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Subcommittee on Energy of the Committee on Energy and Commerce

Hearing on

Federal Energy-Related Tax Policy and its Effects on Markets, Prices, and Consumers

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Comments of

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Chairman Upton, Ranking Member Rush, and members of the Subcommittee, thank you for the opportunity to provide input on the impact of government subsidies on energy markets, prices, and consumers.

For more than 25 years, I have analyzed subsidies to energy on behalf of non-governmental organizations and international agencies. This work has included identification and review of subsidies to particular fuel cycles at the state, national, and international level; evaluation of the commonly applied subsidy valuation approaches around the globe; and peer review of scores of energy subsidy-related reports and academic papers.

Within the United States, the cost of energy subsidies to taxpayers is both substantial and often not properly documented. Regular review to evaluate the fiscal costs of these policies; their impact on market structure, competiveness, and environmental quality; and their ability to achieve stated goals is prudent.

My comments focus on three main issues:

- **All subsidy mechanisms matter**. In order to optimize energy subsidy policy, one needs to look at all mechanisms the government is using to transfer value to market participants, not just tax subsidies.
- **Subsidies to conventional fuels are often more difficult to quantify than those to renewables, but are nonetheless large and long-standing.** Production tax credits, cash grants, and purchase price premiums comprise the majority of government support to large renewable resources such as wind and solar. These interventions are easier to quantify than the credit or risk subsidies, state ownership, lease competitiveness, or upstream tax breaks that dominate the subsidy picture for conventional fuels. Ignoring these more complex instruments, however, will produce a skewed view of government interventions over time and impede development of an optimal reform strategy.
- **Simple changes to policy structures can greatly improve subsidy efficiency and transparency.** There are more and less distortionary ways to provide subsidies to targeted activities. Where subsidy elimination is not possible, reforms can and should restructure both existing and new subsidies to ensure that more efficient approaches are used.

1) All key support mechanisms must be evaluated to properly assess the market, environmental, and fiscal impacts of energy subsidies

The current policy push for tax reform aside, the federal government provides subsidies to energy producers and consumers in many different ways. These include direct spending; credit subsidies such as loan guarantees and direct loans; liability transfers such as subsidized insurance or artificial caps on private liability exposure; purchase mandates that require markets to consume particular forms or quantities of energy even at above-market prices; and direct state ownership of particular supply chain functions. Because some forms of energy have larger environmental impacts during extraction or consumption, regulatory exemptions can allow damages (negative externalities) to go unchecked, creating a competitive hurdle for cleaner alternatives and an unjustified market advantage for the more polluting fuel.

A summary of the common ways governments intervene in energy markets is shown in Table 1 below.

It is notable that interventions can act as a subsidy in some situations and as a tax in others, depending on policy details or ones position in the marketplace. Non-competitive leasing arrangements subsidize producers, but can result in losses to landowners (including states and tribes). Purchase mandates, such as the federal Renewable Fuel Standards for ethanol and biodiesel, reduce costs for energy producers though largely by shifting them to fuel consumers. Many excise taxes on fuels are earmarked for particular purposes (e.g., highway construction, reclamation of abandoned mine lands). If they are set too low (as they usually are), a residual subsidy remains.

Including multiple mechanisms in energy subsidy evaluations is the norm around the world. Though agreement on the exact definition of an energy subsidy is not universal, there *is* universal consensus that a wide mixture of policy types is relevant in assessing subsidy scope and magnitude. The subsidy definitions, policies, and/or analyses conducted by the World Trade Organization (WTO 1995), the G20 (G20 2009 and US Government 2016), Asia-Pacific Economic Cooperation (APEC 2009), the World Bank (2010), the International Monetary Fund (Coady et al., 2015a), the Organisation for Economic Cooperation and Development (OECD 2011, 2015), and the International Energy Agency (2016) all highlight this basic point. So, too, do reviews of US federal energy subsidies by the Energy Information Administration (EIA 2015a), the Government Accountability Office (GAO 2007, 2013), and the Congressional Budget Office (CBO 2015) – all of which address much more than just tax subsidies. My hope is that this subcommittee will do so as well.

