INVESTMENT REPORT
2020/2021

Building a smart and green Europe in the COVID-19 era

Data annex
EUROPEAN INVESTMENT BANK INVESTMENT REPORT
2020/2021

Building a smart and green Europe in the COVID-19 era

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Investment report 2020/2021: Building a smart and green Europe in the COVID-19 era

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About the Report
The EIB annual report on Investment and Investment Finance is a product of the EIB Economics Department, providing a comprehensive overview of the developments and drivers of investment and its finance in the European Union. It combines an analysis and understanding of key market trends and developments with a more in-depth thematic focus, which this year is devoted to European progress towards a smart and green future in a post-COVID-19 world. The report draws extensively on the results of the annual EIB Investment Survey (EIBIS) and the EIB Municipality Survey. It complements internal EIB analysis with contributions from leading experts in the field.

About the Economics Department of the EIB
The mission of the EIB Economics Department is to provide economic analyses and studies to support the Bank in its operations and in the definition of its positioning, strategy and policy. The Department, a team of 40 economists, is headed by Debora Revoltella, Director of Economics.

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Data annex

The availability and quality of the data on investment are critical to supporting effective policymaking. In addition to national accounts, economists need to rely on other sources of macroeconomic data to analyse important aspects of investment, including infrastructure investment and intangible investment, and they increasingly make use of firm-level data.

The EIB has taken important steps towards bridging some of the data gaps by developing an internally consistent methodology to estimate infrastructure investment and public-private partnership (PPP) finance; by running a survey on corporate investment and investment finance; and by participating in the financing of the production of a database on investment in intangible assets and stocks of intangible capital. This annex outlines these datasets and provides references to detailed methodological notes.

Estimating infrastructure investment in the European Union

Data on infrastructure investment, let alone its financing sources, are not available in any ready-to-use form. Over the years, the EIB has developed a new methodology to estimate infrastructure investment.

The basic idea is to use Eurostat’s national accounts data on gross fixed capital formation (GFCF) in the sectors commonly considered to be “infrastructure sectors” (such as education, health, transport and utilities) to construct estimates of total and government infrastructure investment. Non-government infrastructure investment is then derived as the difference between the two.

In a next step, the aggregate of non-government infrastructure investment is broken down into project-based and corporate infrastructure investment. Project-based infrastructure investment consists of PPP and non-PPP projects. These subcomponents of project-based infrastructure investment are obtained from IJ Global, where EPEC data assist in delineating the PPP component of project-based infrastructure investment. Hence, the residual after subtracting project-based infrastructure investment from non-government infrastructure investment serves as a proxy for corporate infrastructure investment.

Finally, newly available Eurostat data on GFCF allow for a more precise proxy for infrastructure investment, which is GFCF in other buildings and structures. The new data have the advantage of excluding many non-infrastructure investments – such as investments in trucks or in other machinery and equipment (that are included in total fixed assets) – and therefore reduce the risk of overestimating infrastructure investments. The new Eurostat data also enable us to differentiate between GFCF in the transport sector and in the information and communication technology (ICT) sector (which were previously lumped together). This gives us a more granular view of individual investment trends across different sectors.

Although the new data capture infrastructure investment better, a few caveats remain. The most important one being the fact that the new data do not enable us to distinguish between GFCF in total fixed assets and in other buildings and structures for the government sector. This means that we have to approximate government investment in other buildings and structures. To do so, we use the following formula:

\[
GGFCF_{\text{obs}} = GGFCF_{\text{tfa}} \times \left( \frac{\text{government net capital stock}_{\text{obs}}}{\text{government net capital stock}_{\text{tfa}}} - \text{implied depreciation} \right),
\]

1 For details see Wagenvoort, R., de Nicola, C. and Kappeler, A. (2010).
2 EPEC Data portal: https://data.eib.org/epec
where $GGFCF(\text{obs})$ and $GGFCF(\text{tfa})$ are, respectively, government GFCF in other buildings and structures and in total fixed assets, where implied depreciation is derived for the total economy as:

$$\text{implied depreciation} = \left( \frac{\text{total economy net capital stock(\text{obs})}}{\text{total economy net capital stock(\text{tfa})}} - \frac{\text{GFCF(\text{obs})}}{\text{GFCF(\text{tfa})}} \right).$$

That is, we use the share of other buildings and structures in the government net capital stock as a proxy for the share of government GFCF in other buildings and structures (adjusted for differences in depreciation rates). In other words, we assume that the share of government GFCF in other buildings and structures is equal to its historical share.

