Breakthrough Energy

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US Economic Impacts of Expanded Federal Energy R&D Investments

A Word from Breakthrough Energy

At Breakthrough Energy, we believe that to prevent the worst impacts of climate change, we need to commercialize and scale clean technologies here in America and across the globe more quickly than ever before. The United States can lead the way in developing the breakthroughs we need to change the way we power the world if we commit the resources and willpower to achieve net-zero greenhouse gas emissions by 2050.

Public sector investment in research and development (R&D) is the foundation upon which such breakthroughs in technology are possible, and as our September 2020 study prepared by PricewaterhouseCoopers LLC made clear, is also a substantial part of the U.S. economy and an engine of job creation. Federally funded R&D supported over 1.6 million jobs in 2018 and added nearly $200 billion in value to the U.S. economy.

The scenario presented here expands on our prior study to estimate the economic impact that increased federal investment in clean energy R&D would have on the U.S. economy and workforce.

The results of this new analysis are compelling: increasing energy R&D investment to $35 billion — roughly the same amount as health and biomedical research — would add $53 billion to the economy as well as support more than 372,000 jobs.

We encourage leaders and policymakers to consider investing in energy R&D not only as a crucial step towards solving the climate crisis, but also as a down payment to rebuilding the economy as we recover from the COVID-19 pandemic and securing the clean energy economy of the future.

About Breakthrough Energy

Breakthrough Energy is a network of entities and initiatives, including investment funds, nonprofit and philanthropic programs, and policy efforts linked by a common commitment to scale the technologies we need to achieve a path to net zero emissions by 2050.

Impacts of Expanded Federal R&D Investments in the Energy Sector, 2021-2030

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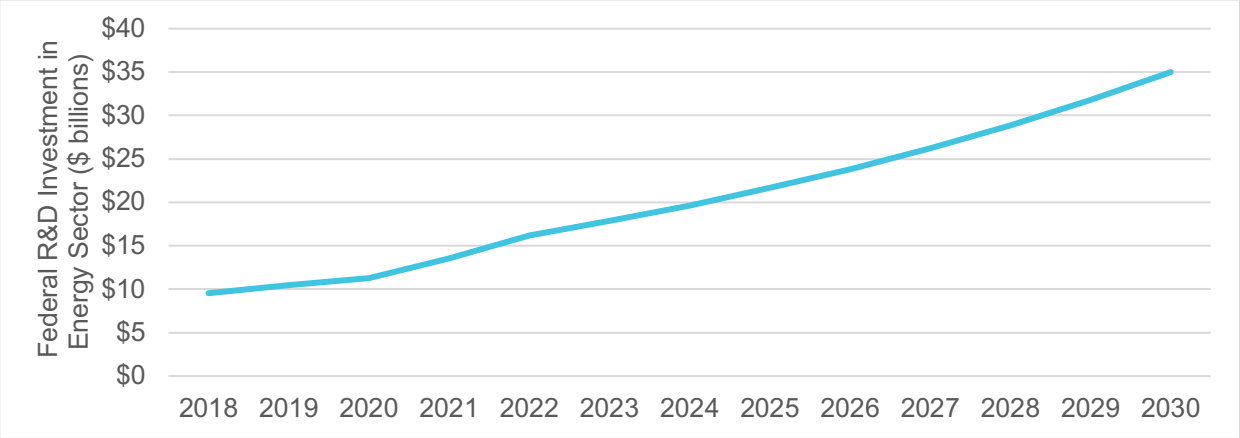
Breakthrough Energy engaged PwC to evaluate the potential economic impacts of an increase in federal energy sector R&D investment assuming a path of spending that would result in a doubling of annual federal energy R&D investment as a share of GDP by 2030.[1] This assumed growth in R&D spending is put forward by Breakthrough Energy to demonstrate the potential economic impacts of a specified scenario of expanded federal energy R&D investment, and is not a budgetary projection based on actual appropriations.

