Statistics report

Energy Technology RD&D Budgets

Overview

2020

Released in October 2020.

The IEA Energy Technology Research, Development and Demonstration (RD&D) data collection and the analysis presented in this paper were performed by Domenico Lattanzio and Alexandre Bizeul under the responsibility of Roberta Quadrelli, in the IEA Energy Data Centre headed by Nick Johnstone. Simon Bennett, Simone Landolina, Jean-Baptiste Le Marois and Louis Chambeau also contributed to this analysis. We would like to thank our numerous contacts in national administrations for their helpful co-operation.

Contacts:

Energy Data Centre, RD&D Statistics
9, rue de la Fédération
75739 PARIS Cedex 15, France
RDD@iea.org

Source: IEA Energy Technology RD&D Budgets (2020 October edition)

Further information on RD&D statistics, including a downloadable database, is available at:

https://www.iea.org/subscribe-to-data-services/energy-technology-rdd.

The content of this overview is available at:

https://www.iea.org/reports/energy-technology-rdd-budgets-2020.

Queries should be addressed to: RDD@iea.org.

In addition, a wide range of free energy statistics can be accessed at: www.iea.org/statistics.

You can access this document online at the following link: https://webstore.iea.org/energy-technology-rdd-budgets-2020-overview.

This database is a component of the broader IEA work on innovation tracking and policy, which includes analysis of investment and innovation trends as part of the IEA's work on *Tracking Clean Energy Progress* (https://www.iea.org/tcep/), *World Energy Investment* (https://www.iea.org/topics/investment/), the IEA Technology Network of 6 000 experts worldwide (https://www.iea.org/tcp/) and the Clean Energy Transitions Programme (https://www.iea.org/cetp/).

Notes:

This report presents data on public energy (RD&D) expenditures collected by the IEA. It includes central or federal government budgets as well as expenditures by state-owned companies.

Unless otherwise specified, this publication refers to total public energy RD&D expenditure data, converted from current prices in national currencies to US dollar (USD) Purchasing Power Parities (PPP) in constant 2019 prices, using GDP deflators and 2019 PPPs. The use of PPPs eliminates the differences in price levels between countries that are not reflected in nominal exchange rates. For more information on PPP methodology see www.oecd.org/std/prices-ppp/.

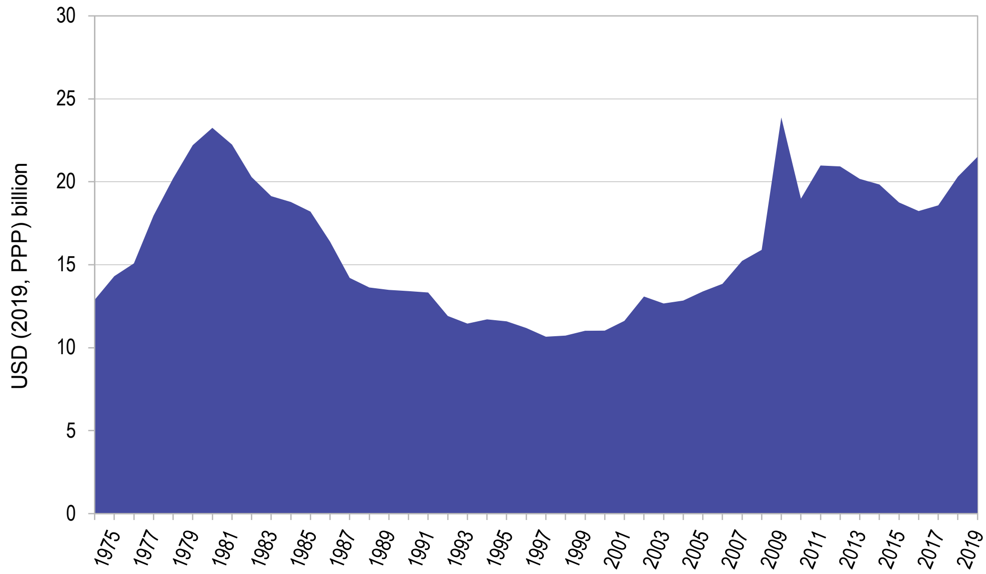
Data for the latest year (2019) are available for: Australia, Austria Canada, Denmark Estonia, France, Germany, Hungary, Ireland, Japan, Korea, New Zealand, Norway, Poland, Slovak Republic, Sweden, Switzerland, the United Kingdom, the United States and the European Union. For the other countries, the latest data refer to 2018. For Czech Republic, Greece and Luxembourg, no recent data are available. Data for the United States for the years 2016-2019 have been estimated by the IEA Secretariat. To produce regional aggregates, missing country data have been estimated by the IEA Secretariat.

KEY TRENDS IN IEA PUBLIC ENERGY TECHNOLOGY RESEARCH, DEVELOPMENT AND DEMONSTRATION (RD&D) BUDGETS

Part I. Overview of public energy RD&D trends in IEA countries

In 2019, the estimated total public energy research, development and demonstration (RD&D) budget for IEA member countries increased by 6% reaching USD 21.5 billion (Figure 1)[1]. This was the third consecutive year of increase after four years of decrease; the 2019 level was one third higher than in 2008 although much lower than the 2009 peak.

