SDG 9 - Industry, innovation and infrastructure

Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation

*Data extracted in May 2021.*

*Planned article update: June 2022.*

This article provides an overview of statistical data on SDG 9 'Industry, innovation and infrastructure' in the European Union (EU). It is based on the set of EU SDG indicators for monitoring of progress towards the UN Sustainable Development Goals (SDGs) in an EU context.

This article is a part of a set of statistical articles, which are based on the Eurostat publication 'Sustainable development in the European Union — Monitoring report on progress towards the SDGs in an EU context — 2021 edition'. This report is the fifth edition of Eurostat’s series of monitoring reports on sustainable development, which provide a quantitative assessment of progress of the EU towards the SDGs in an EU context.

SDG 9 calls for building resilient and sustainable infrastructure and promotes inclusive and sustainable industrialisation. It also recognises the importance of research and innovation for finding lasting solutions to
Industry, innovation and infrastructure in the EU: overview and key trends

Monitoring SDG 9 in an EU context focuses on research and development (R&D) and innovation, sustainable industry and sustainable infrastructure. As Table 1 shows, R&D and innovation in the EU has progressed in terms of R&D personnel, patent applications and tertiary educational attainment over the past few years, alongside stagnation in the EU’s R&D intensity. The analysis on sustainable industry is so far limited to the air emissions intensity of the manufacturing sector, which shows a clearly favourable trend. Indicators on sustainable infrastructure show unfavourable trends for sustainable transport and mobility patterns, especially in the short term, while the roll-out of high-speed internet access has progressed considerably.

### Table 1: Indicators measuring progress towards SDG 9, EU

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Long-term trend (past 15 years)</th>
<th>Short-term trend (past 5 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R&amp;D and innovation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross domestic expenditure on R&amp;D</td>
<td>🎉</td>
<td>🎉</td>
</tr>
<tr>
<td>R&amp;D personnel</td>
<td>🎉</td>
<td>🎉</td>
</tr>
<tr>
<td>Patent applications to the European Patent Office</td>
<td>🎉</td>
<td>🎉</td>
</tr>
<tr>
<td>Tertiary educational attainment (*)</td>
<td>🎉</td>
<td>🎉</td>
</tr>
<tr>
<td><strong>Sustainable industry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air emissions intensity of industry</td>
<td>🎉 (↑)</td>
<td>🎉 (↑)</td>
</tr>
<tr>
<td><strong>Sustainable infrastructure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of buses and trains in total passenger transport</td>
<td>🎉 (↓)</td>
<td>🎉 (↓)</td>
</tr>
<tr>
<td>Share of rail and inland waterways in total freight transport</td>
<td>🎉 (↑)</td>
<td>🎉 (↑)</td>
</tr>
<tr>
<td>Average CO₂ emissions from new passenger cars (*)</td>
<td>🎉 (↑)</td>
<td>🎉 (↑)</td>
</tr>
<tr>
<td>Share of households with high-speed internet connection (*)</td>
<td>🎉 (↓)</td>
<td>🎉 (↓)</td>
</tr>
</tbody>
</table>

(↑) Multi-year trend indicator. 
(↑) Past 10-year period. 
(*) Past 14-year period. 
(↑) Past 15-year period.
Table 2: Explanation of symbols for indicating progress towards SD objectives and targets

<table>
<thead>
<tr>
<th>Symbol</th>
<th>With quantitative target</th>
<th>Without quantitative target</th>
</tr>
</thead>
<tbody>
<tr>
<td>🕰️</td>
<td>Significant progress towards the EU target</td>
<td>Significant progress towards SD objectives</td>
</tr>
<tr>
<td>🟢</td>
<td>Moderate progress towards the EU target</td>
<td>Moderate progress towards SD objectives</td>
</tr>
<tr>
<td>🔴</td>
<td>Insufficient progress towards the EU target</td>
<td>Moderate movement away from SD objectives</td>
</tr>
<tr>
<td>🔴</td>
<td>Movement away from the EU target</td>
<td>Significant movement away from SD objectives</td>
</tr>
</tbody>
</table>