To assess these economic impacts, PwC first estimated actual federal energy R&D investment in 2020 of $11.3 billion, or 0.055 percent of GDP.[2] Federal energy R&D investment under the specified scenario is then assumed to grow at a 20 percent nominal annual rate in 2021 and 2022. After 2022, federal energy R&D investment is assumed under this scenario to grow at a 10.09 percent nominal annual rate through 2030. This results in nominal federal energy R&D investment of $35.0 billion in 2030, or 0.113 percent of GDP.[3]

Figure 1, below, illustrates federal R&D investment in the energy sector under this scenario.

Figure 1. Possible Expansion of Federal R&D Investment in the Energy Sector, 2018-2030



Source: National Science Foundation; Congressional Budget Office; PwC calculations.
Notes: Dollar amounts refer to nominal federally funded expenditures for R&D operations, facilities and equipment, excluding federally funded R&D performed in US territories.

[1] For an assessment of the economic impact of all Federal R&D investment and projections under a scenario of increased investment through 2030, see PwC, "Impacts of Federal R&D Investment on the US Economy," September 2020.
[2] The estimate of federal R&D investment in the energy sector in 2020 is based on an estimate of actual investment of $9.5 billion in 2018, and estimated nominal growth of 9.9 percent in 2019 (to $10.5 billion) and 7.4 percent in 2020 (to $11.3 billion) based on estimates and projections of federal R&D outlays according to the National Science Foundation and Congressional Budget Office. See PwC, "Impacts of Federal R&D Investment on the US Economy," September 2020; National Science Foundation, *Survey of Federal Funds for Research and Development: Fiscal Years 2018-19,* Table 2, January 2020, available at https://ncsesdata.nsf.gov/fedfunds/2018/; and Congressional Budget Office, *Spending Projections, by Budget Account*, data that supplement CBO's March 2020 report *Baseline Budget Projections as of March 6, 2020*, available at https://www.cbo.gov/publication/56268.
[3] GDP projections are based on Congressional Budget Office, *An Update to the Economic Outlook: 2020 to 2030*, July 2020, available at https://www.cbo.gov/publication/56465.

Using the IMPLAN modeling system to quantify the short-term economic impacts of this scenario's increase in federal R&D investment through 2030, PwC estimated the direct, indirect, and induced impacts on the US economy in terms of employment, labor income (including wages, salaries and benefits as well as proprietors' income), value added, and tax payments (**Tables 1**, **2**, and **3**).

In 2021 under this scenario of expanded federal energy R&D, federally funded energy-related R&D would directly provide 43,300 jobs for American workers, pay $5.2 billion in wages, salaries and fringe benefits and proprietors' income, and generate $7.4 billion in value added and $1.3 billion in tax payments to federal, state, and local governments. Including direct, indirect, and induced effects from operational and capital spending, federal R&D investment in the energy sector would support 162,800 jobs, $12.9 billion of labor income, $20.6 billion in value added, and $3.5 billion in tax payments in 2021.

In 2030 under this scenario, federally funded energy-related R&D would directly provide 98,900 jobs, pay $13.4 billion in labor income, and generate $19.1 billion in value added and $3.5 billion in tax payments in the United States. Including direct, indirect, and induced effects from operational and capital spending, federal R&D investment in the energy sector would support 372,300 jobs, $33.4 billion of labor income, $53.0 billion in value added, and $9.0 billion in tax payments.

Over the entire period from 2021 to 2030 under this scenario, federal R&D investment in the energy sector would directly contribute 69,800 annual jobs on average, and cumulatively over the 10-year period provide $89.6 billion in labor income, $127.9 billion in value added, and $23.2 billion in tax payments to the national economy. Including direct, indirect, and induced effects, federal R&D investment in the energy sector would support 262,500 annual jobs on average, and cumulatively support $224.4 billion of labor income, $356.4 billion in value added, and $60.7 billion in tax payments over the 10-year period.

"Including direct, indirect, and induced effects, the assumed higher level of federal R&D investment in the energy sector would support 262,500 annual jobs on average, and cumulatively support $224.4 billion of labor income, $356.4 billion in value added, and $60.7 billion in tax payments over 2021-2030."

