Interreg
EUROPEAN UNION
Danube Transnational Programme
EcoInn Danube

NATIONAL REPORT ON O&O – GERMANY

Project co-funded by European Union funds (ERDF and IPA)
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2017

WP3	Strategy for eco-knowledge
ACTIVITY 3.2	Analysing the environment for ecoinnovation in partner countries
DELIVERABLE 3.2.2	National report on obstacles and opportunities

Project number	DTP1-191-1.1
Title of the project	Eco-innovately connected Danube Region (EcoInn Danube)
Version	Final
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Country	Germany
Date	2017

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1. Abstract

Germany is currently facing a positive economical trend which, with the except of the global crisis in 2009, has been a continuous trend over the last decade. The unemployment rate currently tops the 4%, among the lowest in the EU area.
In terms of the economic context, Germany is a highly export-oriented nation with a strong manufacturing industry and well established eco-innovation areas and markets. The GDP per capita is high and some reports have proved that Germany, as other Member States with relatively a high GDP per capita, had the highest number of innovative enterprises. Germany belongs to the so-called innovator leaders. Innovation leaders have an attractive research system, qualified human resources and a good presence of innovators.
Nonetheless, as this report will show, innovation expenditure has been comparably low and innovation intensity decreasing in the German SMEs in the last years. In 2016 Germany was performing less well than other innovation leaders on the human resources dimension as well for what concern the research system and innovation-friendly environment. At the same time however, Germany was the best European country in terms of firm investments.

As the Eco-Innovation input index shows, in terms of eco-innovation, the performance of Germany are way above the EU as well as the Danube region average. This performance is stronger also if compared to the other innovation leaders.
In 2015, Germany scored above the EU-28 average in regards to the four of the five components of the Eco-innovation composite index (ecoinnovation activities, eco-innovation inputs, eco-innovation outputs and resource efficiency outcomes). It is particularly remarkable for the indicator on government investments in environmental and energy R&D, total R&D personnel and green early stage investments. Germany belongs to the top performer for indicators on company participation in eco-innovation for both material and energy efficiency activities.
Nonetheless, the EIO Report points out that Germany is close to the EU average for material, energy productivity and GHG emission intensity but that it is still underperforming if compared to other leading Member States. Germany scores particularly low for employment in eco-industry and the turnover in eco-industries compared to other European countries. Anyway, the high percentage of knowledge-intensive services and high technology manufacturing definitely constitutes an opportunities also for ecoinnovation.
Germany is currently transitioning from a fossil- and nuclear-fuels based power generation toward a more sustainable, less fossil-centered energy supply system through its "Energy Transition" program (Energiewende). The ultimate goal is to reach 80% of renewables by 2050. Nonetheless, nowadays coal is still the biggest source of energy (43%), followed by gas and nuclear power, both accounting for the 13%. Despite the ongoing shift toward renewable energies, Germany is still highly dependent on imports of fossil fuels (oil, coal and gas) for its energy needs. This is also due to a large and strong industrial sector with high energy requirements. Despite the constant growth of the German economy and of its GDP the energy intensity trend of the country has been mostly in line with the EU average. According to the German Federal Ministry for Economic Affairs and Energy, the country is continuing to integrate renewable energy into the electricity market, creating the electricity market 2.0 – a market fit for integrating a growing share of renewables.
One of the goals of the Federal Government's Sustainable Development Strategy is to improve resource efficiency without any losses in prosperity while at the same time reducing the use of raw materials. The German Government plan to double energy productivity by 2020, thus assuring a more efficient use of primary energy.

Furthermore, the state of the environment in Germany has improved markedly since the reunification in 1990. According to the statistics recorded in 2014 by the German Unweltbundesamt, emissions of greenhouse gases fell by 23,8% between 1990 and 2013. Nonetheless, greenhouses emission per capita remain high in Germany. Another environmental challenge that Germany is facing is the one related to the use of areas for settlement and transport purposes. The target of the Federal Government is to implement space-saving measures for all new construction projects.
Finally, Germany has made of waste management an important technology sector and it has the highest waste recovery quotas worldwide. The country has also often a pioneer role in shaping EU waste legislation.

2. Overall National Ranking

In order to have a comparative analysis of innovation performance in Germany in comparison with the EU-28 and the Danube region, we will use the European Innovation Scoreboard and Index. **The goal will be to understand the country's strengths and weaknesses to identify obstacles and opportunities**. Concretely, the Summary innovation index allow us to have an overview of 27 different indicators in the fields of framework conditions, investments, innovation activities and impacts. Furthermore, we will measure and benchmark the German's innovation policies in the global context through the Innovation Output Indicator. Finally, we will focused on the Eco-innovation scoreboard and the Eco-innovation index.

In terms of the **economic context**, Germany is a highly export-oriented nation with a strong manufacturing industry and well established eco-innovation areas and markets. The **GDP per capita** is high and some reports have proved that Germany, as other Member States with relatively a high GDP per capita, had the highest number of innovative enterprises. Although we can observe a significant increase in R&D expenditures by SMEs in the last years there is still an **innovation gap** between SMEs and large companies. In Germany, the SME R&D intensity remained constant between 2006 and 2014, innovation expenditure has been comparably low and innovation intensity decreasing in the German SMEs.

Innovation Scoreboard

Concerning the European Innovation Scoreboard, Germany belongs to the so-called **innovator leaders**.
In the World Bank's 2016 "Doing Business" report, Germany ranks 17th out 190 countries (World Bank, 2016). However, Germany also have large **deficits** in the areas of starting a business (114th rank), registering property (79th rank) and paying taxes (48th rank).

According to the RIO Germany Report (2016)[1], the main **R&I policy challenges** of this country are:

- Reinvigorate innovation in SMEs
- Capitalise on business opportunities from the digital economy
- Encourage entrepreneurship

To reach those challenges, the main **R&I policy developments** in 2016 were:

- Excellence Strategy
- "Innovative Higher Education Institutions"
- Priority to SMEs
- Framework programme for research on greater internet security

[1] Research and Innovation Observatory - Horizon 2020 Policy Supoort Facility, RIO Country Report Germany https://rio.jrc.ec.europa.eu/en/country-analysis/Germany/country-report

- Framework programme for research and innovation 2016-2020 for microelectronics

As previously highlighted, Germany is one of the innovator leaders. In Figure 1 are shown the four groups of countries (modest innovators, moderate innovators, strong innovators and innovation leaders) in comparison with the EU scoreboard. From this and the following chart, we can notice that the average performance of the innovation leaders has decreased since 2013 and has start to growth again from 2015. In the same period of time, the performance of Germany has instead constantly decreased.

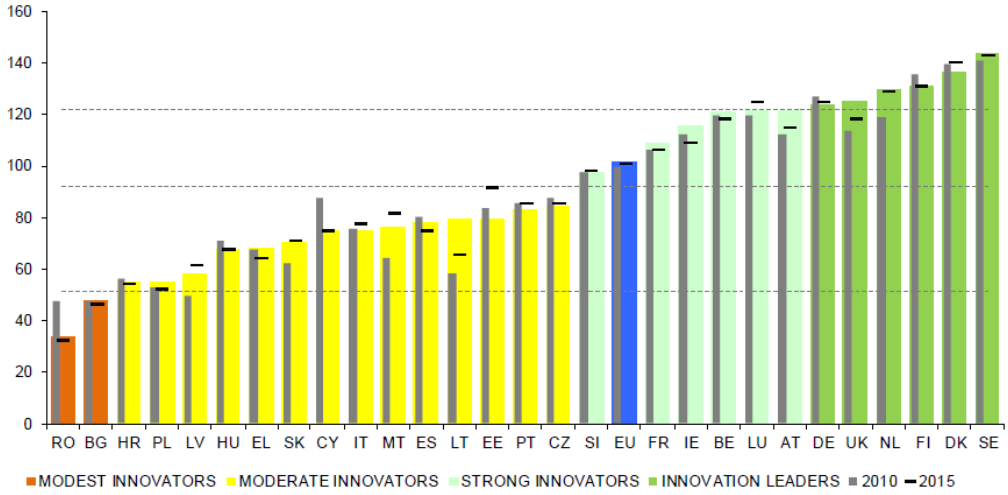


Figure 1 Performance of EU Member States' innovation systems (Source: European Innovation Scoreboard 2017)

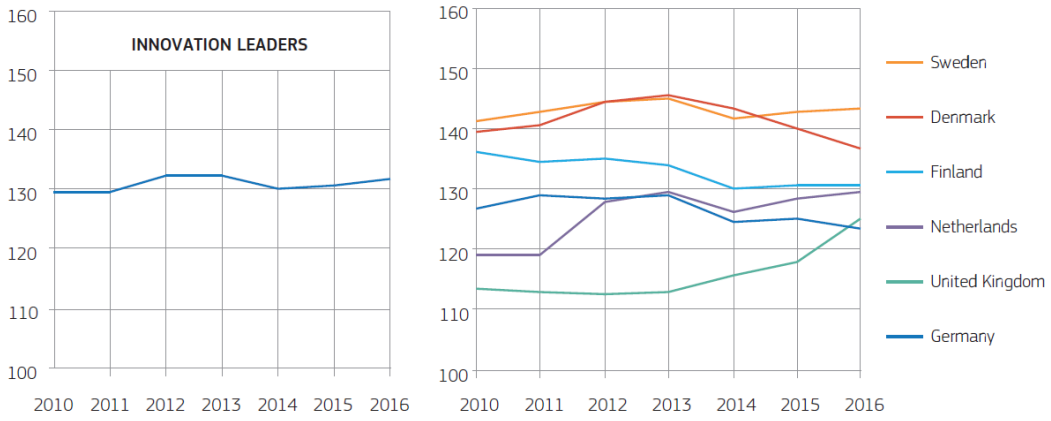


Figure 2 Performance innovation leaders (Source: Innovation Scoreboard 2017)

In figure 2, it is possible to analyse the performance per dimension. The innovation leaders perform particularly well on the dimension of financial support and linkages. They do also have an attractive research system, qualified human resources and a good presence of innovators.

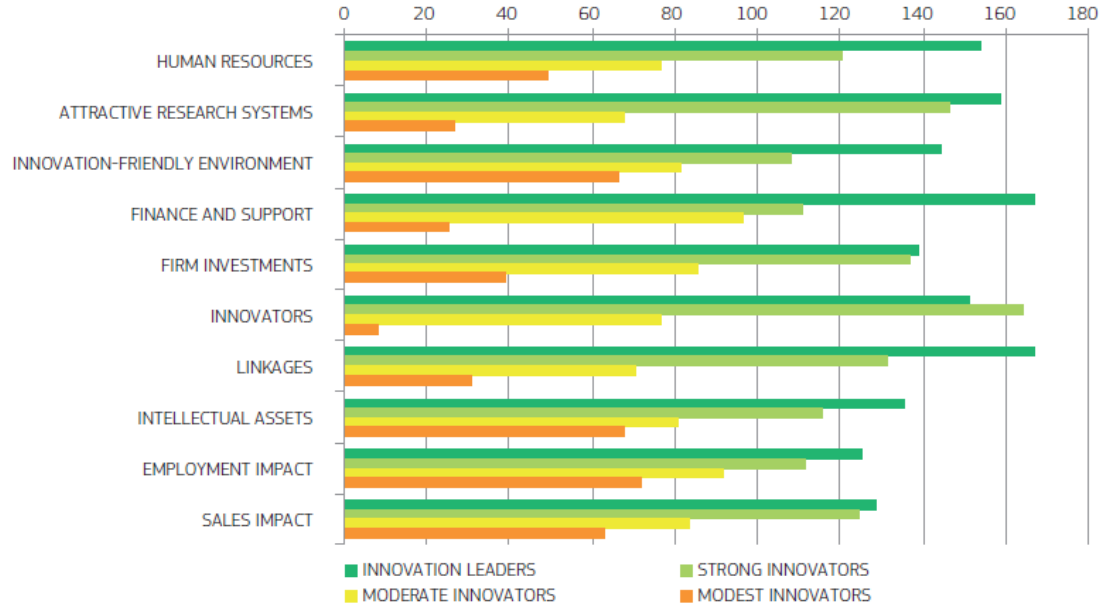


Figure 3 Performance groups: innovation performance per dimension (Source: European Innovation Scoreboard 2017)

In the 2017 Germany EIS report[2], the data show that the **summary innovation index** has decreased between 2010 and 2016. The highest decreasing was in the innovators dimension (-44.6). Moreover, the impacts in employment and sales have also decreased. Having a look to the **innovation performance** in Germany (from 2010 to 2016), one important fact is that the innovation-friendly environment is quite lower than the EU28 average, even if it has increased between 2014 and 2016. Moreover the research systems in Germany are also less performing than the EU28 average. The German European Innovation Scoreboard 2017 also confirms that there are more innovative SMEs collaborating with others. However, there are fewer SMEs creating product or process innovations as well as marketing or organisational innovations compared to the previous year.

Although the leading innovators have a strong performance in most of the dimensions some dimension may still show weaknesses. For example, **in the obstacles side**, while other innovation leaders are the best performing countries in the human resources dimension, Germany was performing less well the others in 2016. Moreover, Germany's performance in attractive research system and in the innovation-friendly environment was below the EU average. **On the opportunities side**, Germany was the best European country in terms of firm investments, it was the third in the innovators performance and the fourth in the linkages impact.

Eco-Innovation Input Index

Taking a look at the Eco-Innovation input index, we can see that in terms of eco-innovation, the performance of Germany are way above the EU as well as the Danube region average. This performance is stronger also if compared to the other innovation leaders.

[2] European Commission, 2017 European Innovation Scorebord report, https://www.rvo.nl/sites/default/files/2017/06/European_Innovation_Scoreboard_2017.pdf

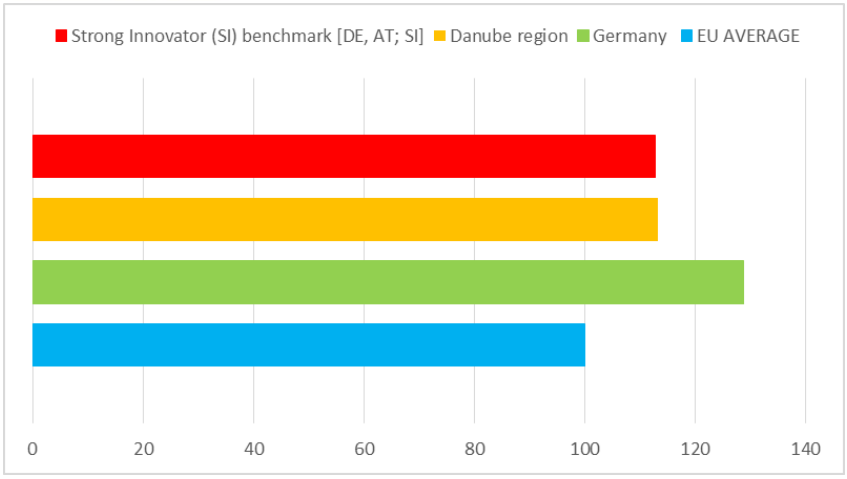


Figure 4 : Eco-innovation index for Germany compared to the EU and Danube region

Germany has the fourth highest eco-innovation performance in the EU according to the 2014-15 Eco-Innovation Scoreboard[3]. In comparison to the 2013 Scoreboard Germany's performance has dropped by one place (in 2013 Germany was ranked third).