Figure 1: IEA member countries total public energy RD&D budget*



* PPP = purchasing power parity. USD 23.9 billion in 2009 is an outlier related to the American Recovery and Reinvestment Act (stimulus) spending, which was allocated to the 2009 budget year. Data from 2018 onwards include for spending of the Ministry of Environment (MoE) of Japan (0.4 USD billion of low-carbon technologies in 2018), which is not covered for previous years. This has effects on the apparent 2017-2018 growth.

Source: IEA. All rights reserved.

In PPP terms, the United States and Japan spent the most on energy RD&D among IEA member countries (Figures 2 and 3), followed by France, Germany, the United Kingdom, Canada, Korea, Italy and Norway. The

[1] All data in this publication are expressed in 2019 prices and purchasing power parity, or PPP, terms, unless otherwise specified. The total IEA budget does not include the European Union funding under the Horizon 2020 programme (USD 2.3 billion in 2019).

expenditure increased in 2019 for all those countries except Japan, where it fell by 2%. The figures also include the energy RD&D budget of the European Union under the Horizon 2020 programme, which is larger than that of all but two IEA member countries: the United States and Japan.

Figure 2: Public energy RD&D budgets by country for IEA members and the European Union*

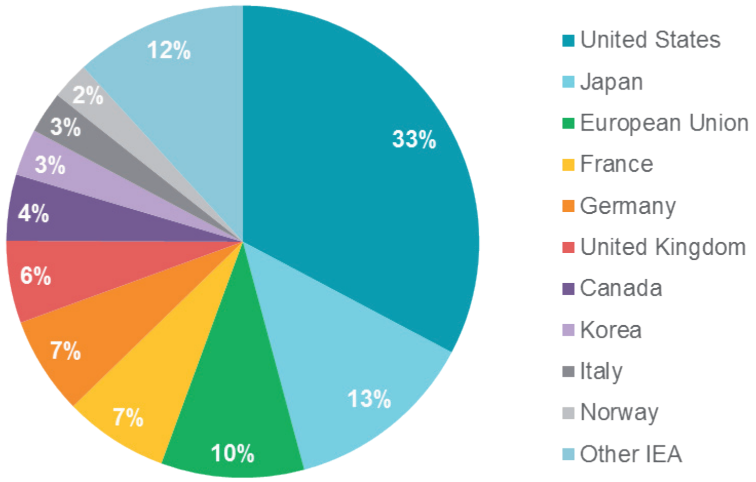
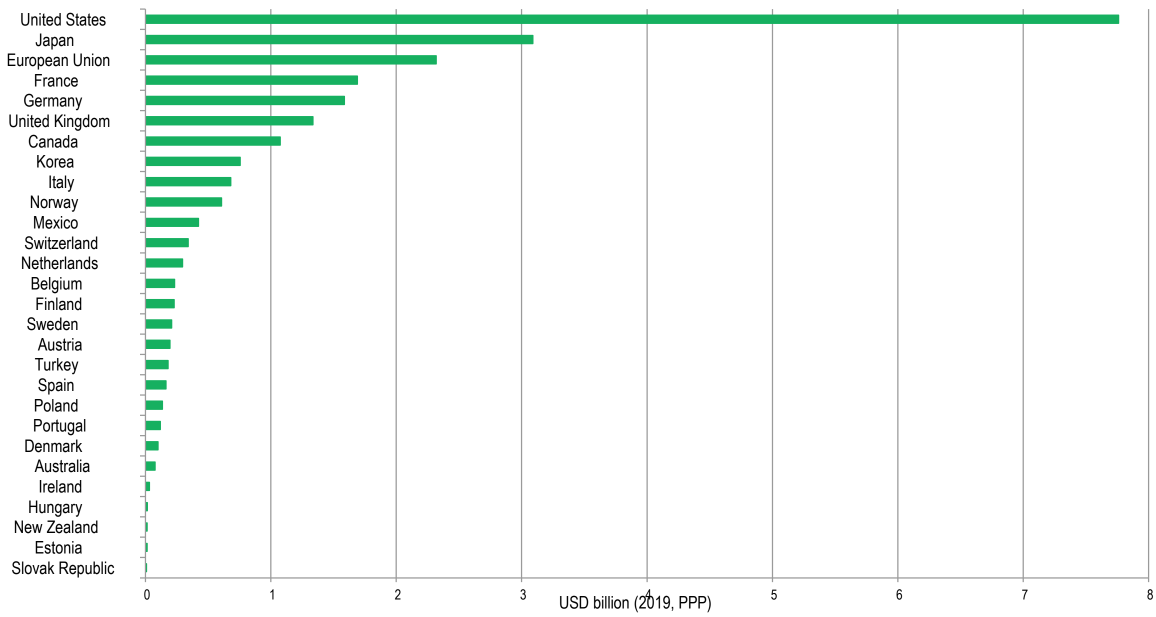


Figure 3: Total public energy RD&D budgets by country for 2019 or latest availabe year*



* The amounts shown in figures 2 and 3 are based on 2019 energy RD&D budgets for: Australia, Austria, Canada, Denmark, Estonia, France, Germany, Hungary, Ireland, Japan, Korea, New Zealand, Norway, Poland, Slovak Republic, Sweden, Switzerland, United Kingdom, the United States and the European Union. For the other countries, data refer to 2018. Data for the United States were estimated by IEA Secretariat. European Union refers to the European Union budget under Horizon 2020, and not to the sum of national budgets of European Union member countries.