Table 1. Economic Impacts of Federal Energy-Related R&D on the US Economy with Possible Expansion, 2021

	Direct Impacts	Indirect Impacts	Induced Impacts	Total Impacts
Employment (thousands of jobs)[a]	43.3	43.2	76.4	162.8
Labor Income ($billions)[b]	$5.2	$3.4	$4.4	$12.9
Value Added ($billions)	$7.4	$5.6	$7.6	$20.6
Tax Impact ($billions)[c]	$1.3	$1.1	$1.1	$3.5

Source: PwC calculations using the IMPLAN modeling system (2018 database).
Notes: All dollar amounts are in nominal terms. Nominal federal R&D investment is assumed to increase by 20 percent in 2021 from 2020. Details may not add to totals due to rounding.
[a] Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.
[b] Labor income is defined as wages and salaries and benefits as well as proprietors' income.
[c] Taxes include federal and state and local income and non-income taxes.

Table 2. Economic Impacts of Federal Energy-Related R&D on the US Economy with Possible Expansion, 2030

	Direct Impacts	Indirect Impacts	Induced Impacts	Total Impacts
Employment (thousands of jobs)[a]	98.9	98.7	174.6	372.3
Labor Income ($billions)[b]	$13.4	$8.8	$11.3	$33.4
Value Added ($billions)	$19.1	$14.5	$19.4	$53.0
Tax Impact ($billions)[c]	$3.5	$2.8	$2.8	$9.0

Source: PwC calculations using the IMPLAN modeling system (2018 database).
Notes: All dollar amounts are in nominal terms. Nominal federal R&D investment is assumed to increase by 211 percent in 2030 from 2020. Details may not add to totals due to rounding.
[a] Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.
[b] Labor income is defined as wages and salaries and benefits as well as proprietors' income.
[c] Taxes include federal and state and local income and non-income taxes.

Table 3. Economic Impacts of Federal Energy-Related R&D on the US Economy with Possible Expansion, 2021-2030

	Direct Impacts	Indirect Impacts	Induced Impacts	Total Impacts
Employment (thousands of jobs)[a]: 10-year average	69.8	69.6	123.1	262.5
Labor Income ($billions)[b]	$89.6	$59.1	$75.8	$224.4
Value Added ($billions)	$127.9	$97.6	$130.9	$356.4
Tax Impact ($billions)[c]	$23.2	$18.7	$18.8	$60.7

Source: PwC calculations using the IMPLAN modeling system (2018 database).
Notes: All dollar amounts are in nominal terms. Nominal federal R&D investment is assumed to increase on an annual basis by 20 percent in 2021 and 2022 and by 10.1 percent each year thereafter until 2030. Details may not add to totals due to rounding.
[a] Employment is defined as the number of payroll and self-employed jobs, including part-time jobs.
[b] Labor income is defined as wages and salaries and benefits as well as proprietors' income.
[c] Taxes include federal and state and local income and non-income taxes.

Appendix: Data Sources and Methodology

This Appendix describes the data sources and methodology used to derive the results for this study relating to federal R&D investment in the energy sector and the associated direct, indirect, and induced employment, labor income, value added, and tax impacts.[4]

Estimating Federal R&D Investment in 2018

PwC's estimates of federal R&D investment, consisting of federally funded expenditures for R&D operations, facilities and equipment, primarily rely on data provided by the National Science Foundation (NSF). We exclude from our national estimates R&D performed in the territories.[5]

We then allocate federal R&D investment by sector using NSF data on federal R&D outlays by agency in FY 2018.[6] In particular, health sector R&D is determined using the share of federal R&D outlays reported by the Department of Health and Human Services. Defense sector R&D is based on the share of federal R&D outlays reported by the Department of Defense, while energy sector R&D is based on the share of federal R&D outlays reported by the Department of Energy (DOE), with DOE Office of Science spending by program allocated between the defense and energy sectors as follows.[7] We assume the following three DOE Office of Science programs are entirely energy related: Basic Energy Sciences, Biological and Environmental Research, and Fusion Energy Sciences. We assume the following three DOE Office of Science programs are 94 percent defense related and 6 percent energy related: Advanced Scientific Computing Research, High Energy Physics, and Nuclear Physics.[8] Thus, in total for these six major programs, 60 percent of R&D spending is deemed energy related and 40 percent defense related. We assume the remainder of the DOE Office of Science R&D budget is split in the same proportion, i.e., 60 percent energy and 40 percent defense.