*: Calculation of trend not possible (for example: time series too short)

**R&D and innovation**

R&D expenditure is a key enabling factor for smart, sustainable and inclusive growth. Introducing new ideas to the market promotes job creation, labour productivity and efficient use of resources. Highly skilled human resources are imperative for keeping the EU’s research and innovation capacity and competitiveness up to date. Innovative products and services, often as a result of R&D activities, contribute to smart growth and sustainable industrialisation. R&D and innovation are also essential for finding solutions to societal and environmental challenges such as climate change and clean energy, security, and active and healthy ageing.

**EU expenditure on R&D has shown only modest growth**

The EU economy is facing increasing global competition and can only remain competitive with other countries and regions in the world by strengthening its scientific and technological base. Therefore, one of the key aims of EU policies over recent decades has been to encourage greater investment in R&D. This is monitored here by looking at **gross domestic expenditure on R&D** in relation to GDP, referred to as R&D intensity. R&D intensity thus reflects both growth in spending on R&D and growth in GDP. The EU has a long-standing objective of increasing its R&D intensity to 3 %, which was reaffirmed in the Council conclusions on the new European Research Area (ERA).

Despite the long-standing 3 % target, the EU’s R&D intensity has shown only modest growth over the past 20 years. After prolonged stagnation between 2000 and 2007, the EU’s R&D intensity has increased slowly, stabilising at just above 2.0 % since 2011 and reaching 2.2 % in 2019. In absolute terms, this corresponded to an R&D expenditure of about EUR 308 billion in 2019. With a gap of 0.8 percentage points, the EU nevertheless remains far from its ambition of raising R&D intensity to 3 % by 2030.

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3Eurostat (online data code: (rd_e_gerdtot))
Private expenditure accounts for two-thirds of total R&D expenditure

An analysis of gross domestic expenditure on R&D by sector of performance shows that the two biggest spenders in 2019 remained the business enterprise sector (66.3 % of total R&D expenditure) and the higher education sector (21.6 %). The share of the government sector was about 11.5 %, while the private non-profit sector accounted for less than 1.0 % of the total R&D expenditure.

The business enterprise sector accounts for the lion’s share of total R&D expenditure and has increased its R&D intensity by 0.32 percentage points over the past 15 years, from 1.14 % of GDP in 2004 to 1.46 % in 2019. In contrast, the R&D intensities of the three other sectors — higher education, government and private non-profit — have more or less stagnated at lower levels.

The number of patent applications to the European Patent Office has grown

Patent applications provide a valuable measure of the inventiveness of countries, regions and companies and of the economic exploitation of research results. In 2020, 65 854 patent applications from within the EU were submitted to the European Patent Office. This figure was reached after an almost continuous period of growth since 2004, when 51 508 applications were submitted. The only year to record a strong year-on-year drop in applications was 2009 as a result of the economic crisis.

The availability of human capital for a knowledge-based society is growing, but gender disparities remain

The growing knowledge orientation of the EU’s economy and society, together with developments in the labour

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4Eurostat (online data code: (rd_e_gerdtot))

market and demographic trends, make human capital increasingly important. Achieving the SDGs will require ambitious investments in R&D and significant innovation. This needs to be supported by a highly skilled labour force, including new scientific and technical occupations in key manufacturing and other sectors such as energy, high-tech services and construction.\(^6\)

The share of **R&D personnel** in the economically active population — including researchers and other staff employed directly in R&D — has increased steadily since 2004, from 0.92 % to 1.41 % in 2019 (full-time equivalent). This trend was mainly driven by the business enterprise sector, which employed more than half of the R&D workforce in 2019.

