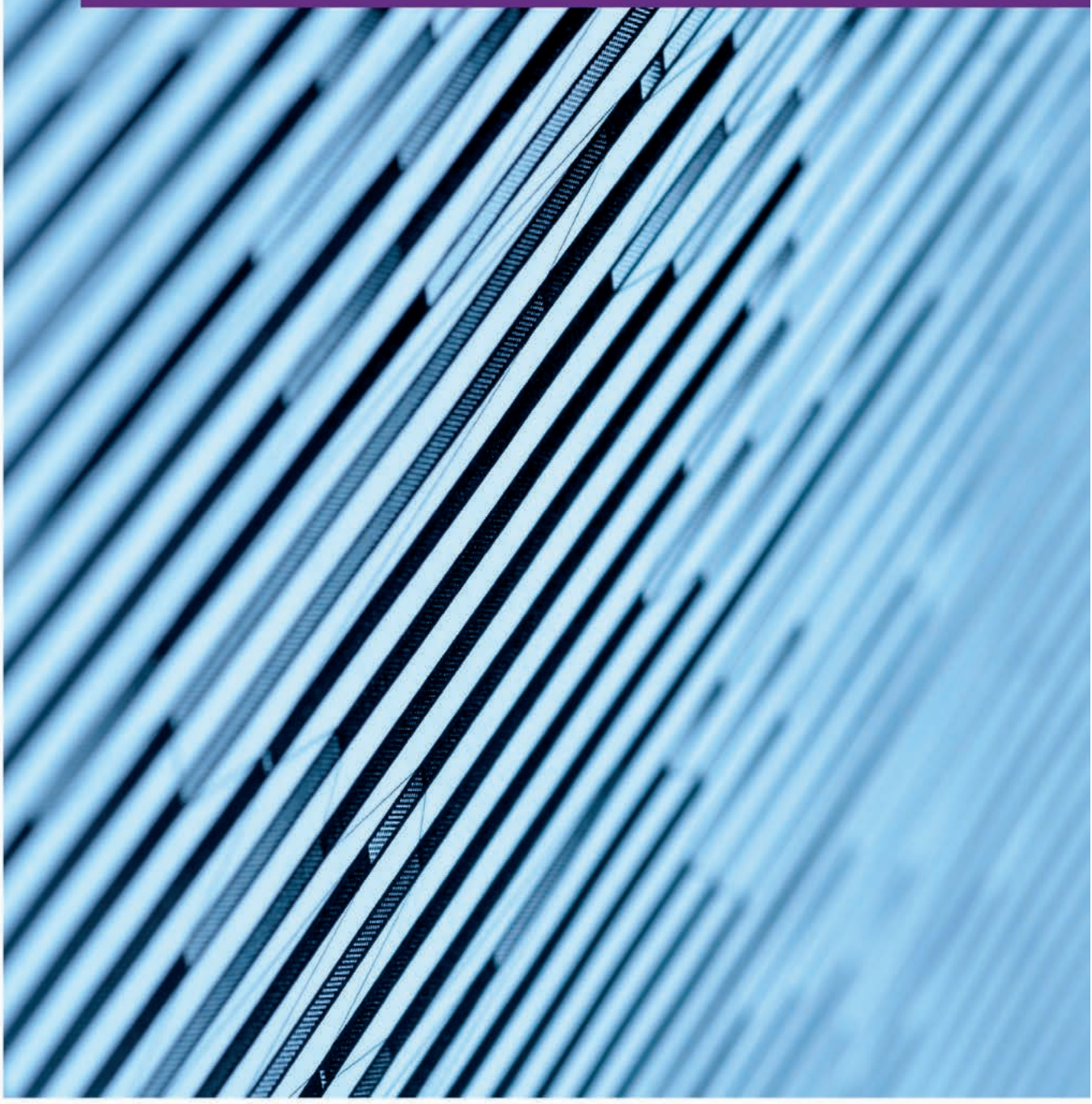
statistics

Energy technology RD&D budgets:

Overview



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Secure Sustainable Together

2019

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The IEA energy RD&D data collection and the analysis presented in this paper were performed by Yasemin Aslan, Rémi Gigoux and Domenico Lattanzio under the responsibility of Roberta Quadrelli, in the IEA Energy Data Centre headed by Nick Johnstone. Simon Bennett and Simone Landolina also contributed to this analysis. We would like to thank our numerous contacts in national administrations for their helpful co-operation.