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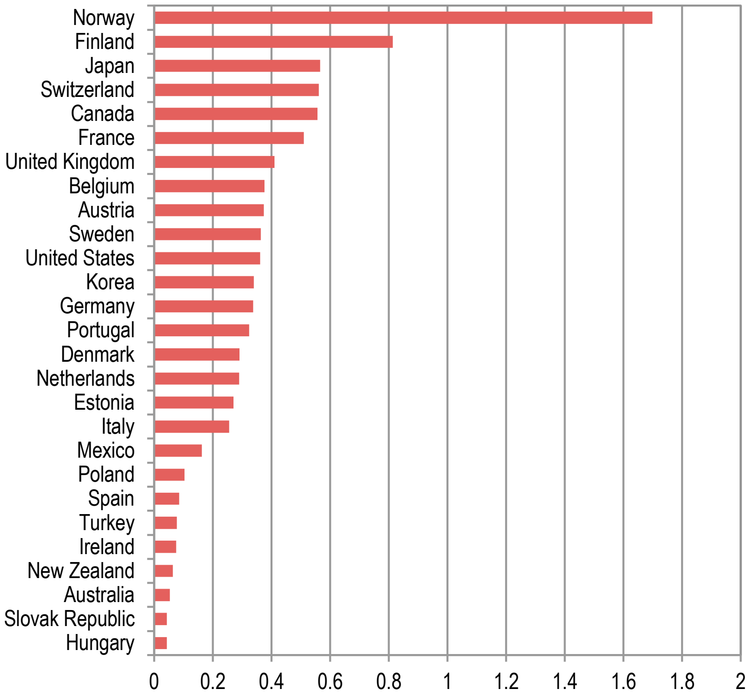
Public energy RD&D budget per unit of GDP varied greatly among IEA member countries, approximately ranging from 0.1 to 1.7 per thousand in 2019 (Figure 4). Norway had the highest level (1.69 per thousand), followed by Finland (0.81). Other leading countries were Japan (0.57), Switzerland (0.57) and Canada (0.56).

Figure 4: Total public energy RD&D budgets per thousand units of GDP by country for 2019*



* Total RD&D in nominal national currencies divided by GDP in nominal national currencies at market prices and volumes, expressed in thousand units of GDP. Based on 2019 data for Australia, Austria, Canada, Denmark, Estonia, France, Germany, Hungary, Ireland, Japan, Korea, New Zealand, Norway, Poland, Slovak Republic, Sweden, Switzerland, the United Kingdom and the United States. For the other countres, data refer to 2018. No recent data were available for Greece, Luxembourg and Czech Republic. Data for the United States have been estimated by the IEA Secretariat.

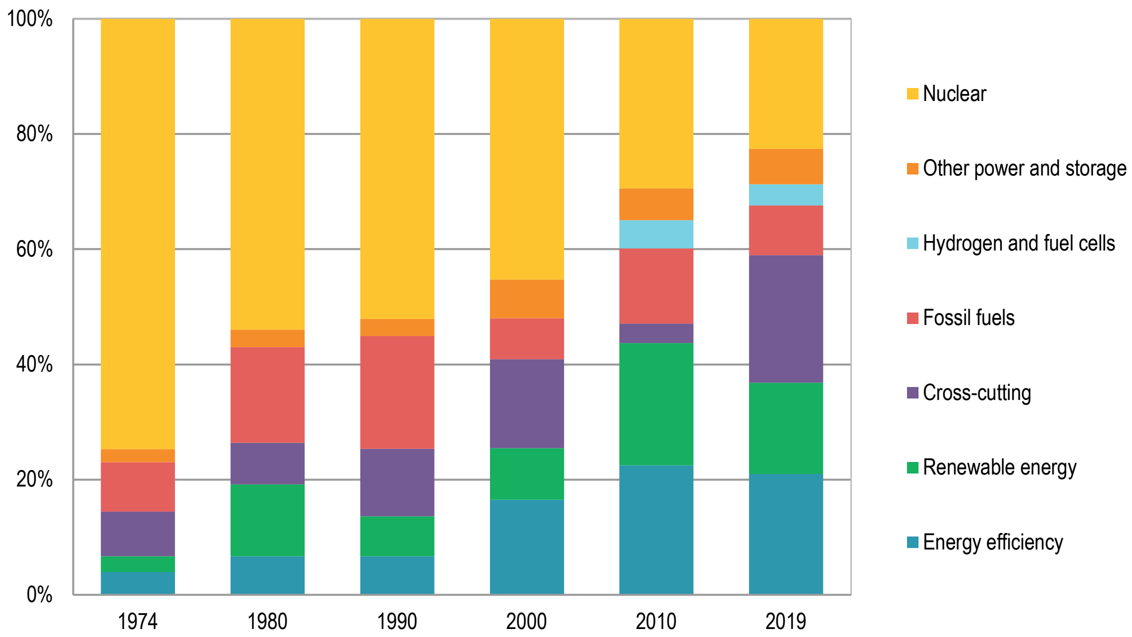
Source: IEA. All rights reserved.