An analysis by sex, however, reveals that women remain considerably underrepresented among researchers based on head count in the EU, accounting for only 32.8 % in 2017. There has been no considerable progress since 2003, when the share stood at 29.0 %. This underrepresentation is particularly strong in the business enterprise sector, where women only made up 21.1 % of researchers in 2017. In contrast, women accounted for more than 40 % of researchers in the other three sectors (government, higher education and non-profit sector), with the private non-profit sector being the closest to achieving parity at 48.3 % in 2017. Compared with the other sectors, the higher education sector recorded the largest increase in female researchers between 2003 and 2017, by 7.7 percentage points.\(^7\)

Data on **tertiary educational attainment** show a general long-term increase in the EU population’s skill levels. Between 2005 and 2020, the share of 25- to 34-year olds with a university degree or similar increased from 27.2 % to 40.2 %. The EU is therefore on track towards reaching its target of raising this share to at least 45 % by 2030, as set out in the Council Resolution on the European Education Area.\(^8\) However, differences between the sexes remain considerable, and when compared with the situation for R&D personnel, the gender imbalance is reversed. While 45.6 % of women aged 25 to 34 years had accomplished tertiary education in 2020, only 34.8 % of men in this age group had done so. This gender gap has widened almost continuously since 2005.

For further details on tertiary education and the gender gap, see the articles on SDG 4 'Quality education’ and SDG 5 'Gender equality’.

![Figure 3: R&D personnel, EU, 2002-2019 (% of active population) Source: Eurostat (sdg_09_30)](image)

**Sustainable industry**

The EU’s industrial sector accounts for more than 20 % of the EU economy and employs around 35 million people.\(^9\) At the same time, it is also a source of many environmental pressures such as material consumption and the emission of greenhouse gases and other air pollutants. Mobilising industry for a clean and circular economy is consequently one of the key priorities of the European Green Deal, which seeks to support and


\(^7\)Eurostat (online data code: [rd_p_femres]).


accelerate the EU’s industry transition to a sustainable model of inclusive growth. The analysis here focuses on air pollutants emitted by industry, using particulate matter emissions from manufacturing as a proxy. For an analysis of the emissions of greenhouse gases from industry, see the article on SDG 13 ‘Climate action’.

The air emissions intensity of industry has improved in recent years

Poor air quality causes premature deaths, impacts quality of life and damages ecosystems. According to a recent report by the European Environment Agency, air pollution led to about 400,000 premature deaths in the EU in 2016. Particulate matter, especially fine particulate matter (PM2.5), is one of the most harmful components of air pollution for human health (see articles on SDG 3 ‘Good health and well-being’ and on SDG 11 ‘Sustainable cities’). In 2018, the EU’s manufacturing sector was responsible for almost a quarter (24.4%) of total PM2.5 emissions. In comparison, in the same year, about a third (32.2%) of total PM2.5 emissions could be attributed to transportation and storage, and slightly more than one fifth (21.6%) to agriculture, forestry and fishing.

Data on emissions intensity monitor a sector’s air emissions relative to its economic output in terms of gross value added (GVA). Between 2008 and 2018, the air emissions intensity of fine particulate matter (PM2.5) of the EU’s manufacturing sector dropped by 27.3%, from 0.11 gram per euro to 0.08 gram per euro. The improvement was slightly stronger when looking at the broader group of fine and coarse particulates (PM10), with the respective emissions intensity decreasing by 31.3% over the same time span.

An analysis of the underlying trends shows there was an absolute decoupling of the manufacturing sector’s particulate matter emissions from its GVA between 2008 and 2018. During this period, the sector’s PM2.5 emissions fell by 24.6%, while its GVA grew almost continuously, by 12.7%. Most of this decoupling, however, took place in the aftermath of the economic crisis, between 2008 and 2013. In the past five years the sector has only seen a relative decoupling, with PM2.5 emissions rising by 1.4% alongside growth in GVA of 17.5% between 2013 and 2018.