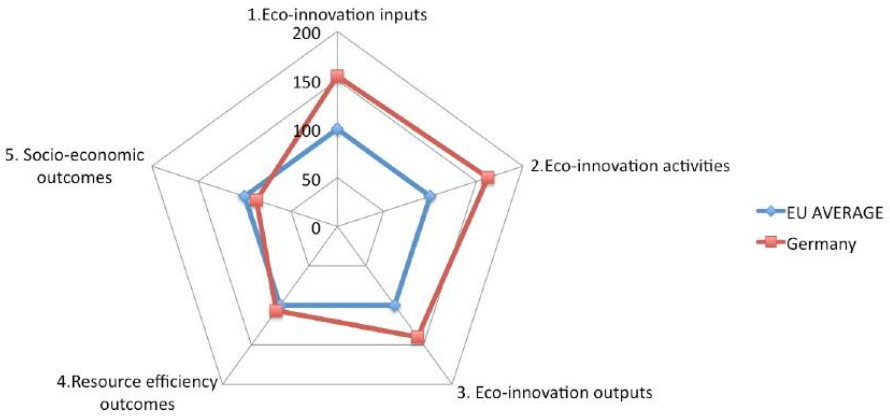


Figure 5 Components of the eco-innovation composite index for Germany 2015

In 2015, Germany scored above the EU-28 average in regards to the four of the five components of the Eco-innovation composite index (ecoinnovation activities, eco-innovation inputs, eco-innovation outputs and resource efficiency outcomes). Nonetheless, it was below the average for what concerns the component of socio-economic outcomes.
Regarding the Eco-Innovation input Germany is performing better not just if compared with the Danube area and the EU average but also in comparison to the other strong innovators. It is particularly remarkable for the indicator on government investments in environmental and energy R&D, total R&D personnel and green early stage investments.[4]

[3] Cfr.Eco-Innovation in Germany, EIO Country Profile, 2014-2015
[4] Cfr.Eco-Innovation in Germany, EIO Country Profile, 2014-2015, pag. 4

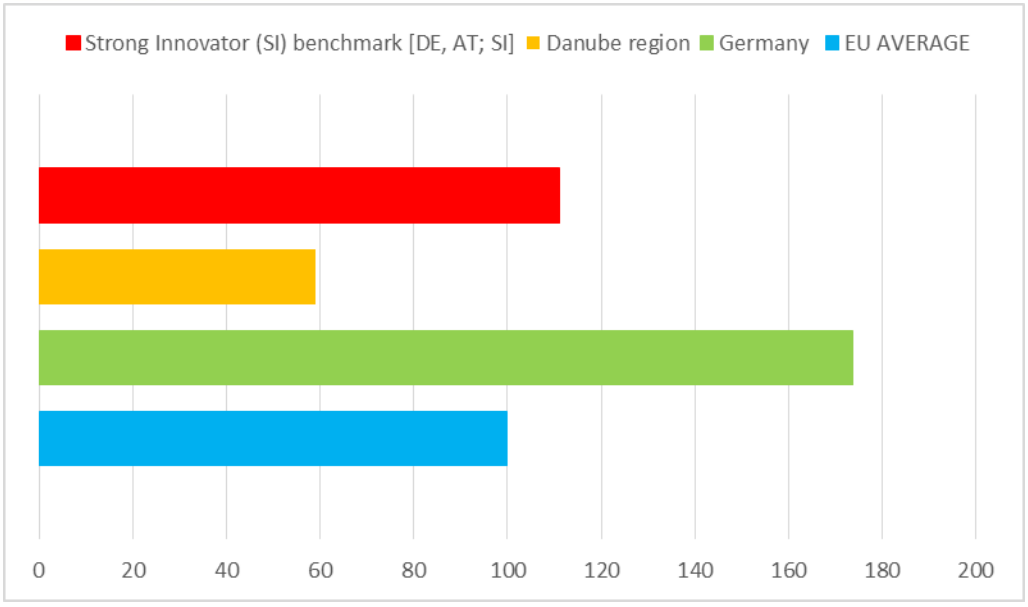


Figure 6 Figure: Eco-innovation inputs index for Germany compared to the EU and Danube region

In regards to the ecoinnovation activities Germany is also performing well on an European comparison. It belongs to the top performer for indicators on company participation in eco-innovation for both material and energy efficiency activities.[5]

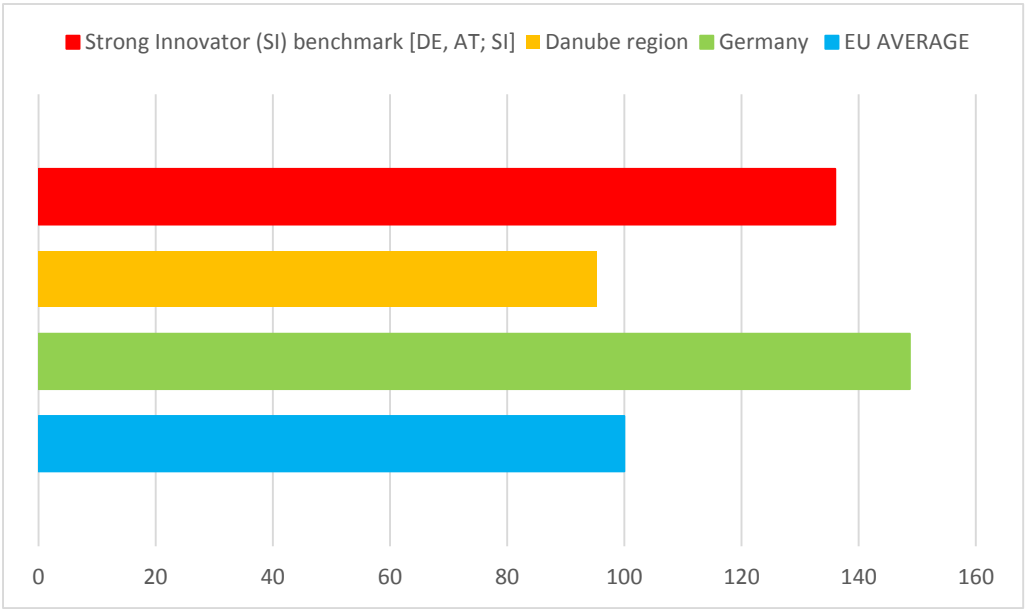


Figure 7: Eco-innovation activities index for Germany compared to the EU and Danube region

Regarding the eco-innovation outputs Germany performed also relatively well if compared to the Danube and EU average. According to the EIO Country profile, Germany is particularly strong when it comes to ecoinnovation patents but it is below the average when it comes to eco-innovation related publications and mediocre in terms of eco-innovation related media coverage.

[5] Cfr. Eco-Innovation in Germany, EIO Country Profile, 2014-2015, page 4

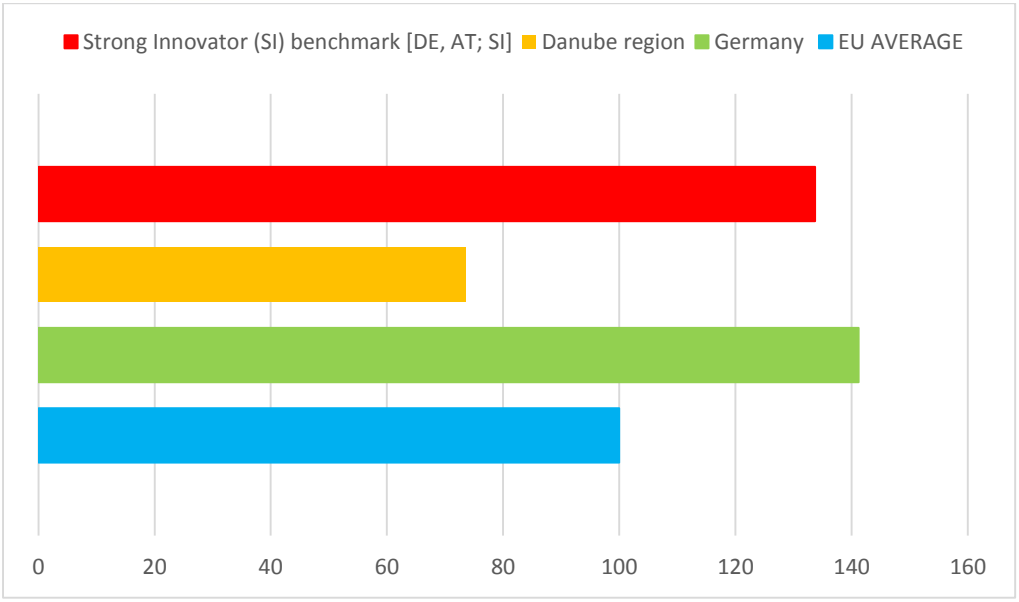


Figure 8 Eco-innovation outputs index for Germany compared to the EU and Danube region

Considering the resources efficiency outcomes, Germany seems again to compare very well to the Danube area and the EU average. Nonetheless, the EIO Report points out that Germany is close to the EU average for material, energy productivity and GHG emission intensity but that it is still underperforming if compared to other leading Member States.

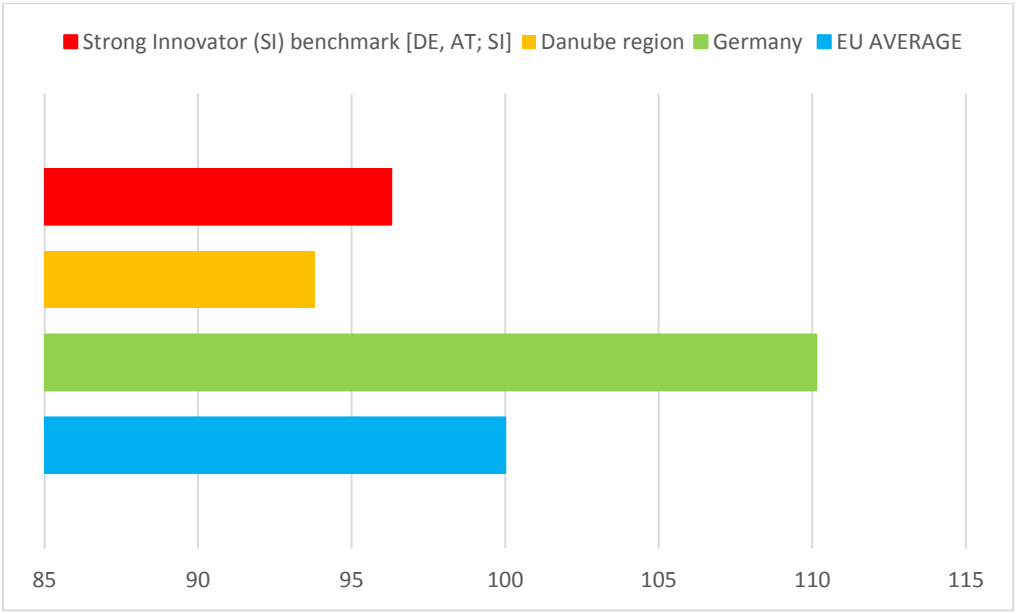


Figure 9 Resources efficiency outcomes index for Germany compared to the EU and Danube region

Finally, at a first look at the socio-economic outcomes index Germany seems to perform quite well in Danube and EU comparison. Anyway, within this indicator the country according to the EIO report scores particularly low for employment in eco-industry and the turnover in eco-industries compared to other European countries.

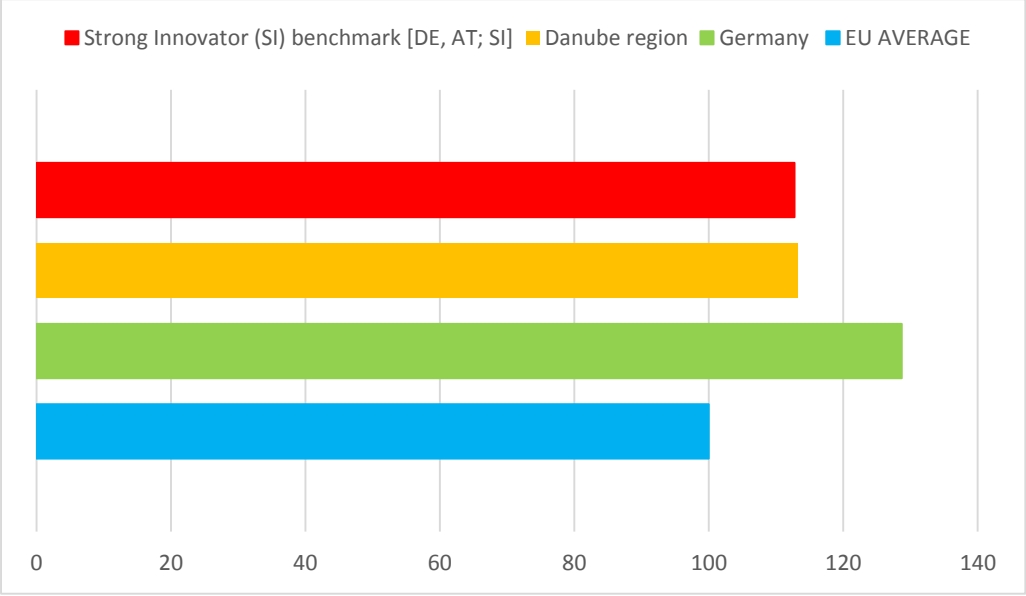


Figure 10 Socio-economic outcomes index for Germany compared to the EU and Danube region

3. Innovation

3. 1 Indicator: New doctorate graduates per 1000 population aged 25-34

To understand the framework conditions, it is important to know the new doctorate graduates. In the figure below we can see that Germany is one of the Danube region countries with the highest indicator in terms of new doctorate graduates per 1000 population aged 25-34. The country performance is in line with the one of strong innovators in 2014-2015, it seems to have been growing over time but it has anyway being stable in the last three years recorded in this statistics. Overall, we can anyway see that till 2015 Germany has had a higher number of doctorate graduate even if compared to the average in the EU.

OPPORTUNITY: this data can be surely considered an opportunity in terms of innovation as skilled workforce is the precondition for achieving progress in a country.

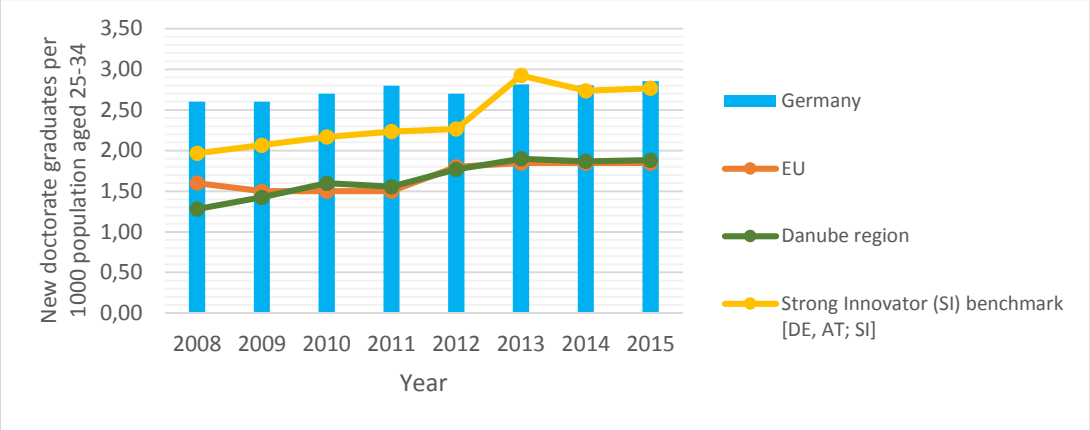


Figure 11 New doctorate graduates per 1000 population aged 25-34 indicator in Germany compared to SI benchmark, and the average of the EU and Danube region

3.2 Indicator: Public R&D expenditure as % of GDP

On the investments side, we can observe in figure 9 that between 2008 and 2015, Germany allocated around 0.80% and 0.90% of its GDP to fund research and development. This represents a higher expenditure than the European Union member states average and the Danube region. This amount has constantly been growing between 2008 and 2014 and only in 2015 has registered a slight decline.

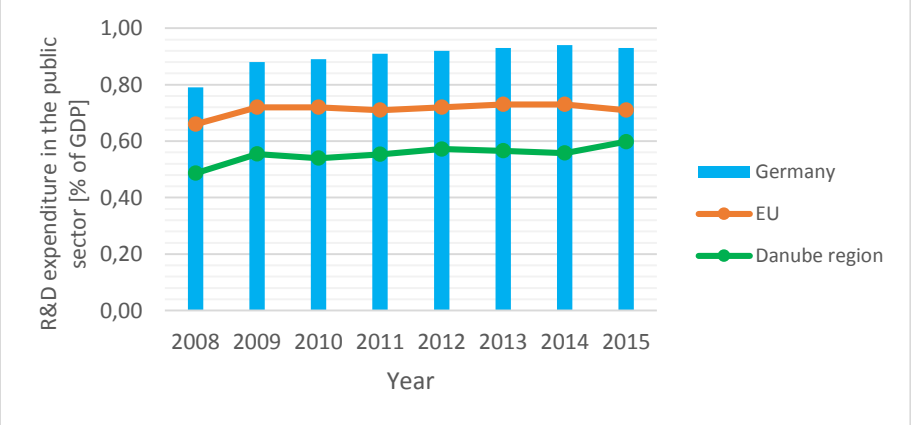
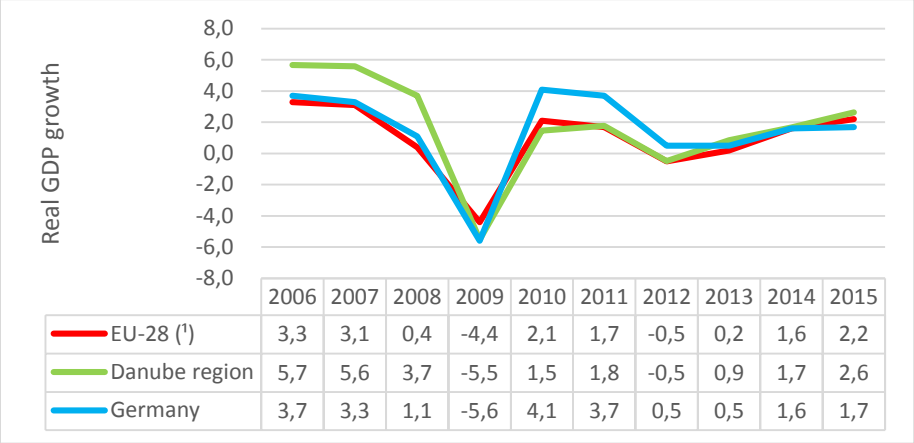


Figure 12 Public R&D expenditure as % of GDP for Germany, the European Union and the Danube region

Moreover, as we can see in the figure 13, the **Real GDP growth** in Germany in the period from 2009 until 2013 was higher than the Danube Region and the EU-28 average. Nevertheless, it started to decrease in 2011 and between 2014 and 2015 the growth was even less if compared to the average of the Danube countries and the EU 28.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
EU-28 (1)	3,3	3,1	0,4	-4,4	2,1	1,7	-0,5	0,2	1,6	2,2
Danube region	5,7	5,6	3,7	-5,5	1,5	1,8	-0,5	0,9	1,7	2,6
Germany	3,7	3,3	1,1	-5,6	4,1	3,7	0,5	0,5	1,6	1,7

Figure 13 Real GDP growth for Germany, the European Union and the Danube region

OBSTACLE: In comparison to both the EU-28, as well as the Danube region, considering a GDP share of public spending for research and innovation, we can notice that Germany has lower its investment in research and innovation and this in turn has been possibly reflected in a decrease of the real GDP growth.