Part II. Public energy RD&D trends across technologies in IEA countries

Over the last 40 years, investment from IEA member countries in energy RD&D has become progressively more diverse (Figure 5). Nuclear power, dominant in 1974 with 75% of total public energy RD&D budget, witnessed year-to-year reductions to reach 22% in 2019, a share comparable to energy efficiency (21%), renewables (15%) and cross-cutting RD&D (22%). RD&D budgets on fossil fuels, which were at their highest in the 1980s and early 1990s, have declined since 2013 (15%) to 8% in 2019.

Budgets for both energy efficiency and renewables grew significantly during the 1990s and 2000s, rising from 7% each in 1990 to 23% and 21% respectively in 2010. Since then, the share of energy efficiency has remained almost constant, whilst the share of renewables has declined to 15%. On the other hand, cross-cutting RD&D[2] grew in the first decade of the 21st century. Budgets for hydrogen and fuel cells kept their share at 3% for the period 2012-2018 to increase to 4% in 2019.

Figure 5: Evolution of IEA total public energy RD&D by technology



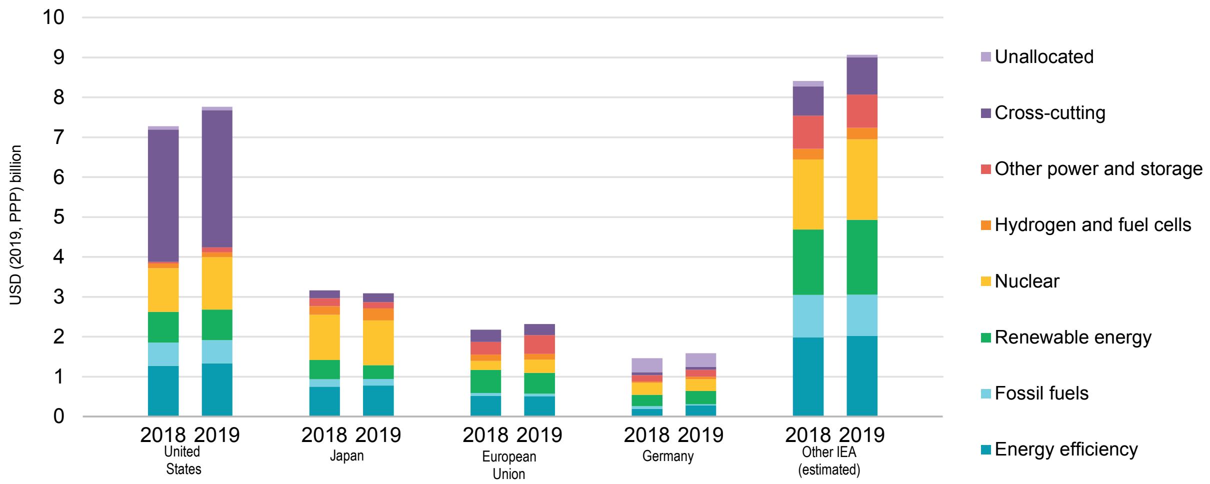
Source: IEA. All rights reserved.

[2] Almost half of the 2019 United States budget was allocated to cross-cutting energy technologies and could not be broken down further. The cross-cutting category mainly corresponds to what the US Department of Energy, Office of Science, reports under its Basic Energy Sciences

In 2019, the United States overcame Japan with the largest RD&D budget for nuclear (USD 1314 million), while Japan remained by far the highest funder of hydrogen and fuel cells research (USD 303 million) (Figure 6). In 2019, the European Union spent almost a quarter of its budget on the other power and storage technology (USD 467 million) being for this technology category a larger funder than any IEA country. For all the remaining technologies, the United States spent the highest budget.[3]

In 2019, the budget increased for all types of technology except for fossil fuels - which decreased by 5%. The highest increase was 21% for hydrogen and fuel cells which followed an increase of 28% recorded in 2018. The budget allocated to renewables significantly grew in Other IEA (14%), mainly thanks to Norway, which increased renewable budget more than four-fold with the demonstration project of a floating off-shore wind plant[4] (USD 242 million for off-shore wind demonstration).

Figure 6: 2018 and 2019 budgets by technology in selected IEA countries and the European Union*



* European Union refers to the European Union budget under Horizon 2020, and not to the sum of national budgets of European Union member countries. Data for the United States have been estimated by the IEA Secretariat. Other IEA inlcudes Austrralia, Austria, Belgium, Canada, Denmark, Estonia, Finland, France, Hungary, Ireland, Italy, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Source: IEA. All rights reserved.

