PRESENT LAW AND ANALYSIS OF ENERGY-RELATED TAX EXPENDITURES

Scheduled for a Public Hearing
Before the
SENATE COMMITTEE ON FINANCE
on June 14, 2016

Prepared by the Staff
of the
JOINT COMMITTEE ON TAXATION

June 9, 2016
JCX-46-16

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INTRODUCTION AND SUMMARY

The Senate Committee on Finance has scheduled a public hearing for June 14, 2016, on energy-related tax incentives.

Since 2004, the Congress has been active in enacting legislation related to energy production (including oil and gas and renewables) and conservation. Part I of this document,[1] prepared by the staff of the Joint Committee on Taxation, provides tables that summarize current energy-related Federal tax incentives.

Part II of this document provides a brief discussion of the economic rationale for certain government intervention in energy markets through the tax code and issues related to the proper design of such tax preferences. These tax expenditures create incentives that have the potential to affect economic decisions and allocate economic resources from other uses to the tax-favored uses. Such tax preferences may produce an allocation of resources that is more efficient for society at large if they are properly designed to overcome negative effects (such as atmospheric pollution, for example) that would otherwise result from a purely market based outcome without any government intervention. Tax expenditures for energy production and conservation have been criticized for lacking well defined objectives, and for lacking coordination among provisions having similar objectives. Some argue that the simultaneous existence of tax preferences for the fossil fuel industry and for renewable energy production represents conflicting government policy. Others have noted that the incentives for renewable energy and conservation are not themselves designed in a coordinated way to produce the most efficient or equitable subsidies for renewable energy and conservation.

[1] This document may be cited as follows: Joint Committee on Taxation, *Present Law and Analysis of Energy-Related Tax Expenditures* (JCX-46-16), June 9, 2016. This document can also be found on the Joint Committee on Taxation website at www.jct.gov.

I. CURRENT AND RECENTLY EXPIRED ENERGY-RELATED TAX EXPENDITURES

A. Summary of Credit for Electricity Produced from Certain Renewable Resources		
Eligible Electricity Production Activity (sec. 45)[2]	**Credit Rate for 2016[3] (cents per kilowatt-hour)**	**Expiration[4]**
Wind	2.3	December 31, 2019
Closed-loop biomass	2.3	December 31, 2016
Open-loop biomass	1.2	December 31, 2016
Geothermal	2.3	December 31, 2016
Municipal solid waste (including landfill gas facilities and trash combustion facilities)	1.2	December 31, 2016
Qualified hydropower	1.2	December 31, 2016
Marine and hydrokinetic	1.2	December 31, 2016

[2] Except where otherwise provided, all section references are to the Internal Revenue Code of 1986, as amended.

[3] Credit rates are adjusted annually for inflation. See IRS Notice 2016-34. In general, the credit is available for electricity produced during the first 10 years after a facility has been placed in service. Taxpayers may also elect to get a 30-percent investment tax credit in lieu of this production tax credit. In the case of wind facilities, the available production tax credit or investment tax credit is reduced by 20 percent for facilities the construction of which begins in 2017, by 40 percent for facilities the construction of which begins in 2018, and by 60 percent for facilities the construction of which begins in 2019.

[4] Expires for property the construction of which begins after this date.

B. Summary of Certain Renewable and Alternative Fuel Incentives		
Fuel Type	**Per Gallon Incentive Amount**	**Expiration**
Agri-biodiesel and biodiesel (secs. 40A, 6426, and 6427)	$1.00 per gallon, plus $0.10 per gallon for small agri-biodiesel producers	December 31, 2016
Renewable diesel (secs. 40A, 6426, and 6427)	$1.00 per gallon	December 31, 2016
Second generation biofuel (cellulosic and algae) (sec. 40(b)(6))	$1.01 per gallon	December 31, 2016
Alternative fuel (secs. 6426 and 6427):[5] • **liquefied petroleum gas** • **P Series Fuels** • **compressed or liquefied natural gas** • **liquefied hydrogen** • **any liquid fuel derived from coal through the Fischer-Tropsch process** • **compressed or liquefied gas derived from biomass** • **liquid fuel derived from biomass**	$0.50 per gallon	December 31, 2016

[5] The refundable component of the alternative fuel mixture credit sunset for alternative fuel mixtures sold or used after December 31, 2011 (sec. 6427(e)(6)(D)).

C. Summary of Investment Tax Credits for Energy Production Property			
Qualified Energy Property (sec. 48)	**Credit Rate**	**Maximum Credit**	**Expiration[6]**
Equipment to produce energy from a geothermal deposit	30% (in lieu of production tax credit)	None	December 31, 2016
	10%		None
Equipment to use ground or ground water for heating or cooling	10%	None	December 31, 2016
Equipment that uses fiber-optics to distribute sunlight inside a structure	30%	None	December 31, 2016
Microturbine property (< 2 megawatt electrical generation power plants of ≥26% efficiency)	10%	$200 per kilowatt of capacity	December 31, 2016
Combined heat and power property (simultaneous production of electrical/mechanical power and useful heat > 60% efficiency)	10%	None	December 31, 2016
Solar electric or solar hot water property	30%	None	December 31, 2019
	26%		December 31, 2020
	22%		December 31, 2021
	10%		None
Fuel cell property (generates electricity through electrochemical process)	30%	$1,500 for each ½ kilowatt of capacity	December 31, 2016

[6] Property must be placed in service by this date for equipment that uses ground or ground water for heating or cooling, combined heat and power property, fuel cell property, and small wind electrical generation property. For all other eligible property, construction of the property must begin by the expiration date.

C. Summary of Investment Tax Credits for Energy Production Property			
Qualified Energy Property (sec. 48)	**Credit Rate**	**Maximum Credit**	**Expiration[6]**
Small (<100 kilowatt capacity) wind electrical generation property	30%	None	December 31, 2016
Wind, biomass, municipal solid waste, qualified hydropower, and marine and hydrokinetic property	30% (in lieu of production tax credit)	None	December 31, 2016

D. Summary of Energy Conservation and Residential Power Credits				
		Credit Rate or Amount	**Maximum Credit**	**Expiration**[7]
Personal credits:				
Credit for nonbusiness energy property installed at a principal residence (sec. 25C)	Insulation to 2009 international energy conservation code standard	10%	$500 (overall 25C credit maximum)	December 31, 2016
	Energy efficient windows, doors, skylights, roofs	10%	$500 ($200 for windows and skylights)	December 31, 2016
	Advanced main air circulating fans	100%	$50	December 31, 2016
	Qualified natural gas, propane, or oil furnace or hot water boilers	100%	$150	December 31, 2016
	Qualified electric heat pump water heaters or natural gas, propane, or oil water heaters	100%	$300	December 31, 2016
	Qualified central air conditioners	100%	$300	December 31, 2016
	Qualified biomass fuel property (wood stoves)	100%	$300	December 31, 2016
Credit for residential energy efficient property (sec. 25D)	Residential solar water heating or solar electric property	30%	None	December 31, 2019
		26%		December 31, 2020
		22%		December 31, 2021
	Residential small wind property	30%	None	December 31, 2016
	Residential geothermal heat pump property	30%	None	December 31, 2016
	Residential fuel cell property	30%	$500 per ½ kilowatt of capacity	December 31, 2016

[7] Expires for property placed in service after the expiration date.

Summary of Energy Conservation and Residential Power Credits (cont'd)				
		Credit Rate or Amount	**Maximum Credit**	**Expiration**[7]
Business Credits:				
Manufacturer credit for new energy efficient home (sec. 45L)	Homes 30% more efficient than standard	$1,000 per home	None	December 31, 2016
	Homes 50% more efficient than standard	$2,000 per home	None	December 31, 2016

E. Summary of Alternative Fuel Vehicle Credits			
Type of Property	**Description of Qualifying Property**	**Credit Amount and Explanation**	**Expiration**
Fuel cell vehicles (sec. 30B)	Vehicles propelled by chemically combining oxygen with hydrogen and creating electricity	• Base credit of $4,000 for vehicles weighing 8,500 pounds or less • Heavier vehicles can get up to a $40,000 credit, depending on weight • An additional $1,000 to $4,000 credit is available to cars and light trucks to the extent fuel economy exceeds 2002 base fuel economy	December 31, 2016
Alternative fuel refueling property (sec. 30C)	Property that dispenses alternative fuels, including ethanol, biodiesel, natural gas, hydrogen, and electricity	30-percent credit up to $30,000 for business property and $1,000 for property installed at a principal residence	December 31, 2016
Plug-in electric-drive motor vehicles (sec. 30D)	Four-wheeled vehicles (excluding low speed vehicles and vehicles weighing 14,000 or more) propelled by a battery with at least 4 kilowatt-hours of electricity that can be charged from an external source	Base credit of $2,500, plus $417 for each kilowatt-hour of additional battery capacity in excess of 4 kilowatt-hours, up to a maximum credit of $7,500	200,000 vehicle per manufacturer limitation
Plug-in electric-drive motorcycles (sec. 30D)	Two-wheeled vehicles able to achieve speeds of at least 45 miles per hour propelled by a battery with at least 2.5 kilowatt-hours of electricity that can be charged from an external source	Credit is 10 percent of cost, up to $2,500	December 31, 2016