3.3 Indicator: Private sector R&D expenditure as % of GDP

Constantly over the time between 2008 and 2015 Germany had a high R&D expenditure in the private sector as % of GDP which surpassed the European Union's average. The German expenditure, as well as the EU average and Danube region, has slightly increased from 2008 to 2015. Moreover, the German's value is nearly twice as much as the Danube's region and it is definitely higher than the EU average.

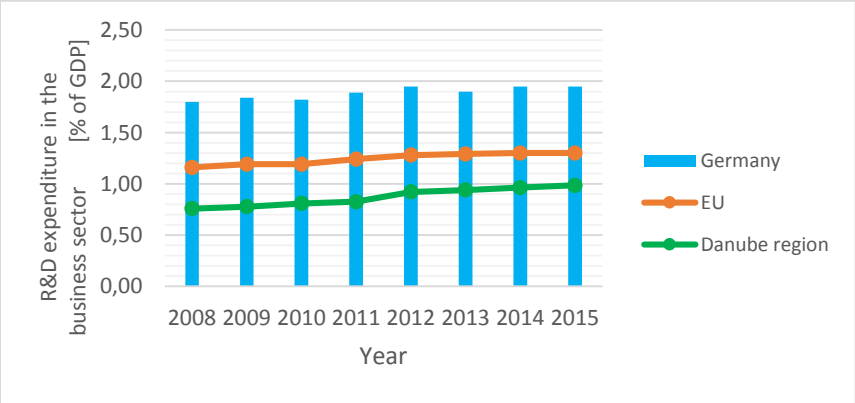


Figure 14 R&D expenditure of the private sector as % of GDP

OPPORTUNITY: Germany's private sector appears to be flourishing over the time and this is reflected by the higher investment into research and development compared to the EU 28 average. This has of course positive reflection on the country's economy and can be further capitalized upon with increased competitiveness, increased know-how and additional marketable value propositions.

3.4 Indicator: Business enterprise R&D expenditure financed by all sectors in million EUR

Germany is the country with the highest Business enterprise R&D expenditure in Europe and it has increased the BERD expenditure from around 43000 million of EUR to nearly 60000 million from 2007 to 2015. The indicator includes funding from the business enterprise sector, the government sector, the higher education sector, the private non-profit sector as well as contributions from abroad.

OPPORTUNITY: The high investment in R&D can surely constitute an opportunity for the country has it can helps in the creation of new technologies, product and services, thus producing a competitive advantage.

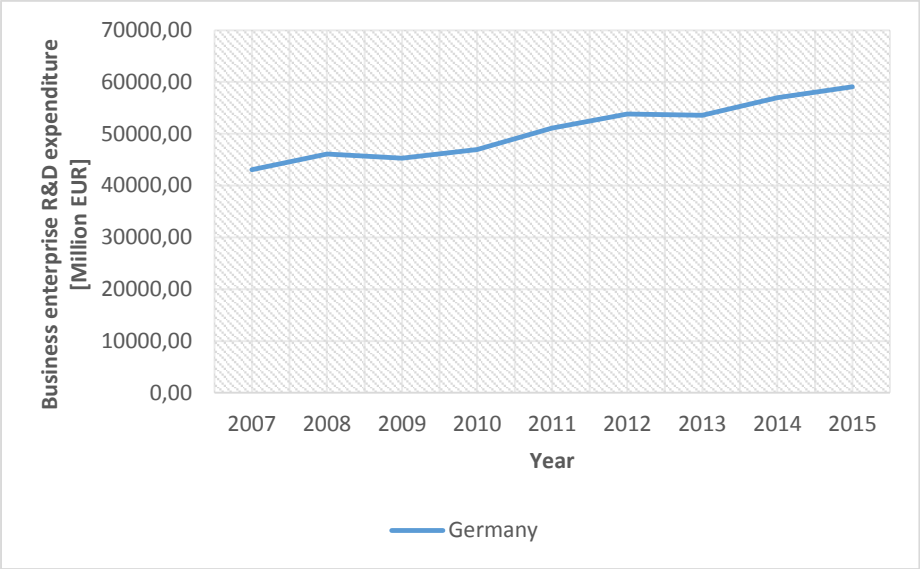


Figure 15 Business enterprise by all sectors

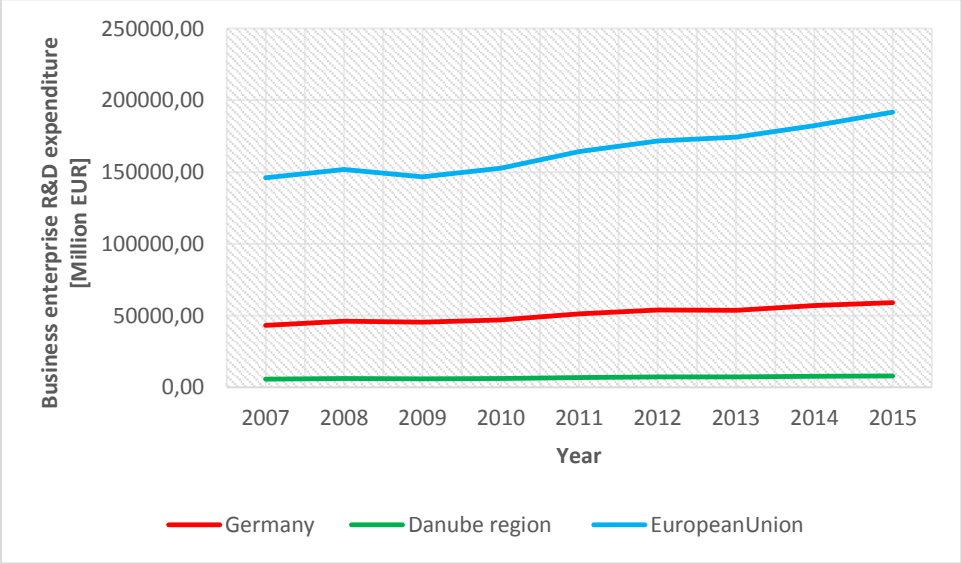


Figure 16 Business enterprise R&D expenditure in million EUR

3.5 Indicator: Business enterprise R&D expenditure financed by public funding as % of GDP

Business enterprise R&D expenditure (BERD) includes financing through public funds (by the government) but disregards other sources of public funds such as from higher education and EU funding. In terms of GDP, Germany's business expenditure in R&D by public funding, in the period of time from 2009 to 2014, was lower than the averages of the Danube region and the EU-28. However, it started to growth again in 2013 and has slightly surpassed the Danube area average between 2014 and 2015, though still remaining below the average of the European Union.

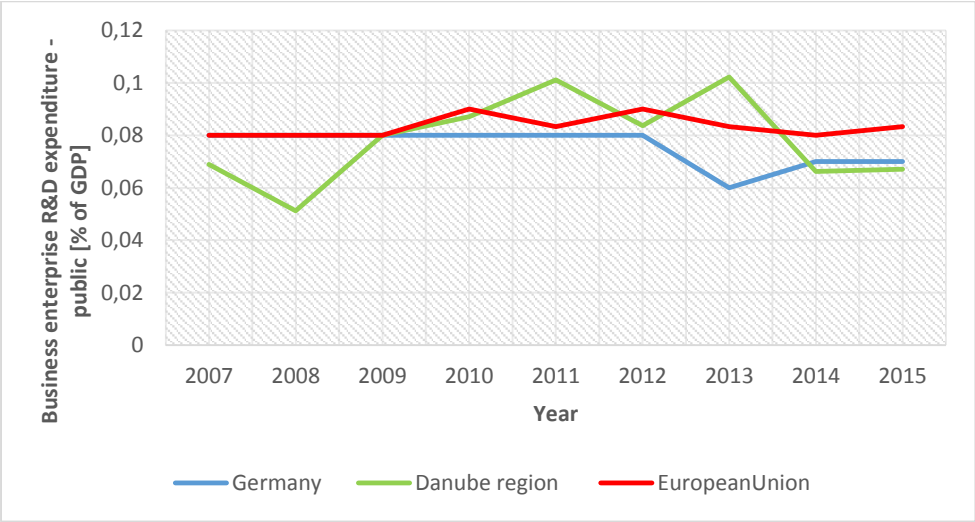


Figure 17 Business enterprise expenditure as % of GDP by the public funding

OBSTACLE: Public funding of Business expenditure in research and development is in Germany lower than the EU average. This could definitely constitute an obstacle, slowing down the support of different fields, included the ecoinnovation one. Nonetheless, Germany has in general a very high BERD expenditure financed by the government and the private sector. This could partially justify the less expenditure deriving from sources as EU funding.

3.6 Indicator: Government budget appropriations or outlays for R&D

The Government budget appropriations or outlays for R&D in Germany had constantly increased between the 2007 to 2011 going from 1,74% of GDP to 1,96%. Starting from 2011 this expenditure has stabilized around the 2% of general government expenditure. It is interesting to notice that in the period of time from 2007 and 2016 the government budget appropriations or outlays for R&D was significantly higher than the EU and Danube region´s average, thus confirming a trend in the expenditure in R&D that it is possible to notice also in the indicators previously considered.

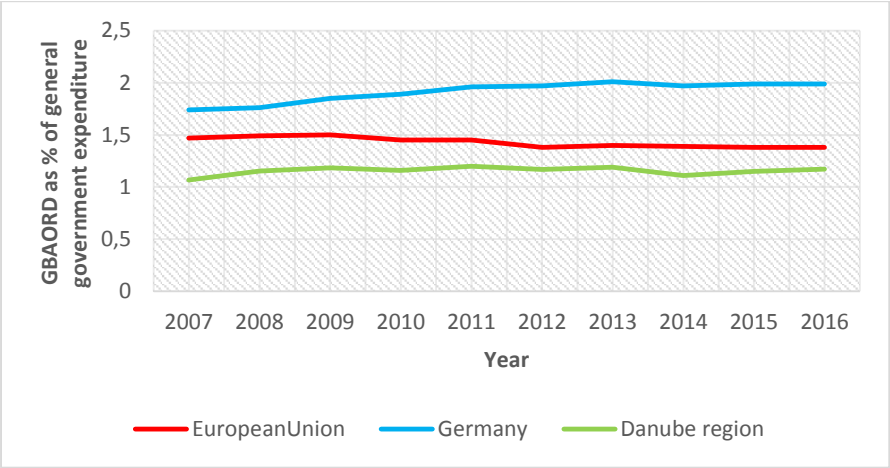


Figure 18 Government budget appropriations or outlays for R&D

OPPORTUNITY: As previously notice, the high government budget appropriations and outlays for R&D constitute a major opportunity in further development of the general economy and also in the support of emerging field like the creation of ecoinnovative products and services.

3.7 Indicator: Total Intramural R&D expenditure (GERD) by sectors of performance

In Germany the total amount of intramural R&D expenditure (GERD – Gross domestic expenditure on R&D) by sectors of performance was nearly of 3% of GDP from 2009 until 2013. Between 2013 and 2014 the expenditure recorded a negative trend but by 2015 returned again to be the 3%. The amount of total intramural R&D expenditure from all sectors (inclusive of funding from the business enterprise sector, the government sector, the higher education sector and the private non-profit sector) has instead constantly growth overtime going from 60.000 Million Euro in 2009 to nearly 90.000 Million Euro in 2015. Consequently, as it can be observed in Figure 19 also the total Intramural R&D expenditure per capita has been very high and definitely above the average of the European Union.

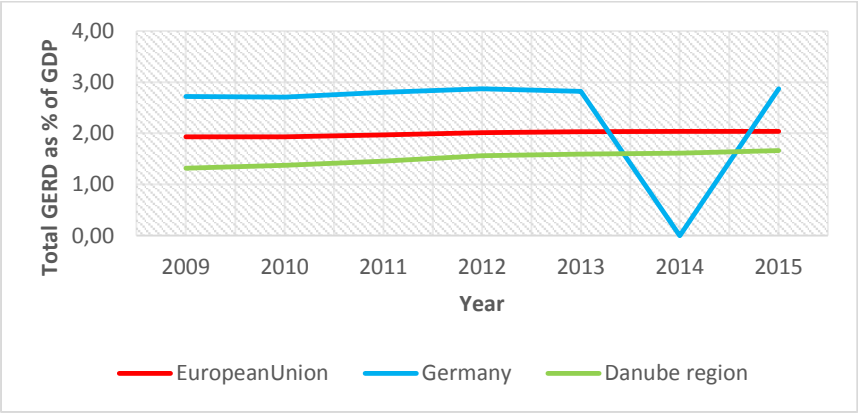


Figure 19 Total Intramural R&D expenditure (GERD) by Sectors of Performance (% of GDP)

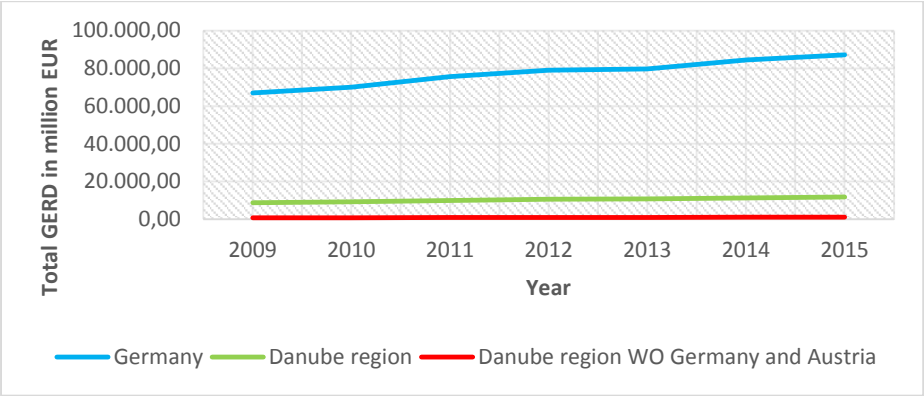


Figure 20 Total Intramural R&D expenditure in million EUR (all sectors)

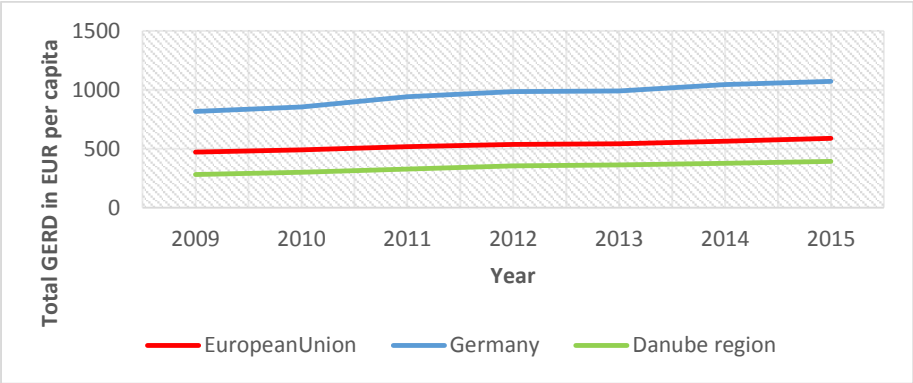


Figure 21 Total Intramural R&D expenditure in EUR per capita (all sectors)

OPPORTUNITY: Also in this case the high total Intramural R&D expenditure above the average of the European Union and of the Danube region constitutes an advantage for Germany and it represents an excellent starting condition for the further development of Eco-innovations.

3.8 Indicator: Turnover from innovation (% of total turnover)

As we can observe in the figure 22, the turnover from innovation as a share of total turnover has varied significantly in the observed time period (from 2004 to 2012 on a biennial basis). Germany´s turnover was higher than the average of EU and the Danube region from 2004 to 2010 in both industry and services. However, in 2012 the services turnover was lower than the EU average. Furthermore, the trend shows that both turnovers had substantially decreased since 2006.

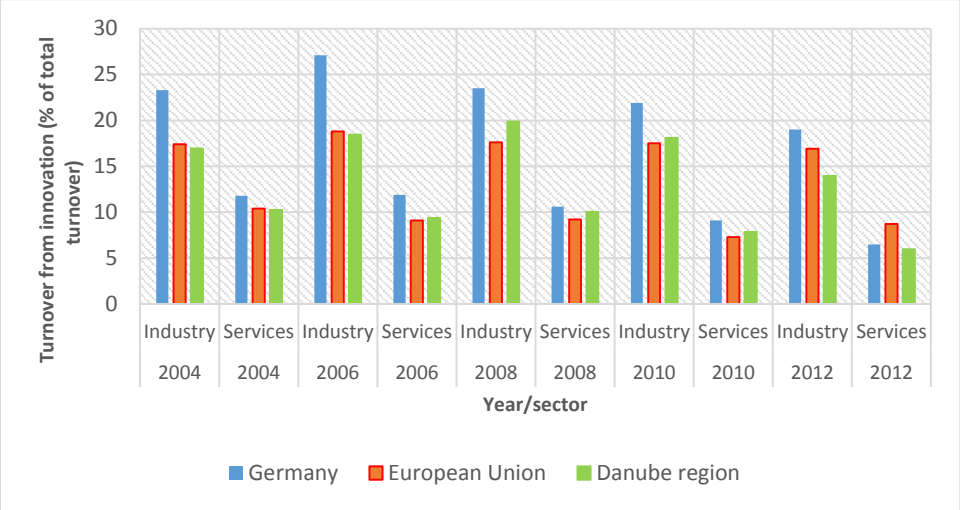


Figure 22 Turnover from innovation (% of total turnover)

If we compare the figures 22, 23 and 24, we can clearly see that there is a significant difference between the turnover from innovation in industry and in service. The industry turnover has remained over time higher than the one generated by the services and has registered a pick in 2006 touching 27,1% of the total turnover. The service turnover instead has reached in the observed timeframe an average of 9,98% of the total turnover.