It should be noted that applying this formula requires us to make two minor data adjustments. First, when data on the net capital stock of a country are missing, we replace the missing value with the average net capital stock of the region in which the country is located (Western and Northern Europe, Southern Europe or Central and Eastern Europe). Second, to deal with outliers, we set negative implied depreciation differentials equal to zero.

### EIB Investment Survey

#### General module

The EIB carries out an annual survey of firms in the European Union (EIBIS General Module) with the aim of monitoring investment and investment finance activities and capturing potential barriers to investment. The survey covers approximately 12,500 companies across the EU27 and the United Kingdom every year and slightly more than 800 firms in the United States for the last two waves. It is administered by telephone (in the local language) and takes an average of 20 minutes to complete. The first wave of the survey took place in 2016 and the survey completed its fifth wave in 2020.

Using a stratified sampling methodology, the EIBIS General Module is representative across all 27 Member States of the European Union, the United Kingdom and the United States. It is representative across four firm size classes (micro, small, medium and large) and four sector groupings (manufacturing, services, construction and infrastructure) within the individual countries.

Firms have to have a minimum of five employees be interviewed, with full-time and part-time employees counted as one and employees working less than 12 hours per week being excluded. Eligible respondents are senior employees with responsibilities for investment decisions.

The survey is designed to build a panel of observations over time, and is set up in such a way that survey data can be linked to firms’ reported balance sheet and profit-and-loss data (see EIBIS-Orbis matched dataset below). Approximately 40% of the companies interviewed in each wave are companies that have already taken part in the survey in the previous wave. The fifth wave of the survey took place between May and August 2020.

The EIBIS General Module complements pre-existing information on investment activities in the European Union. It adds a firm-level dimension to the macroeconomic data available and thus allows for more fine-grained analysis of firm investment patterns. It also adds to existing firm-level surveys at a national level by providing full comparability of results across countries. The survey complements the European Commission investment survey by asking a much wider set of both qualitative and quantitative questions on firm investment activities and the European Central Bank/European Commission SAFE survey by focusing on the link between firm investment and investment finance decisions.

The EIBIS is a very powerful instrument built according to the highest scientific standards. To guarantee this, every step of the survey process is executed and closely monitored by experts in the field. All steps – sampling and weighting, questionnaire development and translation, the fieldwork, and quality control
and data processing – are also subject to strict controls and validation. More information on these technical aspects can be found in the technical report produced by the market research company conducting the survey (Ipsos MORI, 2019). Table 1 presents key numbers about EIBIS.

**Table 1**

<table>
<thead>
<tr>
<th>EIBIS at a glance</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 EU Member States are all consistently represented by the survey – more specifically, non-financial enterprises with at least five employees and belonging to NACE categories C to J.</td>
</tr>
<tr>
<td>4 industry groupings and size classes determine the representativeness of the data within almost each Member State.</td>
</tr>
<tr>
<td>11,971 firms belonging to the EU27 participated in the last wave of the survey, compared to 11,882, 11,738, 11,753 and 12,071 in the previous waves of the survey.</td>
</tr>
<tr>
<td>800 US firms participated in the last wave of the survey.</td>
</tr>
<tr>
<td>9,752 of all firms participating to the last wave responded for at least two consecutive waves.</td>
</tr>
<tr>
<td>88% of firms surveyed in 2020 agreed to be contacted again for next year’s survey.</td>
</tr>
</tbody>
</table>

All aggregated data using the EIBIS General Module in this report are weighted by value added to better reflect the contribution of different firms to economic output. The aggregate survey data, questionnaire and a detailed account of the survey methodology are available on www.eib.org/eibis.

