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Sector Report

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EUROPEAN UNION
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The partnership behind the ESPON Programme consists of the EU Commission and the Member States of the EU27, plus Iceland, Liechtenstein, Norway and Switzerland. Each partner is represented in the ESPON Monitoring Committee.

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This basic report exists only in an electronic version.

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1 Introduction to and conceptual elements of Green Manufacture

Manufacturing, since its origins in the Industrial Revolution, has been the main engine for growth globally. Broadly speaking, it involves the transformation of resources into products (either intermediate, or finished). Along these lines, according to Eurostat statistics (NACE Rev.2), manufacturing comprises "*the physical or chemical transformation of materials, substances, or components into new products*. *The materials, substances, or components transformed are raw materials that are products of agriculture, forestry, fishing, mining or quarrying as well as products of other manufacturing activities. It should be noted that the output of a manufacturing process may be finished in the sense that it is ready for utilisation or consumption, or it may be semi-finished in the sense that it is to become an input for further manufacturing.*"

Manufacturing is still the driving force of the European economy, contributing over 6 500 billion euro in GDP and providing more than 30 million jobs.

It covers more than 25 different industrial sectors, largely dominated by SMEs, and generates annually 1 500 billion euro of value added, as stated by "Factories of the Future" (see section 3.1 for more detail). There has been a massive increase in manufacturing labour productivity by some 46% over 1995-2007 compared with economy-wide productivity growth of less than 20% over the same period (European Commission (EC) DG Enterprise and Industry (2010)). Europe's long tradition in the Manufacturing sector becomes evident when looking at the economic activities distribution in the EU. In fact, according to Eurostat data, in 2005 this sector employed almost 20% of the EU 27 active population, while the highest shares of industrial employment were found in regions of Eastern Europe.

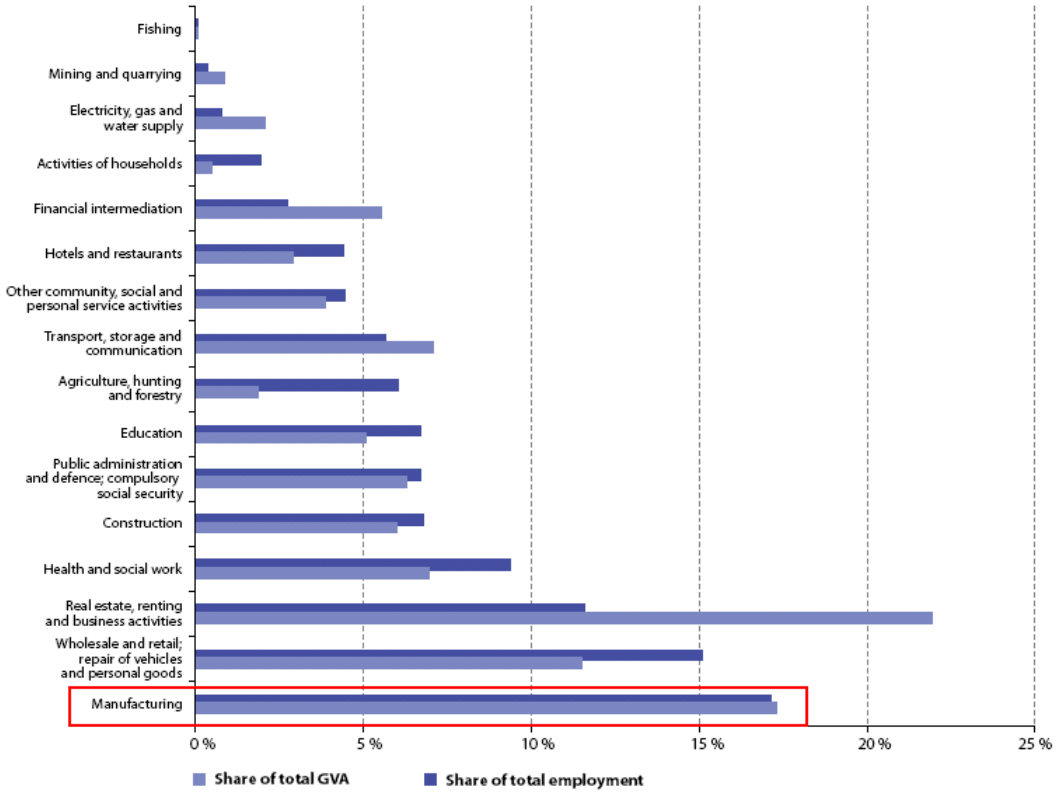


Figure 1 Share of total GVA and employment in 2005 (EU27). *Source: Eurostat*

However, the Manufacturing sector as a whole is very resource intensive and due to the finite nature of many resources and increasing environmental performance standards, it faces several challenges with regard to becoming greener and more resource efficient, such as, economy (scarcity, prices), environment (life cycle based impacts: extraction, transport, manufacturing, recycling, waste), as well as the social pillar of environment. According to UNEP (UNEP (2011)) Manufacturing is responsible for around 35 per cent of global electricity

use, over 20 per cent CO2 emissions and over a quarter of primary resource extraction. In this context, it accounts for up to 17 per cent or air pollution-related health damage.

At the global level, materials and energy use patterns are simply unsustainable. The amounts of materials and energy that industry consumes are such that world's available resources are rapidly depleting. At the same time, this consumption is leading to increases in waste and pollution which, in quantity as well as in toxicity, are overwhelming the assimilative capacity of the world's ecosystem. Moreover, the production and consumption system has contributed to rapid resource depletion, the degradation of ecosystems, and the threat of climate change (Stamm, A. et al. 2009).

In this scenario of resource scarcity, subsequent volatile prices of resources (energy, raw materials, etc.), rising emissions and waste generation, combined with increasing environmental awareness, the initiatives to tackle the pressure of Manufacture on Environment and Society, while enhancing resource efficiency, have boosted both in the EU and worldwide. In relation to GREECO, the most relevant initiatives and hence, Green Manufacture definitions, would be the ones listed below:

- According to UNEP, „*green manufacturing differs from conventional manufacture, in that it aims to minimize the amount of natural resources used to produce finished goods through more efficient (energy and materials) processes, reducing the negative externalities of pollution and waste. These processes include a more efficient transport and logistics, that have a significant percentage of the total environmental impact of industry"*.
- For UNIDO „*Green Industry is industrial production and development that does not come at the expense of the health of natural systems or lead to adverse human health outcomes. Green Industry is aimed at mainstreaming environmental, climate and social considerations into the operations of enterprises. It provides a platform for addressing global, interrelated challenges through a set of immediately actionable cross-cutting approaches and strategies that take advantage of emerging industry and market forces."*
- While the OECD, does not have a green Manufacture definition in place, it does acknowledge the pushing need of Manufacturing becoming more sustainable and has elaborated a Sustainable Manufacturing Toolkit. This toolkit makes use of the US Department of Commerce's definition of Sustainable Manufacturing: "*The creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound.*"
- For Europe there are two slightly differentiated, but complementary, approaches. On the one hand there is the Environmental Goods and Services Sector, which focuses on environmental protection and resource management products, technologies and services. The importance these activities, and their potential to help all of industry to become more sustainable, has been underpinned by DG Enterprise. On the other hand, there is also a trend towards greening the Manufacture sector as a whole, by means of initiatives such as, the Sustainable Consumption and Production Action Plan, the Resource Efficiency Roadmap etc.

Even if the approaches and wording may differ, all the above views acknowledge the need to revert the trend of a resource intensive and polluting Manufacturing sector (be it greener, more resource efficient, more sustainable, etc.). Whilst the manufacturing industry is clearly affected by the current global economic slowdown (according to London-based Markit Economics, the sector's has growth slowed more than initially forecast), it has enjoyed a stronger recovery than most other sectors of the economy. Therefore, consumption patterns need to change, i.e. material and energy consumption must decouple from economic growth, so that they can continue to create wealth, but not at the price of increasing consumption (UNIDO 2010). Only if production systems can decouple their consumption of materials and energy from their production (i.e., produce more with less) will they become sustainable.

Greening the manufacturing sector implies a structural change shifting from the traditional brown industry to an environmental friendlier manufacturing, which according to IEA scenarios, will lead to a considerable energy efficiency improvement by 2050, virtually decoupling energy use and economic growth. Furthermore, manufacture also comprises the

production of environmental goods, creating new green jobs (15% more jobs than business-as-usual scenario in 2050, according to UNEP. Against this background, it should be highlighted that enhanced resource efficiency addresses all three dimensions of sustainability: (i) environmental protection, (ii) promotion of economic growth, and (iii) social development (Bleischwitz, et al. 2009), which is at the core of Green Economy. All in all, the future of manufacturing is vital to European economic growth and sustainability.

It should be highlighted that environmental performance of industry has been enhanced in last years. These changes are still in an improving process, but almost all countries have reduced their GHG emissions, decreased waste stocks through better recycling processes, increased material productivity and consumed resources and energy more efficiently. It has happened especially by the investments in R&D and Innovation, which have been the key of this advance. In addition, Environmental Goods and Services Sector has become an essential activity in the greening of the manufacture (Rademaekers et al. 2011a).

Finally, in GREECO, the first approach to define the GREECO-Manufacturing sector, was to limit it to the below NACE Rev. 2 codes (see Interim Report):

Table 1 Manufacturing activities as in the Interim Report

NACE codes	Activities
Manufacturing	
C20	Manufacture of chemicals and chemical products
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
C22	Manufacture of rubber and plastic products
C24	Manufacture of basic metals
C25	Manufacture of fabricated metal products, except machinery and equipment
C26	Manufacture of computer, electronic and optical products
C27	Manufacture of electrical equipment
C28	Manufacture of machinery and equipment n.e.c.
C31	Manufacture of furniture
C32	Other manufacturing
C33	Repair and installation of machinery and equipment

That is to say, it did not include all the activities considered as Manufacturing in the NACE Rev. 2 Classification. The rationale behind was that it was considered that some activities would be better analyzed within other GREECO sectors due to their links to the primary activity of this sector. E.g. C19 Manufacture of coke and refined petroleum products would be part of the GREECO Energy sector.

However, in the course of a more thorough analysis, data gathering, etc. It has been considered more convenient to broaden the scope of the GREECO Manufacture sector to cover all Section C NACE codes. The reason for this is to facilitate the comparability with Eurostat statistical analyses.

This approach will not result in duplication of efforts, because of analyzing the same activity in two different sectoral reports. On the contrary it will provide complementary insights into the greening potential of these activities, due to the different approaches. In the Manufacture report, the main focus will be on the overall discussion of greening manufacturing plants and their processes for de-linking of energy, resource consumption and environmental depletion. While in the Energy, Transport and Building sectors (all of which consider Manufacturing activities according to NACE Rev.2), the perspective will rather specific and oriented towards the core of the primary activity of those sectoral reports.

All in all, from a green economy perspective, the relevance of the Manufacturing sector, resides precisely in its magnitude, both in importance (in economic terms) and in environmental impact. If Manufacture became greener, it would have a huge potential to enable the decoupling of EU wide economic growth from resource use and environmental impact, because it is one of the most prominent sector for the EU as a whole. Nonetheless, this also poses a significant challenge. Since, as pointed out in the EC Resource Efficiency Roadmap, Europe has the world's highest net imports of resources per person. That is why the present analysis is focused on the European Manufacturing sector, its structure, trends, barriers and opportunities, as well as greening potential.

2 Current state and performance of Manufacture

This section is devoted to analysing the current situation of Manufacturing in Europe, taking into account the sub-sectoral breakdown, as well as the territorial differences in terms of economic, social and environmental performance. The aim is to provide a picture of how the sector is performing and how it should evolve to in order to become greener. To understand the performance of industry in improving its sustainability and resource efficiency, it is important to understand the performance and changes in industry.

Because of the lack of enough regional data for the sector, most of the analyses have been elaborated at national (NUTS 0) level. However, whenever relevant regional data have been available, these have been displayed in maps.

2.1 Socio-economic performance and patterns of Manufacturing

In terms of Gross Value Added (GVA), manufacturing contributed almost 20% of total GVA in EU 27 in 2000, approximately around 17% in 2005 and just below 15% in 2009. Furthermore, in 2005, manufacturing was the main activity of 2.3 million enterprises in the EU-27, which generated a turnover of EUR 6 323 billion. Producing a value added of EUR 1 630 billion, and employing 34.6 million persons, this represented 30.4 % and 27.3 % respectively of the total non-financial business economy.

Over the 2000 -2009 period all sectors have shrunk except for health, real state, consulting (which has doubled its contribution to GVA), financial and construction. However, at the moment it is hard to distinguish, whether it is a result of the on-going economic crisis (temporary) or due to company relocation (permanent). Nonetheless, even if the Manufacturing sector has shrunk ever since it is still one of the engines of growth of global economies and it is still the predominant sector in the EU in terms of GVA and employment. Hence, it is one of the most important sectors for the growth of the EU economy and its level of employment.

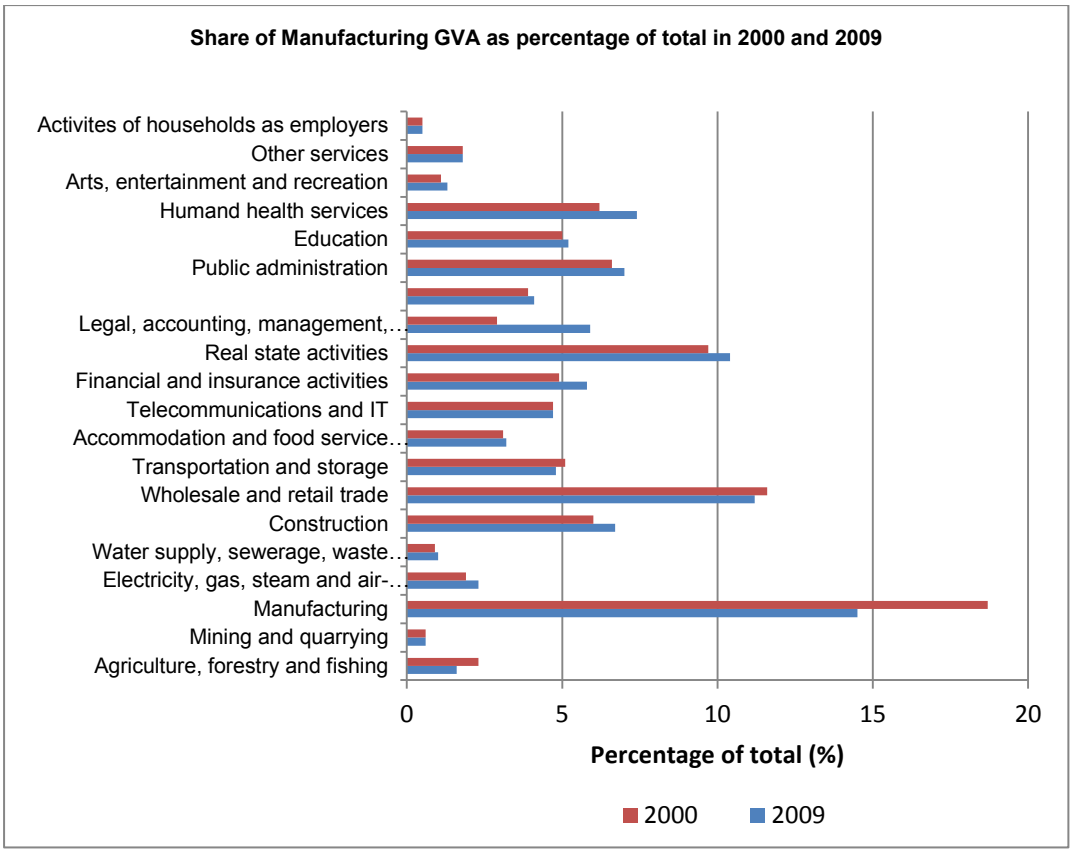


Figure 2 Manufacturing sector's GVA share in EU 27 in 2000 and 2009. *Source: Own elaboration with Eurostat data (nama_nace64_c)*

It should be noted that the impact of the latest crisis on EU sectors was much stronger than previous ones since 1990. It is still too early to determine how long it will take to reach pre-crisis production levels. Judging from the latest available data, it may take more than four years before the pre-recession peak is regained (European Commission (EC) DG Enterprise and Industry (2011)).

As shown in the table below, in 2009 the largest, in terms of GVA, of the nineteen manufacturing activities at NACE sub-section level (NACE Rev.2) were: Food (14,22%), Chemicals (6,18%), Metal products (10,02%), Machinery and equipment (11,03%) and Vehicles (6,64%). These sub-sectors alone accounted together for over 85 % of EU-27 manufacturing value added (2009). In this context, it should be highlighted that the single-largest activity in value added terms was Food. However, the GVA per employee of the Food sector is below the average for Manufacturing. When it comes to Metal products, it is the third most important subsector in terms of GVA. However, this subsector's share of GVA, at 10,02%, is noticeably lower that its share in employment (12,14%). Even if the Chemical subsector is the less important, in terms of GVA, of the above six subsectors, it is a relevant subsector since its labour productivity is well above the Manufacturing's average.

Table 2 Main indicators of Manufacturing by sub-sector in 2009 (EU27). *Source: Own elaboration with Eurostat data (nama_nace64_c and nama_nace64_e)*

	Value added		**Employment**		**Labour productivity**
	million EUR	%	1000 persons	%	million EUR / 1000 persons
Food	196.415,90	14,22%	3.993,50	14,38%	49,18
Textiles	55.860,00	4,04%	2.078,90	7,49%	26,87
Wood	29.734,50	2,15%	971,90	3,50%	30,59
Paper	33.853,60	2,45%	553,50	1,99%	61,16
Printing	32.682,00	2,37%	807,30	2,91%	40,48
Coke	18.507,50	1,34%	150,30	0,54%	123,14
Chemicals	85.289,60	6,18%	980,30	3,53%	87
Pharmaceutical	74.251,90	5,38%	517,30	1,86%	143,54
Rubber and plastic	61.610,50	4,46%	1.297,20	4,67%	47,49
Other non-metallic mineral products	61.945,00	4,49%	1.254,00	4,52%	49,4
Basic metals	50.284,50	3,64%	980,80	3,53%	51,27
Metal products	138.448,40	10,02%	3.369,10	12,14%	41,09
Electronic	70.512,50	5,11%	1.286,00	4,63%	54,83
Electrical equipment	73.693,20	5,34%	1.320,00	4,75%	55,83
Machinery and equipment	152.350,80	11,03%	2.757,80	9,93%	55,24
Vehicles	91.654,00	6,64%	1.982,90	7,14%	46,22
Other transport equipment	34.304,40	2,48%	598,40	2,16%	57,33
Furniture	64.137,90	4,64%	1.789,00	6,44%	35,85
Repair and installation of machinery and equipment	55.527,90	4,02%	1.075,10	3,87%	51,65
Manufacturing	**1.381.064,10**		**27.763,30**		**49,74**

The difference in shares of the value added and employment, indicates differences in labour productivity (valued added per person employed) among the different Manufacturing subsectors. EU27, Iceland, Liechtenstein, Norway and Switzerland labour productivity in Manufacturing was 49,74 (see Table 2) in 2009.

Although Manufacturing is key for the growth of the EU as a whole, the territorial distribution of the sector across the EU27, Iceland, Liechtenstein, Norway and Switzerland, is anything but uniform (see figures below). The predominant countries, both in terms of GVA and employment, are Germany, followed by Italy, France and Spain.

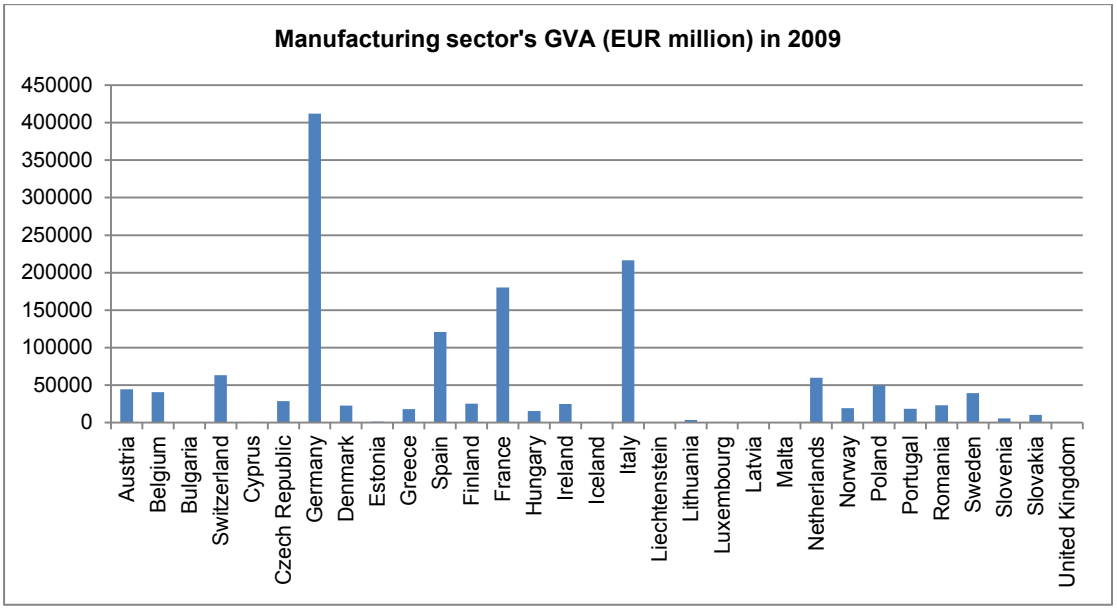


Figure 3 Manufacturing sector's GVA by country in 2009 (EU27, Iceland, Liechtenstein, Norway and Switzerland). *Source: Own elaboration with Eurostat data (nama_nace64_c)*

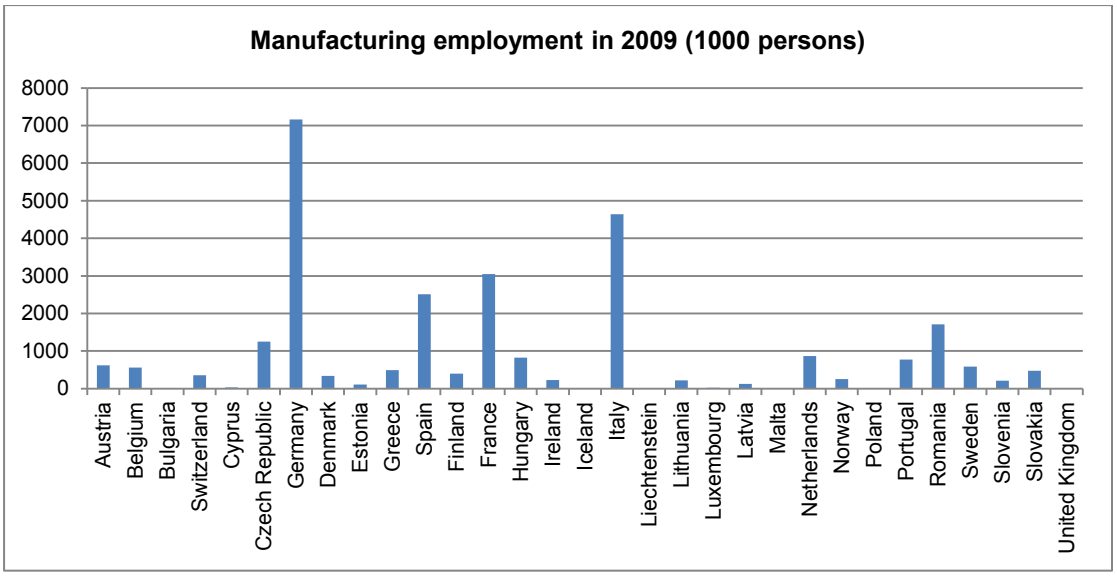


Figure 4 Manufacturing sector's employment by country in 2009 (EU27, Iceland, Liechtenstein, Norway and Switzerland). *Source: Own elaboration with Eurostat data (nama_nace64_e)*

The share of eastern Europe countries is relatively low, when compared to the predominant countries. Nonetheless, these countries have experienced a remarkable boost over the 2000-2009 period, in terms of GVA growth of the sector and labour productivity. This is the case for

Czech Republic, Estonia, Lithuania, Latvia, Poland, Slovakia and Hungary, all of which accessed the EU in the mentioned period. Therefore, it could be derived that the accession to the EU and the common market has benefited the performance of the Manufacturing sector in these countries. However, the productivity of Manufacturing in most of these countries is still below the EU27 average.