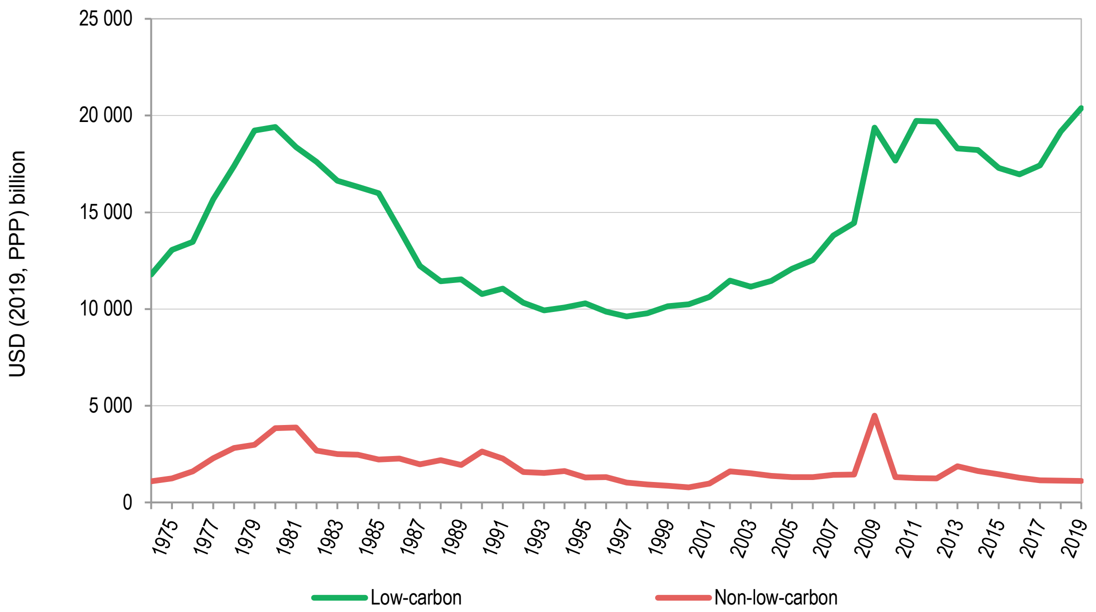
[3] Data for the United States have been estimated by the IEA Secretariat for 2016-2019.

[4] For further information about the project please refer to: https://www.regjeringen.no/en/aktuelt/enova-stotter-equinors-demonstrasjonsprosjekt-for-flytende-havvind/id2666182/.

Part III. Public low-carbon energy RD&D trends in IEA countries

In 2019, public spending in low-carbon[5] energy technologies RD&D significantly increased in IEA member countries to reach USD 20.4 billion and 95% of total budgets (Figure 7), driving the third consecutive annual increase of total spending, after five years of decreases. Spending for non-low-carbon[6] energy technologies stabilised to the 2017 levels just above USD 1 billion.

Figure 7: Evolution of public low-carbon energy RD&D budget in IEA member countries*



* Data from 2018 onwards include for the additional spending of the Ministry of Environment (MoE) of Japan (0.4 USD billion of low-carbon technologies in 2018), which is not covered for previous years. This has effects on the apparent 2017-2018 growth.

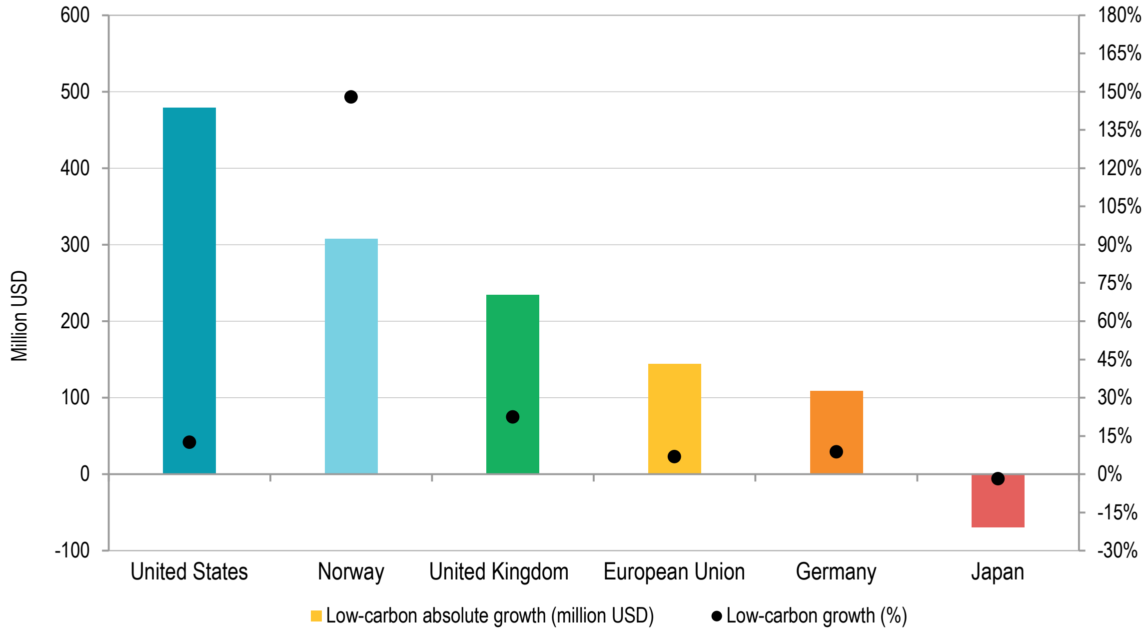
Source: IEA. All rights reserved.