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Source: IEA Energy Technology RD&D Budgets (2019 first edition)

Further information on RD&D statistics, including a downloadable database, is available at: www.iea.org/statistics/rdd/.

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-2019-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/), the Clean Energy Transitions Programme (https://www.iea.org/cetp/) and Technology Roadmaps (https://www.iea.org/publications/technologyroadmaps/).

Notes:

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

Data in this publication refer 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 2018 prices, using GDP deflators and 2018 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/. Other IEA publications like *Tracking Clean Energy Progress* and the *World Energy Investment* report expenditures based on nominal exchange rates, and as such the figures presented in the section on global energy RD&D trends in this report are not presented in PPP terms.

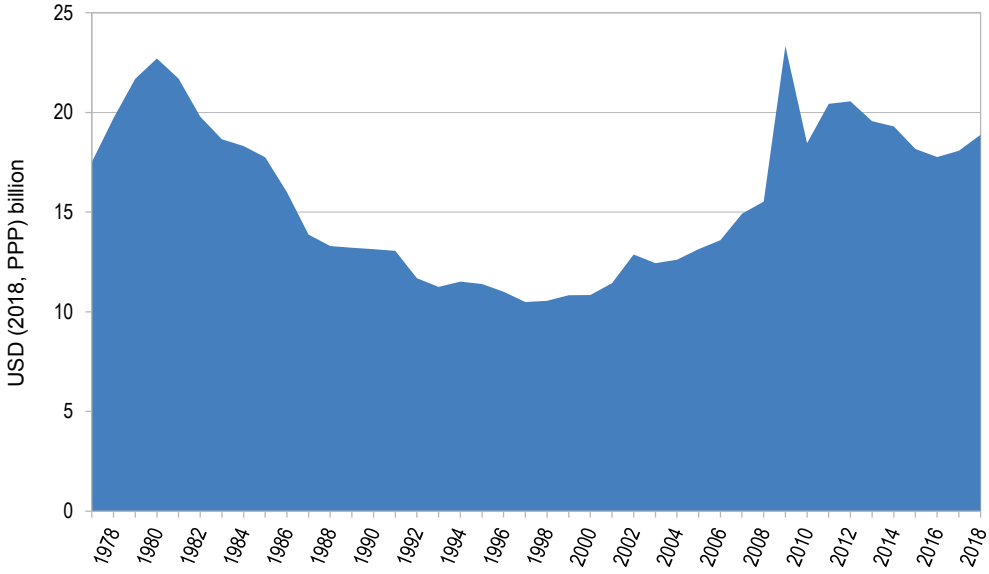
2018 RD&D budgets are available for all IEA countries except France, Poland, Finland, Belgium, Netherlands, Austria, Australia, Spain, Estonia and New Zealand, for which the most recent data are 2017 RD&D budgets data; Czech Republic, for which the most recent data is 2016 RD&D budgets; and Greece, Ireland, Luxembourg and Portugal for which no recent data are available. Data for USA, between the years 2016-2018, have been estimated by the IEA Secretariat. When regionally aggregated, missing 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 2018, the estimated total public energy research, development and demonstration (RD&D) budget for IEA member governments reached to USD 18.9 billion (in purchasing power parity, or PPP, terms)[1]. After four years of decreases through to 2016, total public energy RD&D budget of IEA member countries increased in 2017 by 2% and again in 2018 by 4% (Figure 1), reaching a level 22% higher than in 2008 but still 8% lower than in 2012, and much lower than the peak reached in 2009. The 2018 increase was mostly driven by higher budgets allocated to low-carbon energy technologies.

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



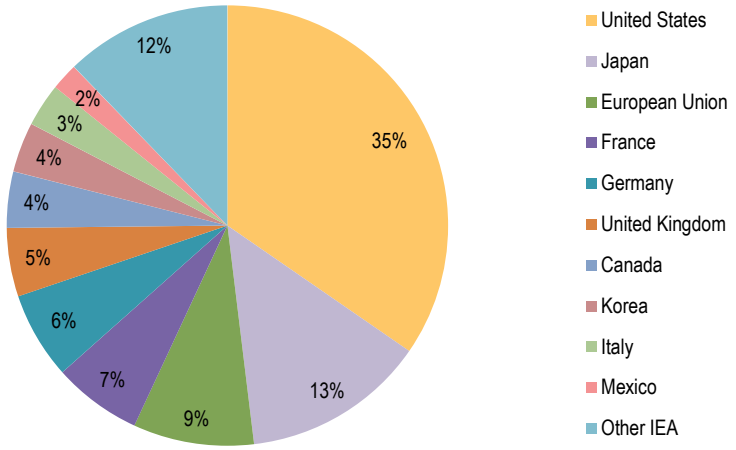
* USD 22.5 billion in 2009 is an outlier related to the American Recovery and Reinvestment Act (stimulus) spending, which was allocated to the 2009 budget year.

