TAX REFORM AND CLEAN ENERGY R&D

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ACCF
AMERICAN COUNCIL FOR CAPITAL FORMATION
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ABOUT W. DAVID MONTGOMERY

David Montgomery recently retired as Senior Vice President of NERA Economic Consulting. He continues to write and testify on major issues in energy and environmental policy and is a Visiting Fellow at Resources for the Future. He has served as an expert witness in antitrust and pollution liability litigation in Federal courts, testified frequently before committees of the U.S. Congress, and led studies of nearly every major legislative or regulatory proposal affecting energy markets in the past 40 years. Dr. Montgomery also advises clients on business strategy, particularly on how future regulations could impact their business. His work on climate change policy, energy regulation, and energy security has been published frequently in professional journals. Dr. Montgomery has had a particular interest in how to create effective incentives for clean energy R&D. In addition to professional papers and Congressional testimony on the topic, he organized a workshop on the role of R&D in climate policy that resulted in a joint statement by the leading experts on the economics of R&D that was published in *Economists Voice*.

Dr. Montgomery served as Assistant Director of the U.S. Congressional Budget Office and Deputy Assistant Secretary for Policy in the U.S. Department of Energy, and he led the modelling and forecasting activities of the Energy Information Administration in the U.S. Department of Energy. He has a Ph.D. in economics from Harvard University, and taught economics at Caltech and Stanford University, and received the award for a "Publication of Enduring Quality" from the Association of Environmental and Resource Economists for his pioneering work on emission trading.

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EXECUTIVE SUMMARY

The Brady-Ryan tax reform plan proposed last summer would decrease taxes on corporate profits and investment income, while preserving the existing credits for research and development (R&D). Since energy R&D is a critical component of R&D activity, now is the time to rethink the framework for national energy R&D. Energy R&D is particularly important for the development of advanced and cost-effective clean energy technologies, defined as technologies that could reduce emissions of greenhouse gases and criteria pollutants. Such technologies could include renewables, nuclear power, improvements in energy efficiency, carbon capture and sequestration, and natural gas as a substitute for more carbon-intensive fuels. Tax reform would provide a substantially better climate for private sector research, development, demonstration and commercialization of new energy technologies.

Tax reform would improve the investment climate in at least three direct ways:

- Lower tax rates and immediate expensing would increase the after-tax rate of return on all investments.

- A territorial tax system would make the U.S. a more attractive location for investment relative to other countries, in particular for conducting R&D on technologies to be deployed in the U.S.

- The combination of lower rates and elimination of the interest deduction would correct a bias against equity financing, which is most suitable for companies engaging in clean energy technology development and commercialization.

Several indirect effects of tax reform might further benefit investment in R&D and deployment of clean energy technologies:

- Higher rates of investment across the board would speed the adoption of new technologies, including clean energy technologies, and lower tax rates on returns to investment would improve the economics of replacing older equipment.

- Lower tax rates, border adjustments, and freeing up of retained earnings of foreign affiliates of U.S. companies would lead to an increased flow of capital into the U.S. from abroad. These increased capital flows would be available for investment in R&D and clean energy as well as other applications.

- Elimination of the interest deduction would very likely doom loan guarantees, thus allowing more funds to flow to clean energy technologies making them better able to survive in the marketplace.

Some aspects of tax reform may by themselves be less favorable to clean energy. Although lower tax rates diminish the value of expensing over normal depreciation and extending expensing to all investment would remove a tax preference now available only to R&D, those potentially negative effects of tax reform cannot be as large as the direct positive effects of lower rates.

Eliminating production tax credits for wind and investment tax credits for solar would also diminish preferences given those fuels over other clean fuels and fossil fuels. However, these changes would be accompanied by elimination of tax incentives for oil and gas production and for the coal industry that have often been cited as the reason for extending special tax treatment to renewables. Moreover, except for some small credits for clean coal technology, existing tax credits do not benefit other forms of clean energy. By eliminating fossil energy subsidies, improving after-tax returns on investment and eliminating disincentives to U.S. technology development, tax reform should stimulate more business R&D and clean energy investment.

The Brady-Ryan proposal used a border adjustment to achieve a territorial tax system in which income is taxed where goods and services are sold, but that provision now appears unlikely to survive in any bill that passes the Senate. Eliminating the border adjustment would make it more difficult to eliminate the incentive to locate R&D and intellectual property in the jurisdictions with the lowest tax rates. Whether eliminating the border adjustment would favor investment in clean energy, renewables or technologies such as carbon capture and storage is difficult to say. The border adjustment would increase the price of imported oil but it could also increase the cost of imported equipment, including solar arrays and wind generators, so that the net effect is ambiguous.

HOW CLEAN ENERGY DEVELOPMENT COULD BE INCENTIVIZED

Achieving proposed goals for global greenhouse gas emissions will require massive investment worldwide in new, low-carbon energy. Unless new and better clean energy technologies are developed, most of those goals will be prohibitively expensive to achieve. To deploy clean energy technologies that are currently cost-effective, or that could become cost-effective under politically achievable policies, would require higher levels of investment. Thus there are good reasons to examine additional incentives for development and deployment of clean energy technology. These incentives could take several forms.

R&D INCENTIVES

R&D receives special treatment under current tax law, due to the recognition that R&D investments provide spillover benefits that cannot be captured fully by their investors. This is the traditional rationale for R&D incentives, and it is even more relevant for clean energy R&D that has additional social benefits of reducing greenhouse gas emissions and various forms of air pollution.[1] Although the U.S. has very strong regulations on criteria air pollutants and air toxics, policies that would create incentives to reduce greenhouse gas emissions continue to be uncertain and unstable.

Current tax incentives for R&D include the Research and Experimentation (R&E) tax credit and expensing. If the current tax incentive is maintained, lower rates combined with continuation of the R&E credit and expensing would substantially improve the after-tax rate of return on R&D. With existing incentives, business R&D has grown slowly as a share of GDP. Clean energy R&D has been flat or declining. Without tax reform, the situation is likely to become worse, since countries that offer preferential rates for intellectual property (IP) income are planning to require a nexus between domestic R&D and IP to obtain preferential rates.

Border adjustments as proposed in the Brady-Ryan plan would eliminate this threat. By eliminating taxes on exports, the border adjustment would make U.S. IP and new technology competitive in any of those countries. Border adjustment would pre-empt the efforts of other countries to attract U.S. companies doing R&D and clean energy development by means of patent boxes or other tax preferences. Even if other countries also make patent and other technology revenue tax-free, the loss of deductibility of imports would keep IP and technology produced in the U.S. competitive.

If border adjustments are not included in tax reform, it might be necessary to rely more heavily on targeted innovation incentives such as patent boxes to make America more competitive with other countries with R&D incentives.

To achieve further increases in R&D spending additional incentives might be required. Both efforts and results-based tax incentives have been used to stimulate R&D. Tax credits and expensing are the effort incentives, lowering the after-tax cost of R&D, and they can range up to more than 100% of qualified expenditures (a "super credit").

The current R&D tax credit is 20% of incremental Qualified Research Expenditure (QRE) over a base determined by the ratio of R&D spending to total revenue in some base years.

Under current law, taxpayers may also claim a special energy tax credit equal to 20% of portion of payments to certain entities for energy research. By expanding eligibility for the credit to include energy R&D performed within a company and increasing the rate, this credit could offset expected cuts in Department of Energy and national laboratory budgets. This would likely be a more efficient expenditure in stimulating R&D because the efforts would be driven by the private sector.

A results incentive that is used in other countries is a patent box — meaning lower or zero tax rates for income from intellectual property. This incentive increases the after-tax returns from successful R&D, and could be limited to specific types of IP or industries.

There are many details that would need to be worked out to make increased credits or a patent box effective. One way to increase R&D incentives would be to make the credit refundable and applied to 100% of qualified R&E expenses (not just increases).

[1] *See, e.g., Kenneth Arrow, ''Economic Welfare and the Allocation of Resources for Invention,'' in The Rate and Direction of Inventive Activity: Economic and Social Factors 609 (1962).*

To stimulate additional basic research that could contribute to new energy technologies, the tax credit for university-based and cooperative research could be increased, or even turned into a super credit.

CLEAN ENERGY INVESTMENT INCENTIVES

Energy tax credits or a variant of the patent box could be expanded to include all investments in clean energy or based on new clean energy technology, but that preference would likely run afoul of the basic principles behind the current tax reform plan. Current tax credits for renewables could be expanded to other investments that reduce greenhouse gas emissions, and the size of the credits could be tied to their relative effectiveness in reducing those emissions. This is particularly important because existing tax incentives apply only to renewables, but natural gas, nuclear power, carbon capture and sequestration and energy efficiency could all lower CO2 emissions relative to current uses of petroleum and coal.

As in the patent box idea, preferential income tax rates could also be applied to the income from application of clean energy technologies, with the magnitude of tax reductions tied to relative performance in reducing emissions. This approach would be superior to tax credits in that it would only reward successful projects and would favor those that are most profitable. However, with lower tax rates overall, the magnitude of the subsidy would be limited to taxes due under normal rates.

In order to create a level playing field for clean energy investments, it is important that tax credits or lower tax be differentiated based on the emission reductions per unit of energy achievable by different types of investment. For investments in what are deemed to be zero-carbon technologies, this calculation would be simple – since tax-writers would only need to specify the lower rate or higher credit for zero-carbon technology investments. The full corporate tax rate and zero credit would apply to investments that do not fall in any clean energy category. But to determine what rate should apply to natural gas or clean coal or energy efficiency investments requires defining a baseline or standard of comparison. Should clean coal be credited with reducing emissions from a coal-fired powerplant with the best current technology or with reducing emissions from the fleet average or from the level of a new natural gas combined cycle unit? What heat rate should be chosen as the baseline for improvements in natural gas technology? All these questions would need to be answered in designing either tax credits or lower tax rates that put all clean energy investments on a level playing field in terms of greenhouse emission reductions.

Either of these approaches would invite controversies over defining clean energy investment and picking winners in clean energy technology. They would also build special preferences back into the tax code, with all the accompanying complexities of definitions and potential for tax avoidance or fraud, contrary to the basic purpose of tax reform.

INTRODUCTION

Research and development are the first steps in the process of technological innovation, and the discoveries made through R&D provide benefits throughout the economy. As a result, R&D is encouraged by policies that include patents and other forms of protection for intellectual property (IP), tax incentives and direct government funding. Qualified R&D expenditures may be expensed under current U.S. tax law and additionally increases in expenditures over past levels qualifies for an R&D tax credit. Current tax law also gives additional incentives for clean energy R&D, in the form of larger credits for funding of R&D at universities and other specified organizations doing energy research.

PROPOSALS FOR TAX REFORM

The tax reforms proposed by Speaker Ryan and Chairman Brady are designed to increase incentives for investment in the United States, by reducing tax rates on both corporate profits and on individual investment income. Since R&D is a form of investment, these rate reductions would increase the rewards from R&D and therefore tend to stimulate additional R&D. At the same time, the increase in all other forms of investment would bring new technologies into use faster.

The Brady-Ryan plan would retain the current R&D tax credit, and by making all credits refundable it would allow even startup firms with little or no other tax liability to gain the full benefits of the credit. It is unclear whether the special energy R&D credit would be retained.

The Brady-Ryan plan would also eliminate depreciation schedules and allow all investments to be expensed immediately, rather than being depreciated over varying periods of years. As a result, R&D would lose an advantage over other investments that it has under current law when expensing is extended to all investment.

The Brady-Ryan plan includes a border adjustment that would exempt all income from exports from tax and deny a deduction for purchases of imports. This would in particular apply to sales of intellectual property to foreign affiliates or other buyers (no tax) and purchases of intellectual property from foreign affiliates or other buyers (no deduction). This provision would encourage filing of patents and transferring IP to U.S. segments of global companies, and eliminate a threat that generally lower taxes or special incentives for R&D conducted in other countries that would erode R&D activity in the U.S.

Finally, the Brady-Ryan plan removes obstacles that limit access of U.S. companies to retained earnings in overseas affiliates by imposing a small one-time tax and exempting future repatriation from tax. This could increase the availability of funds to domestic corporations and possibly increase investment.

The White House announced its approach to tax reform on April 26, 2017, describing a series of tax cuts for individuals and businesses variously estimated to be a net $4 trillion tax cut by 2027. Broadly, the White House approach contained many of the same elements as the Brady-Ryan plan, but without its specificity and without its effort to broaden the base sufficiently to remain neutral. While the White House announced support for a territorial system, it has never endorsed the border adjustment by which the House plan would create such a system. On the business side, the White House supported lowering the business rate to 15% and creation of a territorial tax system that allows U.S. firms to repatriate profits from overseas affiliates without incurring tax liability.[2]

On July 27, 2017 the White House, House and Senate Republican leadership released a joint statement about how they would move forward on tax reform. They announced agreement on "a plan that reduces tax rates as much as possible, allows unprecedented capital expensing, places a priority on permanence, and creates a system that encourages American companies to bring back jobs and profits trapped overseas." At the same time, they stated that they would not pursue the border adjustment or a destination-based cash-flow tax, and would replace it with "a viable approach for ensuring a level playing field between American and foreign companies and workers, while protecting American jobs and the U.S. tax base."[3]

Although there have been many proposals for a territorial tax system that would solve the problem of U.S. firms investing the retained earnings of foreign affiliates

[2] *https://www.whitehouse.gov/the-press-office/2017/04/26/briefing-secretary-treasury-steven-mnuchin-and-director-national*
[3] *https://www.whitehouse.gov/the-press-office/2017/07/27/joint-statement-tax-reform*

overseas to avoid U.S. taxation, there is also agreement that it is considerably more difficult to deal with the problem of locating R&D and intellectual property overseas without something like a border adjustment to police transfer pricing of IP.

POSSIBLE TAX INCENTIVES FOR R&D

With current tax incentives and market demand, clean energy R&D has maintained its share of GDP but clean energy investment has fallen. Thus the question arises of whether there are ways to increase the incentives for clean energy R&D and investment that would be compatible with the overall objectives of the tax reform plan.

Three types of tax incentives are now in use in different countries. They are referred to as credits, super credits, and patent boxes. A good case can be made for increasing the R&D tax credit across the board and for creating a patent box for energy. First, I review the different incentive mechanisms, then discuss their relative merits.

CREDITS

The credit allows the taxpayer to take some fraction of eligible expenses as a credit against its tax liability. The complexity in design of credit comes in the definition of eligible expenses. U.S. tax law recognizes four different ways of calculating the credit, but the basic intention is to reward increases in R&D activity over what it would have been without the credit. This credit could be increased to make up for the diminished relative preference in the tax code, or its administration by the IRS could be simplified to increase its effectiveness.

SUPER CREDITS

Super credits are just the same as ordinary credits except that the credit can be greater than 100% of eligible expenditures. The danger like all cost-plus arrangements is that a firm could waste money on perfectly useless research and still end up with more money in its pocket than it would by doing nothing. However, super credits could be effective and justified in the case of collaborative research with universities or in industry consortia.