In line with this trend, most individual countries increased in 2019 their investments in low-carbon RD&D (Figure 8). In the United States, low-carbon energy RD&D budgets were estimated to grow by 13% with an additional USD 479 million; the second largest increase was in Norway (additional USD 308 million, linked to the wind demonstration project mentioned above). In an opposite trend to most countries, Japan decreased its low-carbon budget by 2%.

[5] In the current IEA categorization of RD&D energy technologies, low-carbon energy technologies are defined as: energy efficiency, carbon capture and storage (CCS), renewable energy sources, nuclear, hydrogen and fuel cells, other power and storage, and other cross-cutting technologies and research.

[6] In the current IEA categorization of RD&D energy technologies, non-low-carbon energy technologies represent coal, gas, oil and other fossil fuel RD&D, excluding CCS.

Figure 8: Variations in public low-carbon energy RD&D budgets for selected IEA countries and the European Union in 2019*



* Data for the United States have been estimated by the IEA Secretariat for 2016-2019.

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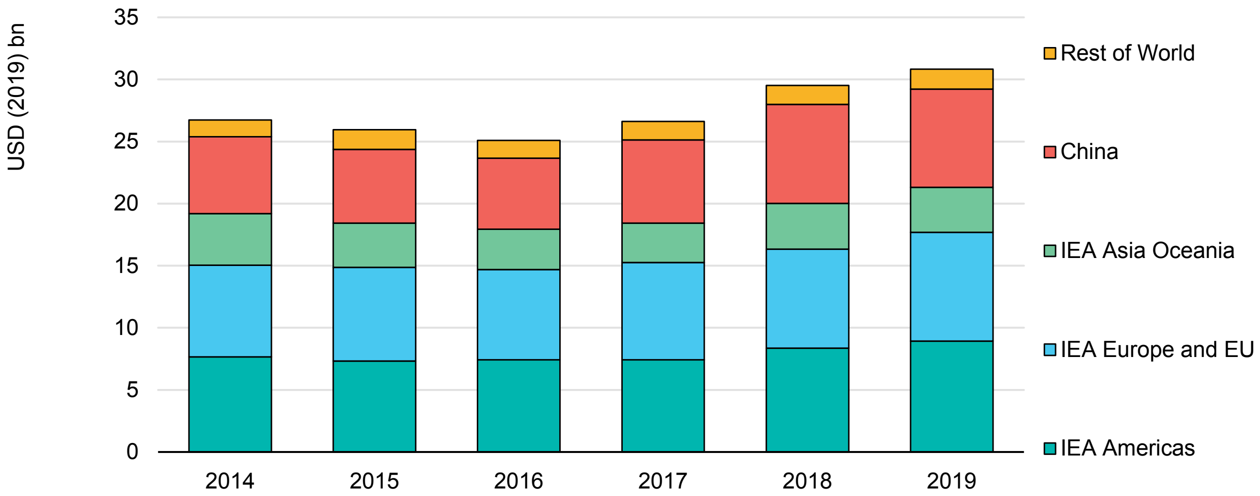
Part IV. Global energy RD&D trends

IEA's work on energy innovation under the World Energy Investment report[7] and the Clean Energy Transitions Programme (CETP) complements the collection and dissemination of IEA member country RD&D budget data by assembling available information on non-IEA government energy RD&D spending and private sector energy R&D spending trends[8], in a sustained effort to increase coverage beyond official data submissions to the IEA.

In 2019, the estimated global public energy RD&D budget reached about USD 30.8 billion[9] (Figure 9), confirming the increasing trend since 2017 after several years of decline. The growth was mostly supported by Europe and the United States, while public spending in energy R&D stabilised in China after two years of strong growth and ahead of the country's next five-year plan.

Figure 9: Global public energy RD&D budget*



* Data for non-member countries are estimated based on public sources and are subject to revisions over time. Data for 2018 include for the first time the additional spending of the Ministry of Environment (MoE) of Japan (0.4 USD billion), which is not covered for previous years. This has effects on the apparent 2017-2018 growth. *IEA Asia Oceania* includes Japan, Korea, Australia and New Zealand. *IEA Europe and EU* includes Austria, Belgium, the Czech Republic, Denmark, Estonia,Finland, France, Germany, Greece, Hungary, Ireland, Italy,Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the European Union. *IEA Americas* includes Canada, Mexico and the United States. Rest of the World includes Australia, Brazil, India and South Africa.

