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Source: IEA Energy Technology RD&D Budgets (2017 edition)

Further information on RD&D statistics is available at:
http://www.iea.org/statistics/RDDonlinedataservice/

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

OVERVIEW: PUBLIC ENERGY RD&D BUDGET IN IEA MEMBER COUNTRIES

In 2016, the estimated total public energy research, development and demonstration (RD&D) budget for IEA member governments reached close to USD 16.6 billion, just below 2015 levels. The total public energy RD&D budget of these countries continues to decrease year-on-year from its recent peak at USD 19.4 billion in 2012 (Figure 1). Despite this decline, total spending is maintained above the levels seen between 1985 and 2008. Data indicate that reductions in spending on fossil fuel and nuclear technologies have not been redirected in full to technologies related to clean energy.

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

Note: PPP = purchasing power parity.

Over the last 40 years, investment from IEA member countries in energy RD&D has become progressively more diverse (Figure 2). Nuclear, dominant in 1974 with 74% of total public energy RD&D budget, witnessed year-on-year reductions to fall to 21% in 2016. In 2016, energy efficiency, renewables and cross-cutting RD&D each reached shares of total energy RD&D budgets comparable to those of nuclear (21%). In fact, RD&D budgets on renewables increased from 3% of the total public budget in 1974 to 19% in 2016, while energy efficiency grew from 4% to 21% over the same period. On the other hand, RD&D budgets on fossil fuels, which were at their highest in the 1980s and 1990s, have been between 11% and 13% of total public energy RD&D budgets since 2009, a year marked by considerable spending on economic stimulus in the United States, including CCS projects relating to fossil fuels.

1. Public energy RD&D collected by the IEA includes central or federal government budgets as well as state-owned companies’ budgets. Data for 2016 are derived from initial country estimates and may be revised.
2. Data in this publication refer to total public energy RD&D expenditure data, converted from current prices in national currencies to US dollar PPPs in constant 2016 prices, using GDP deflators and 2016 PPPs. Purchasing power parities (PPPs) are the rates of currency conversion that eliminate the differences in price levels between countries. For more information on PPP methodology see www.oecd.org/std/prices-ppp/.
This amount does not include the USD 1.93 billion funding budget from the European Commission in 2016 (see page 7).
3. USD 22 billion in 2009 is an outlier related to the American Recovery and Reinvestment Act (stimulus) spending.
The United States and Japan have the largest absolute spending on energy RD&D among IEA member countries (Figure 3). However, the relative share decreased for Japan from 32% in 2005 to 17% in 2015 of the total energy RD&D budget for IEA member countries. At the same time, the United States’ share rose from 32% to 36%. France, Germany, Canada, and Korea maintained their respective shares, while several other IEA countries increased their own significantly, making the RD&D budget for IEA members overall more diversified across countries.
Japan remains the country with the largest nuclear energy RD&D budget, both in absolute terms and as a share of total energy RD&D (USD 1,078 million, equivalent to 40% in 2016), even with levels significantly lower than before 2011. IEA Europe\(^4\) shows the largest combined share of RD&D budget in energy efficiency and renewable energy sources (Figure 4). In the United States, cross-cutting energy technologies represent a large share of RD&D budget (38% in 2015)\(^5\).

![Figure 4: Budgets by technology in the United States, Japan and IEA Europe, 2015](image)

**ENERGY IN TOTAL R&D**

Overall, the 2016 share of energy in total RD&D\(^6\) has broadly stabilised at just over 4% across IEA member countries after decreasing significantly from over 11% in 1981. While the IEA Americas and IEA Europe showed similar trends in time, falling drastically in the 1990s and increasing only slightly in 2016, the IEA Asia Oceania region has shown a rather different trend, decreasing more slowly to just over 9% in 2016. The latest decline was driven primarily by Japan (historically, the country with the highest absolute public energy RD&D budget in this region), which reduced energy RD&D by USD 200 million, or 7%, between 2015 and 2016. Despite this decline, the IEA Asia Oceania region continues to account for the highest share in total R&D by region (Figure 5).

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4. IEA Europe includes all European countries which are members of the IEA, with the exception of Greece and Luxembourg as no data were available in 2015.
5. The main component of the amount reported under cross-cutting energy technologies corresponds to what the US Department of Energy reports under its Science major programme.
In 2016, Japan remained the country with the largest share of public energy R&D in its total R&D budget at just over 12% (Figure 6). The United States, the IEA member country with the largest absolute public energy R&D budget of more than USD 6.5 billion in 2016, had a share of energy in total R&D budget of 2% in the same year.