F. Summary of Certain Non-Fossil Fuel Capital Cost Recovery Provisions		
Eligible Activity	**Description of Provision**	**Expiration**
Five-year cost recovery for certain energy property (secs. 168(e)(3)(B)(vi) and 48(a)(3)(A))	• A five-year Modified Accelerated Cost Recovery System ("MACRS") recovery period is generally provided for equipment using solar and wind energy to generate electricity (*e.g.*, solar panels), to heat or cool (or provide hot water for use in) a structure, or to provide solar (or wind) process heat; equipment using solar energy to illuminate the inside of a structure using fiber-optic distributed sunlight; equipment used to produce, distribute, or use energy derived from a geothermal deposit; qualified fuel cell or microturbine property; combined heat and power system property; qualified small wind energy property; and equipment using the ground or ground water as a thermal energy source (or sink) to heat (or cool) a structure • A five-year MACRS recovery period is also provided for certain small power production biomass facilities (*i.e.*, a qualifying small power production facility within the meaning of section 3(17)(C) of the Federal Power Act (16 U.S.C. 796 (17)(C)), as in effect on September 1, 1986, that also qualifies as certain biomass property, including (i) a boiler, the primary fuel for which will be an alternate substance; (ii) a burner (including necessary on-site equipment to bring the alternate substance to the burner) for a combustor other than a boiler if the primary fuel for such burner will be an alternate substance; (iii) equipment for converting an alternate substance into a qualified fuel; (iv) certain pollution control equipment; and (v) equipment used for the unloading, transfer, storage, reclaiming from storage, and preparation (including, but not limited to, washing, crushing, drying, and weighing) at the point of use of an alternative substance for use in equipment described in (i), (ii) or (iii))	December 31, 2016, for the following property: • Fiber-optic solar energy equipment • Qualified fuel cell and microturbine property, • Combined heat and power system property, and • Thermal energy equipment using ground or ground water
Special allowance for second generation biofuel plant property (sec. 168(l))	A taxpayer may deduct in the placed-in-service year an additional first-year depreciation deduction equal to 50 percent of the adjusted basis of qualified cellulosic biofuel plant property; the remaining 50 percent is recovered under otherwise applicable rules	December 31, 2016

Summary of Certain Non-Fossil Fuel Capital Cost Recovery Provisions (cont'd)		
Eligible Activity	**Description of Provision**	**Expiration**
Pollution control facilities (secs. 169 and 291(a)(4))	A taxpayer may elect to recover the cost of a certified pollution control facility over a period of 60 months (84 months in the case of certain atmospheric pollution control facilities used in connection with a power plant or other property that is primarily coal-fired). A corporation must reduce the amount of basis otherwise eligible for the 60-month (or 84-month) recovery by 20 percent	None
Energy efficient commercial buildings deduction (sec. 179D)	A taxpayer may take in the placed-in-service year an additional deduction of $1.80 per square foot of commercial building property that exceeds certain energy efficiency standards. If a section 179D deduction is allowed, the basis of the property is reduced by the amount of the deduction; the remaining basis is recovered under otherwise applicable rules	December 31, 2016

G. Summary of Fossil Fuel Capital Cost Recovery Provisions		
Eligible Activity	**Description of Provision**	**Expiration**
Geological & geophysical expenditures (sec. 167(h))	• Geological and geophysical ("G&G") expenditures (*e.g.*, expenditures for geologists, seismic surveys, gravity meter surveys, and magnetic surveys) incurred by independent producers and smaller integrated oil companies in connection with domestic oil and gas exploration may be amortized over 24 months • G&G expenditures incurred by major integrated oil companies are amortized over seven years • No expensing of abandoned property	None
Alaska natural gas pipeline (secs. 168(e)(3)(C)(iii), 168(g)(3)(B), and 168(i)(16))	A seven-year MACRS recovery period and a class life of 22 years is provided for any natural gas pipeline system located in the State of Alaska that has a capacity of more than 500 billion Btu of natural gas per day and either is placed in service after December 31, 2013 or the taxpayer elects to treat the system as placed in service on January 1, 2014 (to the extent the system was placed in service before January 1, 2014).	None
Natural gas gathering lines (secs. 168(e)(3)(C)(iv) and 168(g)(3)(B))	A seven-year MACRS recovery period and 14-year class life is provided for natural gas gathering pipelines placed in service after April 11, 2005	None
Deduction for tertiary injectants (sec. 193)	Taxpayers engaged in petroleum extraction activities may generally deduct qualified tertiary injectant expenses paid or incurred while applying a tertiary recovery method	None
Election to expense intangible drilling costs (secs. 263(c) and 291)	Taxpayers may elect to currently deduct intangible drilling costs (IDCs) paid or incurred with respect to the development of an oil or gas property located in the United States. For an integrated oil company that has elected to expense IDCs, 30 percent of the IDCs on productive wells must be capitalized and amortized over a 60-month period	None

Summary of Fossil Fuel Capital Cost Recovery Provisions (cont'd)		
Eligible Activity	**Description of Provision**	**Expiration**
Depletion (secs. 611-613A and 291)	• Depletion is available to any person having an economic interest in a producing mine or oil and gas property (*e.g.*, a working or royalty interest in an oil- or gas-producing property). There generally are two types of depletion--cost and percentage depletion • Under the cost depletion method, the taxpayer deducts that portion of the adjusted basis of the depletable property which is equal to the ratio of units sold from that property during the taxable year relative to the number of units remaining as of the end of taxable year plus the number of units sold during the taxable year • Under the percentage depletion method, a percentage, varying from five percent to 22 percent (generally 15 percent for oil and gas properties), of the taxpayer's gross income from a producing property is allowed as a deduction in each taxable year. The amount deducted generally may not exceed 50 percent (100 percent in the case of oil and gas properties) of the net income from the oil and gas property in any year (the "net-income limitation") • Additionally, the percentage depletion deduction for all oil and gas properties may not exceed 65 percent of the taxpayer's overall taxable income for the year (determined before such deduction, as well as before any deduction allowable under section 199, and adjusted for certain loss carrybacks and trust distributions) • Cost depletion is limited to the taxpayer's basis in the property, whereas percentage depletion is not limited by the basis, but is subject to limitations based on net income derived from the property and taxable income • Percentage depletion for producing oil and gas property (15-percent rate) is available only to independent producers and royalty owners. Integrated oil and gas companies must use cost depletion. Generally, an integrated oil company is a producer of crude oil that engages in the refining or retail sale of petroleum products in excess of certain threshold amounts	None

Summary of Fossil Fuel Capital Cost Recovery Provisions (cont'd)		
Eligible Activity	**Description of Provision**	**Expiration**
Depletion (secs. 611-613A and 291) (cont.)	• Percentage depletion is also available for coal and lignite (10-percent rate) and oil shale (15-percent rate). The percentage depletion deduction for coal and lignite is generally reduced for corporations by an amount equal to 20 percent of the percentage depletion that exceeds the adjusted basis of the property • Percentage depletion is not available to individuals where capital gains rates apply under section 631(c)	None

H. Summary of Fossil Fuel Capital Gains Treatment		
Eligible Activity	**Description of Provision**	**Expiration**
Capital gains treatment of certain coal royalties (sec. 631(c))	• In the case of the disposal of coal (including lignite) mined in the United States, held for more than one year prior to disposal, by the owner in a form under which the owner retains an economic interest in such coal, the excess of the amount realized from the sale over the adjusted depletable basis of the coal (plus certain disallowed deductions) is treated as from the sale of property used in the owner's trade or business (*i.e.*, the sale of section 1231 property) • If the owner's net section 1231 gains, including royalties from eligible coal disposals, exceed its section 1231 losses, the royalties are treated as capital gains • Where individual capital gains rates apply, percentage depletion is not available	None