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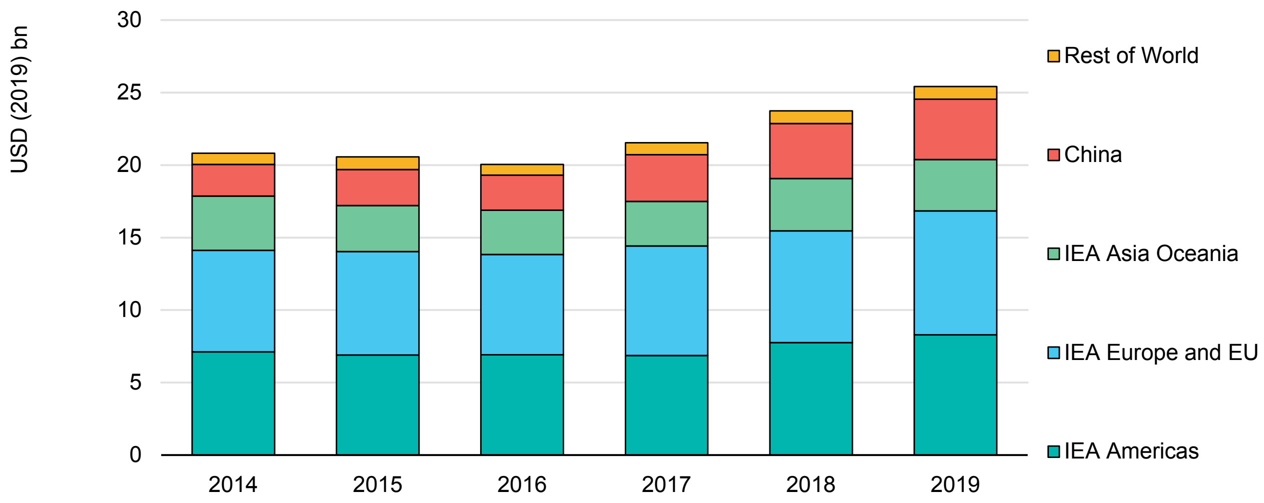
Under Mission Innovation (MI), fifteen IEA member countries and the European Union, as well as key emerging economies such as Brazil, China, India and Indonesia, pledged in 2015 to seek to double their public clean energy R&D spending over five years. While there are differences between IEA and MI classifications and countries, IEA data show that estimated global public low-carbon energy RD&D spending rebounded in 2016 following two years of decline, and it has been on the rise since then, reaching a new high in 2019 at about USD 25.4 billion (Figure 10). Similarly to total spending, this growth was driven by increasing budgets in Europe and the United States, followed by China. Notably, public spending in low-carbon energy R&D grew faster than total energy R&D budgets, at about 7% year-on-year growth rate.

[7] The next release of the IEA World Energy Investment (WEI) report is scheduled for mid-2021.
[8] Updated estimates of corporate energy R&D spending and data for 2020 will be released in the IEA World Energy Investment (WEI) 2021 report.
[9] In this section, figures are based on 2019 prices and exchange rates (not PPP) terms.

These encouraging trends, however, warrant further examination in 2020-21 as the impacts of the Covid-19 pandemic on global energy systems, including on public low-carbon energy R&D budgets, unfold.

Figure 10: Global public low-carbon energy RD&D budget*



* Data for non-member countries are estimated by the IEA based on public sources and are subject to revisions over time. Data for 2018 include for the first time the additional spending of the Ministry of Environment (MoE) of Japan (0.4 USD billion), which is not covered for previous years. This has effects on the apparent 2017-2018.

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Corporate energy R&D spending[10]

Published data for R&D budgets by listed corporations globally show that these are the largest single source of funding for energy R&D. However, unlike public R&D, many of the major companies active across the energy system devote no more than one-tenth to one-third of their total R&D budgets to new technologies, with the bulk of spending going to incremental improvements of existing technologies and product development.

Companies active in energy technology sectors over the last decade have increased their total annual energy R&D spending by around 40% since 2010, based on IEA analysis of latest available data from annual reports. The sample of listed companies active in energy technology sectors for which 2019 data is currently available increased their annual energy R&D spending, by around 5% (Figure 11). The total energy R&D spending of this sample reached about USD 92.4 billion in 2019.

Across the period, companies active in renewable energy technologies represent a particularly bright and resilient story. These companies spent 73% more on R&D between 2010 and 2019, adding over USD 2.6 billion to efforts to improve their technologies, complementing over USD 4 billion spent on renewables R&D by governments.