Note: PPP = purchasing power parity.

1. Does not include USD 1.83 billion of the European Union energy RD&D funding under the Horizon 2020 programme in 2018.

In PPP terms, the United States and Japan spent the most on energy RD&D among IEA member countries (Figure 2 and 3), followed by France, Germany, the United Kingdom, Canada, Korea, Italy and Mexico. For most of these countries, total public energy RD&D expenditure increased in 2018, although it fell in Germany and Korea by 4% and 1%, respectively. The energy RD&D budget of the European Union, under the Horizon 2020 programme is larger than that of all but two IEA member countries: the USA and Japan. If the EU budget were added to IEA European countries' total, it would rise 42% to USD 8.6 billion (PPP).

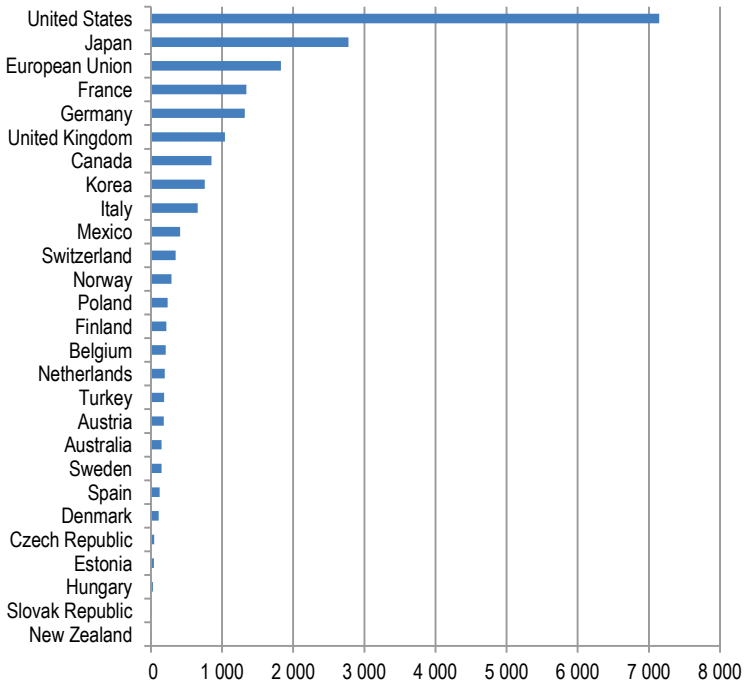
Figure 2: Public energy RD&D budgets by country for IEA members and the European Union*



* The amounts shown are based on 2018 energy RD&D budgets, with the exceptions of France, Poland, Finland, Belgium, Netherlands, Austria, Australia, Spain, Estonia and New Zealand based on 2017 data; Czech Republic based on 2016 data. No recent data were available for Greece, Ireland, Luxembourg and Portugal. Data for USA have been estimated by the IEA Secretariat.

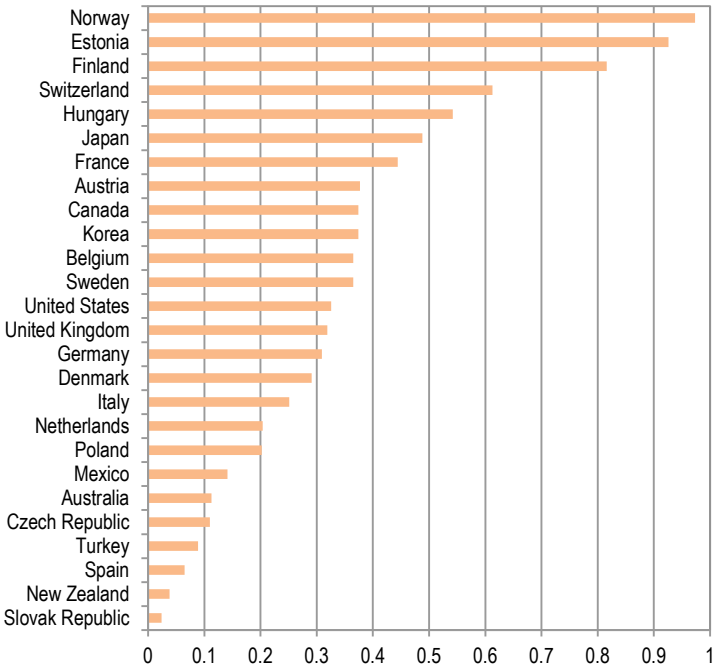
The ratio of overall public energy RD&D budget per unit of GDP varied greatly among IEA member countries, ranging from less than 0.1 USD PPP to at most 1 per thousand in 2017. Norway had the highest level in the IEA, with a ratio of 0.97 USD PPP per thousand, followed by Estonia (0.93). Other leading countries were Finland (0.82), Switzerland (0.61) and Hungary (0.54) (Figure 4).