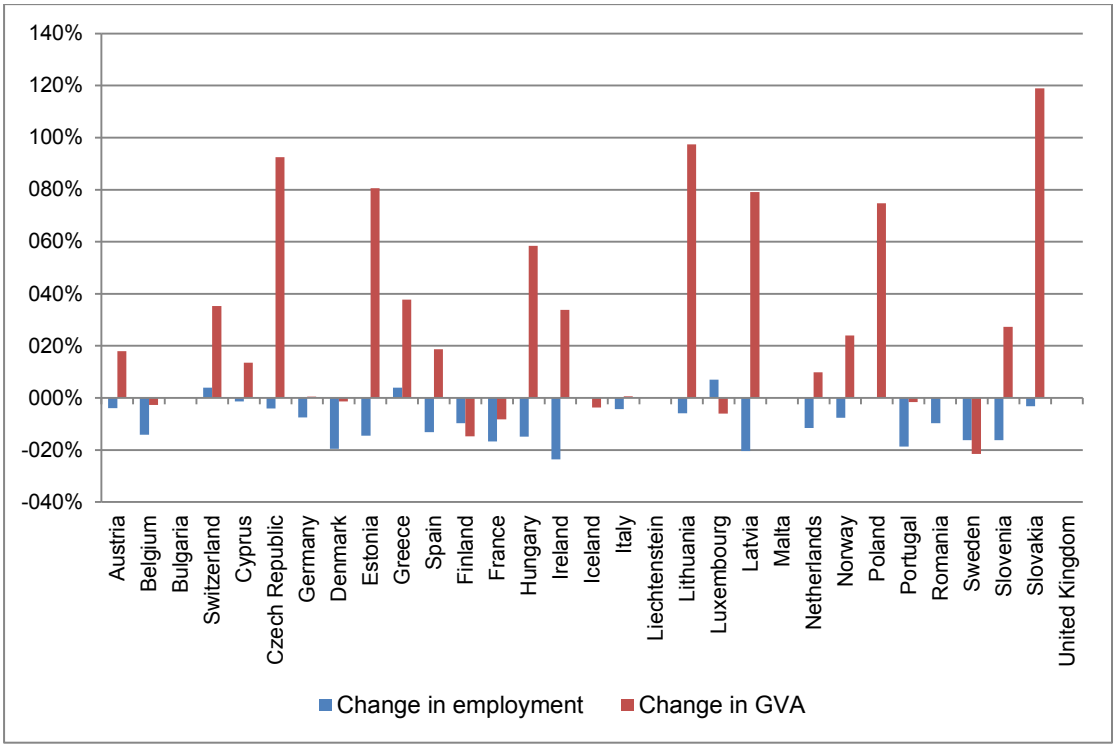


Figure 5 Manufacturing sector's change in GVA and employment by country between 2000 and 2009 (EU27, Iceland, Liechtenstein, Norway and Switzerland). *Source: Own elaboration with Eurostat data (nama_nace64_e and nama_nace64_c)*

The change in labour productivity for the EU15 countries over the same period has been less remarkable. For these countries, the labour productivity has mostly remained in similar levels, with slight increases. This could be due to the fact that the Manufacturing sector was more mature in these countries and major productivity increases will be harder to achieve until radical innovations and technological breakthroughs take place. In fact, R&D intensity is one of the factors driving higher labour productivity growth in manufacturing (European Commission (EC) DG Enterprise and Industry (2012)).

It is also worth noticing that even if most countries have raised the GVA of Manufacturing in varying degrees, only a few have also increased the employment in the sector. Along these lines, for most cases the increase of productivity has been due to a decrease in labour force, rather than an increase in value. In fact, most countries have seen a decrease in the number of employees and some have also experienced a decrease in GVA, such as Finland, Luxembourg, Romania, and Sweden all of which have had an overall decrease in Manufacturing's productivity. Taking Europe as a whole, the above could be a result of technological progress, increased globalisation, production automation and increasing specialisation.

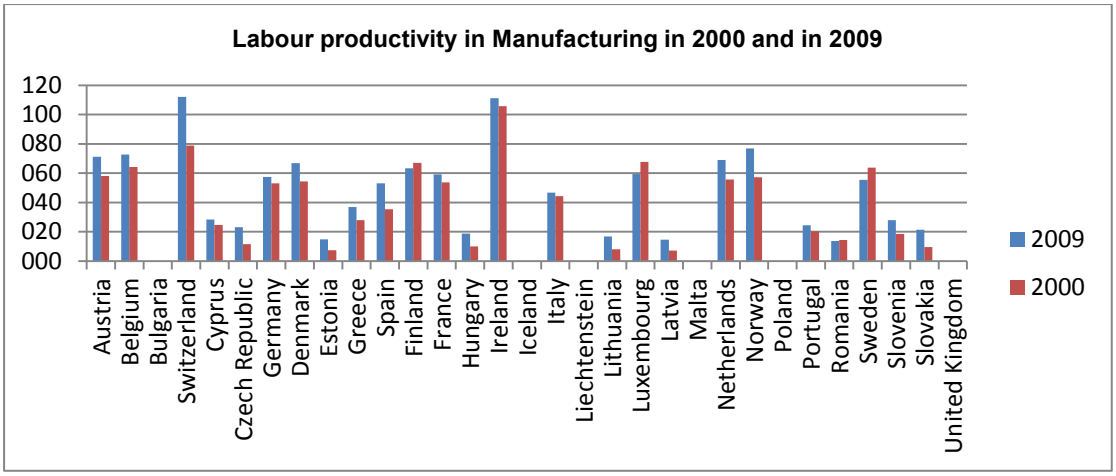


Figure 6 Manufacturing sector's change in labour productivity by country between 2000 and 2009 (EU27, Iceland, Liechtenstein, Norway and Switzerland). *Source: Own elaboration with Eurostat data (nama_nace64_e and nama_nace64_c)*

The table below shows the diversity in regional specialisation across the EU27, Iceland, Liechtenstein, Norway and Switzerland. However, conclusions should be drawn carefully, since there are some remarkable absences, such as Germany, because of data confidentiality. It would be expected that due to the predominance of German Manufacturing, quite a few German regions should be among the most specialised. With the available data, Sweden, Greece and France would be the countries for which Manufacturing is most important, because they have the highest number of regions among the most specialised.

Table 3 Top three most specialised regions by subsection of manufacturing EU27, Iceland, Liechtenstein, Norway and Switzerland, 2009. *Source: Own elaboration with Eurostat data (SBS_R_NUTS06_R2)*

Manufacturing activity	First most specialised	%	Second most specialised	%	Third most specialised	%
Food, beverages and tobacco	Bretagne (FR)	17,6	Ipeiros (EL)	16,2	Thessalia (EL)	12,0
Textiles, apparel and leather	Norte (PT)	17,6	Severozapaden (BG)	13,1	Yuzhen tsentralen (BG)	12,3
Wood and paper products	Norra Mellansverige (SE)	9,4	Itä-Suomi (FI)	8,6	Mellersta Norrland (SE)	8,6
Coke	Sicilia	0,8	Zuid-Holland (NL)	0,7	East Yorkshire and Northern Lincolnshire (UK)	0,7
Chemicals	Prov. Antwerpen (BE)	5,1	Zeeland (NL)	4,8	Cheshire (UK)	3,3
Pharmaceuticals	Prov. Brabant Wallon (BE)	24,0	Hovedstaden (DK)	3,8	Southern and Eastern (IE)	2,4
Rubber and plastics	Auvergne (FR)	14,2	Sterea Ellada (GR)	8,5	Auvergne (FR)	5,6
Metals	Sterea Ellada (GR)	21,1	Norra Mellansverige (SE)	17,6	Západné Slovensko (SK)	8,1
Computer, electronic and optical	Pohjois-Suomi (FI)	5,8	Közép-Dunántúl (HU)	5,6	Etelä-Suomi (FI)	4,0
Electrical equipment	Limousin (FR)	6,4	Západné Slovensko (SK)	5,3	Severovýchod (CZ)	4,5
Machinery and equipment	Peloponnisos (GR)	13,9	Emilia-Romagna (IT)	8,5	Småland med öarna (SE)	8,4
Transport equipment	Střední Cechy (CZ)	12,6	Västsverige (SE)	9,7	Közép-Dunántúl (HU)	9,7
Other manufacturing	Warminsko-Mazurskie (PL)	10,0	Friuli-Venezia Giulia (IT)	9,3	Wielkopolskie (PL)	7,2

Please note that the data for France are 2010 data and that there are gaps in data availability.

With regard to the evolution of Manufacturing subsectors over the same period, even if most sectors grew in GVA, only three increased in labour force: Pharmaceutical, Metal products, Repair and installation of machinery and equipment. Therefore, a trend in reducing employees could be identified. When it comes to the Pharmaceutical subsector it has increased its productivity also due to a remarkable GVA raise.

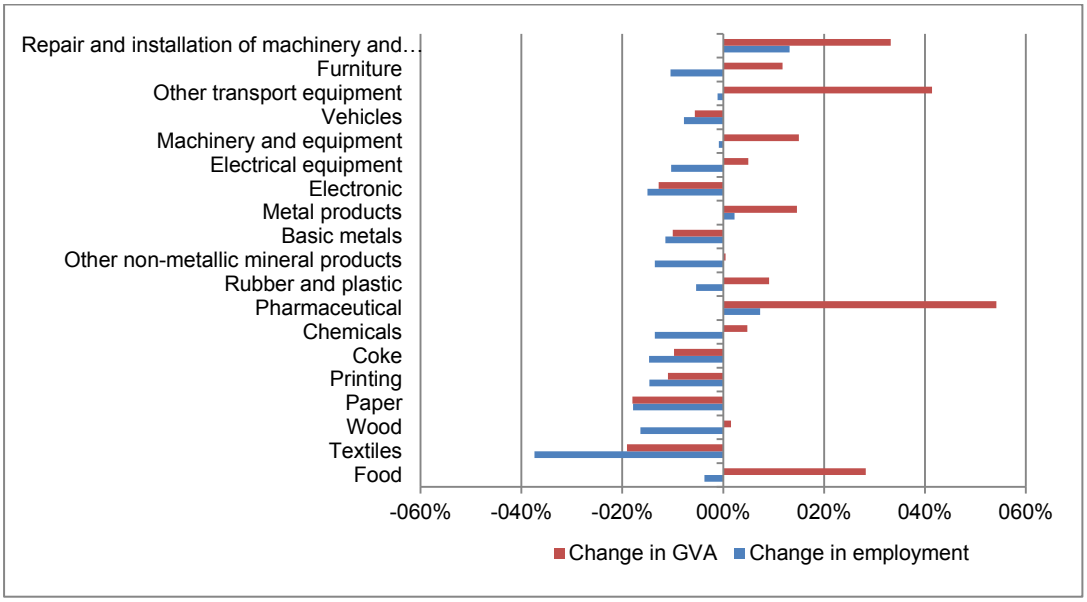


Figure 7 Manufacturing sector's change in GVA and employment by sub-sector between 2000 and 2009 (EU27, Iceland, Liechtenstein, Norway and Switzerland). *Source: Own elaboration with Eurostat data (nama_nace64_e and nama_nace64_c)*

It is also worth mentioning that Paper and Coke have decreased their competitiveness, since their labour productivity has declined because GVA has decreased more than the cuts in labour force.

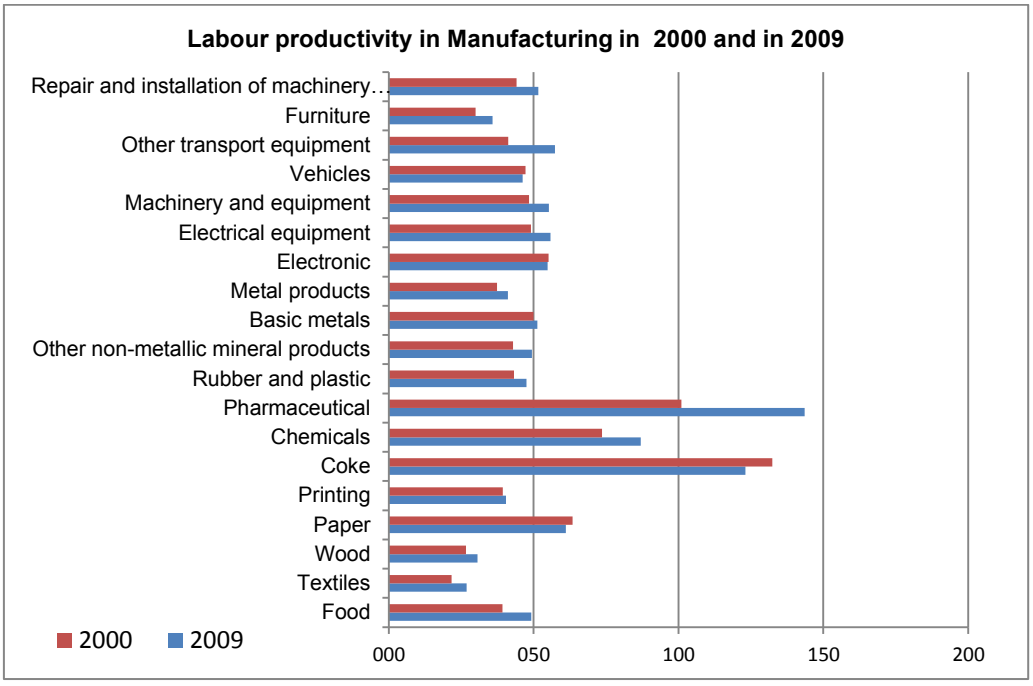
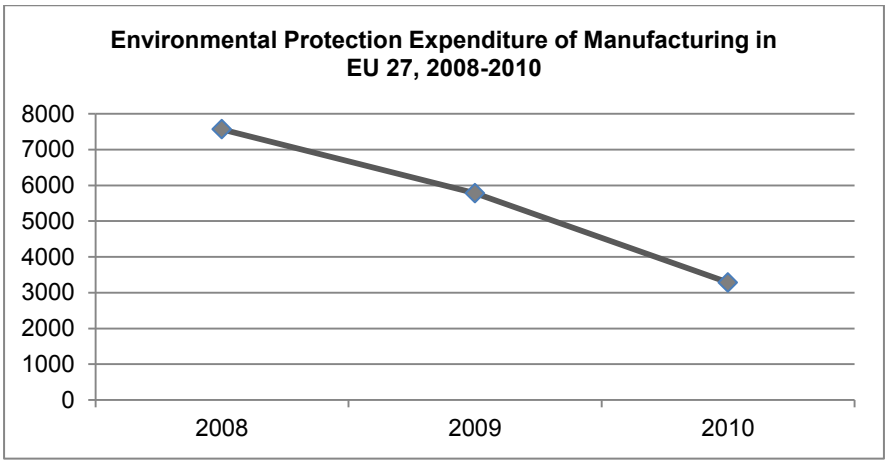


Figure 8 Manufacturing sector's change in productivity by sub-sector between 2000 and 2009 (EU27, Iceland, Liechtenstein, Norway and Switzerland). *Source: Own elaboration with Eurostat data (nama_nace64_e and nama_nace64_c)*

2.2 Environmental performance and patterns of Manufacturing

2.2.1 Environmental protection trends

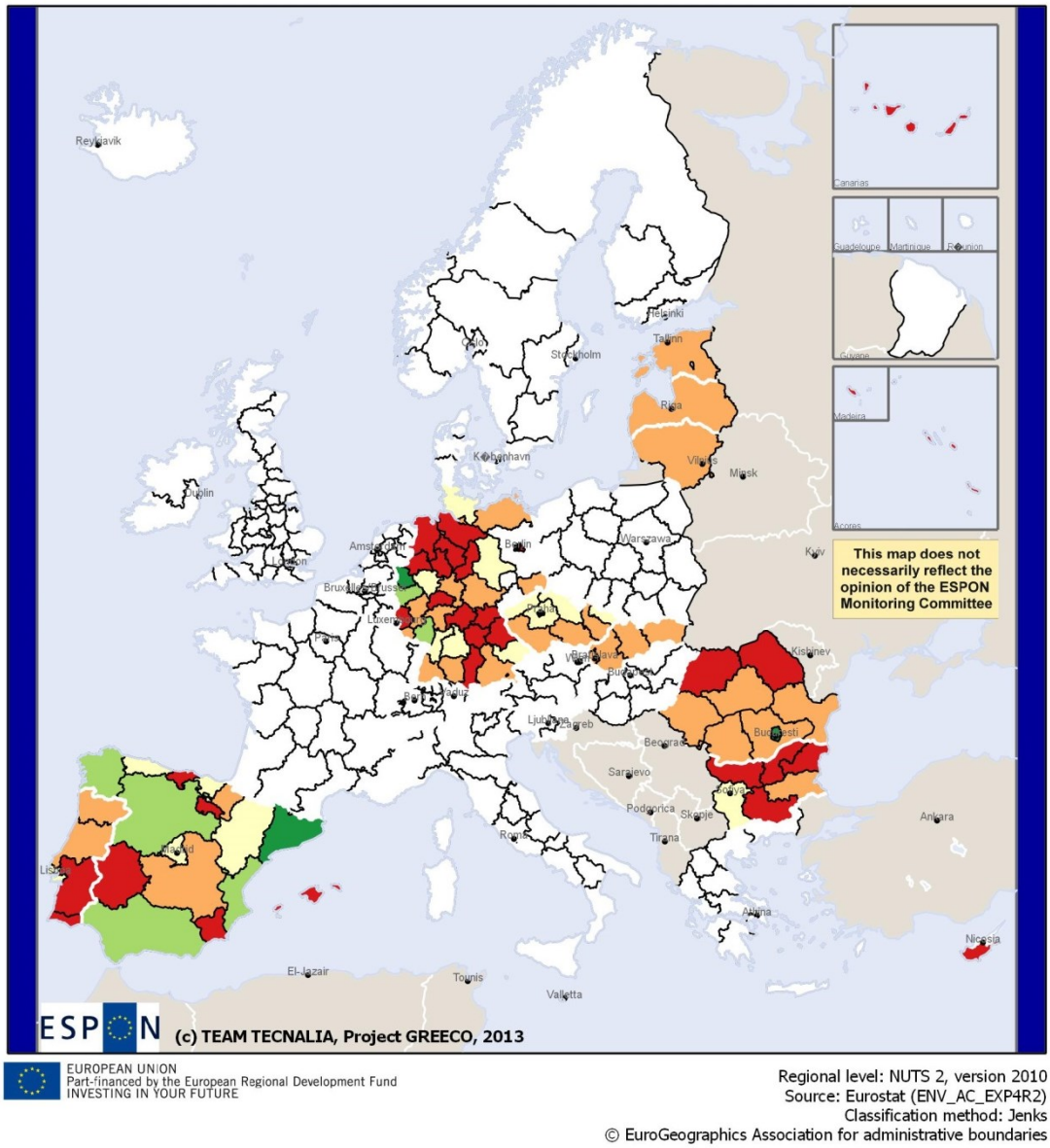
The analysis of Manufacturing's environmental protection expenditure (EPE) can be used to evaluate the importance of environmental activities with respect to the economy as a whole as well as with respect to the different economic sectors and countries. For the EU 27, the level of EPE in Manufacturing has been decreasing for the 2008-2010 period. In fact the EPE level in 2010 is as low as half of the EPE in 2008. However, this could be partially caused by the absence of data for 2009 and / or 2010 or the most investing countries in EPE (see figure below).



* 2010: Data gaps for CH, DE, DK, EL, IT, NL, UK
2009: Data gaps for DK, UK
2008: Data gaps for CH, EL, NL, BG, DK

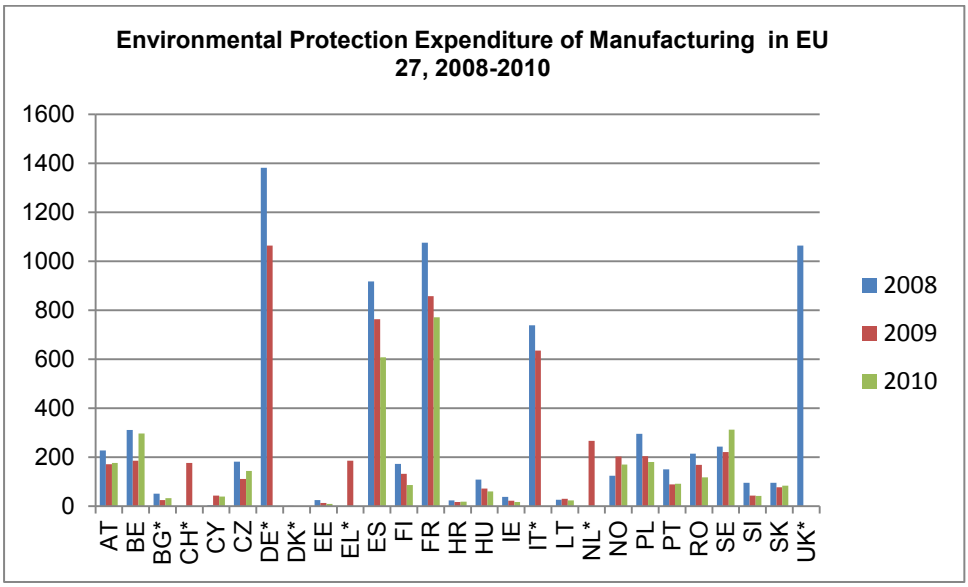
Figure 9 Manufacturing sector's total environmental protection expenditure 2008-2010 (EU27). *Source: Own elaboration with Eurostat data (sbs_env_dom_r2)*

When it comes to regional investment patterns in EPE, the datasets are not complete; thus, it is not possible to carry out a comprehensive analysis at a lower than national territorial level. As depicted in the map below, there are only data available for Bulgarian, German, Spanish, Latvian, Lithuanian, Portuguese, Romanian and Slovakian regions. In addition, at NUTS2 level the EPE data are only available for Industry as whole, and are not disaggregated for Manufacturing.



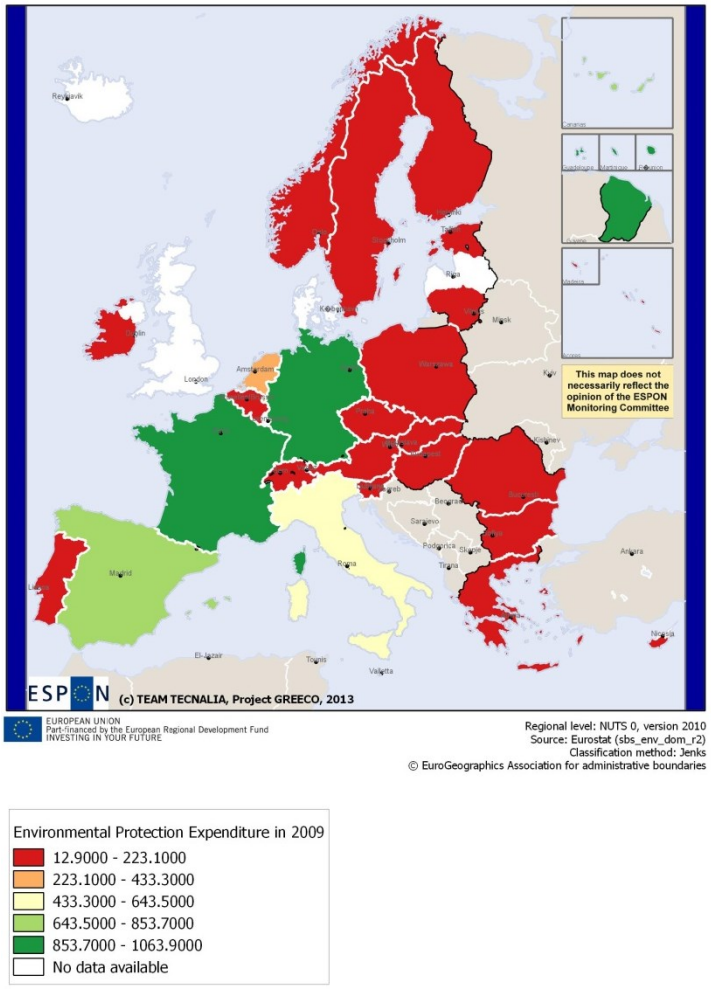
Map 1 Environmental Protection Expenditure of Industry as a whole in 2008. (*Source: Eurostat ENV_AC_EXP4R2*)

On the contrary, the datasets are country level are quite complete and disaggregated for Manufacturing. In this context and with regard to territorial diversity, countries in the European Union showed great heterogeneity in EPE, probably due to both the structure of their industry and their main environmental priorities, being the countries which invest most in environmental protection Germany, Spain, France, Italy and the United Kingdom (only 2008 data available for the UK).