Table 1. Governments transfer value to the energy sector in many different ways

Intervention category	Description
Direct transfer of funds	
Direct spending	Direct budgetary outlays for an energy-related purpose
Research and development	Partial or full government funding for energy-related research and development
Tax revenue foregone	
Tax*	Special tax levies or exemptions for energy-related activities, including production or consumption; includes acceleration of tax deductions relative to standard treatment
Other government revenue foregone	
Access*	Policies governing the terms of access to domestic onshore and offshore resources (e.g., leasing auctions, royalties, production sharing arrangements)
Information	Provision of market-related information that would otherwise have to be purchased by private market participants
Transfer of risk to government	
Lending and credit	Below-market provision of loans or loan guarantees for energy-related activities
Government ownership*	Government ownership of all or a significant part of an energy enterprise or a supporting service organization; often includes high risk or expensive portions of fuel cycle (nuclear waste, oil security, or stockpiling)
Risk	Government-provided insurance or indemnification against accident or operating risks, at below-market prices
Induced transfers	
Cross-subsidy*	Policies that reduce costs to particular types of customers or regions by increasing charges to other customers or regions
Import or export restrictions*	Restrictions on the free market flow of energy products and services between countries
Price controls*	Direct regulation of wholesale or retail energy prices
Purchase requirements*	Required purchase of particular energy commodities, such as domestic coal or biofuels, regardless of whether other choices are more economically attractive
Regulation*	Government regulatory efforts that substantially alter the rights and responsibilities of various parties in energy markets or that exempt certain parties from those changes. Distortions can arise from weak regulations, weak enforcement of strong regulations, or over-regulation (i.e., the costs of compliance greatly exceed the social benefits)
Costs of externalities	Costs of negative externalities associated with energy production or consumption that are not accounted for in prices; examples include greenhouse gas emissions and pollutant and heat discharges to water systems

* Can act either as a subsidy or as a tax depending on program specifics and one's position in the marketplace.

Sources: Koplow (1998); Kojima and Koplow (2015). Main section headings from OECD (2011).

The most important subsidy mechanisms can vary across energy types. For example, credit subsidies, liability caps, and state ownership (for nuclear waste management) are important subsidies for nuclear power. Purchase mandates are very significant for renewable transport fuels such as ethanol and biodiesel. Tax breaks, royalty reductions, lease auction formats, and subsidies to linking infrastructure (often at both the state and federal levels) are important for domestic fossil fuel production and transport.

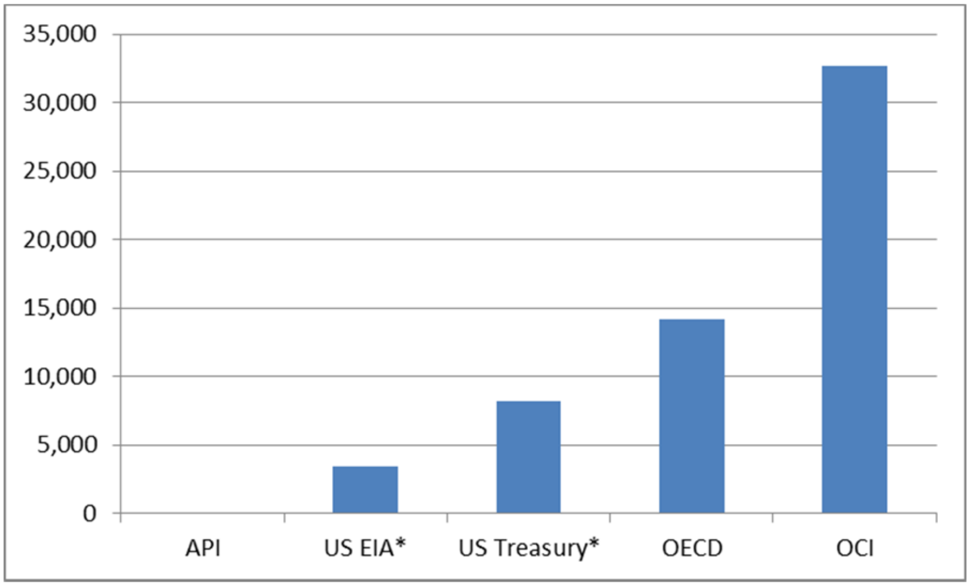
Inconsistent or incomplete capture of the full range of subsidy types is a major contributor to dispersion in estimates. Three main factors are a play: the adoption of different subsidy definitions (sometimes politically driven) that exclude relevant supports; limited research scope (a perennial challenge with EIA's periodic subsidy reviews), data access, or valuation challenges that reduce coverage for policies recognized as conferring subsidies; and changes in how often a particular subsidy is claimed by market participants year-to-year (subsidy "uptake") due to shifts in market prices, eligibility, or technical changes in production methods.