Representativeness of the general module

The EIB Investment Survey is designed to be representative for the European Union (EU27), the United Kingdom and the United States at a country level and for most countries at a country-industry-group and country-size-class level.

In a recent EIB working paper (Brutscher, Coali, Delanote and Harasztosi, 2020), we assessed the data quality of EIBIS. We did this in three steps. Firstly, we benchmarked the sampling frame from which all survey respondents are drawn, the Bureau van Dijk Orbis database, against official statistics to see how well our sampling frame captures the relevant business population.

Secondly, we compared the final EIBIS sample against random draws of firms from the same sampling frame and compared statistics constructed from the financial information included in the sampling frame. The purpose of this exercise was to assess whether and to what extent firms’ willingness or unwillingness to participate in the survey may have led to a selection bias.

Lastly, we compared aggregate statistics calculated from the final EIBIS sample to corresponding statistics from Eurostat and the Organisation for Economic Co-operation and Development (OECD). In addition, we compared statistics based on financial information calculated from EIBIS to the counterpart obtained from the CompNet database. This purpose of this exercise is to evaluate both the level and dynamics of financial information calculated from firm-level data.

Overall, the results from all three steps are very positive. Firstly, the assessment of the sampling frame, a comparison of the Bureau van Dijk Orbis dataset with the Eurostat Structural Business Statistics (SBS) for the EU27 and the United Kingdom for the relevant sector/size classes showed coverage ratios (such as the number of firms in Orbis / number of firms in the SBS database) between 75% and 100% for the majority of countries. It is between 50% and 75% in a few countries, and in only four – Cyprus, Greece, Luxembourg and Poland – does the coverage ratio fall below 50%.³

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³ For the United States, the statistics were compiled from the US Census Bureau and the Bureau of Economic Analysis.

⁴ An important driver of the positive coverage ratio is that EIBIS samples firms with five or more employees. Coverage ratios tend to be higher for larger firms, so excluding the smallest firms from sampling significantly boosts coverage.
Having a sampling frame that covers a high percentage of the population of interest is necessary for the EIBIS survey results to reflect what is happening in the non-financial corporate sector in the European Union. It is not a sufficient, however, insofar as, like any other survey, EIBIS runs the risk of selection bias if there are systematic differences between firms that are willing to participate in the survey and firms that are not.

Secondly, to test whether (and if so, to what extent) the EIBIS sample is subject to such selection issues, we compared the distribution of a set of financial ratios in the final EIBIS sample against those of five randomly drawn samples from the same sampling frame. The financial ratios were calculated using information in Orbis. The idea was that if the distributions between the EIBIS sample and the random samples are statistically identical; this provides evidence that selection bias does not pose a major issue for representativeness and vice versa.

Using a Kolmogorov-Smirnov approach to compare the two samples, we find that for almost all countries, the percentage of variables for which the null hypothesis of equal distribution in the EIBIS and random samples is rejected is very low, suggesting a high degree of resemblance between EIBIS and the random sample. In other words, comparing the final EIBIS sample with a series of random samples from the same sampling frame, we find little evidence of sampling bias in our data.

Finally, a comparison of the financial information from Orbis for firms in the final EIBIS sample to CompNet data also suggests a good coverage of both EIBIS and Orbis information. The CompNet data are based on a “distributed micro-data approach”; relevant data are extracted from often-confidential firm-level datasets available within national central banks or national statistical institutes and aggregated so that the confidentiality of firm data is preserved. The outcome of CompNet is a wide range of indicators at the country-sector-size-class level.

To assess the final EIBIS sample; we reproduced the same country-sector-size-class level indicators using the Orbis information for firms in EIBIS (where possible) and compared them to those in the CompNet dataset. What we found is a very close match between the two datasets, with the evolution of financial variables in EIBIS and the CompNet database being very similar.

More information on both the EIBIS General Module and the Add-on Module can be provided upon request to eibis@eib.org.

EIB Municipality Survey 2020

In 2020, the EIB Municipality Survey surveyed 685 municipalities in the European Union on their infrastructure investment activities and associated barriers.