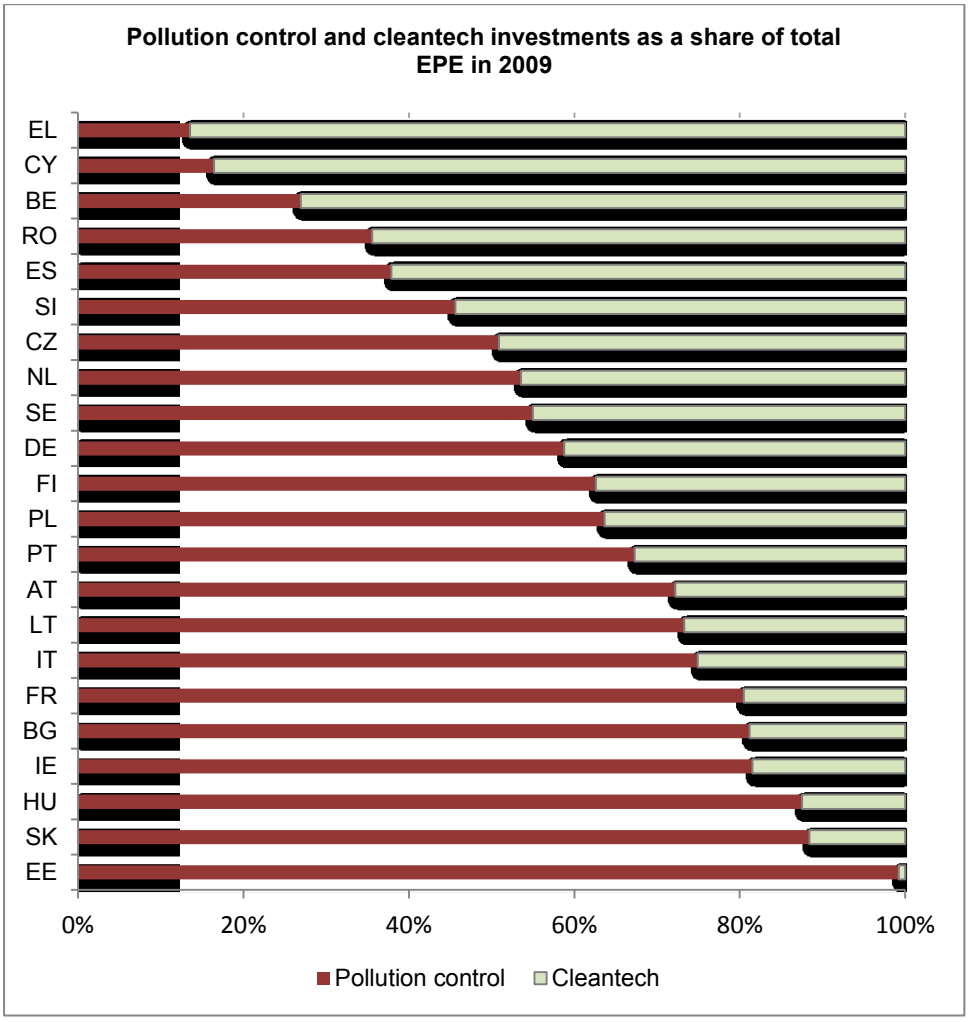
* 2010: Data gaps for CH, DE, DK, EL, IT, NL, UK
2009: Data gaps for DK, UK
2008: Data gaps for CH, EL, NL, BG, DK

Figure 10 Manufacturing sector's total environmental protection expenditure 2008-2010 by country (EU27). *Source: Own elaboration with Eurostat data (sbs_env_dom_r2)*



Map 2 Environmental Protection Expenditure in 2009. (*Source: sbs_env_dom_r2*)

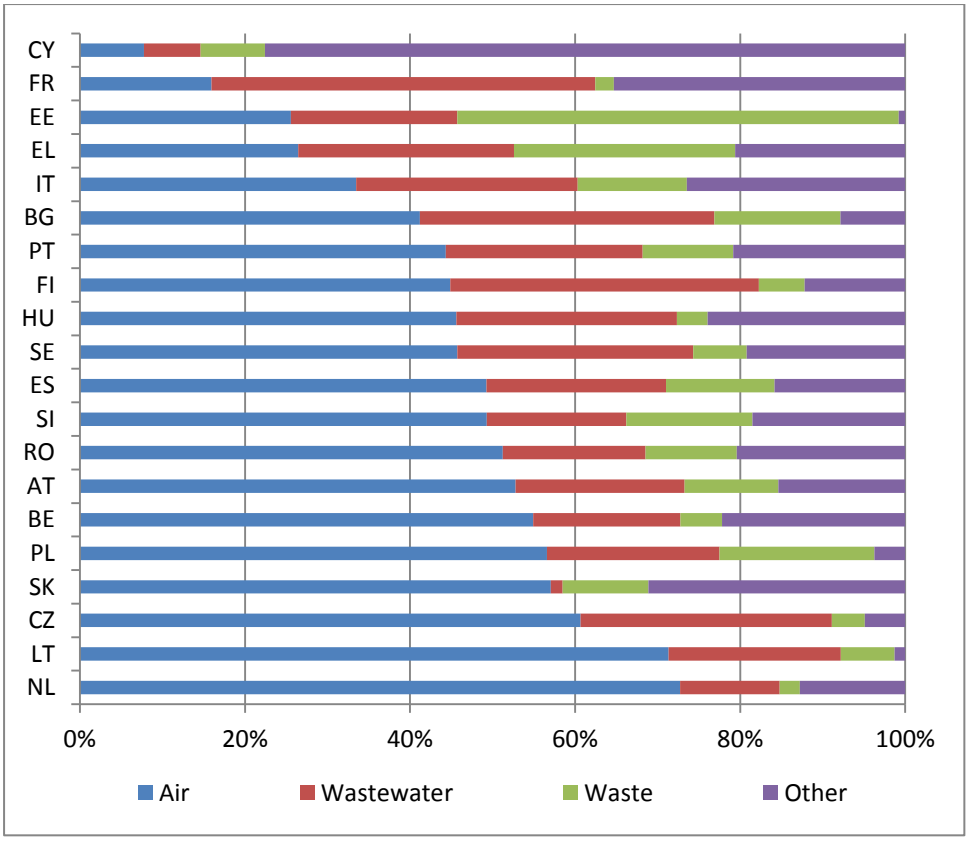
In the case of Germany, this predominant investment volume could be because of the size of Manufacturing and its share of the German economy. In the case of Spain, France and Italy on the contrary, the share of Manufacturing in these countries is similar to the average of EU27, but invest remarkably more than other EU27 countries in environmental protection. Therefore, it could be derived that environmental protection is important for the Manufacturing sectors of these countries. In contrast, eastern European countries, which have shares of Manufacturing closer to Germany and above the average, invest considerably less in EPE.



Please note there are no data for Lithuania, Luxembourg, Latvia and Malta.

Figure 11 Environmental protection expenditure by type of investment in EU27 in 2009. *Source: Own elaboration with Eurostat data (sbs_env_dom_r2).*

Environmental protection investments are composed of pollution control investments and cleaner technology ('integrated technology') investments. The latter comprises investments which change the production process towards a preventive approach of pollution control, rather than the “end-of-pipe” approach of pollution control investments. In Europe as a whole, pollution control investments represent the biggest part of investment (57 %), being this the case for most countries. However, the share of each investment type varies widely from country to country. It is remarkable that only a few countries spend more than 50% in preventive approaches (Slovenia, Spain, Switzerland, Romania, Belgium, Norway, Cyprus and Greece).



Please note data for DK are missing and for FR, CZ and EE are incomplete.

Figure 12 Environmental protection expenditure by environmental domain in EU27 in 2009. *Source: Own elaboration with Eurostat data (sbs_env_dom_r2).*

In 2009 Manufacturing's EPE in EU27 was devoted mainly to the core environmental domains (almost 80%), which cover prevention and treatment of air pollution, wastewater treatment and waste management (see figure above). Countries that spent considerably more on non-core domains (protection and remediation of soil, groundwater and surface water, noise and vibration abatement, protection of biodiversity and landscapes, protection against radiation, research and development and other environmental protection activities) are Cyprus (76%), France (35%) and Slovakia (31%). In addition, Belgium, Hungary and Italy also spent above average on non-core domains.

2.2.2 Decoupling Manufacturing growth from environmental depletion

As aforementioned, Manufacturing is a very resource intensive sector, because traditionally its core activity (production process) has depended heavily on resources, both energy and raw materials and as a consequence generates waste and emits pollutants. Decoupling sector growth from depletion represents separating the impacts of Manufacturing or weakening the links between such impacts and growth. Hence, making Manufacturing greener inevitably comprises delinking, which is a prerequisite for achieving Sustainable Development.

This section presents the progress made, evidencing the delinking and improvements made by EU manufacturing. Decoupling is analysed in terms of key sustainability, and thus green economy, indicators, such as energy use and waste generation. It should be highlighted that so far, significant progress has been made and most EU countries are in their way for achieving absolute delinking of Manufacturing. Over the past decades, Manufacturing has increased its resource efficiency and sustainability and in doing so it has reduced costs.

When it comes to energy use decoupling, it should be mentioned that to some extent it has been the Energy sector the one leading the way, with its focus on increasing the share of renewables and increasing the energy efficiency. Furthermore, delinking is also present in waste generation trends.

It should be noted that to some extent, the financial crisis reduced environmental impacts, but with recovery these are growing again (see figure below as an example). Therefore a clear picture of the effects of the financial crisis on the one hand and the delinking of Manufacturing is not available yet. In any case, promoting industrial sustainability and resource efficiency remain as the cornerstones of EU policy towards sustainability, competitiveness and employment.

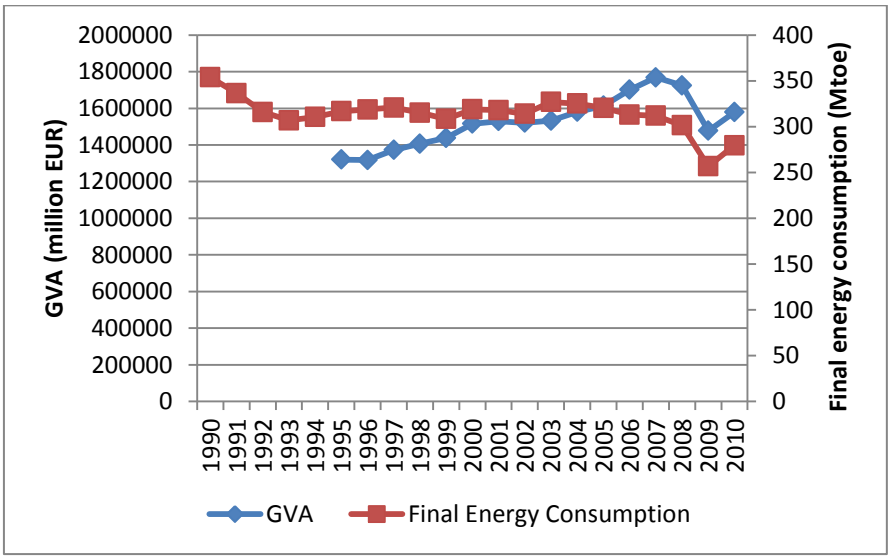
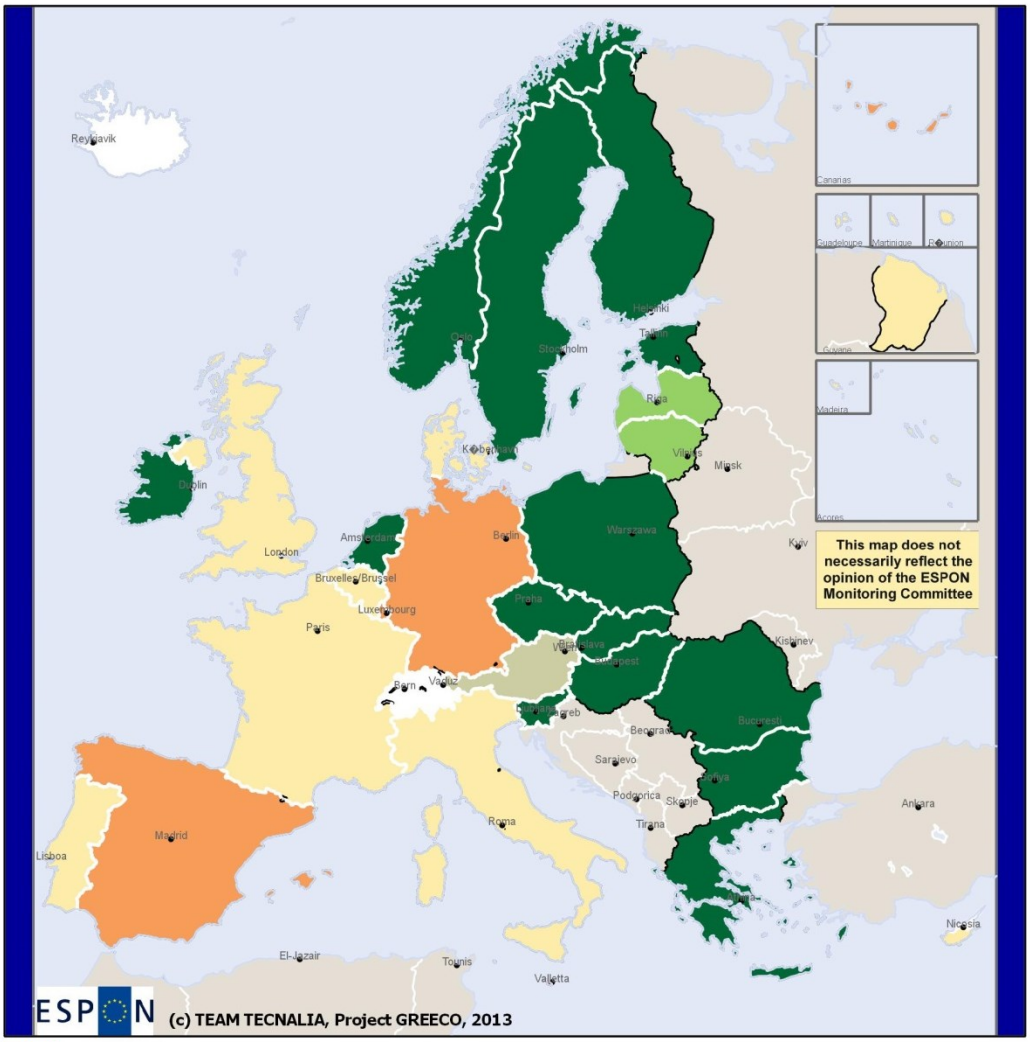


Figure 13 Decoupling of final energy consumption from GVA in EU27. *Source: Own elaboration with ODYSSEE data.*

Energy delinking

In the map below, countries are arranged according to the delinking of Manufacturing's final energy consumption from GVA growth. The final energy consumption is the total energy consumed by end users, such as households, industry and agriculture. It is the energy which reaches the final consumer's door and excludes that which is used by the energy sector itself. Therefore, the study of the evolution of the final energy consumption by the Manufacturing sector, enables to analyse the energy dependency in each country and its relation to sectoral growth.



Map 3 Delinking of final Manufacturing's final energy consumption from GVA between 2000 and 2009. *Source: Own elaboration with ODYSSEE data*.

The Europe 2020 strategy is about delivering growth that is: smart, sustainable and inclusive, with a strong emphasis on job creation. Along these lines, increasing energy sustainability is one of the top five targets of the strategy, the goal being to reduce energy consumption by 20% less than the projected energy consumption in 2020. Therefore, the combined progress in energy savings and growth is a major and challenging goal of the EU as a whole. In this context, EU industry, including manufacturing, is driving the energy savings in the EU, having decreased its final energy consumption by 4% between 1995 and 2008, which is in contrast with the overall increase (9.7%) over the same period.

The map above and the figure below categorise the delinking behaviour of each country in the period 2000-2009 with regard to energy. In this context, delinking implies that the final energy consumption grows less than GVA. The diagonal line in the diagram separates delinking countries from relinking countries and the categories have been defined as follows:

- Absolute delinking: GVA of the sector has grown and final energy consumption decreased in this sectors (energy <0 < GVA).
- Relative delinking with growth: GVA of the sector has grown and final energy consumption has grown less than GVA (0 < energy < GVA).
- Relative delinking: GVA of the sector has decreased and final energy consumption has decreased sharper (energy < GVA < 0).
- Relative relinking with growth: both GVA and final energy consumption have grown, but final energy consumption sharper (0 < GVA < energy).
- Relative relinking: both GVA and final energy consumption have decreased, but GVA sharper (GVA < energy < 0).
- Absolute relinking: GVA of the sector has decreased, while the final energy consumption has increased (GVA < 0 < energy).

The split between relinking and delinking countries is noticeably biased towards the delinking side. Only 5 countries have relinking behaviour and of these only Malta shows an absolute relinking trend.

For the EU15, final energy consumption has decreased in all countries but in Austria and the majority displays a delinking trend. In fact Finland, Ireland, the Netherlands and Sweden have achieved an absolute decoupling over the period of study. However, some countries, such as Spain and Germany have experienced a relative relinking, even if with a small margin.

For the new Member States, the 2000-2009 period was a delinking period, since only Malta relinked. In addition the vast majority of countries experienced an absolute delinking. This could be a result of accessing the EU, in addition to the aforementioned increased productivity, also an increased energy efficiency took place.

However, it should be noted that the change in employment and energy consumption through 2000-10 went through a boom period followed by a severe recession. For the countries experiencing a reduction of final energy use alongside with a reduction in GVA, it could be expected that the trend will reverse when the GVA rises again.

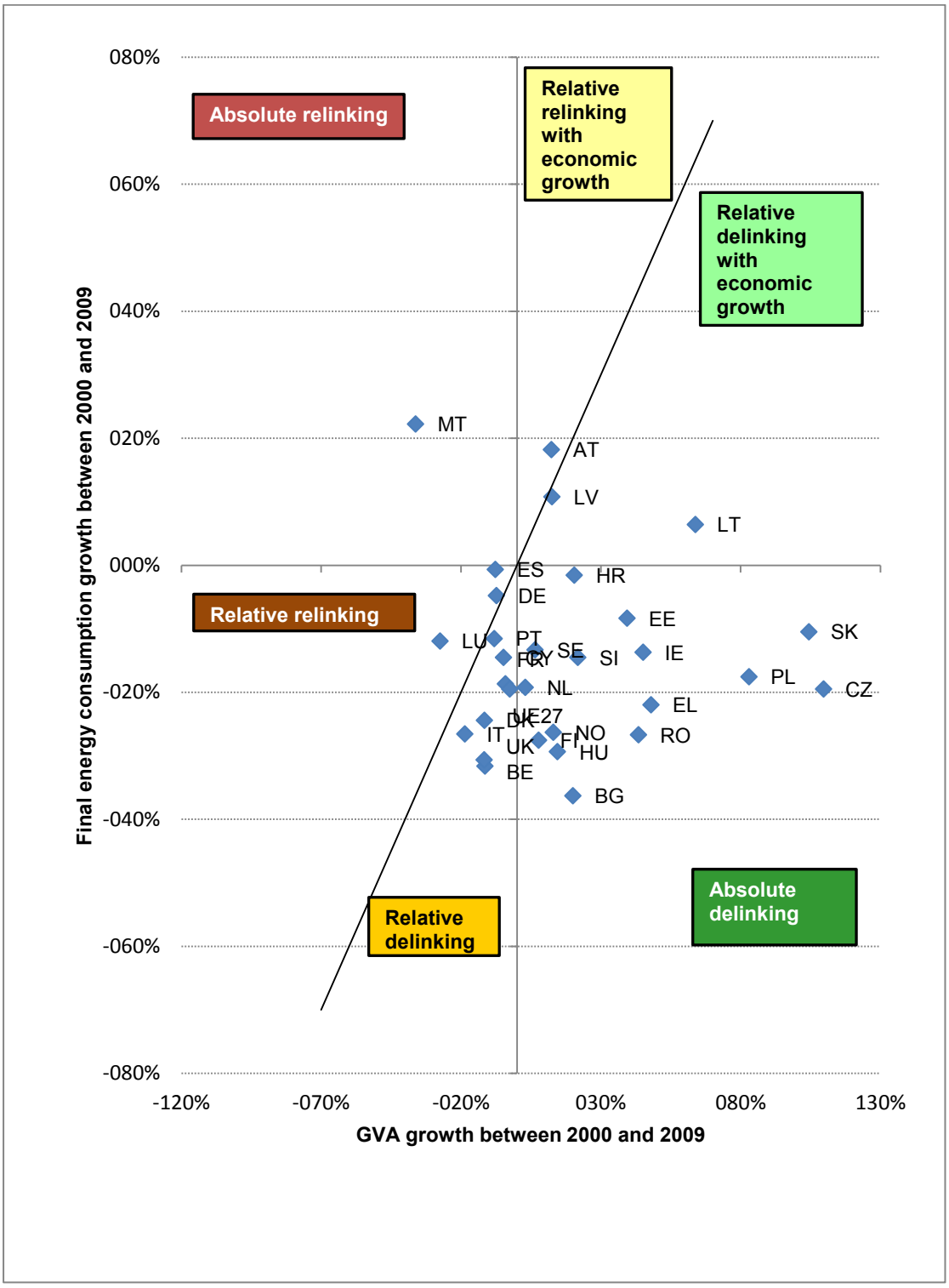
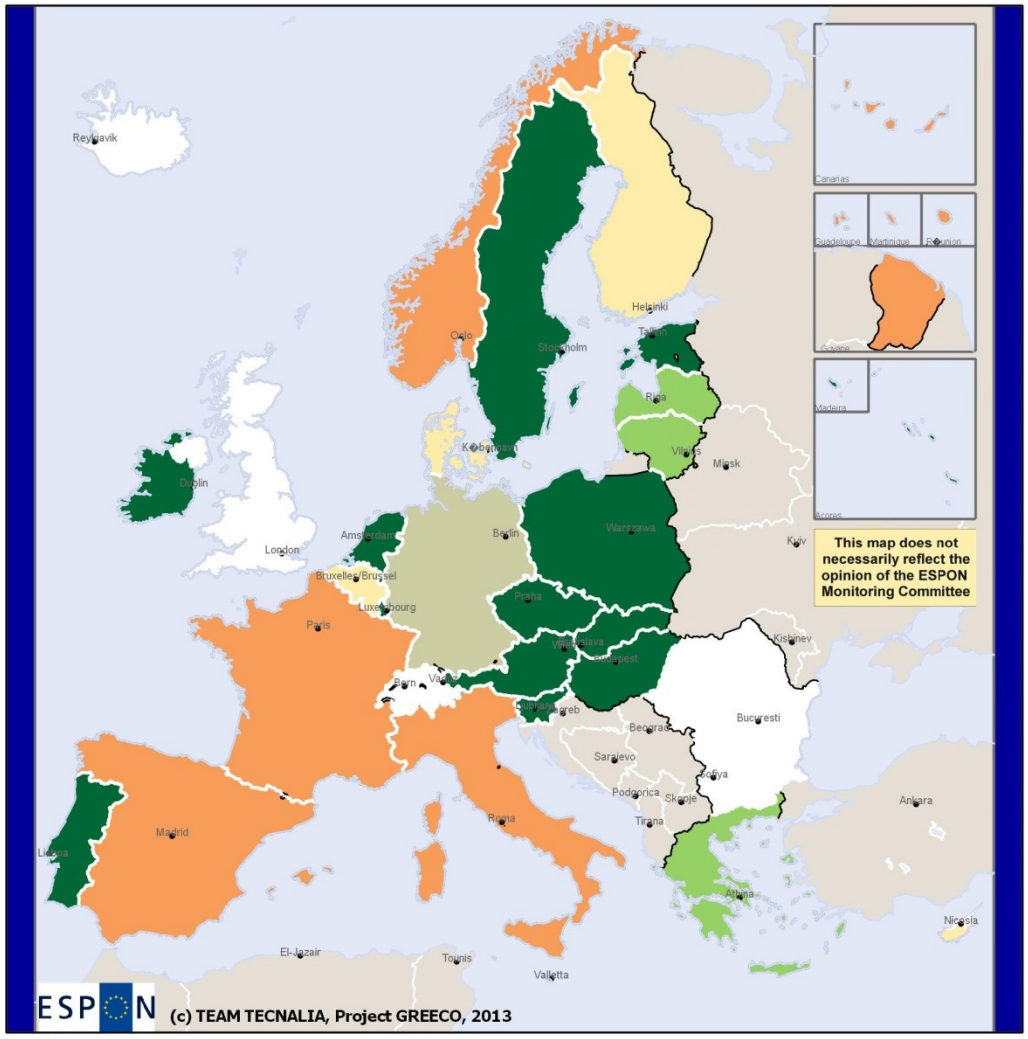


Figure 14 Delinking of final energy consumption from GVA in EU27 between 2000 and 2009. *Source: Own elaboration with ODYSSEE data.*

Waste generation delinking

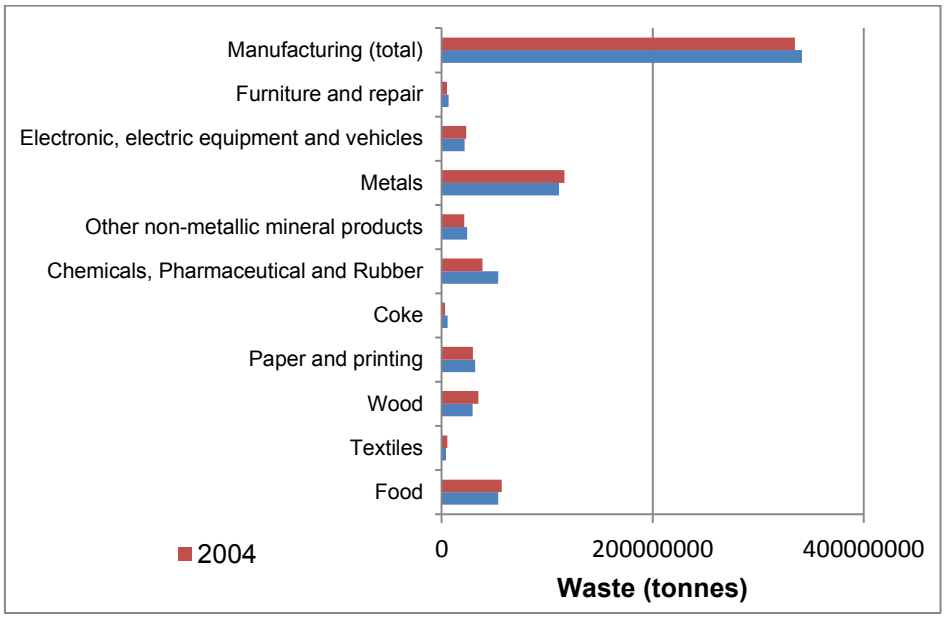
As in the section above, the map and graph below arrange European countries according to the delinking of Manufacturing's waste generation from GVA growth. The analysis of the evolution of waste generation in the Manufacturing sector enables to evaluate each countries progress towards a greater resource efficiency and its relation to sectoral growth. All of which is aligned with the fulfilment of EU waste management policies, which aim to reduce the amount of waste generated and when waste generation is unavoidable to promote it as a resource and achieve higher levels of recycling and the safe disposal of waste.