Estimating the Direct, Indirect, and Induced Economic Impacts

We have relied on the IMPLAN national model for 2018 to calculate the economic impacts of federal R&D investment in the energy sector. IMPLAN is a modeling system developed for estimating economic impacts and is similar to the Regional Input-Output Modeling System

[4] For additional description of data sources and general methodology, see PwC, "Impacts of Federal R&D Investment on the US Economy," September 2020.
[5] National Science Foundation, *National Patterns of R&D Resources: 2017-18 Data Update,* NSF 20-307, Tables 6 and 10, January 8, 2020, available at https://www.nsf.gov/statistics/natlpatterns/. NSF notes that "the data for 2018 are estimates and will later be revised." National Science Foundation, *Survey of Federal Funds for Research and Development: Fiscal Years 2018-19,* Table 2, January 2020, available at https://ncsesdata.nsf.gov/fedfunds/2018/. Following guidance from the Office of Management and Budget (OMB), each federal agency identifies operational expenditures for the conduct of R&D as well as capital expenditures for "R&D plant", defined as construction and rehabilitation of R&D facilities and acquisition, design, or production of major movable equipment for use in R&D activities. Office of Management and Budget, "Circular No. A-11: Preparation, Submission, and Execution of the Budget", Section 84, December 2019, available at https://www.whitehouse.gov/wp-content/uploads/2018/06/a11.pdf.
[6] National Science Foundation, *Survey of Federal Funds for Research and Development: Fiscal Years 2018-19,* Tables 4 and 53, January 2020, available at https://ncsesdata.nsf.gov/fedfunds/2018/.
[7] Department of Energy, *FY 2020 Congressional Budget Request: Budget in Brief*, page 42, March 2019, available at https://www.energy.gov/sites/prod/files/2019/03/f60/doe-fy2020-budget-in-brief_0.pdf.
[8] NSF data on federal budget authority for R&D by budget function in FY 2018 indicates that the defense budget function is 94 percent of the sum of the defense and energy budget functions. National Science Foundation, *Federal R&D Funding, by Budget Function: Fiscal Years 2018-20,* NSF 20-305, Table 1, December 4, 2019, available at https://ncses.nsf.gov/pubs/nsf20305/#&.

developed by the US Department of Commerce. The model is primarily based on government data sources.

IMPLAN is built around an "input-output" table that relates the purchases that each industry has made from other industries to the value of the output of each industry. To meet the demand for goods and services from an industry, purchases are made in other industries according to the patterns recorded in the input-output table. These purchases in turn spark still more purchases by the industry's suppliers, and so on. Additionally, employees and business owners make personal purchases out of the additional income that is generated by this process, further increasing demand that ripples through the economy. Multipliers describe these iterations. The Type I multiplier measures the direct and indirect effects of a change in economic activity. It captures the inter-industry effects only, i.e., industries buying from local industries. The Type II (Social Accounting Matrix or SAM) multiplier captures the direct and indirect effects, and, in addition, it also reflects induced effects (i.e., changes in spending from households as income increases or decreases due to the changes in production).

Economic multipliers are often used to measure the overall change in production that would result from a marginal increase in a particular industry. For example, a value added multiplier converts a $1 million increase in output of an industry into the total change in value added throughout the supply chain. For this study, PwC has treated the Scientific Research and Development Services sector in the North American Industrial Classification System (NAICS) as the originating industry, while recognizing the fact that a large number of researchers are also employed directly by the federal government.[9] Through the IMPLAN multipliers for the NAICS R&D sector, PwC has quantified the direct, indirect, and induced impacts of federal energy R&D investment in the 2021 to 2030 period in terms of employment, labor income, value added, and tax payments at the national level.

[9] The Scientific Research and Development Services sector comprises establishments primarily engaged in conducting original investigation to gain new knowledge (research) and creating new or improved products or processes based on research findings or other scientific knowledge (experimental development). Because the activity of research is similar whether it is performed in this sector or by researchers in the federal government, the indirect and induced economic effects are expected to be similar per dollar of direct expenditure.