PATENT BOXES

Revenue or profits from intellectual property in specified forms is taxed at lower rates than other business income. This could include royalties, licensing fees, sale of good or services embodying IP (e.g. software) that is the product of R&D. There is an expectation that countries providing patent boxes would insist that there be a nexus between the intellectual property and R&D conducted within the taxing jurisdiction.

PROS AND CONS

The R&D tax credit was only made permanent in 2015 so that there is little experience on which to base any conclusions about its effectiveness. Calculations of the credit are complex, and it applies only to increases in R&D spending over some base period. This design was intended to avoid windfalls to established businesses already doing R&D on a large scale, but its complexity and failure to reward continuation of past efforts diminish its effectiveness. Its definitions have led to efforts to reclassify many existing expenditures as R&D and therefore also to counterproductive disputes with the IRS over what constitutes R&D.

The special energy credit applies to 100% of eligible R&D spending, but where that spending may take place is highly restricted, with in-house R&D projects ineligible. This provision simplifies administration of the credit, eliminating controversies that have plagued the general R&D credit and new ones about whether the R&D has advancement of qualified energy technologies as its purpose. It certainly limits revenue loss, but at levels of private energy R&D investment estimated later in this study, including in-house research would entail less than $1 billion total revenue loss for the special energy credit.

The super credit would magnify all the problems of the credit, and seems to be more of a device for international tax competition than for stimulating R&D.

The patent box has the attraction that it is based on output rather than input. That is, rather than sharing the cost of R&D whether successful or not, it increases the reward for successful R&D by lowering taxes on the sale of resulting intellectual property. All the problems of defining R&D expenditures and avoiding windfalls could go away, but would be replaced with the issues of nexus of patents to R&D and how to incentivize IP developed and used within one firm without licensing or otherwise selling IP to others.

PROPOSED TAX REFORMS

Since House Speaker Paul Ryan and Ways and Means Committee Chairman Kevin Brady released their Blueprint for comprehensive tax reform in August 2016, it has provided a framework for action on tax reform in the Trump Administration. The Blueprint is designed to increase incentives for investment in the United States and to eliminate provisions in the tax code that drive businesses to shift profits and manufacturing to other countries.

The Brady-Ryan tax plan has 12 key provisions:

BUSINESS

- Lower the corporate income tax rate from 35 percent to 20 percent
- Allow immediate expensing of all investment
- Eliminate the interest deduction for businesses
- Institute Border Adjustments, by allowing no deductions for cost of imported goods or services and exempting export income from taxation

PERSONAL

- Consolidate personal income tax brackets and reduce the higher rate in each bracket
- Increase the income level at which no taxes are due
- Eliminate the Alternative Minimum Tax and Estate Tax
- Tax investment income at 50% of the applicable personal tax rate

REPATRIATION

- Impose a once-for-all tax on accumulated foreign earnings at a rate of 8.75% on cash holdings and 3.5% on other holdings
- Exclude all dividends from foreign subsidiaries from taxable income going forward

TAX CREDITS

- Eliminate all business tax preferences (credits, accelerated depreciation, depletion) except
    - Retain the current Research and Experimentation (R&E) tax credit
    - Make all excess deductions and unused tax credits deferrable with interest

As this is written, it is not entirely clear whether the House leadership would use Budget Reconciliation to pass tax reform with a simple majority or attempt to negotiate with moderate Democrats to create a bill that could attract 60 votes in the Senate. It is also unclear how the Senate Republican leadership might decide to alter the House plan.

The Brady-Ryan plan is designed from the outset to qualify for passage under Budget Reconciliation. That requires in particular that the plan be revenue-neutral after the 10-year budget window. The House uses dynamic scoring, which means taking into account the other increases in tax revenue that would accrue if the Plan is found to stimulate faster economic growth. Even with dynamic scoring, the rate reduction parts of the plan clearly reduce revenue, which is made up from repatriation taxes and the elimination of deductions for interest and cost of imported goods and services. All of these features have some relevance for the impact of the plan on private-sector R&D spending.

On April 26, 2017 the White House started to lay out its proposals for tax reform in a one-page description. It proposes both a territorial tax system and a one-time tax on retained earning of foreign affiliates of U.S. corporations, lowers the business tax rate to 15% and consolidates personal tax brackets with lower rates in each. The brief description does not mention deductibility of interest or lower tax rates on personal income from investment that are included in the Brady-Ryan plan. At present, there are not enough details on the White House plan to draw any strong conclusions about how its effects might differ from those of the Brady-Ryan plan.

CLEAN ENERGY INVESTMENT AND R&D UNDER CURRENT TAX LAW

Clean energy investment receives substantial subsidies from tax expenditures under current law. In 2015, Congress passed a pair of tax and spending bills that extended wind and solar credits. Under the legislation, the 30 percent Investment Tax Credit for solar was extended for three years, after which it will ramp down incrementally through 2021, and remain at 10 percent permanently beginning in 2022.

The 2.3-cent Production Tax Credit (PTC) for wind was also extended through 2016. Projects that begin construction in 2017 will see a 20 percent reduction in the incentive. The PTC will then drop 20 percent each year through 2020.

It is expected that tax reform would allow the solar and wind credits to wind down as scheduled, and the proposal to eliminate all current special tax preferences suggests that the permanent 10% solar credit would be eliminated along with all other tax subsidies.

According to a 2015 study by the Energy Information Administration (EIA), renewables benefited from $5.5 billion in tax expenditures in 2013, most coming from the Solar Investment Credit and the Wind Production Tax Credit. Biofuels received an additional tax benefit of $1.7 billion in the form of exemption from fuel excise taxes, which would not be affected directly by tax reform.

Tax expenditures for the benefit of investments in Smart-Grid, energy conservation, and other end-use efficiency investments totaled an additional $2.8 billion, for total clean energy tax expenditures of $10 billion in 2013. In addition, nuclear power received $1.1 billion in tax expenditures, entirely for decommissioning.

At the same time, tax reform would likely end tax expenditures for coal, oil and gas. Although frequently cited by proponents of additional tax incentives for clean energy, fossil fuel subsidies are declining and are dwarfed by renewable and conservation/end use subsidies. According to EIA, "Total subsidies for natural gas and petroleum liquids declined 20% from $2.7 billion in FY 2010 to $2.2 billion in FY 2013 (see **Figure 1**)." Tax incentives for oil and gas production primarily take the form of special depreciation rules that would disappear when expensing is extended to all forms of investment, including clean energy investments that now receive their own special tax incentives. EIA estimated that "Tax expenditures related to the excess of percentage over cost depletion for wells declined from $1 billion to $530 million between FY 2010 and FY 2013. However, expensing of exploration and development costs rose from $422 million to $550 million over the same period, likely reflecting increased domestic drilling activities."[4]

Coal tax expenditures are also substantial, though they for the most part cover environmental and labor cost and likely have little effect on the demand for coal in electricity generation.

Figure 1 of the EIA report reproduced below provides more detail on tax expenditures and other subsidies, and compares 2010 and 2013 levels of subsidies. **Figure 2** provides more detail on the activities that receive tax benefits. **Figure 3** provides additional details on tax expenditures benefiting renewables.

FIGURE 1: EIA ESTIMATES OF ENERGY SUBSIDIES: QUANTIFIED ENERGY-SPECIFIC SUBSIDIES AND SUPPORT BY TYPE, FY 2010 AND FY 2013 (MILLION 2013 DOLLARS)

BENEFICIARY	DIRECT EXPENDITURES	TAX EXPENDITURES	RESEARCH & DEVELOPMENT	DOE LOAN GUARANTEE PROGRAM	FEDERAL & RUS ELECTRICITY	TOTAL	ARRA RELATED
2013							
Coal	74	769	202	-	30	1,075	129
Refined coal	-	10	-	-	-	10	-
Natural Gas and Petroleum Liquids	62	2,250	34	-	-	2,346	4
Nuclear	37	1,109	406	-	109	1,660	29
Renewables	8,363	5,453	1,051	-	176	15,043	8,603
Biomass	332	46	251	-	-	629	369
Geothermal	312	31	2	-	-	345	312
Hydropower	197	17	10	-	171	395	216
Solar	2,969	2,076	284	-	-	5,328	3,137
Wind	4,274	1,614	49	-	-	5,936	4,334
Other	209	-	380	-	5	594	229
Subtotal	8,291	3,783	977	-	176	13,227	8,597
Renewables Electric							
Biofuels	72	1,670	74	-	-	1,816	6
Electricity - Smart Grid and Transmission	8	211	831	-	134	1,184	780
Conservation	833	630	501	-	-	1,964	1,574
End Use	3,513	1,997	466	-	-	5,976	2,046
LIHEAP	3,116	-	-	-	-	3,116	-
Other	397	1,997	466	-	-	2,860	2,046
Total	12,891	12,428	3,491	-	449	29,258	13,166
2010							
Coal	46	485	307	-	100	937	74
Refined coal	-	179	-	-	-	179	-
Natural Gas and Petroleum Liquids	80	2,752	9	-	77	2,918	0
Nuclear	66	957	446	279	144	1,893	33
Renewables	5,491	8,539	1,140	284	189	15,642	5,530
Biomass	178	551	301	-	-	1,030	246
Geothermal	65	1	2	13	-	81	64
Hydropower	60	18	11	-	181	270	79
Solar	461	126	320	182	-	1,090	628
Wind	4,063	1,241	58	90	1	5,453	4,105
Other	317	-	368	-	7	691	342
Subtotal	5,143	1,938	1,061	284	189	8,614	5,465
Renewables Electric							
Biofuels	348	6,601	79	-	-	7,028	65
Electricity - Smart Grid and Transmission	4	61	534	21	213	833	486
Conservation	3,091	3,364	610	4	-	7,069	6,375
End Use	6,001	1,011	427	1,066	-	8,505	1,126
LIHEAP	5,378	-	-	-	-	5,378	
Other	623	1,011	427	1,066	-	3,127	1,126
Total	**14,779**	**17,348**	**3,473**	**1,656**	**723**	**37,979**	**13,624**

Source: "Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2013," Table ES2, U.S. Energy Information Administration, March 2015, https://www.eia.gov/analysis/requests/subsidy/

FIGURE 2: EIA ESTIMATES OF ENERGY-SPECIFIC TAX EXPENDITURES, FY 2010 AND FY 2013 (MILLION 2013 DOLLARS)

TAX PROVISION	FY 2010	FY 2013
Energy Investment Credit	137	1,950
Energy Production Credit	1,624	1,670
Biodiesel Producer Tax Credit	517	1,600
Nuclear Decommissioning	949	1,100
Credit for Residential Energy Efficient Property	232	960
Credit for Energy Efficiency Improvements to Existing Homes	3,364	610
Temporary 50-Percent Expensing for Equipment used in the Refining of Liquid Fuels	801	600
Expensing of Exploration and Development Costs	422	550
Excess of Percentage over Cost Depletion	1,033	530
Amortization of Certain Pollution Control Facilities	105	400
Alternative Fuel and Fuel Mixture Credit	179	350
Exclusion from Income of Conservation Subsidies Provided by Public Utilities	232	340
Tax Credit and Deduction for Clean-Burning Vehicles	264	270
Advanced Energy Manufacturing Facility Investment Tax Credit	190	210
Transmission Property Treated as Fifteen-Year Property	105	200
Credit for Investment in Clean Coal Facilities	253	180
Credit for Construction of New Energy Efficient Homes	21	150
Credit for Energy Efficient Appliances	158	150
Natural Gas Distribution Pipelines being Treated as 15-Year Property	127	100
Amortize All Geological and Geophysical Expenditures over 2 Years	158	100
Capital Gains Treatment of Royalties on Coal	53	90
Credit for Holding Clean Renewable Energy Bondsb	74	70
Allowance for the Deduction of Certain Energy Efficient Commercial Building Property	63	70
Alcohol Fuel Credits	74	40
Exclusion of Special Benefits for Disabled Coal Miners	41	30
Partial Expensing for Advanced Mine Safety Equipment	3	27
Exception from Passive Loss Limitation for Working Interests in Oil and Gas Properties	32	20
Qualified Energy Conservation Bonds	0	20
Biodiesel and Small Agri-Biodiesel Producer Tax Credits	21	20
Alternative Fuel Production Credit	179	10
Alcohol Fuel Exemption	5,989	10
Mine Rescue Training Credit	-	1
Deferral of Gain from Disposition of Transmission Property to Implement FERC Restructuring Policy	-53	-
Credit for Production from Advanced Nuclear Power Facilities	-	-
Expensing of Capital Goods with Respect to Complying with EPA Sulfur Regulations	-	-
5-Year Net Operating Loss Carryover for Electric Transmission Equipment	-	-
Total	**17,348**	**12,428**

Source: "Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2013," Table 1, p. 10, U.S. Energy Information Administration, March 2015, https://www.eia.gov/analysis/requests/subsidy/pdf/subsidy.pdf

FIGURE 3: EIA ESTIMATES OF RENEWABLE-RELATED ENERGY SPECIFIC TAX EXPENDITURES, FY 2010 AND FY 2013 (MILLION 2013 DOLLARS)

TAX PROVISION	FY 2010	FY 2013
Energy Investment Credit	137	1,950
Energy Production Credit	1,595	1,630
Biodiesel Producer Tax Credit	517	1,600
Advanced Energy Manufacturing Facility Investment Tax Credit	132	133
Credit for Holding Clean Renewable Energy Bonds	74	70
Alcohol Fuel Credits	74	40
Biodiesel and Small Agri-Biodiesel Producer Tax Credits	21	20
Alcohol Fuel Exemption	5,989	10
Alternative Fuel Production Credit	-	-
Total	**8,539**	**5,453**

Source: "Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2013," Table 3, p. 16, U.S. Energy Information Administration, March 2015, https://www.eia.gov/analysis/requests/subsidy/pdf/subsidy.pdf

CLEAN ENERGY INVESTMENT

The most recent detailed data on actual clean energy investment in the USA is contained in the World Energy Investment Outlook published by the International Energy Agency in 2014.[5]

The IEA estimates that between 2000 and 2013 investment in fossil fuel production averaged $108 billion per year, and investment in fossil fueled power generation averaged $19 billion (See **Figure 4**). In the same period, investment in renewable electricity generation averaged $16 billion and biofuels averaged $5 billion. Energy efficiency investments averaged $40 billion, covering industry, transportation and buildings.

The IEA also projected that average annual investments between 2014-2020 would be much larger, with renewable electricity investments growing to $31 billion per year and energy efficiency investments to $59 billion annually. Biofuels investment was projected to remain flat at $3 billion.

A study performed by Bloomberg for the United Nations in 2017 estimated higher levels of U.S. investment in renewable energy, between $35B and $49B from 2011 – 2015, and down to $46.4B in 2016 (see **Figure 5**). Bloomberg did not include clean coal technology, energy efficiency or nuclear in its study.[6]

Bloomberg also broke down the sources of finance for renewable investment, which is relevant to the effects of tax reform. Their study found that most clean energy investment is financed through "asset finance," which is a generic term for sources of funds for utility scale solar and wind projects, so that the actual composition of financing (equity, debt, retained earnings) for these projects is unclear.