Map 4 Delinking of Manufacturing's waste generation from GVA between 2004 and 2010.
Source: Own elaboration with Eurostat data (nama_nace64_c and ENV_WASGEN).

The EU's approach to waste management is based on three principles: (1) waste prevention, (2) recycling and reuse, and (3) improving final disposal and monitoring. The current analysis focuses on the trends on waste prevention in the Manufacturing sector. This can be achieved through cleaner technologies, eco-design, or more eco-efficient production and consumption patterns. Building on this, in Manufaturing waste is no longer seen as an output of which to get rid of by landfilling, on the contrary it is increasingly seen as important resources for other industries (reuse). That is why, it is important to guarantee that adequate framework conditions exist for waste to be used as inputs to other industries whenever possible.

Waste generation data over the 2004 – 2008 period are represented in the figure below. This shows that even if for most subsectors the total waste generation decreased, when focusing on Manufacturing as a whole there was a slight increase (2%) in the amount of waste generated. The figure also shows that the subsector generating the largest amount of waste is Metals, followed by Food. However these two subsectors have decreased their waste generation amount.



2004: No data for Belgium, Switzerland, Hungary, Liechtenstein,Portugal.
Data gaps for Iceland, Luxembourg, Latvia, Malta.
2008: No data for Switzerland, Hungary, Iceland.
Data gaps for Cyprus, Liechtenstein, Latvia, Malta, Portugal.

Figure 15 Manufacturing sector's change in waste generation by sub-sector between 2004 and 2008 (EU27, Iceland, Liechtenstein, Norway and Switzerland). *Source: Own elaboration with Eurostat data (ENV_WASGEN)*

Furthermore, the map above and the figure below categorise the delinking behaviour of each country in the period 2004-2010 with regard to waste generation. In this context, delinking implies that the final energy consumption grows less than GVA. The diagonal line in the diagram separates delinking countries from relinking countries and the categories have been defined as for the energy delinking study.

The split between relinking and delinking countries is noticeably biased towards the delinking side. Only 5 countries have relinking behaviour and none shows an absolute relinking trend.

For the EU15, waste has decreased in all countries but in Germany and the majority displays a delinking trend. In addition, Austria, Ireland, Luxembourg, the Netherlands, Portugal and Sweden have achieved an absolute decoupling over the period of study. However, some countries, Spain, France and Italy have experienced a relative relinking. That is to say, that

when GVA grows again it is expected that the waste generation will do the same.

For the new Member States, the 2004-2010 period was a delinking period, when all countries experienced a decrease in waste generation. Moreover, most of them increased the GVA in Manufacturing while decreasing the waste generation.

Finally, as in the previous case, the relatively low data for 2010 may, at least in part, reflect the downturn in economic activity as a result of the financial and economic crisis. In fact, most countries have experienced a sharp (when compared to the 2000 – 2009 period) decline in Manufacturing's GVA. That is why, most likely countries experiencing a reduction of waste generation with a reduction of GVA, will reverse the trend when GVA increases.

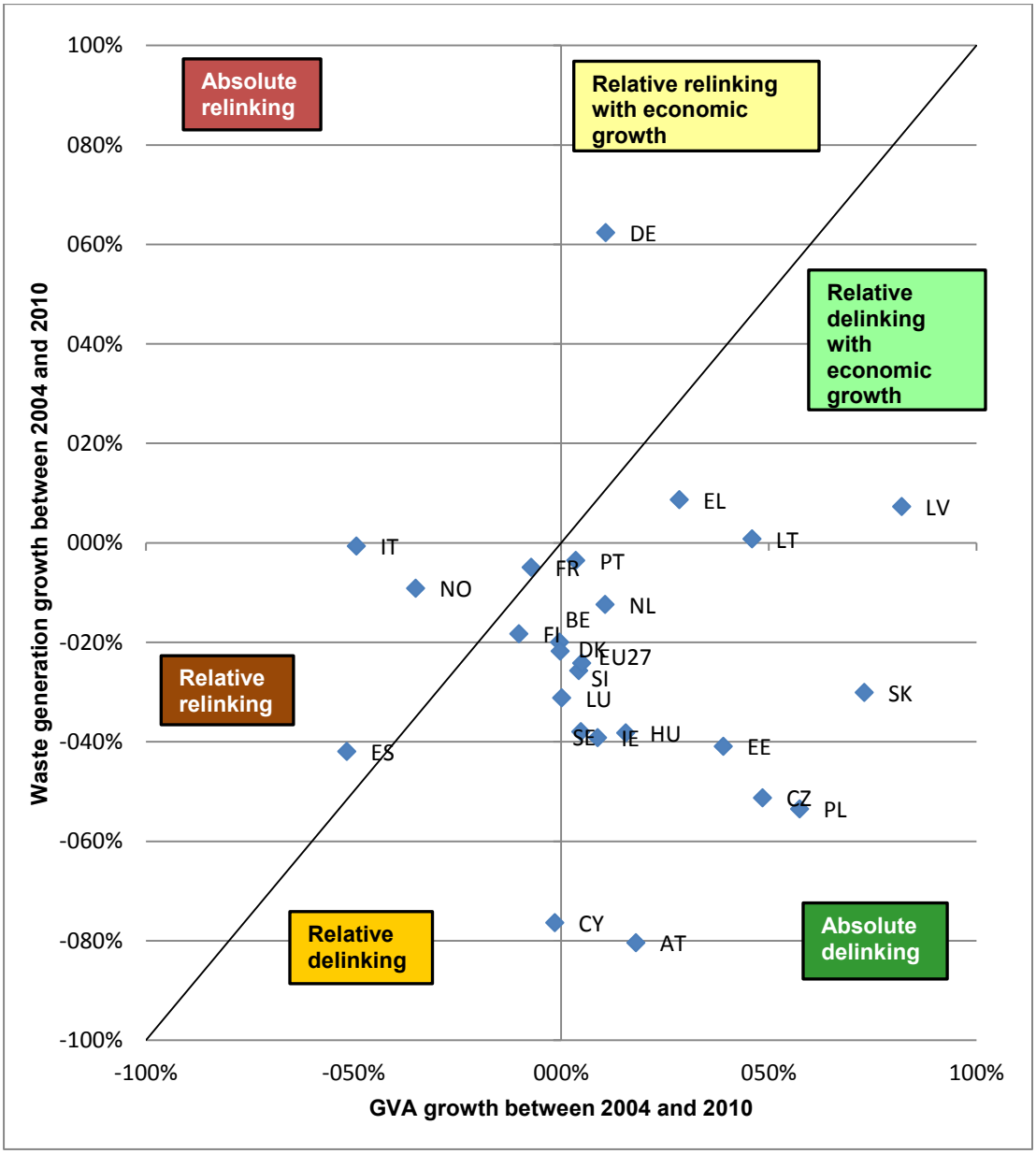


Figure 16 Delinking of waste generation from GVA in EU27 between 2004 and 2010. *Source: Own elaboration with Eurostat data (nama_nace64_c and ENV_WASGEN).*

2.3 Territorial patterns of Manufacturing

The current section is devoted to analyse what is the territorial scattering of manufacturing across the European regions and to try to shed some light on the factors behind such scattering.

The distribution of economic activity (as a whole) across the EU may be described by the following highlights. EU countries differ in their production structures, even if there are groups of countries with similar structures. Over the years countries have become more specialized. However, EU regions show a mixed pattern. Approximately half of EU regions became more specialized, while the other half became less specialized. In addition, distribution patterns are very dependent on the industry type. For instance, high tech industries and with economies of scale tend to be more spatially concentrated than others (Combes and Overman, 2003).

The EU integration process has to some extent influenced the changes in productions structure, the vast majority of EU countries experiencing a growing difference between their industrial structure and that of their EU partners (MideltfartKnarvik et al.). These growing divergences in the geography of national production may be the consequence of either countries having industries, which grow at different rates (countries with high-growth industries becoming more specialized sooner) or countries changing production type. A remarkable example of the latter is the change in the industrial structure of Ireland, Scotland an Finland, where new high-tech industries and the ones subject to increasing returns to scale were established.

If we focus on manufacturing, European manufacturing has undergone profound changes especially due to EU integration, but also because of globalisation and subsequent acceleration in the diffusion of knowledge, information and technology. Moreover, the manufacturing geography is a dynamic process, thus location patterns are changing over time. For the last years, research has been focused on identifying the nature of the agglomeration and dispersion forces determining such patterns (Combes et al., Midelfar-Knarvik et al., Braunerhjelm et al., Ekholm et al. etc.). However, this is on-going research and much work remains to be done. The main findings so far have been that:

- Core-periphery patterns (where industry is located mainly in the core) between countries have decreased over years, but have remained stable at subnational level.
- The nature of the sector (high tech. vs. labour intensive) plays a role in the agglomeration / dispersion. The most remarkable change in structure being the location and expansion of high-tech industries in the EU periphery.
- Industrial location is predominantly the result of two opposing forces: agglomeration trends due to localized economies of scale and dispersion trends mostly due to natural resource dependency. However changes over time show a mixed pattern. Certain industries initially dispersed became more concentrated (e.g. textiles, leather, furniture, etc.). Others previously concentrated became dispersed (beverages, tobacco, office and computing machinery, etc.). Yet, others which were concentrated, remained concentrated: vehicles, aircraft, chemical and petroleum.
- In the EU the integration policies and the accession of new member states (abolished trade barriers, access to the single market) have played a relevant role with regard to where industries locate and whether they become more specialized.

In summary, countries have become more specialized, while specific sectors have become more dispersed.

In addition, another factor to be taken into account is where in the value-chain, belongs each subsector. The more in the middle, that is to say, the stronger the upstream and downstream linkages, the more sensitive it is towards where to establish, usually tending to be based in central countries / regions with a good accessibility / mobility (Jovanović, 2011),. Moreover, the relatively high geographical concentration of related firms in relatively small areas

facilitates knowledge spillovers and fosters further concentration. This agglomeration in central areas trend is more pronounced in the case of industries with a high degree of increasing returns to scale. It should be noted that economies of scale usually have limits, such as passing the optimum design point where costs per additional unit begin to increase (diseconomies of scale); for instance, exceeding the nearby raw material supply, such as wood in the lumber and pulp and paper industry. A common limit for low cost per unit weight commodities is saturating the regional market, thus having to ship product uneconomical distances. Other limits include using energy less efficiently or having a higher defect rate.

In such a context, the predominant distribution patterns observed have been that labour intensive manufacturing industries (e.g. textiles), have become more concentrated and have agglomerated mainly in southern Europe. On the contrary, high-tech industries such as office and computing machinery, radio, TV and communication, and professional instruments have become less concentrated. That is to say, that the primary features behind territorial distribution depend on the nature of the sector involved. The above has somehow led to countries specializing according to comparative advantage but with the result being distinctly different in terms of industrial concentration.

Nonetheless, the above does not strictly apply to the regional level. At the regional level, changing industrial structures have derived in a lack of specialization combined with increased geographical concentration (increasing disparities among regions). Thus, inequality among member states has decreased, but regional inequality within member states has increased (Braunerhjelm et al., 2000).

Besides, manufacturing is not especially dependent on land consumption, apart from plant location. However, it is indirectly dependent on land-based resources, through raw material consumption requirements. Indeed, manufacturing is a resource intensive sector and as such, immobile production factors, i.e. natural resources are the relevant feature leading to the geographical dispersion of manufacturing industries. This way, those industries that are more resource-intensive have spread out to where the resources are based. Localized natural advantages such as coal and iron resources have traditionally played a significant role both on manufacturing location and on the specialization of the respective regions. Nevertheless, this influence is declining, even if it is not clear what the reason for this is. It could be due to structural changes (e.g. change of demand preferences, change of technologies, etc.) or to increasing EU integration
When it comes to greening manufacturing versus traditional manufacturing's resource intensity, attention should be paid to resource efficiency approaches. In special to cradle-to-cradle and industrial symbiosis approaches, where the emphasis is in minimizing waste generation, while enhancing resource productivity.

> *Industrial symbiosis can be defined as sharing of services, utility, and by-product resources among diverse industrial actors in order to add value, reduce costs and improve the environment.*
>
> *Cradle to Cradle design is a biomimetic approach to the design of products and system. It is a holistic framework that seeks to create systems that are not only efficient but also essentially waste free. The main premise of the Cradle to Cradle philosophy is that products can be designed is such a way that after their normal lifetime they can be perpetually re-used for something new.*

These approaches could influence in the near future the agglomeration and location patterns of industries. For instance, industrial symbiosis approaches could cause the agglomeration of companies in a certain location, in order to these companies to share services, as well as to some of the companies use the wastes generated by others. Along these lines, it should be highlighted that there already is a number of examples running in the EU. The most remarkable are located in the UK, the Netherlands and Denmark (European Commission (EC) – DG REGIO (2012)):

- UK (West Midlands): The Industrial Symbiosis Network helps to identify opportunities to recover and reprocess waste products from one industry that can then be re-used

by other businesses. This, in turn, reduces the amount of waste going to land fill, cuts carbon emissions and creates greener jobs. The project was piloted in the West Midlands in 2003 and because of its success it has been replicated across the UK since 2005. The success of the industrial symbiosis initiative is largely due to the fact that it is publicly funded and offers benefits to businesses from any sector.

- Netherlands (Venlo): The region of Venlo, located in the southeast of the Netherlands, is developing diverse initiatives that test the Cradle to Cradle® (C2C) concept in practice. It is also the first region in the world to apply the C2C principles on such a large scale. Currently in Venlo, the C2C principles are not only applied to the manufacture of products, but also to the development of large buildings and the organisation of living and working areas. In Venlo, the municipal authorities have been pivotal in creating conditions for C2C initiatives by forging public-private partnerships, supporting innovation, experimentation and demonstration, using public procurement as a powerful tool and developing C2C principles and targets.

- Denmark (Kalundborg): In Kalundborg Symbiosis, public and private enterprises buy and sell waste products from industrial production in a closed cycle. The residual products traded can include steam, dust, gases, heat, slurry or any other waste product that can be physically transported from one enterprise to another. A residual product originating from one enterprise becomes the raw material of another enterprise, benefiting both the economy and the environment.

The ongoing European integration process is deemed likely to increase trade and factor mobility thereby affecting the division of labour and production between countries and regions, and thus the core-periphery divide of regional incomes. In fact, the issue of market potential in the EU remains an area of interest since there is a belief that accessibility could explain the core-periphery patterns. However there is an on-going discussion about the methodology and variables to apply in order to measure accessibility, In fact, different approaches, deliver different measures of regional accessibility, which makes it hard to come to a conclusion (Combes and Overman, 2003).

In the period following the completion of the Single European Market, lagging regions saw an improvement in economic performance. The spread to economic activity to peripheral countries was limited and mainly due to (labour) cost advantages, thus focused on labour intensive industries. This is consistent with the view that as costs of trade fall for products of certain industries, the periphery may become more attractive for investment as the returns on the capital are greater. Therefore, the change in the production structure data in the EU found certain support in the modification in the structure of EU trade. That is to say, the Single Market has had certain empirical effect in the manufacturing structure in both accession countries and already member states. Nonetheless, research results in relation to trade barriers and trade liberalization have not been conclusive with regard to their impact in manufacturing concentration, the accession to the EU.

When it comes to trade, it should also be bore in mind that geography in space (or in culture) tends to limit competition as it creates distance (physical or perceived) and costs among producers, sellers and their clients. If costs of trade are high, industries tend to disperse. When this cost is reduced agglomeration can take place as demand in distant places can be met by exports.

In addition, evidence shows that EU workers are rather reluctant to move region / country because of work, this leading to manufacturing being more dispersed in the EU than in the US (where employee mobility is high and so it is regional specialization by sector), because industries locate where trained workforce is.

Finally, know-how and innovation also play a role in industry location and will be ineludible when it comes to greening manufacturing. According to econometric analyses, one of the principal forces determining industrial location is the availability of high-education human capital. This is especially the case for high-tech sub-sectors such as, pharmaceutical, computer and electronic equipment etc.

Along these lines, (Eco)innovation tends to be located in more densely populated regions and in more sectorally diversified regions. In fact, diversity matters for growth and many spillovers take place within input-output relationships between different industries along their value chain. They often originate in downstream sectors favouring the growth of upstream industries. Lastly, the importance of spillovers does not depend on the technological intensity of the industry. Therefore, in principle regions with a sector diversity and an (eco)innovation record in principle would have the highest potential for making their manufacturing sector greener.

To round up, there is also some evidence that regional policies at the EU level have affected industrial structure and industry location in the past and hence, could continue to do so in the future (even if it is not an easy task to foresee what the outcome will be). The most influential policy so far has been European Structural Funds expenditure, by attracting industries that are R&D intensive to determined regions. Nonetheless, Structural Funds encouraged R&D intensive industries to locate in countries and regions that had relatively small endowments of skilled labour, thus acting counter to the countries' comparative advantage.

3 Drivers and enablers

One of the most urgent challenges facing the EU and the world is the need for a shift towards a low-carbon and resource efficient economy. The growing population and the rise of emerging economies lead to a rising competition over natural resources, higher prices and environmental depletion, all of which represent the greatest challenge for the EU manufacturing sector.

As aforementioned, the EU Manufacturing sector is resource intensive, especially when it comes to energy. Nonetheless, the energy dependency varies across the EU being more predominant in new Member States than in the EU 15 (European Commission (EC) DG Enterprise and Industry (2010)). The most energy-intensive manufacturing sub-sectors comprise iron, steel and non-ferrous metals, pulp and paper, chemicals, non-metallic mineral products, and textiles. Moreover, these sectors have already heavily invested in energy efficiency and have substantially reduced their energy intensity since 1990, especially in the wake of rising energy prices.

In fact, these sectors have somehow reached a technological threshold and it will be hard to further progress until radical innovations take place. Along these lines, the technological development towards a pattern of production less aggressive to the environment is seen as a partial solution to the problem (Tilman Santarius, 2012). While innovating, companies seek solutions to problems that are tackled within, and often created by, a given technological paradigm. Thus, once the technological paradigm is established, innovations become selective in the ability to solve problems, while hindering other solutions that would be outside the technological paradigm in that specific period. In other words, technologies are elected according to the predominant features of the selective environment. Liebowitz & Margolis (1995) illustrate how under the different forms of path-dependency mechanism technologies become more attractive as they are more used. That is, the technology is not elected because it is the most efficient, but it becomes more efficient because it has been elected. Formally, the process can adopt the form of temporal autocorrelation in linear modeling.

This can lead to a socially undesirable technology lock-in effect – where lock-in is defined as market dominance of an inferior incumbent technology at the expense of a superior contender. When there are two or more technologies that are substitutes, profit-maximizing innovators may focus their efforts on improving productivity of existing technologies to the extent that the market size for these technologies is large and the return higher technology (Dutz & Sharma, 2012).

This way, companies get caught in the more widespread technology linked to the prevailing technological paradigm. These events have major effects on the company's ability to find solutions to specific problems, that is, on its ability to innovate, including in the direction of Environmentally Friendly Technologies (EFTs). Hence, technology has temporal

interdependence (path-dependent) since it is the result of predefined trajectories (Lustosa, 2011).

In such a context, further investment in R&D and innovation would be essential to enable further progress on energy efficiency and to reduce carbon dioxide emissions. In addition, measures aiming at combating climate change (e.g.ETS) should properly take into account efforts already made by them and that the economic burden placed on these industries preserves their ability to invest (European Commission (EC) DG Enterprise and Industry (2010)). In the words of Gordon Moffat:

BOX 1: Gordon Moffat's, Director General of Eurofer, the European steel industry association, views on ETS:

"*I'm thinking of climate policy for instance, where they've included process industries, such as ours, in the ETS, which is not designed for process industries. Our emissions, which have reduced by 50% by the way since the 1970s, are an inevitable part of the manufacturing process. If you want steel, CO2 is a byproduct of it.*

Our aim is to reduce that as much as possible but by imposing limitations on us, by failing to provide full free allowances, by failing to provide compensation for the electricity prices which arise from the ETS, they are exacerbating the problem, making it more difficult for the industry to adjust, to invest in order to find the technologies which are necessary.

90% of the cost of the ETS is being borne by 40% of the economy, which is manufacturing industry. It would be far more efficient, and sensible, if the burden of moving towards a low-carbon economy was being covered by the whole economy."

When it comes to less energy-intensive subsectors, the Electra report[1] suggested that an energy saving potential of between 30% and 65% could be achieved in some processes, providing that low consumption and high efficiency equipment (lighting systems, motors, power capacitors, transformers, cables….) are utilised with appropriate automation & controls for their optimisation, together with procedures and tools to monitor performance and maintain systems. However, a barrier to turn this opportunity into reality is the current budgetary constraint and access-to-finance difficulties (ibid).

In addition growing population, an increase in GDP levels and changing lifestyles are causing consumption levels to rise globally. Thus, a higher anhigher demand for resources will be created. Key resource scarcities (including easily recoverable oil reserves, metal ores and water) will challenge the Manufacturing sector (UNEP 2011). Moreover, even when global resources would be sufficient to meet increasing demand, the resource-stocks are not equally distributed over the world. On the contrary, they tend to be located in a limited number of countries, which causes an increasing dependency on imports. This, in turn, feeds concerns about commodity prices, the new world order and security of supply. Along these lines, executives of leading global manufacturing companies (from Asia, Europe and America) believe that the impact of minerals and metals scarcity will increase strongly in the next five years (PWC 2011). This potential threat has been identified by the EU and accordingly, since 2007 various policy efforts have been devoted to overcome such a risk.

[1] Electra Report: Twenty solutions for growth and investment to 2020 and beyond on electrical and electronic engineering

BOX 2: European Commission reference documents on raw materials scarcity:

- Communication on commodity markets and raw materials - COM(2011) 25 final
- Opinion of the European Economic and Social Committee on the 'Processing and exploitation, for economic and environmental purposes, of industrial and mining waste deposits in the European Union (Own-initiative opinion)' CCMI/087 26 October
- Opinion of the European Economic and Social Committee on the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on 'Tackling the challenges in commodity markets and on raw materials (COM(2011) 25 final)'
- Opinion of the European Economic and Social Committee on the 'Access to secondary raw materials (scrap iron, recycled paper, etc.) (own-initiative opinion)' CCMI/078 17 February 2011
- Opinion of the European Economic and Social Committee on the 'Non-energy mining industry in Europe' (2009/C 27/19) 3 February 2009
- Communication on the Raw Materials Initiative "Meeting our critical needs for growth and jobs in Europe" - COM(2008) 699 final
- Staff Working Document accompanying the Communication - SEC(2008) 2741
- Staff Working Document: "Analysis of the competitiveness of the non-energy extractive industry in the EU" - SEC(2007) 771

In addition, nine Member States[2] have already developed national strategies on raw materials.