Figure 3: Total public energy RD&D budgets by country for 2018 or latest year available*



* The amounts shown are based on 2018 energy RD&D budgets, with the exceptions of France, Poland, Finland, Belgium, Netherlands, Austria, Australia, Spain, Estonia and New Zealand for which it is based on 2017 data; Czech Republic for which it is based on 2016 data. No recent data were available for Greece, Ireland, Luxembourg and Portugal. Data for USA have been estimated by the IEA Secretariat.

Figure 4: Total public energy RD&D budgets per thousand units of GDP by country for 2017*



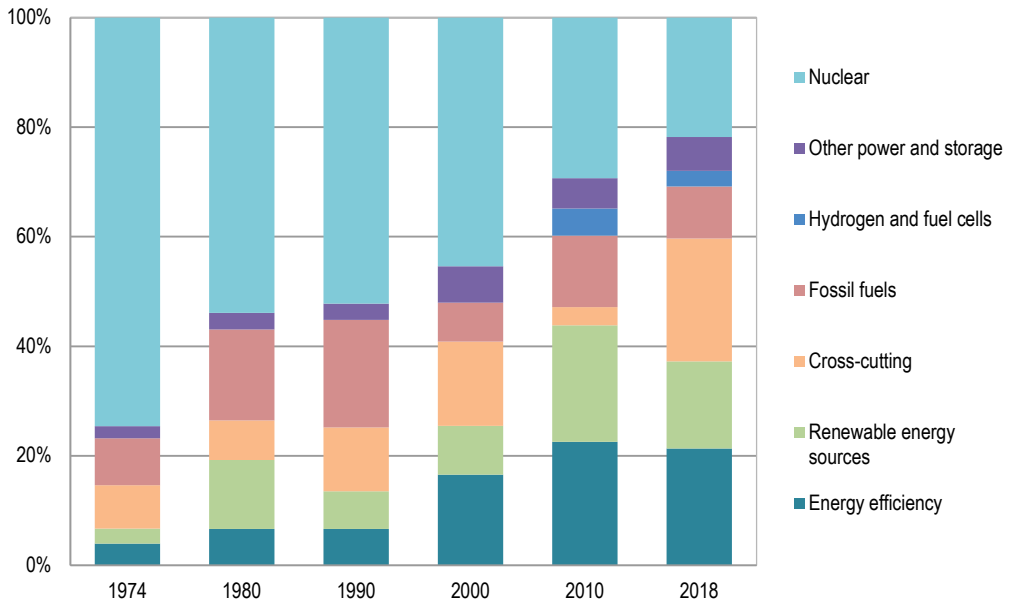
* Based on 2017 data, except for Czech Republic (2016 data). No recent data were available for Greece, Ireland, Luxembourg and Portugal. Data for USA have been estimated by the IEA Secretariat.

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 22% in 2018, comparable to the shares for energy efficiency (21%), renewables (16%) 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 9% in 2018.

RD&D 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. However, since then the share of expenditures on energy efficiency (21%) has remained almost constant, whilst the share of renewables declined to 16%. On the other hand, cross-cutting RD&D grew in the first decade of the 21st century. RD&D budgets for hydrogen and fuel cells kept their share at 3% since 2012.