I. Summary of Energy Credits Related to Fossil Fuels			
Eligible Activity	**Description**	**Credit Amount**	**Expiration**
Enhanced oil recovery (EOR) credit (sec. 43)	• Credit for expenses associated with an EOR project • An EOR project is generally a project that involves the use of one or more tertiary recovery methods to increase the amount of recoverable domestic crude oil	• 15 percent of enhanced oil recovery costs	None
Marginal wells credit (sec. 45I)	Production credit for marginal wells or wells that have an average daily production of not more than 25 barrels per day	• \$3-per-barrel credit (adjusted for inflation from 2004) for the production of crude oil from marginal wells • \$0.50-per-1,000-cubic-feet credit (adjusted for inflation from 2004) for the production of natural gas from a marginal wells	None
Indian coal credit (sec. 45)	Production credit for coal produced from reserves that on June 14, 2005, were owned by (or held in trust on behalf of) an Indian tribe	• \$2-per-ton credit (adjusted for inflation; \$2.387 per ton for 2016)	December 31, 2016
Advanced coal project credit (sec. 48A)	• Investment credit for projects that use integrated gasification combined cycle (IGCC) or other advanced coal-based electricity generation technologies • Credits are allocated by the Secretary • First round allocations are capped at \$800 million for IGCC projects and \$500 million for other projects • Second round allocations are capped at \$1.25 billion • Second round projects must generally sequester 65 percent of total CO_2 emissions (70 percent in the case of reallocated credits) • All credits have been fully allocated	• 20 percent for first round IGCC projects • 15 percent for other first round projects • 30 percent for second round projects	None

Summary of Energy Credits Related to Fossil Fuels (cont'd)			
Eligible Activity	**Description**	**Credit Amount**	**Expiration**
Gasification credit (sec. 48B)	• Investment credit for qualified projects that use gasification technology • Qualified projects convert coal, petroleum residue, biomass, or other materials recovered for their energy content into a synthesis gas for direct use or subsequent chemical or physical conversion • Credits are allocated by the Secretary • First round allocations are capped at $350 million • Second round allocations are capped at $250 million • First round projects are generally limited to industrial applications; second round projects include projects designed to produce motor fuels • Second round projects must generally sequester 65 percent of total CO_2 emissions • All credits have been fully allocated	• 20 percent for first round • 30 percent for second round	None

J. Summary of Energy-Related Bond Provisions	
Type of Bond	**Description**
New Clean Renewable Energy Bonds ("New CREBs") (sec. 54C)	• Tax credit bond • New CREBs may be issued to finance "qualified renewable energy facilities." Qualified renewable energy facilities are facilities that qualify for the tax credit under section 45(d) (other than Indian coal and refined coal production facilities and without regard to any placed in service dates) and are owned by a public power provider, a governmental body or a cooperative electric company. • Credit rate is 70 percent of the rate that permits issuance of bonds without discount and interest cost to the issuer • Qualified issuers include electrical cooperatives, clean renewable energy bond lenders, public power providers, State and local governments (including Indian tribes), and not-for-profit electric utilities which have a loan or loan guarantee under the Rural Electrification Act • Volume limited ($2.4. billion)[8]
Qualified Energy Conservation Tax Credit Bonds ("QECs") (sec. 54D)	• Tax credit bond • Bond issuance must be used for "qualified conservation purposes" • Credit rate is 70 percent of the rate that permits issuance of bonds without discount and interest cost to the issuer • Volume limited ($3.2 billion) and allocated by the Secretary of the Treasury generally in proportion to State population
Tax-exempt bonds for certain public energy-related projects (sec. 103)	• Tax-exempt governmental bond • May be used for financing government-owned and operated electrical and gas powered generation, transmission and distribution facilities • Not subject to any volume caps

[8] But see Internal Revenue Service, *Published Volume Cap Limits and Available Amounts of Volume Caps for New Clean Renewable Energy Bonds* (updated May 10, 2016) regarding amounts of available volume cap: "For projects to be owned by governmental bodies the Published Volume Cap Limit for the period commencing May 1, 2016, is $85,457,185.86 and the amount of available volume cap, as of May 1, 2016, is $427,285,929.30. For projects to be owned by cooperative electric companies the Published Volume Cap Limit for the period commencing May 1, 2016 is $40,624,555.04 and the amount of available volume cap, as of May 1, 2016, is $203,122,775.20." https://www.irs.gov/Tax-Exempt-Bonds/Published-Volume-Cap-Limits-and-Available-Amounts-of-Volume-Caps-for-New-Clean-Renewable-Energy-Bonds.

Summary of Energy-Related Bond Provisions (cont'd)	
Type of Bond	**Description**
Tax-exempt bonds for certain private energy-related projects (secs. 141 and 142)	• Tax-exempt qualified private activity bond • May be used for financing certain exempt facilities including privately owned and/or operated utility facilities (local district heating and cooling facilities, certain private electric and gas facilities, and hydroelectric dam enhancements); qualified green building and sustainable design projects • Generally subject to private activity volume cap
Safe harbor from arbitrage rules for prepaid natural gas (sec. 148)	• Allows tax-exempt bonds to be used to finance prepaid natural gas contracts without application of the otherwise applicable arbitrage rules

K. Summary of Other Energy Provisions			
Eligible Activity	**Description**	**Credit Amount**	**Expiration**
Energy research credit (sec. 41)	• Flat-rate (*i.e.* non-incremental) credit for payments made to energy research consortia for qualified energy research • Includes research related to fossil fuels as well as to renewable energy technologies	20 percent of qualified expenses	None
Advanced nuclear power production credit (sec. 45J)	• Credit for production of nuclear power from new facilities that use modern designs and have received an allocation from the Secretary • Secretary may allocate up 6,000 megawatts of credit-eligible capacity	1.8 cents per kilowatt-hour for the eight-year period starting when the facility was placed in service	Qualified facilities must have been placed in service by December 31, 2020
Carbon dioxide sequestration credit (sec. 45Q)	• Credit for the sequestration of industrial source carbon dioxide produced at qualified U.S. facilities • Qualified facilities must capture at least 500,000 metric tons of CO_2 per year	• \$10 per metric ton for CO_2 used as a tertiary injectant and then permanently sequestered (adjusted for inflation: \$10.92 for 2015) • \$20 per metric ton for CO_2 permanently sequestered without being first used as a tertiary injectant (adjusted for inflation: \$21.85 for 2015)	End of the year in which the Secretary determines that 75 million metric tons of CO_2 have been captured and sequestered (as of June 9, 2015, approximately 35 million tons of credit-eligible CO_2 had been sequestered)

Summary of Other Energy Provisions (cont'd)			
Eligible Activity	**Description**	**Credit Amount**	**Expiration**
Advanced energy project credit (sec. 48C)	• Investment credit for qualified projects that re-equip, expand, or establish a manufacturing facility for the production of specified energy related products • Credits are allocated by the Secretary and are capped at $2.3 billion • All credits have been fully allocated	30 percent	None
Energy conservation subsidies provided by public utilities (sec. 136)	• Energy conservation subsidies provided by public utilities are excluded from gross income	N/A	None
Domestic production deduction (sec. 199)	• Taxpayers generally are permitted a deduction equal to nine percent of the lesser of qualified production activities income ("QPAI") or taxable income (not to exceed 50 percent of qualifying W-2 wages) • If a taxpayer has oil related QPAI, the deduction is reduced by three percent of the least of the taxpayer's oil related QPAI, QPAI, or taxable income • In computing oil related QPAI (and QPAI), independent refiners only allocate 25 percent of oil related transportation costs to domestic production gross receipts	N/A	December 31, 2021 with respect to the treatment of transportation costs of independent refiners
Deferral of gains from the sale of electric transmission property (sec. 451(i))	• A taxpayer may elect to recognize gain ratably over an eight year period for gains on disposition of certain electric transmission property	N/A	December 31, 2016

Summary of Other Energy Provisions (cont'd)			
Eligible Activity	**Description**	**Credit Amount**	**Expiration**
Passive loss rules for working interests in oil and gas property (sec. 469)	• Passive activity loss rules not applicable to working interest in any oil or gas property that taxpayer holds directly or indirectly through an entity that does not limit the taxpayer's liability • Losses and credits from such interests, in general, may offset income from other activities of taxpayer	N/A	None
Reduced rate of tax for alcohol from natural gas ("partially exempt methanol or ethanol") (sec. 4041(m))	• Taxed at 9.15 cents per gallon (alcohols other than ethanol) • Taxed at 11.3 cents per gallon (ethanol)	N/A	After September 30, 2022, the rates of tax are 2.15 cents per gallon for alcohols other than ethanol and 4.3 cents per gallon for ethanol
Reduced tax for diesel-water fuel emulsion (secs. 4081(a)(2)(D), 4081(c) and 6427(m))	• Diesel fuel tax rate of 24.3 cents per gallon is reduced to 19.7 cents per gallon for diesel-water fuel emulsions to reflect the reduced Btu content per gallon resulting from the water • Refund of the difference between the two rates is available to the extent tax-paid diesel is used to produce a qualifying emulsion diesel fuel	N/A	None
Certain publicly traded partnerships treated as corporations (secs. 7704 and 851)	• General rule that a publicly traded partnership is taxed as a corporation is not applicable if 90 percent of gross income is interest, dividends, real property rents, or certain other types of qualifying income • Other types of qualifying income includes income and gains from certain activities with respect to natural resources	N/A	None