Till 2012 Germany registered the highest turnover from innovation in industry in the European Union, this has anyway constantly decreased from 2006, thus remaining over the European and Danube region average.

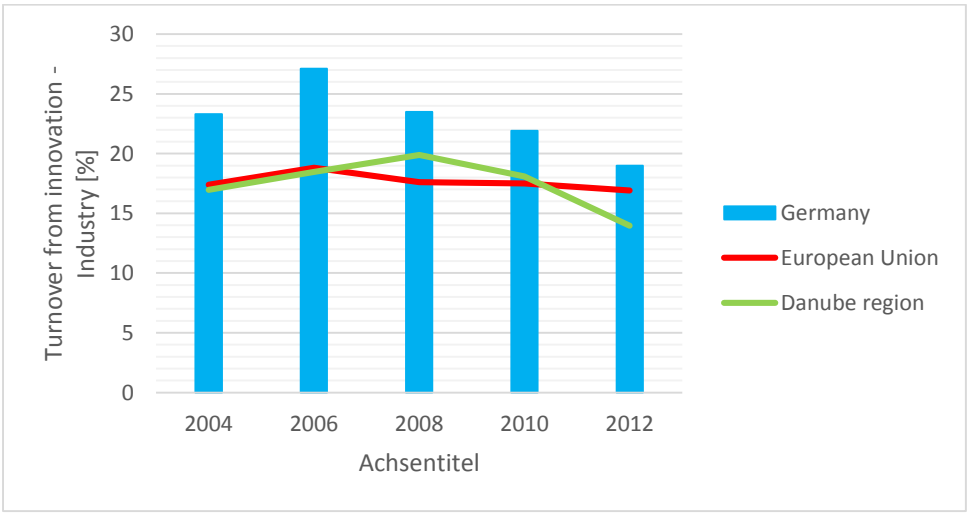


Figure 23 Turnover from innovation in industry (% of total turnover)

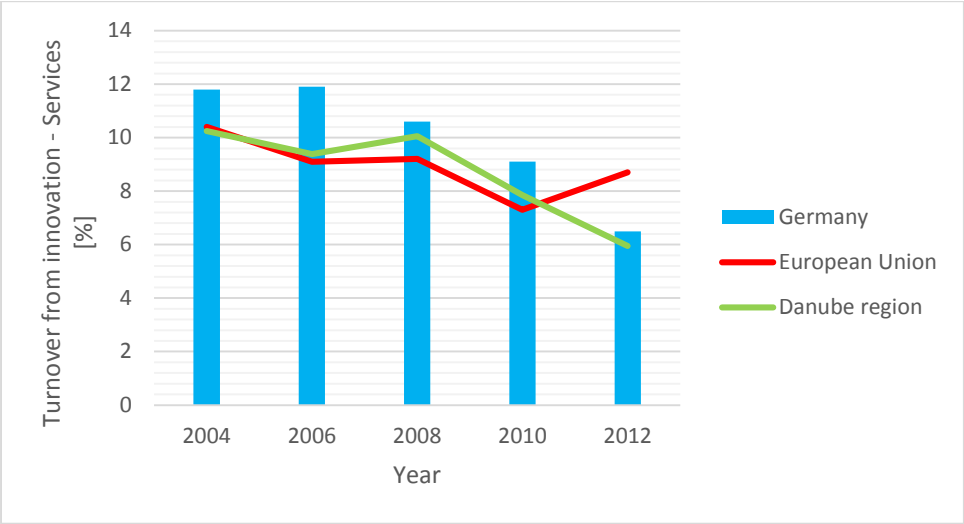


Figure 24 Turnover from innovation in services (% of total turnover)

The turnover from innovation in services is on average half the one produced in the industry. Furthermore, starting from 2006 this indicator registered a negative trend and in 2012 stopped at 6,5% being thus below the EU average of 8,7%.

OBSTACLE: The shares of turnover from innovation in both the industry and service sectors, though presenting a general decrease, remained still significant in an European comparison. Nonetheless, if the data from 2012 to 2017 should confirm such a decreasing trend, this might surely constitute an obstacle for future investment and innovation activities in the country.

3.9 Indicator: Value added by knowledge intensity (in services and manufacturing)

Value added at factor cost for knowledge-intensive services (KIS) and less knowledge-intensive services (LKIS) expressed as a share of the total value added and as a share of the value added from services has decreased in Germany in the period from 2006 to 2012, raising a 6%. Germany has one of the highest share of value added at factor cost for KIS and LKIS of all observed countries.

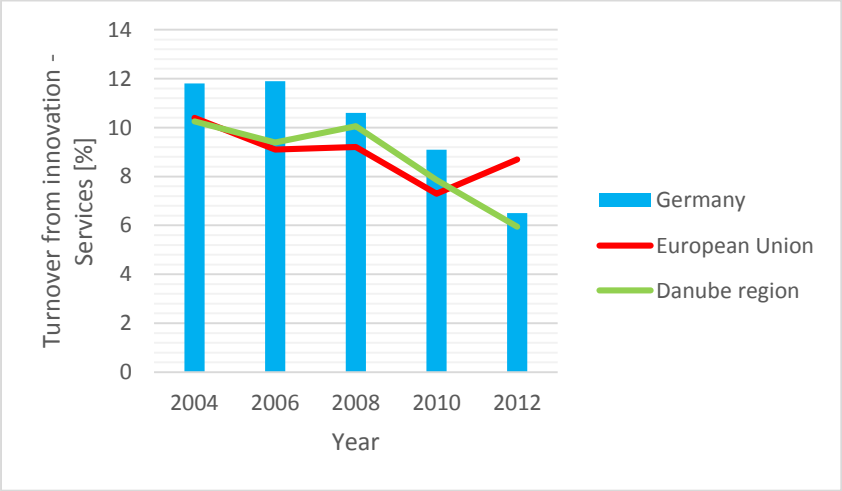


Figure 25 Turnover from innovation in services in Germany (% of total turnover)

With respect to knowledge intensive services the trend is very similar. The share of knowledge intensive services compared to total value added has been stable reaching a peak value in 2010 and 2013 of over 35% of the total added value. On average in the considered timeframe (2007-2014) this indicator has been constantly above the Danube region and EU average.

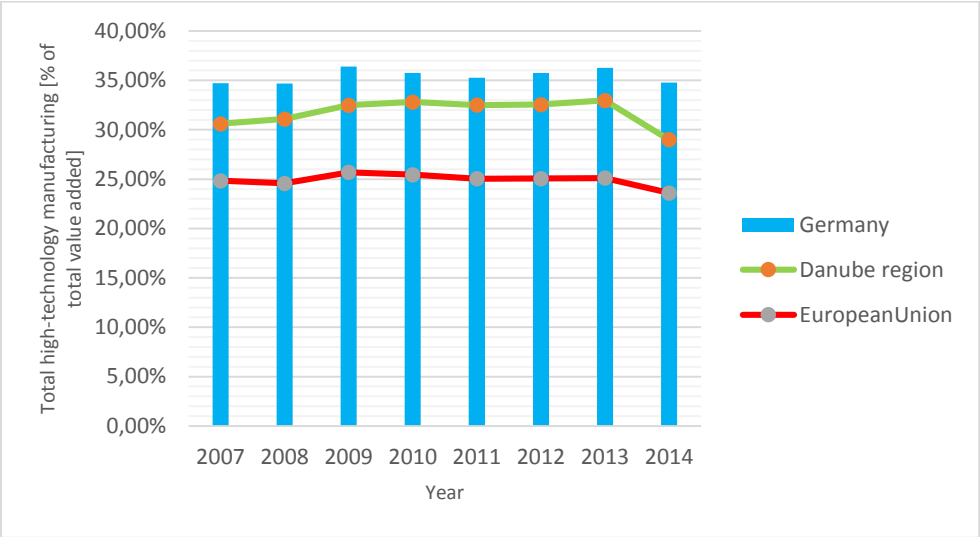


Figure 26 Total knowledge intensive services in Germany [% of total value added]

High-technology manufacturing as a share of total value added has declined in the period from 2007 to 2009 from 2,52% to 2,11%, which was also the lowest documented. From 2009 Germany has registered a small increase reaching the 2,21%, a value that has remained mostly stable registering small changes till 2013. Comparably the trend for the countries in the Danube region has been very similar, albeit less expressed and moving around the average below 2%.

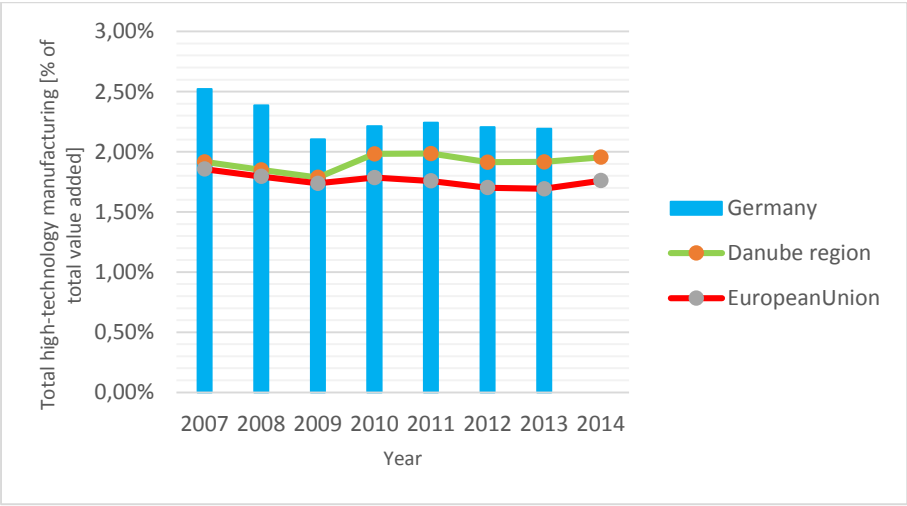


Figure 27 Total high-technology manufacturing [% of total value added]

OPPORTUNITY: Value added at factor cost for knowledge-intensive services (KIS) and less knowledge-intensive services (LKIS), total knowledge intensive services and high technology manufacturing have

surpassed the averages of both the countries in the European Union and the Danube region. The high percentage of knowledge-intensive services and high technology manufacturing definitely constitutes an opportunities also for ecoinnovation.

3.10 Indicator: Scientists and engineers as % of active population

The share of scientists and engineers within the German total population has increased by 2,2% in nine years, reaching a peak value of 7,5% in 2016. The national growth followed the trend of countries in the European Union and the Danube region but it has always registered value considerably above these averages. Compared to the average of countries in the Danube region, Germany has on average 1,78% more of scientist and engineers as a share of active population, and it is in this regards one of the leaders in 2016.

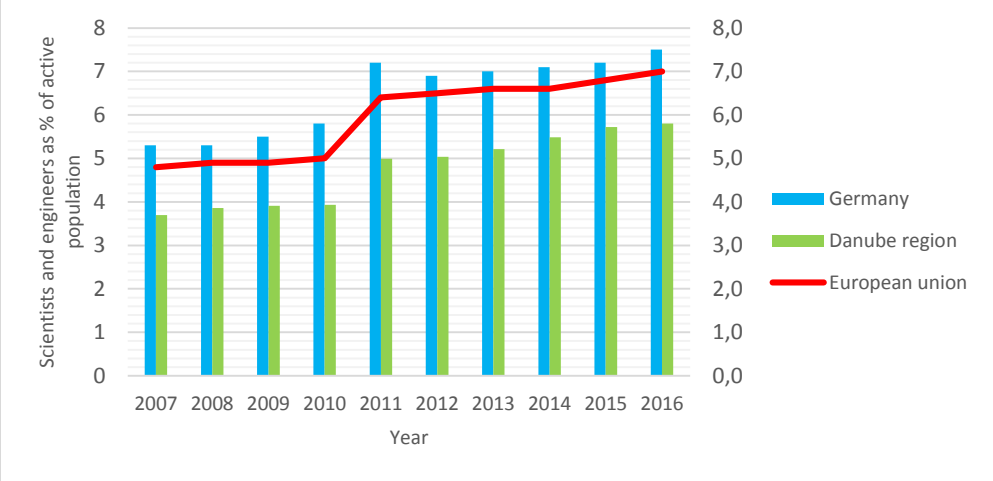


Figure 28 Scientists and engineers as % of active population in Germany

OPPORTUNITY: The share of highly educated persons in the field of engineering and science in the national workforce presents high value in Germany that have constantly been growing over time. This sets great framework conditions for the country ensuring a great representation in the knowledge, technology and scientific development. Being at the forefront of innovation and science offers in turn considerable development opportunities for Germany that might reflect also in the ecoinnovation field.

3.11 Indicator: Employment in Knowledge Intensive Activities (KIA) and medium/high-tech manufacturing

In Germany, employment in knowledge intensive activities in both manufacturing and services is above the average of the EU and the Danube region. However, Employment in medium-high and high-tech manufacturing as a share of total employment in Germany is below the EU.

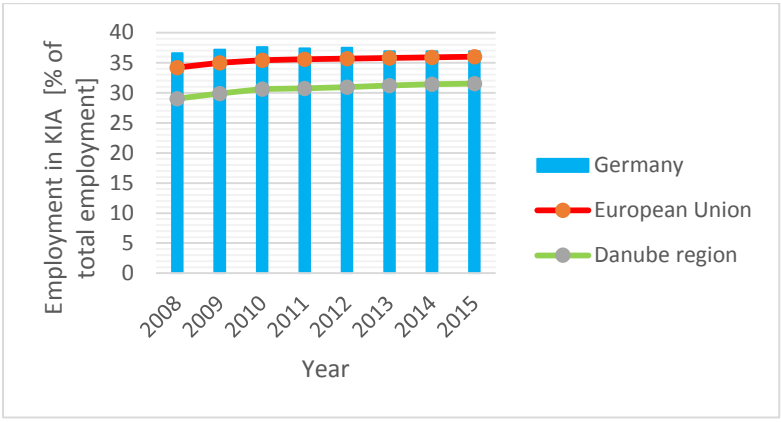


Figure 29 Employment in Knowledge Intensive Activities (KIA) as a share of total employment in Germany

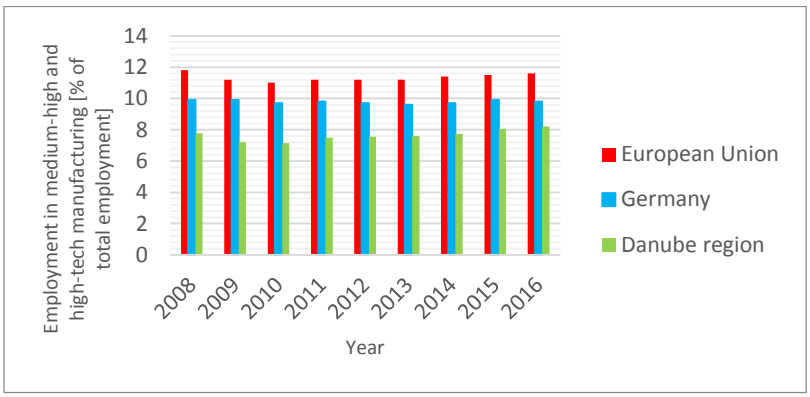


Figure 30 Employment in medium-high and high-tech manufacturing as share in total employment in Germany

3.12 Indicator: Innovation Output Indicator (composite)

Germany has comparably higher value of the composite indicator focused on innovation output to that of the average of the countries in the Danube region. This indicator has remained stable between 2011 to 2014 and it is generally higher than the average for Austria, the other country that is leading the statistic for this particular indicator.

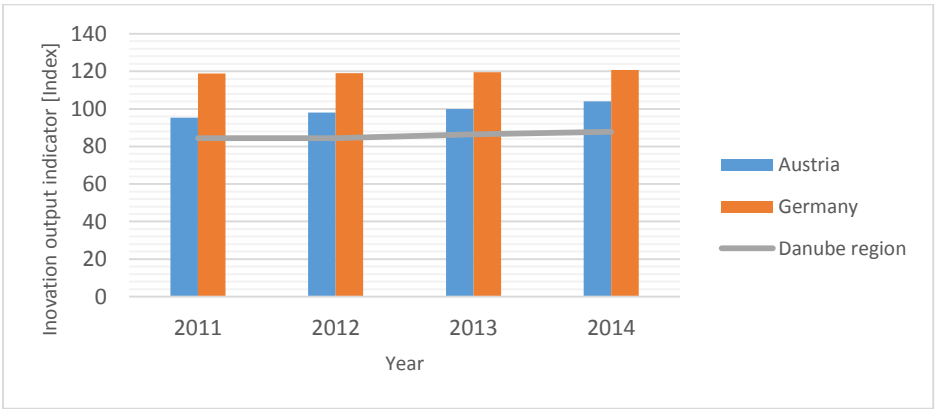


Figure 31 Innovation Output Indicator Index

OPPORTUNITY: The composite indicator illustrates that the output from innovation in Germany is high compared to developed countries. It is a clear opportunity in the future development of eco-innovative products and services on the country level.