The survey was administered by telephone (in the local language) and targeted at mayors, treasurers and/or municipalities’ chief civil engineers. It took on average (median) 20 minutes to complete. Fieldwork took place between June and August 2020. As part of the survey, 685 municipalities were interviewed in all 27 Member States, split across the following countries and country groupings (regions).  

<table>
<thead>
<tr>
<th>Country Grouping</th>
<th>Number of Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western and Northern Europe</td>
<td>268</td>
</tr>
<tr>
<td>Southern Europe</td>
<td>268</td>
</tr>
<tr>
<td>Central and Eastern Europe</td>
<td>168</td>
</tr>
</tbody>
</table>

The Kolmogorov-Smirnov (KS) test is a nonparametric statistical test for the equality of probability distribution between two samples. Unlike a t-test, KS does not just compare the means of a variable, but also tests the null hypothesis that two samples are drawn from the same distribution by quantifying the distance between the empirical distribution functions of two samples. It therefore compares the shapes of the two distributions and evaluates whether the vertical differences between them are statistically significant.
The sample frame from which municipalities were randomly selected was a comprehensive list of European municipalities. All larger municipalities were eligible to be included in the exercise. The exact size of the cut-off was decided country by country to ensure a minimum number of interviews per country, which was between five and 57 (depending on the population size of the country). The survey results can thus be interpreted as reflecting the views of larger municipalities in each country.

Regional and European Union-wide figures are weighted using country weights based on the urban population in each country, thus taking into account size differences across countries. Within countries, answers are unweighted, giving each municipality the same weight.

More information about the design of the Municipality Survey can be found in the 2020 EIBIS technical report. The publication is available at www.eib.org/eibus.

EIB Online Survey on Environmental Innovations
Complementing the above-mentioned surveys, the EIB, together with Ipsos, administered an online survey. This Online Survey on Environmental Innovations collected 1,609 firm-level responses on the introduction of environmental innovations, the motivations to do so and the obstacles encountered. In addition, the survey asked companies about the current policy designs and regulations in place, as well as about the financing and impacts of the environmental innovations.

Eligible companies were sampled from Crunchbase (43% of respondents) and Orbis (57% of respondents) in the EU27, the United Kingdom and the United States. It took respondents approximately 15 minutes to complete the survey and the setup was automatically adjusted depending on whether firms introduced environmental innovations or not. The fieldwork started at the beginning of September 2020 and was closed mid-October.

EIBIS-Orbis matched dataset
This report includes analysis based on a dataset that combines firm-level information from Bureau van Dijk's Orbis with the first survey round of EIBIS – the EIBIS-Orbis matched dataset. The matching was carried out by the current survey provider Ipsos to preserve firms' anonymity. Orbis is a proprietary dataset that contains firm-level accounting information and ownership data, gathered and standardised to the so-called “global format” that makes accounting data comparable across jurisdictions. Items from the balance sheet and profit-and-loss accounts have been used to construct standard financial ratios for firms that reflect financing activity and financial health. All data were reviewed following standard cleaning procedures to eliminate outliers and inconsistencies. Negative values for fixed assets, total assets and other stock variables were removed and all ratios have been winsorised at 1% level.

The matched dataset complements the cross-sectional perspective of EIBIS with time series information starting in 2000. It makes it possible to construct custom panel datasets used in several analyses in this report.

Patent data
The patent data used in this chapter comes from PATSTAT (Worldwide PATent STATistical Database). This is a single patent statistics raw database, held by the European Patent Office (EPO) and developed in cooperation with the World Intellectual Property Organization (WIPO), the OECD and Eurostat. With the objective of being sustainable over time, PATSTAT came into operation in 2006 and concentrates on raw data, leaving indicator production mainly to its licensed users. PATSTAT’s raw patent data come from more than 100 regional and national patent offices worldwide, including of course the largest and most important organisations such as the European Patent Office (EPO), the United States Patent and Trademark Office (USPTO), the World Intellectual Property Organization (WIPO), the Japanese Patent Office (JPO) and the Chinese Patent Office (SIPO). PATSTAT is a relational database: more than 20 related
tables contain information on relevant dates (filing, publication, grant, etc.), applicants and inventors, technological domains, references to prior art, etc. Updates are produced twice a year, in a spring and autumn edition. The data sourced for this chapter were produced in collaboration with ECOOM (The Centre for Research and Development Monitoring).