Using the example of US fossil fuel subsidies, Figure 1 illustrates how significant this dispersion can be – with estimates ranging to from zero to more than $30 billion per year. The zero value was put forth by the American Petroleum Institute, the largest trade association for the oil and gas industry (Comstock 2014). Although it can be dismissed on technical grounds, the politics remain central and affect the ability to institute rational reforms. Large budgets enable their viewpoint to be promoted heavily, even permeating the recent confirmation hearings for Secretary of State Rex Tillerson (see Koplow 2017).

The data year is a contributing factor to variance on the remaining estimates (due to changes in subsidy uptake), as is the inclusion of some state-level tax breaks in the OECD and OCI estimates. However, differences in how well a study covers all mechanisms of support also matters. Think tanks that receive large amounts of funding via the fossil fuel industry tend to focus only the lowest estimates, in this case produced by the EIA. However, the EIA research scope is set by the requesting members of Congress and has contained important gaps in the past (see Koplow 2010). Many of these scoping issues are now clearly presented in EIA's release materials (EIA 2015b). Evaluating a mix of studies is helpful in ensuring adequate policy coverage.

Figure 1. Estimated US subsidies to fossil fuels

(Millions USD/year)



Sources: Comstock (2014); OCI (2014); EIA (2015a); OECD (2015); United States (2015).
Notes:
* Federal subsidy estimates only; no sub-national data in totals.
Data years: 2013 (EIA, OCI); 2014 (OECD); average projected 2016-25 (US Treasury).

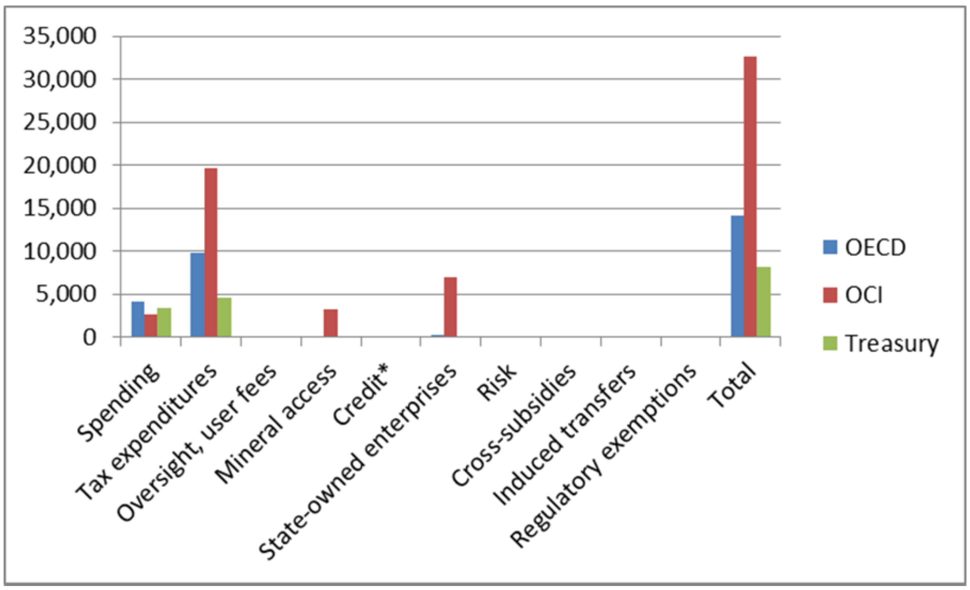
Figure 2 provides another window on the coverage gap problem. All of the estimates are dominated by tabulated subsidies from direct spending and tax breaks. Only Oil Change International (OCI) captures any values for subsidies to mineral access and state owned infrastructure. Shortfalls in reclamation fees, caps on oil spill liabilities and fairly extensive regulatory exemptions (see Kosnik 2007) are not captured at all.