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11European Commission (2021), Clean air.
12European Environment Agency (2019), Cutting air pollution in Europe would prevent early deaths, improve productivity and curb climate change.
14Eurostat (online data code: (env_ac_ainah_r2)).
15Eurostat (online data code: (env_ac_ainah_r2)).
16Eurostat (online data code: (nama_10_a10)).
Sustainable infrastructure

The European Green Deal aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy. To achieve this vision, the EU needs to address the twin challenge of the green and the digital transformation. In this context, the Green Deal calls for accelerating the shift to sustainable and smart mobility as well as for investments in digitalisation to support the ecological transition. Multimodal freight transport as well as automated and connected multimodal mobility will consequently need to play an increasing role, together with smart traffic management systems enabled by digitalisation.

Cars remain the dominant mode for passenger transport

Well-functioning and efficient transport and mobility systems are key elements for a competitive economy. Growth in transport activities puts increasing pressure on natural resources and on societies. Emissions of greenhouse gases, air pollutants and noise from transport affect the climate, the environment and human health. As the transport sector is responsible for nearly one-quarter of greenhouse gas (GHG) emissions in the EU (see the article on SDG 13 ‘Climate action’), sustainable transport is an essential ingredient in sustainable development strategies. Rethinking future mobility includes optimising the use of all means of transport, promoting car sharing and the integration between different modes of collective transport such as trains and buses.\(^{17}\)

The modal share of passenger transport has not changed substantially since 2000, with passenger cars still accounting for almost 83\% of total inland passenger transport in the EU in 2018.\(^{18}\) As a result, the share of buses and trains has stagnated around 17\% and accounted for 17.1\% in 2018. This is a 1.0 percentage point decrease since the share peaked at 18.1\% in 2013.

\(^{17}\)Tram and metro systems are not included because the data collection methodology for these means of transport is not sufficiently harmonised between Member States.

\(^{18}\)Eurostat (online data code: tran_hv_psmo).

Figure 4: Air emissions intensity of industry for particulate matter, EU, 2008-2018 (grams per euro, chain-linked volumes, 2010). Source: Eurostat (sdg_09_70)

Figure 5: Share of buses and trains in total passenger transport, EU, 2000-2018 (% of total inland passenger-km) Source: Eurostat (sdg_09_50)
CO2 emissions from new car fleets increased between 2016 and 2019

While cars remain the dominant mode for passenger transport, new car fleets have generally become cleaner. Average carbon dioxide (CO2) emissions from new passenger cars fell between 2007 and 2016, before starting to rise again, reaching 122.2 grams of CO2 per kilometre (g CO2 per km) in 2019. This rebound has pushed the EU further away from its target of 95 g CO2 per km that will apply from 2020 onwards.

Because the efficiency improvements in new car fleets have struggled to offset rising passenger transport volumes, replacing conventional cars with zero-emission vehicles (ZEVs) will be crucial to achieving climate neutrality and the EU’s greenhouse gas emissions reduction targets. According to data from the European Alternative Fuels Observatory, the share of ZEVs — including both battery electric vehicles and hydrogen vehicles — in newly registered passenger cars in the EU rose from 0.4 % in 2015 to 5.3 % in 2020. The most recent year-on-year change showed a particular strong boost in ZEV uptake in the EU, up from 1.9 % in 2019. While considerable differences between European countries remain, the data show that countries with a high share of ZEVs in newly registered passenger cars — such as the Netherlands, Denmark or France — are among the best performers in terms of their car fleets’ CO2 emissions (see the article on SDG 12 ‘Responsible consumption and production’).

The EU’s freight transport system still relies on road transport

Similar to passenger transport, the modal split of freight transport has not changed substantially since 2005. Despite the EU policy objective of shifting freight from road to rail, road continues to have by far the largest share of EU freight transport among the three inland transport modes analysed in this report (road, rail and inland waterways). The share of rail and inland waterways in total freight transport in the EU accounted for 23.7 % in 2019. Between 2014 and 2019, this share decreased by 2.4 percentage points.