Venture capital and private equity finance for renewables was estimated at $2.3 billion, while share issues for specialist companies on public markets dropped

[5] *IEA Special Report: WORLD ENERGY INVESTMENT OUTLOOK 2014https://www.iea.org/publications/freepublications/publication/WEIO2014.pdf*

[6] *Frankfurt School-UNEP Centre/BNEF. 2017. Global Trends in Renewable Energy Investment 2017, http://fs-unep-centre.org/publications/global-trends-renewable-energy-investment-2017*

FIGURE 4: IEA PROJECTIONS OF ENERGY INVESTMENT, UNITED STATES

	AVERAGE ANNUAL INVESTMENTS					CUMULATIVE INVESTMENTS	
	HISTORICAL	NEW POLICIES SCENARIO				NPS	450
	2000-13	2014-20	2021-25	2026-30	2031-35	2014-35	2014-35
ENERGY SUPPLY (BILLION, YEAR-2012 US DOLLARS)							
Total	**188**	**283**	**263**	**273**	**270**	**6012**	**6468**
Oil	53	114	105	104	84	2260	1903
Upstream	41	98	95	95	77	2021	1683
Transport	5	5	2	0	0	46	45
Refining	7	11	7	9	7	193	176
Gas	49	66	69	65	73	1500	1261
Upstream	35	45	49	45	54	1057	863
Transport	14	21	20	20	19	443	398
Coal	6	6	5	4	4	102	65
Mining	4	4	4	4	4	89	52
Transport	2	1	0	0	0	14	13
Power	75	94	82	95	101	2052	2968
Fossil fuels 19	19	16	14	19	20	373	705
Of which: Coal	4	5	5	12	12	185	472
Of which: Gas	15	10	10	7	7	183	230
Nuclear	0	5	2	4	5	90	180
Renewables	16	31	32	38	41	771	1344
Of which: Bioenergy	2	8	8	6	6	143	192
Of which: Hydro	1	8	2	3	4	57	71
Of which: Wind	9	8	8	18	18	292	514
Of which: Solar PV	4	9	9	9	11	212	286
Transmission	12	13	10	11	12	254	235
Distribution	28	29	24	24	24	564	503
Biofuels	5	3	3	5	7	98	270

ENERGY EFFICIENCY (BILLION, YEAR-2012 US DOLLARS)						
Total	**40**	**59**	**72**	**79**	**1331**	**1930**
Industry	2	3	4	4	70	140
Energy intensive	1	2	2	2	35	68
Non-energy intensive	1	1	2	2	35	73
Transport	20	33	44	51	778	904
Road	18	31	40	46	710	816
Aviation, navigation and rail	2	3	4	5	69	88
Buildings	18	23	24	25	483	886

Source: IEA Special Report: WORLD ENERGY INVESTMENT OUTLOOK 2014, p. 165. https://www.iea.org/publications/freepublications/publication/WEIO2014.pdf

FIGURE 5: RENEWABLE ENERGY INVESTMENT IN THE U.S. BY SECTOR AND TYPE, 2016

	ASSET FINANCE	RE-INVESTED EQUITY	SDC	PUBLIC MARKETS	VC/PE	CORP R&D	GOV &D	TOTAL
Solar	14.7	-0.8	13.1	0.2	1.7	0.3	0.1	29.3
Wind	14.7	-0.6	-	1.1	0.2	0.0	0.1	15.5
Biofuels	0.1	-	-	0.0	0.3	0.1	0.6	1.0
Geothermal		-	-			0.0	0.1	0.1
Biomass & w.t.e	0.2	-	-		0.1	0.0	0.1	0.4
Small Hydro	0.1	-	-		0.0	0.0	0.0	0.1
Marine		-	-	0.0	0.0	0.0	0.0	0.1
Total	**29.8**	**-1.5**	**13.1**	**1.3**	**2.3**	**0.5**	**1.0**	**46.4**

Source: Frankfurt School-UNEP Centre/BNEF. 2017. Global Trends in Renewable Energy Investment 2017, p. 24, Figure 15, http://fs-unep-centre.org/sites/default/files/publications/globaltrendsinrenewableenergyinvestment2017.pdf

from $9.7 billion in 2015 to $1.3 billion in 2016. Neither is included by Bloomberg in "asset finance."

Bloomberg attributed the level of renewable power plant investment to the availability of tax credits:

"The five-year extension to the Production Tax Credit for wind and the Investment Tax Credit for solar, agreed unexpectedly in Congress in December 2015, underpinned investor interest in US renewables throughout last year – although its long duration also meant that some developers decided to take their time before pressing ahead with new projects."[7]

The Energy Information Administration's 2017 Annual Energy Outlook projects steady increases in production of both renewables and natural gas through 2020, with the rate of growth in renewable energy slowing significantly when the solar and wind tax credits expire (see **Figure 6**)

EIA credits the near term growth spurt in renewables to the extended tax credits for wind and solar and the Clean Power Plan (see **Figure 7**). Wind capacity additions cease after expiration of the credit, but EIA projects that continued cost reductions and its availability during peak periods would make solar capacity continue to grow.

According to EIA, "The Clean Power Plan (CPP) and state-defined Renewable Portfolio Standards (RPS) increase demand for wind and solar electricity generation throughout the projection period. The scheduled expiration of production tax credits encourages an increase in wind capacity additions ahead of CPP implementation. While many wind projects would be economic without the tax credits, most of the profitable wind capacity will be added to take advantage of the tax credits prior to their expiration. Substantial cost reductions, performance improvements, and a permanent 10% investment tax credit (ITC) support solar generation growth throughout the projection period."[8]

Even with the permanent solar credit, optimistic cost assumptions and the Clean Power Plan , new capacity additions would be split evenly between solar and natural gas (see **Figure 8**). If the permanent 10% solar tax credit were eliminated by tax reform and the Clean Power Plan rescinded, the outlook for both wind and solar would be less favorable. The burst of wind capacity expansion in 2023 is strongly influenced by CPP requirements and the expiring tax credit, and solar expansion thereafter depends on the permanent 10% ITC. Therefore, projected growth in renewables could be slowed significantly by the combination of tax and regulatory reform.

[7] *Ibid. pp. 23-24.*
[8] *EIA AEO 2017 p. 78*

R&D

Two provisions of current tax law provide subsidies for business R&D: businesses may expense 100% of Qualified Research Expenditure and they are eligible for a Research and Expenditure tax credit which has been permanent since 2015. The R&E tax credit has three components, a credit based on QRE, a basic research credit, and an energy research credit. Excess deductions and unused credits are non-refundable, except for certain small businesses.

Research on tax incentives and investment suggests that an R&D tax credit increases business R&D investment by one dollar for each dollar of revenue loss, so that it is at least as cost-effective as direct government funding, even before taking into account the benefits of private sector determination of the direction of research and management of the R&D process.[9]

QUALIFIED RESEARCH EXPENDITURE

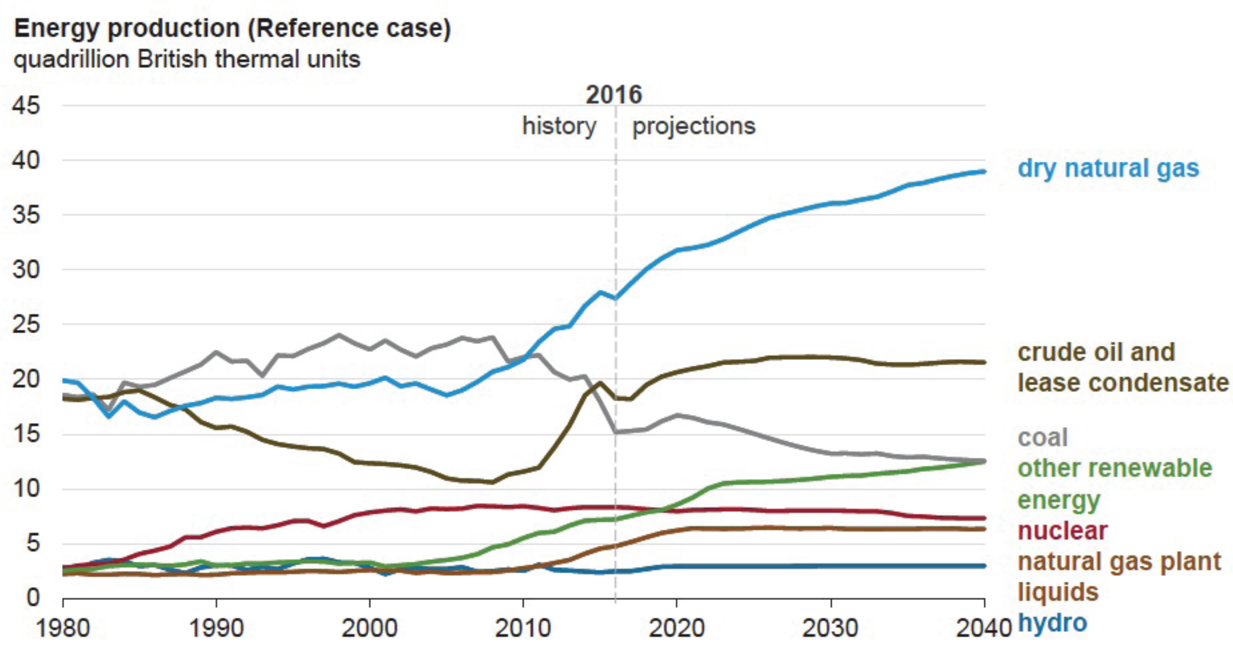
Both expensing and the credit apply to QREs. The definition of QRE is not obvious and has led to protracted disputes between taxpayers and the IRS.

INCREMENTAL R&E CREDIT

The QRE credit is designed to be incremental, and can be calculated in a regular or a simplified version. The incremental calculations are intended to reduce windfalls by approximating the amount of QRE that would occur without the credit. The regular credit is equal to 20% of a firm's QREs above a base amount, and the alternative simplified credit (ASC) is equal to 14% of QREs above 50% of its QRE's in the previous three years. The marginal effective rate for the regular credit is 13%, owing to the rule that any deduction of research expenditures under Section 174 must be reduced by the amount of the credit.

FIGURE 6: EIA ENERGY SUPPLY PROJECTIONS

U.S. ENERGY PRODUCTION CONTINUES TO INCREASE IN THE REFERENCE CASE—

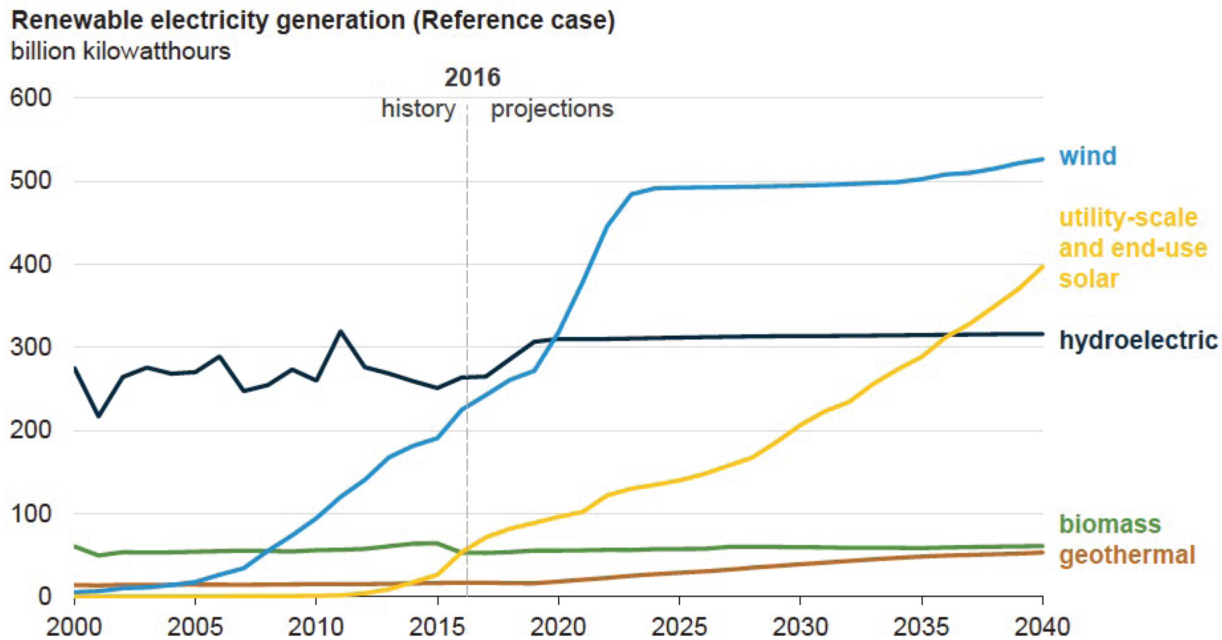


Source: U.S. Energy Information Administration, Annual Energy Outlook 2017, p. 14, https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf

[9] *Bronwyn H. Hall, Effectiveness of Research and Experimentation Tax Credits: Critical Literature Review and Research Design, report for Office of Technology Assessment, June 15, 1995, pp. 11-13, available athttp://emlab.berkeley.edu/~bhhall/papers/BHH95%20OTArtax.pdf.*

FIGURE 7: EIA RENEWABLES PROJECTIONS

WIND AND SOLAR GENERATION BECOME THE PREDOMINANT SOURCES OF RENEWABLE GENERATION IN THE REFERENCE CASE—



Source: U.S. Energy Information Administration, Annual Energy Outlook 2017, p. 78, https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf

The incremental nature of the regular and ASC make them less effective in stimulating total R&D than a credit for full expenditures, but they do appear to give a greater increase in R&D per dollar of lost revenue. A Congressional Research Service report summarizes the objections to the incremental credits:

"Firstly, they are more complex to design and use. The complexity issue should not be underestimated as it increases transaction costs for both the government and firms, and it could even prevent some firms from applying if the application costs are, or are perceived to be, higher than the uncertain benefits. Secondly, incremental incentives are possibly less effective in stagnating economic environments or during recessions when the incremental expenditure might be zero or negative. Finally, incremental features might lead to strategic behavior on the part of firms to time their R&D investments in order to maximize tax benefits, thus distorting the temporal profile of the R&D investment."[10]

BASIC RESEARCH CREDITS

The basic research credit applies to funding of research at certain nonprofit organizations, and is intended to foster collaborative research. Basic research is defined as "any original investigation for the advancement of scientific knowledge not having a specific commercial objective."[11] The basic research credit is equal to 20% of total payments for qualified basic research above a base amount. In addition, in-house basic research expenditures may be included in QRE's for the regular credit or ASC, and basic research payments that would fall below the base amount for the basic research credit may also be included in QREs.[12]

SPECIAL ENERGY CREDITS

Under IRC Section 41(a)(3), taxpayers may also claim a tax credit equal to 20% of a portion of payments to certain entities for energy research. No definition of "energy research" is provided in the Internal Revenue Code but it appears to include all forms of research

[10] *CRS, Research Tax Credit: Current Law and Policy Issues for the 114th Congress p. 9.*
[11] *Ibid.*
[12] *Ibid.*

that qualify for the basic or incremental R&E credit. The percentage of payments to qualified nonprofit energy research organizations is 65%, and the percentage of payments to universities, federal laboratories, and certain small businesses is 100%. This credit is flat, not incremental, but it does not apply to in-house research. That restriction is somewhat loosened by the possibility that businesses can form their own non-profit research organizations, as long as each has a minimum of five members, none of who contribute more than 50% of the budget.