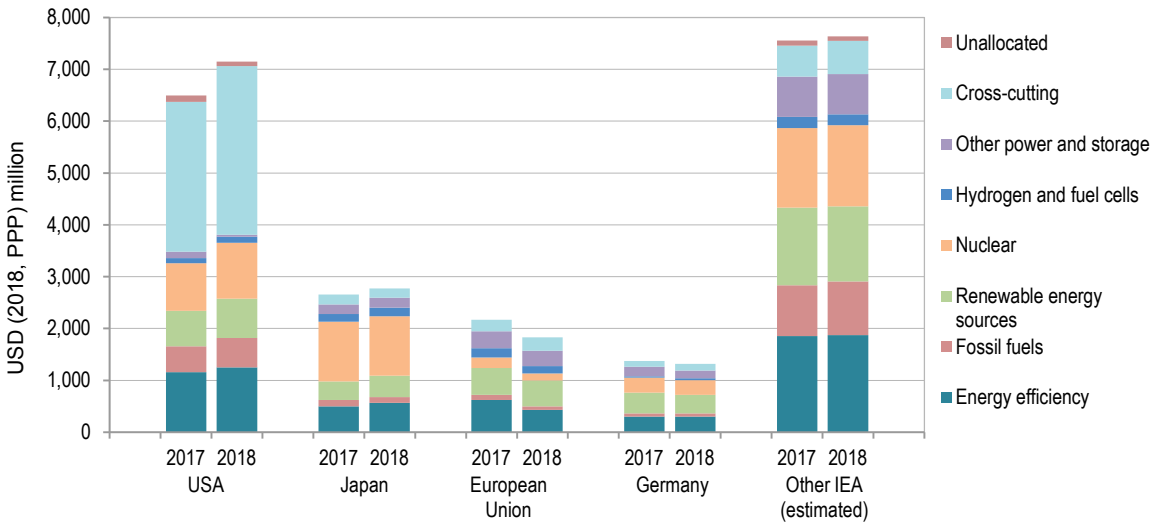
Figure 5: Evolution of IEA total public energy RD&D by technology



In 2018, Japan remained the country with the largest RD&D budget for nuclear (USD 1144 million in PPP), hydrogen and fuel cells (USD 169 million in PPP) and other power and storage (USD 189 million in PPP) (Figure 6). For the remaining technologies, the United States has the highest RD&D budget. For the United States, almost half of the 2018 energy RD&D budget was allocated to cross-cutting energy technologies[2] and cannot be broken down further.

The energy RD&D budget increased in 2018 for all types of technology except for "other power and storage technologies", which decreased by 9%. The increase was 11% for cross-cutting technologies, 8% for hydrogen and fuel cells, 7% for fossil fuels, 5% for both energy efficiency and nuclear and 1% for renewables.

Figure 6: 2017 and 2018 budgets by technology in selected IEA countries and the European Union*



* Data for Mexico are included in this graph within Other IEA. 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 USA have been estimated by the IEA Secretariat.

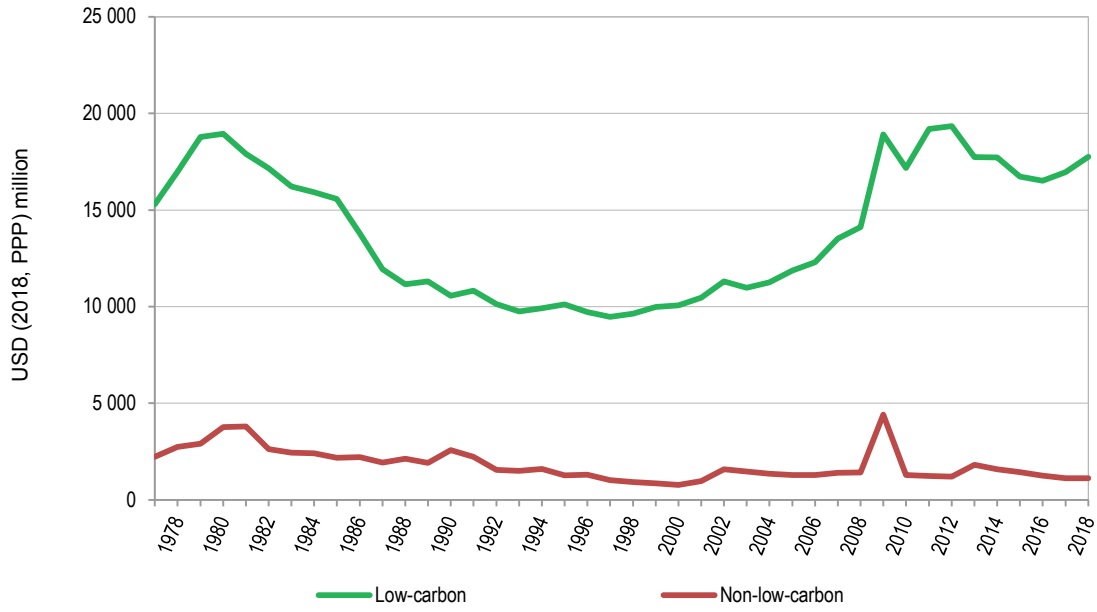
2. The main components of the amount reported under cross-cutting energy technologies corresponds to what the US Department of Energy, Office of Science, reports under its Basic Energy Sciences program and selected items of its Biological & Environmental Research program. Data for USA have been estimated by the IEA Secretariat.