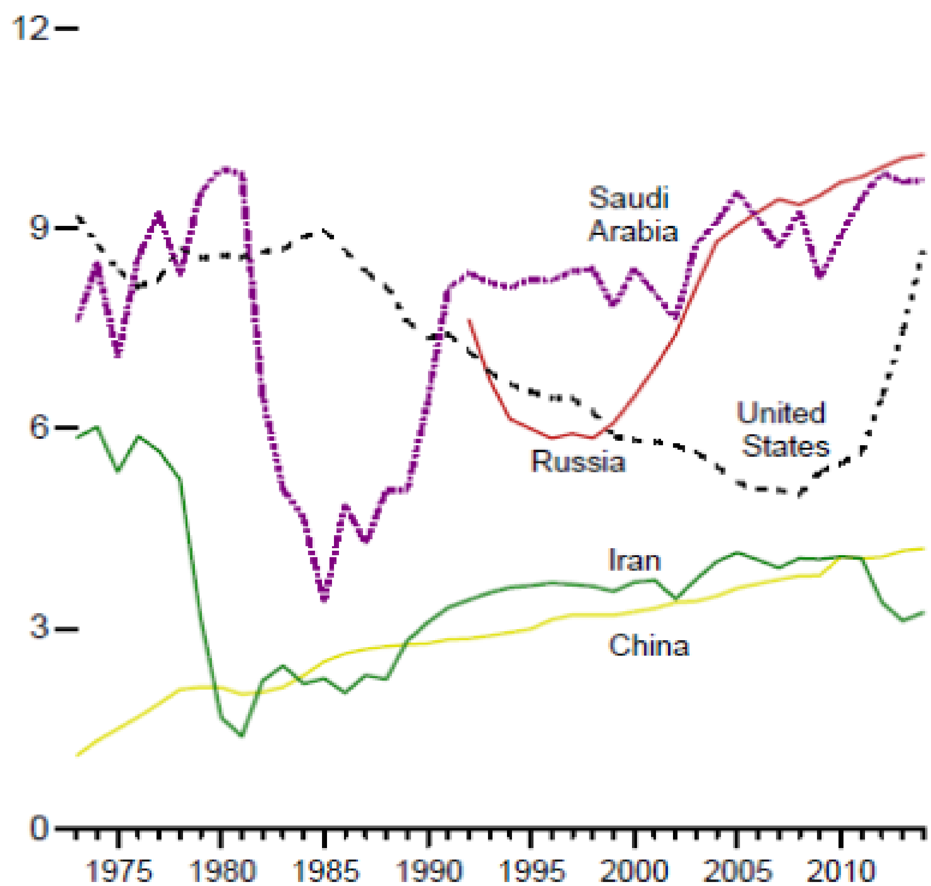
II. DATA AND ANALYSIS

A. Overview of Domestic Oil, Natural Gas, Coal and Renewable Energy Production

Oil and natural gas production

Despite having only 1.3 percent of the world's oil reserves,[9] the United States remains one of the largest oil producers in the world.

Figure 1.−Crude Oil Production in Selected Countries: 1973-2015 (millions of barrels per day)

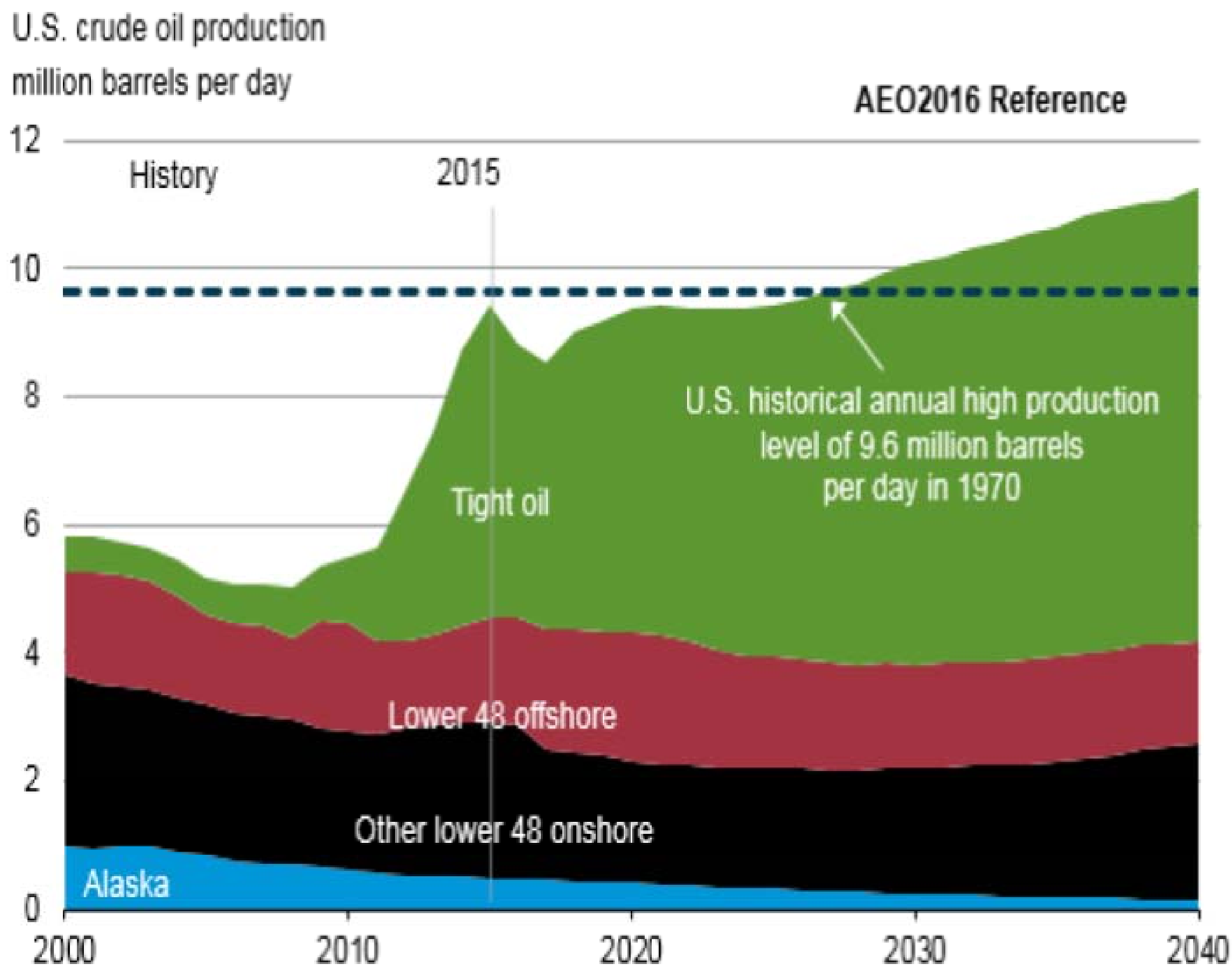


Source: Energy Information Administration, *Monthly Energy Review*, February 2016, Figure 11.1a, p. 164.

[9] Energy Information Administration, *International Energy Outlook 2013*, July 2013, Table 6, p. 37.

Until the middle of the last decade, domestic oil production had been declining steadily since in the mid-1980s. Production has increased significantly over the past several years, largely as a result of tight oil development.[10]

Figure 2.−Projected Domestic Crude Oil Production by Source, 2000-2040 (millions of barrels per day)



Source: Energy Information Administration, *Annual Energy Outlook 2016 Early Release: Annotated Summary of Two Cases*, May 17, 2016, p. 44.