How do we measure innovation and knowledge diffusion?

Throughout Chapter 8, different data sources are used to gain a clearer understanding of the climate and digital innovation landscape. In an ideal world, we would have detailed statistics available on each firm’s own R&D investment in green and digital technologies, as well as on its external knowledge sourcing, implementation and further dissemination of the different innovations. In the real world however, such ready-made data are unfortunately not available (for a detailed discussion on the difficulties in measuring intangible assets, see Haskel and Westlake, 2018).

To gain insight into what is going on in climate and digital innovation, we have relied on EPO patent data, survey data and data taken from Crunchbase. The table below gives an overview of the different data sources and their uses. In Chapter 8, we do not refer to R&D data because they are already extensively discussed in other chapters and they are not sufficiently fine-grained for an examination of the different underlying domains in green and digital innovation. In addition, while R&D expenditure is a good measure of a firm’s investment in innovation, it is by no means an output measure.

To grasp the (intermediate) outputs of innovation, patent data have long been broadly accepted proxies. They allow for levels of completeness (both geographically and over time) and granularity that are not attainable with other data sources (for a more detailed discussion of patent data and their merits – and disadvantages – see Box B in Chapter 8).

The instrumental nature of patent data in measuring climate change innovations is reflected in the number of companies seeking protection for these innovations. One of the arguments against using patent data to measure innovation is that not all firms patent all their innovations. However, the propensity to patent appears relatively high among firms introducing new green technology (Figure 1).

Figure 1
Share of environmental innovators seeking IP protection

Source: EIB Online Survey on Environmental Innovations.
Base: All environmental innovators.
Question: In relation to any of the changes generating environmental impacts in your own company, which of the following applies?

Given that patent data only focus on technological innovation, we have used survey data to assess the level of adoption of green and digital technologies by different firms, as well as the overall taste for green investment. We have worked with data from the EIB Investment Survey, as well as data gathered
from a targeted online module. This online module is different in its setup and scope, but is a unique exercise in which firms are specifically asked about their environmental innovations, knowledge diffusion, motivations and obstacles and investment and finance.

Besides firm-level survey data allowing for a complementary look at climate innovations from a different angle, the online module in particular helped us focus on startups and scale-ups, which are by nature less active in patenting. The online module respondents are sourced from Orbis and Crunchbase, and therefore provide more detailed insight into specific subgroups of firms. In some instances, Crunchbase is also used as a stand-alone database for providing overall insight into the green and digital activities of startups and scale-ups.

Using these complementary data sources enriches the climate debate. Not only can we look at the issue from different angles, we can also evaluate the robustness of the main messages across different data sources and different stages of innovation.

**Table 3**

**Measuring the different stages of innovation**

<table>
<thead>
<tr>
<th>Technology development</th>
<th>R&amp;D expenditure and personnel</th>
<th>Patented inventions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(-) input measure of innovation</td>
<td>(+) measures innovation by definition</td>
</tr>
<tr>
<td></td>
<td>(-) difficult to identify environmental activities</td>
<td>(+) measures (intermediate) outputs of innovation</td>
</tr>
<tr>
<td></td>
<td>(-) limited detailed data availability</td>
<td>(+) granularity, possibility to identify specific &quot;environmental&quot; aspects</td>
</tr>
<tr>
<td></td>
<td>(+) ease of communication</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(+) good coverage of government expenditure</td>
<td></td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Technology diffusion</th>
<th>Patenting activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(+) global coverage, long-time series</td>
</tr>
<tr>
<td></td>
<td>(+) captures only technological innovation</td>
</tr>
<tr>
<td></td>
<td>(+) timeliness</td>
</tr>
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<table>
<thead>
<tr>
<th>Non-tech innovation and adoption of technologies</th>
<th>Survey data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(+) can measure broader and all aspects of innovation</td>
</tr>
<tr>
<td></td>
<td>(-) availability, cost, comparability</td>
</tr>
</tbody>
</table>

**The EU Industrial R&D Investment Scoreboard**

The EU Industrial R&D Investment Scoreboard provides economic and financial data and analysis of the top global corporate research and development investors. It is based on company data extracted directly from each company’s annual report.