TOTAL R&D TRENDS

From 1989 to 2007, total R&D stayed around 2.5% of GDP, and since 2007 it has grown to about 2.8% of GDP. Over the entire period, R&D funded by business has grown while federally funded R&D has fallen. These patterns have been consistent since 1989 with business-funded R&D rising from 1.3% to 2% of GDP and federally financed R&D falling from 1.1% to 0.6% of GDP. Including all funding sources, R&D was 2.8% of GDP in 2015.[13]

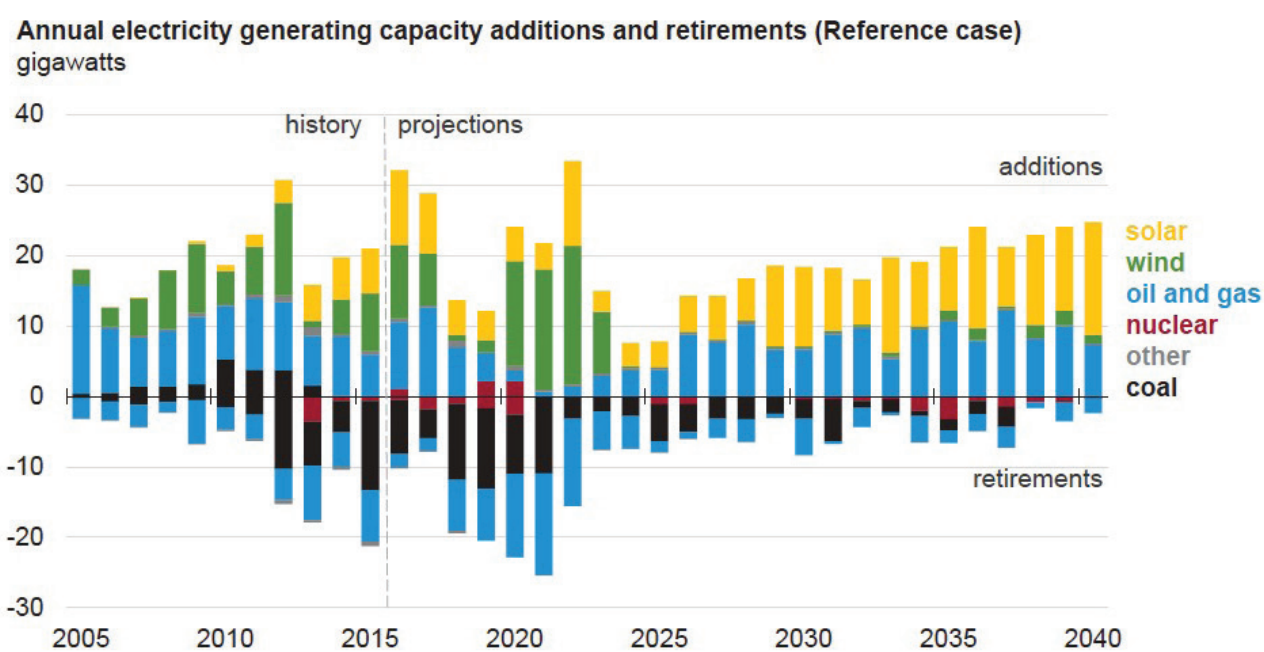
Figure 9 illustrates these trends, showing first the shares of sectors that perform R&D and second the sectors that fund R&D.

The NSF divides R&D into basic research, applied research, and development. Basic research has held around 17% of total R&D spending, applied research around 20% and experimental development around 63%. (**Figure 10**)

Through 2008, business shares of applied research and experimental development increased, while the business share of basic research remained steady just

FIGURE 8: EIA PROJECTIONS OF CAPACITY ADDITIONS AND RETIREMENTS

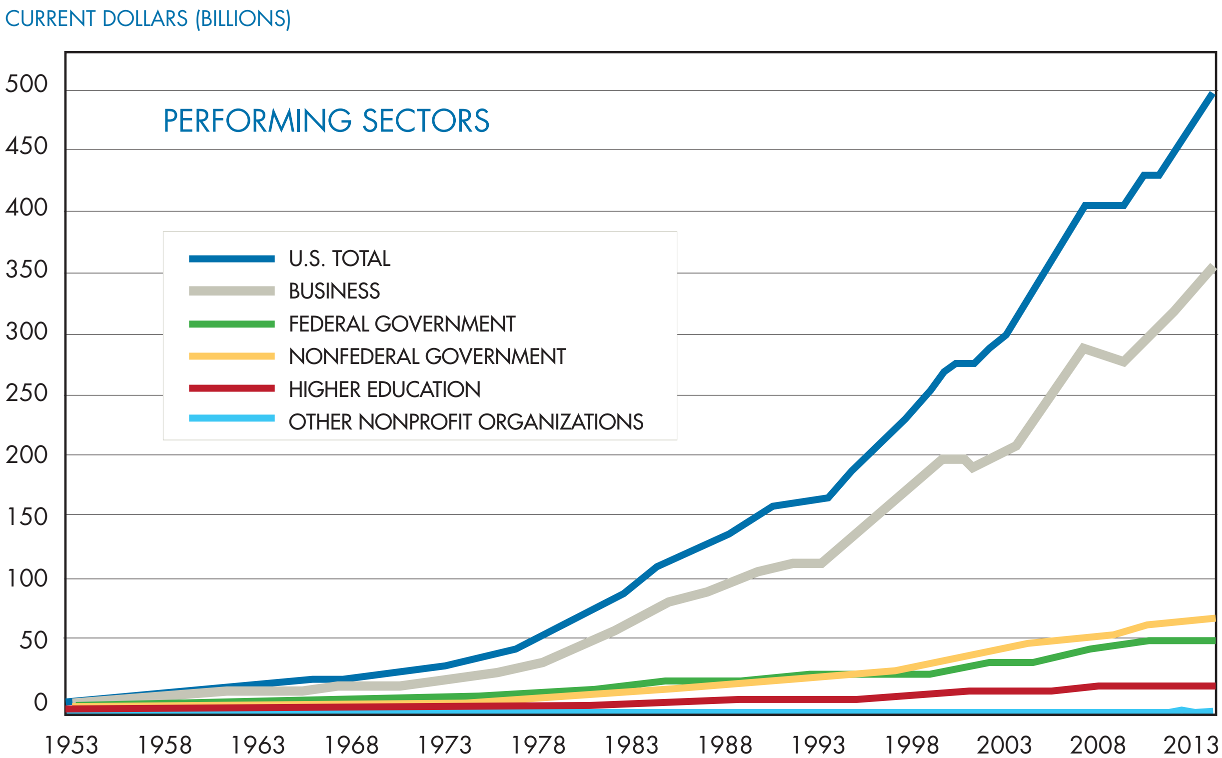
LOWER CAPITAL COSTS AND THE AVAILABILITY OF TAX CREDITS BOOST NEAR-TERM WIND ADDITIONS AND SUSTAIN SOLAR ADDITIONS—

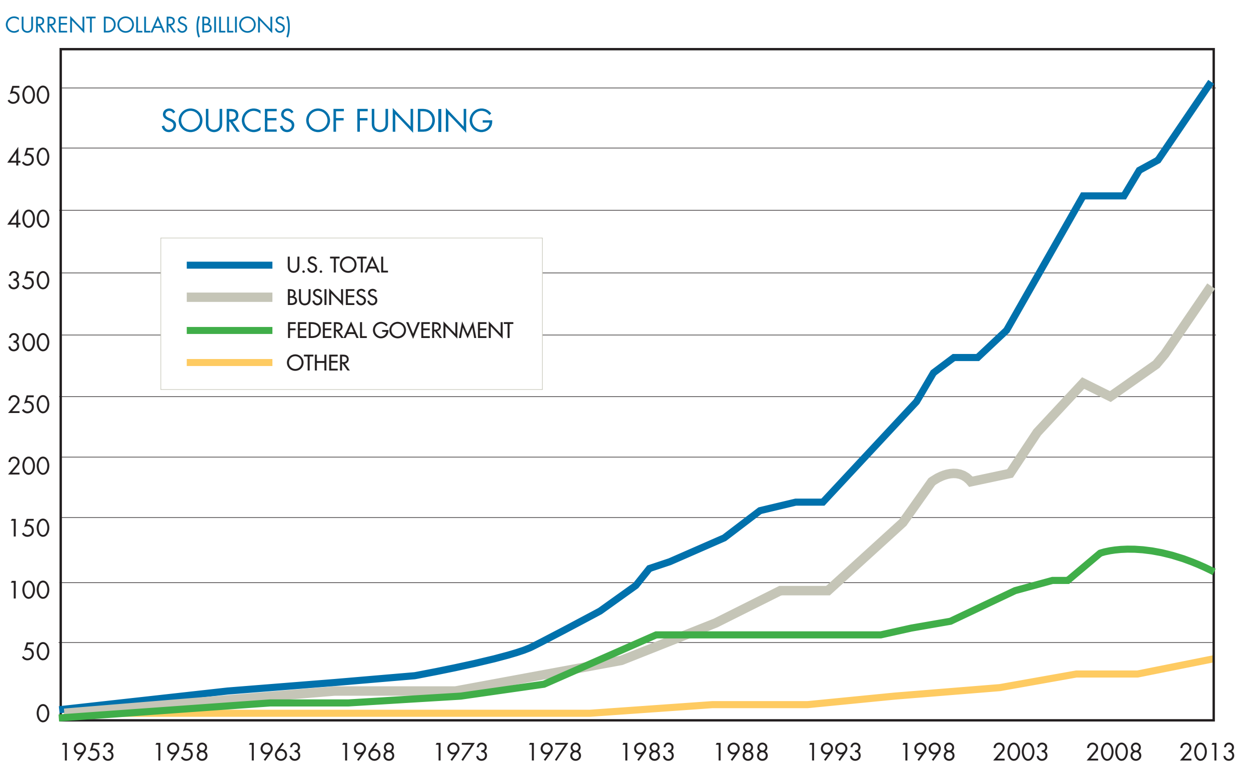


Source: U.S. Energy Information Administration, Annual Energy Outlook 2017, pg. 72, https://www.eia.gov/outlooks/aeo/pdf/0383(2017).pdf

[13] *NSF, National Patterns of R&D Resources: 2014–15 Data Update Detailed Statistical Tables, NSF 17-311, March 2017 p. 3.*

FIGURE 9: BUSINESS FUNDED AND CONDUCTED A GROWING SHARE OF R&D FROM 1953-2003





Source: U.S. R&D Increased by More Than $20 Billion in Both 2013 and 2014, with Similar Increase Estimated for 2015 InfoBriefs | NSF 16-316, September 15, 2016. p. 3. (https://www.nsf.gov/statistics/2016/nsf16316/nsf16316.pdf) under 20%. By 2015 the business share of basic research reached 27% (See **Figure 11**). The business share of development has grown to over 80% and of applied research holds around 60%.[14]

GOVERNMENT SUPPORT FOR BUSINESS R&D

The definitions of Qualified Research Expenditures and the incremental nature of the basic R&D credit greatly reduce the amount of credit that can be claimed. Whereas 20% of the total $245 billion of R&D spending in 2010 estimated by NSF would be $49 billion, only $8.5 billion was claimed for the tax credit (see **Figure 12**). The narrow definition of QRE cuts eligible R&D funding by one-third and the credit claimed amounts to only 2% of the remainder. Thus there is substantial room to expand the use of the credit without increasing its rate.

A study done for the OECD[15] provides useful insights into how the U.S. supports private sector R&D relative to other countries. The tax subsidy rate for R&D expenditures in the U.S. was estimated by the OECD to be about 3% (see **Figure 13**) – that is, the total amount of tax expenditures for R&D is only 3% of U.S. business R&D spending.

Their comparison of government support of business R&D across countries shows that the government share is relatively small in the U.S., and the U.S. subsidy rate in effect in 2013 was among the smallest across all countries reporting.

Although this study estimates U.S. tax subsidy rates to be much lower than those in other countries, there are large variations in other countries in the subsidies received by different types of businesses. Moreover, the OECD study did not include immediate expensing of R&D as a tax incentive and therefore leaves out the most important incentive given by the U.S.

FIGURE 10: BASIC RESEARCH SHARE OF U.S. R&D EXPENDITURES DECLINED SINCE 2010

TYPE OF WORK	1970	1980	1990	2000	2010	2011	2012	2013	2014a	2015b
CURRENT $BILLIONS										
All R&D	26.3	63.2	152.0	268.9	409.0	428.7	436.2	456.6	477.7	499.3
Basic Research	3.6	8.7	23.0	42.7	77.3	74.3	74.6	80.1	84.0	86.7
Applied Research	5.8	13.7	34.9	56.7	81.0	84.1	89.1	90.3	93.6	96.3
Experimental Development	16.9	40.7	94.1	169.5	250.7	270.3	272.4	286.2	300.1	316.3
CONSTANT 2009 $BILLIONS										
All R&D	115.3	142.5	227.6	328.4	404.1	414.9	414.5	427.0	439.5	454.9
Basic Research	15.8	19.7	34.5	52.2	76.4	71.9	70.9	75.0	77.3	79.0
Applied Research	25.2	30.9	52.3	69.2	80.0	81.4	84.6	84.4	86.1	87.7
Experimental Development	74.3	91.8	140.9	207.0	247.7	261.6	258.9	267.6	276.1	288.2
PERCENT DISTRIBUTION										
All R&D	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Basic Research	13.7	13.8	15.2	15.9	18.9	17.3	17.1	17.6	17.6	17.4
Applied Research	21.9	21.7	23.0	21.1	19.8	19.6	20.4	19.8	19.6	19.3
Experimental Development	64.4	64.5	61.9	63	61.3	63.1	62.5	62.7	62.8	63.3

a Some data for 2014 are prelimanary and may later be revised

b The data for 2015 are estimates and will later be revised

Source: U.S. R&D Increased by More Than $20 Billion in Both 2013 and 2014, with Similar Increase Estimated for 2015 InfoBriefs | NSF 16-316, September 15, 2016, p. 7 (https://www.nsf.gov/statistics/2016/nsf16316/nsf16316.pdf)

[15] *Appelt, S. et al. (2016), "R&D Tax Incentives: Evidence on design, incidence and impacts", OECD Science, Technology and Industry Policy Papers, No. 32, OECD Publishing, Paris. http://dx.doi.org/10.1787/5jlr8fldqk7j-en*

A more relevant number for international comparisons may be tax incentives and direct government funding for business R&D as a percentage of Gross Domestic Product (GDP) (see **Figure 14**). This comparison shows that despite the rather low rate of tax subsidy, U.S. business R&D spending is so high that U.S. support for business R&D as a percent of GDP is above average for countries analyzed.