Considerable differences do exist at country level though. In 2019, three countries (Latvia, Lithuania and Romania) had higher freight transport shares for rail and inland waterways than for road. Particularly high shares of rail transport were reported from the Baltic countries Latvia, Lithuania and Estonia. And in the Netherlands, freight transport via inland waterways still plays a very important role (modal split of 42.7 % in 2019).

A look at the absolute transport of goods reveals that in the EU road freight transport (in tonne-kilometres) is strongly linked to economic growth. Between 2014 and 2019, the EU’s GDP grew by 11.2 %, while the goods transport by road increased even more strongly, by 14.8 %. Over the same period, goods transport by rail increased only by about 5 % in the EU, while inland waterways transport contracted by 7.3 %.

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19 Source: Eurostat (online data code: (ROAD_TP_VEHMOV)).
20 See https://www.eafo.eu.
21 Eurostat (online data codes: (nama_10_gdp) and (ttr00005)).
22 Estimated data based on Eurostat (online data code: (rail_go_total)).
23 Eurostat (online data code: (iww_go_atygo)).
Considerable progress has been made in rolling out fixed very high capacity network connections across the EU. Digital connections are crucial for today’s economies and societies. Instant communication between individuals, bank transfers, office work, public dissemination of information, or data analysis are only some of the activities that depend on the internet. Regions without fast internet connections have serious social and economic disadvantages in a digitalised world. Making Europe fit for the digital age is consequently one of the six Commission priorities for 2019 to 2024, with the aim of making the digital transformation work for people and businesses while helping to achieve the target of a climate-neutral Europe by 2050.

Data collected by the European Commission services for the key dimensions of the European information society show that the uptake of fixed very high capacity network (VHCN) connectivity — referring to fibre connections or other networks offering similar bandwidth — in the EU has improved considerably since 2013. While only 15.6 % of EU households enjoyed such connectivity in 2013, this share has risen considerably, reaching 59.3 % of households in 2020. If VHCN roll-out continues at this pace, the EU will reach 100 % coverage well ahead of 2030. VHCN connectivity has also improved in rural areas. Between 2013 and 2020, the share of rural households with fixed VCHN connection increased from 3.6 % to 27.8 % across the EU.

**Context**

To combat the wide range of political, economic and sustainability challenges faced by the EU, SDG 9 calls on countries to build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation. Inclusive and sustainable industrial development is an important source of income and allows for rapid and sustained increases in living standards for all people. Research and development (R&D) and innovation drive competitiveness, economic growth, job creation, labour productivity and resource efficiency. They are crucial for delivering the European Green Deal and the Digital Single Market. Through a 'green transformation', industry also has a role in achieving a clean and circular economy. Similarly, investments in sustainable infrastructure are key elements for achieving the SDGs. This involves increasing the deployment of low-emissions and zero-emission vehicles, renewable and low-carbon fuels and infrastructure, as well as the roll-out of high-speed internet connectivity in order to remain competitive in an increasingly digitalised world. Additionally, R&D and innovation are of key importance for tackling the COVID-19 pandemic and its economic and social consequences, as well as supporting the recovery in the EU.

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24 See European Commission, Key Indicators.

25 In the context of the EU’s digital agenda scoreboard indicators, rural areas are defined as those with fewer than 100 people per km2.
See also

- All articles on sustainable development goals

Database

- Sustainable Development Indicators

Dedicated section

- Sustainable Development Indicators

Methodology

More detailed information on EU SDG indicators for monitoring of progress towards the UN Sustainable Development Goals (SDGs), such as indicator relevance, definitions, methodological notes, background and potential linkages, can be found in the introduction of the publication ‘Sustainable development in the European Union — Monitoring report on progress towards the SDGs in an EU context — 2021 edition’.

Publications

Further reading on industry, innovation and infrastructure


External links

Further data sources on industry, innovation and infrastructure