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

RD&D spending in low-carbon[3] energy technologies in IEA member countries saw a significant increase in 2018 to reach USD 17.8 billion (2018 prices and PPP) representing 94% of total RD&D budgets (Figure 7). As total energy RD&D spending, after four years of decreases since 2012, low-carbon energy technologies in IEA member countries increased in 2017 by 3% and again in 2018 by 5% (faster than total spending).

Spending for non-low-carbon[4] energy technologies kept its low levels in 2018, just above USD 1 billion and comparable to 2017.

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



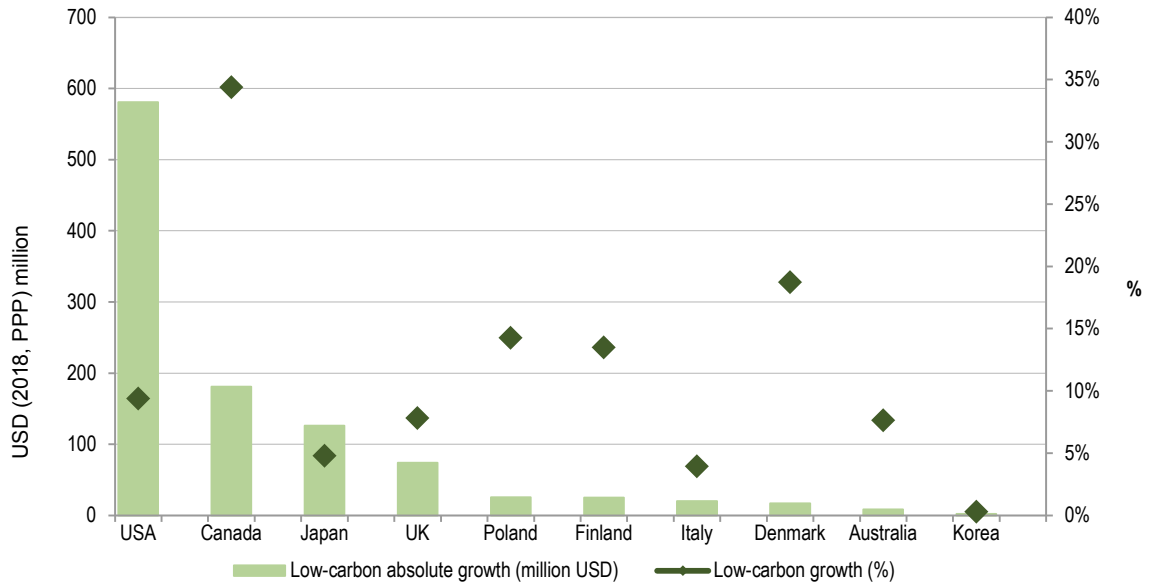
Source: IEA. All rights reserved.

The most of IEA member countries reflected these trends and increased their investments in low-carbon RD&D in 2018 (Figure 8). In the United States, low-carbon energy RD&D budgets were estimated to grow by 9% with an additional USD 581 million. The second largest increase was in Canada, where low-carbon energy RD&D budgets grew by 34%, amounting to USD 181 million. For Japan, the growth rate was 5%, for an amount of USD 126 million.

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

4. 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. However, CCS is included in low-carbon.