The same study finds that direct government funding of business R&D plus tax incentives added up to about 0.17% of GDP in 2013, or about $45 billion, a number consistent with business R&D being 1.94% of GDP, or $325 billion, in the same year.

Of this, tax incentives for business R&D were about .07% of GDP, or just $11billion in 2013. Thus, even substantial increases in tax incentives for R&D across the board would make relatively little difference to the revenue neutrality of the tax reform package.

The OECD study also addressed questions of how effective the higher subsidy rates adopted in other countries have been in stimulating R&D. This is a difficult question to answer, because of the many factors that make R&D effort differ across countries other than government subsidies. It concludes that the econometric evidence is that every percentage point by which a subsidy is raised leads to about a 1% increase in R&D spending – that is, that increasing the tax credit, for example, by 1% would increase R&D spending by 1%, or just about exactly the amount of the credit. However, this does not help to explain why some countries with high rates of subsidy have relatively low R&D as a share of GDP, while the U.S. has a relatively high rate of business funding for R&D despite its comparatively low subsidy rate. This highlights the importance of other factors, such as patent protection and the general investment climate, in promoting R&D.

ENERGY R&D TRENDS

According to data from the OECD, energy R&D has risen from $4 billion in 2007 to $6.3 billion in 2015. This trend is shown in **Figure 15**. The discontinuity in 2009 was due to the massive influx of stimulus funding for large-scale demonstration projects (with $3B+ for IGCC, $2B+ for Smartgrid).[16] Funding for Integrated Gas Combined Cycle (IGCC) demonstration was classified by the OECD as fossil energy R&D.

Leaving aside the massive injection of funds for demonstration of IGCC technology under ARRA, fossil energy research remains a very small fraction of the R&D budget, with clean energy R&D growing from $4 billion to $6 billion from 2007 to 2014. If IGCC had been more appropriately classified as clean energy R&D, funding for fossil R&D would have remained flat in 2009 and the stimulus funds dumped into energy R&D would have been shown as going to clean energy R&D in their entirety.

Recent data on the split between public and private energy R&D are hard to find, since National Science Foundation (NSF) surveys appear to have ceased in 2009. From what is available, it appears that business funding of energy R&D substantially exceeded direct government funding through 2005 (see **Figure 16**), but more recent trends are simply unavailable.

According to the American Association for the Advancement of Science (AAS), there was $2.3 billion for energy research and $4.6 billion for basic science in the Department of Energy (DOE) budget for 2016.[17] Assuming that the OECD does not include basic science in its R&D database, that would put direct government funding for energy R&D at about 40% of both total and clean energy R&D.

While there are solid reasons for government support of basic science, a mission largely carried out by the NSF and the National Institutes of Health as well as the DOE, the need for government support of applied research, development and demonstration, is far less clear. These activities involve application of new or existing science to develop specific technologies and processes for commercial use, a role which the private sector can do far better. Thus there would be good reasons for replacing public energy R&D, done through grants, demonstration projects and the national laboratories, with private energy R&D incentivized through tax policy.

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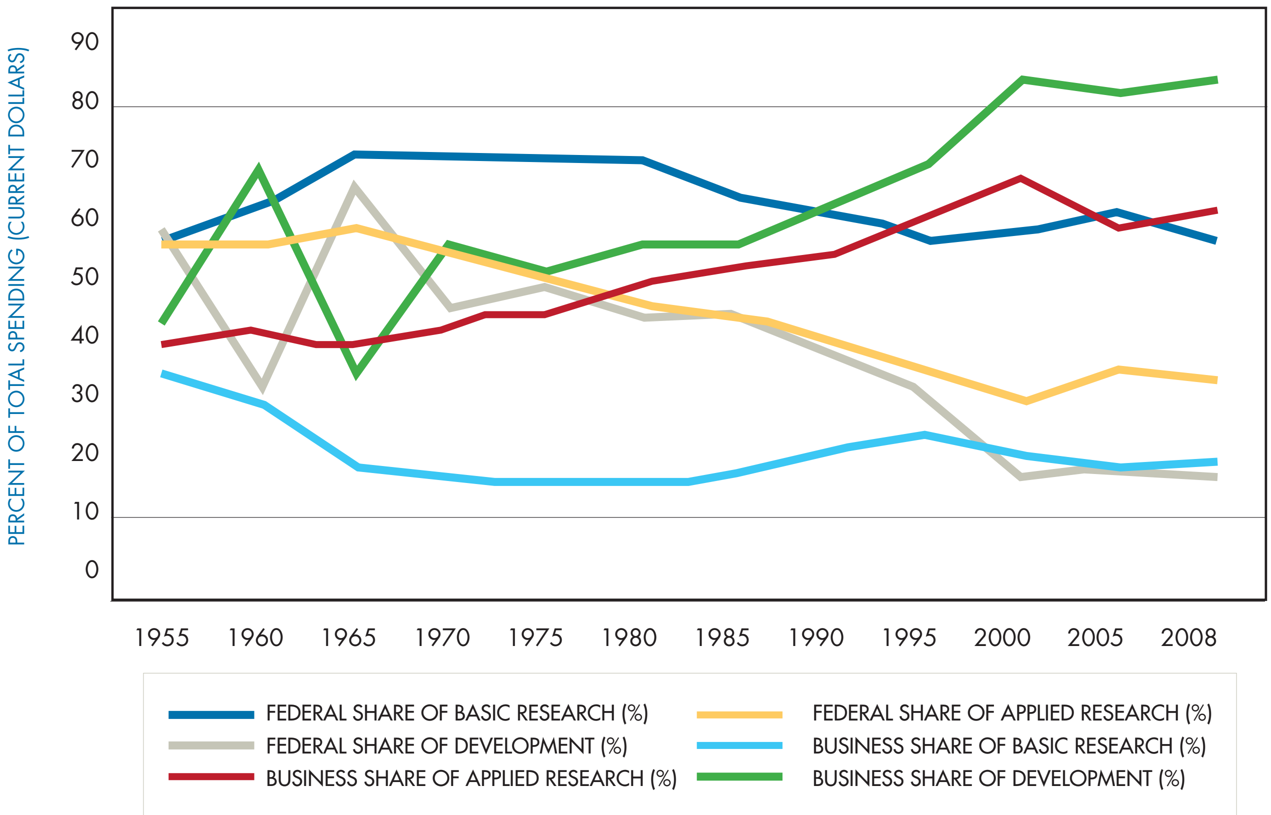
[16] *http://www.oecd-ilibrary.org/energy/data/iea-energy-technology-r-d-statistics_enetech-data-en*
[17] *https://www.aaas.org/fy16budget/federal-rd-fy-2016-budget-overview*

FIGURE 11: BUSINESS SHARE OF BASIC AND APPLIED RESEARCH GREW 1955-2008



Source: Gary Guenther "Research Tax Credit: Current Law and Policy Issues for the 114th Congress" Congressional Research Service, March 13, 2015, Figure 1, p. 31. https://fas.org/sgp/crs/misc/RL31181.pdf

HOW CHANGES FROM EXISTING LAW COULD AFFECT R&D

Based on a qualitative provision-by-provision analysis of the Brady-Ryan plan, I conclude that on balance it is likely to provide a more favorable climate for R&D. Only one provision is likely to have a negative effect on clean energy investment or R&D. My qualitative evaluation of each provision is summarized in **Figure 17**.

R&D TAX CREDIT

R&D is singled out for as the only tax preference preserved in the Plan, which states explicitly that an R&D tax credit would be retained:

"This Blueprint would provide a business credit to encourage research and development (R&D). America is a country of innovators and risk takers and historically the United States has been a world leader in technological advances. Today, however, our trading partners are using tax benefits and other incentives to attract research activity to their countries. The work done by Congress last year to make the R&D credit permanent was an important step in ensuring the viability of the United States as a location for R&D activity. The Blueprint would include an R&D credit in similar form so that America would continue to be an attractive place to conduct research. The Committee on Ways and Means would evaluate options for making the R&D credit more effective and efficient."

LOWER TAX RATES

Taken alone, the lower corporate tax rate benefits all investment, including clean energy investment and R&D. But the lower tax rate also decreases the effectiveness of the R&D tax credit. Since the lower tax rate raises the after-tax return on any given project, it clearly improves the expected profitability of all R&D investments. But at the same time, it diminishes the benefits of the retained R&D tax credits, since they are applied against a lower tax rate. The preference for R&D is therefore diminished relative to other investments.

FIGURE 12: FEDERAL RESEARCH TAX CREDIT WAS AWARDED TO LESS THAN 6% OF BUSINESS R&D SPENDING, 2000 TO 2010 ($ BILLIONS)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Business Spending on Domestic R&D (BSDRD)[a]	$183	$185	$177.5	$183	$188	$204	$223	$243	$254	$243	$245
Qualified Research Spending (QRS)[b]	$110	$100	$116	$124.5	$116	$130	$145	$158	$151	$143	$160
Federal R&D Spendingc	$76	$84.5	$94	$103.5	$112	$119	$122	$127	$127	$133	$147
Current Year Research Tax Credit[d]	$7.2	$6.4	$5.7	$5.5	$5.6	$6.4	$7.3	$8.3	$8.3	$7.9	$8.5
Ratio of Credit to BSDRD (%)	3.9%	3.5%	3.2%	3.0%	3.0%	3.1%	3.3%	3.4%	3.3%	3.2%	3.5%
Ratio of Credit to QRS (%)	6.5%	6.4%	4.9%	4.4%	4.8%	4.9%	5.0%	5.2%	5.5%	5.5%	5.3%

a. Total spending on domestic basic and applied research, as well as development, by companies only.

b. Spending on research that qualifies for the regular, alternative incremental, and university basic research tax credits, as reported by corporations claiming the credit on their federal income tax returns.

c. Federal obligations for defense and non-defense R&D spending by fiscal year.

d. Total value of claims for the regular, incremental and basic research tax credits reported in federal corporate income tax returns. Because of limitations on the use of the general business credit, of which the research credit is a component, and audits of corporate claims for the credit by the Internal Revenue Service, the total amount of the research credit actually used in a particular year may differ from the total amount claimed.

Source: Gary Guenther "Research Tax Credit: Current Law and Policy Issues for the 114th Congress" Congressional Research Service, March 13, 2015, Table 3, pp. 17-18. https://fas.org/sgp/crs/misc/RL31181.pdf

EXPENSING

The same thing is true of allowing all investment to be expensed. Since R&D is already expensed, extending expensing to all investment removes a preference and therefore decreases the relative attractiveness of R&D compared to other investments.

If tax reform leads, as it should, to increased investment and economic growth overall, this would make the R&D tax credit more effective because greater investment and growth would enhance the returns to R&D and likely increase the rate at which R&D expenditures would have increased without the credit. The incremental R&D credit would in this case apply to a larger percentage of total R&D expenditures and thereby provide an increased incentive for R&D spending. This would especially be true in industries and areas of R&D where spending has stagnated.

INTEREST DEDUCTION

The remaining provisions of the Plan are generally positive for R&D. Abolishing the interest deduction is likely to benefit R&D and clean energy investments by eliminating the capital market distortion in which tax policy favors debt over equity finance.

According to a comprehensive analysis of a proposal to reduce corporate tax rates and eliminate the interest deduction:

> "The reduced corporate tax rate mitigates the increase in the EMTR [Effective Marginal Tax Rate] on debt-financed investment and significantly decreases the EMTR on equity-financed investment….
>
> Further, beyond distorting financing decisions, the bias for debt can distort investment decisions….

The authors go on to describe how the bias toward debt financing has a chilling effect on relatively new and growing companies that invest heavily in R&D.

> "R&D expenditures are poorly suited for debt finance for various reasons. First, a large fraction of R&D investment is in human capital, which cannot be collateralized. Second, R&D investments do

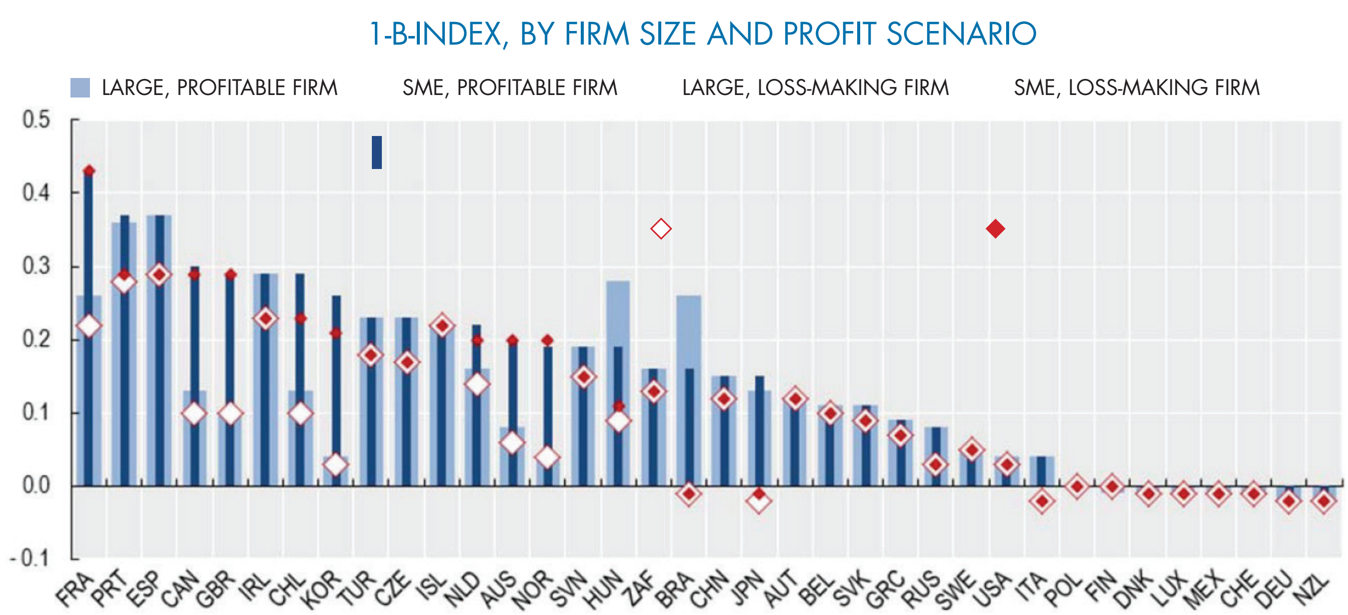
not generally provide a stable source of cash flow from which interest expense can be paid. Third, the probability distributions of the payoffs of many R&D projects are positively skewed: They have a relatively high chance of failure (a burden that debt holders would bear) and a relatively small chance of large gains (a reward that debt holders would not share).

Further, such young, R&D-intensive companies may have small or negative cash flows, limiting their access to internal equity. Therefore, for those companies, the marginal source of funding might be new share issues, [See generally Brown et al., ''Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom,'' 64 J. of Fin. 151 (Feb. 2009)] which face an especially high EMTR. ….. By reducing the bias toward debt finance and against equity finance, our proposal could alleviate the distortions that disfavor investment in R&D."[18]

The lower personal tax rate on investment income would increase the supply of savings for all forms of investment, including R&D and reduce the before-tax return on equity required to attract investment. This is an unambiguous benefit. Taken together, lower corporate tax rates and lower personal rates for investment income cause both savings and investment schedules to shift outward, giving unambiguously higher savings and investment.