The Scoreboard has been published annually since 2004 to provide a reliable, up-to-date benchmarking tool for comparisons between companies, sectors, and geographical areas, as well as to monitor and analyse emerging investment trends and patterns. It aims to raise public awareness and support for R&D investment among individual companies and policymakers, and encourages companies to disclose information about their R&D investments and other intangible assets.

The 2019 edition of the Scoreboard comprises the 2 500 companies investing the largest sums in R&D in the world in 2018/19. These companies, based in 44 countries, each invested over EUR 30 million in R&D for a total of EUR 823.4 billion, which is approximately 90% of the world’s business-funded R&D.

The data for the Scoreboard are taken from companies’ publicly available audited accounts. As in more than 99% of cases these accounts do not include information on the place where R&D is actually performed, the company’s R&D investment in the Scoreboard is attributed to the country in which it has its registered office. The Scoreboard’s approach is, therefore, fundamentally different to that of statistical offices when preparing business enterprise expenditure on R&D data, which are specific to a given territory. The R&D financed by business sector in a given territorial unit (BES-R&D) includes R&D...
performed by all sectors in that territorial unit. The Scoreboard R&D figures are hence comparable to BES-R&D data only at a global level; this should be borne in mind when interpreting the Scoreboard’s country classifications and analyses.

The data for the 2019 Scoreboard were collected from companies’ annual reports and accounts by Bureau van Dijk – A Moodys Analytics Company. In order to maximise completeness and avoid double counting, the consolidated group accounts of the ultimate parent company are used. Companies that are subsidiaries of any other company are not listed separately. Where consolidated group accounts of the ultimate parent company are not available, subsidiaries are included. In the case of a demerger, the full history of the continuing entity is included. The history of the demerged company can only go back as far as the date of the demerger to avoid double counting of figures. In case of an acquisition or merger, pro-forma figures for the year of acquisition are used along with pro-forma comparative figures, if available.

The R&D investment included in the Scoreboard is the cash investment funded by the companies themselves. It excludes R&D undertaken under contract for customers such as governments or other companies. It also excludes the companies’ share of any associated company or joint venture R&D investment when disclosed. However, it includes research contracted out to other companies or public research organisations, such as universities. Where part or all of R&D costs have been capitalised, the additions to the appropriate intangible assets are included to calculate the cash investment and any amortisation eliminated.

More information on the Scoreboard and methodological limitations is available at: https://iri.jrc.ec.europa.eu/rd_monitoring.

Investment in climate change mitigation
Climate change mitigation investments are spread across many economic sectors, they have diverse impacts on greenhouse gas emissions and the data sources have varying degrees of accuracy and consistency. The estimates drawn together in this report are organised under the headings renewable energy and energy networks, energy efficiency, transport infrastructure, agriculture forestry and land use, and R&D.

These categories correspond to the EU taxonomy: low-carbon activities (compatible with a 2050 net zero carbon economy – such as renewables, electric vehicles, afforestation, etc.); transition activities (activities that contribute to a transition to a zero net emissions economy in 2050 but that are not currently operating at an expected optimal level – such as building renovation, etc.); and activities that facilitate low-carbon performance, substantial emissions reduction or environmentally sustainable investments (enabling activities – such as smart technologies, R&D, etc.).

Renewable energy
The International Energy Agency (IEA) provided estimates for the regional blocs (European Union, United States and China) of total investment in renewable energy. These are based on public information and IEA estimates of capacity additions, combined with estimates of investment costs. These cost estimates are not published and were not released to the EIB for this study. As a result, there are limits on the depth of the analysis that can be performed.

End-use renewables (rooftop solar thermal, etc) are included with renewable generation. This is a larger amount for China than for the United States and European Union.

