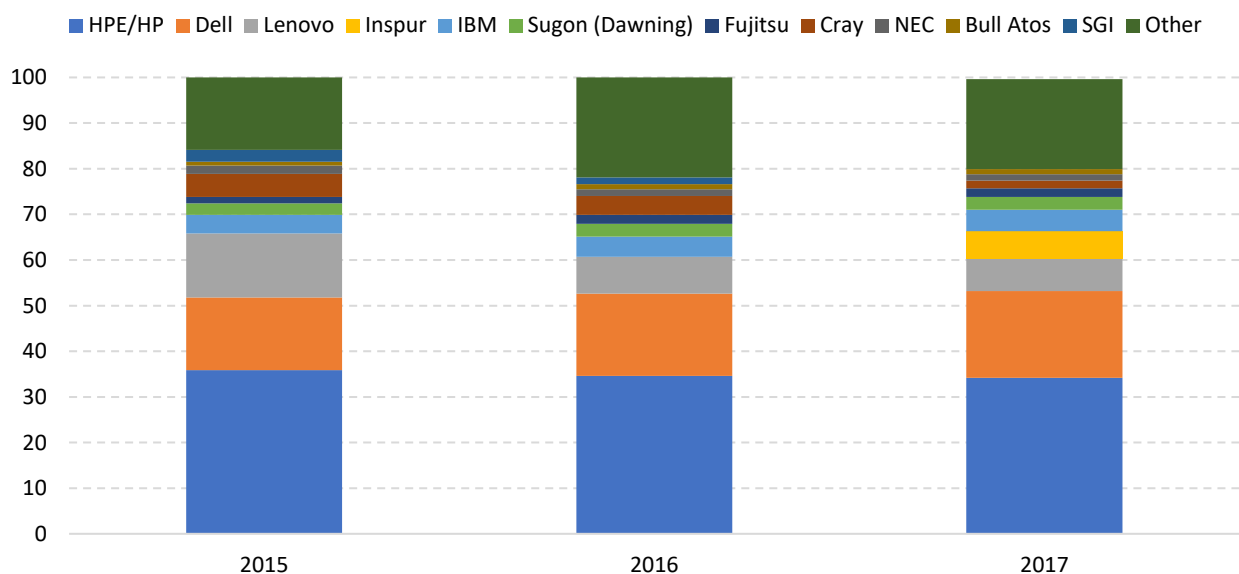
According to InsideHPC, "High Performance Computing most generally refers to the practice of aggregating computing power in a way that delivers much higher performance than one could get out of a typical desktop computer or workstation in order to solve large problems in science, engineering, or business." To be simple, supercomputers have just more processors, memory, disk, etc., than regular computers. This is why they are way performing and also much more expensive. For decades, scientists are aware of the wide range of applications that can be explored thanks to supercomputers which are essentially used for high calculation applications, typically probabilities like weather forecasting, probabilistic analysis or simulation. When it comes to probabilities, one can think about big data and its wide range of possibilities. Supercomputers are the ideal machines to work on large quantity of data in order to analyse it.

Diagram: Worldwide revenue from the supercomputer market from 2015 to 2021 (in billion U.S. dollars)



Source: Statista

Diagram: High Performance Computing vendor market share worldwide from 2015 to 2017



Source: Statista

Universities, cities, multinationals are buying or developing supercomputers. Despite being very expensive, the demand in the HPC industry is always increasing. Europe is only close behind the USA with 95 supercomputers (compares with 124 in the USA), but there is no European supply, except for Atos-Bull. European can take a strong position in the development of the applications that are almost infinite within the HPC industry. This is why the EU has recently decided to invest €2.7 billion into the development of supercomputers and almost the same amount (€2.5 billion) for the artificial intelligence which could directly benefit from the HPC industry development.

1.1.5 MNE interaction

According to IC Insights, in 2016 the computer IC market was the largest end-use IC segment with 113 billion U.S. dollars (102 B €). Europe is a small actor in the manufacture of computer IC since the region represents only 7,6% of the global computer IC consumption in 2016. In details, in terms of prices, MPUs represents the largest part of the computer IC product segment (45 billion U.S. dollars in 2016) just ahead of memories (38 billion U.S. dollars in 2016). Due to the memory price volatility, it is expected that memory replace MPUs as the largest part of the computer IC product segment.

European actors are not weighing much in the computing industry. Indeed, the European semiconductor producers only account for 2% of the global production of semiconductors dedicated to PC & data processing.

Investments in high-end processing capabilities is becoming priority for a lot of countries (China, India, Russia, Japan, etc.), that are wishing to no longer depend on American technologies.

Roadmap – For every electronic system type, what is the size and growth of computer in Europe compared to the other segments and what is the European position in computer compared to the other regions

COMPUTER	Analog	Logic	MOS Memory	MOS DSP	MOS MCU	MOS MPU	TOTAL ICs
European computer market in 2017 – M €	92	1,025	3,221	3	14	4,708	9,063
Rank of computer in Europe in terms of market size	1 – Automotive 2 – Industrial 3 – Communications 4 – Consumer 5 – Computer 6 – Gov/Military	1 – Communications 2 – Computer 3 – Automotive 4 – Consumer 5 – Industrial 6 – Gov/Military	1 – Computer 2 – Communications 3 – Industrial 4 – Automotive 5 – Consumer 6 – Gov/Military	1 – Automotive 2 – Communications 3 – Industrial 4 – Gov/Military 5 – Consumer 6 – Computer	1 – Automotive 2 – Industrial 3 – Consumer 4 – Communications 5 – Gov/Military 6 – Computer	1 – Computer 2 – Communications 3 – Industrial 4 – Gov/Military 5 – Automotive 6 – Consumer	1 – Computer 2 – Automotive 3 – Communications 4 – Industrial 5 – Consumer 6 – Gov/Military
CAGR 2017–2022 European computer market	8%	7%	7%	7%	7%	– 1%	3%
Rank of computer in Europe in terms of CAGR 2017–2022	1 – Automotive 2 – Computer 3 – Gov/Military 4 – Communications 5 – Industrial 6 – Consumer	1 – Automotive 2 – Industrial 3 – Computer 4 – Gov/Military 5 – Consumer 6 – Communications	1 – Automotive 2 – Consumer 3 – Industrial 4 – Computer 5 – Gov/Military 6 – Communications	1 – Automotive 2 – Industrial 3 – Communications 4 – Computer 5 – Consumer 6 – Gov/Military	1 – Automotive 2 – Computer 3 – Industrial 4 – Communications 5 – Consumer 6 – Gov/Military	1 – Consumer 2 – Industrial 3 – Automotive 4 – Computer 5 – Communications 6 – Gov/Military	1 – Automotive 2 – Industrial 3 – Consumer 4 – Computer 5 – Communications 6 – Gov/Military
Share of European consumption	3%	0.05%	0.06%	13%	3%	12%	7%
Rank of Europe	1 – Asia-Pacific 2 – Japan 3 – Europe 4 – Americas	1 – Asia-Pacific 2 – Americas 3 – Japan 4 – Europe	1 – Asia-Pacific 2 – Americas 3 – Europe 4 – Japan	1 – Asia-Pacific 2 – Americas 3 – Europe 4 – Japan	1 – Asia-Pacific 2 – Japan 3 – Europe 4 – Americas	1 – Asia-Pacific 2 – Americas 3 – Europe 4 – Japan	1 – Asia-Pacific 2 – Americas 3 – Europe 4 – Japan

Source: DECISION Études & Conseil, IC Insights

1.1.6 Appendix

Table: Detailed US Census figures 2010-2016 in value (k€)

Code	Meaning of Products and services code	2010	2011	2012	2013	2014	2015	2016
334111	Electronic computer manufacturing	12 772 047	5 005 891	7 311 574	5 923 635	6 161 689	8 263 090	8 063 532
3341111	Host computers multiusers	9 028 575	2 813 415	4 296 186	3 427 801	3 703 359	5 157 056	4 839 533
3341117	Single user computers microprocessor-based capable of supporting attached peripherals	3 229 486	1 703 447	2 297 395	1 905 105	1 785 921	2 303 215	2 413 017
334111D	Other computers (array analog hybrid and special-use computers)	281 771	270 886	410 823	335 047	353 980	342 457	350 735
334111W	Electronic computer manufacturing nsk total	232 214	218 142	307 170	255 683	318 429	460 361	460 247

Source: US Census

Table: Data Processing – Electronic equipment production in millions of euros (Hardware only)

Region	2012	2013	2014	2015	2016	2017	2012-2017*	2017-2022*	2022**
Europe	15 973	15 170	15 023	14 639	14 340	14 159	-2.4 %	-1 %	13 465
North America	30 156	29 111	29 098	29 481	29 905	30 096	0.0 %	0 %	30 096
Japan	35 313	33 807	33 256	33 210	32 804	31 782	-2.1 %	-2 %	28 728
China	173 028	176 978	186 225	186 402	185 904	183 834	1.2 %	-1 %	174 824
Other Asia-Pacific	72 325	70 916	72 942	76 628	81 603	86 402	3.6 %	4 %	105 121
Rest of the World	9 668	9 379	9 484	9 516	9 366	9 348	-0.7 %	0 %	9 348
World	336 462	335 362	346 027	349 876	353 922	355 620	1.1 %	0.2 %	359 842

*CAGR : Compound Annual Growth Rate

** Forecast

Source: DECISION Etudes & Conseil

Table - PRODCOM – PC & Data Processing

PRODCOM Code	Subsection	2010		2016		CAGR 2010-2016	
		Quantity	Value	Quantity	Value	Quantity	Value
26201100	Computers & DP	10 001	4 001 950	1 406	430 998	-28%	-31%
26201300	Computers & DP	3 193	1 682 162	2 454	1 800 000	-4%	1%
Total PCs		13 194	5 684 112	3 860	2 230 998	-19%	-14%
26201640	Computers & DP	4 348	976 125	7 811	852 063	10%	-2%
26201800	Computers & DP	2 032	750 000	2 687	379 943	5%	-11%
26201650	Computers & DP	21 013	111 163	34 738	183 908	9%	9%
26201700	Computers & DP	657	230 821	655	280 000	0%	3%
26201660	Computers & DP	3 931	649 047	8 038	718 777	13%	2%
Total Peripherals		4 588	2 717 155	8 692	2 414 691	11%	-2%
26202100	Computers & DP	14 370	2 382 400	19 794	5 282 609	5%	14%
26202200	Computers & DP	120	40 000	1 277	83 035	48%	13%
Total Storage & memories		14 490	2 422 400	21 071	5 365 644	6%	14%
26201200	Computers & DP	621	267 419	622	412 821	0%	8%
26201400	Computers & DP	4 632	2 627 776	1 035	2 349 019	-22%	-2%
26201500	Computers & DP	897	483 109	1 406	998 753	8%	13%
26203000	Computers & DP	25 000	498 518	2 759	397 083	-31%	-4%
269900Z0	Computers & DP	18 000	1 060 575	11 031	1 538 411	-8%	6%
Total Other computer & DP		18 000	4 937 397	11 031	4 937 397	-8%	0%
26204000	Computers & DP	-	3 905 442	-	1 569 685	-	-14%
27114240	Computers & DP	135 721	759 342	164 035	818 516	3%	1%
Total Parts and Accessories		135 721	4 664 784	164 035	2 388 201	3%	-11%
Total Computers & Data Processing		271 443	20 425 848	208 690	17 336 930	-4%	-3%

Note: The production in quantity represents the European production sold during the year. This is why there could be 0 quantity sold but a positive production in value.

Source: Eurostat, DECISION Etudes & Conseil

PRODCOM – Definitions

PRODCOM Code	PRODCOM Definition
26201100	Laptop PCs and palm-top organizers
26201300	Desktop PCs
PCs	
26201640	Printers, copying machines and facsimile machines
26201800	Machines which perform two or more of the functions of printing, copying or facsimile transmission
26201650	Keyboards
26201700	Monitors and projectors principally used in an automatic data processing system
26201660	Other input or output units, whether or not containing storage units in the same housing
Peripherals	
26202100	Storage units
26202200	Solid-state, non-volatile data storage devices for recording data from an external source
Storage & memories	
26201200	Point-of-sale terminals, ATMs and similar machines capable of being connected to a data processing machine or network
26201400	Digital data processing machines: presented in the form of systems
26201500	Other digital automatic data processing machines whether or not containing in the same housing one or two of the following units: storage units, input/output units
26203000	Other units of automatic data processing machines
269900Z0	Network communications equipment (e.g. hubs, routers, gateways) for LANs and WANs and sound, video, network and similar cards for automatic data processing machines)
Other computer & DP	
26204000	Parts and accessories of the machines
27114240	Other transformers, n.e.c., having a power handling capacity <= 1 kVA
Parts and Accessories	
Computers & Data Processing	

Source: Eurostat

Manufacture of PC & Data Processing NACE 2 code

NACE Code	Segment	Details
26.20	Manufacture of computers and peripheral equipment	<ul style="list-style-type: none"> 30.02 Manufacture of computers and other information processing equipment (Except installation) 32.30 Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods (Video beamers)

Source: Eurostat

Annex 7 – Audio & Video

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1.1.7 Scope and presentation of the Audio & Video electronics segment and its value chain

The “audio, video and other consumer electronics” segment includes the traditional television, video and audio equipment, as well as set-top boxes, game consoles. It now also includes PCs and peripheral equipment, digital watches, digital cameras and camcorders, mobile and smartphones, wearables, personal care...