Nor are some other very large potential supports to fossil fuels that can be important considerations when thinking about the longer-term energy path of the country. The IMF, for example, estimated that state and federal consumption taxes on fossil fuels in the United States are lower than those on other goods and services by $45 billion per year (Coady et al., 2015b).

Defense spending to protect oil supply security is another area not picked up in any of these estimates. Stern (2010) analyzed long-term trends in defense spending as well as ex-region support costs for the Persian Gulf force projection. Using detailed budget information and an activity-based costing approach, he estimated the average annual cost of the Persian Gulf mission at more than $200 billion. Though he did not attribute a specific portion to oil, the spending base is so high that any reasonable cost sharing with the historically-significant oil mission would constitute material support to oil. Interestingly, the Persian Gulf oil security costs are funded by US taxpayers, though benefits accrue to oil suppliers and consumers in Europe and Japan as well. Recovering this cost via an excise fee on shipments would help to encourage increased supply diversification (Koplow 2015).

The goal of these comments is not to resolve all of the data disparities, but merely to call attention to the need for more systematic review of federal policy to support Congressional reform efforts.

Figure 2. Coverage disparity across subsidy types, US fossil fuels
(millions USD/year)



Notes:
*Insufficient data to calculate credit subsidies. Face value of commitments to fossil fuel projects in 2013 were about US$4.5 billion/year (OCI, 2014).
Data years: 2013 (OCI); 2014 (OECD); average projected 2016-25 (US Treasury).

2) Energy subsidies are significant even for conventional fuels

While other testimony submitted for this hearing will likely focus on subsidies to renewable energy, it is important to note that subsidies to conventional fuels in the United States are also large, and have been in place for much longer. A detailed review of federal subsidies to all fuel cycles I conducted for base year 1989 is illustrative: conventional energy resources (fossil, nuclear and large scale hydro) received eight dollars in subsidies for every one supporting renewables; and energy supply received 35 dollars in subsidies for every dollar supporting end-use efficiency (Koplow 1993).

While patterns today are not quite so skewed, the continuing significance of government support both to fossil energy and nuclear can be seen below.

a) Nearly half of the proven, but not-developed, US oil reserves are subsidy dependent

A recent paper prepared with the Stockholm Environment Institute modelled the impact of key subsidies on the investment returns at more than 800 domestic oil fields (Erickson, Down, Lazarus and Koplow 2017). The assessment focused primarily on federal tax breaks, though also evaluated some non-tax federal supports and state-level subsidies in Texas and North Dakota. The analysis utilized detailed data on reserves and field economics developed by Rystad Energy.

The results are summarized in Table 2. Across the US, 45 percent of these discovered, but not yet producing, reserves, were dependent on subsidies in order to meet their minimum economic hurdle rate. The subsidy dependency ratio jumps to nearly three quarters for the offshore Gulf of Mexico due to the higher costs of operating there. It is notable that this high subsidy dependency value in the Gulf region was based on our prospective review, and excluded the billions in subsidies granted to producers via the Deep Water Royalty Relief Act of 1995 (GAO 2007).