4. ENERGY

4.1 General overview of energy sector

Germany is currently transitioning from a fossil- and nuclear-fuels based power generation toward a more sustainable, less fossil-centered energy supply system. This plan is called "Energiewende" (Energy transition). The key moment for this push toward energy efficiency and climate neutral power generation (with the ultimate goal of 80% of renewables by 2050) was after the Fukushima nuclear disaster in 2011, when Germany announced the phasing out of its nuclear reactors which accounted at the time for the 20% of the national electricity supply.
As of the last datasets available (2016), Germany continues its shift toward renewable power generation which account all together for the 31% of the global power produced. For what regards the renewable sources, the biggest are wind (12%), biofuels and waste (9%), solar (6%) and hydroelectric (3%).
Coal is still the biggest source of energy (43%), followed by gas and nuclear power, both accounting for the 13%.

4.2 Indicator: Energy dependence

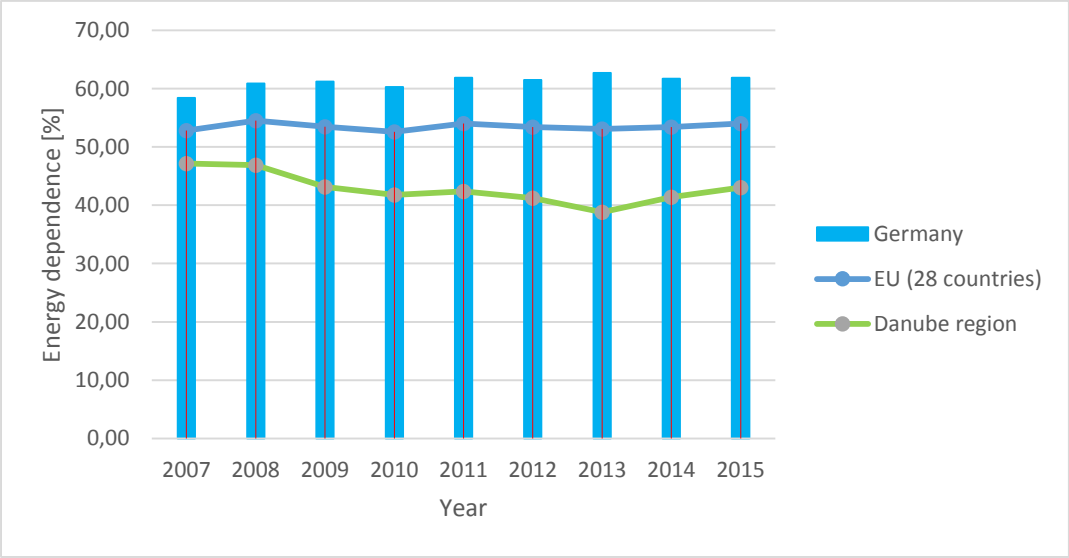


Figure 32 Energy dependence of Germany compared to EU-28 and the Danube region

Despite the ongoing shift toward renewable energies, Germany is still highly dependent on imports of fossil fuels (oil, coal and gas) for its energy needs. The large industrial sector – combined with EU' largest population – contribute to Germany's higher than EU and Danube region averages energy requirements. While the abovementioned "Energiewende" plan is actively contributing in reshaping the country's energy

trade balance, Germany is still heavily dependent on third-parties countries (namely Russia) for its energy needs. In 2015, in fact, Russia accounted for about 43% of all fossil sources used by Germany. (39,5% of crude oil, 46,6% of natural gas, 30,3% of coal).
With this said, Germany relies on its transformation plan to correct the energy imbalance and to secure its energy needs. According to the latest data (2015), however, Germany has an high dependency (61,9%) on foreign energy, mainly because its current imbalance towards fossil fuels for energy production, which are either unavailable or too expensive to extract domestically.

OBSTACLE: The external energy dependence of Germany might constitute an obstacle to a total shift into renewable energy. The large industrial sector in the country has in fact high energy needs that might be difficult to be satisfied within a shifting path toward renewable energies.

4.3 Indicator: Energy intensity of the economy

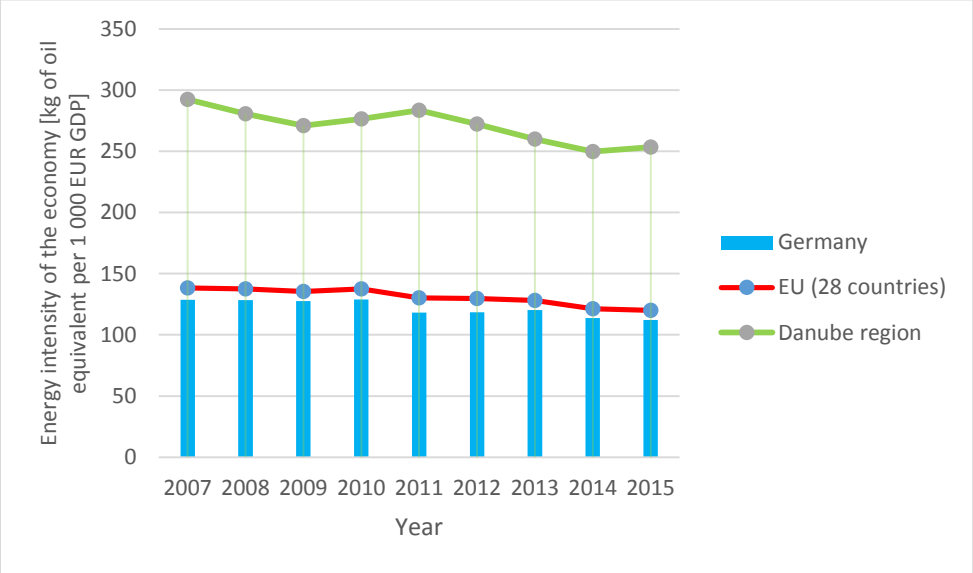


Figure 33 Energy intensity of the German economy

While Germany economy has been on a growth trend in the last decade, the figure above shows how the energy intensity trend of the country has been relatively in line with the EU average in a time of global financial and economical turmoil. This can be explained with both the high productivity of German industry and with the government push towards energy-efficiency which contributed – according to the German government – a reduction in primary energy consumption of 8,3% between 2008 and 2014[6]. In other terms, the energy intensity of German economy has shown a phenomenon defined as "absolute decoupling", which occurs when energy consumption falls while GDP grows. While the absolute decoupling is relevant in economic terms[7], it also has very significant environmental consequences, since is likely to alleviate the environmental pressures from energy production and consumption.

[6] Federal Ministry for Economy Affairs and Energy, Ready for the next phase of energy transition http://www.bmwi.de/Redaktion/EN/Dossier/energy-transition.html
[7] European Environment Agency, Energy Intensity https://www.eea.europa.eu/data-and-maps/indicators/total-primary-energy-intensity-3

OPPORTUNITY: If the energy intensity of Germany should continue to remain relative low compared to the economic growth, this could definitely constitute an opportunity for the country to keep on diminishing the energy consumption while shifting towards renewable energy sources. The reduction in the primary energy consumption of the German population shows furthermore a growing awareness of environmental topics within the German public opinion.

4.4 Indicator: Share of renewable energy in gross final energy consumption

Gross final consumption of energy is defined in the Renewable Energy Directive 2009/28/EC as "the energy commodities delivered for energy purposes to industry, transport, households, services (including public services), agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution and transmission."[8]

Renewable energy in the EU has been increasingly growing in the last years. The share of energy from renewable sources in gross final energy consumption has almost doubled in the last years, from around 8,5% in 2004 up to 16,7 % in 2015. Renewable energy sources accounted for a 13,0 % share of the EU-28's gross inland energy consumption in 2015. The EU seeks to have a 20 % share of its gross final energy consumption from renewable sources by 2020.

The share of renewable energy consumption in the final energy consumption in Germany has been constantly growing from 2008 to 2015 but it is still surprisingly lower than the EU and Danube region average. In this respect, Germany has still some way to go to meet the agreed target for 2020.

OBSTACLE and OPPORTUNITIES: Thus performing less well than other European countries, Germany is anyway likely to meet its target for renewable energies in 2020. The use of renewable energy has many potential benefits, including a reduction in greenhouse gas emissions and a reduced dependency on fossil fuel markets (in particular, oil and gas) which still is a problem Germany is facing. In this respect, Germany should do even more to raise its consumption of energy from renewable sources. This would allow to reduce its energy dependency from Russia and possibly stimulate the growth of the Green Tech sector in the country.

[8] Eurostat, Statistic explained, Renewable energy statistics http://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics

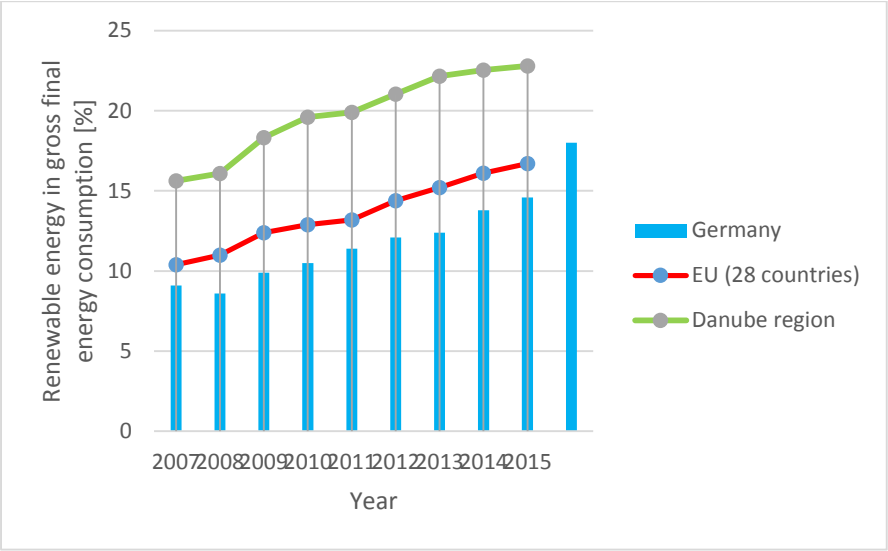


Figure 34 Share of renewable energy consumption in final energy consumption in Germany

4.5 Indicator: Electricity generated from renewable sources

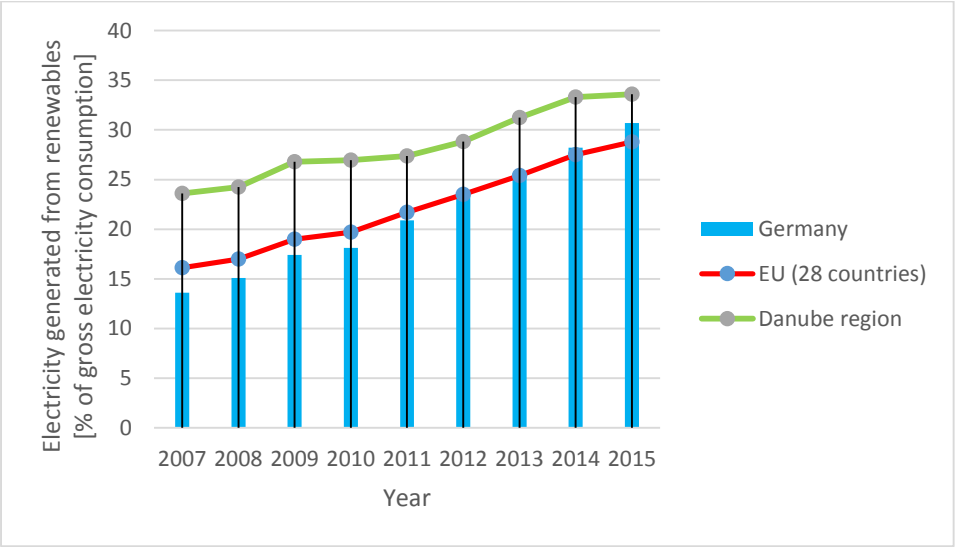


Figure 35 Share of electricity generated from RES in Germany

As shown in Figure 32, Germany's share of electricity generated by renewable sources has been on the rise and generally in line with the EU28 average. The reduction of the dependence on (imported) fossil fuels, as described in the previous sections, has helped the country to reduce the relative gap with the Danube region countries. As already mentioned, the most important source of renewable energy is wind (12%) followed by biofuel & waste (9%) and solar (6%), with only a small amount derived from hydroelectric (3%).

Germany plans to further increase the share of energy generated by renewables: according to the "Energiewende" plan, in fact, 40-45% of energy is to be sourced by renewables by 2025, in order to reach the goal of 80% in 2050. According to the German Federal Ministry for Economic Affairs and Energy, the country is "continuing to integrate renewable energy into the electricity market, creating the electricity market 2.0 – a market fit for integrating a growing share of renewables – and are enabling the development of a digital infrastructure that is capable of connecting more than 1.5 million electricity producers and large-scale consumers. Moving forward together at European level is more efficient than pursuing national strategies unilaterally. This is why our reforms are anchored in the European internal market."

OPPORTUNITY: The growing share of electricity generated by renewable sources surely constitutes an opportunity for Germany. The German Federal Ministry for Economic Affair and Energy is pushing the country to reach 40% of electricity generated by renewable sources by 2025. Should this plan be successfully implemented, the country would be able to reduce the pressure of its strong industrial sector onto the environment.

4.6 National energy policy

The Germany's flagship national energy programme, as mentioned in the previous sections, is the "Energiewende", or Energy Transition, which was designed by the German government around the 1997 EU Directive on Electricity Production from Renewable Energy Sources, but in 2010-2011 the plan went into major redesign, due to the Fukushima disaster and the subsequent abandon of nuclear power as major source during the transition. In setting the goal of 80% of renewable-sourced energy by 2050, the Energiewende not only regulates the supply of energy, but it also envisages major and deep changes in its distribution and in its consumption.
As showed by Figure 36 below[9], the national energy policy is summarized in the "10-point energy agenda", which is the latest policy framework available for what regards the energy transition.

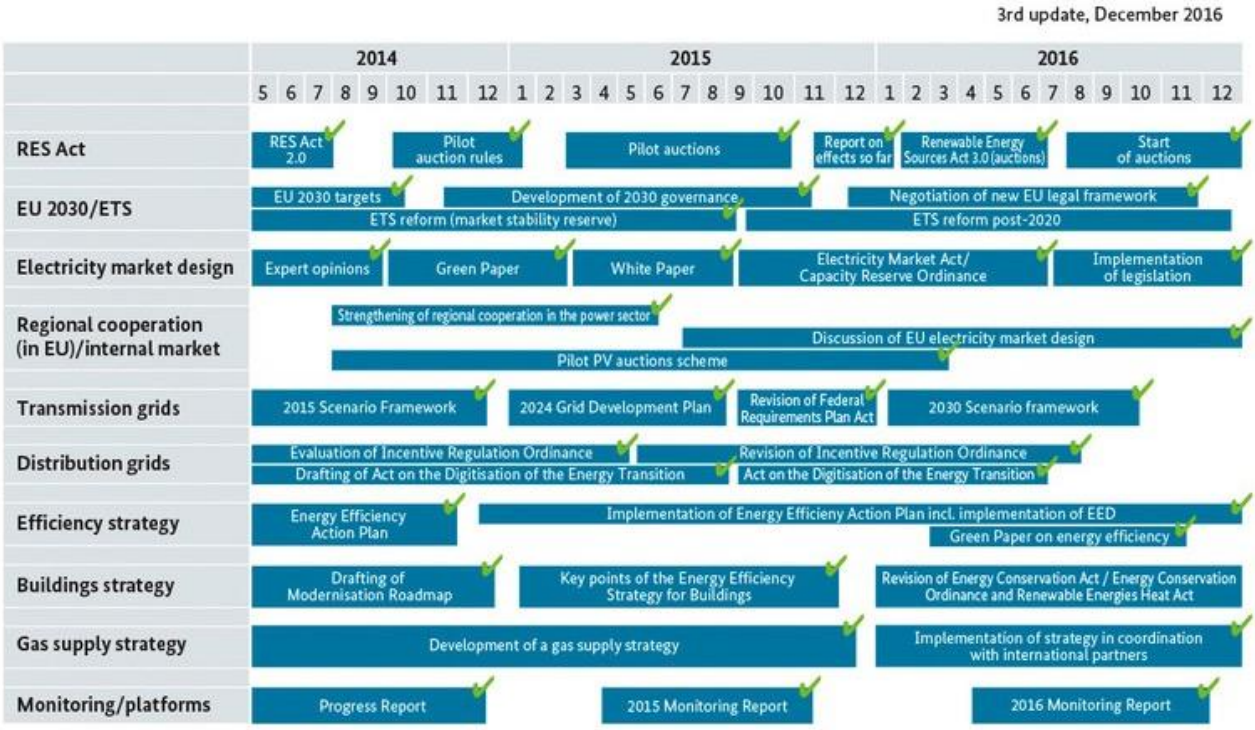


Figure 36 Energy reforms key projects in Germany

The policy framework translates in five main operative platforms, namely "Energy Grids", "Electricity market", "Energy efficiency", "Buildings" and "Research and innovation". "Energy Grids" platform aims at discussing the next decades' investment and development in the national grid, in order to expand the

[9] European Environment Agency, Energy Intensity https://www.eea.europa.eu/data-and-maps/indicators/total-primary-energy-intensity-3

capacity and the smart technologies operating the grid to be able to implement the European internal market in electricity. The "Electricity market" platform aims at designing the most effective market rules to be able to fully benefit from the enlarged EU-wide competition, while ensuring at the same time the security of the energy supplies given the flexibility of the renewables market. The "Energy Efficiency" platform builds on the 2014 National Action Plan on Energy Efficiency (NAPE), which set the objective of halving the primary energy consumption by 2050 with an integrated set of measures spanning from incentive programmes to full-fledged structural initiatives such as the Energy Efficiency Strategy for Buildings launched in 2017. This strategy pivots around a new tool (software) for the energy-efficient retrofitting of buildings and a renovation road map tailored to individual buildings. This software-based tool is used by energy advisors on efficiency in buildings to give owners a clear overview of the modernisation work that their building needs. The tool points to untapped possibilities for energy conservation and the use of renewables, and also gives an estimate of the relevant investment costs and of the savings that could be achieved in terms of heating costs and carbon emissions

Finally, the "Research and Innovation" platform acts as advisory body for the national policy makers, hosting a strategic dialogue on energy research with the national stakeholders, business and scientific communities. This integrated policy framework is complemented by the 2014' Erneuerbare-Energien-Gesetz (the Renewable Energy Sources Act), which was revised and updated in 2017. This Act was instrumental to open up the renewable energies market, since it established the transition from a government-fixed tariff scheme to a competitive auction mechanism, in which the prices are set by the market.