Taken together, the elimination of the interest rate deduction together with tax rate reductions would assist companies that have to raise equity finance, which is the most desirable form of financing for risky activities such as R&D and introduction of new energy technologies. Lower corporate tax rates and lower rates on personal investment income would lower the cost of equity financing by substantially reducing double taxation of dividends and increasing the after tax return to equity investors.

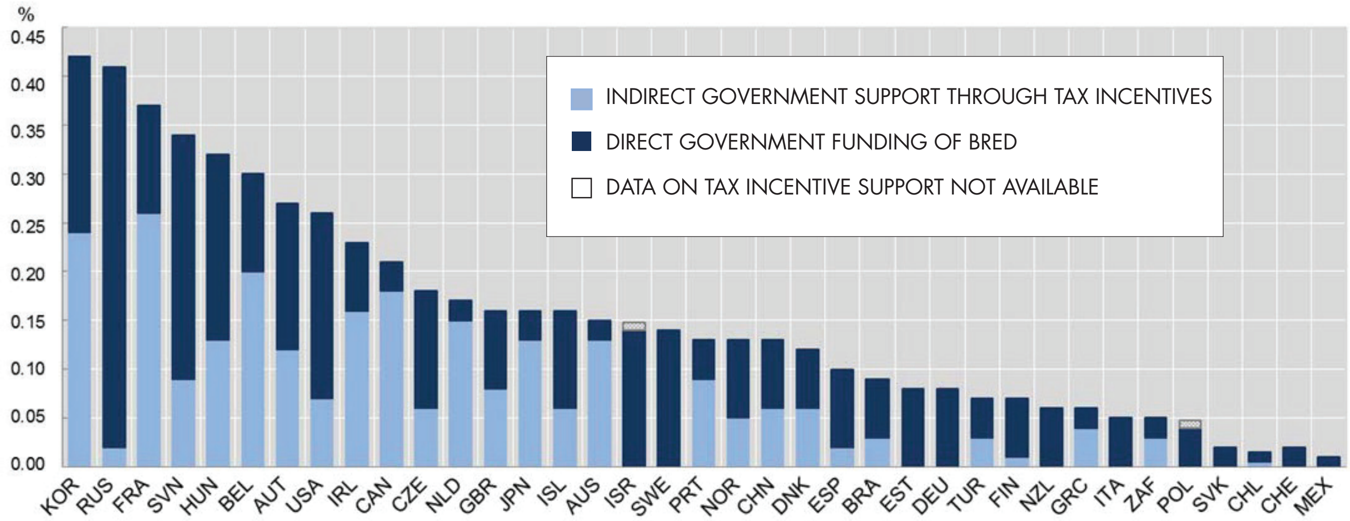
FIGURE 13: COMPARISON OF TAX EXPENDITURES BY COUNTRY: IMPLIED TAX SUBSIDY RATES ON R&D EXPENDITURES, 2015



Source: Appelt, S. et al. (2016), "R&D Tax Incentives: Evidence on design, incidence and impacts", OECD Science, Technology and Industry Policy Papers, No. 32, OECD Publishing, Paris. Figure 1, p. 13. http://dx.doi.org/10.1787/5jlr8fldqk7j-en

[18] *Capping the Deductibility of Corporate Interest Expense By Robert C. Pozen and Lucas W. Goodman COMMENTARY / SPECIAL REPORT TAX NOTES, December 10, 2012 1215-2016*

FIGURE 14: US RANKS HIGH ON TAX INCENTIVES AND DIRECT FUNDING FOR BUSINESS R&D, 2013 (AS A PERCENTAGE OF GDP)



Source: Appelt, S. et al. (2016), "R&D Tax Incentives: Evidence on design, incidence and impacts", OECD Science, Technology and Industry Policy Papers, No. 32, OECD Publishing, Paris. Figure 1, p. 13. http://dx.doi.org/10.1787/5jlr8fldqk7j-en

Elimination of the interest deduction would also have the salutary effect of ending the use of loan guarantees, because the loss of the deduction for interest payments is likely to far outweigh any lower interest rates achievable with a guaranteed loan. Loan guarantees make it possible for investors to obtain project financing from lenders rather than raising equity capital, and eliminating the deductibility of interest would make it excessively costly to leverage risky projects with guaranteed loans. This would go a long way toward correcting the bias in federal policy toward excessively risky prospects that cannot attract investment on their own and open the way for projects with sound business plans that can attract private equity investment on terms appropriate to the risks involved.

REFUNDABILITY

Refundable credits, or as they are described in the Plan, credits that can be deferred indefinitely with interest, are key to making enhanced incentives for R&D effective. By making credits refundable, startup companies investing heavily in R&D or established companies that decide to make significant moves into developing new technology would no longer risk losing credits if they do not have sufficient other income to offset.

BORDER ADJUSTMENT

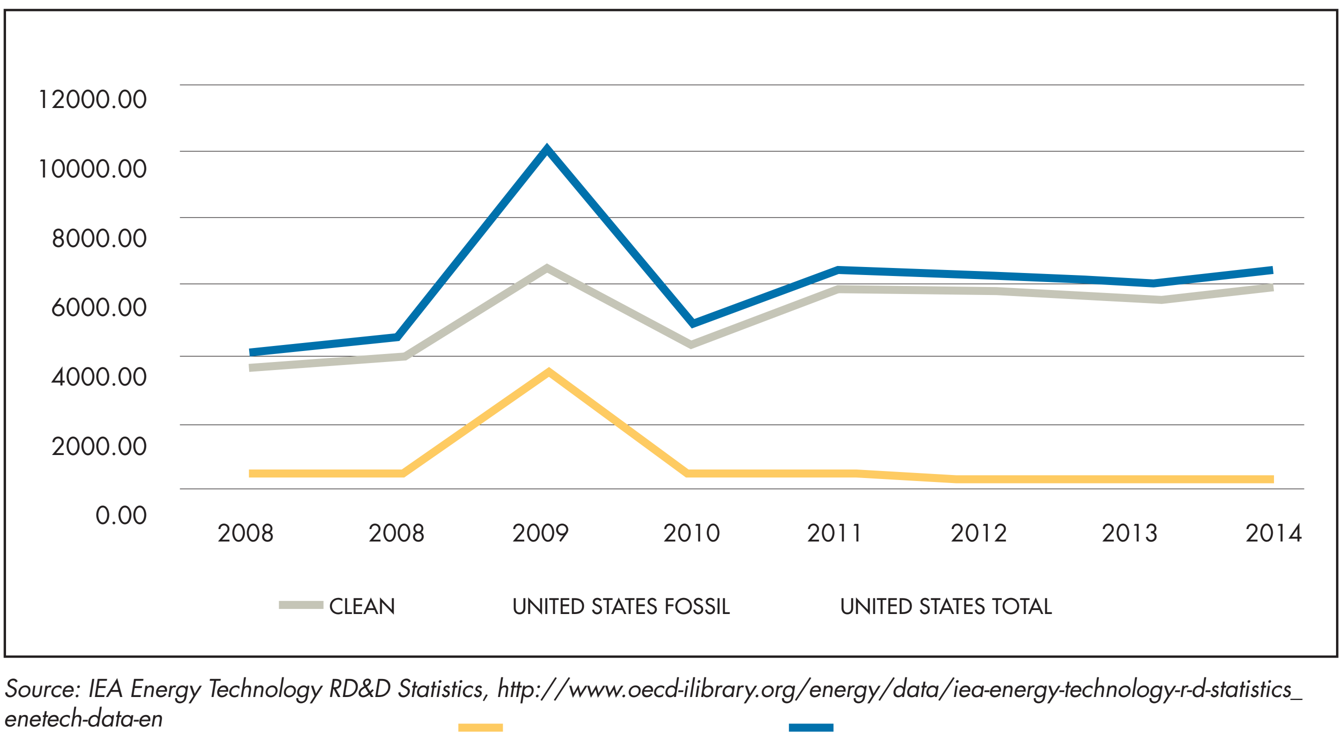
The border adjustment generally removes bias against investment in the United States that is built into a system that taxes income of American companies worldwide. Our competitors that have versions of a value added tax rebate the tax on exports to the US and add the tax to exports that we send to them. The border adjustment mirrors that treatment, so that goods and services are taxed where they are sold, not where they are produced. In terms of R&D, the border adjustment means that all intellectual property revenue generated overseas would no longer be taxed. This includes royalty payments, licensing fees, and revenues for exports of products embodying new technology protected by trade secrets or patents whether received from an affiliate or from an arms-length sale. Likewise, no payments to foreign companies for IP would be deductible from taxable income.

In the first instance, this eliminates any incentive to play games with transfer pricing or to assign intellectual property to overseas affiliates in order to avoid U.S. income taxes or take advantage of more favorable tax incentives for R&D. It also eliminates a significant threat to U.S. R&D, which is that countries that give favorable tax treatment to revenue from sales of intellectual property would require that the IP be derived from R&D done within their borders. This issue of "nexus" is raised by OECD guidelines for prevention of base erosion and profit shifting, which mandate participating countries to impose nexus requirements.[19]

Whether the border adjustment will cause any long term benefit for domestically produced clean energy technology by increasing the prices of globally traded fossil fuels is a contentious issue. On first blush, it would appear that eliminating the deductibility of the cost of imports would raise the domestic prices of both imported goods and their domestic substitutes. Likewise, the tax preference for exports would increase the price of those goods when sold within the U.S. as well. This suggests that both imported crude oil and exported natural gas would raise in price, thus shifting users toward lower-carbon alternatives. At the same time, wind turbines from Germany and solar cells from Korea would also increase in price, both stimulating interest in domestically produced equipment and reducing demand for those cleaner technologies overall. According to this view, there would likely be a penalty on fossil fuels and possibly an incentive for more domestic investment in clean energy.

Another school of thought holds that there would be no change in the relative prices of fossil fuels and other energy sources, because all goods will be subject to the same border adjustments. In a weaker form of this argument, it can be pointed out that without detailed modeling of the supply chain for every good, it is impossible to tell which will rise and which will fall relative to others. Because if all prices go up, that is just a one-shot dose of inflation and will not shift the playing field between fossil fuels and cleaner energy.

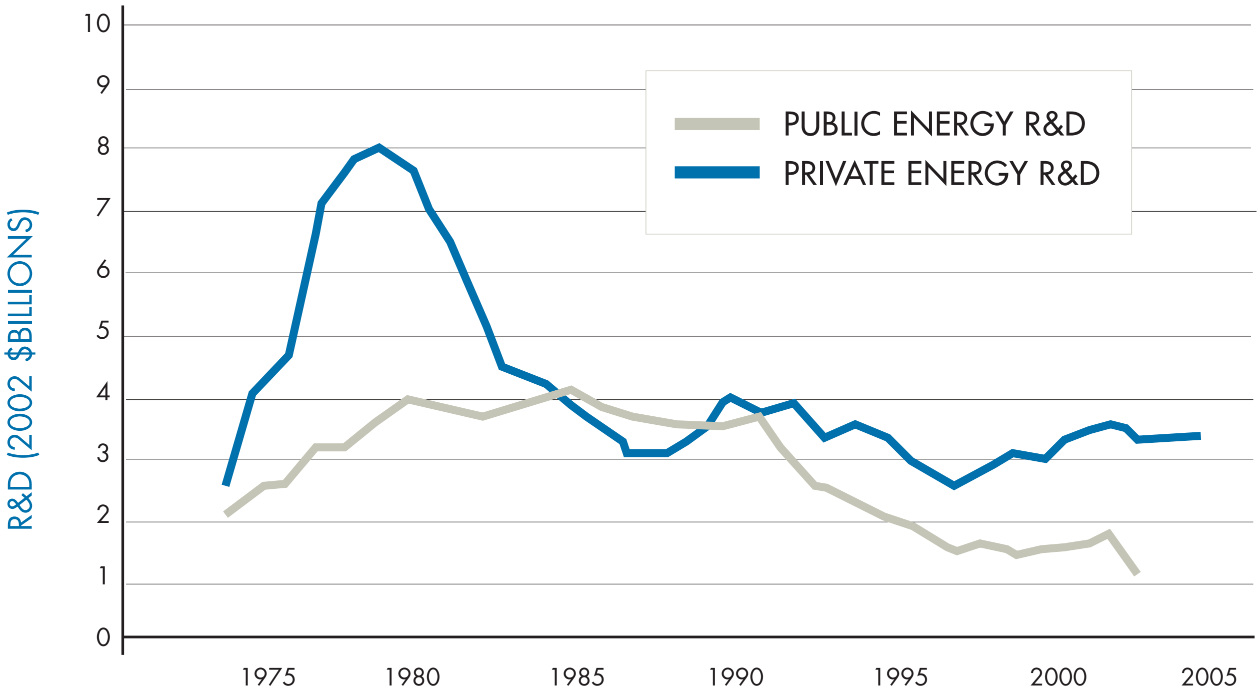
FIGURE 15: CLEAN ENERGY R&D GREW WHILE FOSSIL REMAINED FLAT 2007-2014 (IN MILLION 2014 $)



Source: IEA Energy Technology RD&D Statistics, http://www.oecd-ilibrary.org/energy/data/iea-energy-technology-r-d-statistics_enetech-data-en

[19] *OECD/G20 Base Erosion and Profit Shifting Project Action 5: Agreement on Modified Nexus Approach for IP Regimes*

FIGURE 16: PRIVATE ENERGY R&D IS CONSTANT AND PUBLIC ENERGY R&D IS FALLING



Source: Appelt, S. et al. (2016), "R&D Tax Incentives: Evidence on design, incidence and impacts", OECD Science, Technology and Industry Policy Papers, No. 32, OECD Publishing, Paris. Figure 1, p. 13. http://dx.doi.org/10.1787/5jlr8fldqk7j-en

A stronger version of this theory is that there will be no change in U.S. prices at all, because an increase in the value of the dollar will completely wipe out the cost-increasing effect of the border adjustment. The entire cost of the border adjustment would be shifted to foreign importers and exporters dealing with the U.S.

At this point, no resolution of these conflicting points of view appears imminent. My own opinion is that there are likely to be some changes in relative prices across commodities, and likely some increase in relative price of fossil fuels, but not nearly as much as the application of the border adjustment alone would produce.

All of these considerations may be moot in light of the successful campaign against a border adjustment spearheaded by the retail sector. Many Republican senators have announced their unalterable opposition to border adjustment, and it is not clear it will even survive in the House of Representatives.

To maintain the two key features of the Brady-Ryan plan, territoriality and revenue neutrality, without the border adjustment will be difficult. Any other approach to territoriality requires a much more complex set of rules and regulations, and the border adjustment would provide about 20% of the "base-broadening" revenues required to offset rate reductions.