Figure 8: Variations in public low-carbon energy RD&D budgets for selected IEA countries between 2017 and 2018*



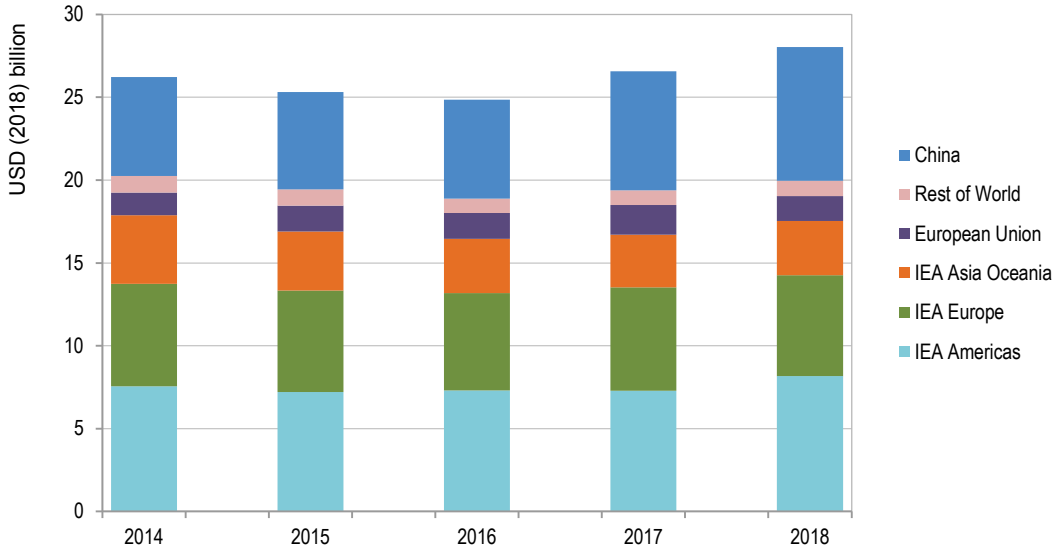
* In this graph, Poland, Finland and Austria data refers to growth between 2016 and 2017. Data for USA, between the years 2016-2018, have been estimated by the IEA Secretariat.

Part IV. Global energy RD&D trends

The IEA's *World Energy Investment 2019*[5] and *Tracking Clean Energy Progress*[6] publications complement the collection and dissemination of the 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[7].

In 2018, the estimated total public energy RD&D budget for the world reached USD 28 billion (in 2018 USD) (Figure 9). After two years of decreases until 2016, the budget increased in 2017 and 2018, mostly due to higher budgets allocated in 2018 by China and IEA Americas.

Figure 9: Global public energy RD&D budget*



* Includes the data for Mexico.

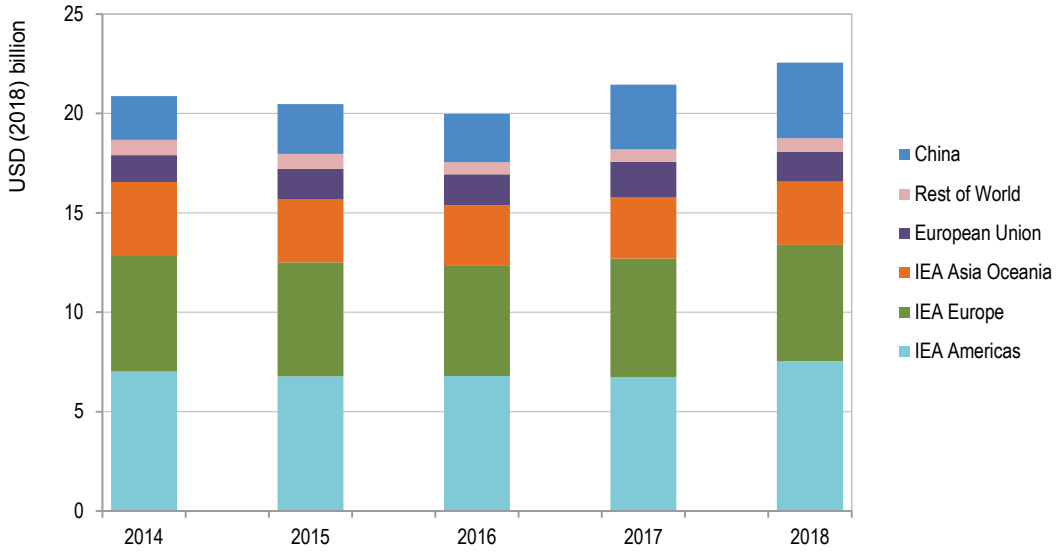
Under Mission Innovation (MI), fifteen IEA member countries and the European Union, as well as key emerging economies such as Brazil, China, India, and Indonesia, pledged in 2015 to seek to double public clean energy R&D spending over five years. While there are differences between IEA and MI classifications and countries, IEA data show that , after two years of decline to 2016, estimated global public low-carbon energy RD&D spending rose in 2017 and 2018, reaching USD 23 billion in 2018 (Figure 10). This was mostly due to higher budgets allocated in 2018 by IEA Americas and China.