5. ENVIRONMENTAL PROTECTION

5.1 Environmental challenges

The state of the environment in Germany has improved markedly since the reunification in 1990.

According to the statistics recorded in 2014 by the German Unweltbundesamt, **emissions of greenhouse** gases fell by 23.8% between 1990 and 2013. Nonetheless, as shown in the figure below, greenhouses emission per capita remain high in Germany and well-above the Danube regions and EU average. In 2007 12,12 tonnes of CO2 equivalent per capita were produced, this value sensibly diminished in 2015 reaching 11,41 tonnes thus still remaining over the EU average of 8,75 tonnes of CO2 equivalent per capita.

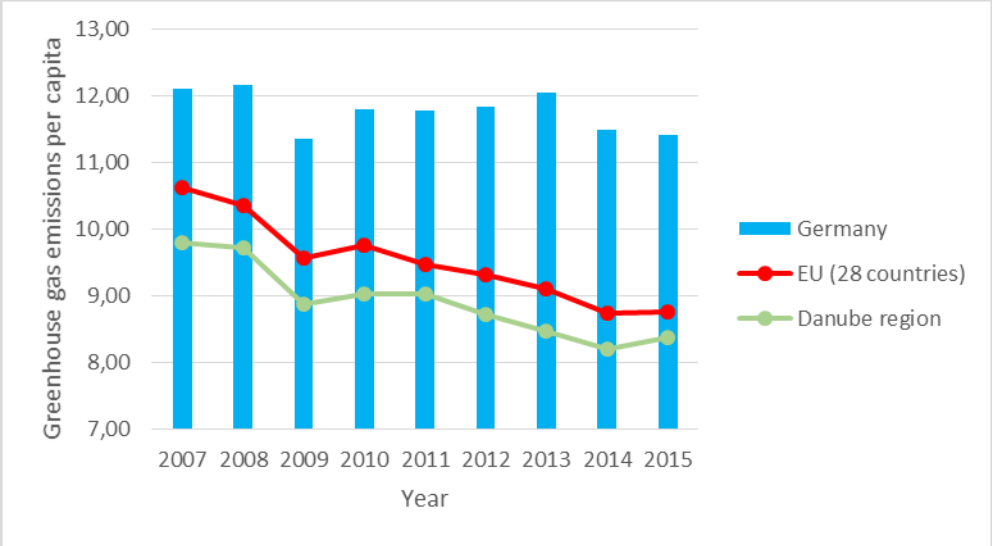


Figure 37 Greenhouses gas emission per capita

Emissions of eutrophying and acidifying air pollutants and of ozone precursors decreased to 60% of their 1990 level by 2012. Nevertheless, concentrations of NO2, PM10 and O3 remain too high and are beyond the value considered not dangerous for human health.
Although pollution of watercourses has decreased, more needs to be done with regard to some persistant pollutants, heavy metals, pesticides and medicinal products.
Roughly half of the phosphorous entering flowing water in Germany today comes from agriculture, and the other half originates from cities (municipal water treatment plants and rainwater run-offs). In addition to nitrate pollution, it is one of the causes of an oversupply of nutrients (eutrophication) in rivers, lakes and seas.[10]
Priorities in environmental policies are set on **climate protection, sustainable use of energy and resources**, a further **reduction of substance inputs to the environment** and **promoting the transition to a green economy.**

One of the goals of the Federal Government's Sustainable Development Strategy is to **improve resource efficiency** without any losses in prosperity while at the same time **reducing the use of raw materials**.
Extracting raw material has clearly a negative impact on the natural environment. The Federal Government has already set the target in the German Resource Efficiency Programme (ProgRess) II in 2015 of continuing to increase raw material input productivity. In the years from 2000 to 2010, raw material input productivity was already increasing by an average of around 1.5% annually. [11]

Another important aspect is the one related to **energy productivity**: this is in fact considered an indicator of an efficient use of primary energy. In Germany, the aim is for energy productivity to double by 2020 compared to 1990. Thanks to a reduction of primary energy consumption and to an increase in GDP, the energy productivity in Germany had already risen to 145% by 2013.[12]

[10] Cfr. Federal Statistical Office, Sustainable Development 2016
https://www.destatis.de/EN/Publications/Specialized/EnvironmentalEconomicAccounting/Sustainability/Indicators2016.pdf?__blob=publicationFile
[11] Cfr. Federal Statistical Office, Sustainable Development 2016
[12] Cfr. European Environment Agency, Germany country briefing - The European environment — state

A lot of effort has been put in Germany to foster the implementation of renewable energy production. In 2013, 12% of final energy consumption came from renewable energy sources, according to the European Environmental Agency. Renewables also accounted for 9,1% of heat and 5,5% of fuel consumption. Renewable energy sources accounted for 25,3% of gross electricity consumption, 9,1% of heat provision and 5,5% of fuel consumption. As a result, about 146 million tonnes of CO2 equivalent greenhouse gas emissions were avoided.[13]

In the Energy transition program (Energiewende) pursued by the German government, beside the expansion of renewable energies, a great focus is put on energy efficiency which might reduce the energy consumption. The goal is to maintain high level of GDP and prosperity while reducing the energy consumption.
According to the Federal Government's energy concept, final energy productivity is to be increased by 2,1% annually in the period 2008 to 2050. At the same time, primary energy consumption is to be reduced by 20% by 2020 and by 50% by 2050, both compared with 2008.[14]

This target has yet not be met in 2015, this is mostly due to an increase of a final energy consumption by private households. On the other side, the final energy consumption of the industry at an annual rate of change of around 1,2% remained below the growth rate of gross domestic product and thus had a positive impact on final energy productivity.[15]

Primary energy consumption fell by 7,6% in the period from 2008 to 2015. Although representing a positive trends and marking one of the best value since 1990 this is still not enough to meet the target value for 2020.

Another environmental challenge that Germany is facing is the one related to the **use of areas for settlement and transport purposes**. Daily consumption of new land for settlement and transport amounted to about 69 hectares in 2012 and 74 hectares averaged over the four years from 2009 to 2012.[16]
The target of the Federal Government is to implement space-saving measures for all new construction projects and in brownfield development such as the reduction in residential and commercial vacancy as well as re-densification and increased densities of development in order to counteract the reduction in settlement density.[17]

5.2 Resource Efficiency

Domestic material consumption and resource productivity

Domestic material consumption in Germany, an indicator measuring the total amount of material used by the economy, has been oscillating in the observed time period (2007-2016) around 16 tonnes per capita. This amount, even if still relatively high, is anyway lower compared to the benchmark of other strong innovators and in line with the average of the Danube region in 2015 and 2016.

[13] Federal Ministry for Economic Affairs and Energy, 2014, Second Monitoring Report "Energy of the future"
[14] Cfr. Federal Statistical Office, Sustainable Development 2016
[15] Cfr. Federal Statistical Office, Sustainable Development 2016
[16] Cfr. European Environment Agency, Germany country briefing - The European environment — state and outlook 2015
[17] Cfr. Federal Statistical Office, Sustainable Development 2016

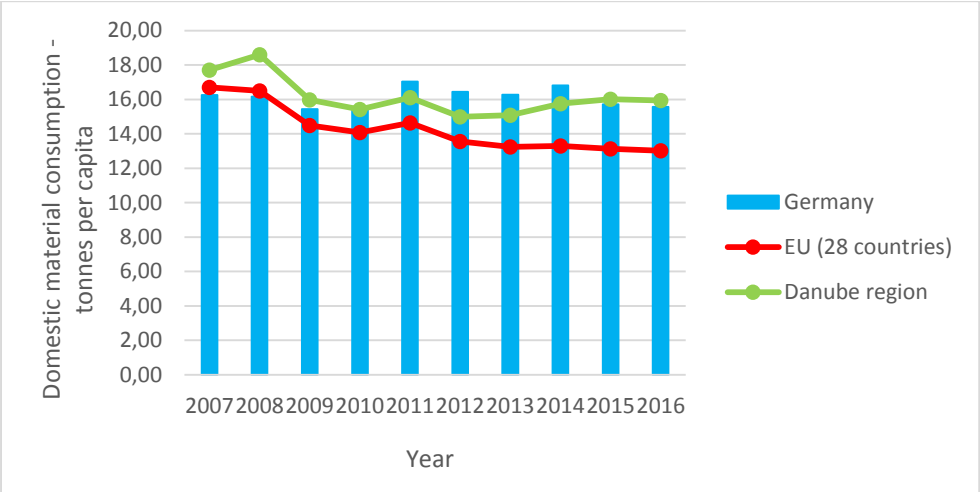


Figure 38 Domestic material consumption tonnes per capita

Taking a look at the resource productivity indicator which is obtained dividing the gross domestic product (GDP) by domestic material consumption (DMC), we can see that Germany has slightly improved is resource productivity going from 1,9 Euro per Kg in 2007 to 2,2 Euro per Kg in 2016. This value is significantly above the Danube Region average and still in some measure above the EU average.

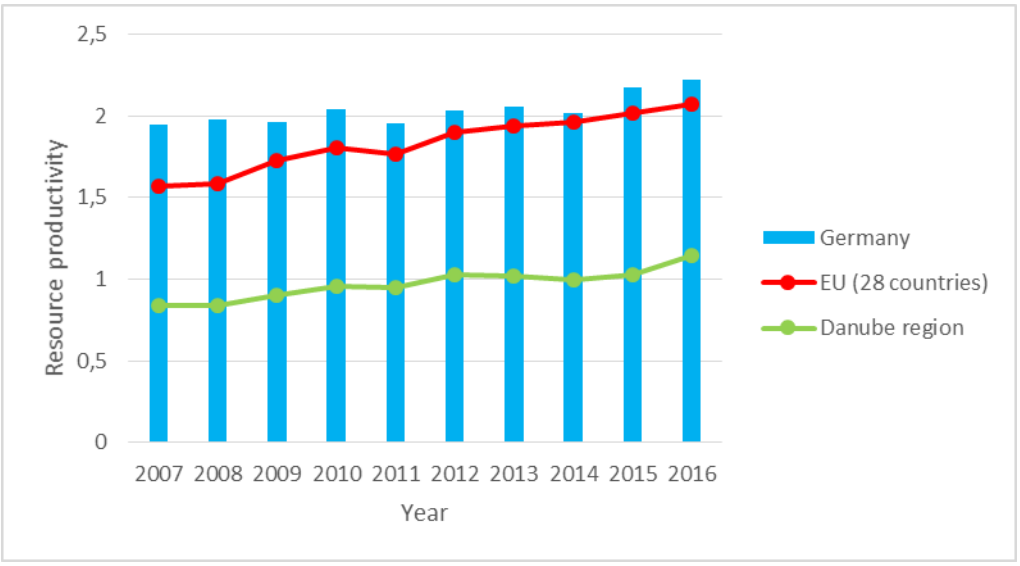


Figure 39 Resource Productivity in Germany

OSTACLE AND OPPORTUNITIES: The material consumption in Germany, though being lower than the Danube region area, should be still improved to reduce the impact of the German economy on the environment. Resource productivity has been growing in the observed time period but also in this case further effort are need to reach even better target.

5.3 Waste and recycling

The German approach to waste management is synthetized by the “waste hierarchy”: waste prevention, re-use, recycling, recovery, disposal. At the basis is the idea of preventing the creation of waste through an accurate and effective uses of resources. Waste recovery comes into play instead to reintroduce raw

materials and energy into the economic cycle. The German government aims to achieve almost complete high-quality recovery, of municipal waste at least, by 2020. The target for other types of waste is a recycling and energetic recovery quota of 65%. Significant ecological progress has been made with the entry into force of the strict ban on landfilling untreated household waste or general waste from industry on 1 June 2005.[18]

Nowadays Germany has made of waste management an important technology sector and it has the highest waste recovery quotas worldwide. Germany has often a pioneer role in shaping EU waste legislation; on a national level, the German government supports sustainable waste management concepts for obtaining raw materials or energy from waste.

Another important instrument of the German waste management policy is the so-called product responsibility. This requires producers to design their products in a way which allow the lowest waste production and it holds them accountable to ensure the recovery and disposal of residual substances, both in the production of goods and in their subsequent use. The legal bases for this are the Circular Economy Act and the Federal Immission Control Act. Product responsibility has been introduced for packaging, end-of-life vehicles, waste electrical and electronic equipment, batteries and waste oils.[19]

Recycling rate

As highlighted above, Germany is performing quite well in an European comparison for what concerns the recycling rate for packaging waste. In 2015 almost 70% of packaging waste were recycled, a value which is aligned with the performance of other strong innovators and slightly above the EU average.

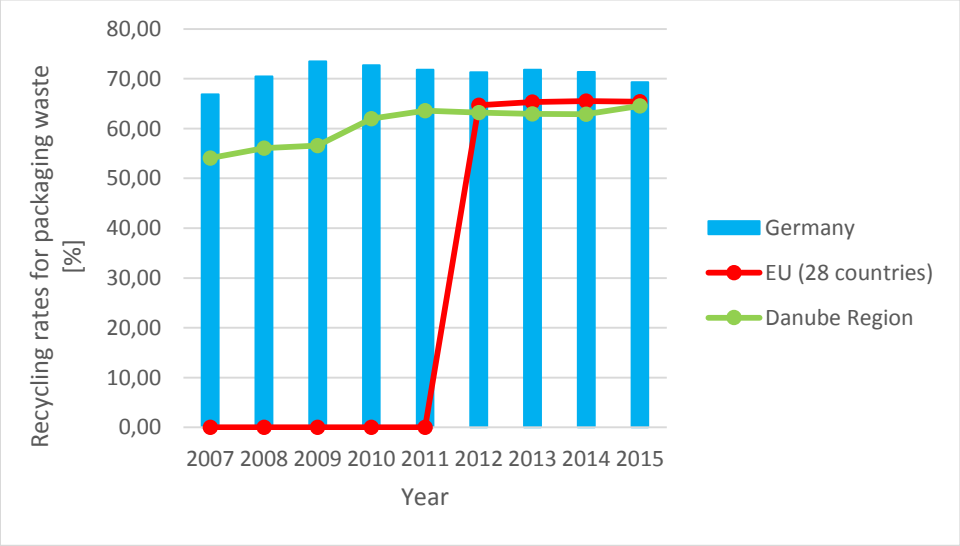


Figure 40 Recycling rate for packaging waste

Around 65% of municipal waste was recycled in Germany in 2015, the highest value achieved in that year in an European comparison. The recycling rate, expressed in percentage, is the tonnage recycled from municipal waste divided by the total municipal waste arising. Recycling includes material recycling, composting and anaerobic digestion. Municipal waste consists to a large extent of waste generated by

[18] General Information Waste management - Website of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety http://www.bmub.bund.de/en/topics/water-waste-soil/waste-management/general-information/
[19] General Information Waste management - Website of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety http://www.bmub.bund.de/en/topics/water-waste-soil/waste-management/general-information/

households, but may also include similar wastes generated by small businesses and public institutions and collected by the municipality; this latter part of municipal waste may vary from municipality to municipality and from country to country, depending on the local waste management system. The recycling rate of Germany has been in the entire observed period (2007-2015) well above the EU and Danube region average, signalized a certain attention of the German population to the recycling issue.

OPPORTUNITY: the good recycling rate and the development of technology for the waste management surely constitutes a positive signal for Germany. Nonetheless, to achieve even better results Germany should still invest more in product responsibility, the practice according to which waste is best prevented by holding the generator of waste responsible, so to reduce the waste that is generated with the production and distribution of products.