In order to remain consistent with the usual industry classifications, we have chosen the more conventional scope, leaving PCs to the Data Processing Report, and mobile and smartphones to the Communications Report. Other products (digital watches, cameras and camcorders) have not been treated as such, as cameras are largely being replaced by the smartphone photo video function, and digital watches will be looked at in the section concerning the emerging wearables market. Personal care products will be dealt with in the Health and Care Report, although some products are included in small domestic appliances (e.g. shavers).

Thus “Audio, video and other consumer electronics” in this Report covers Audio-Video only, i.e. TVs (plasma, LCD, LED...), DVD/Blu-Ray players, radios and other audio equipment, game consoles, speakers, headphones and soundbars, home-cinema equipment, set-top boxes, aerials, etc.

TVs represent close to half of the audio/video electronics equipment market worldwide. Although TV production in Europe represents less than 4% of the world total, the world TV market for components and MNE can remain a significant market for European semiconductor manufacturers like STMicroelectronics who have competencies and still develop specific components for this end-market, whether production of the end equipment is in Europe or elsewhere.

The other half consists of a variety of devices used to perform dedicated functions (taking pictures, recording videos, playing music, showing films, running video games, receiving encoded TV signals, etc.). This diverse group includes:

- DVD Players/Recorders;
- Game Consoles;
- Portable Media Players;
- Set Top Boxes;
- Aerials;
- Radio;
- Other audio (Hi-Fi, soundbars, speakers, headphones...).

1.1.8 Audio & Video Electronics in figures

i. Methodological note

European production is measured by Eurostat, who gathers and analyses figures from the national statistical offices across Europe, and publishes them in two distinct sources, the SBS NACE 2 statistics, which give turnover, employees, and other indicators, and the Prodcom statistics, which give production in value and quantity, as well as imports and exports.

There are differences between the Prodcom and the SBS NACE industry database:

- The SBS NACE industry statistics are “activity” statistics, i.e. they measure the activity of “statistical units” (which may be companies or subdivisions of companies) located in the EU. Units are assigned one NACE 4 digits code according to their “principal activity”, i.e. the activity accounting for the most value added (which may be less than 50% when there are more than 2 secondary activities). The whole of the activity of the unit (including secondary activities) is classified under the principal activity code. The database presents various indicators, among which turnover, value added, employees and investment;
- Prodcom data presents the value (in euros) and quantity (in units) produced in the EU in a more detailed 8 digits code (where the four first digits are the same as the NACE code), as well as import-export data. Prodcom.
- **In the figures presented by DECISION in the pyramids/overview and used to undertake comparisons with the other end-user electronic segments, the Prodcom figures have been selected as they are supposed to provide a more precise measure of the production level and location.**

Table – Audio & Video electronics in 2015

	NACE	PRODCOM
Turnover or production (Billion euros)	19.7	18.4
Value added (Billion euros)	3.2	
Employees (number)	60 000	
Investment (Billion euros)	0.3	
Value added/turnover	16.2%	
Investment/value added	9.4%	
Turnover/employees (euros)	328 333	

Source: Eurostat

In spite of the differences mentioned above between NACE turnover and Prodcom production, the two figures are very close for Audio & Video Electronics.

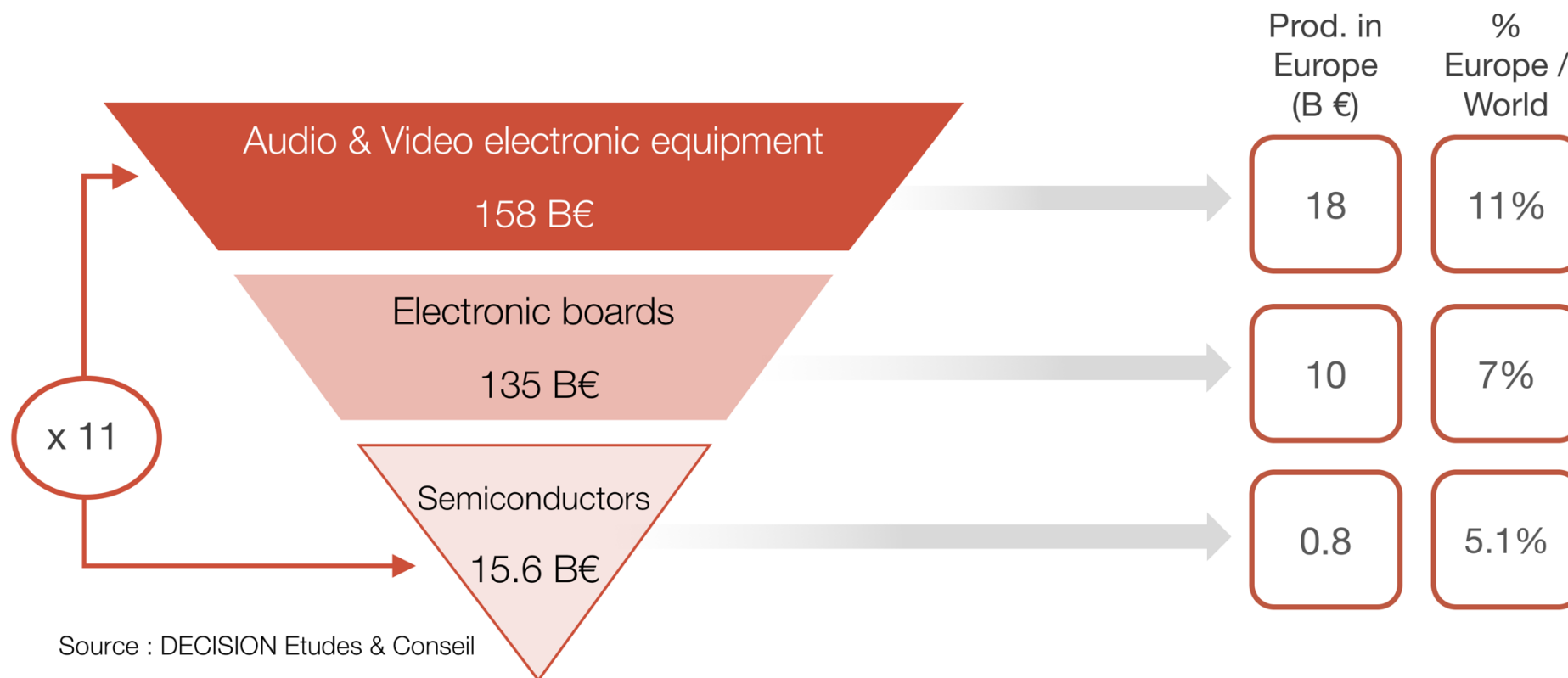
ii. Europe's position in the World

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.

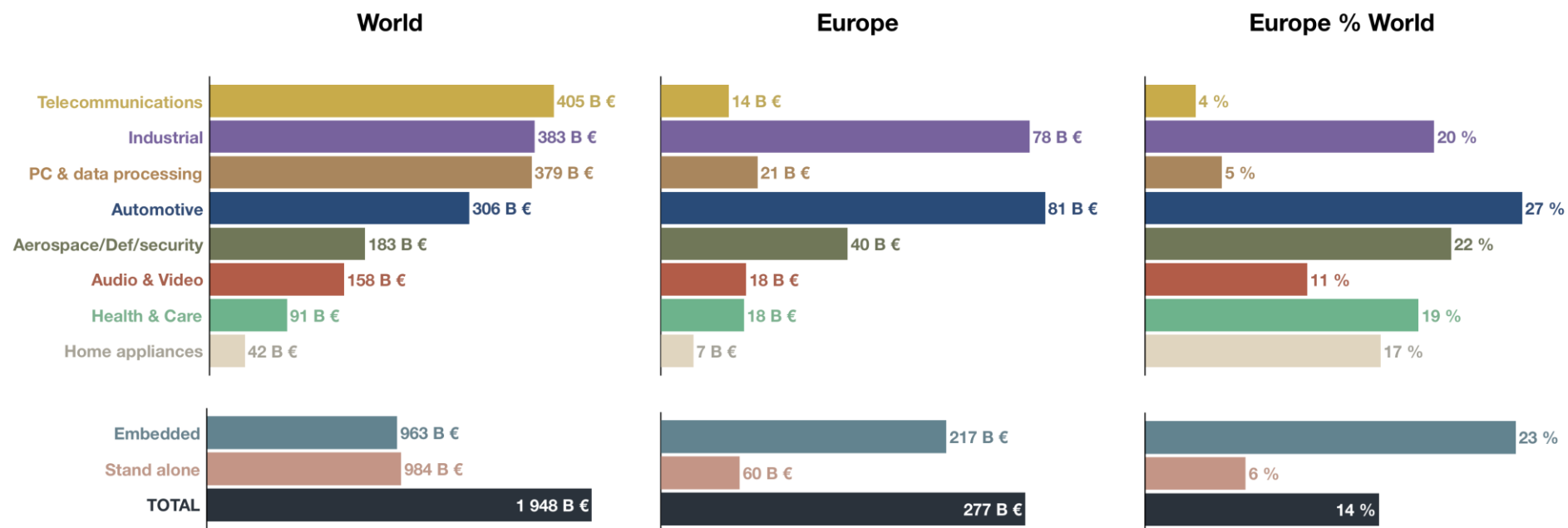
The domination of Asian companies does not mean all their production is located in Asia. A number of Asian companies (in particular Samsung and LG) who hold large shares of the European market have production facilities in Europe. This is probably why European production of Audio & Video electronics, 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.

Worldwide Audio & Video electronics value chain in 2017



Electronic equipment production in 2017 (B €)



Source: DECISION Etudes & Conseil

Table - 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.

The question is whether the natural decline in the European market share will deter market-oriented production investment in Europe, or not. This probably depends on what measures the EU takes to encourage production investment in Europe.

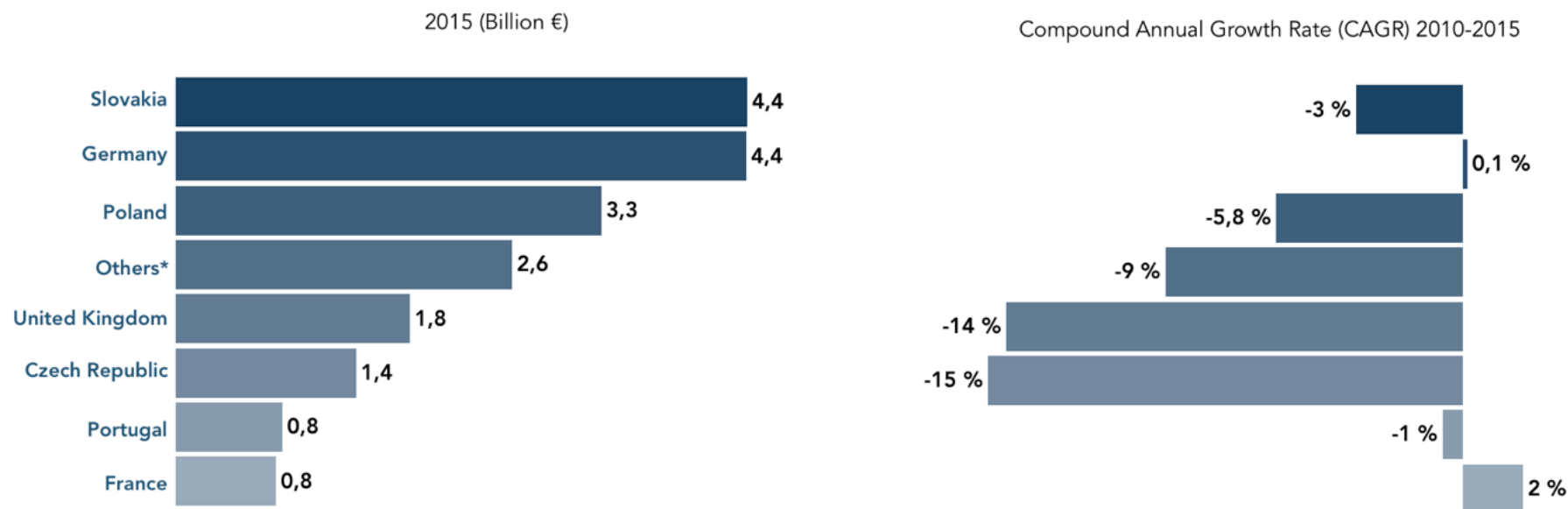
iii. European activity and production statistics

A. Eurostat SBS industry database

In the figures below, we show 4 indicators from the SBS NACE industry activity database (Structural Business Statistics, Annual detailed enterprise statistics for industry, Eurostat):

- Turnover;
- Employees;
- Value Added at factor costs;
- Investment (Net investment in tangible assets).

Bar chart - Manufacture of Audio & Video electronics – Turnover



Others*: Italy, Netherlands, Denmark, Sweden, Austria, Spain, Bulgaria, Slovenia, Romania, Finland, Hungary, Latvia, Greece, Belgium and Croatia (excluding Estonia, Cyprus, Lithuania, Luxembourg and Malta because of missing values).