With regards to the overall public energy R&D budget per unit of GDP, the ratio varies greatly, ranging from less than 0.1 to over 1 per thousand, with largest values in Finland, Norway, Denmark and Japan.

Figure 5: Share of energy in total R&D by region, 1981-2016

Figure 6: Top 10 IEA countries in share of energy in total R&D, 2016 (left), and in energy RD&D per thousand units of GDP, 2015 (right)

7. Total public energy RD&D expenditure in nominal national currencies divided by GDP in nominal national currencies at market prices and volumes, expressed in thousand units of GDP.
CASE STUDY: EUROPEAN UNION ENERGY RD&D, HORIZON 2020

The IEA energy RD&D database also includes separate data on the set of relevant Horizon 2020 projects funded under the 2014, 2015 and 2016 calls for proposals of the European Commission. Energy efficiency and renewable energy technologies were the leading areas of European Commission RD&D investment, reaching significant shares (24% and 26% respectively) of the total energy RD&D budget in 2015. RD&D for fossil fuels had the smallest share, accounting for 6% of the total budget in 2015 (Figure 7).

In Figure 7, the European Commission’s energy RD&D budget for 2015 is also shown along side to the budgets of IEA member countries that are also members of the EU with available data for 2015. While energy efficiency and renewables show similar shares nationally and regionally, the European Union budget shows more emphasis on cross-cutting and energy storage technologies, and less on nuclear. This comparison indicates a strong level of alignment of priorities but, without further information on the nature of the projects, it is not possible to judge whether the two funding sources are acting to meet total regional R&D needs in a complementary manner.

Figure 7: Total public RD&D budget shares for the European Commission (left) and IEA/EU member countries (right), 2015

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8. Data were provided by the Directorate-General for Research and Innovation and the Directorate for Energy. Relevant projects include an explicit reference to energy R&D objectives. In these data, only grants are considered while financial instruments or contributions to other initiatives are not. Projects have been classified according to their contribution to energy-related R&D objectives as either ‘fully’, ‘partially’ or ‘not’ contributing. The EU contribution to projects fully contributing was taken into account fully (100%), while for projects partially contributing only 40% of the EU contribution has been taken into account.

9. Countries that submitted data for 2015 include: Austria, Belgium, Czech Rep, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy (data for 2014), Netherlands, Poland, Portugal, Slovak Republic, Spain, Sweden, UK.

10. Figure 7 total budget amounts are shown in EUR at 2016 prices. These numbers are equivalent to USD 1.9 billion for the EC and USD 5.4 billion for IEA/EU member countries (at 2016 prices and PPPs).

11. A significant amount of what is reported under “Cross-cutting” by the European Commission corresponds to “Smart Cities and Communities (SCC)” which is a very substantial spending item for the EU Horizon 2020 programme. SCC is covering energy efficiency in buildings and transport as well as renewable energy and electricity transmission and distribution.
FEATURED: CLEAN ENERGY RD&D TRENDS IN IEA MEMBER COUNTRIES

Reflecting an analysis presented in the Tracking Clean Energy Progress 2017 report, while spending on topics related to clean energy doubled between 2000 and 2010\(^{12}\), it has not offset the moderate decline in total RD&D spending since 2010. This lack of investment growth in clean energy research in recent years underpins the importance of further investment in RD&D. Recognition of this situation prompted the timely launch of the Mission Innovation (MI) initiative/pledge in November 2015 at COP21 in Paris by a group of twenty countries\(^{13}\). The aim of the MI is to accelerate global clean energy innovation, with each of the MI participants seeking to double their government and/or state-directed clean energy research and development investment over the next five year period to 2021. Signatory countries all share a common goal to foster research and development of breakthrough technologies and are seeking to increase collaboration on transformational projects in the area of RD&D.

MI members are working to define the information-sharing framework for MI, as the clean energy RD&D focus areas vary across countries and a common basis for data collection and reporting across all countries is not available\(^{14}\). The key focus areas include energy efficiency (in industry, buildings and transportation), renewable technologies, hydrogen and fuel cells, electricity grids, energy storage, carbon capture and storage,\(^{15}\) and, in some countries, cleaner fossil fuels, nuclear, and basic energy research. While each MI country’s energy research and development portfolio is unique and reflects national priorities, the key role of clean energy technologies in total RD&D is evident in the group of twelve MI countries,\(^{16}\) which are also IEA members (Figure 8).