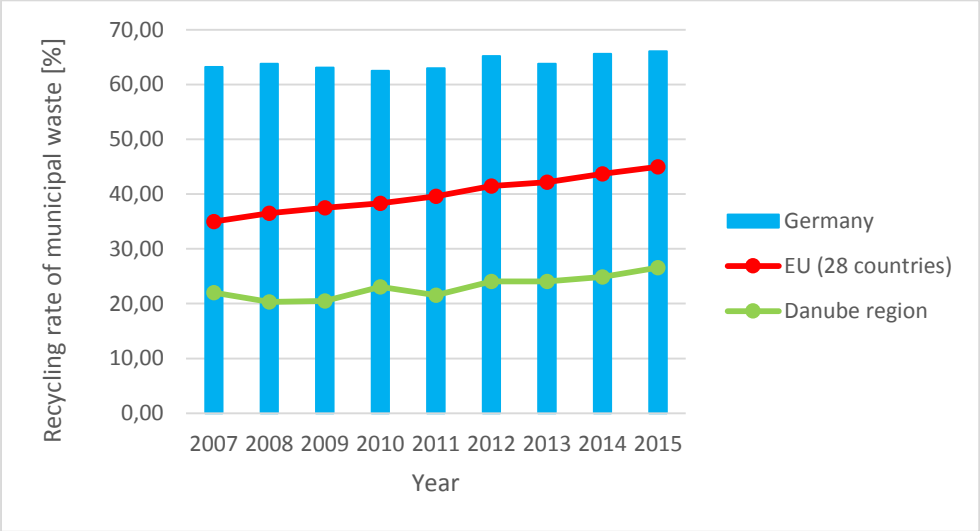


Figure 41 Recycling rate of municipal waste

The 'recycling rate of e-waste' is the 'collection rate' multiplied by the 'reuse and recycling rate'. Electronic waste is generated by the diffusion of several electronic devices which are often replaced for new upcoming model. The rate of recycling e-waste on an European level is still surprising small considering the impact on the environment of electrical and electronic equipment. Germany constitutes in this case no exception and in 2015 was able to recycle only 36,7% of the e-waste while the consume of electronic devices keep on growing in the country.

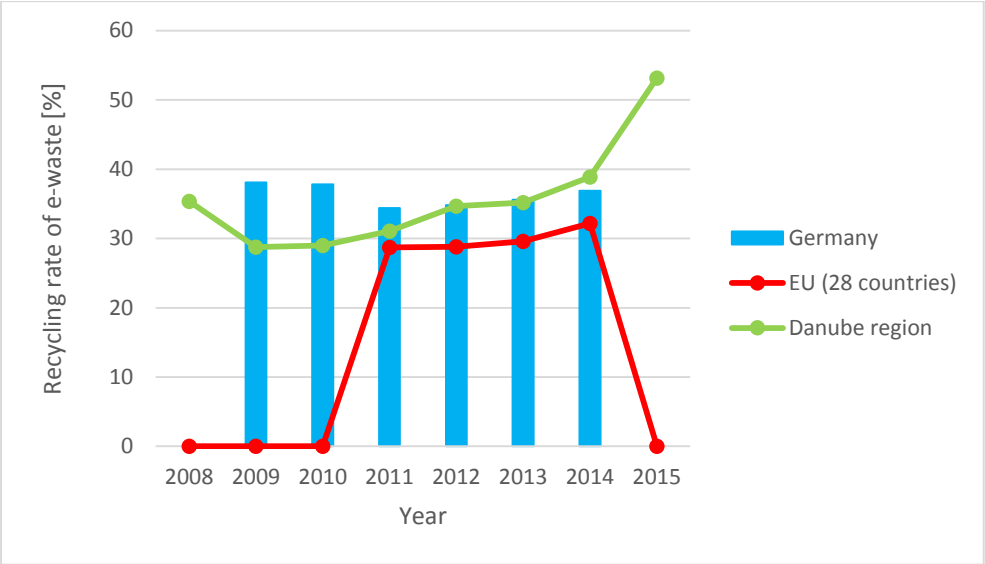


Figure 42 Recycling rate of e-waste

OBSTACLE: The recycle of e-waste in Germany as well as on an European level is still too low compared to the always increasing use and diffusion of electronic devices. Adequate measure should therefore be adopted in time to prevent electronic waste to be generated and consequently dispersed in the environment. There is a need to increase the repair and re-used of older devices and to raise consumers' awareness on ethical and environmental sustainable shopping attitude.

Air pollution

Germany seems to be on the way to meeting the standards of air pollution control set by the EU. For sulphur dioxide and volatile organic compounds it is sufficient to apply the measures already adopted and implemented in the past.[20] However, additional reductions are needed for nitrogen oxides and ammonia. The necessary reductions in nitrogen oxide emissions will be achieved in the transport sector and in stationary installations. The necessary reductions for ammonia emissions will be achieved in the agriculture sector.[21] Many cities in Germany anyway still register high level of air pollution. A report published by the German Environment Ministry in 2013 showed that levels for air pollutants are being exceeded in many parts of the country. According to the research, Stuttgart often had an annual nitrogen dioxide level that was more than double the acceptable threshold value. Cities with pollution levels just below Stuttgart's were Munich, Reutlingen, Düren, Limburg and Freiburg. Fine dust particles pose another serious problem. Here, the maximum is 40 µg up to a particle size of ten micrometres per cubic metre of air. Stuttgart exceeded this limit on 91 days in 2013.[22]

[20] General information on Air pollution, German Federal Ministry for the Environment, Nature Conservation, Building und Nuclear Safety http://www.bmub.bund.de/en/topics/air-mobility-noise/air-pollution-control/general-information/
[21] General information on Air pollution, German Federal Ministry for the Environment, Nature Conservation, Building und Nuclear Safety http://www.bmub.bund.de/en/topics/air-mobility-noise/air-pollution-control/general-information/
[22] Antwort der Bundesregierung http://dipbt.bundestag.de/dip21/btd/18/043/1804393.pdf

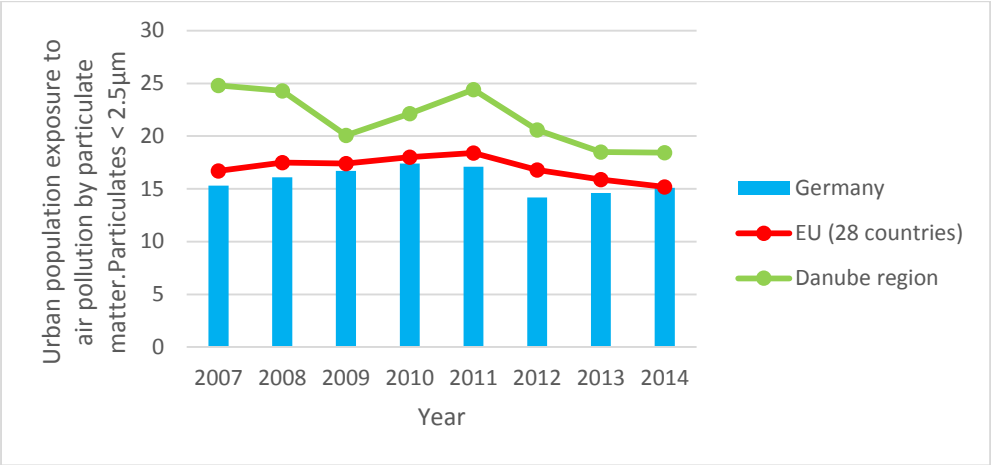


Figure 43 Urban Population exposure to air pollution by particulate matter < 2.5µm

Figure 44 Urban Population exposure to air pollution by particulate matter < 10 µm

5.4 Environmental legislation

As outlined before, the priorities in Germany environmental policies mostly concentrate on the following aspects:

- Climate protection
- sustainable use of energy and resources
- reduction of substance inputs to the environment
- transition to a green economy.

Climate protection plays a central role in environment and energy policy. The **German Climate Action Plan 2050**[23] is a climate protection policy document approved by the German government on 14 November 2016. The plan outlines measures by which Germany can meet its various national greenhouse gas emissions

[23] Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety, Climate Action Plan 2050, https://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutzplan_2050_kurzf_en_bf.pdf

reduction goals through to 2050 and service its international commitments under the 2016 Paris Climate Agreement. The Climate Action Plan 2050 addresses the areas of action energy, buildings, transport, industry, agriculture, land use and forestry. It also sets out overarching targets and measures. It follows a document approved in December 2014 called Climate Action Programme 2020 (Aktionsprogramm Klimaschutz 2020) only covering the period until 2020.
Under the interim target for 2030, Germany's total greenhouse gas emissions need to be reduced by at least 55 percent compared to 1990 by 2030 at the latest.

Area of action	1990 *(in million tonnes of CO_2 equivalent)*	2014 *(in million tonnes of CO_2 equivalent)*	2030 *(in million tonnes of CO_2 equivalent)*	2030 (reduction in % compared to 1990)
Energy sector	466	358	175 – 183	62 – 61 %
Buildings	209	119	70 – 72	67 – 66 %
Transport	163	160	95 – 98	42 – 40 %
Industry	283	181	140 – 143	51 – 49 %
Agriculture	88	72	58 – 61	34 – 31 %
Subtotal	1209	890	538 – 557	56 – 54 %
Other	39	12	5	87%
Total	**1248**	**902**	**543 – 562**	**56 – 55 %**

Figure 45 Emissions from areas of action set out in definition of the target (Source: Climate Action Plan 2050)

There are several area and measures which are covered by the Climate Action Plan 2050[24].

- In the **energy sector**, the goal is to achieve in 2030 a reduction of CO2 of 61-62% compared to 1990. The energy supply must be "almost completely decarbonised" by 2050, with renewables as its main source. Also electricity generation should be based almost entirely on renewable energies;
- In the **building sector** the target to achieve in 2030 is a reduction of CO2 of 66% compared to 1990. The government will invest heavily in programs to implement high-energy standards for buildings. Heating, cooling, and electricity supply will be progressively switched to renewables;
- In the **transport sector**, the ambition is to achieve in 2030 a reduction of 40-42% relative to 1990. The plan refers to stricter emission limits for new cars that will be set by the European Union but it does not foreseen a deadline for all new cars to be emission free;
- In the **industry sector**, the plan targets to achieve a reduction of 140-143 millions tonnes CO2eq by 2030. The challenge here is to reduce the emission thus staying competitive on an international level. In this sense, the search for environmental friendly technology could constitute a motor for innovation in the German industry
- In the **agriculture sector**, the target is a reduction of 31-34% relative to 1990. Even though emission zero in agriculture are no possible, a reduction of emission and a more efficient use of resources

[24] Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety, Climate Action Plan 2050, https://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutzplan_2050_kurzf_en_bf.pdf

should be pursued. The plan states that 20% of agricultural land by 2030 "should be used for organic farming", compared with 6.3% in 2014.

To achieve the goal of the Climate Action Plan, one mean will be the revision of the taxation till 2050 in order to create incentive for ecological economic activities. The German government will reduce environmentally harmful subsidies.

The most important pillar of the German energy efficiency strategy is the so called "Energiewende", as previously described in paragraph 4.1. The **Energy Transition plan** that was mainly redesign after the Fukushima disaster in 2011 comprehends important measure for energy saving, improving energy efficiency and expanding renewable energy. "The Federal Government has set itself the goal of reducing primary energy consumption by 20% by 2020 and 50% by 2050 compared to 2008. It aims to reduce electricity consumption by 10% by 2020 and 25% by 2050. Final energy productivity is to grow on average by 2.1% annually until 2050. The share of renewables in the electricity sector is to be increased by 40 to 45% by 2025 and by 55 to 60% by 2035"[25]. The plan wants furthermore to achieve all these targets while maintaining a high level of prosperity and competitive energy prices.

For what concerns the consumption of material and raw materials, Germany has adopted in 2012 the so called **German Resource Efficiency Programme (ProgRess)**[26]. Aim of this programme is to make the extraction and use of natural resources more sustainable and to reduce associated environmental pollution as far as possible. The programme attaches particular importance to market incentives, information, expert advice, education, research and innovation and to strengthening voluntary measures and initiatives by industry and society. The resource efficiency policy will help Germany meet its global responsibility for the ecological and social impacts of resource use. The goal is to reduce the use of resource in absolute terms.

In Progress II there is a strong focus on sustainable building and sustainable urban development and the resource efficiency of products in the information and communication technology (ICT). Ten action areas are considered in this context[27]:

- Securing a sustainable raw material supply
- Increasing resource efficiency in production
- Making production and consumption more resource-efficient
- Developing a resource-efficient circular economy
- Sustainable building and sustainable urban development
- Resource-efficient information and communication technology
- Cross-cutting instruments
- Exploiting synergies with other policy areas and resolving goal conflicts
- Supporting resource efficiency policy at local and regional level
- Strengthening resource policy at international and EU level

Already in 2008, the Federal Government adopted the **Strategy for Adaptation to Climate Change**. The aim

[25] Cfr. European Environment Agency, Germany country briefing - The European environment — state and outlook 2015
[26] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Overview of German Resource Efficency Programme (ProgRess) http://www.bmub.bund.de/en/topics/economy-products-resources-tourism/resource-efficiency/german-resource-efficiency-programme/overview/
[27] Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Overview of German Resource Efficency Programme (ProgRess)

of the strategy is to reduce vulnerability to the consequences of climate change, i.e. to maintain or improve the adaptability of natural, social and economic systems.
Finally, for what concerns the control of air pollution, the German government purses four strategies:[28]

- laying down environmental quality standard
- emission reduction requirements according to the best available technology
- product regulations
- laying down emission ceilings

The limit values are more and more often stipulated in European air pollution control directives and then transposed into German law.

5.5 Environmental taxes

In 1999 Germany implemented the first step of an Ecological Tax Reform. This introduces an incremental increase in taxes on fuel and energy. This model expects that a raise on taxes on energy might create an incentive for energy savings and energy efficiency. Besides, the principle behind is the idea that the additional public income generated by these taxes is used to contribute to the public pension scheme. At the same time taxes on labor are reduced by increasing taxing on mineral oils, gas and electricity.
In Germany, pollution and resources taxes are regional taxes (groundwater, wastewater and waster) or local tax (packaging). The tax rates also can be different in regions and cities.

Looking at Figure 46 we can notice that in 2015 the environmental tax revenue in relation to GDP were in Germany among the lowest in Europe. The highest value were instead reached in Croatia (4,1%) followed by Denmark (4,0 %), Slovenia (3,9 %) and Greece (3,7 %). As indicated by the Eurostat[29], statistics related to environmental taxation should anyway be read with caution as the reason behind the number might be different. Although low revenues from environmental taxes could signal relatively low environmental tax rates, these low level could be also be the results of a change of behavior in consumption generated by a high taxation.

[28] General information on Air pollution, German Federal Ministry for the Environment, Nature Conservation, Building und Nuclear Safety http://www.bmub.bund.de/en/topics/air-mobility-noise/air-pollution-control/general-information/
[29] Eurostat, Statistic explained, Environmental tax statistics http://ec.europa.eu/eurostat/statistics-explained/index.php/Environmental_tax_statistics

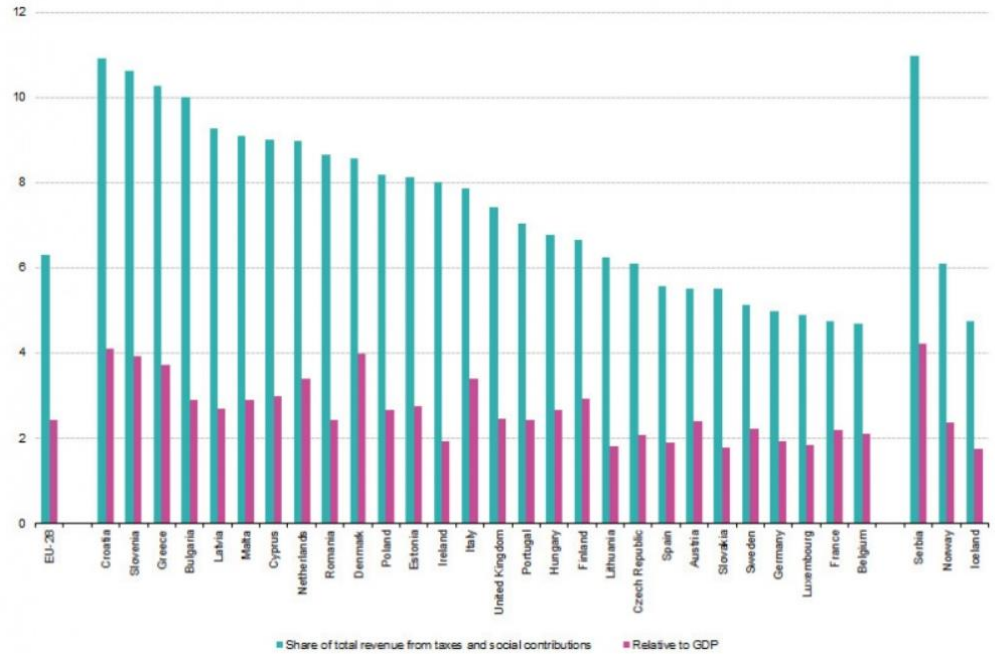


Figure 46 Total environmental tax revenue in 2015 (source: Eurostat)

The environmental tax revenue in Germany has been decreasing in the years between 2011 and 2015 and it is in general significantly lower than the EU and Danube region average.
In Germany, taxes on energy represented 83% of total environmentally related tax revenue, compared to 70% on average among the 39 countries.[30]