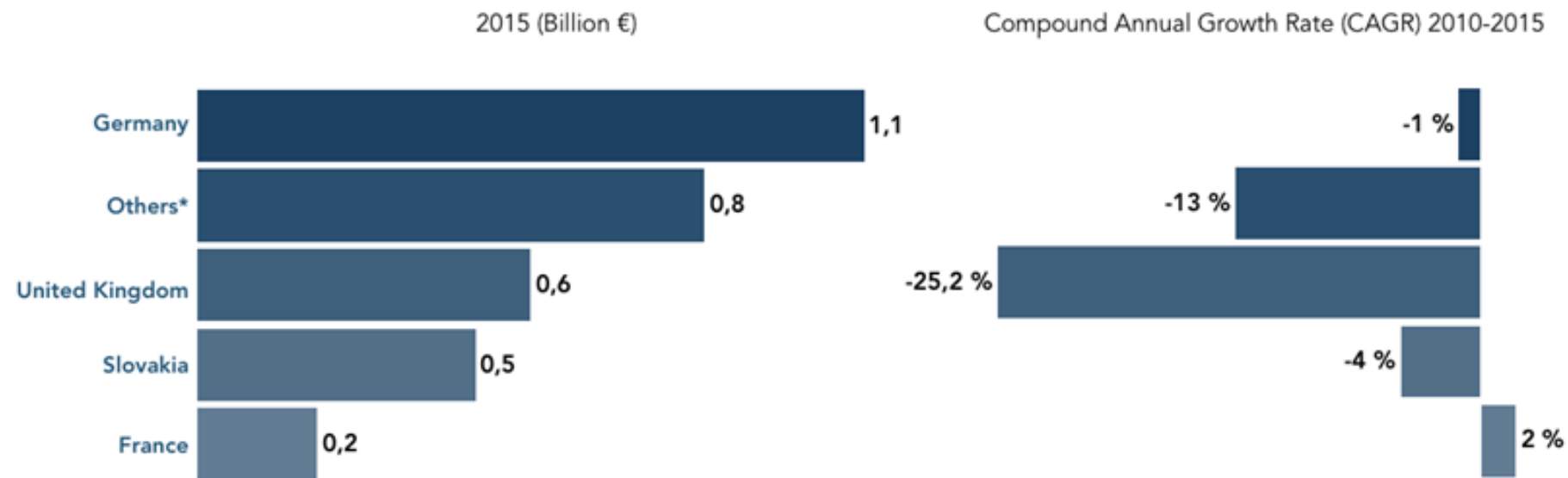
Source: Eurostat, DECISION Etudes & Conseil

The manufacture of audio & video electronics represented a turnover of 19.6¹ billion Euros in 2015 in the EU. From 2010 to 2015, the audio & video electronics turnover in the EU decreased at an average annual rate of -6%.

Almost half of the European manufacture of audio & video electronics (around 45%) is located in two countries, Slovakia and Germany, with turnovers of 4.4 billion euros each. Audio & video electronics manufacture in Europe has decreased in all Member States except for Germany (+0,1% CAGR) and France (+2% CAGR).

¹ The Eurostat SBS industry database indicates an EU production of audio & video of 19.6 B €. The Eurostat Prodcom database indicates an Eu production of Home Appliances of 17.9 B €. In this study, when the Prodcom database provides reliable figures, the figures considered as the “European production” are the Prodcom ones.

Bar chart - Manufacture of audio & video electronics – Added value

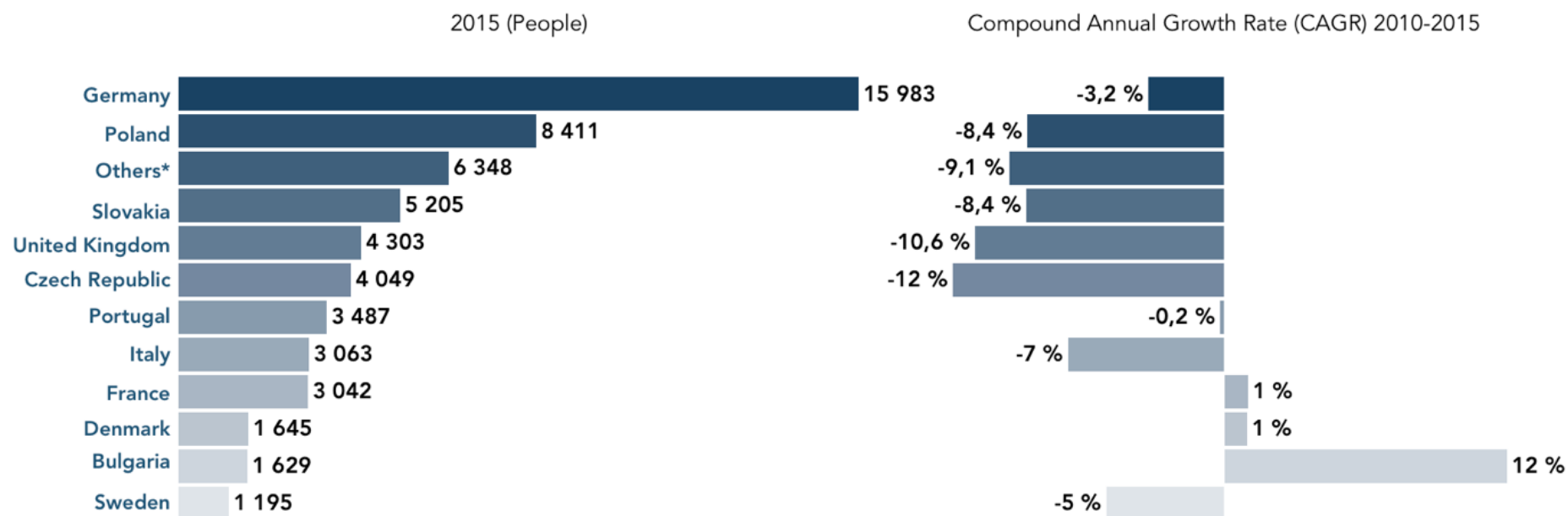


Others*: Portugal, Poland, Sweden, the Netherlands, Czech Republic, Denmark, Italy, Spain, Austria, Bulgaria, Slovenia, Hungary, Greece, Latvia, Finland, Romania and Belgium (excluding Estonia, Ireland, Croatia, Cyprus, Lithuania, Luxembourg and Malta because of missing values).

Source: Eurostat, DECISION Etudes & Conseil

In 2015, European audio & video electronics manufacturers generated an added value of 3.2 billion euros. German producers generated more than a third of the added value (1.1 billion euros) while Slovakia generated 500 million euros in 2015. Total added value decreased at an average annual rate of -12% over the 2010-2015 period.

Bar chart - Manufacture of audio & video electronics – Employees



Others*: Spain, Romania, Slovenia, Austria, Hungary, Finland, Latvia, Croatia and Greece (excluding Belgium, Cyprus, Estonia, Ireland, Lithuania, Luxembourg and Malta because of missing values).

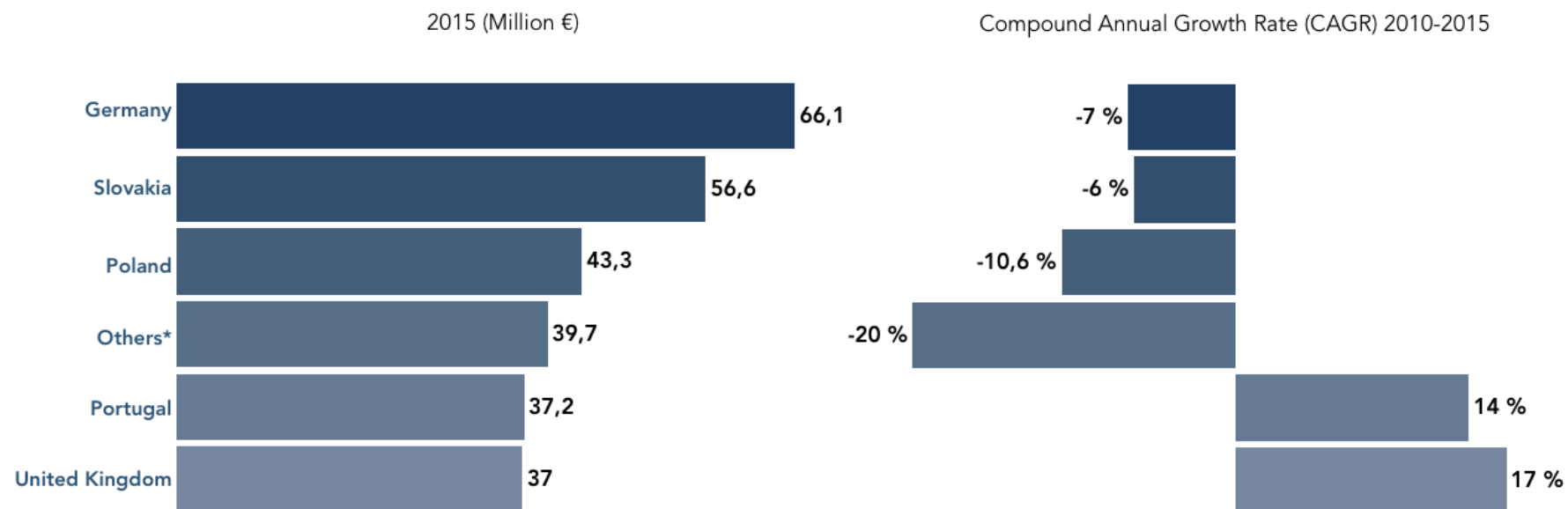
Source: Eurostat, DECISION Etudes & Conseil

The European workforce dedicated to audio & video electronics was 84,000 people in 2015. Germany was the first employer with 15,983 people. Poland is the second employer with more than 8,000 people dedicated to the manufacturing of audio & video electronics. From 2010 to 2015, the number of employees dedicated to the manufacture of audio & video electronics in the EU decreased by -7% on average each year.

Slovakia is the third employer with more than 5,000 people dedicated to the manufacturing of audio & video electronics thanks to its geographical position of being in the middle of the "New Silk Road" between Asia and Europe and from its favourable location between the seaports of southern and northern Europe. The exponential increase of exchanges between Europe and Asia has led some manufacturers to locate their plants in Poland, Slovakia, Poland, and Hungary in order to reduce delivery time and increase profits thanks to the cheap and qualified workforce. For example, some of the biggest audio & video electronics manufacturers have built factories in Slovakia. Foxconn built an LCD TV production division (its largest division in Slovakia) where LCD and OLED TVs are assembled and tested. In its Trstna (Slovakia) factory, Panasonic produces car speakers, and Samsung makes displays in one of its Slovakian factories.

By summing all of their employees, Eastern European countries (Poland, Slovakia, Czech Republic, Bulgaria, Romania, Slovenia, Hungary, Latvia and Croatia) are the first employers with 21 143 people dedicated to the manufacturing of audio & video electronics.

Bar chart - Manufacture of audio & video electronics – Investment



Others*: Denmark, Sweden, Italy, Bulgaria, Austria, the Netherlands, Croatia, Belgium, Romania, Latvia, Greece, Hungary, Cyprus, Slovenia, Finland, Spain and France (excluding Estonia, Ireland, Lithuania, Luxembourg, and Malta because of missing values).

Source: Eurostat, DECISION Etudes & Conseil

Investment in tangible assets only represented 306 million euros in 2015. Technology in the assembly lines or on other areas within the manufacturing plants has not radically changed between 2010 and 2015, which is in line with the decrease of turnover and value added. However, Germany and Slovakia are still maintaining their leading position in the industry. The electronic industry is the second largest pillar of the Slovakian industry and represents 11% of the country's total industrial production

B. European industrial production figures (Prodcom)

Table - EU audio & video electronics production value (Million euros)

	2010	2016	CAGR %	2016 share %
Car radios	2 151.5	2 736.0	0.6	15.3
Other radios	182.1	24.9	-28.2	0.1
Total radios	2 333.6	2 760.9	-0.6	15.4
TV receivers	19 831.9	9 309.8	-11.8	51.9
Video equipment	1 935.0	1 060.6	-9.5	5.9
Audio equipment	2 992.0	3 494.0	2.6	19.1
Parts	2 961.1	1 813.4	-7.8	10.1
Total audio & video electronics	30 063.7	17 938.8	-8.2	100.0

Source: Eurostat, DECISION Études & Conseil

Table - EU audio & video electronics production in quantity (thousand units)

	2010	2016	CAGR %
Car radios	38 618	21 678	-9.2
Other radios	828	607	-5.0
Total radios	39 446	22 285	-9.1
TV receivers	89 074	39 557	-12.6

Source: Eurostat, DECISION Études & Conseil

Production of audio & video electronics in the EU still amounts to almost 18 billion euros, although it has shrunk by almost half from 30 billion euros in 2010. The main production fields are television receivers (52%), audio equipment (19%) and car radios (15%).

In quantities, production in Europe has also more than halved for TV receivers (from 89 million to 40 million) and almost halved between 2010 and 2016 for car radios (from 39 million to 22 million).

In Audio equipment, between 2010 and 2016, the value of European production grew from 3 billion euros to 3.5 billion euros (2.6% annual growth), while the production volume fell from 829 million units to 375 million units (12% annual decrease). In terms of units' speakers and headphones account for most of the numbers (90% of the total). European manufacturers have been able to increase the quality and average price of their produce, achieving an increase in production value despite a severe decrease in quantities.