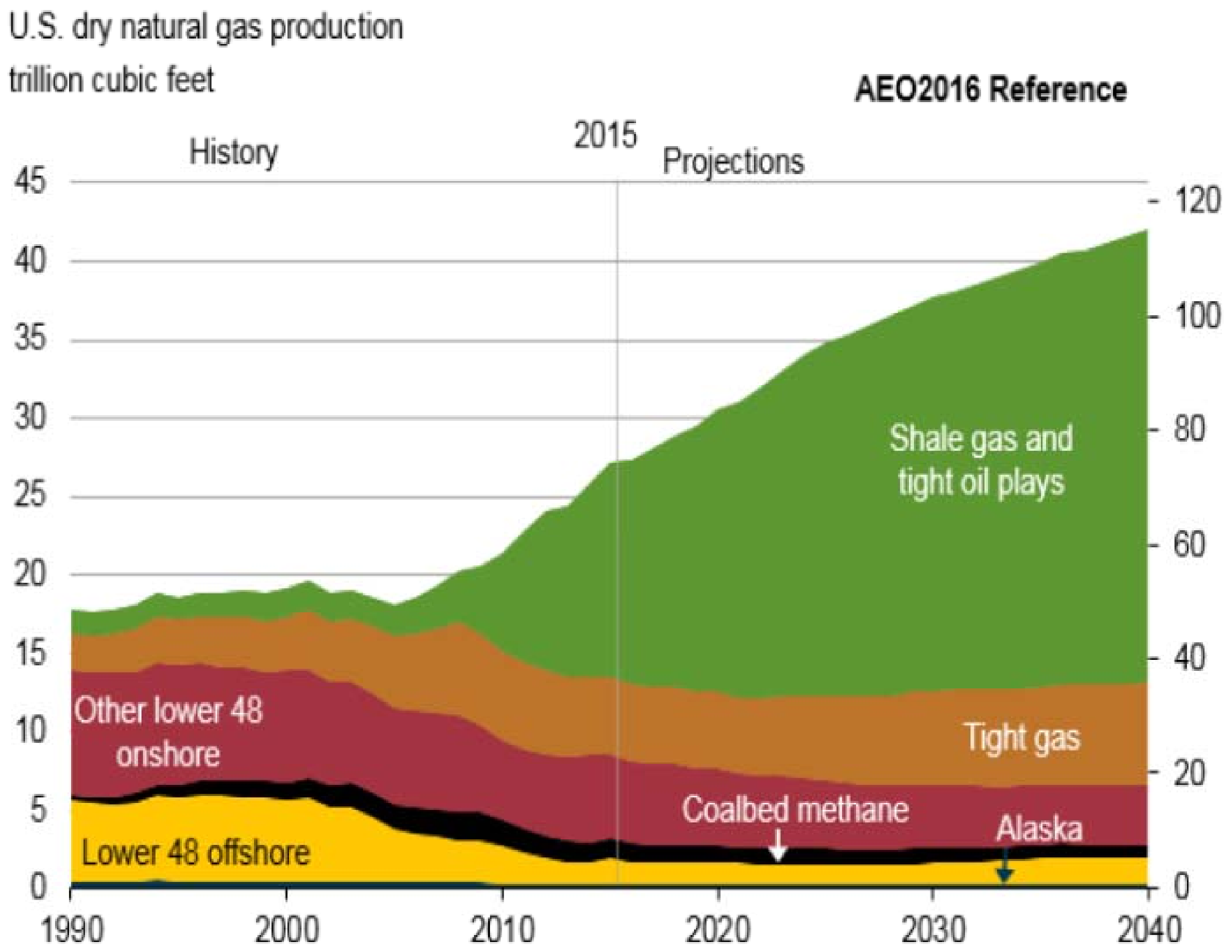
The United States has a slightly larger share of the world's natural gas reserves compared to oil reserves but it still amounts to only four percent of the global total.[11] Domestic production

[10] Energy Information Administration, *Annual Energy Outlook 2014*, April 2014, p. MT-27.

[11] Energy Information Administration, *International Energy Outlook 2013,* July 2013, Table 9, p. 63.

of natural gas is expected to increase significantly over the next 25 years, with much of the increase attributable to natural gas produced from shale formations.[12]

Figure 3.−Projected Domestic Natural Gas Production by Source, 1990-2040 (trillions of cubic feet per day)



Source: Energy Information Administration, *Annual Energy Outlook 2016 Early Release: Annotated Summary of Two Cases*, May 17, 2016, p. 53.

The oil and gas industry continues to be a large employer in the United States. In May 2016, the domestic oil and gas extraction sector employed a seasonally adjusted average of 173,900 workers.[13]

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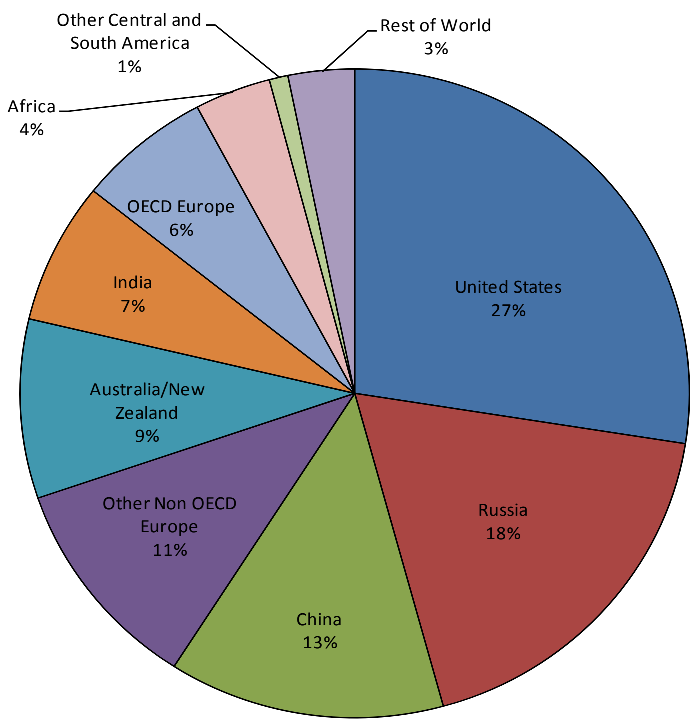
[12] Energy Information Administration, *Annual Energy Outlook 2015*, April 2015, p. 20.

[13] Bureau of Labor Statistics, *The Employment Situation: May 2016*, June 3, 2016, Table B-1.

Coal production

As with oil, the United States is one of the biggest producers of coal in the world.[14] Unlike with oil, however, and as illustrated below, the United States has by a substantial margin the world's largest coal reserves.

Figure 4.−Estimated World Coal Reserves by Country



Source: Generated using data from the Energy Information Administration, *International Energy Outlook 2013*, July 2013, Table 12, p. 85.

Domestic coal production has fallen in recent years as a result of gas-on-coal competition.[15] Over the next 25 years, coal production is projected to increase gradually.[16]

The coal mining sector continues to be a major source of employment in the United States. In May 2016, the coal mining sector employed a seasonally adjusted average of 53,900 workers.[17]

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[14] The United States is the world's second largest producer of coal after China. Energy Information Administration, *International Energy Outlook 2013*, July 2013, Table 10, p. 74.

[15] Energy Information Administration, *Annual Energy Outlook 2015*, April 2015, p. 23.

[16] *Ibid*.

Renewable energy production

In part as a result of tax incentives provided for the development of renewable sources of energy, renewable energy production has grown significantly in recent years. For example, net power generation from wind energy has increased significantly over the past dozen years, from 14.1 terawatt-hours in 2004 to 190.9 terawatt-hours in 2015.[18] However, the United States continues to rely primarily on fossil fuel sources for energy. In 2015, 81.3 percent of U.S. energy consumption came from fossil fuels while 9.9 percent of U.S. energy consumption came from renewable sources (including 2.4 percent from conventional hydroelectric power), with the remainder coming from nuclear power.[19] Commensurate with its relatively small contribution to the overall U.S. energy portfolio, the renewable electricity sector is not a major source of employment in the United States.[20]

[17] Bureau of Labor Statistics, *The Employment Situation: May 2016*, June 3, 2016, Table B-1.

[18] Energy Information Administration, *Electric Power Monthly*, August 2014, Table 1.1A, and March 2016, Table 1.1.A.

[19] Energy Information Administration, *Monthly Energy Review*, March 2016, Table 1.3, p. 7.

[20] The Bureau of Labor Statistics estimated that for 2011 there were 3,780 private sector green goods and services jobs in hydroelectric power generation, 2,724 in wind power generation, 1,166 in biomass power generation, 1,017 in geothermal power generation, and 522 in solar power generation. See Bureau of Labor Statistics, *Employment in Green Goods and Services - 2011*, March 19, 2013. (This survey has been discontinued.)

B. Economic Analysis of Energy Tax Expenditures

1. General economic rationale for certain tax expenditure intervention in energy markets

A common economic rationale for government intervention in certain markets (including many aspects of energy markets) is that often there exist "externalities" in the consumption or production of certain goods. The externalities lead to "market failures," wherein either too little or too much of certain economic activity occurs relative to what is the socially optimal level of activity. An externality exists when, in the consumption or production of a good, there is a difference between the cost (or benefit) to an individual from consumption or production and the cost (or benefit) to society as a whole. When the society-wide, or "social," costs of consumption exceed the private costs of consumption, a negative externality exists. When the social benefits from consumption or production exceed private benefits, a positive externality exists. When negative externalities exist, there is overconsumption of the good that causes the negative externality relative to what would be socially optimal. When positive externalities exist, there is underconsumption of the good that produces the positive externality.