Besides, it should be highlighted the study issued by the EC analyzing both performance of EU industry and the drivers and barriers towards a greater resource efficiency. According to this study the main drivers for manufacturing to become greener are (Rademaekers et al. 2011b):

- Cost reduction
- Productivity improvement
- Regulation
- Corporate image

In other words, firms try to increase their competitiveness by lowering costs, increasing productivity and innovation (European Commission (EC) DG Enterprise and Industry (2011)).

In addition, when the economic crisis is over, it is very likely that the energy and raw material prices will increase. As a result, the green transition (and competitiveness increase) in the manufacturing sector will reside in it becoming increasingly resource efficient.

Against the backdrop of the above (current and future) challenges for Manufacturing, the main drivers for the green transition may be summarised as follows.

[2] Austria, Denmark, Finland, France, Germany, Greece, Netherlands, Portugal and United Kingdom.

Table 4 Overview of the main driving forces for the green transition.

Barriers / challenges	Drivers / enablers	Policy recommendations	(Sub)sector
The most prominent barriers identified are: - Information barriers: lack of access to information. - Raw material price volatility, combined with market failures (distorted prices) - Financial barriers, lack of financial incentives, or misalignment of incentives - Governance barriers: in certain cases a tendency towards maintaining status quo - Technological barriers: eco-efficient technologies have reached performance limits	The main driving forces identified may be grouped as follows: - Resource efficiency: both from the perspective of increasing resource productivity in order to reduce costs and maximize production and from the perspective of reducing the risk derived from fuel dependency and resource scarcity - Policy / governance: on the one hand due to regulatory requirements, but also because of a policy framework which increasingly supports the decarbonisation of economy - Increasing environmental/sustainability awareness of companies, but also of consumers (corporate image) - Market: the market niche for environmental technologies is becoming larger - Socio-demographic changes: the ageing workforce is also considered as a driving force for change.	The policy actions identified to overcome the challenges / barriers identified would be: - Improve access to knowledge: dissemination, fill information gaps, create and support knowledge networks, awareness raising - Improve access to finance - MBIs: benchmarking and labeling, taxes, subsidies - RDI investments to fill knowledge gaps. - Policy framework supporting transition, e.g. reform waste legislation so that it promotes recovery of materials and waste separation, foster industrial symbiosis, etc. - Regulatory framework stricter with regard to polluters. - Introduce eco-efficiency indicators All of which complemented with policy impact assessment, monitoring and evaluation	Manufacturing as a whole
- New technology investments hindered: technological constraints, lack of harmonized standards - Policy targest not accordable with innovation cycle of industry - (some) technology reaching performance limits	- Regulation, environmental standards - Consumer demands - Rising energy prices	- Support standardisation	Automotive
- Technology reaching performance limits --> potential for resource optimisation almost fully exploited	- Increasing energy efficiency - Reducing emissions - **Cost reduction driver	- Benchmarking and standards - RDI investments - Pay attention to cross-sectoral implications	Cement

Barriers / challenges	Drivers / enablers	Policy recommendations	(Sub)sector
- Access to knowledge / technology for SMEs - Technological barriers--> acccess to knowledge (not much sharing due to high competition and subsequent knowledge protection) - Due to business model less incentive to material savings	- Policy --> regulation - Increasing competition outside EU - Cost reduction: less energy and resources	- RDI investment - Taxes and tariffs - Information sharing	Chemicals
- No technology to recover WEEE - Missing regulation to encourage recovery - Lack of access to knowledge - Lack of access to finance - Missing public awareness	- Environmental awareness of industry - (critical) Raw material scarcity - energy security	- Increase control on illegal exports of WEEE - Support recovery - RDI investments for REE recovery from WEEE	Electronics
- Energy prices uncertainty - Technological lock-in (uncertainty, pay back time) - Lack of access to knowledge	- Raw materials (water, energy, etc.) - Policy (regulation, environmental responsibility) - ** Resource efficiency (both input and output)	- Foster benchmarking, labeling, etc. - Improve waste separation policies - Correct pricing of resources (inputa and output) - Raising awareness - Technical assisstance programmes - Access to finance	Food
- Inefficient recycling schemes (inefficient separation makes recycling difficult)	- Energy intensity- Emissions	- Regulations discouraging dumping (taxes, etc.) needed- Networks needed- Consumer oriented recycling awareness raising needed- Cradle-to-cradle approach needed	Glass
- Technology reaching performance limits - Financial constraints: investments needed for researching in technological breakthroughs	- Energy intensity - Emissions and waste - Raw material scarcity	- Policy needs to address: access to raw materials, further elaboration of waste shipment directive, high cost of energy in Europe, waste disposal. - Dissemination, access to knowledge boosting	Non-ferrous metal

Barriers / challenges	Drivers / enablers	Policy recommendations	(Sub)sector
- non-transparent energy markets - ETS has increased competition to acquire wood (raw material for pulp & paper industry) - increasing exports of recyclable paper make it unavailable for EU industry	- energy efficiency - resource availability --> also water intensity - emissions	- Increase transparency of energy market - Investement --> stimulate innovation - Increase access to recyclable paper	Pulp and paper
- Technology reaching performance limits	- Energy intensity and cost	- Foster adoption of BAT - Investement in technology breaktrhoughs - Correct pricing of resources (inputa and output) - Raising awareness - Technical assisstance programmes - Access to finance	Steel

Sources: Adapted from

- European Commssion (EC) DG Enterprise and Industry (2010) EU Manufacturing Industry: What are the Challenges and Opportunities for the Coming Years?
- Anton Geyer, Fabiana Scapolo, Mark Boden, Tibor Döry, Ken Ducatel (2003) The Future of Manufacturing in Europe 2015-2020-The Challenge for Sustainability
- UNEP (2011) Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication
- Koen Rademaekers, Sahar Samir Zaki Asaad, Johannes Berg (2011) Study on the Competitiveness of the European Companies and Resource Efficiency
- Martin Jänicke (2012) „Green Growth“: From a growing eco-industry to a sustainable economy
- Koen Rademaekers, Sahar Samir Zaki, Matthew Smith. (2011) Sustainable Industry: Going for Growth & Resource Efficiency
- United Nations Industrial Development Organization (2011) Unido Green Industry Initiative for Sustainable Industrial Development
- British Government (2011) Enabling the Transition to a Green Economy: Government and business working together

3.1 Overview of European policy

As highlighted in the Europe 2020 Strategy, Manufacturing is fundamental in the transition towards a new growth model for the EU. Along these lines, the core message of the EU Communication on "*An integrated industrial policy for the globalisation era*" is that Manufacturing must be placed centre stage if Europe is to remain a global economic leader. In words of Vice President Antonio Tajani:

> *"Industry is at the heart of Europe and indispensable for finding solutions to the challenges of our society, today and in the future. Europe needs industry and industry needs Europe. We must tap into the full potential of the Single Market, its 500 million consumers and its 20 million entrepreneurs."*

Nonetheless, to tap the full potential of Manufacturing in relation to a green growth for Europe (and the world), the sector needs to undergo this green transition, and hence appropriate policies need to be in place (UNEP 2011).

In such a context, this section is devoted to analyse the most relevant policies applicable to Manufacture in the EU. A straight forward search in the Directory of European Union legislation in force in EUR Lex delivers over 1500 acts for Industrial policy and over 500 acts for Environment. Studying such a number of legislative documents in addition to other policy documents such as Roadmaps, Communications, etc. in GREECO would be an over ambitious task. That is why the policies considered do not comprise an exhaustive list of all policies applicable to Manufacture / Industry, but the most relevant in terms of their potential to contribute to a greener Europe. It should also be noted that the rationale has been to select those policy documents applicable to the Manufacture sector as a whole, rather than applicable only to branches / sub-sectors of Manufacture.

Against this backdrop, the policies considered in this report may be summarised in the table below.

Table 5 Main policies and legislation regarding Manufacturing from a Green Economy perspective

Type of policy	Year	Short description
Communication	2000	Communication (2000) 265 - Promoting sustainable development in the EU non-energy extractive industry
Directive	2000	DIRECTIVE 2000/60/EC establishing a framework for Community action in the field of water policy
Green paper	2000	COM(2000) 87 - Green Paper on greenhouse gas emissions trading within the European Union
Communication	2001	Communication (2001) 264 - A Sustainable Europe for a BetterWorld: A European Union Strategy for Sustainable Development
Directive	2001	Directive 2001/80/EC of the European Parliament and of the Council of 23 October 2001 on the limitation of emissions of certain pollutants into the air from large combustion plants
Directive	2001	DIRECTIVE 2001/81/EC on national emission ceilings for certain atmospheric pollutants
Communication	2001	COM (2001) 31 - On the sixth environment action programme of the European Community 'Environment 2010: Our future, Our choice'
Communication	2002	Communication (2002) 714 - Industrial Policy in an Enlarged Europe
Communication	2002	Communication (2002) 262 - Productivity: The Key to Competitiveness of European Economies and Enterprises
Decision	2002	DECISION No 1600/2002/EC laying down the Sixth Community Environment Action Programme

Type of policy	Year	Short description
Communication	2003	Communication (2003) 704 - Some Key Issues in Europe's Competitiveness – Towards an Integrated Approach
Communication	2003	Communication (2003) 302 - Integrated Product Policy: Building on Environmental Life-Cycle Thinking
Directive	2003	Directive 2003/87/EC of the European Parliament and of the Council establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC
Directive	2003	Consolidated version of Directive 2003/87/EC of the European Parliament and of the Council establishing a scheme for greenhouse gas emission allowance trading within the Community
Directive	2004	Directive 2004/35/CE Environmental liability with regard to the prevention and remedying of environmental damage
Communication	2004	Communication (2004) 274 - Fostering structural change: an industrial policy for an enlarged Europe
Directive	2004	Directive 2004/101/EC of the European Parliament and of the Council amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community, in respect of the Kyoto Protocol's project mechanisms
Communication	2005	Communication (2005) 670 - Thematic Strategy on the sustainable use of natural resources
Communication	2005	Communication (2005) 474 - Implementing the Community Lisbon Programme: A policy framework to strengthen EU manufacturing - towards a more integrated approach for industrial policy
Communication	2005	Communication (2005) 666 - Taking sustainable use of resources forward: A Thematic Strategy on the prevention and recycling of waste
Communication	2005	COM(2005) 446 final - Thematic Strategy on air pollution
Directive	2006	DIRECTIVE 2006/21/EC on the management of waste from extractive industries and amending Directive 2004/35/EC
Regulation	2006	REGULATION (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
Decision	2006	Commission Decision 2006/780/EC on avoiding DOUBLE COUNTING of greenhouse gas emission reductions under the Community emissions trading scheme for project activities under the Kyoto Protocol pursuant to Directive 2003/87/EC of the European Parliament and of the Council (notified under document number C(2006) 5362)
Communication	2006	COM(2006)231 - Thematic Strategy for Soil Protection
Communication	2007	Communication (2007) 379 - Small, clean and competitive, a programme to help small and medium-sized enterprises comply with environmental legislation
Communication	2007	Communication (2007) 374 - Mid-term review of industrial policy: A contribution to the EU's Growth and Jobs Strategy
Decision	2007	EEA Joint Committee Decision No 146/2007 linking the EU ETS with Norway, Iceland and Liechtenstein
Communication	2008	Communication (2008) 397 - Action Plan for sustainable consumption and production (SCP) and sustainable industrial policy (SIP)

Type of policy	Year	Short description
Directive	2008	Directive 2008/101/EC of the European Parliament and of the Council amending Directive 2003/87/EC so as to include aviation activities in the scheme for greenhouse gas emission allowance trading within the Community
Communication	2008	COM(2008) 800 - A European Economic Recovery Plan
Communication	2009	Communication (2009) 400 - Mainstreaming sustainable development into EU policies: 2009 Review of the European Union Strategy for Sustainable Development *(This is the most recent assessment of the EU SDS)*
Communication	2009	Communication (2009) 512 - "Preparing for our future: Developing a common strategy for key enabling technologies in the EU"
Directive	2009	Directive 2009/29/EC of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community
Directive	2009	DIRECTIVE 2009/125/EC - establishing a framework for the setting of ecodesign requirements for energy-related products
Non-paper	2009	NON-PAPER "GREEN ELEMENTS FROM MEMBER STATES´ RECOVERY PLANS"
Regulation	2009	REGULATION (EC) No 1221/2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS)
Communication	2010	Communication (2010) 2020 - EUROPE 2020 A strategy for smart, sustainable and inclusive growth
Communication	2010	Communication (2010) 614 - An Integrated Industrial Policy for the Globalisation Era - Putting Competitiveness and Sustainability at Centre Stage *(Also a Flagship Initiative of Europe 2020)*
Directive	2010	Directive 2010/75/EU Industrial emissions (integrated pollution prevention and control)
Regulation	2010	Commission Regulation (EU) No 920/2010 for a standardised and secured system of registries pursuant to Directive 2003/87/EC of the European Parliament and of the Council and Decision No 280/2004/EC of the European Parliament and of the Council - version not including changes brought by Regulation of 18 November 2011
Communication	2011	Communication (2011) 571 - Roadmap to a Resource-Efficient Europe
Communication	2011	Communication (2011) 21 - A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy
Communication	2011	COM(2011) 25 - TACKLING THE CHALLENGES IN COMMODITY MARKETS AND ON RAW MATERIALS
Communication	2011	COM(2011) 112 - A Roadmap for moving to a competitive low carbon economy in 2050
Regulation	2011	Commission Regulation establishing a Union Registry for the trading period commencing on 1 January 2013, and subsequent trading periods, of the Union emissions trading scheme pursuant to Directive 2003/87/EC of the European Parliament and of the Council and Decision 280/2004/EC of the European Parliament and of the Council and amending Regulations (EC) No 2216/2004 and (EU) No 920/2010
Commission Decision	2011	COMMISSION DECISION of 7 December 2011 concerning a guide on EU corporate registration, third country and global registration under Regulation (EC) No 1221/2009 of the European Parliament and of the Council on the voluntary participation by organisations in a Community eco-management and

Type of policy	Year	Short description
		audit scheme (EMAS)
Directive	2012	DIRECTIVE 2012/19/EU on waste electrical and electronic equipment (WEEE)
Voluntary action	N.A.	Eco-Management Audit Scheme (EMAS)
Voluntary action	N.A.	Environmental Technology Verification (ETV)
Voluntary action	N.A.	Eco-label
Voluntary action	N.A.	Retail Forum for Sustainability
Voluntary action	N.A.	ECAP - Environmental Compliance Assistance Programme for SMEs

Please note that policies dealing with waste and energy are not covered in detail in this report, because they are thoroughly analysed in the Energy and Waste GREECO reports.

As it could be derived from the above table, when it comes to Manufacturing there is not one single policy (such as the Common Agricultural Policy, CAP) which is more influential or predominant. On the contrary, there are a number of different policies, different in type, and in scope, which combined aim for a greener Manufacturing sector. For the last decade, the policies dealing with Manufacture in the EU have been mainly oriented to:

- Limiting environmental damage. E.g. Water Framework Directive (WFD), Industrial Emissions Directive, Emissions Trading Scheme (ETS).
- Creating jobs. E.g. An Integrated Industrial Policy for the Globalisation Era
- Increasing productivity. E.g. Some Key Issues in Europe's Competitiveness, Thematic Strategy on the sustainable use of natural resources.

That is to say, EU policies are oriented towards promoting economic growth of the sector, while preserving the environment and reinforcing the social aspects, by creating and securing quality jobs. All of which are different aspects of Sustainable Development. In addition, in recent years, this approach has been reinforced by the Europe 2020 Strategy and in special the policies dealing with resource efficiency. Moreover, the European Commission has recently proposed a new Environment Action Programme (EAP) for the EU: "Living well, within the limits of our planet"[3]. This EAP will guide environment policy up to 2020 with the purpose of transforming the EU into a green economy. With regard to the implications for the Manufacturing sector (and businesses as a whole), the most relevant aspects of this EAP are that it will reinforce the resource efficiency and eco-innovation uptake. In other words, the challenge of sustainable Manufacturing and the importance of resource efficiency have been acknowledged and addressed by Europe. In fact, to implement its Europe 2020 Strategy, the EU has shaped seven flagship initiatives, including the Industrial Policy (An Integrated Industrial Policy for the Globalisation Era) and Resource Efficiency (A resource-efficient Europe) flagships under the umbrella of sustainable growth. This EU policy approach materialises UNEP's vision on which should be the policy priorities for greening Manufacture (UNEP 2011): (i) closed-cycle manufacturing and life cycle approaches (meaning waste recovery and recycling) and (ii) co-generation – combined heat and power, which aims to increase energy efficiency by promoting industrial symbiosis.

Finally, it should also be noted that while in views of the European Commission (DG Enterprise and Industry) coordinated European level approaches are needed, rather than national sectoral approaches,

[3] http://ec.europa.eu/environment/newprg/index.htm

> "*the concept of national sectors and industries is obsolete. Coordinated European policy responses are needed. Europe also needs an approach that looks at the whole value chain, from infrastructure and raw materials to after-sales service. Promoting the creation and growth of small and medium-sized enterprises has to be at the core of EU industrial policy. Moreover, the transition to a sustainable economy has to be seized as an opportunity to strengthen competitiveness. Only a European Industrial Policy targeting competitiveness and sustainability can muster the critical mass of change and coordination needed for success.*"

the Committee of the Regions considers that local and regional authorities should play a greater role in formulating EU policy as this would ensure better implementation (2011/C 15/02) and DG Regional Policy also stresses the relevance of taking the territorial perspective into account. Furthermore, UNEP, also shares the view that since manufacturing is not a uniform industry, governments need to consider approaches that best suit national circumstances (UNEP 2011). It is noteworthy, that despite the on-going debate on the issue, the realiy a number of policies are already considering place-based approaches to increase effectiveness. For instance, the IED explicitly mentions the need to consider specific local characteristics and it is managed at MS level (even at regional level in some MS). Moreover, the Flagship Initiative "*An industrial policy for the globalisation era*" acknowledges regional diversity and the need for place-based approaches to increase Europe's competitiveness, e.g.

- modernisation of EU's industrial base by means of Regional Policy and CAP;
- need to enhance harmonization of different legal environments;
- promoting "smart specialization" through EU Regional policies.

In addition, the EMAS scheme places its emphasis on cooperation between MS for best practice exchange, benchmarking, etc.

Besides, regardless the territorial level considered for policy-making, all organisations identify the challenge of finding the right mix of policies and regulatory mechanisms. This mix to facilitate the transition to a greener manufacturing, should encourage closed-cycle manufacturing, enable efficiency improvements through greater uptake of cleaner technologies, reform harmful subsidies and support crediting and trading schemes among others (UNEP, ITC, ICTSD 2012). This section provides an overview of the current policy framework in the EU, from strategic documents to voluntary instruments.

Overview of strategic documents in relation to greening Manufacture

When it comes to making Manufacture more sustainable there are two EU policy strands which set the frame and are the most relevant. On the one hand, there is the environmental policy strand, aiming at protecting environment and boosting the environmental pillar of sustainable development as a whole. On the other hand, there is the industrial policy strand, focused on Industry / Manufacturing and aiming at increasing its competitiveness and making it more sustainable.

Environmental policy

The Environmental Action Plans have been the cornerstones of environmental policy in the EU. At the moment, the European Commission has proposed a new Environment Action Programme (the 7th), namely "Living well, within the limits of our planet". This upcoming Environment Action Programme (EAP) will guide environment policy up to 2020 and aims to enhance Europe's ecological resilience and transform the EU into an inclusive and sustainable green economy. However, this EAP, which will be determining for the EU's green transition, has not entered into force yet. At the moment, the 6th EAP is in place. The 6th EAP was adopted by a joint decision of the European Parliament and the Council in 2002 and it was the first EAP to be adopted through the co-decision procedure. Hence, it was granted a status of political relevance and authority which its predecessors lacked. Even if the exact legal nature of the 6th EAP may not be clear, it undoubtedly represents the political commitment of the Parliament, the Council and the Commission and thus, provides a benchmark to evaluate EU wide environmental policy.

The 6th EAP introduced the Thematic Strategies as a mechanism to identify further proposals for legislation and measures to achieve its objectives. Along these lines, the 6th EAP has been

implemented both through Thematic Strategies and related action plans and programmes (in *italic* the most relevant in relation the Manufacturing sector):

- *Air Thematic Strategy*
- Marine Thematic Strategy
- *Waste Thematic Strategy*
- Urban Thematic Strategy
- *Natural Resources Thematic Strategy*
- Pesticides Thematic Strategy
- *Soil Thematic Strategy*
- *European Climate Change Programme*
- *Energy Efficiency Action Plan*
- EU Biodiversity Action Plan
- EU Forest Action Plan
- Environment and Health Action Plan
- Urban Mobility Action Plan
- *Environmental Technologies Action Plan*
- *Sustainable Consumption and Production Action Plan*

In the process of developing EU environmental policies, a broad range of stakeholders were involved in the definition of the Thematic Strategies. Beneficial as this approach was, it also lengthened the environmental policy-making process and delayed the formulation of concrete policy proposals and the adoption of resulting measures.

Since the 6th EAP was adopted, the EU has successfully adopted a number of new environmental policies and measures, agreed ambitious targets in various areas, and developed several cross-cutting strategies and plans, e.g. the EU Sustainable Development Strategy (SDS) and Lisbon Strategy. However, it is difficult to accurately establish the extent to which this overarching framework has influenced policy developments. In fact, some of the priority actions identified by the Environment Action Plan, fell outside the scope of the Thematic Strategies and some additional programmes and strategies have been developed due to demands in other policy sectors (Energy Efficiency Action Plan, Forest Action Plan, Urban Mobility Action Plan) or from the European Council (ETAP and SCP-SIP Action Plan, both related to the SDS and Lisbon Strategy).

Regardless the above debate, the 6th EAP is considered to be the environmental pillar of the EU's Sustainable Development Strategy and it has provided a forum to move forward the debate on certain issues. Furthermore, some of the action plans and programmes within the Thematic Strategies, have become more prominent than Environment Action Plan itself.

When it comes to the role that the different Environmental Action Programmes have played, it is worth highlighting that they have been valuable in terms of allowing regular stocktaking, focusing political debate in the institutions on the evolving priorities of environmental policy (Withana et al. 2010).

Industrial policy

The European Union has recognized that in order to underpin the recovery from the economic crisis and foster sustainability it is essential to increase the productivity in manufacturing. In fact, as outlined in the Europe 2020 Strategy, industry is at the centre stage of the new growth model for the EU. In the turmoil of the economic crisis, industry has been hit hard and all subsectors are facing the challenges of adjusting to a low-carbon economy. Nonetheless, these challenges will differ from subsector to subsector. For this reason, under the flagship initiative "An industrial policy for the globalization era", the Commission is working with stakeholders to draw up a framework for a modern industrial policy. The main goal of such a new framework is to support the transition of manufacturing sectors to greater energy and resource efficiency, while developing a strong and competitive sector, that is to say, foster the the transition towards a low-carbon and resource-efficient economy (i.e. Green Economy). When it comes to the Industrial Performance Scoreboard, Member States have engaged in reforms to boost their competitiveness in five key areas: manufacturing productivity; export performance; innovation and sustainability; business environment and infrastructure; and finance and investment.

The above is one of the most recent and ambitious policy initiatives to increase the competitiveness of the manufacturing sector, while making it greener. However, it is not the only relevant initiative towards decoupling industrial production from environmental depletion. Among other, the Sustainable Consumption and Production and Sustainable Industrial Policy (SCP / SIP) Action Plan and the Communication on A policy framework to strengthen EU manufacturing are two important precursors. The first addressed the challenge of sustainable consumption and production identified by the renewed Sustainable Development Strategy and provided the basis for other relevant policies, such as, the Ecodesign directive, the Ecolabel Regulation, the revision of the EMAS Regulation, etc. The latter focused on designing policies for Manufacture in a more integrated manner in order to boost sectoral productivity growth and international competitiveness, while implementing the Lisbon Programme.