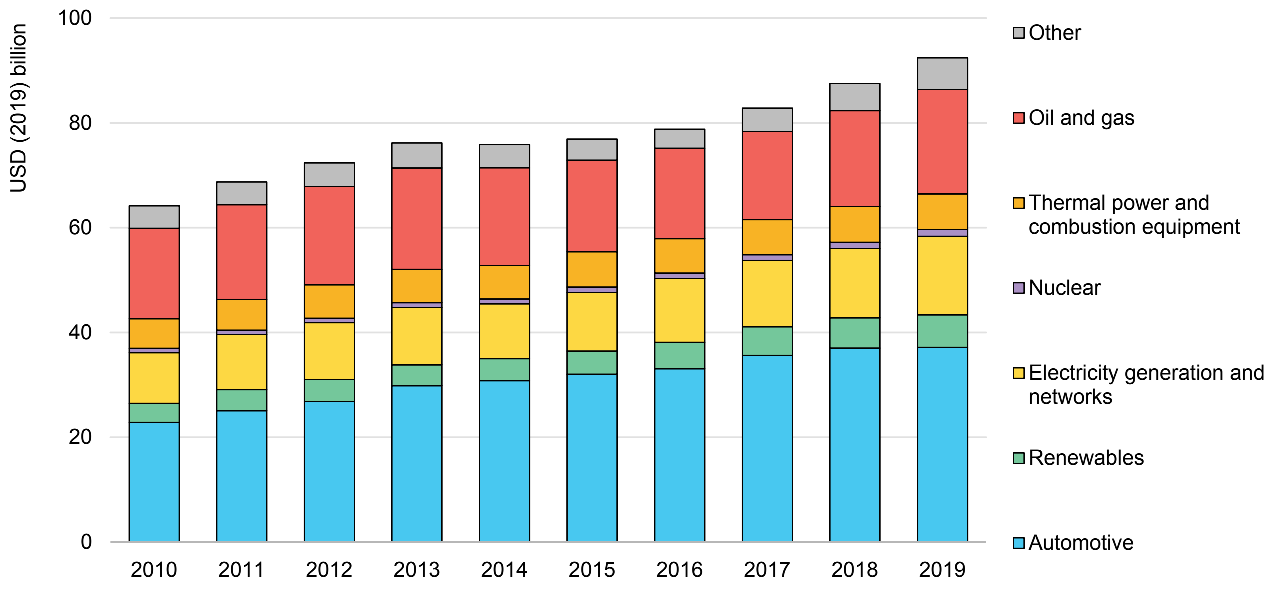
[10] This section presents updated trends and findings up to 2019 which were published in WEI-2020 and/or in previous IEA Energy Technology RD&D budgets publications. Updates and methodology refinements have been undertaken in 2020, as detailed in World Energy Investment 2020. Updated time series and data for 2020 will be published in World Energy Investment 2021.

Automakers – who typically have much higher R&D budgets than energy companies in absolute terms and as a share of revenue – continue to increase their spending as government policies and competitive pressures drive increased focus on energy efficiency and electric vehicles. However, the data suggest they may be facing a balancing act between a weaker outlook for car sales revenue and the need to invest in new vehicles and manufacturing supply chains. Energy-related automotive R&D is estimated to have stabilised between 2018 and 2019 after several years of growth.

The financial crisis of 2008 and the oil price collapse of 2014 provide some insight into the likely response of companies to the impacts of the Covid-19 pandemic. In 2009-10 the total R&D spending of major sectors held up well relative to revenues, with the exception of the automotive sector. However, the electricity supply and renewables sectors were the only ones not to experience slower growth or cuts to R&D budgets in this period. After 2014, oil and gas company R&D took four years to return to growth and remains below the 2013 level.

While R&D spending is likely to suffer, it can be expected to be much less affected than capital expenditures, as companies seek to retain R&D staff and capabilities, and complete ongoing projects. As in 2009, the outcome will be policy-dependent, with tax incentives and R&D-specific loans being proposed for inclusion in stimulus packages. Still, for the large-scale demonstration of technologies, such as CCUS, cuts to investment could be more damaging than those to R&D.

Figure 11: Global corporate R&D spending in energy-related sectors



Note: "Other" comprises CCUS, electricity storage, insulation, lighting, other fossil fuels and smart energy systems. Corporate energy R&D spending includes reported R&D expenditure by companies in sectors that are dependent on energy technologies, including energy efficiency technologies where possible. Classifications are based on the Bloomberg Industry Classification System. "Automotive" includes technologies for fuel economy, alternative fuels and alternative drivetrains from main manufacturers. To allocate R&D spending for companies active in multiple sectors, shares of revenue per sector are used in the absence of other information. All publicly reported R&D spending is included, though companies domiciled in countries that do not require disclosure of R&D spending are underrepresented. Depending on the jurisdiction and company, publicly reported corporate R&D spending can include a range of capitalised and non-capitalised costs, from basic research to product development and, in some cases, resource exploration. Numbers over 2017-19 are updated compared to World Energy Investment 2020.

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Overall responsibility:

Roberta Quadrelli

Statistics:

Domenico Lattanzio

Alexandre Bizeul

Contacts:

Energy Data Centre

RDD statistics

9, rue de la Fédération

75739 Paris Cedex

Tel: +33 (0) 1 40 57 66 26

rdd@iea.org

Media enquiries:

Tel: +33 (0) 1 40 57 65 54

ieapressofice@iea.org

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