The reason for the overconsumption or underconsumption is that private actors in general do not take into account the effect of their consumption on others, but only weigh their personal costs and benefits in their decisions. Thus, they consume goods up to the point where the marginal benefit to them of more consumption is equal to the marginal cost (generally, the price) that they face. But from a social perspective, consumption should occur up to the point where the marginal social cost (generally, the price to the consumer plus any external costs imposed on others) is equal to the marginal social benefit (the benefit received by the consumer, plus any social benefit from the individual consumption). Absent some intervention, only when there are no externalities do private actions lead to the socially optimal level of consumption or production, because only in this case are private costs and benefits equal to social costs and benefits.

Tax preferences that encourage investment in specific areas increase economic efficiency only when market-based pricing signals have led to a lower level of investment in a good than is socially optimal. In general, this can occur in a market-based economy when private investors do not capture the full value of an investment−that is, when there are positive externalities to the investment that accrue to third parties who did not bear any of the costs of the investments. For example, if an individual or corporation can borrow funds at 10 percent and make an investment that will return 15 percent, they generally make that investment. However, if the return were 15 percent, but only eight percent of that return went to the investor, and seven percent to society at large, the investment generally does not take place, even though the social return (the sum of the return to the investor and other parties) would indicate that the investment should be made. In such a situation, it may be desirable to subsidize the return to the investor through tax credits or other mechanisms so that the investor's return is sufficient to cause the socially desirable investment to be made. In this example, a credit that raises the return to the investor to at least 10 percent would be necessary. Even if the cost of the credit were paid through general tax increases for others, society as a whole would presumably be better off because of the seven percent return to society from the investment. In this situation, the credit would only need to raise the return to the investor by two percent for the investor to break even. Thus, even if the rest of society bears the full cost of a credit that raises the investor return from eight percent to ten percent, they would enjoy a five-percent net return to the investment (seven percent less two percent).

Pollution is an example of a negative externality, because the costs of pollution are borne by society as a whole rather than solely by the polluters themselves. In the case of pollution, there are various ways the government could intervene in markets to limit pollution to more economically efficient levels. One approach is to control pollution directly through regulation of polluters, such as by requiring coal burning electric utilities to install scrubbers to limit their emissions of various pollutants.

Other more market oriented approaches to achieving socially optimal levels of pollution control are also possible. One such approach is to set a tax on the polluting activity that is equal to the social cost of the pollution.[21] Thus, if burning a gallon of gasoline results in pollution that represents a cost to society as a whole of $1, it would be economically efficient to tax gasoline at $1 per gallon. By so doing, the externality is said to be internalized, because now the private polluter faces a private cost equal to the full social cost, and the socially optimal amount of consumption takes place. An alternative market-based approach to control pollution is to employ a system of payments, for example, tax credits, to essentially pay polluters to reduce pollution. If the payments can be set in such a way as to yield the right amount of reduction (that is, without paying any more or less than the reduction is valued), the socially desirable level of pollution will result. The difference between these two approaches is who pays for the pollution reduction. Under the tax approach, polluters and those who buy goods and services from polluters bear the social costs of their pollution. The alternative approach suggests that the pollution reduction costs should be borne more broadly by those who receive the benefit of the reduction.

In the case of a positive externality, the tax policy that maximizes economic efficiency is to provide a tax preference (*i.e.*, a negative tax) for the consumption or production that produces the positive externality. By the same logic as above, the externality becomes internalized, and the private benefits from consumption become equal to the social benefits, leading to the socially optimal level of consumption or production. An example where such a positive externality is thought to exist is in basic scientific research, as the social payoffs to such research are not fully captured by private parties that undertake, and incur the cost of, such research. As a result, a socially sub-optimal level of such research is undertaken. The provision of a subsidy for such research can correct this market inefficiency and lead to socially optimal levels of research.

Some have argued that decreasing the dependence of the United States on foreign source energy is desirable for geopolitical and national defense reasons, and that these reasons constitute an externality that provides a rationale for subsidizing domestic fossil fuel production as well as subsidizing conservation and renewable energy production. In recent years there has been increasing focus in the tax code on energy conservation and renewable energy production

[21] An appropriately designed cap-and-trade system may achieve a similar economic result as imposing a tax on pollution.

incentives. The remainder of the discussion herein focuses on some considerations in the design of these incentives.

2. Issues in the design and efficacy of tax expenditures for energy conservation and renewable energy production

In general

The negative externality that is relevant when evaluating energy-related tax expenditures is the pollution caused when fossil fuels are burned to produce energy. The combustion releases greenhouse gases and air particulates that may damage the environment and harm human health, imposing a cost on society that is not borne by the individuals or firms producing or consuming the energy.[22] As a result, the price of energy derived from fossil fuels, relative to the price of energy derived from cleaner sources, is inefficiently low and may distort the demand for, and supply of, energy. In particular, there may be (1) excess consumption of energy derived from fossil fuels and (2) underinvestment in energy conservation property and the production of energy from sources that generate little or no pollution, such as the wind or the sun.

Economists generally agree that the most efficient means of addressing these economic distortions is through a direct tax on the pollution rather than through the indirect approach of targeted tax credits for certain energy-related technologies. The imposition of a direct tax on pollution leads indirectly to the adoption of some of the technologies favored in the tax code, but only if these technologies were in fact the most efficient technologies. The establishment of the economically efficient prices on pollutants, through taxes, results in the socially optimal level of pollution. To achieve this result, the tax should be set to equal the cost to society of the incremental pollution. One method of implementing such a tax is to measure emissions released when fossil fuels are being burned (*e.g.*, in a motor engine to power a car or at a power plant to produce energy) and charge a price for it. Measuring emissions (and administering an emissions tax) may be impractical in a number of circumstances, so a more practical option is to charge a price on the volume of fossil fuel used (*i.e.*, a tax on motor fuel or the fossil fuels that a power plant uses), since there are scientific formulas that relate emissions to the quantity and type of fossil fuel burned. Since the amount of pollution that results from the combustion of fossil fuels varies by fuel type and how it is burned, such a pollution tax is not expected to be uniform across fossil fuels (*e.g.*, a tax on natural gas should be lower than a tax on coal, which generates more pollution when burned). Although designing such a tax is not straightforward and requires an estimate of the cost of pollution, among other variables, economists generally agree that this approach is a more efficient and simpler way of addressing distortions in the energy market than employing an array of tax incentives to encourage particular types of economic behavior.[23] To assess the effectiveness and design of energy-related tax provisions, it is useful to compare the behavior they promote with the behavior resulting from a direct tax on pollution.

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[22] These individuals and firms, however, may be affected by the production and consumption of energy by other individuals and firms.

[23] For a discussion of issues related to the design of a pollution tax, see Thomas Barthold, "Issues in the Design of Environmental Excise Taxes," *Journal of Economic Perspectives*, vol. 8, no. 1, Winter 1994, pp. 133-151.

A tax on pollution is technologically neutral—a tax does not favor any particular technology that individuals might choose to utilize, or favor any particular behavioral modification that individuals may choose to make, in their pollution reducing responses to the tax. Rather, individuals would choose the most cost effective and economically efficient means of altering their behavior in response to the tax. For example, the optimal behavioral responses to a broad based tax on fossil fuels may lead to installation of greater amounts of home insulation, but may also lead to individuals turning down the thermostat or switching off unnecessary lighting. It would be difficult or impractical to design tax subsidies to directly incentivize turning down thermostats, switching off lights, or other similar forms of optimizing behavior. A tax on pollution encourages individuals and firms to make energy consumption, production, and investment decisions that are optimal for them, and these decisions may differ from some of the responses that are favored in the tax code.

Nonetheless, many provisions of current law provide targeted tax credits for investment in, or expenditures on, certain assets that reduce, directly or indirectly, the consumption of conventional fuels and the attendant negative externalities. The design of these tax benefits is directly relevant to how close these tax benefits come, individually and collectively, to achieving their intended objectives in a cost effective and efficient manner. Ideally, their design would be coordinated to try to mimic the more economically efficient outcome that a broad-based tax would provide.

The most important consideration in the efficient design of targeted subsidies is to determine what activities to subsidize and how much to subsidize them (*i.e.*, what a credit rate should be, for example). In setting the policy parameters, the government is implicitly setting the price it is willing to pay for the energy production or conservation that is produced or conserved in the manner specified by the tax provision. To be technologically neutral and economically efficient, the government should set policy parameters so that the implicit price it pays for the same objective, say fossil fuel displacement (typically measured in millions of British thermal units,[24] or "MMBtu"), is the same under each tax provision that has the same purpose. If it sets its policies in this manner, then only the most cost effective production of such fossil fuel MMBtu displacement will be subsidized.