Research policy

Finally, another route besides environment and industrial policy envisioned by the European Parliament and the European Commission to achieve a more sustainable manufacturing sector is research, development and innovation (RDI) effort. As part of the European Economic Recovery Plan, the Commission is launching three Public-Private Partnerships (PPPs). The three PPPs represent a powerful means of boosting research efforts in three large industrial sectors – automotive, construction and manufacturing – which have been particularly affected by the economic downturn and where innovation can significantly contribute towards a more green and sustainable economy. In this framework, the "Factories of the Future" initiative for the manufacturing sector (PPP-FoF), the Manufuture European Technology Platform and the European Factories of the Future Research Association have a special relevance for the Green Manufacture sector. "Factories of the Future" is an initiative to support the manufacturing industry in the development of new and sustainable technologies. The objective is to help EU manufacturing enterprises, in particular SMEs, to adapt to global competitive pressures by improving the technological base of EU manufacturing across a broad range of sectors. This programme is financed jointly by industry and the European Commission under the Seventh Framework Programme.

On a more practical level, the objectives are also implemented down to the EU 7th Framework Programme for Research and Innovation (FP7). Especially the Specific Programme Cooperation includes several relevant funding themes, including environmental research and production technologies research. The FP7 environmental theme contains strands such as conservation, sustainable management and recycling of natural and human-made materials. The most relevant theme or sub-division seems to be however the Nano- and materials technology theme, as exhibited particularly in the 2012 and 2013 Work Programme on Nanosciences, nanotechnologies, Materials and new Production technologies – NMP of the EU FP7. The NMP 2012 and 2013 calls included, among others, the following themes/calls: "Adaptive production systems and measurement and control equipment for optimal energy consumption and near-to-zero emissions in manufacturing processes", "Improved use of renewable resources at factory level" and "Innovative methodologies addressing social sustainability in manufacturing".

The major emerging issue in EU RDI policy is the phase-out of FP7 and the emerging Horizon 2020 – The framework programme for Research and Innovation (H2020). Starting 2014, H2020 supersedes FP7, while it is foreseeable that some of the themes found in the H2020 proposal might be introduced to FP7 during its last year. In principle, under H2020, the Competitive Industries objective will provide major investment in key industrial technologies, maximise the growth potential of European companies by providing them with adequate levels of finance and help innovative SMEs to grow into world-leading companies.

Manufacture regulation

Traditionally sectoral regulations have been performance-based and rather focused on end-of-pipe solutions, once damage has been done. In the EU, important legislative efforts have been devoted to minimising the environmental impact of the Manufacturing sector. These efforts have been mainly materialised in directives and regulations focused on limiting damage. That is to say they are mostly of application for emission reduction, waste water discharge decrease, etc.

BOX 3: Examples of EU regulations applicable to Manufacturing:

DIRECTIVE 2000/60/EC establishing a framework for Community action in the field of water policy

DIRECTIVE 2001/81/EC on national emission ceilings for certain atmospheric pollutants

DIRECTIVE 2006/21/EC on the management of waste from extractive industries and amending Directive 2004/35/EC

"REGULATION (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)"

Directive 2010/75/EU Industrial emissions (integrated pollution prevention and control)

DIRECTIVE 2012/19/EU on waste electrical and electronic equipment (WEEE)

Of the above legislations, the Industrial Emissions Directive (IED / IPPC) has special relevance, since it is the cornerstone of EU legislations addressing industrial installations. This directive is focused on installations with a high pollution potential, in terms of activity type and size. Hence, this type of installations may only operate if they hold a permit including requirements with regard to the protection of air, water and soil, waste minimization, etc. It is remarkable that this directive regulates not only end-of-pipe solutions, but it places emphasis on preventing damage and on an integrated approach. Hence, the IED has a mainly incremental approach since it prefer pollution prevention approaches and only foresees emission control when prevention is not possible. This approach goes one step further than traditional policy-making in the field, setting the ground for incentivizing industry to dynamically improve standards.

Along these lines of preventive approaches, it is worth highlighting the recent eco-design directive. This directive, though only focused on energy-related products, paves the way to improve resource efficiency, from the product design phase. In addition, in recent years the legislative framework applicable to Manufacturing activities, has welcomed a set of new regulations, such as the WEEE and REACH directives.

Besides, the regulatory framework in the EU has also promoted the principle of "*polluter pays*", not only in the IED / IPPC Directive, but in special in the 2004/35/CE Environmental liability Directive. This supports the Polluter Pays and Extended Producer Responsibility (EPR) and fosters manufacturers to favour closed-cycle manufacturing and recycling (UNEP 2011 Manufacturing).

In any case, in order to boost the impact of these measures, regulatory and control approaches should be combined with other policy instruments, such as market based instruments and voluntary agreements.

Market based instruments: economic incentives and disincentives

Market based instruments (MBIs) may be defined as .instruments or regulations that encourage behaviour through market signals rather than through explicit directives (Stavins 2000).

Market-based instruments are increasingly being considered for environmental protection (one of the three pillars of Sustainable Development, which is the ultimate goal of green economy) where regulatory approaches have had limited success in preventing environmental damage or traditional policy tools have not proofed so efficient. In recent years in Europe, increasing interest has been paid to the market based instruments for resource efficiency. The reason for this is that the aforementioned increasing resource demand represents a great challenge to the EU Manufacturing Sector. In this context, market based instruments may be categorised as follows:

- Price-based instruments change prices of products and services in order to highlight their impact. If the impact is considered negative, the instrument would increase its price (taxes). On the contrary, if the impact is considered positive, the instrument would be subsidy-like. E.g. Environmental taxes operate by raising the prices of resource use and pollution through taxing the relevant environmental emissions or resource use.
- Rights-based instruments specify new rights / obligations. That is to say, they pursue to control the amount of the resource to be used or the output to be released and limit it to the desired level.
- Market friction instruments are mechanisms which intend to make markets work better by improving information flows. These instruments are intimately related to voluntary action / agreements and for this reason will be dealt with in more detail in the below section.

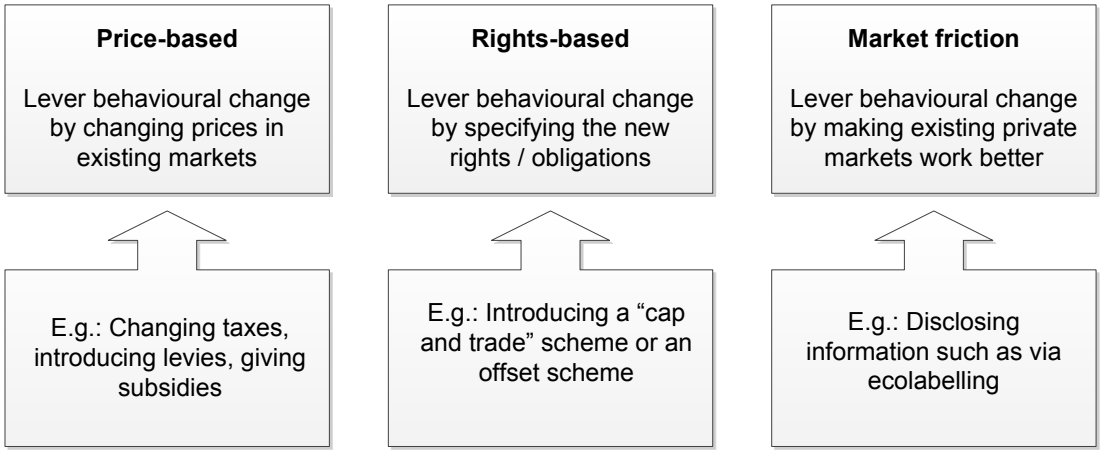


Figure 17 Typologies of Market Based Instruments. *Source: Whitten et al.*

Price-based instruments:

In relation to price-based instruments, environmental taxes saw a decline in the 2000s in Europe, probably partly due to higher international energy prices but also partly due to the emergence of the EU Emisstion Trading System, which would fall under the category of rights-based MBIs (Ekins et al.). The hypothesis is that such a policy instrument could contribute to a greener economy impacting on the three pillars of sustainable development: environmental improvement, the generation of economic activity and employment and the stimulation of green technologies and new environmental industries.

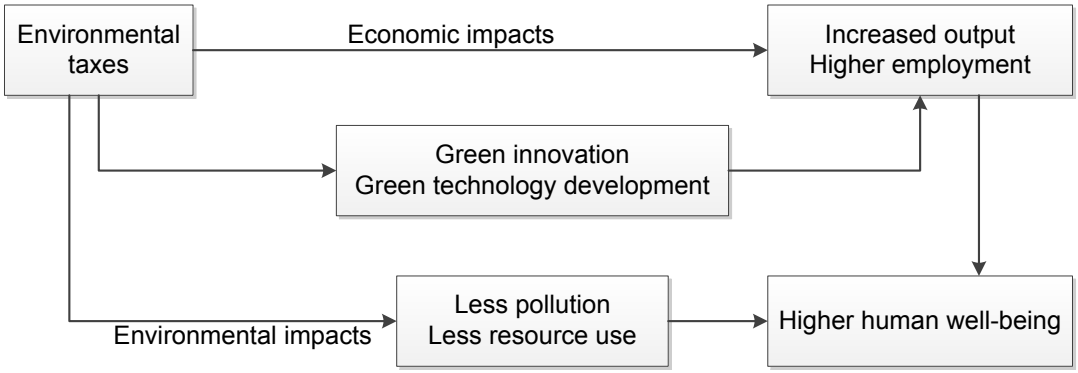


Figure 18 Hypothesized paths from ETR to higher human well-being. *Source: Ekins et al.*

Environmental taxes brought in approximately 290 million of EUR of revenue in 2010. The revenue from these taxes started to decrease in mid-2000s, having a low in 2008, when the economic crisis started. However, total taxes experienced a slight upturn in 2010.

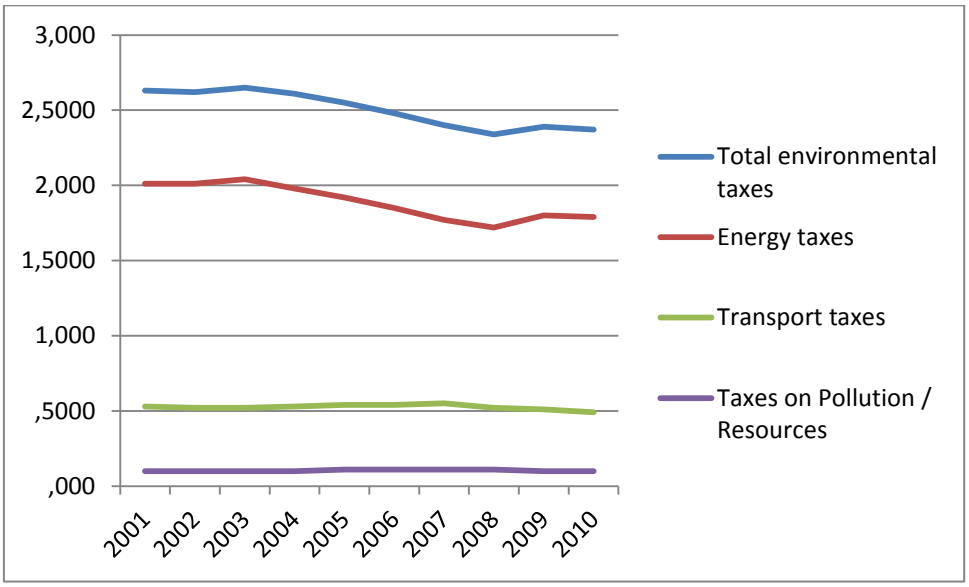


Figure 19 EU27 Environmental Tax Revenue as a percentage of GDP. *Source:Own elaboration with Eurostat data (ENV_AC_TAX).*

Revenues from environmental taxes in the EU-27, accounted for 2.37% of GDP and for 6.19% of total revenues from taxes and social contributions (TSC) in 2010.

Table 6 Environmental tax revenue in EU-27 as a share of GDP and of TSC. *Source: Eurostat.*

	2005	2006	2007	2008	2009	2010
% GDP	2.55	2.48	2.4	2.34	2.39	2.37
% TSC	6.54	6.29	6.09	5.95	6.24	6.19

It is remarkable that in terms of total tax revenues, the EU is above 2008 level (even if there has been a slight decrease in 2010). On the other hand, in terms of their share in GDP, they have remained approximately stable. This could suggest that these taxes are less volatile than others during a recession. However, this development, measured at the weighted EU average level, hides substantial differences between the Member States. Even in leading countries such as Denmark and the Netherlands, environmental tax revenue growth is not quite keeping pace with GDP growth (Rademaekers et al. 2011 c).

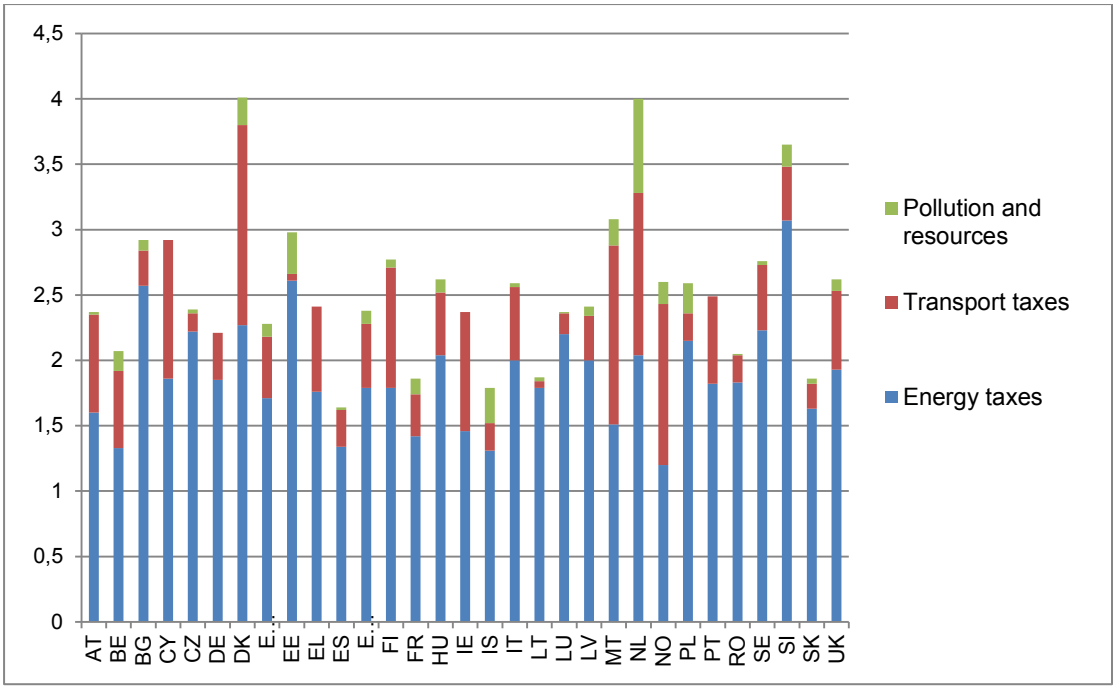


Figure 20 Environmental Tax Revenue as a percentage of GDP in year 2010.
Source:Own elaboration with Eurostat data.

In the EU the environmental taxes, which are taken account of, are charged on energy, followed by transport and to a lesser extent pollution and resources. This coincides with the trend in environmental taxing world-wide identified by the OECD. The OECD has also recognized that the taxes charging the source of pollution would leave a greater range of possibilities for innovation, while it would be more complicated when sources are dispersed and varied (OECD (2010). Taxation, Innovation and the Environment. OECD, Paris).

Subsidies or economic incentives are the other approach of price-based economic instruments, since they intend to foster certain type of behaviour. Along these lines, in the context of the global economic crisis, several governments have included subsidies for greening industry and cleaner technologies. In 2008 the EU launched the European Economic Recovery Plan, which identified an important number of green initiatives with a focus on energy-saving and climate-change related measures. This plan also foresaw providing incentives for the construction and auto industries to develop greener cars and energy-efficient buildings. The non-paper developed by DG ENV in the context of the above plan, provided an analytical overview of "green" efforts in Member States. The “green stimulus” provided by individual Member States is mostly focused on energy efficiency, renewable energy and greening transport. Even though some of the stimulus categories, such as waste treatment, energy efficiency, could also benefit the Manufacturing sector, in principle there is not specific stimulus for greening Manufacturing. In a historical context, certain subsidies have also prevented transformative investments in manufacturing, because they concealed the cost of externalities. For this reason, for an effective greening of manufacturing, special attention should be paid to avoiding environmentally harmful subsidies. Subsidies should aim for reflecting the full economic and social costs of resource use and pollutant emission (UNEP 2011). E.g. the EHS reform carried out by Germany in 2011, which led to a reduction of energy tax exemptions for companies and for the Manufacturing sector included the requirement for increasing its energy efficiency by 1.3% in 2013-2015 and 1.35% in 2016 (Withana et al. 2012).

Rights based instruments:

When it comes to rights-based instruments, in 1989 the EU introduced an atmospheric emissions regulatory approach through its Large Combustion Plant Directive, which is somehow the precursor of the EU Emission Trading System (EU ETS). The scheme (cap-and-trade type) pursues to meet the Kyoto commitments and it is a key piece of the European Union's policy to tackle climate change and to decrease industrial emissions cost-effectively

(it covers circa 11 000 industrial plants in 30 countries). The system has been fine-tuned over time, and in the future there will be a single, EU-wide cap on emissions and auctioning will become the default method for allocating allowances, progressively replacing free allocation. Emission trading has a higher potential in terms of as cost-effectiveness, long-term effects and dynamic efficiency, compared to control policy instruments. However, in recent years the EU ETS faces the challenge of a growing surplus of allowances, largely because of the economic crisis which has depressed emissions more than anticipated. That is why the Commission has decided to postpone the auctioning of some allowances. This would be favourable for heavy industries, which prefer allocation rather than auctioning.

Finally, no matter the MBI type, it should be noted that a critical factor in their success is a supportive broader institutional environment (Whitten et al.).

Voluntary action

In the EU there is a wide range of instruments available which have pursue to improve environmental behaviour of companies but which are not mandatory. These would be related to the market friction MBIs, since the goal of most of them is to stimulate markets to produce a desired resource efficient our environmental outcome by improving information flows. The most prominent instruments of this kind in Europe would be:

- Eco-Management Audit Scheme (EMAS)
- Environmental Technology Verification (ETV)
- Eco-label
- Retail Forum for Sustainability
- ECAP - Environmental Compliance Assistance Programme for SMEs

EMAS:

The EU Eco-Management and Audit Scheme (EMAS) is a voluntary management tool for evaluating, reporting and improving environmental performance of companies, as well as, communicating environmental achievements to stakeholders. In its origins, participation was restricted to companies in industrial sectors. Since 2001, however, EMAS has been open to companies from all sectors. In January 2010 the new EMAS regulation entered into force (Regulation (EC) No 1221/2009).

The rationale behind EMAS is that the interest in their environmental performance is increasing for companies, because proceeding without considering the environmental implications is no longer acceptable. Since EMAS is a voluntary scheme, the companies participating are those which have a proactive approach to environmental challenges look for ways to continually improve their environmental performance. It should be noted that the number of organizations (and sites) registered has been growing steadily since 1997. Currently, more than 4,500 organizations and approximately 7,800 sites are EMAS registered, of which almost 1,300 are companies in leading industries, as defined by EMAS.

Table 7 Number of leading industries registered in EMAS. *Source: EMAS Reports and Statistics*

Type	Count
Number of registered companies in 'Waste and disposal': NACE code 38	413
Number of registered companies in 'Fabricated metal products': NACE code 25	175
Number of registered companies in 'Electricity, gas': NACE code 35	241
Number of registered companies in 'Chemicals': NACE code 20	176
Number of registered companies in 'Manufacture of food products': NACE code 10	129
Number of registered companies in 'Manufacture of paper and paper products': NACE code 17	93

Environmental Technology Verification (ETV)

In 2001 the European Commission launched the EU ETV Pilot Programme. Environmental Technology Verification (ETV) is a tool to help innovative environmental technologies reach the market. Nowadays, innovative and clever new technologies face barriers in their uptake and commercialization because of the uncertainty in performance inherent to their novelty. Under ETV, claims about innovative environmental technologies are verified by qualified third parties, hence providing evidence that the vendor claims about the innovation and performance are both credible and scientifically sound. This instrument provides information on new environmental technologies which could make greener the manufacturing sector.

Eco-labeling

The increasing demand for eco-labels resides in the fact that companies have acknowledged that in a climate of increasing environmental awareness, these labels could provide a competitive advantage. As such, eco-labelling is a voluntary method for certifying and labeling the environmental performance of a product or service. That is to say, an eco-label is a label which highlights the environmental benefits of product or services in relation to other products or services in its category. In contrast to other types of green-labeling, eco-labels are based upon third party verification.

The International Standard Organization (ISO) has developed the below norms in order to standardize the eco-label awarding criteria:

- ISO 14020 Environmental labels and declarations – General Principles
- ISO 14024 Environmental labels and declarations – Type I environmental labelling – Principles and procedures
- ISO 14021 Environmental labels and declarations – Self-declared environmental claims (Type II environmental labelling)
- ISO 14025 Environmental labels and declarations – Type III environmental declarations – Principles and procedures

With these norms, the ISO defined three labeling mechanisms.

- Type I: only 10% of the products within a sector may obtain it. It is restricted to the best-performing ones.
- Type II: they are self-declarations, rather than eco-labels and they are developed and approved by the company itself.
- Type III: These provide environmental data in relation to product or service.

Table 8 Overview of eco-labeling characteristics. *Source: Workshop on "Eco-labeling" Bilbao, 3rd November 2010.*

ISO 14020 Eco-labels and Environmental Product Declaration	Type I Eco-labels	SEMI Type I Eco-labels	Type II Self-declaraions	Type III EPD
ISO Norm	ISO 14024	N.A.	ISO 14021	ISO 14025
Short description	El producto que la lleva cumple con unos requisitos ambientales predefinidos, consensuados por entidades reconocidas y de acceso públicos	El producto que la lleva cumple con unos requisitos ambientales predefinidos, consensuados por entidades reconocidas y de acceso públicos	El fabricante hace sus propias etiquetas medioambientales , en forma de símbolos o gráficos, definiendo sus propios criterios MA	Informe técnico que resume los datos más significativos del comportamiento ambiental de un producto.
Identifies eco-products	Yes	Yes	Yes (?)	No
Verification / Certification	- Verification compulsory (independent third party) - Certification: third party.	- Verification compulsory (independent third party) - Certification: third party.	- Self-verification - Self-certification	- Verification: compulsory (ISO 14025 or PCR): obligatoria (ISO Certification: voluntarya
Credibility	High	High	Low	High
Need to comply with environmental requirements	Yes. Life Cycle	Yes. Specific.	Voluntary. General and / or specific.	No
Environmental information provided	Low	Low	Variable	High
Cost	High	Medium / High	Low	High
Widespread recognition	- Client: High - Consumer: Low The goal is to award the "best in class" in products	- Client: High - Consumer: High The goal is to award as many products as possible.	- Client: Low - Consumer: High	- Client: Low - Consumer: Low Information usually does not reach the end-user.
Examples				

Retail Forum for Sustainability

The European Commission and the European retail sector launched the Retail Forum in 2009 as a contribution towards a more sustainable Europe. The rationale of the Forum is that retailers are placed between producers (e.g. manufacturers) and consumers. Therefore, they are in a strategic position to influence both and promote more sustainable consumption and production processes. In such a context, the Retail Forum is a multi-stakeholder platform set up in order to exchange best practices on sustainability in the European retail sector and to identify opportunities and barriers that may further or hinder the achievement of sustainable consumption and production.

ECAP - Environmental Compliance Assistance Programme for SMEs

The Environmental Compliance Assistance Programme for SMEs (ECAP) was set up to make it easier for SMEs to comply with their obligations and improve their environmental performances. This programme aims to (1) minimise the administrative burden on companies, (2) help SMEs integrate environmental concerns into their businesses, (3) support regional and national networks, (4) build up local know-how, (5) improve communication and (6) provide funding. It disseminates best-practices, provides toolkits, organises workshops, etc.

During 2010 and 2011 a study on the on the implementation of ECAP and on the contribution of SMEs to environmental impacts, and their rate of compliance with environmental legislation, was carried out. This review to be completed within the framework of the Sustainable Consumption and Production/Sustainable Industrial Policy review was due for autumn 2012.

Nonetheless, this increasing number of voluntary actions and potential voluntary agreements may also be considered under a different perspective. In the words of Olivier Hoedeman (Corporate Europe Observatory) to Euractiv:

> "*This growing shift to voluntary commitments in environmental matter means there is an essential factor that's being left out – and that's simply that of government action. It's a standard industry strategy to propose voluntary agreements to avoid regulation.*"

To sum up, as aforementioned, there would not be a one-size-fits-all solution, neither a most prominent policy instrument. The key would be a policy-mix successfully combining different types of policy instruments, ranging from command and control, to voluntary actions. In addition, to an effective policy-instrument implementation, these need to be supported and periodically reviewed. Moreover, in the case of MBIs, perception of the instrument itself is also vital.