REPATRIATION

Finally, the Plan provides a definitive solution for repatriation of earnings currently accrued in overseas affiliates of U.S. companies. It imposes a one-time tax on accumulated earnings, and then eliminates all taxes on dividends for overseas affiliates going forward. This provision should free up substantial amounts of cash for U.S. corporations. However, it is unclear whether this additional cash would lead to any greater investment in R&D or other projects than would be the case if the profits remained overseas.

Studies of the behavior of companies that took advantage of the temporary tax holiday for repatriation of earnings in 2004 have reached opposite conclusions about how repatriated earnings were used. Even though the 2004 tax holiday required that the repatriated earnings be employed for approved activities, principally new investment that would not have been undertaken otherwise, some studies found no increase in investment. One study claimed that multinationals that repatriated higher levels of earnings did not increase their domestic investments any more than multinationals that repatriated lower levels.[20] Another found that a significant share of repatriated earnings was used for share repurchase even though that was not an approved use.[21] A survey of several studies by the Congressional Research Service concluded that the reduction in the tax rate on repatriated earnings did not increase investment.[22]

On the other hand, several convincing studies found the opposite. One estimated the uses of repatriated earnings after 5 years and found they were distributed among cash acquisitions, new investment and R&D, with all approved uses getting 72% and R&D getting 9% of the repatriated earnings.[23] Another found that most repatriated earnings went to approved uses in capital constrained firms, i.e. those unable to raise external funds for planned investments, but had no effect on investment by non-capital constrained firms.[24] A third found that firms retained repatriated funds, which might lead to increased domestic investment.[25]

The repatriation provisions of the Brady-Ryan plan do not create a tax holiday, but rather a once-for-all tax on total accumulated foreign earnings of affiliates, followed by zero tax on repatriated earnings. This would not necessarily lead to an immediate influx of cash, as companies have discretion about when to repatriate earnings. There is some expectation that with lower U.S corporate tax rates and threats that other countries would tax those earnings, repatriation would happen quickly.

Another difference of the Brady-Ryan plan from a tax holiday is that it would be very difficult to impose restrictions on how repatriated funds are utilized, given the discretion that companies have in scheduling dividends from foreign affiliates. For example, if a company schedules dividends to coincide with the timing of cash needs for investments that it would have undertaken anyway, there would be no way to verify additionality of investment. Therefore, even if restrictions on use of funds repatriated under the tax holiday were

FIGURE 17: EVALUATION OF BRADY-RYAN PLAN PROVISIONS

TAX REFORM	EFFECT ON R&D INCENTIVE	REASON
Retain R&E credit	++	All other credits disappear
Lower Corporate Rate	++	Increases after tax return on investment
Eliminate all expensing	neutral	Gives all investment a prefrence now reserved for R&D
Abolish interest deduction	+	R&D not debt-financed
Border Adjustment	++	Eliminates threat of OECD nexus rules
Lower personal rate	+	Increases attractiveness of equity investment
Eliminate renewable, oil, gas and coal credits	-	Renewable credits larger than fossil; all forms of energy must compete on level playing field
Refundable credits	+	Makes credits useful for startups
Repatriation	neutral	

20 *Bringing It Home: A Study of the Incentives Surrounding the Repatriation of Foreign Earnings Under the American Jobs Creation Act of 2004. Authors JENNIFER BLOUIN, LINDA KRULL*

21 *The Corporate Financing Effects of the Temporary Tax Deduction for Repatriated Dividends Joseph Newhard Private Enterprise Research Center Texas A&M University July 2016*

22 *Tax Holiday for Overseas Corporate Profits Would Increase Deficits, Fail to Boost the Economy, and Ultimately Shift More Investment and Jobs Overseas. Center on Budget and Policy Priorities. Updated June 19, 2014 By Chuck Marr and Brian Highsmith*

2 *Where the Money Really Went: A New Understanding of the AJCA Tax Holiday. Northwestern Law & Econ Research Paper No. 13-35 19 Aug 2013 Last revised: 21 Apr 2014 Thomas J. Brennan Harvard Law School*

24 *Investment and Capital Constraints: Repatriations Under the American Jobs Creation Act. Michael Faulkender Mitchell Petersen Rev Financ Stud (2012) 25 (11): 3351-3388.*

25 *The Effect of the Domestic Production Activities Deduction on Corporate Payout Behavior Posted: 13 Feb 2008 Last revised: 6 Jun 2014 Jennifer L. Blouin University of Pennsylvania - Accounting Department Linda K. Krull University of Oregon Casey M. Schwab Indiana University - Kelley School of Business - Department of Accounting Date Written: May 31, 201*

effective, it is less certain how funds repatriated under the Brady-Ryan plan would be used.

OVERALL EFFECTS OF TAX REFORM ON R&D AND CLEAN ENERGY ENVESTMENT

Now that we have looked at proposed tax reform, the treatment of clean energy investment and R&D under current tax law, and trends in clean energy investment and R&D under current law, we can pull these topics together. Under current tax law, total R&D is very gradually increasing as a share of GDP while energy R&D remains at best flat. Business funding has gradually replaced government funding for applied research and experimental demonstration, and where it occurs that trend can be expected to increase the productivity of R&D funding and usefulness of results. Clean energy investment, on the other hand, has been stagnant, with the major contributor being utility-financed construction of central station solar and wind power mandated by state-level Renewable Portfolio Standards.

There is one broader issue about incentives for R&D, and that has to do with the permanence of tax reforms instituted through the budget reconciliation process. The passage of the PATH Act in 2015 that made the R&E tax credit permanent was hailed as a move that would greatly increase its effectiveness. R&D does not always produce immediate results and financial rewards, and can involve a lengthy and complex process of moving an idea derived from basic research through applied research, product development, return to the laboratory to work out unforeseen problems, and then into commercial application. Knowing how R&D expenses would be treated throughout that entire process can be critical to managing the risks involved. The same is true of how future earnings based on R&D would be taxed.

The Budget Resolution approved by the House Budget Committee on July 20, 2017 contains reconciliation instructions to the House Ways and Means Committee for deficit-neutral tax reform.[26] This implies that if this Budget Resolution is adopted, enacting tax reform through the reconciliation process will require that the package be revenue neutral during the 10-year budget window. To comply with Senate rules, tax reform also must not increase deficits beyond the 10-year period. Because of the timing of base-broadening provisions and rate reduction provisions in the Brady-Ryan Plan, it is projected to reduce revenues in years outside the 10-year window. To deal with this, the common practice in reconciliation is to make tax changes sunset after 10 years. This is what produced the debacle of expiration of the tax cuts enacted by President Bush 10 years after their enactment, and could diminish the value of tax reform as a stimulus to long lead time R&D.

Overall, the Brady-Ryan plan is likely to increase incentives for both clean energy R&D and clean energy investment. The following effects of tax reform are all favorable to clean energy investment:

1. Lower tax rates improve the expected present value of R&D investments and clean energy investments.

2. Extension of expensing to all investments also improves the rate of return on clean energy investments.

3. Elimination of the bias toward debt financing provides advantages to new companies with heavy R&D expenditures or riskier investments in development and commercialization of new technologies.

4. The Border Adjustment automatically eliminates any incentive for companies to move either their R&D activities or manufacturing offshore. The effects on investment and R&D are synergistic, since greater manufacturing of clean energy equipment in the U.S. will pull business R&D spending in the U.S. to improve those technologies and greater R&D will provide new technologies which the border adjustment makes it more profitable to manufacture in the U.S. than elsewhere.

5. Elimination of current tax incentives for wind and solar is unlikely to reduce currently projected investments, which are just sufficient to meet mandated levels of renewable generation.

6. Elimination of current tax expenditures for fossil fuels ensures consistent and neutral tax treatment of investment in all forms of energy.

7. Higher rates of investment and faster turnover of the capital stock increase the opportunities for

[26] *https://budget.house.gov/budgets/fy18/*

adoption of new technology, in particular clean energy technology.

Nevertheless, without more market demand for clean energy there may not be a large response to this improved environment for clean energy investment. Therefore, I turn now to discussing ways in which the Plan could be modified to increase incentives for clean energy investment, for R&D in general and clean energy R&D in particular. How to achieve bipartisan agreement to make tax reform permanent is a political question beyond the scope of this paper.

WAYS TO FURTHER INCREASE INCENTIVES FOR CLEAN ENERGY R&D

The tax code can be used in various ways to promote desired activities. Most broadly, tax incentives for R&D can be divided into those that reduce the cost of doing R&D, which I call "efforts-based" incentives, and those that reward or increase the returns to the results of R&D, which I call "results-based" incentives.

Both efforts and results-based tax incentives have been used to stimulate R&D. Tax credits and expensing are the effort incentives, lowering the after-tax cost of R&D, and they can range up to more than 100% of qualified expenditures (a "super credit"). Currently energy R&D receives volume-based tax credits whereas other R&D receives incremental credits. Some studies suggest that volume-based credits produce a greater R&D response overall.

A results incentive that is used in other countries is a patent box — meaning lower or zero tax rates for income from intellectual property (IP). This incentive increases the after tax returns from successful R&D, and can be limited to specific types of IP.

Thus there are three broad forms of tax incentive now in use that could be applied in the U.S. These would be:

- Expanded R&D credit
  The current R&D tax credit is a complex formula that involves identifying Qualified Research Expenditures , calculating the increase in QRE for the tax year over some base, computing a 20% credit, and reducing the amount of R&D expenditures that can be expensed in that year. As discussed above, the result is that the nominal 20% credit ends up effectively being a 3% credit. The credit could be expanded by adopting the same definition of R&D expenditures as used to qualify for expensing under Section 174, by allowing the credit on 100% of qualified expenses not just those deemed incremental, or by increasing the credit rate.

- Super credit
  A super credit is a tax credit of more than 100% of qualified expenditures. Raising the current credit from 20% to more than 100% while retaining the definition of QRE and incremental expenditures would be an awkward but possible way to correct the current dilution of the incentive. Since the current nominal credit is 6 2/3 times the effective credit, getting the effective credit up to 20% would require a nominal credit of 133%.

- Patent Box
  Income or revenue derived from R&D activity could be taxed at a rate lower than the standard corporate rate or rates. This preference has been labeled a "patent box." Income from intellectual property is the most common way to define income eligible for this treatment, but there are many ways that such a definition could be expanded. For application to energy investment, a patent box might be created that applies a lower tax rate to income from investments that embody new energy technology or that involve specified types of "clean" energy.

Figure 18 lists the countries that use one or more of these three types of incentives:[27]

There are many details that would need to be worked out to make increased credits or a patent box effective and minimize distortions. I describe the major issues seen with each, and estimate how their rates should be set to offset the diminished effect of existing incentives.

TAX CREDITS AND SUPER-CREDITS

The most direct way to increase incentives for R&D in general and energy R&D in particular is by modifying the current credits. My calculations for some simple examples suggest that the R&E credit would have to be increased from 20% to 40% to restore the relative preference for R&D over other investments that it has under current law. This is by no means definitive, it would take much more careful calculation of pro-forma after-tax profitability for a variety of projects to make a precise estimate.

It would also be possible to increase the effectiveness of the R&E credit by conforming the definition of R&D for tax credit purposes to the established definition of QRE for expensing, prohibiting retroactive claims on amended returns, and replacing the regular credit with the alternative simplified credit in order to eliminate complicated and arbitrary base year calculations.[28]

For concreteness in discussion of energy R&D credits, let us assume that the incremental credit for all forms of R&D is doubled to 40% in order to maintain the advantage of R&D over other forms of investment that it enjoys under current tax law. According to IRS data, in 2011 approximately $9 billion R&D credits were claimed.29 The static revenue loss from doubling the credit would be a similar $9 billion, but the dynamic effects of tax reform on economic growth would likely increase R&D incremental expenditures and therefore make the revenue loss from raising the credit larger.

If the R&E credit after tax reform remains an incremental credit and the energy R&D credit remains a volume credit, the current preference for energy R&D would also be maintained. Thus, if the policy objective is to increase clean energy R&D specifically, the most straightforward approach would be to raise the credit rate for clean energy above that for other R&D.

Based on the estimate that business investment in clean energy R&D is about $3 billion per year, and assuming the credit is fully refundable, raising the credit by 10 percentage points would lose about $300 million in tax revenue annually.

There is a general consensus that every dollar of revenue loss for R&D tax credits stimulates approximately $1 of additional R&D spending.[30] This limits how much it would be possible to increase clean energy R&D through increased tax credits. Raising the tax credit for clean energy R&D by 50 percentage points would lose about $1.5 billion of revenue and increase business clean energy R&D by a similar amount annually. This would be about a 50% increase in R&D spending on clean energy, from $3 billion to $4.5 billion annually. At least initially, any greater increase in R&D spending could well drive up research salaries and costs until the supply of qualified researchers and expanded facilities catch up.

Some countries have adopted super-credits for R&D, which entail credits larger than the qualified research expenditures. These seem to be more of a tool for attracting companies to locate within the countries offering the credits than serious efforts to increase the volume and effectiveness of R&D, since the incentive for waste is so great when more than 100% of costs would be reimbursed.

The one place where a super credit might be justified is in the area of collaborative research, either among companies or between companies and universities. There the mixture of parties involved in R&D would mitigate the agency problems, and the super-credit would become a vehicle for government-funded cost sharing in projects that the business funders and university researchers choose as most promising. Thus it would combine government funding to offset the market failures associated with R&D with the benefits of a business perspective on the innovations and technologies most likely to succeed in the market.

For these reasons, it might be better to think about how to design results-based incentives for clean energy R&D. There are inherent difficulties in the design of any efforts-based R&D incentive. The complaints that companies have about the arbitrariness of and difficulty of compliance with IRS rules on R&D credits are, in my opinion, evidence of the inescapable difficulties of determining whether a particular activity within a company is or is not R&D. There are many ways that a technological innovation can be achieved, ranging

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27 *Joint Economic Committee. March 10, 2016 Patent Boxes: A Brief History, Recent Developments, and Necessary Considerations*

28 *As recommended by Jason J. Fichtner and Adam N. Michel. "Can a Research and Development Tax Credit Be Properly Designed for Economic Efficiency?" Mercatus Research, Mercatus Center at George Mason University, Arlington, VA, July 2015.*

29 *Fichtner and Michel.*

30 *Bronwyn Hall, John Van Reenen. How effective are fiscal incentives for R&D? A review of the evidence Research Policy Volume 29, Issues 4–5, April 2000, Pages 449–*

FIGURE 18. R&D TAX INCENTIVES BY COUNTRY

COUNTRY	R&D CREDIT	R&D SUPER DEDUCTION	PATENT OR INNOVATION BOX
Australia	X		
Austria		X	
Belgium	X	X	X
Brazil	X		
Canada	X		
China	X		
Czech Republic	X		
Denmark	X		
France	X	X	
Hungary	X	X	X
India	X		
Ireland	X		
Italy	X	X	
Japan	X		
Korea	X		
Liechtenstein	X		
Lithuania	X		
Luxembourg	X		
Malta	X	X	X
Netherlands	X	X	X
Poland	X		
Portugal	X		
Romania	X		
Russia	X		
Singapore	X		
Slovak Republic	X		
South Africa	X		
Spain	X	X	
Switzerland	X		
Turkey	X	X	X
United Kingdom	X	X	X
United States	X		

Source: Joint Economic Committee. March 10, 2016 Patent Boxes: A Brief History, Recent Developments, and Necessary Considerations, p. 8. https://www.jec.senate.gov/public/_cache/files/02a2a18a-1e08-42ce-8c14-72b6138b54dd/031016-patent-boxes.pdf from learning by doing to basic laboratory science. Likewise, there are many places in the process of developing and commercializing a new technology where new technical challenges arise. As a result, any operational definition of R&D draws lines within a continuum of related activities. The problem is even worse when a credit is intended to stimulate R&D toward a particular application, in this case clean energy. For example, much of the applied research that would improve cellulosic ethanol processes is genetic research to create plants with better combinations of lignin and starch. This research could also have applications outside energy and might even be pursued by companies more interested in those applications.