Figure 8: IEA Mission Innovation 14 countries energy technology public RD&D budget, estimated evolution 1976-2016

\(^{13}\) MI participating countries: Australia, Brazil, Canada, Chile, China, Denmark, Finland, France, Germany, India, Indonesia, Italy, Japan, Mexico, Netherlands, Norway, Republic of Korea, Saudi Arabia, Sweden, United Arab Emirates, United Kingdom, United States, and European Union.
\(^{15}\) In the current IEA categorization of RD&D energy technologies, carbon capture and storage is included under “Fossil fuels,” electricity grids and energy storage under “Other power & storage,” and cleaner fossil energy under “Fossil fuels.”
\(^{16}\) The 14 countries which are both IEA and Mission Innovation members include: Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Republic of Korea, Sweden, United Kingdom, United States.
ESTIMATING GLOBAL PUBLIC AND PRIVATE ENERGY RD&D SPENDING

In 2017, the IEA undertook a first bottom-up analysis of public spending data for non-IEA member countries as well as private sector data, for its World Energy Investment and Tracking Clean Energy Progress reports. In those reports, we have tracked global energy R&D spending totalling USD 65 billion in 2015 (the latest year for which full data is available) based on an assessment of spending by public and private bodies, equal to 4% of total energy investment. But overall energy R&D is not growing in real terms (Figure 9). Spending in 2015 was 3% lower than the previous year, largely due to a drop in spending by the oil and gas industry in response to the financial difficulties caused by the collapse in oil prices. This drop has not been offset by rising spending on clean energy RD&D, which has also been essentially flat at around USD 27 billion since 2012.

More is spent on energy sector R&D in the United States than in any other country. The country was also the lead spender on clean energy R&D in 2015. Spending on energy R&D in all European countries is slightly higher than that of the United States and suffered a lower drop in 2015. The share of China in both total energy and clean energy RD&D has reached one fifth, having risen by around 7% per year since 2012, and China is the highest spender per unit of gross domestic product (GDP), having overtaken Japan in 2014.

Figure 9: World energy R&D spending by source of funding, 2012-15


Note: SOE = State-owned enterprises (companies with government ownership of 50% or more). VC = early-stage venture capital-funding. Corporate and SOE spending includes that of firms with revenue in all main energy sectors, including energy supply, energy equipment manufacturers and service companies.

Sources: Bloomberg LP (2017); IEA (2017); Cleantech Group (2017); NBS (2013-17); government sources.

Publicly reported R&D spending by energy companies worldwide, including SOEs, has been falling, largely because of less oil industry spending. Spending fell by 4% in real terms in 2015 and 1% in 2016 (Figure 10). The 15% decline in R&D spending by oil and gas companies – including oil service companies – in 2015 and a further 5% fall in 2016 has not been fully offset by increased spending on clean energy R&D. While firms generally try to smooth their R&D spending over time, if possible, to retain key skills, R&D can be vulnerable to sharp changes in the total capital budgets

17. Please refer to Tracking Clean Energy Progress 2017 (IEA, 2017) and World Energy Investment 2017 (IEA, 2017) for a description of the challenges to this analysis and the approach taken.


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of companies, especially in markets with highly volatile prices, like oil. R&D expenditure reported by companies active in clean energy sectors is growing: it reached USD 7.2 billion in 2016, USD 1.2 billion more than in 2012, and now represents 18% of all reported corporate energy sector R&D spending. We estimate that more energy research is undertaken by companies on fossil fuel technologies than on renewable energy, electric mobility, storage and smart grids.

While oil and gas companies account for a sizeable chunk of corporate energy R&D, their R&D intensity (spending relative to total corporate revenue) is around 0.4% – a similar level to that of electricity utilities but low compared with other sectors. Manufacturers of thermal power-generation equipment and clean-energy companies spend around 3.5% of their revenue on R&D. In the latter case, this reflects the greater need for innovation in less mature markets. Outside the energy sector, just the five largest corporate spenders on R&D in the IT sector have R&D budgets equivalent to all public and private energy sector R&D worldwide, while the top two IT companies in this regard have equivalent spending to all the clean energy R&D expenditure we have tracked.

![Figure 10: Publicly reported energy R&D spending by companies](image)


Note: Sample includes some SOEs. Classifications are based on Bloomberg Industry Classification System. R&D is allocated according to shares of revenue per sector for companies active in multiple sectors. Clean energy includes renewable energy, electric mobility, electricity storage, nuclear, LEDs and smart grids. Thermal power includes original equipment manufacturers (OEMs) of power plant equipment for fossil-fired generators.

Sources: Bloomberg LP (2017), Bloomberg Terminal; Company disclosures.