5. *https://www.iea.org/media/publications/wei/WEI2019-Methodology-Annex.pdf*

6. *https://www.iea.org/tcep*

7. In this part, figures are not presented in PPP terms.

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



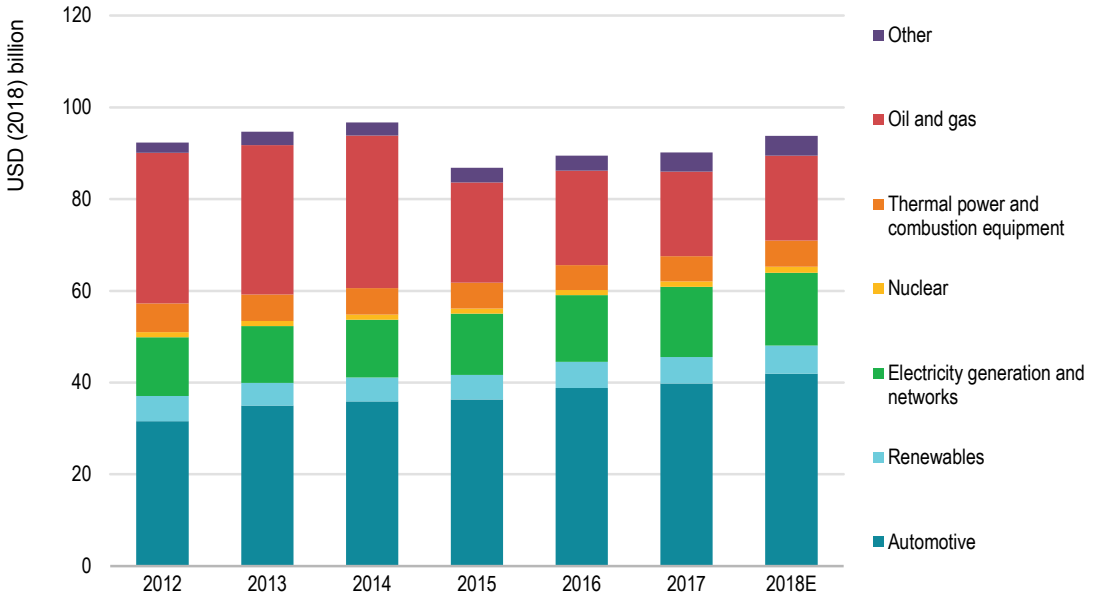
* Includes the data for Mexico.

Published data by corporations on their R&D budgets show them to be the largest single source of funding for energy R&D, despite lower spending in recent years. The sample of listed companies active in energy technology sectors for which 2018 data is currently available increased their annual energy R&D spending, by around 4% (including automakers) (Figure 11). The total energy R&D spending of this sample reached nearly USD 94 billion in 2018. Excluding transport, two-thirds of the total corporate energy R&D was in low-carbon sectors.

Corporate R&D spending by companies in the oil and gas and other fossil fuel extraction sectors showed 1% growth in real terms in 2018, the first increase in R&D spending in this sector since 2014. Spending remains 45% below 2014 levels, however, and is not rising significantly as a share of revenue.

While the rebound of oil and gas company R&D budgets is sluggish, that of electricity generation and supply companies continues to rise. Siemens and General Electric occupied the top spots in the list of the highest global energy R&D spenders, with Petrochina dropping out of the top three for the first time in a decade. Four of the top ten are Chinese companies, and five are in the electricity sector.

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



Notes: Classifications are based on Bloomberg Industry Classification System. All publicly reported R&D is included, though companies domiciled in countries that do not require disclosure of R&D spending are under-represented. To allocate R&D spending for companies active in multiple sectors, interviews with company decision-makers and, in the absence of other data sources, the shares of revenue per sector were used. "Other" comprises CCUS, electricity storage, insulation, lighting, other fossil fuels and smart energy systems.

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 R&D spending as government policies and competitive pressures drive higher spending on energy efficiency and electric vehicles. Automakers' were the biggest contributors to the growth in corporate energy R&D spending technologies in 2018. This trend is notable among major European and US car and auto parts companies, whose R&D spending rose by around 7% on average in 2018, compared to 4% for Japanese and Korean firms. However, the increasingly global presence of Chinese automakers is reflected in their R&D spending, which rose more than 20% on average.

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.

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