Table - EU audio & video electronics production value by Member State (million euros)

	2010	2016
Poland	6 785	2 867
Slovakia	122	2 569
Hungary	2 156	1 383
Germany	2 739	1 030
Portugal	867	894
United Kingdom	975	407
Italy	480	340
Czech Republic	270	303
Denmark	278	249
France	530	225
Others	1 462	113
Total disclosed by country	16 664	10 380
Confidential	13 400	7 559
EU Total	30 064	17 939

Source: Eurostat, DECISION Etudes & Conseil

Table - Re-estimated Member State breakdown of audio & video electronics production

Country	Production B €	% share
Germany	4.4	23.9
Slovakia	4.4	23.9
Poland	2.9	15.8
Hungary	1.4	7.6
Portugal	0.9	4.9
Others	1.6	10.9
Confidential	2.4	13.0
Total	18	100.0

Source: Eurostat, DECISION Études & Conseil









1.1.9 Company positioning

In the TV global market, the top 10 manufacturers are all Asian. The first two are South Korean, the next two are Chinese, and the two after are Japanese.

The two Korean world leader manufacturers have a relatively stable market share, and the Japanese, who used to be the global market leaders, are all losing market shares.

On the other hand, the Chinese manufacturers are all gaining market shares, and will doubtless dominate the industry in the next coming years.

Table - The top 10 LCD TV manufacturers on the global market (%)

Company	Country	2010	2017	2017 rank	Trend
Samsung	S Korea	17.9	20.2	1	
LG Electronics	S Korea	12.1	12.1	2	
TCL	China	3.6	10.9	3	
Hisense	China	3.9	6.0	4	
Sony	Japan	11.3	5.6	5	
Sharp	Japan	7.4	4.2	6	
AOC/TP Vision (ex Philips)	China		4.1	7	
Skyworth	China		3.8	8	
Panasonic	Japan	5.0	3.0	9	
Haier	China		2.9	10	
Toshiba	Japan	7.3			
Others		31.5	27.2		
Total		100.0	100.0		

Source: DECISION Etudes & Conseil

1.1.10 Technological and market development

iv. Dematerialization and the shift to the smartphone

The main technological and market development in audio & video electronics is the migration of most video and audio functions to the smartphone as the new hub for personal electronics, communications, entertainment, security, social networking and also personal professional activity.

This will lead to the disappearance of most video and audio equipment, or at least to their radical change to adapt to the smartphone environment. The television set itself should however remain for some time as a market, as its screen size is a clear asset compared to the smartphone. And considering that in India, for example, only 40% of households have a television, the global growth prospects for the TV market remain bright. But as in the case of land line telephones, the market should jump directly to the mobile phone solution.

The rise of digital audio and video equipment first provided a significant boost to audio/video device makers, triggering a strong replacement market in audio (first CD players and later MP3 players) and then video (DVD players, media players, digital cameras and camcorders), improving consumer satisfaction. These new digital audio-video devices have grown faster than ever experienced before in the electronics industry, stimulated by automated and standardised production processes, increased miniaturisation and constant price reduction. The dematerialisation of the digital content and the development of broadband connectivity features finally enabled simpler and larger access to digital content. During these years, the audio/video market was among the fastest growing sectors of the entire electronics industry, with most of its sub-segments experiencing double-digit annual growth, the most striking example being the incredibly fast development of the portable media players market and more particularly Apple's iPod and other MP3 players.

However, competition between digital device makers stimulated pressure on prices and forced players to add both higher performances ("high definition" or HD feature) and new functionalities to their platforms in order to maintain their market shares. This is how "historical" audio/video product lines have progressively been blurred by multi-functional digital devices such as digital still cameras capable of recording high definition video sequences, game consoles that can read Blu-ray DVDs and connect to the internet, set-top boxes able to both record videos and run video games on-line.

Instead of fighting against the commoditisation of their equipment and bringing added value to their products, audio-video device makers have in reality intensified their own competition and even further accentuated the pressure on prices.

Of course, such a market shift had a significant impact on the industrial base and competitive landscape. Past audio-video giants in Europe (Thomson, Philips, etc.), in the USA (RCA, Eastman Kodak) and Japan (Sony, Pioneer, Matsushita, Toshiba, Sharp, etc.) proved to be not agile enough to adapt to this new business environment and progressively abandoned market shares, product segments and eventually their entire consumer activities for some of them.

In parallel new market leaders emerged in the audio-video industry focusing from the start on new digital technology and ad-hoc manufacturing organization without having to maintain legacy products. Such players are predominantly localized in Asia and more particularly in Korea (Samsung, LG) and China (TCL, Hisense, Lite-On, Mitac, etc.), with the noticeable exception of Apple although its production is entirely subcontracted in Asia.

The winning platforms that take all the benefits of digital convergence are those which provide the user with seamless access to a complete ecosystem of services/applications capturing a sizeable share of the digital content revenue. The three platforms enabling such a synergistic integration originate in different sectors of the electronics industry: telecommunications (smartphones), data processing (PC / tablets) and audio-video (set-top boxes / connected TVs). One should note that Apple is the undisputed leader for at least two key platforms with the iPhone and iPad and there are rumours of a projected Apple TV set following the success of its Apple TV box, thus completing its coverage of the digital convergence revenues!

v. Developments in the audio & video electronics field

That is why technological developments in the TV and audio industry, although significant, appear minor with respect to this major shift.

The replacement of the cathode ray tube by flat screens is now completed. In 2007, flat-screen LCD televisions surpassed global sales of cathode ray tube (CRT) televisions, and today LCD TVs are by far the most widely produced and sold television type. LCD TVs had quickly displaced the only major competitors in the large flat screen market, the plasma display panel and rear-projection television.

For a couple of years now, manufacturers have been progressively replacing High Definition Televisions (HD TV) with Ultra High Definition Televisions (UHD or 4K), which resolution is four times higher than regular HD TV (3840 x 2160 pixels for 4K TV in comparison with the 1920 x 1080 pixels for HD TV). HD and 4K technologies have been developed thanks to the displays technology that enables showing a large quantity of pixels on a screen. In the 4K market, manufacturers will generalize the HDR (High Dynamic Range) technology into their models. HDR enables a wider range of colours to appear on screen with deeper blacks and whiter whites working in unison to create a more dynamic picture.

Those technologies only work on LCD (Liquid Crystals Display) or plasma displays. As a consequence, the development of new LCD technology is the main current technologic evolution regarding TVs production. There are two types of new LCDs:

- OLED (Organic Light Emitting Diodes), developed by LG and adopted by a lot of main actors of the industry like Sony, Philips or Panasonic. OLED is a self-imitating technology: It means that the panel lights itself;
- QLED (Quantum Dot LED), developed only by Samsung. As older technologies, QLED relies on back-lighting and do not generate its own light.

Technologically speaking, there is no significant difference between those two technologies QLED displays are brighter than OLEDs' in which blacks are deeper. Since OLED displays demand largely exceed high-ends smartphone, the quantity of demand for this technology is highly and steadily rising. LG's technology should progressively gain market shares thanks to its OLED technology that is more competitive than the QLED technology.

Table - OLED panel production capacity worldwide for TVs and smartphones 2016-2022 (in million square meters)

	2016	2022
OLEDs for smartphones	5.4	31.9
OLEDs for TVs	2.7	18.2
Total	8.1	50.1
Share of TVs	33%	36%

Source: DECISION Etudes & Conseil

In parallel of 4K TV democratisation and OLED/QLED development, the average TV screen size is growing. The average TV screen is expected to reach 48,9-inches by 2020.

Furthermore, the flexible TV market will grow. Flexible TVs are assembled on a flexible base material (clear plastic film, reflective metal foil or graphene). The first flexible TVs have already been put on the market at very high prices (for instance the LG's W7 which cost \$10,000 for the 55-inches model and \$20,000 for the 65-inches model).

8K TV (twice the horizontal and vertical resolution of the 4K UHD, giving four times as many pixels overall) is also a promising technology, but it is not expected to go mainstream in the coming decade. Besides TV programmes are not even fully 4K compatible yet.

In terms of software, Artificial Intelligence (AI) will impact the industry. For example, the entire LG's 2018 line-up of TVs includes the AI engine ThinQ. The integration of AI on TVs serves two purposes. First, a series of algorithms can take advantage of the TV processor to improve the quality of the images displayed on the TV screen. Second, AI works in conjunction with the TV operating system using natural-language processing to allow audio & videos to use their voices to control the TV, select programs and access web-content. Even if AI already existed in some high-end TVs in the early 2010s, machine learning has boosted the capabilities of these functions.

1.1.11 MNE interaction

IC Insights gives the following regional breakdown of the IC market for the consumer electronics segment. The semiconductor and IC markets should normally reflect the regional consumer electronics production, but this is not the case here. The small share of Europe, and the large shares of the Americas and Japan in comparison are not consistent with the geographical breakdown of consumer electronics production.

The reason is probably that semiconductor revenues are not necessarily located in the country where they are finally incorporated into a product. For Japan the semiconductor purchases may be located in Japan at the manufacturer's headquarters (Sony, Sharp, Panasonic...), even though the components are not actually used and assembled in Japan, but on the companies' production sites throughout the world, including Europe.

The same is probably true of Samsung, LG and Foxconn, who assemble in Europe but may do the purchasing from Korea or Taiwan.

Table - IC consumption in the consumer electronics segment in 2016

Region	B \$	B €	% share
Europe	1 094	989	3.5
Americas	7 943	7 182	25.5
Japan	3 755	3 395	12.0
Asia Pacific	18 376	16 615	59.0
Total	31 168	28 181	100.0
Total consumer electronics		154 000	
% ICs in consumer electronics		18.3	

Source: IC Insights, DECISION Etudes & Conseil

Roadmap – For every electronic system type, what is the size and growth of the consumption in Europe compared to the other segments and what is the European position compared to the other regions

CONSUMER	Analog	Logic	MOS Memory	MOS DSP	MOS MCU	MOS MPU	TOTAL ICs
European consumer market in 2017 – M €	368	394	270	13	214	13	1,272
Rank of consumer in Europe in terms of market size	1 – Automotive 2 – Industrial 3 – Communications 4 – Consumer 5 – Computer 6 – Gov/Military	1 – Communications 2 – Computer 3 – Automotive 4 – Consumer 5 – Industrial 6 – Gov/Military	1 – Computer 2 – Communications 3 – Industrial 4 – Automotive 5 – Consumer 6 – Gov/Military	1 – Automotive 2 – Communications 3 – Industrial 4 – Gov/Military 5 – Consumer 6 – Computer	1 – Automotive 2 – Industrial 3 – Consumer 4 – Communications 5 – Gov/Military 6 – Computer	1 – Computer 2 – Communications 3 – Industrial 4 – Gov/Military 5 – Automotive 6 – Consumer	1 – Computer 2 – Automotive 3 – Communications 4 – Industrial 5 – Consumer 6 – Gov/Military
CAGR 2017–2022 European consumer market	– 4%	1%	25%	– 5%	– 1%	19%	6%
Rank of consumer in Europe in terms of CAGR 2017–2022	1 – Automotive 2 – Computer 3 – Gov/Military 4 – Communications 5 – Industrial 6 – Consumer	1 – Automotive 2 – Industrial 3 – Computer 4 – Gov/Military 5 – Consumer 6 – Communications	1 – Automotive 2 – Consumer 3 – Industrial 4 – Computer 5 – Gov/Military 6 – Communications	1 – Automotive 2 – Industrial 3 – Communications 4 – Computer 5 – Consumer 6 – Gov/Military	1 – Automotive 2 – Computer 3 – Industrial 4 – Communications 5 – Consumer 6 – Gov/Military	1 – Consumer 2 – Industrial 3 – Automotive 4 – Computer 5 – Communications 6 – Gov/Military	1 – Automotive 2 – Industrial 3 – Consumer 4 – Computer 5 – Communications 6 – Gov/Military
Share of European consumption	7%	3%	2%	4%	10%	2%	4%
Rank of Europe	1 – Asia-Pacific 2 – Europe 3 – Japan 4 – Americas	1 – Asia-Pacific 2 – Americas 3 – Japan 4 – Europe	1 – Asia-Pacific 2 – Americas 3 – Japan 4 – Europe	1 – Asia-Pacific 2 – Americas 3 – Europe 4 – Japan	1 – Asia-Pacific 2 – Japan 3 – Europe 4 – Americas	1 – Americas 2 – Asia-Pacific 2 – Japan 3 – Europe	1 – Asia-Pacific 2 – Americas 3 – Japan 4 – Europe