4 Concluding remarks

Manufacturing is essential if Europe is to remain a global economic leader. The importance of intensifying Europe's industrial has been recently acknowledged. Voices towards de re-industrialization (relocalization) of Europe have raised, i.e. Antonio Tajani, the EU commissioner in charge of Enterprise and Industry, presented a communication in October 2012 to promote the re-industrialization of Europe. Moreover, in the context of the economic crisis, this re-industrialization is regarded as a mean to underpin the recovery of economic growth and jobs. Along these lines, the European Commission aims at industry's share of GDP increasing from 16% to 20% by 2020.

BOX 4: European Commission Vice President Antonio Tajani, Commissioner for Industry and Entrepreneurship:

"*We cannot continue to let our industry leave Europe. Our figures are crystal clear: European industry can deliver growth and can create employment. Today we tabled the conditions for the sustainable reindustrialisation of Europe, to develop the investments needed in new technologies and to rebuild a climate of confidence and entrepreneurship. By working together and restoring confidence, we can bring back industry to Europe.*"

Nonetheless, current manufacturing is a resource intensive sector because traditionally its core activity (production process) has depended heavily on resources, both energy and raw materials and as a consequence generates waste and emits pollutants. According to UNEP (UNEP (2011)) Manufacturing is responsible for around 35 per cent of global electricity use, over 20 per cent CO2 emissions and over a quarter of primary resource extraction. In this context, it accounts for up to 17 per cent or air pollution-related health damage. In addition, global demand for material extraction and processing is expected to double over the next 40 years, with critical implications for greenhouse gas (GHG) emissions and other pollutants, as well as resource security (Allwood et al. 2013). That is to say, the production and consumption system has contributed to rapid resource depletion, the degradation of ecosystems, and the threat of climate change (Stamm, A. et al. 2009).

Therefore, resource efficiency measures are needed to revert this depletion and degradation trend, particularly since manufacturing uses a third of global energy, mostly in the production of bulk materials. Accordingly, the shift towards a green(er) Manufacturing is ineludible to achieve a sustainable future (in economic, environmental and social terms). That is to say the green economy transition implies a structural change from the traditional brown industry to an environmental friendlier sector. It should be noted that according to UNEP (UNEP 2011) direct job effects of greening manufacturing may be neutral or small, the indirect, however, effects might be significantly higher. However, in the context of a Europe wide sustainable re-industrialization, in the words of Antonio Tajani, the green transition could potentially improve both environment and create employment.

However, potential rebound effects should not be neglected. Technology improvements in resource efficiency have been outpaced by economic growth. Therefore, overall resource and energy consumption has not decreased. That is why the impact of technological innovation on resource efficiency needs to be enhanced (Stamm et al. 2009). Along these lines, sustainable manufacturing will become a reality seems to be hardly a question of technological opportunities alone. New technology, socio-economic factors, and the policy framework will jointly determine the dynamics of change. The scenarios indicate that progress towards sustainability will depend on the successful alignment of technological, organisational, and societal factors that are required for 'system changes' towards sustainability. (Geyer et al. 2003). Policy is needed to achieve effective decoupling, and technology development and deployment will have to play a crucial role. (Geyer et al. 2003, Stamm et al. 2009, UNEP 2011). Furthermore, policy is needed to stimulate the green transition in industry, since according to Aghion et al (2011), in the absence "in the absence of government intervention,

economies will tilt towards dirty innovation to a socially suboptimal extent". Thus, there is a role for policy to boost technological change towards clean innovation Aghion et al (2010),

All in all, the challenge for Europe is how it can design and govern manufacturing policies that foster material efficiency and yet are competition-friendly and thus growth-enhancing (Allwood et al. 2013).

Against the backdrop of the above challenges, the policy actions identified to overcome the challenges / barriers identified would be:

Policy message 1: Improve access to knowledge
One of the more often quoted barriers for manufacturing industries is the lack of access to information and knowledge. Therefore, measures improving the access to knowledge and facilitating knowledge spillovers would be very beneficial. E.g. creation and support of knowledge networks, reinforce the linkages between all actors, dissemination of good practices, etc.

Policy message 2: Raise public awareness
Increasing resource efficiency is in the interest of the manufacturing industry. Therefore, this transition is likely to take place, even if the motivation may be either "green transition" driven or "lowering costs" driven. However, part of this transition will bring a paradigm change and thus will also require a strong public commitment and support, e.g. the renewable energy transition and subsequent infrastructure requirements (Geyer et al. 2003). In addition, meeting consumer demands is one of the most powerful drivers for change.

In such a context, awareness raising and increasing public participation is essential. E.g. information campaigns, marketing (including control on green commercial claims), etc. oriented to foster a green consumer behaviour.

Policy message 3: Lower financial burdens
Design Market Based Instruments (MBIs) to address the lack of financial incentives issue. E.g. promote benchmarking, reform taxes and subsidies (i.e. EHS) so that they support resource efficiency, make use of green procurement approaches, etc.

Improve access to finance and funding, e.g. to facilitate the implementation of green innovations.

Policy message 4: RDI investments to fill knowledge gaps
Some manufacturing subsectors (e.g. Steel) are technologically very mature and as such, current technologies are reaching performance limits and the potential for resource optimization are almost fully exploited.

In such a context, and related to the aforementioned financial burdens, RDI investments are need for researching technological and innovation breakthroughs. E.g. further support to to address the limits of BAT.

Policy message 5: Introduce eco-efficiency indicators
So far, progress has been made on consumption of resources measurement. However, there is yet progress to be made on developing the right resource efficiency indicators. These eco-efficiency indicators would enable to set a measurement framework to monitor progress towards resource efficiency and would benefit the policy-making process at the EU level.

Policy message 6: Increase policy support to the transition
All in all, the policy framework should promote the green transition and discourage "business as usual" behaviour. However, in some cases it has been found that regulation is not exploited to its full potential, e.g. for encouraging material recovery from WEEE, or for maintaining status quo (Rademaekers et al. 2011b and UNIDO 2011b).

That is why, it is of utmost importance to exploit to its full potential the EU policy framework, so that it promotes recovery of materials and waste separation, fosters industrial symbiosis and cradle-to-cradle approaches, etc. All of which should be complemented with policy impact assessment, monitoring and evaluation.

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6 ANNEX: Territorial dimension of Manufacturing – A snapshot

Table 9 Territorial factors of Manufacturing.

Are the following *territorial factors* important in relation to greening of the sector:		
1. ***Settlement types***	***y/n***	***Why? Why Not?***
i. Urban areas	***Y***	According to econometric analyses, one of the principal forces determining industrial location is the availability of high-education human capital. This is especially the case for high-tech sub-sectors such as, pharmaceutical, computer and electronic equipment etc. In addition, another factor to be taken into account is where in the value-chain, belongs each subsector. The more in the middle, that is to say, the stronger the upstream and downstream linkages, the more sensitive it is towards where to establish, usually tending to be based in central countries / regions with a good accessibility / mobility (Jovanović, 2011). Moreover, the relatively high geographical concentration of related firms in relatively small areas facilitates knowledge spillovers and fosters further concentration. This agglomeration in central areas trend is more pronounced in the case of industries with a high degree of increasing returns to scale.
ii. Rural areas	***N***	
iii. Urban-rural interactions	***N***	
2. ***Land and land-based resources***	***y/n***	***Why? Why Not?***
i. Land consumption or dependence	***N***	Besides, manufacturing is not especially dependent on land consumption, apart from plant location. However, it is indirectly dependent on land-based resources, through raw material consumption requirements. Indeed, manufacturing, particularly heavy industry, is a resource intensive sector and as such, immobile production factors, i.e. natural resources are the relevant feature leading to the geographical dispersion of some manufacturing industries. Localized natural advantages such as coal and iron resources have traditionally played a significant role both on manufacturing location and on the specialization of the respective regions. Nevertheless, this influence is declining, even if it is not clear what the reason for this is. It could be due to structural changes (e.g. change of demand preferences, change of technologies, etc.) or to increasing EU integration. Allegedly, this trend will be further strengthened by the greening of the economy. When it comes to greening manufacturing vs. traditional manufacturing's resource intensity, attention should be paid to resource efficiency approaches. In special to cradle-to-cradle and industrial symbiosis approaches, where the emphasis is in minimizing waste generation, while enhancing resource productivity.
ii. Material Consumption or dependence	***Y***	
iii. Energy consumption or dependence on specific energy types or systems	***Y***	
iv. Management of ecosystem services (types of ecosystems/landscapes; spatial characteristics of ecosystems; options for maintaining and developing these services)	***N***	
3. ***Market relations (Production; consumption; export, import) and innovation***	***y/n***	***Why? Why Not?***

Are the following *territorial factors* important in relation to greening of the sector:			
i.	Local/regional markets	***Y***	The ongoing European integration process is deemed likely to increase trade and factor mobility thereby affecting the division of labour and production between countries and regions, and thus the core-periphery divide of regional incomes. In fact, the issue of market potential in the EU remains an area of interest since there is a belief that accessibility could explain the core-periphery patterns. However there is an on-going discussion about the methodology and variables to apply in order to measure accessibility, In fact, different approaches, deliver different measures of regional accessibility, which makes it hard to come to a conclusion (Combes and Overman, 2003). In the period following the completion of the Single European Market, lagging regions saw an improvement in economic performance. The spread to economic activity to peripheral countries was limited and mainly due to (labour) cost advantages, thus focused on labour intensive industries. This is consistent with the view that as costs of trade fall for products of certain industries, the periphery may become more attractive for investment as the returns on the capital are greater. Therefore, the change in the production structure data in the EU found certain support in the modification in the structure of EU trade. That is to say, the Single Market has had certain empirical effect in the manufacturing structure in both accession countries and already member states. Nonetheless, research results in relation to trade barriers and trade liberalization have not been conclusive with regard to their impact in manufacturing concentration, the accession to the EU.
ii.	National markets	***Y***	
iii.	EU markets	***Y***	
iv.	Global markets	***Y***	
4.	***Inter- and intra-territorial relations***	***y/n***	***Why? Why Not?***
i.	Within territories (place based; local cultures; relating to territorial/national policies)	***Y***	When it comes to trade, it should also be bore in mind that geography in space (or in culture) tends to limit competition as it creates distance (physical or perceived) and costs among producers, sellers and their clients. If costs of trade are high, industries tend to disperse. When this cost is reduced agglomeration can take place as demand in distant places can be met by exports.
ii.	Between territories (networks; competition)	***Y***	
iii.	Across territories (cross-border supply and demand)	***Y***	
5.	***Place-based factors***	***y/n***	***Why? Why Not?***
i.	Competitiveness through strong local economies	***Y***	As mentioned above, proximity influences the costs of trade and hence the distribution of companies (dispersed across regions if costs are high, concentrated if costs are low). The skilled labour force is also a determining factor, in especial for knowledge intensive industries. This factor is especially relevant in the EU, since EU workers are rather reluctant to move region / country because of work, this leading to manufacturing being more dispersed in the EU than in the US (where employee mobility is high and so it is regional specialization by sector), because industries locate where trained workforce is.
ii.	Multi-functionality	***N***	
iii.	Tacit/experiential knowledge	***Y***	
iv.	PROXIMITY	***Y***	

Are the following *territorial factors* important in relation to greening of the sector:		
		Moreover, clustering promotes knowledge spillovers. There is a variety of practical examples, which confirm that regions and cities play an important role in developing innovation, successful regions and cities becoming European or global knowledge nodes or networks.
6. ***Consumer relations***	***y/n***	***Why? Why Not?***
i. Are development and innovation consumer-demand driven?	***Y***	It is remarkable that when it comes to manufacturing in the EU, innovation goes hand in hand with public-private partnership i.e. Factories of the Future, which is is one of the three Public-Private Partnership included in the Commission's recovery package, consisting of a research programme to support the manufacturing industry in the development of new and sustainable technologies. On the one hand, producers seek to reduce costs by producing more, while consuming less material, using less energy and creating less waste. On the other hand consumers demand greener products as the increasing number of eco-labeling schemes portrait. In addition, new technologies, like telecom, electronics and biotechnology, are also changing production patterns and consumer choices in a way difficult to assess yet.
ii. Are development and innovation producer driven?	***Y***	
iii. Are development and innovation based on well-defined territorial conditions or on open access?	***N***	
7. ***Accessibility and mobility***	***y/n***	***Why? Why Not?***
i. Transport connections (transport of materials; transport of labor)	***Y***	Transport is essential for the functioning and development of economies. When it comes to Manufacturing, it becomes essential, since it makes raw materials available to producers, enables the distribution of product and also provides the link between jobs and workers. In addition, transport is also a sector in its own right, but that would fall out of the scope of the current analysis. Transport connections and accessibility have conditioned the territorial distribution of sectors. As above mentioned, sectors with strong upstream and downstream linkages tend to establish in central countries / regions with a good accessibility / mobility. However, over the years, decreasing transport costs have led to de-concentration. It should also be taken into account, that until the global economic crisis of 2008, the trend was to delocalize Manufacturing within Europe and/or from Europe to the rest of the world. From the transport connections point of view, the globalization phenomenon and the EU's Eastern enlargement caused a rapid increase of population mobility and exchanged goods among the countries of the old and new Europe, and especially between Europe and the rest of the world. Recently, however, voices towards de re-industrialization (*relocalization*) of Europe have raised, i.e. Antonio Tajani, the EU commissioner in charge of enterprise and industry, presented a communication in October 2012 to promote the re-industrialisation of Europe.
ii. Regional Accessibility (access to markets; access to supply of materials; access to public services)	***Y***	
iii. Information connections (use of communication and information services; need of interaction; questions of consumer and producer cultures)	***N***	
8. ***Policy and governance by territorial level***	***y/n***	***Why? Why Not?***
i. Scale of sector-based policy support		At EU level there is a vast number of policy documents supporting the transition towards a greener

Are the following *territorial factors* important in relation to greening of the sector:		
• From the EU Level	***Y***	manufacturing sector. For the last decade, the policies dealing with Manufacture in the EU have been mainly oriented to: - Limiting environmental damage. E.g. Water Framework Directive (WFD), Industrial Emissions Directive, Emissions Trading Scheme (ETS). - Creating jobs. E.g. An Integrated Industrial Policy for the Globalisation Era - Increasing productivity. E.g. Some Key Issues in Europe's Competitiveness, Thematic Strategy on the sustainable use of natural resources. At the national level, the numbers of countries with a resource efficiency or raw material strategy is increasing (e.g. Austria, Denmark, Finland, France, Germany, Greece, Netherlands, Portugal and United Kingdom). Thus, there is an indirect support for greening manufacture, even if not explicitly addressed to manufacture. Finally, at the regional level, it could be possible for regions to fix stricter emission levels than those in the European directives. Fostering, in this way, industry becoming greener.
• From the national level	***Y***	
• From the regional level	***N***	
• From the local/municipal level	***N***	
ii. Role of other EU policies with territorial dimension	***N***	So far, the policies dealing with manufacturing have not included an explicit territorial dimension. That is to say, they are sector-based and place-blind.
iii. Private versus public sector – led development. Are consumer organizations advocating for developing the green economy. At what political scale are they located?		Manufacturing is a diverse sector in terms of size (big companies versus SMEs), subsector (ranging from food processing to metals), so the challenges the sector faces are also diverse. However, it could be generalized, that the wide range of voluntary instruments, which pursue to improve environmental the behaviour of companies, somehow reflect the environmental awareness. E.g.: • Eco-Management Audit Scheme (EMAS) • Environmental Technology Verification (ETV) • Eco-label • Retail Forum for Sustainability • ECAP - Environmental Compliance Assistance Programme for SMEs

Table 10 Territorial outcomes of Manufacturing.

Territorial outcomes of greening the sector:	
Inter- and intra-territorial relations	Even if it is not possible to assess it yet, it could be expected that the greening of Manufacturing sector across European countries, would create a community beyond regional / national borders, a community of green manufacturers, which would exchange good practices and lessons learnt. This could potentially contribute to reducing distance (physical or perceived) and hence re-shape inter-and intra-territorial relations.
Settlement types	Current green economy trends suggest that (1) those industries creating synergies will show a natural tendency to cluster, and (2) that those industries treating industrial waste and residuals will tend to locate nearby larger polluting plants.
Land and land based resources	The most promising outcome of greening manufacturing would be to make it less resource intensive, make it more efficient, by means of re-use and recycling. E.g. cradle-to-cradle approaches, eco-design, industrial symbiosis, etc.
Market relations (Production; consumption; export, import) and innovation	It is to be expected that greening manufacturing (and its products) will raise consumer awareness, which in turn will push for even a greener production, in a virtuous circle.
Place-based factors	One of the outcomes to be expected from greening manufacturing is the reinforcement of existing knowledge-networks and clusters, but also the creation of new ones, contributing to the dissemination of good practices and resulting in an enhanced green transition.
Accessibility and mobility	Transport (of materials and products, especially) is a pillar for the functioning of manufacturing and it has also conditioned the location of manufacturing industries to some extent, i.e. transport costs. The relation of accessibility and mobility with the greening of manufacturing cannot be evaluated straight forward. On the one hand, re-industrializing Europe would decrease transport needs and hence reduce the environmental impact of manufacturing. But, on the other hand, reinforcing the industrial activity of Europe (even if this industry is greener than before), would increase certain environmental implications (emissions, waste, etc.). Therefore, the evaluation of trade-offs should be carried out on a case-by-case basis.
Policy and governance by territorial level	There is a wealth of evidence that regions and localities can play a significant role in pursuing sustainable development (the ultimate goal of greening the economy), mainly because of their closeness to not only local environmental problems, but also to local know-how on how to overcome challenges. Along these lines, the greening of Manufacturing, in this case, should go hand in hand with EU and national policies integrating the territorial dimension, in addition to the sectoral perspective.

7 ANNEX: Manufacturing non-policy factors – A snapshot

The industrial sector causes much damage to the environment, either by the production processes involved or by manufactured products that pollute and/or generate disposal problems after use. Manufacturing is responsible for around 35 per cent of global electricity use, over 20 per cent of CO2 emissions and over a quarter of primary resource extraction (UNEP, 2011).

Table 11 Technological lock-in barriers.

Factor	Technical or technological lock-in and path dependence in the industry sector
Description	The technological development towards a pattern of production less aggressive to the environment is seen as a partial solution to the problem (Tilman Santarius, 2012). Technological change in the direction of cleaner technologies entangles innovation. The innovation process corresponds to all the activities that generate technological change and dynamic interaction between them, not necessarily primary inventions alone. Against this background, the European Commission defines eco-innovation as any innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole lifecycle. Eco-innovation can be found in all forms of new, or significantly improved, products, goods, services, processes, marketing methods, organisational structures, institutional arrangements and lifestyle and social behaviours, which lead to environmental improvements compared to relevant alternatives (European Commission (EC) – DG REGIO (2012)). While innovating, companies seek solutions to problems that are tackled within, and often created by, a given technological paradigm. Thus, once the technological paradigm is established, innovations become selective in the ability to solve problems, while hindering other solutions that would be outside the technological paradigm in that specific period. In other words, technologies are elected according to the predominant features of the selective environment. Liebowitz & Margolis (1995) illustrate how under the different forms of path-dependency mechanism technologies become more attractive as they are more used. That is, the technology is not elected because it is the most efficient, but it becomes more efficient because it has been elected. Formally, the process can adopt the form of temporal autocorrelation in linear modelling. This can lead to a socially undesirable technology lock-in effect – where lock-in is defined as market dominance of an inferior incumbent technology at the expense of a superior contender. When there are two or more technologies that are substitutes, profit-maximizing innovators may focus their efforts on improving productivity of existing technologies to the extent that the market size for these technologies is large and the return higher technology (Dutz & Sharma, 2012). This way, companies get caught in the more widespread technology linked to the prevailing technological paradigm. These events have major effects on the company's ability to find solutions to specific problems, that is, on its ability to innovate, including in the direction of Environmentally Friendly Technologies (EFTs). Hence, technology has temporal interdependence (path-dependent) since it is the result of predefined trajectories (Lustosa, 2011). In addition, currently, existing environmental technologies (e.g. BAT) are not necessarily widely used nor adopted on an industry-wide level, for many reasons, including lack of access to finance, long pay back time, and access to knowledge. Moreover, having reached the technical limits in some industries find little incentive for investment in resource efficiency measures (Raedemakers et al. 2011b).
Specificity for the green economy	Although this factor is not specific for the green economy transition, it is a key element for technological transitions in general. Considering that the shift towards a green economy also involves a technological transition to a post-

Factor	Technical or technological lock-in and path dependence in the industry sector
	carbon low-resource economy, the selection of path-dependency as one of the headline factors for the green manufacturing sector seems completely justified.
Provable impact on the green economy spheres	**Economic: negative impact (-)** There are countless examples on how path-dependence links to the economic sphere, impacting the efficiency of many markets. See for example of Messner (2002) for a empirical evidence on the substitution of copper for aluminium and Kalkuhl et al. (2012) for market failures in energy innovations. **Environmental: negative impact (-)** Countless contributions argue that industrial economies have been locked into fossil fuel-based energy systems through a process of technological and institutional co-evolution driven by path-dependent increasing returns to scale. See for example Unruh (2000) for an overview of such general approach. **Social: uncertain to negative impact (o/-)** Current institutional arrangements, including the lack of incentives for the private sector to innovate for sustainability, and the lags inherent in the path dependent nature of innovation, contribute to lock-in, as does our incapacity to easily grasp the interactions implicit in complex problems, referred to here as the ingenuity gap. Large-scale transformations in information technology, nano- and biotechnology, and new energy systems have the potential to significantly improve our lives; but if, in framing them, our globalized society fails to consider the capacity of the biosphere, there is a risk that unsustainable development pathways may be reinforced. Nonetheless, promising social and technical innovations with potential to change unsustainable trajectories need to be nurtured and connected to broad institutional resources and responses (Westley, Olsson, Folke, et al., 2011). A more articulated and critic approach can be found in Mahoney, J. (2000) **Territorial: unknown/unexplored to negative impact (o/-)** Martin and Sunley (2006, 2010) and Martin (Martin, 2011) have argued that in many important aspects, path dependence and lock-in are place-dependent processes, and as such require geographical explanation. Authors claim that “path dependence may help explain why regional growth disparities persist; it may help explain why particular industries and technologies develop in certain locations but not in others; and it may help us to understand why some regional economies are better able to adapt over time than others” (Martin & Sunley, 2010, p. 3). However, authors argue that the precise meaning of “regional lock-in” is unclear, and little is known about why it is that some regional economies become locked into development paths that lose dynamism, whilst other regional economies seem able to avoid this danger and in effect are able to ‘reinvent’ themselves through successive new paths or phases of development. The issue of regional path creation is thus equally important, but has been rarely discussed. Authors conclude that whilst path dependence is an important feature of the economic landscape, the concept requires further elaboration if it is to function as a core notion in an evolutionary economic geography.
Trade-offs: mixed +/- impacts on green economic spheres?	In this specific case, there are not provable trade-offs between the green economy spheres. All the dimensions involved are impacted negatively, particularly the territorial dimension. For example, path-dependence could explain why some attempts to create new industrial development or clusters fail in some regions, because it can constrain the scope for policy-makers to influence regional economic outcomes (Martin, 2011).
Externalities: impact on other sectors /	Technological lock-in and path-dependence within the industry sector has obvious impacts on other sectors such as e.g. transport, building and

Factor	Technical or technological lock-in and path dependence in the industry sector
case studies	construction, as well as water and waste management.
Interactions with other factors	In a context of path-dependence, when difficulties increase and finding solutions becomes more complicated, there is a strong incentive for a shift on the technological paradigm. Still, in order to a new technological paradigm to emerge, it is necessary that advances in basic knowledge occur, as well as other institutional and market factors. Thus, technological transitions towards environmental sustainability are characterised by involving many aspects (economic as well as non-economic factors such as (1) development of specific capabilities of enterprises, (2) infrastructure and (3) institutional changes) included in an evolutionary process that faces nonlinearity, cumulativity and temporal interdependence.
Causal level of operation (proximate/direct versus underlying/indirect factors)	Direct/proximate Technological lock-in and path-dependence within the industry sector is clearly a barrier directly preventing new environmentally-friendly technologies to spread and disseminate. More than triggering a given process, what technological lock-in and path-dependency do is preventing economic-efficiency driven factors to operate within a given economic context. Thus, it can be said that path-dependency blocks technological triggers.
Spatial level of operation (internal versus external factors)	External Technological lock-in and path-dependence within the industry sector can be labelled as an external barrier, whose manifestation on specific territories might vary..
Type of market force involved	Supply-side factor
Policy recommendations: making the link between policy and non-policy factors	"Policies to redevelop a region's economy are more likely to succeed if they take proper account, and built upon, the legacies (specifically, of course, the strengths and competences) inherited from the region's previous developmental history"(Martin, 2011, citing Sydow, Lerch & Staber, 2010). "At the same time, a path-dependence approach may help identify appropriate moments of policy action, such as when a new technological and industrial path appears to be emerging in a region. Policy intervention at this stage can help establish the new path, for example by promoting externalities of various kinds, or perhaps even steer in different directions. More generically, path-dependence suggests an important role for regional policies that are aimed to foster and facilitate constant cumulative adaptation and innovation in a region's economy so that its industrial development paths do not get 'locked-in' and the region does not lose its dynamic competitiveness" (Martin, 2011).
Possible indicators	Temporal autocorrelation in the penetration of specific technologies

Table 12 Economic drivers

Factor	Economic drivers
Description	The principal driver for change in Manufacturing is economic. Either as direct cost reduction (savings) or as indirect cost reduction (increasing productivity). In such a context, resource efficiency is a strategy for cost reduction, by: • Increasing energy efficiency (since Manufacturing is very energy-intensive) • reducing emissions and waste • maximising material efficiency: doing more with less and wasting not. In addition it is also a strategy to reduce vulnerability in the context of material scarcity, changing prices, energy security, etc. In the end it contributes to increasing productivity and thus competitiveness.
Specificity for the green economy	Since cost reduction most often takes place by increasing resource efficiency, this driver is by definition the greening of Manufacturing.
Provable impact on the green economy spheres	**Economic: uncertain impact (+/-)** In theory, an enhanced resource efficiency at firm level should have a positive impact at firm level. However, studies examining the impact of resource efficiency measures on the competitiveness of the firm have not been decisive. Some showed that investment in resource efficiency is likely to increase firms' competitiveness (e.g. through improved sales), while others attributed the lower market shares to the higher prices associated with better environmental performance. (Raedemakers et al. 2011b). **Environmental: positive impact (+)** Resource efficiency by definition reduces environmental pressures associated to resource use (doing more with less, waste no, etc.) **Social: positive impact (+)** A more resource efficient Manufacturing sector will deplete environment less, which is positive for the society as a whole. **Territorial: unknown (o)**
Trade-offs: mixed +/- impacts on green economic spheres?	
Externalities: impact on other sectors / case studies	Manufacturing sectors also have the highest multiplier effects; inter-linkages can generate positive, but also negative, changes in terms of production or employment in other sectors (European Commission (EC) DG Enterprise and Industry (2011)). Therefore, the potential of having an impact on other sectors, such as transport and construction is high.
Interactions with other factors	This driver is potentially linked to the technological lock-in barrier. In some cases even if the motivation exists, the right technologies might not be in place and limit the deployment of resource efficiency measures. In addition, financial barriers and economic drivers are inter-related. However, while the first is demand-side driven, the latter is supply-side driven.