A proportion of investment in networks is assigned to renewable energy. Firstly, network investment is divided between maintenance (replacement of existing lines) and expansion. All expansion is assigned to renewables. Very little non-renewable capacity is being installed so all expansion is due to renewables.

The remaining investment in maintenance is divided between renewable and non-renewables according to the share of renewable energy in total generation capacity.
Bloomberg New Energy Finance (BNEF) data were made available via EIB access to the BNEF database.

BNEF data are available for China, European Union and the United States, but not all EU Member States are included. BNEF data cover 15 EU Member States: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Spain and Sweden.

The clean energy data on new projects reflect new project commitments. The basis of these data are different from the IEA data. Whereas the IEA data record investment in the year the money was spent, BNEF data record the expenditure in the year of financial close of the project. BNEF data do not provide comprehensive coverage (such as rooftop solar thermal), and do not estimate total investment cost. Their data are typically the announced project cost at financial close, and this may be different to the IEA’s estimate of investment cost within a specific year.

When there is reference to BNEF data, the following definitions apply:

Wind – Electricity generation using wind turbines. Included in this sector are players across the entire value chain of both offshore and onshore developments. From manufacturers of turbines, components and subassemblies to developers, generators, utilities and engineering firms.

Solar – All technologies which capture energy directly from the sun. These include production of electricity using semiconductor-based technology (PV) materials, use of concentrated sunlight to heat fluids that drive power generation equipment (solar thermal), and passive methods which use sunlight to heat water. Whilst company level investment of passive methods is recorded, investment in passive projects is not.

Biofuels – Liquid transportation fuels including biodiesel and bioethanol. These can be derived from a range of biomass sources including sugar cane, rape seed, soybean oil of non-food cellulosic feedstock. Our database excludes producers of base biomass, but includes suppliers of everything from the processing technologies and equipment, through the logistics of distribution, to manufacturers of energy systems which are specially adapted for the use of biofuels and products, and the services on which they depend.

Biomass and Waste – Electricity and or heat produced with bio-based feedstocks, typically through incineration but also through more advanced processes like gasification or anaerobic digestion. This sector also includes waste-to-energy which includes energy produced through landfill gas projects and incineration of municipal and industrial waste.

Energy smart technologies – This sector covers technologies like digital energy, smart grids, power storage, hydrogen and fuel cells, advanced transportation and energy efficiency on both the demand and supply side.

Other renewables – Includes small hydro – hydro projects with capacities small or equal to 50 MW; geothermal – extraction of useful power from heat stored in the earth; marine – the extraction of tidal, wave and thermal energy from the ocean.

Energy efficiency

The IEA made available estimates of investment in energy efficiency for the United States, China and the EU27 from 2014 to 2019. In broad terms, the methodology of calculating these estimates looks at the additional cost of an energy-efficient alternative over and above the less efficient alternative that serves a similar purpose. In the auto sector, for example, many manufacturers make eco models that are more expensive than the regular model. The cost difference, under the IEA methodology, is assigned to energy efficiency investment. The IEA describe the methodology in detail in the Energy Efficiency Investment Report.

The underlying calculations have not been made available to the EIB. No breakdown has been provided for the EU Member States.
The IEA methodology has changed over time. Originally, a top down methodology was used, which applied average energy prices to the annual energy savings (due to improvement in energy intensity). This addressed the question: how much would consumers have been willing to pay for the improvement in energy intensity visible from one year to the next?

The new bottom up methodology has also been refined over a number of years.

Without the opportunity to review the underlying model and data, it is difficult to judge the accuracy of the data. The IEA have made their own judgement, and in their report discuss the implications at the global level. They do not make conclusions about developments at a fine degree of granularity. Therefore, caution needs to be exercised in reading too much into the energy efficiency data.

Transport infrastructure

The OECD International Transport Forum (ITF) collects data on an annual basis from its member countries, covering investment, maintenance spending and capital value of transport infrastructure. Data are collected from transport ministries, statistical offices and other institutions designated as official data sources.