Source: DECISION Études & Conseil, IC Insights

Annex 8 - Home Appliances

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Overview

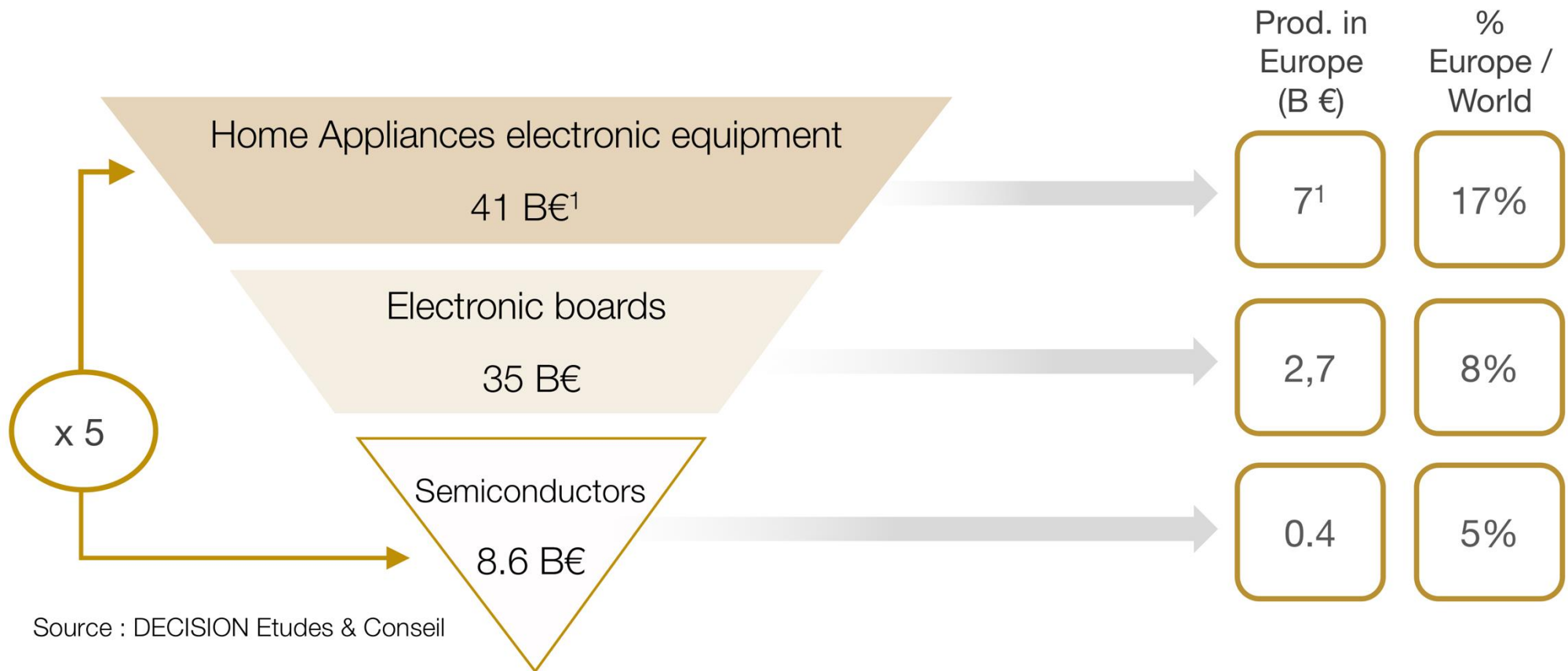
Domestic appliances are the last end-user segment for MNE and other electronic components in terms of production in Europe. European production of domestic appliances was 7 billion euros in 2017, and the industry employed around 42 500 people.

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.

Worldwide Home Appliances electronics value chain in 2017



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.

1.1.12 Scope and presentation of the segment of the segment and its value chain

vi. Power and water are requisites

Nearly all our electric domestic appliances appeared in the late 19th century or in the very first years of the 20th. From then their development was governed mainly by the availability of electric power and running water in the home. For example, in 1930 in the USA 70% of households were electrified, but whereas the majority of people living in larger towns and cities had electricity, only 10 percent of those who lived on farms and in rural areas had electric power.

- Between 1950 and 1990 vast progress in electrification was made all around the world. Between 1970 and 1990 electrification jumped from less than half (49%) of the world's population in 1970 to over three quarters (76%) in 1990. By the early 2010s 81 to 83 percent of the world's population had access to electricity;
- But today about 1.3 billion people still lack electricity, mostly in Africa and the Indian subcontinent. One estimate suggests that in 2010 as many as half of India's households lack electricity. Access to electricity remains the major factor governing the development of the world market for electric domestic appliances, even if for small appliances this can be overcome by battery or even solar cell operation.

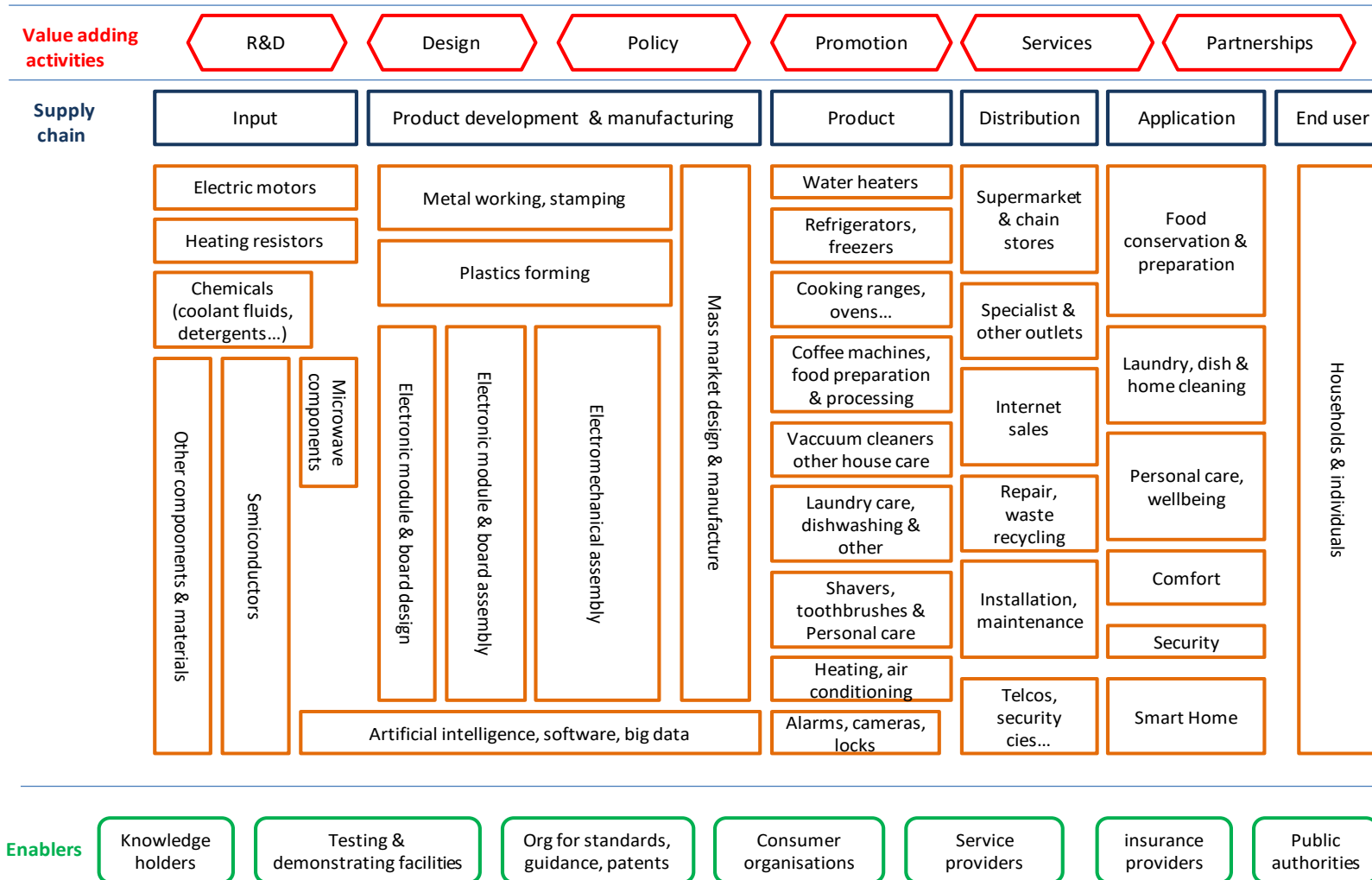
vii. From electronics pervasion to the smart home

During the second half of the 20th century electronic controls were increasingly introduced in domestic appliances (heat and motor controls, programmers). Today, the average electronic content of electric domestic appliances is no more than 5 to 10%, but it is growing steadily, at least twice or three times as fast as the domestic appliance market itself. And the start of this century is marked by the apparition of autonomous robots (vacuum cleaners, lawn-mowers) and connected appliances, in the context of the "Internet of Things" and of the "Smart Home".

As a consequence, the market for MNE and semiconductors used in domestic appliances should grow by 10% on average per year between 2016 and 2022, given a global growth of the appliance market of around 5% over the same period.

viii. The domestic appliance value chain

Domestic electric appliances value chain



Source: DECISION Etudes & Conseil

ix. Market categories

The electric domestic appliances market is traditionally split between *Major Appliances* and *Small Appliances*.

The definition of these categories varies according to sources. Major appliances always include refrigerators and freezers, washers and dryers, disposers, and dishwashers. Electrical cooking devices, microwave ovens, room air conditioners and heating are sometimes considered as major appliances, sometimes set apart, and sometimes as small.

For this study we have regrouped the detailed Eurostat Prodcom statistics into five categories (see detailed product code list in appendix):

- “Major appliances” include refrigerators and freezers, laundry washers and driers, and dishwashers;
- “Small appliances” include mostly electromechanical appliances with an electric motor but also devices using heat (house care, small electrical cooking devices, food & drink processing, clothes care, personal care);
- “Heating appliances” include space and water heating devices;
- “Cooking appliances” include electric and microwave ovens, cookers and cooking plates;
- “Parts” include parts for the above categories.

1.1.13 Figures, Europe 2010-2016, world and main countries

x. Europe positioning in the world

Important remarks:

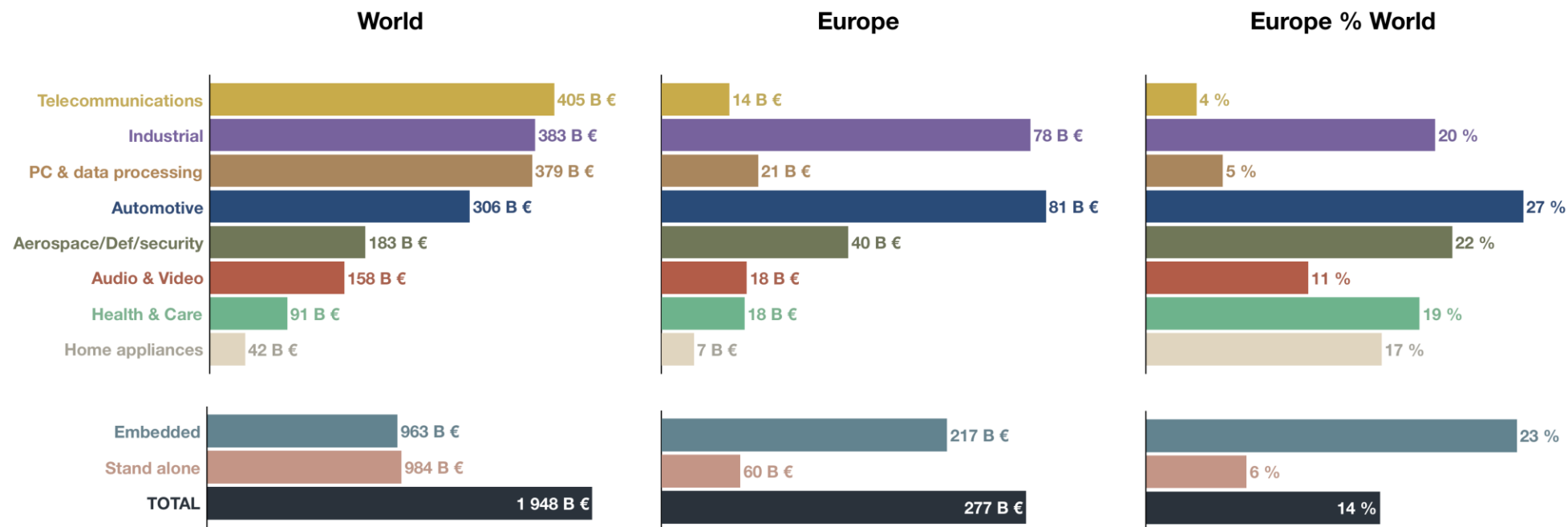
- **Measure of Home Appliances production in the world:**
 - Traditionally, every home appliance including electronic content is considered as an “electronic equipment” as a whole. Thus, the figures presented in the following Home Appliances correspond to the values of home appliances equipment as a whole (global production of 160 B € in 2016).
 - Yet, in nearly 90% of the cases, the great majority of the value of such home appliances is constituted of non-electronic sub-systems.
 - As a consequence, in order to be more precise in the measure of the global electronic equipment production and to ease the comparison between the different segments, the figures corresponding to “Home Appliances” presented in the pyramids and in the overviews correspond to an estimation of the value of the electronic sub-systems inserted in the home appliances final goods (global production of 41 B € in 2016).
- **Measure of Home Appliances production in Europe: Three different figures are presented in this report.**
 1. The Eurostat SBS industry database provides a figure of 35 B € in 2016. This figure corresponds to the sum of the turnovers of the companies located in Europe whose principal activities consists in producing Home Appliances (>50 of the turnover dedicated to Home Appliance production). In other words, this figure does not correspond directly to the production value of Home Appliances in Europe (overs-estimation).
 2. The Eurostat prodcom database provides a figure of 27 B € in 2016. We consider this figure as a reliable estimation of the production value in Europe in 2016.
 - Finally, the figure of 27 B € corresponds to the total value of the home appliances produced in Europe. Yet, in nearly 90% of the cases, the great majority of the value of such home appliances is constituted of non-electronic sub-systems. Therefore, the estimation from DECISION of the production value in Europe of the electronic sub-systems inserted in Home Appliances is 7 B €.