Energy tax credits or a variant of the patent box could be expanded to include all investments in clean energy or based on new clean energy technology, but that preference would likely run afoul of the basic principles behind the current tax reform plan. Current tax credits for renewables could be expanded to other investments that reduce greenhouse gas emissions, and the size of the credits could be tied to their relative effectiveness in reducing those emissions. This is particularly important because existing tax incentives apply only to renewables, but natural gas, nuclear power, carbon capture and sequestration and energy efficiency could all lower CO2 emissions relative to current uses of petroleum and coal.

As in the patent box idea, preferential income tax rates could also be applied to the income from application of clean energy technologies, with the magnitude of tax reductions tied to relative performance in reducing emissions. This approach would be superior to tax credits in that it would only reward successful projects and would favor those that are most profitable. However, with lower tax rates overall, the magnitude of the subsidy would be limited to taxes due under normal rates.

In order to create a level playing field for clean energy investments, it is important that tax credits or lower tax be differentiated based on the emission reductions per unit of energy achievable by different types of investment. For investments in what are deemed to be zero-carbon technologies, this calculation would be simple – since tax-writers would need only to specify the lower rate or credit for zero carbon technology investments. The full corporate tax rate and zero credit would apply to investments that do not fall in any clean energy category. But to determine what rate should apply to natural gas or clean coal or energy efficiency investments requires defining a baseline or standard of comparison. Should clean coal be credited with reducing emissions from a coal-fired powerplant with the best current technology or with reducing emissions from the fleet average or from the level of a new natural gas combined cycle unit? What heat rate should be chosen as the baseline for improvements in natural gas technology? All these questions would need to be answered in designing either tax credits or lower tax rates that put all clean energy investments on a level playing field in terms of greenhouse emission reductions.

Either of these approaches would invite controversies over defining clean energy investment and picking winners in clean energy technology. They would also build special preferences back into the tax code, with all the accompanying complexities of definitions and potential for tax avoidance or fraud, contrary to the basic purpose of tax reform.

PATENT BOX

According to a position paper released by the Joint Economic Committee, "Tax systems that treat IP income preferentially … are referred to as 'patent boxes' (a.k.a. innovation, license, or knowledge boxes, which indicate a broader class of IP than patents). Their proliferation among the tax codes of America's competitors has brought the debate to Washington. In fact, members of Congress have already begun to explore, in a bipartisan fashion, how such a regime would work in the United States."

Defining the patents, innovations, licenses or knowledge that would qualify for a clean energy patent box is somewhat more difficult than defining clean energy per se, but nowhere near as complex as defining R&D. Targeting to clean energy can be accomplished by listing the eligible energy carriers for alternative fuels and the eligible improvements in products and characteristics that qualify as energy efficiency.

Defining IP itself appears to be the most profound weakness of patent boxes as more than another tool to be used in the international competition for high tech firms.

In the current setting for tax reform, where revenue estimates are critical to the viability of any proposal that would lose revenue, patent boxes also have a disadvantage in the difficulty of estimating revenue loss. This is not so much a problem of predicting the effectiveness of the patent box as it is in estimating what U..S companies baseline earnings from clean energy IP might be.

Therefore, this is a very interesting and potentially useful new approach to clean energy incentives, and has the additional advantage of encouraging licensing and sale of IP rather than retention as trade secrets used only in one company's products.

REVENUE NEUTRALITY AND R&D INCENTIVES

As long as deadlock in the Senate requires tax reform to be dealt with in a reconciliation bill, any proposal to increase R&D incentives needs a revenue offset. The carbon tax combined with increased credits for clean energy R&D or a patent box provides both enhanced incentives for R&D and a source of revenue.

Based on preliminary calculations, it is possible that the same incentive for R&D could be provided by a tax credit somewhat less than that currently in place. Taking into account just the lower tax rate that incremental profits attributable to R&D would pay, the net present value of after tax profits could be sustained with an R&D credit around 17%. If stronger incentives for R&D were desired, for example by increasing the regular R&E tax credit from 20% to 40% and the energy R&D credit from 20% to 70%, the loss of revenue would be about $10.5 billion annually. A tax on CO2 emissions of $10 per ton would apply to 5,500 million tons annually, and therefore raise about from $10.5 billion to $21 billion annually, which after the standard revenue estimator's 20% deduction for loss of other tax revenues comes out to a $44 billion net increase in revenue. Even if reforms to IRS rules for credits and R&D stimulated by the carbon tax doubled the revenue loss from the credits from $10.5 billion to $21 billion annually, more than half of the carbon tax revenues would be available to offset other parts of the tax reform package or to go toward a patent box for clean energy.

OPPORTUNITIES FOR CLEAN ENERGY INVESTMENTS

The tax reform package is purposely designed to increase investment across the board. Between 2007 and 2014, average gross fixed capital formation as a percent of GDP was just 19.4 percent, putting the U.S. behind its top 10 trading partners, except for the United Kingdom. Productivity growth has slowed from 2.7% in 2001 – 2007 to 1.1% from 2008 – 2016.[31] According to the Tax Foundation's Taxes and Growth Model, the House Republican tax plan would increase the long-run size of the economy by 9.1 percent over 10 years. The larger economy would result in 7.7 percent higher wages and a 28.3 percent larger capital stock. The plan would also result in 1.7 million more full-time equivalent jobs by 2025.

Since net private domestic investment has stagnated at about $450 billion since 2012,[32] continuation of that trend would increase the capital stock over the next 10 years by just $4 trillion. Estimating the U.S. capital stock at $52 trillion in 2016,[33] net private domestic investment would have to total $14 trillion over the next 10 years. Thus, the Tax Foundation estimates imply an increase in net private investment of about $10 trillion over the next 10 years, or about $1 trillion per year due to tax reform.

Net private domestic investment equals gross investment minus real economic depreciation of the capital stock. Thus the amount of new equipment added to the capital stock equals gross private domestic investment, which was $2.8 trillion in 2016. Note that these numbers imply that U.S. investment for the past 8 years has just barely exceeded retirement of existing capital.

Adding an additional $1 trillion of investment per year would increase the amount of new equipment being installed every year by about 35%. This increase of 35% in demand for new plant and equipment means that new technologies embodied in that equipment will also penetrate the market at a 35% faster rate. This acceleration will be a huge benefit to the penetration of new and cleaner energy technologies.

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31 *Bureau of Labor Statistics, Beyond the Numbers, January 2017 | Vol. 6 / No. 2*

32 *https://fred.stlouisfed.org/series/W790RC1Q027SBEA?utm_source=series_page&utm_medium=related_content&utm_term=related_resources&utm_campaign=categories*

33 *https://alfred.stlouisfed.org/series?seid=RKNANPUSA666NRUG&utm_source=series_page&utm_medium=related_content&utm_term=related_resources&utm_campaign=alfred*

Clean energy investment would benefit from the same incentives as other investment – higher after tax returns on investment, less bias against investments with relatively long pay-out periods, and greater competitive advantages of investing and producing in the United States due to the shift to a territorial tax system.

Higher growth in GDP will also produce faster growth in electricity demand and new car purchases, which will accelerate. New automobile designs and technology that improve fuel economy only enter the fleet through new car sales. If GDP grows by an additional 9.1% over the next decade and new car sales match that growth, there will be about 5% more new vehicles embodying new technology in the fleet by 2025.

Similarly for electricity, improved natural gas, combined cycle, wind and solar generating capacity become a larger fraction of the generating fleet as demand growth and capacity expansion speed up. Lower taxes and immediate expensing of new investment will also make retirement of existing units and replacement with new equipment embodying new technology more attractive. With a lower required return on new investment needed to achieve satisfactory after-tax returns to investors, the future cost savings from replacement will become more important relative to the capital cost of retiring an old unit and replacing it with a new one.
This combination of accelerated turnover and faster growth of the share of new equipment will be seen throughout the economy. All this will happen without any additional incentives.

Energy tax credits or a variant of the patent box could be expanded to include all investments in clean energy or based on new clean energy technology, but that preference would likely run afoul of the basic principles behind the current tax reform plan. Current tax credits for renewables could be expanded to other investments that reduce greenhouse gas emissions, and the size of the credits could be tied to their relative effectiveness in reducing those emissions. This is particularly important because existing tax incentives apply only to renewables, but natural gas, nuclear power, carbon capture and sequestration and energy efficiency could all lower CO2 emissions relative to current uses of petroleum and coal.

As in the patent box idea, preferential income tax rates could also be applied to the income from application of clean energy technologies, with the magnitude of tax reductions tied to relative performance in reducing emissions. This approach would be superior to tax credits in that it would only reward successful projects and would favor those that are most profitable. However, with lower tax rates overall, the magnitude of the subsidy would be limited to taxes due under normal rates.

Either of these approaches would invite controversies over defining clean energy investment and picking winners in clean energy technology. They would also build special preferences back into the tax code, with all the accompanying complexities of definitions and potential for tax avoidance or fraud, contrary to the basic purpose of tax reform.

APPENDIX A

DEFINITIONS

SUPER CREDIT: A tax credit for R&D that gives credit for more than 100% of eligible expenses.

PATENT BOX: A special lower rate for income derived from the development of intellectual property (which could include copyrights, trademarks, trade secrets, secret formulas or processes, know-how, and other forms of innovation).

NEXUS: Rule that in order to take an IP tax break, the research and development or manufacturing that gave rise to the IP must be completed in whole or in part within the host country.

BORDER ADJUSTMENT: A provision in the Blueprint that makes cost of imported goods and services non-deductible and excludes revenue from exports from taxable income.

TERRITORIAL TAX SYSTEM: One which taxes business income based on where products are sold rather than where they are produced.

R&D DATA

TABLE 1. U.S. GROSS DOMESTIC PRODUCT, R&D, AND RATIO OF R&D TO GROSS DOMESTIC PRODUCT (AND COMPONENTS): 1953–2015

YEAR	GDP			TOTAL R&D		R&D/GDP (%)							
						R&D, by performer				R&D, by source of funding			
Year	Current $billions	Constant 2009 $billions	Deflator[a] (2009 = 1.00000)	Current $billions	Constant 2009 $billions	Total	Business	Federal[b]	Higher education	Other[c]	Business	Federal	Other[d]
1989	5,657.7	8,786.4	0.64392	141.9	220.4	2.51	1.77	0.40	0.28	0.06	1.33	1.07	0.11
1990	5,979.6	8,955.0	0.66774	152.0	227.6	2.54	1.80	0.39	0.28	0.07	1.39	1.03	0.12
1991	6,174.0	8,948.4	0.68996	160.9	233.2	2.61	1.86	0.38	0.29	0.08	1.49	0.98	0.13
1992	6,539.3	9,266.6	0.70568	165.4	234.3	2.53	1.79	0.37	0.30	0.08	1.47	0.93	0.13
1993	6,878.7	9,521.0	0.72248	165.7	229.4	2.41	1.68	0.36	0.30	0.08	1.40	0.88	0.13
1994	7,308.8	9,905.4	0.73786	169.2	229.3	2.32	1.61	0.34	0.30	0.08	1.36	0.83	0.13
1995	7,664.1	10,174.8	0.75324	183.6	243.8	2.40	1.69	0.33	0.30	0.08	1.45	0.82	0.13
1996	8,100.2	10,561.0	0.76699	197.3	257.3	2.44	1.76	0.31	0.29	0.08	1.52	0.78	0.13
1997	8,608.5	11,034.9	0.78012	212.2	271.9	2.46	1.81	0.29	0.29	0.08	1.58	0.75	0.13
1998	9,089.2	11,525.9	0.78859	226.5	287.2	2.49	1.84	0.28	0.29	0.08	1.63	0.73	0.13
1999	9,660.6	12,065.9	0.80065	245.3	306.4	2.54	1.88	0.28	0.29	0.08	1.70	0.70	0.14
2000	10,284.8	12,559.7	0.81887	268.9	328.4	2.61	1.94	0.28	0.30	0.09	1.81	0.66	0.15
2001	10,621.8	12,682.2	0.83754	279.7	334.0	2.63	1.90	0.31	0.32	0.11	1.77	0.70	0.16
2002	10,977.5	12,908.8	0.85039	279.4	328.5	2.55	1.77	0.32	0.35	0.11	1.65	0.73	0.17
2003	11,510.7	13,271.1	0.86735	293.1	337.9	2.55	1.74	0.32	0.36	0.11	1.62	0.75	0.18
2004	12,274.9	13,773.5	0.89120	304.5	341.7	2.48	1.70	0.31	0.36	0.11	1.56	0.75	0.17
2005	13,093.7	14,234.2	0.91988	327.2	355.7	2.50	1.73	0.30	0.36	0.11	1.59	0.74	0.17
2006	13,855.9	14,613.8	0.94814	352.9	372.2	2.55	1.79	0.30	0.35	0.11	1.64	0.73	0.18
2007	14,477.6	14,873.7	0.97337	380.0	390.4	2.62	1.86	0.30	0.35	0.11	1.71	0.74	0.18
2008	14,718.6	14,830.4	0.99246	407.0	410.0	2.76	1.97	0.31	0.37	0.11	1.75	0.81	0.20
2009	14,418.7	14,418.7	1.00000	405.3	405.3	2.81	1.96	0.33	0.40	0.13	1.71	0.88	0.22
2010	14,964.4	14,783.8	1.01222	409.0	404.1	2.73	1.86	0.34	0.40	0.13	1.66	0.86	0.22
2011	15,517.9	15,020.6	1.03311	428.7	414.9	2.76	1.90	0.34	0.40	0.12	1.72	0.83	0.21
2012	16,155.3	15,354.6	1.05215	436.2	414.5	2.70	1.87	0.32	0.39	0.11	1.71	0.78	0.21
2013	16,663.2	15,583.3	1.06930	456.6	427.0	2.74	1.94	0.31	0.38	0.11	1.78	0.73	0.22
2014e	17,348.1	15,961.7	1.08686	477.7	439.5	2.75	1.96	0.30	0.37	0.12	1.84	0.69	0.23
2015f	17,937.8	16,341.8	1.09766	499.3	454.9	2.78	2.00	0.29	0.37	0.11	1.92	0.63	0.23

Source: National Science Foundation. https://www.nsf.gov/statistics/2017/nsf17311/pdf/tab1.pdf

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