Without subsidies, nearly 20 billion barrels of oil-equivalents across the country would have remained in the ground. For many industries, tipping projects from uneconomic to investable and productive generates only positive outcomes; think new medications that fight difficult diseases, for example. Fossil fuels are different. The subsidies do generate economic activity and jobs, but they also increase the negative environmental impacts from extraction and consumption and production expands.

Our assessment indicated the subsidy-dependent fossil fuels would result in an additional 8.1 Gt of CO_2 being released. The Intergovernmental Panel on Climate Change (IPCC) has estimated that if society is going to maintain even a two- thirds chance of limiting warming to the internationally agreed goal of 2°C (Clarke et al. 2014), net global emissions from 2016 onward cannot exceed 840 Gt CO_2. In that context, the decision by the U.S. federal and state governments to continue subsidizing these investments would produce oil that, once burned, will produce CO_2 emissions equivalent to about 1% of the remaining global carbon budget available to *all sectors of all economies* (Erickson, Down, Lazarus and Koplow 2017).

Economies are dynamic, of course; and a drop in US production would in part be met with increased imports from abroad – particularly if these other nations continued to subsidize their own fossil fuel production. Yet even after adjusting for imported fuels, the US subsidies are still driving a *net* increase of 1.5 Gt of CO_2.

Table 2. Impact of subsidies on undeveloped oil resources and GHG emissions (at $50/bbl)

Area	Economic oil resources, discovered but not yet producing (billion barrels)	Percent subsidy-dependent	Increase in economic oil resources due to subsidies		Increase in net GHG emissions (Gt CO_2)
			(billion barrels)	(Gt CO_2)	
Williston basin	4.1	59%	2.4	1.0	0.2
Permian basin	20.3	40%	8.0	3.3	0.6
Gulf of Mexico	2.1	73%	1.5	0.6	0.1
Rest of U.S.	16.7	46%	7.6	3.1	0.6
Total U.S.	**43.3**	**45%**	**19.6**	**8.1**	**1.5**

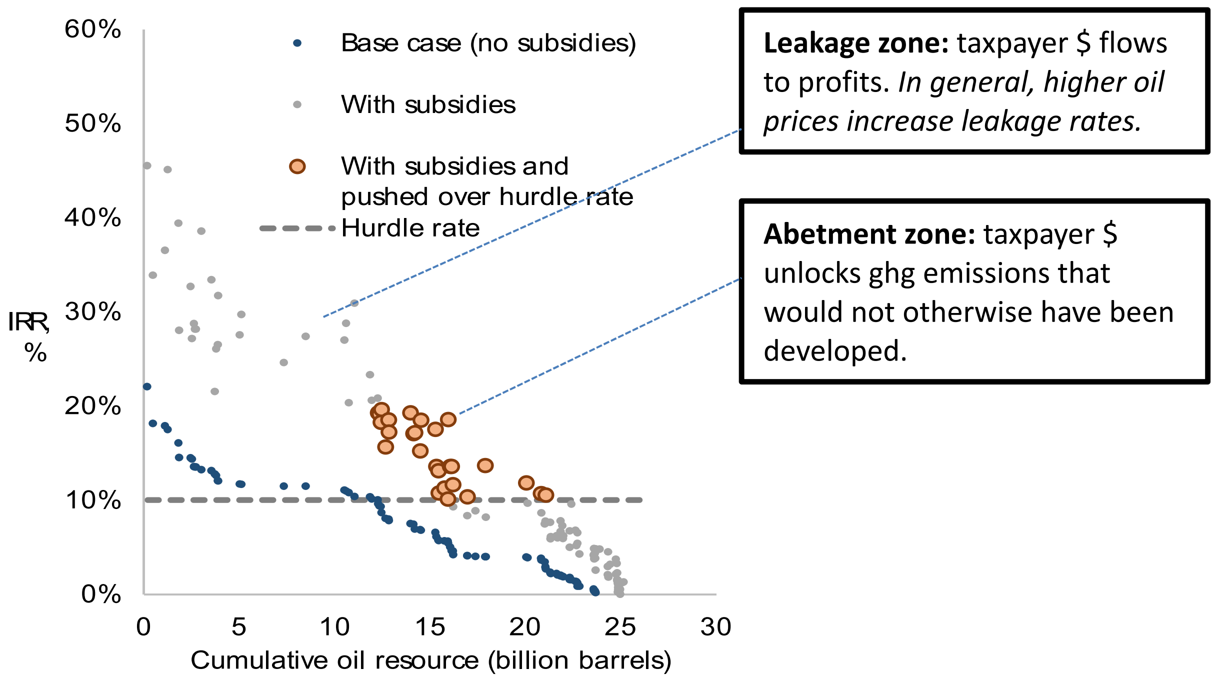
Source: SEI analysis based in part on data from Rystad Energy, in Erickson, Down, Lazarus, and Koplow (2017).