Results:

Home appliances is the smallest of the eight electronic end-user segments with a global production of 41 B € in 2017.

In 2017, Home appliances represented 2.1% of the global electronic equipment production and 2.5% of the European electronic equipment production.

Diagrams: End-user electronic equipment production in 2017 (M €)



Source: DECISION Etudes & Conseil

Europe, with 17% of the world production of home appliances is second behind China (37%), significantly before the USA (11%) and Japan (9.5%).

In the home appliances market each geographical region has its own particularities, and products need to be adapted to local lifestyles, unlike other electronic markets which are much more uniform (consumer audio video for example). This is true between Europe, North America, Latin America, Asia, or Africa. But it is also true on a smaller scale between the different European countries.

In Europe the market is still fragmented, but the large European players have been acquiring a lot of local manufacturers, often still using the brands and production sites of their acquisitions. The very mature North American market has undergone serious industrial concentration during recent years, leaving Whirlpool as the sole remaining global player.

The world market and production growth will be pulled by the growing purchasing power of the new emerging middle classes in Brazil, China and India. The Chinese domestic appliance market is the first in the world and is growing fast.

Table - 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

In the coming years, the most impressive market growth should be seen in India. The saturated European, North American, and Japanese markets are mainly driven by innovation. Internet-connected and controlled smart large appliances are expected to progressively replace conventional refrigerators and washing machines.

In terms of production, China is the world leader for home appliance manufacturing with close to 40% of the world production in 2016.

In South Korea, the home appliance components are manufactured at home and then shipped for final assembly to factories in Europe, Africa or North America in order to be retailed in the corresponding geographical region. This industrial organisation is mainly a result of a restrictive fiscal policy and also aims to create better logistical efficiency.

In Japan, the situation of the domestic appliance industry is described by JEMA as follows: "In the face of increasing globalisation, Japan's home appliance industry has been transferring its production mainly to other Asian countries, especially for low-end and small products. As a result, so-called "out-in" in which products are imported to Japan from overseas factories is increasing. In addition, "out-out" sales in which goods are shipped from overseas factories to their domestic markets or to countries other than Japan are also increasing. That is, products are developed and produced according to the lifestyles and conditions in the countries where they are to be sold. Japan's home appliance industry has been proceeding with "production in optimum locations and sales in optimum locations" while focusing on the reduction of production costs and exchange risk. The domestic market is expected to offer solid demand although the demand may be subject to business and weather conditions. This is because repurchase demand is expected mainly from a medium-term perspective and demand for high value-added products meeting the needs of consumers such as energy saving & efficient appliances and smart home appliances is also expected. In the global market, demand is growing for home appliances in emerging countries, specifically, in Asian countries, with sales expected to be promoted through the development of products matching the culture, lifestyles, habits, and the sense of values in the region."

Table - US production of electric domestic appliances (M€)

	Refriger freezer	Laundry	Electric cooking	Other major	Small	Total
2016	4 010	3 464	2 344	4 373	2 976	17 167
2015	3 689	3 176	2 359	4 398	3 072	16 694
2014	2 718	2 578	1 929	3 478	2 283	12 986
2013	2 529	2 654	1 787	3 247	2 296	12 513
2012	3 150	3 201	2 247	3 950	2 800	15 348
2011	2 490	2 574	1 421	2 801	1 838	10 124
2010	2 617	2 652	1 425	2 828	2 034	11 556

Source: US Census

xi. EU's turnover, employment, value added and investment

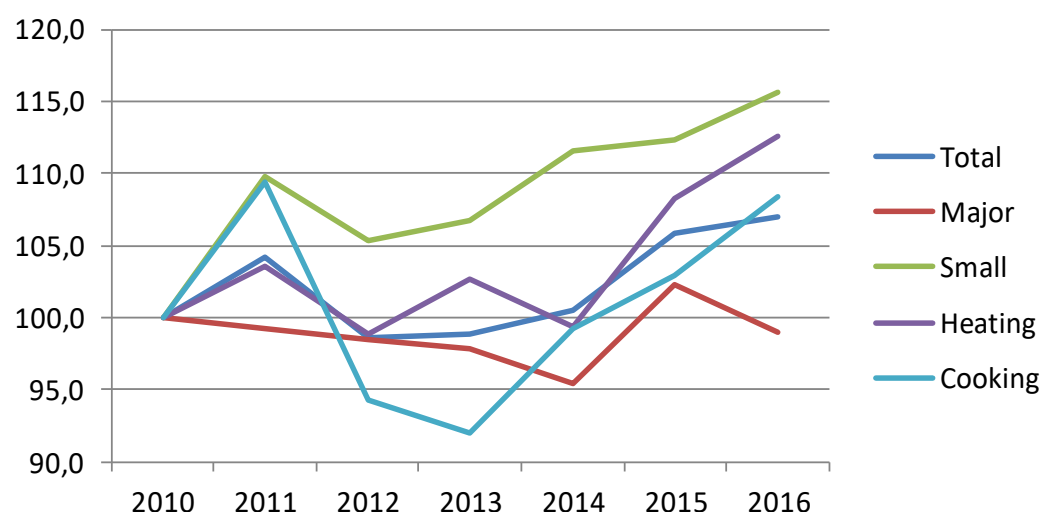
A. Production breakdown by types of products

Table - Electric domestic appliances: European Production in Value (M€)

Year	Total	Major	Small	Heating	Cooking	Parts
2010	25 362	10 923	5 034	2 381	4 239	2 785
2011	26 416	10 846	5 525	2 466	4 638	2 941
2012	25 021	10 763	5 303	2 354	3 999	2 602
2013	25 074	10 693	5 375	2 446	3 901	2 660
2014	25 483	10 421	5 616	2 365	4 209	3 227
2015	26 856	11 168	5 654	2 577	4 365	3 092
2016	27 141	10 817	5 823	2 680	4 594	3 227

Source: Eurostat Prodcom

Graph – European production of household appliances 2010-2016 (index 2010=100)



Source: Eurostat Prodcom

Electronic domestic appliances: European Production in Quantity (1000 units)

Year	Total	Major	Small	Heating	Cooking
2010	241 182	45 545	137 938	28 489	29 210
2011	241 001	44 783	141 228	30 082	24 908
2012	242 259	43 329	143 544	25 958	29 428
2013	236 882	44 257	140 973	25 098	26 554
2014	239 448	43 025	147 443	23 741	25 239
2015	239 841	44 189	143 096	26 601	25 955
2016	257 982	43 299	159 630	29 192	25 861

Source: Eurostat Prodcom

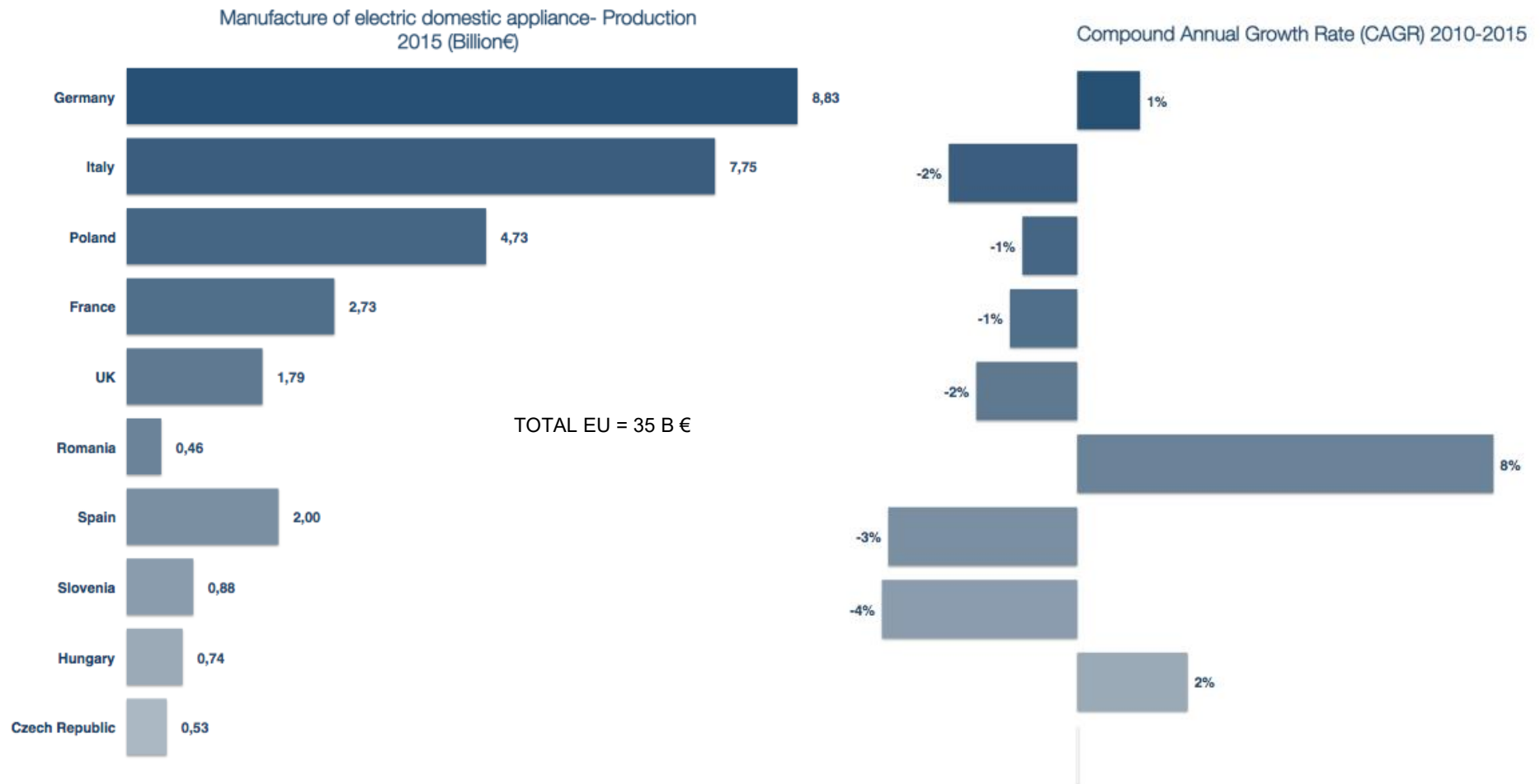
B. Geographical breakdown in Europe - Countries

Table - European industrial base in Electric Domestic Appliances by Member State (%)

Country	Production (%)		People employed (%)	
Year	2010	2015	2010	2015
Germany	23.8	25.2	23.6	24.6
Italy	24.9	22.1	21.0	16.7
Poland	14.2	13.5	14.1	15.3
France	8.3	7.8	7.2	6.4
UK	5.6	5.1	5.9	5.9
Romania	0.9	1.3	3.7	5.3
Spain	6.8	5.7	6.1	4.6
Slovenia	3.0	2.5	4.6	4.2
Hungary	1.9	2.1	3.8	3.6
Czech Republic		1.5		2.4
Others	10.6	13.2	10.0	11.0
Total	100.0	100.0	100.0	100.0