The lack of common definitions and practices to measure transport infrastructure spending hinders comparisons between countries. While the survey covers all sources of financing, a number of countries exclude private spending. Coverage of urban spending also varies between countries. Indicators such as the share of GDP needed for investment in transport infrastructure depend on a number of factors, such as the quality and age of existing infrastructure, maturity of the transport system, geography of the country and transport intensity of its productive sector. Caution is therefore required when comparing investment data between countries. However, data for individual countries and country groups are consistent over time and useful for identifying underlying trends in levels of spending. Definitions and methods are addressed in a companion report (ITF, 2013).

For the United States, the data sources have changed. The 1992-2003 data are from the US Department of Transportation (Bureau of Transportation Statistics, 2005). The 2004-2015 data are from Railroad Facts, published by the Association of American Railroads. Since 2004, data cover only Class 1 Railroads. Class 1 Railroad capital expenditures accounts for roughly 94% of total railroad capital expenditures.

Forestry

Eurostat data are available for the European Union for gross fixed capital formation in forestry up to 2017. Data are extrapolated to 2019 assuming a constant ratio to total GFCF.

For the United States, data are available from the Bureau of Economic Analysis up to 2018. These are also extrapolated assuming a constant ratio to total GFCF.

No data are available for China.

Research and development

BNEF data are used for R&D. BNEF source the data as follows. Government R&D figures are sourced from IEA, International Monetary Fund (IMF), OECD and various government agencies. Corporate R&D is sourced from Bloomberg for key quoted companies in all clean energy sectors.

The data were made available in current USD billion rounded to the nearest hundred thousand. This gives rise to rounding errors and the sum of government and corporate R&D does not equal the sum of R&D across sectors.

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7 See Capital Expenditures table on https://www.aar.org/.
For comparison of climate change mitigation investment between the United States, China and the European Union, government and corporate R&D have been used. For analysis of the EU Member States, the sector breakdown is also used.

Inflation and exchange rates

Data are presented in real 2019 EUR million. Source data are on different bases and the following procedures were used to convert them to real 2019 EUR million.

**IEA investment data**

IEA investment data are in real 2019 USD billion. These were converted to real 2019 EUR by applying the average 2019 exchange rate (from the Bank of England). Where necessary, the data are further converted to current EUR million using the GDP deflator for the EU27. The GDP deflator is derived from the Eurostat data by rebasing to 2019=100. This rebasing is done so as to preserve the implied inflation rates year by year.

For the real EUR data, these procedures have the effect of preserving the growth rates in the IEA data.

**BNEF clean energy and R&D**

BNEF data are in current USD billion. They were converted to real 2019 EUR with the following steps. Firstly, the USD series are put in real terms using the US GDP deflator. The deflator is rebased to 2019=100 preserving the implied year-to-year inflation rates. Secondly, the Real USD series are converted to real 2019 EUR using the average 2019 exchange rate from the Bank of England.

This procedure avoids introducing changes due to changes in the exchange rate. Only the 2019 exchange rate is used in the conversion. However, exchange rate effects may already be present in the original BNEF data.

If required, the real EUR data are converted to current EUR using the EU GDP deflator.

**OECD data and Eurostat data on Forestry and Transport**

These data are in current EUR and are converted to real 2019 EUR using the applicable GDP deflators. The country-by-country deflators are derived from the Eurostat data and rebased to 2019=100 as described above. Use of the country-specific deflators takes account of differences in inflation in different countries. This is the best procedure for making country comparisons. However, it should be noted that the method does not necessarily maintain additivity – the sum of the deflated countries does not equal the deflated total.

**Avoided energy consumption and avoided CO₂**

Avoided energy consumption and avoided CO₂ are calculated for the purpose of comparison with investment levels.

Avoided energy is calculated by breaking down the change in final energy consumption into the change due to improvements in energy intensity and the change due to GDP growth. The method used follows the standard LMDI methodology summarised by Ang (2015). The change due to the improvement in energy efficiency is then used as avoided energy consumption in the denominator. Similar methodology is applied for CO₂, using CO₂ intensity instead of energy intensity.
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Data annex

Glossary of terms and acronyms