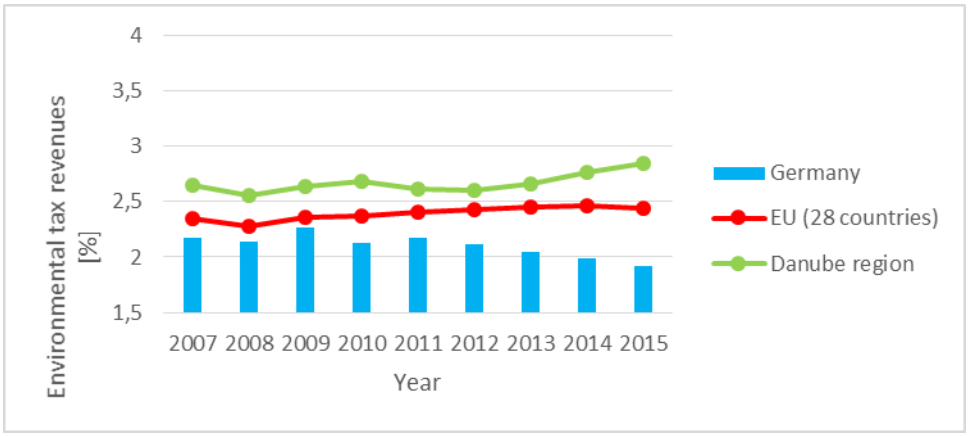
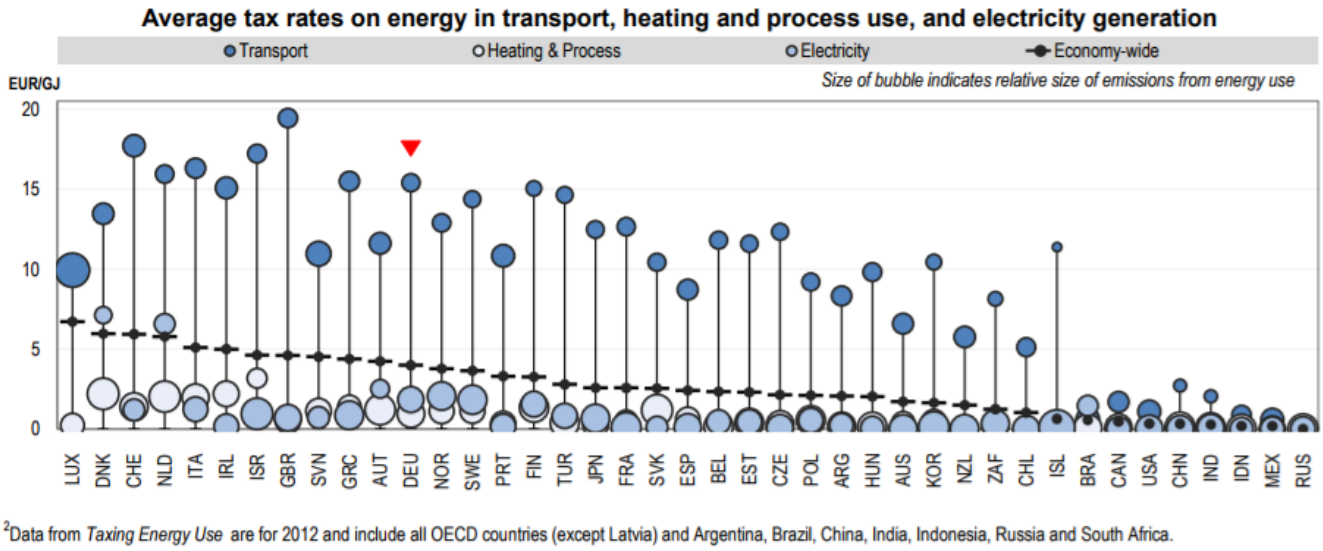


Figure 47 Environmental tax revenues

Germany has higher average tax rates on transport fuels (15,39 EUR/GJ) than on fuels used for heating and process purposes (0,94 EUR/GJ) or electricity generation (1,84 EUR/GJ).[31]

[30] OECD, Environmentally related taxes, https://www.oecd.org/ctp/tax-policy/environmental-tax-profile-germany.pdf
[31] OECD, Environmentally related taxes, https://www.oecd.org/ctp/tax-policy/environmental-tax-profile-germany.pdf



[2]Data from *Taxing Energy Use* are for 2012 and include all OECD countries (except Latvia) and Argentina, Brazil, China, India, Indonesia, Russia and South Africa.

Figure 48 Average tax rates on energy in transport, heating and process use and electricity generation (Source: OECD)

6. ECONOMY AND DEMOGRAPHY

Germany is currently facing a positive economical trend which, with the except of the global crisis in 2009, has been a continuous trend over the last decade. The growth rate has followed the global economy trends, and the country economic system proved to be solid and capable of absorbing systemic shocks, such as the financial crisis in 2009. The generally positive trend post-2009 in the Eurozone, coupled with low interest rates and a general increase in productivity, helped the country to boost its exports and business investments, sustaining thus the trade-balance and financial surplus. The substantial growth is also sustained by internal private consumption, thanks to the low unemployment and a general wage increase.
For what regards its demographics, Germany shares with the rest of Western Europe a declining population trend. Despite a surge of immigrants, the UN predicts that German population will fall from 82m in 2012 to 74,5m in 2050; furthermore, in the same time span the population will get older, with only a mere 13% of the population set to be under 15 years old in 2050. While this trend is shared by many EU countries, the effects on German economy can be particularly severe. A recent study published by Deutsche Bundesbank expect the German economy's production potential to slow down considerably due to the demographic-induced decline in the total number of hours worked and the labour productivity related to the transformation of the economy ("in an ageing society, services, such as care for the elderly, gain in significance compared to the production of good") and to the decreasing (or stagnating) productivity typical of older members of workforce.

6.1 Indicator: Gross domestic product at market prices in PPS per capita

The German GDP, as mentioned in the previous section, has been on a substantial rise in the last decade, and it generally ranked among the best economies in Europe in particular and in the OECD countries in general. The GDP has fallen in 2009 as a consequence of the global financial crisis, and quickly recovered in the aftermath thanks to the low interest rates, the currency depreciation and the boost of national export. The normalized PPS graph shown in Figure 49, shows that the country' GDP performs better than the EU28 average.

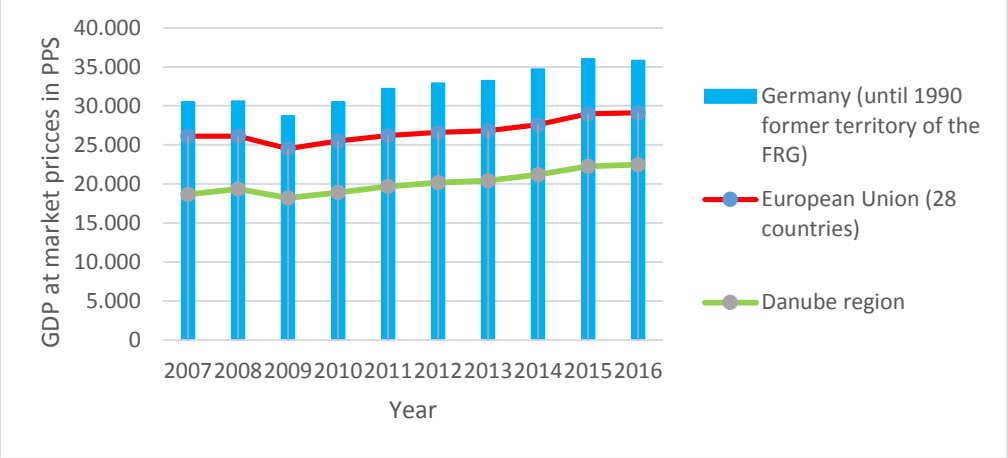


Figure 49 Gross domestic product at market prices in PPS per capita in Germany, the EU and the Danube region

The real GDP graph as shown in Figure 50 shows that Europe's largest economy was slowing down its growth in the years preceding 2009; when the global crisis hit in 2009, the effects on the country's GDP brought to the most severe fall of real GDP among many high income countries, and among the worse in EU28. The next-years rebound, however, helped the country's economy to recover from the loss of real GDP and to return to ta path of growth, which is currently easing.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
EU-28 (1)	3,3	3,1	0,4	-4,4	2,1	1,7	-0,5	0,2	1,6	2,2	
Danube region	5,68	5,58	3,71	-5,52	1,46	1,77	-0,48	0,85	1,67	2,63	
Germany	3,7	3,3	1,1	-5,6	4,1	3,7	0,5	0,5	1,6	1,7	1,9

Figure 50 Real GDP growth

OPPORTUNITY: The growing GDP helps the German economy in investing more and more in research and new emerging field as the ecoinnovation one.

6.2 Indicator: Employment rate as a share of total population of age group 20-64

German labour market conditions improved continuously during the last decade, and it will continue to

improve according to the latest OECD projections[32]. The introduction of the federal minimum wage in 2015 did not interrupt increase of employment rate, nor the decline in unemployment.

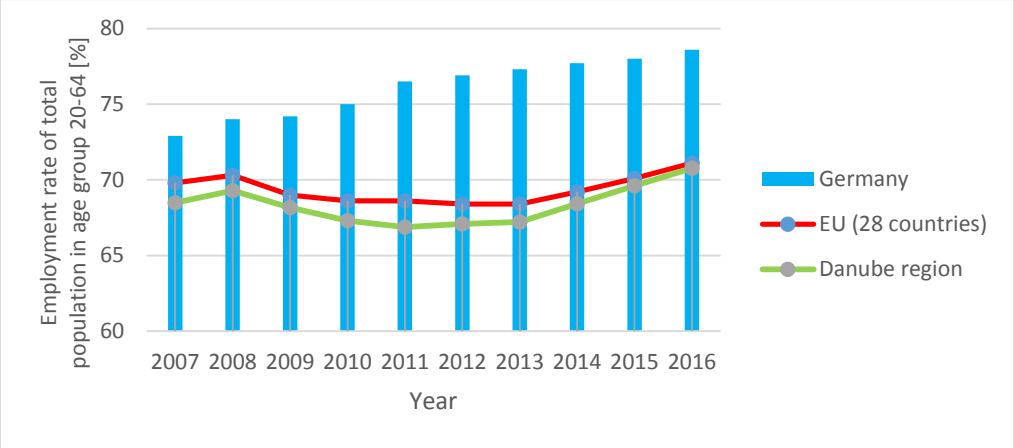


Figure 51 Employment rate as a share of population age 20-64 in Germany

6.3 Indicator: Unemployment rate as a share of active population

The unemployment rate in 2007 was higher than the EU-28 average, but thanks to the combination of previous social and labour reforms and the growth of German production and GDP it established itself on a descending path since. The unemployment rate currently tops the 4%, among the lowest in the EU area, and it is project to fall to 3.7% in 2018, less than half its rate in 2007. Furthermore, the youth unemployment rate ranks amongst the lowest in EU28 and OECD areas: among employable persons aged 15-24 only 7% is actually unemployed, while the 93% is actively employed.

OPPORTUNITIES: the low unemployment rate in Germany signalizes the good health of its economic system and constitutes a strength for a continuous economical growing path with positive return also in terms of new investment and R&D.

[32] OECD, Employment Outlook 2017, https://www.oecd.org/germany/Employment-Outlook-Germany-ENG.pdf

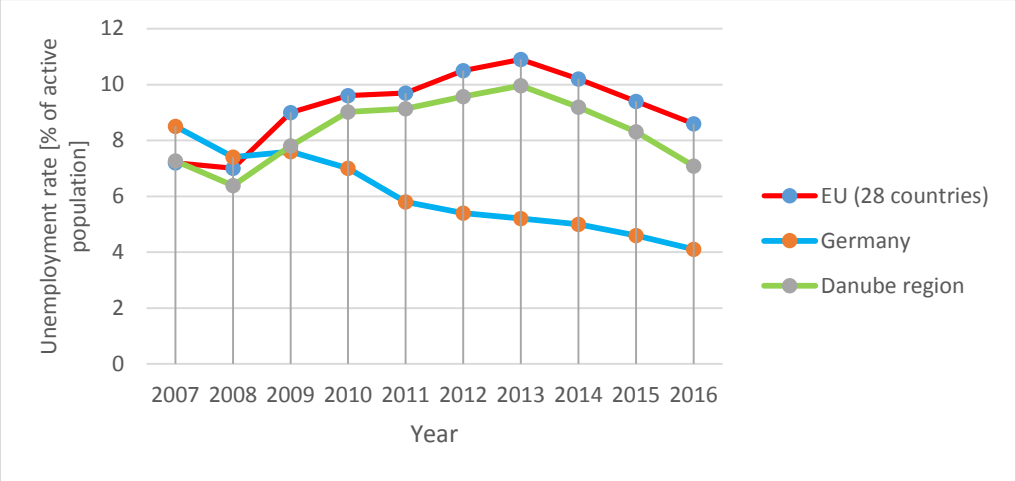


Figure 52 Unemployment rate as a share of active population in Germany

7. Conclusion

As clearly showed within this report, Germany is an innovation leader, with a modern and growing economy, a high level of GDP and satisfying private and public investment in innovation and R&D activities.
The country is one of the world leaders when it comes to climate protection and expanding the use of renewable energy. This course has been particularly fasten by the nuclear disaster in Fukushima in Japan in 2011: in this occasion, the German federal government decided to phase out nuclear power and strengthened its commitment to full energy transition. In addition to the renouncement of nuclear power, the climate protection project provides for a 35 % increase in the share of renewables by 2020, and 80 % by 2050. By then the energy efficiency of German buildings should have also improved considerably, making them virtually climate neutral.
Nonetheless, the implementation of this measure in reality has not always being easy and immediately successful. A part from the commitment of the Government, such measures require in fact a high commitment and engagement of the final consumers. In introducing an environmentally compatible, extensive and climate neutral energy supply also the commerce and industry have a significant role to play. The data available shows that the energy transition will only succeed in Germany if the industry and other big players will significantly expand their investments in energy efficiency and renewables in the future, along with private households.
The German Government has adopted a national Sustainable Development Strategy that set the goals and challenges derived by the commitment of the country to global sustainable development, and outlines the concrete measures and targets to achieve them.

To reach the sustainable development goals set by the German Government and ratified with the adoption of Agenda 2030 in 2015, Germany should still achieve following targets in the future decades:
The primary energy consumption has to be reduced by 20 % by 2020 and 50 % by 2050 compared to 2008
Final energy productivity has to be increased by 2,1 % per year from 2008 to 2050.
Share of renewable energies in gross final energy consumption have to be increased to 18 % by 2020, to 30% by 2030 and 60 % by 2050. Share of renewable energy sources in electricity consumption has to be increased to at least 35 % by 2020, to at least 50 % by 2030, to at least 65 % by 2040 and to at least 80 % by 2050.

Market share of goods certified by independently verified sustainability labelling schemes has to be increased by 34 % by 2030.

Energy consumption and CO2 emissions from private household consumption need to be constantly reduce so the awareness raising among the population as well as further incentives and taxes might play a key role in fostering sustainable behavior of the final consumers.

Greenhouse gas emissions have to be reduced by at least 40 % by 2020, by at least 55 % by 2030, by at least 70 % by 2040 and by 80 % to 95 % by 2050, in each case compared to 1990.

The financing for the international reduction of greenhouse gases and adaptation to climate change has to be doubled by 2020 compared to 2014. Private and public spending on research and development should reach at least at least 3 % of GDP by 2030.

Built-up area and transport infrastructure expansion has to be reduced to 30 ha minus x per day by 2030.

Finally the trend for raw material input productivity of 2000 – 2010 has to be maintained until 2030.

8.Sources

Research and Innovation Observatory - Horizon 2020 Policy Supoort Facility, RIO Country Report Germany https://rio.jrc.ec.europa.eu/en/country-analysis/Germany/country-report

European Commission, 2017 European Innovation Scorebord report, https://www.rvo.nl/sites/default/files/2017/06/European_Innovation_Scoreboard_2017.pdf

OECD, Employment Outlook 2017, https://www.oecd.org/germany/Employment-Outlook-Germany-ENG.pdf

Federal Ministry for Economy Affairs and Energy, Ready for the next phase of energy transition http://www.bmwi.de/Redaktion/EN/Dossier/energy-transition.html

European Environment Agency, Energy Intensity https://www.eea.europa.eu/data-and-maps/indicators/total-primary-energy-intensity-3

Eurostat, Statistic explained, Renewable energy statistics http://ec.europa.eu/eurostat/statistics-explained/index.php/Renewable_energy_statistics

Federal Statistical Office, Sustainable Development 2016 https://www.destatis.de/EN/Publications/Specialized/EnvironmentalEconomicAccounting/Sustainability/Indicators2016.pdf?__blob=publicationFile

European Environment Agency, Germany country briefing - The European environment — state and outlook 2015

Federal Ministry for Economic Affairs and Energy, 2014, Second

Federal Ministry for Economic Affairs and Energy, 2014, Second Monitoring Report "Energy of the future"

Federal Statistical Office, Sustainable Development 2016

General Information Waste management - Website of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety http://www.bmub.bund.de/en/topics/water-waste-soil/waste-management/general-information/

General information on Air pollution, German Federal Ministry for the Environment, Nature Conservation, Building und Nuclear Safety http://www.bmub.bund.de/en/topics/air-mobility-noise/air-pollution-control/general-information/

Antwort der Bundesregierung http://dipbt.bundestag.de/dip21/btd/18/043/1804393.pdf

Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety, Climate Action Plan 2050, https://www.bmub.bund.de/fileadmin/Daten_BMU/Download_PDF/Klimaschutz/klimaschutzplan_2050_kurzf_en_bf.pdf

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Overview of German Resource Efficency Programme (ProgRess) http://www.bmub.bund.de/en/topics/economy-products-resources-tourism/resource-efficiency/german-resource-efficiency-programme/overview/

Eurostat, Statistic explained, Environmental tax statistics http://ec.europa.eu/eurostat/statistics-

explained/index.php/Environmental_tax_statistics

OECD, Environmentally related taxes, https://www.oecd.org/ctp/tax-policy/environmental-tax-profile-germany.pdf

OECD, Employment Outlook 2017, https://www.oecd.org/germany/Employment-Outlook-Germany-ENG.pdf