While the government's policy parameters indicate the price it is willing to pay for fossil fuel MMBtu displacement at the margin, in practice it is difficult to know how much overall incremental fossil fuel displacement (and pollution reduction) the government is buying in the aggregate with a given conservation or renewables production credit. The reason is that the government subsidy typically applies to "inframarginal" activity, or activity that would have occurred even in the absence of the credit (as oppose to activity that only occurs because of the subsidy). The government incurs an expense in subsidizing such inframarginal activity in order to induce others at the margin to engage in the tax-favored activity they otherwise would not have undertaken.

[24] A British thermal unit is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

For example, a credit is provided under present law for the purchase of certain energy efficient furnaces. If the credit is assumed to be $500 and it is further assumed that the typical energy consumption from the efficient furnace as compared to an average furnace results in 1,000 MMBtu less fossil fuel consumption over its lifetime, then the government has set the price of 50 cents for each MMBtu of displaced fossil fuel consumption to encourage the adoption of the more efficient furnace. However, many investments in the energy efficient furnaces might have taken place even in the absence of the credit, and thus the government pays, via the credit, for fossil fuel displacement that would have occurred anyway. If two million furnaces are sold (leading to a billion dollars in credits being claimed), but only 200,000 of these are sold as a direct result of the credit, then only one tenth (200,000 divided by 2 million) of the fossil fuel displacement from the energy efficient furnaces can be said to have occurred because of the credit. Ninety percent of the fossil fuel displacement would have occurred by the 1.8 million more efficient furnaces that would have been purchased in the absence of the credit.

Thus, in this hypothetical example, the true budget cost of the aggregate incremental displaced fossil fuel consumption is 10 times the implicit government price at the margin, or $5, for each MMBtu of displaced fossil fuel consumption.[25] Additionally, individuals who have purchased a more efficient furnace might choose to heat their homes to a greater degree than without the tax credit since it costs less to do so. This behavioral response negates some of the initial fossil fuel displacement from the purchase of the more efficient furnace, and inflates the cost to the government of a given amount of fossil fuel displacement.[26]

While the government can in theory establish an efficient set of subsidies for the activities it chooses to subsidize, in practice it cannot administratively identify and set up programs to subsidize every conceivable energy-saving practice. Additionally, it is not possible to identify meritorious technologies not yet invented. The government must continue to expand the class of credit-eligible activities if it wishes to minimize the economic distortions that come from favoring certain technologies through tax subsidies over other technologies that prove equally capable of achieving reductions in fossil fuel consumption. Furthermore, the investment in research to develop such new technologies might be constrained by the existence of tax subsidies for current technologies. Investors in such research run the political risk that their newly discovered technologies will not be granted any tax subsidies and may find it difficult to compete with existing subsidized technologies.

Table 1 compares selected tax incentives to illustrate the varying implicit prices that the government is willing to pay per MMBtu of fossil fuel displacement. The differing amounts

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[25] This type of budgetary inefficiency can sometimes be tempered by targeting the credit at investment or expenditures above a base amount.

[26] In the conservation literature, this phenomenon of greater energy efficiency leading to behavioral responses that tend to increase the use of the more energy efficient equipment has come to be termed the "rebound effect," and has been estimated to reduce expected energy savings by up to 30 percent in the case of space heating and automobiles (see Frank Gottron, "Energy Efficiency and the Rebound Effect: Does Increasing Efficiency Decrease Demand?," Congressional Research Service report RS20981, July 2001. See also "On the Rebound: The Interaction of Energy Efficiency, Energy Use and Economic Activity," *Energy Policy*, Volume 28, June 2000.)

show that at the margin the government pays more to displace Btus from certain activities over others, which is not economically efficient.[27]

Column 1 in Table 1 lists the statutory credit amount in cents per kilowatt-hour and dollars or cents per gallon. Column 2 converts the statutory credit amounts to express them in terms of dollars per unit of heat energy (in millions of Btus) embedded in the credit-eligible fuel or in the kilowatt-hour of electricity.

Column 3 in Table 1 shows the credit amount per MMBtu of displaced fossil fuel consumption, factoring in the thermal efficiency of power generation being displaced. A renewable fuel, such as ethanol, directly displaces a fossil fuel on a Btu per Btu basis. The fossil fuel heat energy that a kilowatt-hour of renewable electricity displaces, however, depends on the thermal efficiency with which the fossil-fueled electricity generation station being replaced converts the heat energy of the fossil fuel to the heat energy of a kilowatt-hour of electricity. This measure of the generating station's thermal efficiency is known as the "heat rate." According to the Department of Energy, the average annual heat rate factor for fossil-fueled power plants in the United States is 9,510 Btus per kilowatt-hour.[28] Thus, though a kilowatt-hour of electricity has heat energy of 3,412 Btus, as noted at the bottom of Table 1, it requires on average 9,510 Btus of fossil fuel to produce that kilowatt-hour at a domestic fossil-fuel-burning power plant. Thus, a kilowatt-hour of renewable electricity displaces on average 9,510 Btus of fossil fuel feedstock. Factoring in thermal efficiency basically accounts for the fact that the average coal-fired or natural gas-fired power plant is only about 36 percent efficient (3,412 / 9,510). If the objective of the Federal government's renewable energy policy is defined as displacement of fossil fuel energy, then column 3 shows the varying amounts that the government pays to accomplish that objective.

As noted above, it cannot be known from this information alone what the total budget cost is for the aggregate incremental renewable production that occurs as a result of the credits, due to renewable production that would have occurred in the absence of the credits. If, as an example, half of the wind energy production would have occurred in any event, then the total Federal revenue cost of achieving the incremental wind energy produced is twice that stated in the table, if one assumes that all wind energy produced receives the credit.[29] In other words, the

[27] This discussion assumes that the benefits across all types of alternative energy are equivalent and that fossil fuels are being displaced (rather than, for example, nuclear power). In reality, different alternative energy sources might displace different types of fossil fuels, whose negative externalities may vary. Also, the production of certain renewables, such as solar or wind energy, may be more benign than the production of others, such as ethanol. Thus, depending on these other factors, varying credit rates could be economically efficient if there are differences across the renewables in the net benefits from each renewable and the fossil fuel it displaces.

[28] Energy Information Administration, *Monthly Energy Review*, March 2016, Table A6, p. 189.

[29] The section 45 electricity production credit is allowed only on the wind produced for the first ten years the facility is placed in service. If the existence of the credit induces a wind facility to be built that would not otherwise have been, and such a facility lasts for 20 years, then half of the wind produced from such facility does not receive any Federal credit, and the true cost of the Federal credit for that facility is half of what is shown on the table.

average cost of the subsidy per unit subsidized may be much lower than the cost of the subsidy when expressed in terms of the cost per marginal additional units of the subsidized activity that result from having the subsidy in place.

Table 1.–Comparison of Selected Energy Production Tax Credits			
	(Column 1) Statutory credit amount	**(Column 2) Credit amount in dollars per MMBtu of heat energy**	**(Column 3) Credit amount in dollars per MMBtu of heat energy of displaced fossil fuel feedstock***
Wind power	2.3 cents per kilowatt-hour	$6.74	$2.42
Geothermal power	2.3 cents per kilowatt-hour	$6.74	$2.42
Open-loop biomass	1.2 cents per kilowatt-hour	$3.52	$1.26
Advanced nuclear power	1.8 cents per kilowatt-hour	$5.28	$1.89
Biodiesel	$1.00 per gallon	$8.45	$8.45

Notes:
1 kilowatt-hour = 3,412 Btus
1 gallon of biodiesel = 118,296 Btus (low heating value)
Displaced fossil fuel feedstock calculation assumes a fossil fuel heat rate thermal conversion factor for wind, geothermal, biomass, and nuclear power of 9,510 Btus per kilowatt-hour.
Btus per kw-hour and thermal heat rate conversion factor taken from Energy Information Agency, *Monthly Energy Review*, March 2016, Table A6, p. 192.
Btu content of biodiesel taken from Energy Information Administration, *Annual Energy Outlook 2007*, February 2006, Table 12, p. 59.
* This calculation does not account for the fossil fuels associated with the production of biofuels, nor does it account for all of the energy that is consumed indirectly in the production of electricity. Thus, for example, it does not account for the energy required to make the steel used in the construction of any wind turbines or the fossil fuels used to grow any biofuel crops.

One can also compute the implicit price that the government is willing to pay per MMBtu for the various provisions designed to encourage taxpayers to conserve energy. As an example, one can compute the implicit price the government is willing to pay to conserve motor fuel in the case of plug-in electric motor vehicles available for purchase in 2016 for which taxpayers could claim a tax credit. For example, the 2016 Nissan Leaf, an electric-drive motor vehicle, uses 30 kilowatt-hours of electricity to travel 114 miles of combined city and highway driving.[30] The gasoline-equivalent energy content of electricity is 12,307 watt-hours per gallon of gasoline.[31]

[30] Environmental Protection Agency, *Fuel Economy Guide: Model Year 2016*, April 4, 2016, p. 30.