Factor	Economic drivers
Causal level of operation (proximate/direct versus underlying/indirect factors)	Proximate/direct Reducing costs by means of increasing resource efficiency directly makes Manufacturing greener.
Spatial level of operation (internal versus external factors)	External Economic drivers within the industry sector can be labelled as an external barrier, whose manifestation on specific territories might vary.
Type of market force involved	Supply-side factor
Policy recommendations: making the link between policy and non-policy factors	• Foster benchmarking, labeling, etc. • Improve waste separation policies • Correct pricing of resources • Raising awareness • Technical assisstance programmes • Access to finance • Foster adoption of BAT • Investement in technology breaktrhoughs
Possible indicators	Change in time of: • Domestic material consumption (DMC) • Raw Material Consumption (RMC) • Energy consumption • Waste generation by EWC And analyze if decoupling from GVA.

Table 13 Financial barriers

Factor	Financial barriers
Description	Even if cost reduction is a strong driver for Manufacturing to pursue change, the external economic dimension, the financial factors, may hinder resource efficiency in industry: **Misalignment of incentives** Across one value chain, incentives for resource efficiency may not necessarily be aligned. Misalignment of incentives across the EU for resource efficiency creates varying incentives across industries. For the industry representatives interviewed by Raedemakers' (2011b) resources in the EU are managed at a national level rather than at an EU level, and even if the EU sets the framework, national legislations vary. One of the consequences of this is that multinationals face difficulties exporting waste to other countries (intra EU) as they have to comply with different technical specifications. **Lack of incentives** Absence of financial incentives in the form of tax breaks and subsidies, for example, are important elements missing from the picture of resource efficiency at EU level and investment in resource efficiency measures may not be affordable straight forward. E.g. limited financial incentives makes the export of scrap material cheaper than local recycling. **Lack of market demand:** Contributing to the lack of financial incentives is the long pay back time for large investment. Large investments in resource efficiency often result in product price increase. This latter, although justifiable from the environmental and the investor's perspectives, may not meet the market demand it is expected to. Thus for the firm it will mean a loss in market share and competitiveness. In addition to the "acceptance" factor, consumers' choices are usually influenced by short-term considerations and habits. As such, consumers' choices may not necessarily coincide with the more sustainable solutions. In addition, market failures can distort market prices and send the wrong cost information to economic actors, serving as a barrier to the green transition. (Raedemakers et al. 2011b and UNIDO 2011b).
Specificity for the green economy	Financial barriers are the main hampering factor for the green economy transition.
Provable impact on the green economy spheres	**Economic: negative impact (-)** In the short term it could occur that it is less costly for companies not to invest in resource efficiency. However, in the long run they will become less productive and competitive and will have a negative economic impact. **Environmental: negative impact (-)** The hindering of investments in greater resource efficiency clearly have a negative impact in the environment. **Social: negative impact (-)** In addition to the negative social impact of a depleted environment, the fact that this absence of implementation of resource efficient approaches, also hinders the growth of green jobs in the field of environmental technologies. **Territorial: unknown/unexplored to negative impact (o/-)**
Trade-offs: mixed +/- impacts on green economic spheres?	As mentioned above, manufacturing sectors also have the highest multiplier effects; inter-linkages can generate positive, but also negative, changes in terms of production or employment in other sectors (European Commission (EC) DG Enterprise and Industry (2011)). Therefore, the potential of having an impact on other sectors is high.

Factor	Financial barriers
Externalities: impact on other sectors / case studies	
Interactions with other factors	Financial barriers and economic drivers are inter-related. However, while the first is demand-side driven, the latter is supply-side driven.
Causal level of operation (proximate/direct versus underlying/indirect factors)	Underlying / indirect
Spatial level of operation (internal versus external factors)	External / internal Financial barriers may vary widely depending on regional assets.
Type of market force involved	Demand-side factor
Policy recommendations: making the link between policy and non-policy factors	• Improve access to finance • Support cradle to cradle approaches, e.g. life cycle perspective, ecodesign, etc. • Modify waste legislation to foster recovery (waste as a resource) • Promote benchmarking and labeling to raise awareness and foster market penetration • MBIs: taxes, subsidies, etc. • R&D investment: Increased funding for the innovation chain (e.g. research, development, deployment, information-sharing) • Reform of harmful subsidies (also a policy recommendation for the regulatory framework)
Possible indicators	• Environmental Protection Expenditure in Manufacturing. • Public investment in R&D • Private investment in R&D

Table 14 Regulatory framework drivers

Factor	Regulatory framework drivers
Description	Compliance with environmental regulations is perceived as being a strong driver towards achieving resource efficiency, and thus the transition towards green Manufacturing. In fact, firms do not operate in vacuum, on the contrary the policy framework plays a key role in shaping their choices and thus, performance. Moreover, the current policy context in the EU is in favour of increasing resource efficiency and making industry more sustainable (see policy framework section). Mindful that manufacturing is not a uniform industry, governments need to consider approaches that meet the realities of specific industries and their value by regulatory reform, new policies and economic instruments in order to enable energy and broader resource-efficiency improvements. (UNEP 2011). In addition, it should be noted that stringent and rapidly changing EU regulations, are perceived by industry as higher levels of uncertainty and creating challenges for long term investments for industries. (Raedemakers et al. 2011b).
Specificity for the green economy	The regulatory framework driver is not necessarily specific to the green economy. But as long as it is focused on green economy oriented policies, it would be specific to green economy.
Provable impact on the green economy spheres	**Economic: positive impact (+)** **Environmental: positive impact (+)** **Social: positive impact (+)** **Territorial: positive impact (+)** The right policy-mix has the potential for delivering positive impacts in all green economy spheres.
Trade-offs: mixed +/- impacts on green economic spheres?	
Externalities: impact on other sectors / case studies	
Interactions with other factors	Regulatory framework can condition the rest of factors.
Causal level of operation (proximate/direct versus underlying/indirect factors)	It is a flexible factor, depending on the policy measure it could direct (e.g. taxes, subsidies), or rather indirect (e.g. capacity building).
Spatial level of operation (internal versus external factors)	External
Type of market force involved	Demand-side

Factor	Regulatory framework drivers
Policy recommendations: making the link between policy and non-policy factors	• Foster benchmarking, labeling, etc. • Foster voluntary agreement schemes- • Promoting investment and spending in areas that stimulate a green economy • Addressing environmental externalities and market failures • Limiting government spending in areas that deplete natural capital • Rules, regulations, standards. E.g. Improve waste separation policies Monitoring and impact assessment of policies • Enforcement incentives (e.g. adequately priced fines for noncompliance, correct pricing of resources) • Reform of harmful subsidies (also a policy recommendation for the regulatory framework) • Regulatory and control mechanisms; • Economic or market-based instruments; • Fiscal instruments and incentives; • Voluntary action, information and capacity building: technical assistance programmes, awareness rising, etc.
Possible indicators	

8 ANNEX: Manufacturing Sector Policy Analysis – A snapshot

Table 15 Overview of policies aiming at limiting environmental damage.

Type of policy and hierarchy	Directive	
Name	Industrial emissions directive (IED) *DIRECTIVE 2010/75/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast) (Text with EEA relevance)*	
Description	• Provides a number of definitions; • It is based on the following principles: *(1) integrated approach*: permits must take into account the whole environmental performance of the plant, covering e.g. emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure. *(2) best available techniques*: emission limit values (ELVs) must be based on the Best Available Techniques (BAT), as defined in the IPPC Directive. *(3) flexibility*: licensing authorities may set less strict emission limit values in specific cases (upon assessment) *(4) inspections*: a site visit shall take place at least every 1 to 3 years, using risk-based criteria. *(5) public participation*: in the decision-making process, and to be informed of its consequences, by having access to: permit applications, permits, results of the monitoring of releases and the European Pollutant Release and Transfer Register (E-PRTR). • It is for application for certain activities (listed in Annex I) and for certain polluting substances (listed in Annex II) • Repeals a number of directives (listed in Annex IX) • Includes a correlation table between the IED articles and other directives.	
Targets	• Targets are sorted by pollutant and refer to Best Availabe Technique (BAT) associated emission level.	
Territorial implication	**Characterisation**	Average to strong
	Description	• The directive takes into account the need to consider specific local characteristics. • It is for Member States to determine the approach for assigning responsibilities to operators of installations provided that compliance with this Directive is ensured. • In some Member States it is regional authorities who grant permits.
Indicators	The *European Pollutant Release and Transfer Register (E-PRTR)* contains, among others, the data of the facilities affected by the IED.	
Distance to target (Graph or map should be provided in support of the distance to target analysis)	In the case of the IED, the target is to comply with emission levels and the monitoring is carried out at facility level (whether they comply with their permit or not).	
Policy effectiveness	**Characterisation**	High
	Description	Most of the MS have complied with the January 2013 deadline for transposing the directive (20th June 2012 data). The IED, as the successor of the IPPC directive, has great potential to limit environmental damage from industrial activities.

Transformative character of policy	**Characterisation**	Incremental
	Description	The IED has a mainly incremental approach since it prefer pollution prevention approaches and only foresees emission control when prevention is not possible.
Green economy implication	**Characterisation**	Positive strong (++++)
	Description	• This directive aims to "prevent, reduce and as far as possible eliminate pollution arising from industrial activities". Therefore, it contributes directly towards greening Manufacture. • It has an integral approach so that to avoid shifting of pollution from one environmental medium to another. • Permits granted need to be update. In addition, the reference to emission limits achievable by Best Available Techniques (BAT) and the EC's aim to update also BAT lists not later than 8 years, stimulate increasing environmental performance. • However, it is not of application for the industry as a whole, but for certain activities with fixed production capacities or outputs.

Type of policy and hierarchy	Directive	
Name	2003/87/EC - Consolidated version of Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community	
Description	The EU emissions trading system (EU ETS) is a cornerstone of the European Union's policy to combat climate change and its key tool for reducing industrial greenhouse gas emissions cost-effectively. The first - and still by far the biggest - international system for trading greenhouse gas emission allowances, the EU ETS covers more than 11,000 power stations and industrial plants in 31 countries, as well as airlines. • Operates in the 27 EU countries, the three EEA-EFTA states (Iceland, Liechtenstein and Norway) and Croatia • Covers around 45% of the EU's greenhouse gas emissions The EU ETS works on the 'cap and trade' principle. The overall volume of greenhouse gases that can be emitted each year by the power plants, factories and other companies covered by the system is subject to a cap set at EU level. Within this Europe-wide cap, companies receive or buy emission allowances which they can trade if they wish. • Limits emissions from: o More than 11,000 heavy energy-using installations in power generation and manufacturing industry o Flights to and from the EU and the three EEA-EFTA states	
Targets	The target is that in 2020 greenhouse gas emissions from the sectors covered by the ETS will be 21% lower than in 2005. For achieving so, from 2013 onwards, the cap on emissions from power stations and other fixed installations is reduced by 1.74% every year. An additional reduction of -80-95% by 2050 is also a target. Please note a separate cap applies to the aviation sector: for the whole 2013-2020 trading period, this is 5% below the average annual level of emissions in the years 2004-2006.	
Territorial implication	**Characterisation**	Low to average
	Description	• The ETS is of application for companies in such a context, anyone with an account in the EU registry can buy or sell allowances, whether they are a company covered by the EU ETS or not. Trading can be done directly between buyers and sellers, through several organised exchanges or through the many intermediaries active in the carbon

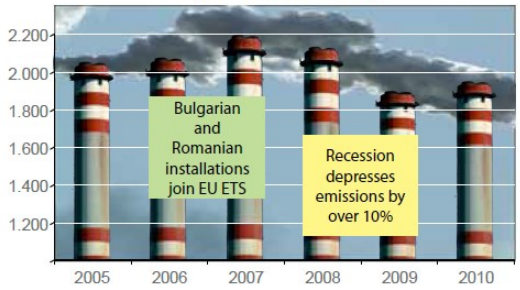
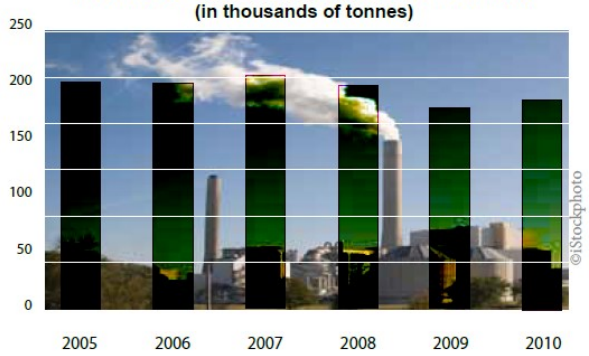
		market. • The European Commission sees the EU ETS as an important building block for developing an international network of emission trading systems.
Indicators	Industrial installations and aircraft operators are required to monitor and report their annual emissions in accordance with legally binding guidelines adopted by the European Commission.	
Distance to target (Graph or map should be provided in support of the distance to target analysis)	Source: European Commission (EC) – Climate Action http://ec.europa.eu/clima/publications/docs/factsheet_ets_emissions_en.pdf **Graph A: Annual emissions of all EU ETS installations (in millions of tonnes)**  **Graph B: Average annual emissions per installation (in thousands of tonnes)**  	
Policy effectiveness	**Characterisation**	High
	Description	The graphs above show that the EU ETS is genuinely contributing to reducing the EU's greenhouse gas emissions. However, it should be noticed that the main drop took place when the economic crisis hit first. Therefore, it is still too early to distinguish between the drop due to the policy initiative or the drop due to a reduced industrial activity because of the crisis.
Transformative character of policy	**Characterisation**	Transformative
	Description	The ETS aims at cutting emissions with a broad and flexible approach. The need to purchase or draw on their reserves of allowances and credits creates a permanent incentive for companies to reduce their emissions. But companies can also sell allowances and credits, for instance if they judge they have more than they are going to need. These flexibilities in the system allow companies to choose the most cost-effective options to address their emissions.
Green economy implication	**Characterisation**	Positive strong (+++)
	Description	The ETS is a corner stone in the transition to a low carbon economy. By capping overall greenhouse gas emissions from major sectors of the economy, the EU ETS creates an incentive for companies to invest in technologies that cut emissions. The market price of allowances - the 'carbon price' – creates a greater incentive the higher it is.

Table 16 Overview of policies aiming at improving industrial policy and its contribution towards jobs, SD, etc.

Type of policy and hierarchy	Communication	
Name	COM (2010) 614 - An Integrated Industrial Policy for the Globalisation Era. Putting Competitiveness and Sustainability at Centre Stage	
Description	It focuses its suggestions on: • improving framework conditions for industry • strengthening the single market • promoting an industrial innovation policy • facilitating globalisation (trade, access to raw materials, etc.) • promoting industrial modernisation (resource efficiency • sector-specific dimension — a targeted approaches	
Targets	The Communication puts forward a strategy towards industrial policy in order to foster growth, EU competitiveness and also the transition towards a low-carbon and resource-efficient economy (i.e. Green Economy).	
Territorial implication	**Characterisation**	Average to strong
	Description	• This Communication acknowledges regional diversity and the need for place-based approaches to increase Europe's competitiveness. E.g. ○ modernisation of EU's industrial base by means of Regional Policy and CAP; ○ need to enhance harmonization of different legal environments; ○ promoting "smart specialization" through EU Regional policies; ○ Etc.
Indicators	The indicators of success selected are: • The improvement in international competitiveness, comparing both the EU's productivity and cost developments with those of its competitors. • The number of new jobs created in industry and industry-related services, with particular reference to the number created in SMEs; • The rate at which manufacturing output rises, particularly output in the eco-industries; • The share of medium- and high-technology manufacturing sectors in total manufacturing • Value-added and employment	
Distance to target (Graph or map should be provided in support of the distance to target analysis)	When it comes to the Industrial Performance Scoreboard, Member States have engaged in reforms to boost their competitiveness in five key areas: manufacturing productivity; export performance; innovation and sustainability; business environment and infrastructure; and finance and investment. In such a context, three main groups emerged: • The group of *'consistent performers'*: Germany, Denmark, Finland, Sweden, Austria, Ireland, the Netherlands, the United Kingdom, Belgium and France, who perform well in all dimensions. • The group of *'uneven performers'*: Estonia, Slovenia, Spain, Italy, Portugal, Greece, Malta, Cyprus and Luxembourg, who perform well in some and badly in others. • The *'catching-up'* group: Bulgaria, Romania, the Czech Republic, Poland, Hungary, Slovakia, Latvia and Lithuania, who still lag behind in most indicators.	
Policy effectiveness	**Characterisation**	Strong
	Description	This Communication remains a cornerstone of industrial policy contributing to Europe 2020 (it laid out a strategy for sustainable growth, competitiveness and job creation).
Transformative	**Characterisation**	Transformative-Radical

character of policy	**Description**	This communications seeks a "fresh approach" in terms of • Bringing together a horizontal basis and sectoral application. • Considering the whole value and supply chain, from access to energy and raw materials to after-sale services and the recycling of materials. • Regular monitoring and reporting on the EU's and Member States' competitiveness and industrial policies and performance.
Green economy implication	**Characterisation**	Positive strong (++++)
	Description	• It acknowledges regional diversity and the need for place based approaches. • It is devoted to foster the sustainability transition. • It aims at supporting growth and job creating in the Manufacturing sector.

Table 17 Overview of financial instruments contributing to a greener Manufacturing.

Type of policy and hierarchy	Financial instrument – Incentive / grant programme	
Name	Factories of the Future	
Description	It is one of the three Public-Private Partnership included in the Commission's recovery package and is financed jointly he programme will be financed jointly by industry and the European Commission under the Seventh Framework Programme (FP7).	
Targets	The objective is to help EU manufacturing enterprises, in particular SMEs, to adapt to global competitive pressures by improving the technological base of EU manufacturing across a broad range of sectors, through the following sub-domains: • Sustainable manufacturing • ICT-enabled intelligent manufacturing • High performance manufacturing • Exploiting new materials through manufacturing	
Territorial implication	**Characterisation**	Low.
	Description	It has a sectoral approach and but does not pay especial attention to the territorial dimension. Nonetheless, in the closely related ERANET Manunet, MS work together to support research into eco-innovation for the manufacturing sector.
Indicators	N.A. Nonetheless, it is worth highlighting that the FoF roadmap mentions that new key performance indicators that include sustainability parameters need to be developed for monitoring Manufacturing process.	
Distance to target (Graph or map should be provided in support of the distance to target analysis)	N.A.	
Policy effectiveness	**Characterisation**	Average to Strong
	Description	The PPP has put forward research topics through FP7 on a yearly basis since 2009. These topics have been granted and research is on-going. Nonetheless, it is early to assess the effectiveness of the contribution of this research to the transition for a greener Manufacturing.
Transformative	**Characterisation**	Radical-Incremental

character of policy	**Description**	One of the domains explicitly approached is Sustainable Manufacturing. In addition, the improvement of the technological base comprises resource efficiency and eco-innovation aspects. In fact, it is expected to deliver sustainable manufacturing tools, methodologies and processes.
Green economy implication	**Characterisation**	Strong
	Description	As aforementioned, this financial instrument fosters research to make Manufacturing more resource efficient, sustainable and competitive.

Table 18 Overview of voluntary instruments contributing to a greener Manufacturing.

Type of policy and hierarchy	Voluntary Action (Awareness Programme)	
Name	EU Eco-Management and Audit Scheme (EMAS) *REGULATION (EC) No 1221/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 November 2009 on the voluntary participation by organisations in a Community eco-management and audit scheme (EMAS), repealing Regulation (EC) No 761/2001 and Commission Decisions 2001/681/EC and 2006/193/EC*	
Description	EMAS is a voluntary management tool for evaluating, reporting and improving environmental performance of companies, as well as, communicating environmental achievements to stakeholders. In its origins, participation was restricted to companies in industrial sectors. Since 2001, however, EMAS has been open to companies from all sectors.	
Targets	Rather than a target, EMAS has the objective of helping companies optimise their production processes, reduce environmental impacts and use resources more efficiently.	
Territorial implication	**Characterisation**	Strong
	Description	The EMAS Regulation applies to all 27 EU Member States, the three European Economic Area Member States (i.e. Norway, Iceland and Liechtenstein) and European Union Accession Countries. What makes the territorial dimension of EMAS relevant is the strong emphasis on communication and cooperation between MS (best practice exchange, benchmarking, etc.).
Indicators	The EMAS regulation foresees performance in the following key environmental areas: • Energy efficiency; • Material efficiency; • Water; • Waste; • Biodiversity; and • Emissions.	
Distance to target (Graph or map should be provided in support of the distance to target analysis)	N.A.	
Policy effectiveness	**Characterisation**	Average-Strong
	Description	The number of organizations (and sites) registered has been growing steadily since 1997. Currently, more than 4,500 organizations and approximately 7,800 sites are EMAS registered, of which almost 1,300 are companies in leading industries, as defined by EMAS.

Transformative character of policy	**Characterisation**	Incremental.
	Description	EMAS is devoted to minimizing environmental impacts at organization level, preferably by preventing damage.
Green economy implication	**Characterisation**	Positive (+++)
	Description	Current environmental and climate change concerns clearly illustrate the need to strive towards more resource efficient and eco-innovative production processes. As part of the EU Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy the European Commission initiated the latest revision of EMAS in order to fully exploit the scheme's potential for improving the resource efficiency of production processes. Sustainable growth based on a more resource-efficient, greener and more competitive economy is also part of in the Europe 2020 strategy (the economic reform strategy of the EU). Resource efficiency, achieved by decoupling economic growth from resource and energy use, is one of the seven so-called 'flagship' initiatives. The rationale behind EMAS is that the interest in their environmental performance is increasing for companies, because proceeding without considering the environmental implications is no longer acceptable. Since EMAS is a voluntary scheme, the companies participating are those which have a proactive approach to environmental challenges look for ways to continually improve their environmental performance.

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