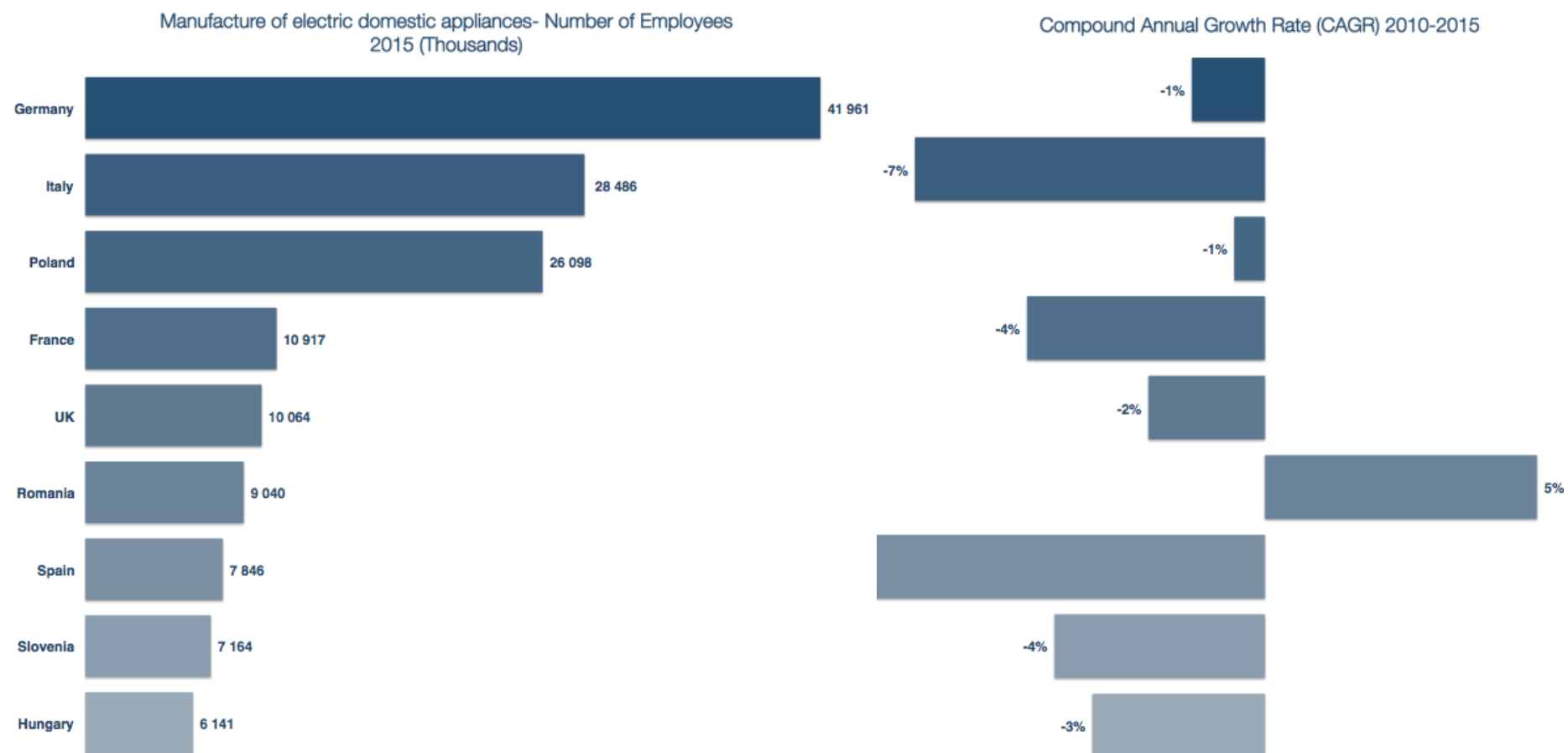
Source: Eurostat, SBS industry database, NACE2

Graph (1/3) - Geographical breakdown of European activities in Electric Domestic Appliances



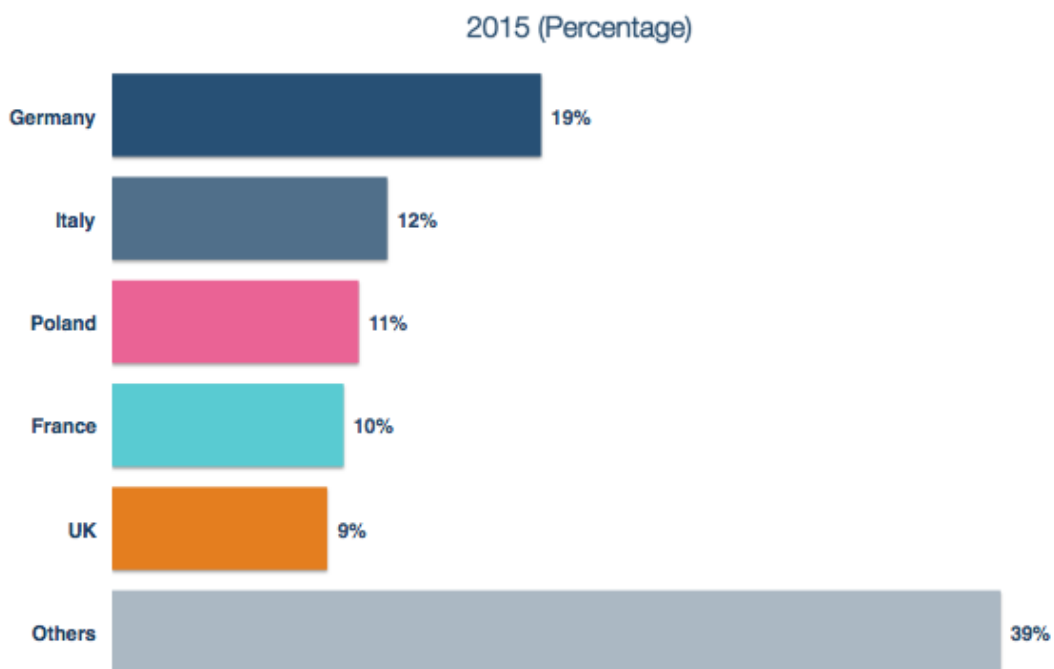
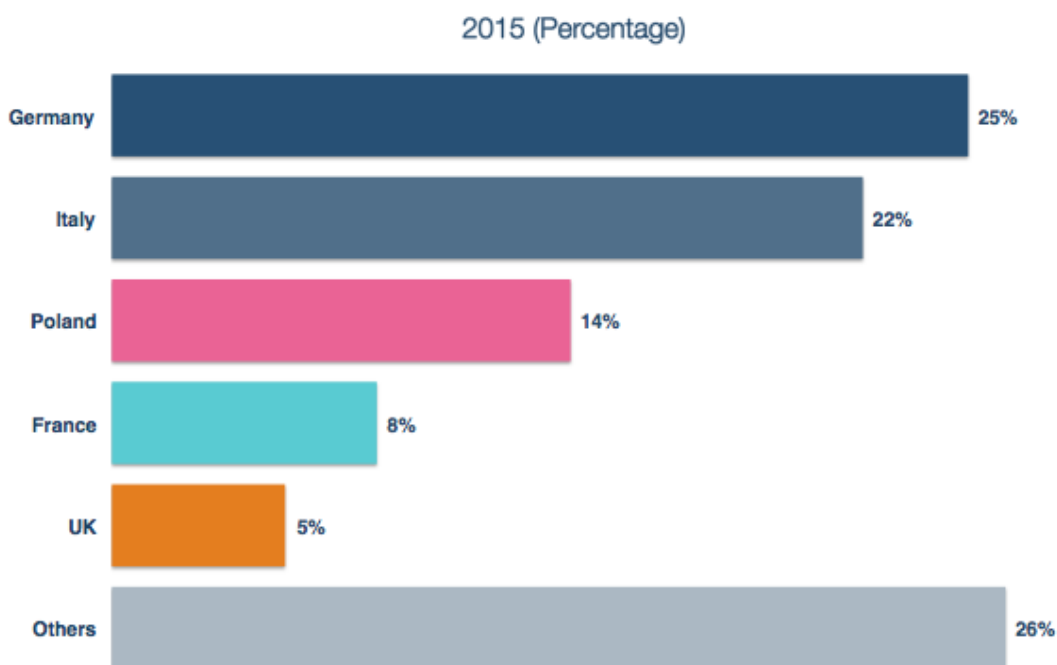
Source: Eurostat, SBS industry database, NACE2

Graph (1/3) - Geographical breakdown of European activities in Electric Domestic Appliances



Source: Eurostat, SBS industry database, NACE2

Graph (3/3) - Geographical breakdown of European activities in Electric Domestic Appliances



Others in the graph above include:

Romania; Austria; Denmark; Belgium; Romania; Norway; Portugal; Croatia; Ireland; Slovakia; Bulgaria; Greece; Lithuania; Cyprus; Latvia; Luxembourg; Malta; Netherlands; Spain; Slovenia; Hungary; Czech Republic

Geographical distribution of European activity in Electric Domestic Appliances

Country	Production		People employed	
	2010	2015	2010	2015
Belgium	174.0	248.9	1 049	1 194
Bulgaria	182.4	277.6	2 841	3 383
Czech Republic	:	528.4	:	4 070
Denmark	87.1	:51.2*	404	:316*
Germany	8 163.3	8 818.3	45 027	42 006
Estonia	0	0	0	:0
Ireland	75.4	:	414	:
Greece	204.0	126.9	1 588	988
Spain	2 350.4	1 980.7	11 604	7 907
France	2 867.0	2 739.0	13 778	10 927
Croatia	24.2	10.5	703	285
Italy	8 567.3	7 734.9	40 066	28 537
Cyprus	0	0	0	0
Latvia	:	:	10	14
Lithuania	48.6	120.8*	1 091	1898*
Luxembourg	0.0	0.0	0	0
Hungary	637.3	735.0	7 292	6 214
Malta	0	0	0	0
Netherlands	:	:	1 489	2 281
Austria	766.9	632.0	3 444	3 263
Poland	4 867.6	4 723.2	26 802	26 045
Portugal	211.2	256.2	1 924	2 121
Romania	:297.7'	:450.0e	7 079	8 992
Slovenia	1 038.1	881.5	8 853	7 131
Slovakia	289.6	397.2	1 906	2 213
Finland	139.6	100.2	840	602
Sweden	616.7	175.2	4 888	1 092
United Kingdom	1 909.3	1 776.7	11 172'	10 000e
EU total (1)	34 337.6	35 054.0	190 500	170 575
Norway	127.0	90.0e	616	486
Switzerland				
Turkey	5 295.1'	7 086.0*	36 076'	49 260*

* 2014 ** 2013 *** 2012 **** 2011 '2009 "2008

(1) the total includes figures not disclosed at country level

Source: Eurostat, SBS industry database, NACE2

The Eurostat SBS industry database indicates an EU production of Home Appliances of 35 B €. The Eurostat Prodcom database indicates an EU production of Home Appliances of 27 B €. In this study, when the Prodcom database provides reliable figures, the figures considered as the "European production" are the Prodcom ones.

Indicators for the Electric Domestic Appliance industry in Europe

Key indicator	2010	2016
Production (M€)	34 338	35 054*
Added value (M€)	10 031	9 768*
Tangible Investment (M€)	1 038**	1 307*
Persons employed (number)	196 800	170 575*
Turnover per person employed (€)	208 350	260 000*
Apparent labor productivity (Gross added value per person employed) (€)	50 960	57 000*
Wage adjusted labor productivity (Apparent labor productivity by average personnel costs) (%)	138	141*
Share of personnel costs in production (%)	20.8	19.6*
Average personnel costs (personnel costs per employee) (€)	36 820	40 700*
Employer's social charges as a percentage of personnel costs (%)	23.4	22.5*
Investment per person employed (€)	5 200**	7 700*
Investment rate (investment/added value at factors cost) (%)	10.8**	13.4*

* 2015, ** 2009

Source: Eurostat Prodcom, NACE2

xii. Focus on the factory production (Prodcom)

Indicators for the Electric Domestic Appliance industry in Europe

	2010	2016
Production (M€)	25 362	27 140
Exports (M€)	6 784	
Imports (M€)	10 756	

* 2015, ** 2009

Source: Eurostat SBS industry database, NACE2

1.1.14 Company positioning, Europe, World

Europe holds a strong position, with two companies among the top five, four among the top ten, and nine among the top twenty (ten if the Turkish Arcelik is included). Only One American company (Whirlpool) is left among the leaders, but is by far the world largest, with a wide global manufacturing base.

Most of the American and European leading companies have consolidated their local market shares through successive acquisitions. Asian companies are more recent players. Whereas the Koreans LG Electronics and Samsung have established brands, the Chinese still often manufacture for resale under European, American or Japanese brand names in these regions. This is also true of eastern European manufacturers or the Turkish company Arcelik. The growth of Asian markets has drawn South Korean and also Chinese companies into the group of world market leaders. Whirlpool, the US giant is still n°1 of the sector, followed by the Europeans Bosch-Siemens (Germany) and Electrolux (Sweden). The Chinese Haier and Midea follow, before the Koreans LG Electronics and Samsung.

Some companies have gone bankrupt during the restructuring, among which the Spanish Fagor Electrodomesticos, which ranked n°8 among the European home appliance manufacturers 2013, and the Korean Daewoo in 1999.

In the small appliance field competition is fierce between the different types of players, ranging from specialists in small appliances (like world leader SEB or Philips), to divisions of world appliance giants like Electrolux, or Panasonic, not forgetting niche innovative players addressing premium segments like Dyson or Vorwerk.

Table - Main world players in Home Appliances

Rank	Company	Country	Founded	Sales B € 2016
1	Whirlpool (fiscal 2017)	USA	1911	18.8
2	Bosch Siemens Hausgeräte (fiscal 2017) (Bosch)	Europe (Germany)	1967	13.8
3	Electrolux (2016)	Europe (Sweden)	1919	12.7
4	Haier	China		12.0
5	Midea	China		10.0
6	LG Electronics (2016)	S Korea		9.4
7	Samsung Electronics	S Korea		9.1
8	Panasonic (fiscal March 2017)	Japan		9.0
9	SEB	Europe (France)		6.5
10	Miele	Europe (Germany)		3.9
11	Arcelik	Turkey	1955	3.9
12	Gree Electric	China	1989	3.5
13	Philips	Europe (NL)		3.4
14	Hitachi	Japan		2.3
15	Dyson	Europe (UK)	1991	2.0
16	Gorenje	Europe (Slovenia)	1950	1.2
17	Candy	Europe (Italy)	1945	1.0
18	Amica	Europe (Poland)		0.7
19	Godrej	India	1897	0.7
20	Anhui Konka Household appliances (Konka group)	China	2003	0.5
	CATA Electrodomesticos	Europe (Spain)	1947	0.1

Source: DECISION Etudes & Conseil

Table – 2016 – Main Home Appliance manufacturers in Europe

Company	Country	Global Sales Rank	Global Sales (B€)	Europe Sales Rank	Europe Sales (B€)	Europe Production Rank	Europe production
Bosch Siemens Hausgeräte (fiscal 2017) (Bosch)	Europe (Germany)	1	13.8	1	8,0 (?)	1	8,3 (?)
Electrolux (2016)	Europe (Sweden)	2	12.7	2	4.0	2	4,8
Whirlpool (fiscal 2017)	The USA	3	18.8	3	3,8	3	3,8
Miele	Europe (Germany)	4	3.9	6	2.7	4	3.7
Arcelik	Turkey	5	3.9	5	3.0	5	3,1
Philips	Europe (NL)	6	3,4	7	2.0 (?)	6	1,7 (?)
Gorenje	Europe (Slovenia)	7	1.2	9	1.2	7	1,2
SEB	Europe (France)	8	6.5	4	3,6	8	1,1
Dyson	Europe (UK)	9	2,0	10	1.0 (?)	9	0,8
Candy	Europe (Italy)	10	1,0	14	0,8	10	0,7 (?)
Amica	Europe (Poland)	11	0,7	15	0,6	11	0,5
Haier	China	12	12.0	8	1.2 (?)	12	0,2 (?)