[31] 65 Fed. Reg. 36987 (June 12, 2000). This value factors in the efficiencies associated with producing and transmitting electricity, including the U.S. average fossil-fuel electricity generation efficiency (32.8 percent), and the U.S. average electricity transmission efficiency (92.4 percent). The calculation also factors in the petroleum refining and distribution efficiency (83 percent). *Ibid.* The assumptions embedded in this guidance have a significant impact

This results in a fuel efficiency of 46.8 miles-per-gallon equivalent.[32] The 2016 Nissan Sentra, a comparable gasoline-powered vehicle, obtains 32 miles per gallon in combined city and highway driving. Assuming a useful life of 120,000 miles, the Leaf will consume the equivalent of 1,184 fewer gallons of gasoline over its lifetime as compared to the Sentra.[33] The energy content of that gasoline is 78.1 MMBtus (at 114,000 Btus per gallon of gasoline). Thus, the $7,500 tax credit available to this vehicle amounts to $55.56 of credit per million British thermal units of displaced fossil fuel energy.

The $55.56 figure represents the credit cost per displaced MMBtu of fossil fuel only to the extent that the long run marginal energy source for the generation of electricity is *fossil-fuel based*. If the marginal energy source for electrical generation were nuclear or wind, for example, then the Leaf would displace fossil fuel consumption to the full amount of gasoline consumed by the Sentra over its lifetime. At 32 miles per gallon the Sentra consumes 3,840 gallons over 120,000 miles, or 437.8 MMBtus. This implies a credit cost of $17.13 per MMBtu of displaced fossil fuel energy if the marginal source of electrical generation is nuclear, wind, or other source that is not fossil-fuel based.[34]

Whichever measurement is used, there are likely more efficient ways to conserve energy. However, there may be other policy goals behind government support for electric vehicles. Since the primary fuel sources for electricity generation are domestically based, widespread use of electric vehicles would reduce reliance on foreign-source oil, given that traditional gasoline engines rely primarily on a fuel a little under half of which is imported from foreign suppliers.[35] However, widespread use of electric vehicles might then entail greater reliance on coal resources, thus raising concerns about greenhouse gas emissions.

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on the calculations in the text. For example, the U.S. average fossil fuel electricity generation efficiency may not be the right efficiency value to use, if one assumes that domestic power production at the margin is being supplied by more efficient natural gas generators. In addition, according to the Energy Information Administration, 32 percent of U.S. power production comes from non-fossil fuel sources such as nuclear, hydroelectric, and other renewable power. Energy Information Administration, *Annual Energy Outlook 2014 Early Release Overview*, p. 14, Figure 13. These sources of power are not factored into the calculation.

[32] Thirty kilowatt-hours per 114 miles equals 263.2 watt-hours per mile. 263.2 watt-hours per mile divided by 12,307 watt-hours per gallon of gasoline equals 0.02138 gallons of gasoline per mile. One gallon of gasoline divided by 0.02138 gallons of gasoline/mile equals 46.8 miles per gallon.

[33] (120,000 miles/46.8 miles per gallon equivalent) - (120,000 miles/32 miles per gallon) = -1,184 gallons.

[34] The $55.56 and $17.13 of credit per MMBtus are not directly comparable to the values in Table 1 because neither calculation includes a comprehensive carbon footprint analysis that accounts for all of the fossil fuel energy consumed in the entire production process. In addition, Column 3 in Table 1 relies on recent data from the Energy Information Agency to assume an average thermal efficiency of about 36 percent for electricity generated using fossil fuels, while the watt-hours per gallon of gasoline factor in the vehicle calculation uses a thermal efficiency factor of 32.8, as required by regulation (see footnote 31, above).

[35] Energy Information Administration, *Monthly Energy Review*, March 2016, Table 3.1, p. 49, and Table 3.3b, p. 55. In 2015, crude oil imports averaged 7.4 million barrels per day, while total supply averaged 16.8 million barrels per day.

Vehicles that rely on both gasoline and electric power, such as the Chevy Volt, pose an additional challenge to calculate a credit cost per displaced MMBtu of energy. The Chevy Volt is an electric-drive motor vehicle whose battery is charged either by a remote source of electricity or by an onboard gasoline generator. An evaluation of the tax credit for this vehicle would require an additional assumption about the average charging method by users of the vehicle.

Similar calculations can be made for other tax preferences that are intended to encourage conservation or displace existing energy sources with more environmentally benign energy sources. However, many such calculations are sensitive to the geographic location of the taxpayer and the qualified energy property. For example, the payoff in reduced energy consumption from additional insulation of a personal residence depends upon the climate in which the taxpayer resides and the amount of insulation initially in the residence. The tax credit available to taxpayers for additional insulation depends only upon the quantity of insulation and the price paid for the insulation, and the price of insulation does not vary widely across the nation. Therefore, the implicit price that the government is willing to pay per MMBtu conserved varies with such factors as the location of the taxpayer and pre-existing levels of insulation.

As a further example, consider the hypothetical installation of a 10-kilowatthour rated photovoltaic power system. Based on data compiled by The Lawrence Berkeley National Laboratory, the installed cost of such a system is approximately $53,000.[36] If, over the assumed 25-year life of such a system, it could garner eight hours of daylight for 365 days per year, it would produce 730,000 kilowatt-hours of electricity, offsetting an equal amount of electricity produced from other sources. The present-law 30-percent tax credit for the installation of such a system would imply that the government was willing to pay $6.38[37] per MMBtu of displaced electricity. However, if in a different location the same system were only to average five hours of sunlight per day, it would produce 456,250 kilowatt-hours of electricity. At the same installed cost, the present-law 30-percent tax credit for the installation of the system would imply that the government was willing to pay $10.21[38] per MMBtu of displaced electricity.

Alternative minimum tax, nonrefundability, and other constraints on tax expenditures

Another design issue that affects the efficacy of many tax credits is their restricted availability. Many tax credits have stipulated dollar limitations, are nonrefundable, or cannot be used to offset tax liability determined under the alternative minimum tax ("AMT"). If a credit designed to overcome an externality is capped, then after the cap is reached the marginal cost of

[36] Galen Barbose, Naim Darghouth, Samantha Weaver, and Ryan Wiser, "Tracking the Sun VI. An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2012," p.1, Lawrence Berkeley National Laboratory, July 2013. For projects installed in 2012, median prices for systems under 10 kW were $5.30 per watt.

[37] If measured in terms of displaced fossil fuel consumption as was done in column 3 of Table 1, the comparable figure would be $2.29 per MMBtu of displaced fossil fuel consumption.

[38] If measured in terms of displaced fossil fuel consumption as was done in column 3 of Table 1, the comparable figure would be $3.66 per MMBtu of displaced fossil fuel consumption.

further investment becomes equal to the market price again, which is presumed to be inefficient because of the externality. The impact of these limitations is to make the credit less valuable to those without sufficient tax liability to claim the full credit, for those subject to the AMT, or those who have reached any cap on the credit. Given the arguments outlined above as to the rationale for targeted tax credits, it is not economically efficient to limit their availability based on the tax status of a possible user of the credit. It can be argued that, if such social benefits exist and are best achieved through the tax system, the credit should be both refundable and available to AMT taxpayers. In some cases making the credits refundable may introduce compliance problems that would exceed the benefits from encouraging the targeted activities for the populations lacking sufficient tax liability to make use of the credit. With respect to the AMT, the rationale for the limitation is to protect the objective of the AMT, which is to insure that all taxpayers pay a minimum (determined by the AMT) amount of tax. Two differing policy goals thus come in conflict in this instance. Similarly, caps on the aggregate amount of a credit that a taxpayer may claim are presumably designed to limit the credit's use out of some sense of fairness, but again, this conflicts with the goal of pollution reduction.

Fossil fuel production incentives

The favorable tax treatment accorded fossil fuel industries generally operates by reducing the tax burden on capital employed in the sector, thus encouraging more capital to be employed in that sector of the economy. The incentives for fossil fuel production reduce the after-tax costs associated with these activities, likely increase the amount of capital employed in these activities in the long run, and potentially reduce the prices of fossil fuels.

As the rationale for many of the tax incentives for renewable energy and conservation is to reduce the use of fossil fuels, many have questioned the rationale for simultaneous tax subsidies to increase fossil fuel production. One argument in favor of tax incentives for fossil fuels is that it reduces poverty and promotes the middle class by making transportation and residential heating and cooling more affordable. This argument involves social equity rather than economic efficiency but is nevertheless a valid policy goal. Another argument in favor of incentivizing domestic fossil fuel production is that a healthy domestic fossil fuels production base serves national security goals by reducing America's dependence on foreign sources of energy. There remains a natural tension between these policy goals and the environmental policy goals discussed earlier.