Source: DECISION Etudes & Conseil

Table – 2016 – Main Home Appliance manufacturers in Europe

Company	Country	Europe Production (B €)	Europe Production Rank	Employees in the world	Employees in Europe
Bosch Siemens Hausgeräte (2017)	Europe (Germany)	8.3	1	61 856	37 000
Electrolux	Europe (Sweden)	4.8	2	55 400	21 052
Whirlpool (fiscal 2017)	The USA	3.8	3	92 000	18 500 (?)
Miele	Europe (Germany)	3.7	4	19 465	9 600 in factories
Arcelik	Turkey	3.1 (including Turkey)	5	19 136	15 000 (?)
Philips	Europe (Netherlands)	1.7 (?)	6	10 600	5 000 (?)
Gorenje	Europe (Slovenia)	1.2	7	10 700 (2012)	10 700 (2012)
SEB	Europe (France)	1.1	8	33 600	15 000 (?)
Dyson	Europe (The UK)	0.8	9	8 500	3 500
Candy	Europe (Italy)	0.7 (?)	10		
Amica	Europe (Poland)	0.5	11	2 500	2 000 (?)
Haier	China	0.2 (?)	12	35 000	

Source: DECISION Etudes & Conseil

Analysis of the table above – Comments on factory production.

- **Bosch Siemens Hausgeräte.** BSH operates some 43 factories worldwide. After 1967 refrigerators and dishwashers were built in Giengen, cookers in Traunet and washing machines in Berlin. In the autumn of 1976, a new production facility for dishwashers was opened in Dillingen an der Donau. In 1976, BSHG became active for the first-time outside Germany and acquired Pitsos, Greekmarket leader in refrigerators. IN 1984, a European sales network was set up to strengthen BSHG's position in the European market. At the end of the 1980s, the acquisition of appliance manufacturers Balay and Safel gave BSHG an important foothold in the Spanish market. In 1993, activities were launched in Slovenia. The company began expanding its business beyond Europe in 1994;
- **Electrolux.** Employees by region: Europe (38%), North America (18%), Australia New Zealand and Japan (2%), Africa & Middle East (6%), Latin America (29%), South East Asia & China (7%). The group is sourcing a large volume of input goods and finished goods from China to Electrolux global factories;
- **Miele.**
 - The group holds 8 factories in Germany (accounting for more than 7 056 employees), 3 in the rest of Europe (accounting for 2 109 employees), 1 in China (452 employees).
 - Germany: 231 employees in Arnsberg in a cooker hoods factory, 1 905 employees in Bielefeld in a vacuum cleaners dishwashers factory, 609 employees in Bünde in a hobs steam cookers warming drawers factory, 461 employees in Euskirchen in a factory of electric motors, 2 294 employees in Gütersloh in a washing machines washer driers parts factory, 550 employees in Gütersloh in a module & sensors factory, 387 employees in Lehrte in a washing machines tumble driers ironing customized solutions factory, 619 employees in Oelde;
 - Austria: 273 employees in sterilizers parts and systems;
 - Romania: 273 employees in Brasov;
 - Czech Republic: 1 563 employees in a washing machines timble driers dishwasher's factory;
 - China: 452 employees in Dongguan in a vacuum cleaner's factory.
- **Arcelik.** This group holds 15 factories in the world: 7 in Turkey, one in Romania, one in Russia, one in China, one in Thailand, one in Pakistan and 3 in South Africa;
- **Philips.** Philips holds factories in Poland and China;
- **Gorenje.** The main production facilities of this group are the following: In Velenje (Slovenia), a cooking appliances plant Mora Moravia in Marianske Udolf (Czech Republic), a fridge-freezer plant in Valjevo (Serbia), a water heater and radiator plant in Stara Pazova (Serbia), and a plant in Sweden;
- **SEB.** The global repartition of the production is the following: Asia (China and Vietnam) 33%, Europe 31%, South America 6%, Other 2%. 28% of the sourcing is from China;
- **Dyson.** Factories locations: The UK (3 500 employees), Malaysia (4 000 employees in 2004), Singapore (1000 employees in 2013);

- **Candy.** The list of the European factories is the following: Italy, the UK (Kelvinator, Hoover, Baumatic), France (Rosières), Spain (Mayc-Otsein), Portugal (Hoover), Finland (Helkama), Russia (Vyatka), China (Jinling), Turkey (Doruk);
- **Amica.** Factories in Poland and China;
- **Haier.** This group holds 29 factories in the world, among which 13 are in China. The countries of countries in which Haier holds factories is the following: China, Indonesia, Philippines, Malaysia, Pakistan, Jordan, Tunisia, Nigeria, Egypt, Algeria, South Africa, Italy (Meneghetti, Campodoro, refrigerator assembly), New Zealand (2012 Fisher & Paykel), the USA (GE plants bought in 2016).

1.1.15 Technological and market development

The growth of the large appliances market will come from the increase in ownership in countries (in Asia and Africa mostly) where it is still low, partly due to the fact that not all households (especially outside the cities) yet have access to electricity, and also, in the more mature markets, from accelerated replacement due to the new incentive to buy “smart appliances” enabling their control from the smartphone in the context of the smart home.

Smart appliances: the development of smart appliances is pulled by **energy-efficiency** demand from consumers and **web-based new services**. These are in close relation with the development of smart homes and buildings, but also of smart grids. One of the benefits will be better energy efficiency, the awareness of which will increasingly be achieved by government regulations. The availability of new generation of low-cost sensors (thanks to the automotive market), allowing for remote control and monitoring, is also helping this evolution. Smart home appliances operate through a range of wireless technologies, including Wi-Fi, RFID, ZigBee and Bluetooth.

Starting with new types of refrigerators, washers, and air conditioners, the smart appliances market should grow rapidly, initially in the USA, owing to technological advancements and widespread awareness. The global market, estimated at around 18 billion euros in 2016 could reach 325 billion by 2022,

A new concept that is also developing very quickly is the **robot**, i.e. a largely autonomous appliance capable moving and operating on its own, with no direct human control. This concept is for the moment used mainly for vacuum cleaners and lawn mowers. Robot vacuum cleaners already account for about 10% of the market, and their share is growing very fast. Most manufacturers now offer robots in their product range

In the coming years, the **smart home**, with “connected home systems” will be a significant driver for this sector, integrating appliances, entertainment, professional activity, security and health. Technologies today are sufficient to make remote control of house appliances from a mobile handset a reality, but work and time is still needed to develop simple services and attractive products for the customers.

Most appliance players are developing systems to use smartphones or tablets as remote controls for consumer electronics, domestic appliances, home automation systems, or remote monitoring or surveillance. All key players on the appliances market are offering such features. Different types of monitoring and control systems are being used in order to explore how such appliances can evolve into the concept of smart homes.

Embedded controls in the appliances are now generalised, such as. programming and control devices to manage refrigerator temperature level, washing machine cycle programmers, temperature control, speed control, oven programmers and temperature control, etc. A simple On/Off without variable control has become rare and is now reserved to bottom of the line small home appliances.

Home networks: communicating devices that allow collecting information on the current situation of the equipment and dialogue with its owner or directly with other devices or energy providers. Different communication protocols are usable to create a home network either wireline or wireless as Wi-Fi, RFID, ZigBee and Bluetooth etc.

Several manufacturers are developing very innovative and even futuristic smart home configurations. The technology for such systems is available, but the question is whether the market is ready for such developments. However, the revolution enabled by mobile phones and smartphones will certainly cause rapid market evolutions.

1.1.16 MNE interactions

The semiconductor content of domestic appliances, at about 5% is not very great, and leads to a market of nearly 8.6 billion euros in 2016. This because domestic appliances also include a lot of electromechanical components (resistors, motors, pumps, compressors...) that are necessarily a large share of the product cost.

Semiconductors in domestic appliances have however been a double-digit growing market since 2010, and this trend should continue in the coming years, albeit slightly slower.

Several trends in domestic appliance design are contributing to an increasing semiconductor content.

- increased use of inverter-based variable speed control for motors, compressors, and pumps, partly driven by the emphasis on energy efficiency and stricter appliance standards.
- The trend toward electronic controls and displays. Driving complex menus and multiple languages requires the use of more advanced microcontrollers, leading to an increasing share of 16- and 32-bit solutions. Displays and touch controls are being implemented as a means of product differentiation from competitors.
- The trend towards smart and connected appliances, in the IoT and “smart home” context

Power semiconductors are the largest segment in the domestic appliance market for semiconductors, and in particular IPMs (intelligent power modules) and IGBTs (insulated gate bipolar transistors) as modules or discretes. Microcontrollers are growing, with increasing display and communication functions.

1.1.17 Appendix: NACE, Prodcod, NAICS (USA) codes

NACE Rev 2: 27.51 Manufacture of electric domestic appliances

Prodcod codes

Household appliances

Major appliances

27511110	Combined refrigerators-freezers, with separate external doors
27511133	Household-type refrigerators (including compression-type, electrical absorption-type) (excluding built-in)
27511135	Compression-type built-in refrigerators
27511150	Chest freezers of a capacity <= 800 liters
27511170	Upright freezers of a capacity <= 900 liters
27511200	Household dishwashing machines
27511300	Cloth washing and drying machines, of the household type

Small appliances

27511400	Electric blankets
27511530	Table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor of an output <= 125 W
27511580	Ventilating or recycling hoods incorporating a fan, with a maximum horizontal side <= 120 cm
27512123	Vacuum cleaners with a self-contained electric motor of a power <= 1 500 W and having a dust bag or other receptacle capacity <= 20 l
27512125	Other vacuum cleaners with a self-contained electric motor
27512170	Domestic food grinders, mixers and fruit or vegetable juice extractors, with a self-contained electric motor
27512190	Other electromechanical appliances
27512200	Shavers, hair-removing appliances and hair clippers, with self-contained electric motor
27512310	Electric hair dryers
27512330	Electric hairdressing apparatus (including hair curlers, curling tongs) (excluding hair drying hoods, hair dryers)
27512350	Electric hand-drying apparatus

27512370	Electric smoothing irons
27512410	Vacuum cleaners, including dry cleaners and wet vacuum cleaners (excluding with self-contained electric motor)
27512430	Domestic electric coffee or tea makers (including percolators)
27512450	Domestic electric toasters (including toaster ovens for toasting bread, potatoes or other small items)
27512490	Electro-thermic appliances, for domestic use (excluding hairdressing appliances and hand dryers, space-heating and soil-heating apparatus, water heaters, immersion heaters, smoothing irons, microwave ovens, ovens, cookers, cooking plates, boiling rings, grillers, roasters, coffee makers, tea makers and toasters)

Heating

27512530	Electric instantaneous water heaters
27512560	Electric water heaters and immersion heaters (excluding instantaneous water heaters)
27512630	Electric storage heating radiators
27512650	Electric radiators, convection heaters and heaters or fires with built-in fans
27512690	Other electric space heaters

Cooking

27512700	Domestic microwave ovens
27512810	Domestic electric cookers with at least an oven and a hob (including combined gas-electric appliances)
27512830	Electric cooking plates, boiling rings and hobs for domestic use
27512850	Domestic electric grills and roasters
27512870	Domestic electric ovens for building-in
27512890	Domestic electric ovens (excluding those for building-in, microwave ovens)

Parts

27512900	Electric heating resistors (excluding of carbon)
27513010	Parts for vacuum cleaners
27513030	Parts for electro-mechanical domestic appliances with a self-contained electric motor (excluding parts for vacuum cleaners)
27513050	Parts for shavers and hair clippers with a self-contained electric motor
27513070	Parts of appliances of HS 8516

US Census codes

- 3352 - Household appliance manufacturing
 - 33521 - Small electrical appliance manufacturing
 - 335210 - Small electrical appliance manufacturing
 - 33522 - Major appliance manufacturing
 - 335221 - Household cooking appliance manufacturing
 - 335222 - Household refrigerator and home freezer manufacturing
 - 335224 - Household laundry equipment manufacturing
 - 335228 - Other major household appliance manufacturing

European Commission

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