The impacts of these subsidies on individual oil fields can be seen more clearly in Figure 3 below, which illustrates three general categories of projects for the Permian Basin. The first category contains fields that are too expensive to develop at today's prices even with subsidies. The second category are fields that are highly profitable even with no government interventions, and for which taxpayer supports simply boost the economic returns "leaking" to resource owners or production companies in the form of higher profits. As leakage associated with a particular subsidy grows, the policy benefit to keeping it in place declines. This is why some subsidies are structured to phase out (albeit imperfectly) as market prices rise.

Where subsidies tip a project from low returns to investable, the subsidies are triggering incremental economic activity in the subsidized sector. From an environmental perspective, the subsidies work against carbon abatement, and instead abet increased emissions.

Our analysis assumed market prices of $50/barrel of oil, roughly in line with current prices. In general, higher commodity prices will make fewer wells dependent on subsidies to be economic. This same trend will mean that more of the taxpayer support simply leaks to producers as higher profits. At prices lower than $50 per barrel, the subsidy dependency rises as does the impact of those subsidies on greenhouse gas emissions.

Figure 3. Effect of subsidies on project economics at $50 per barrel, for fields discovered but not yet producing – Permian Basin



Source: Erickson, Down, Lazarus, and Koplow, 2017

b) Subsidies to the nuclear fuel cycle have often exceeded the value of power produced

A 1954 advertisement that General Electric placed in *National Geographic* magazine about nuclear power stated that "*We already know the kinds of plants which will be feasible, how they will operate, and we can estimate what their expenses will be. In five years – certainly within 10 – a number of them will be operating at about the same cost as those using coal. They will be privately financed, built without government subsidy.*"

More than sixty years later, the nuclear power sector remains as dependent on government subsidies as ever. This is a global issue, not US-specific despite industry claims about low cost reactor delivery elsewhere. The economics of nuclear are somewhat less murky in the United States than in other large nuclear countries like China or Russia where state involvement and ownership pervades nearly every segment of the fuel cycle.

But even here, the subsidy picture is challenging to piece together – evident in the fairly large spread between high- and low-subsidy estimates in Figure 4 below. The chart summarizes the findings from a detailed review of subsidies to the nuclear fuel cycle that I did for the Union of Concerned Scientists in 2011 (Koplow 2011). Quite often, the subsidies exceeded the value of the power produced.

Figure 4 divides subsidy levels by time period and ownership type. The subsidies available for reactors built in the 1970s and 1980s are not the same as the policies in place today; and for operating reactors, some of the original subsidies to capital are no longer affecting the cost structure of the facility. Similarly, taxable investor-owned utilities and tax-exempt public utilities did not receive the same subsidies either. Many reactors are owned by multiple parties and can include fractional ownership from both groups.

The federal policies in place today have remained fairly constant since this analysis was done. The nuclear production tax credit is nearing expiration, though most people expect it will be extended at least to apply to the US reactors now under construction. The major differences since 2011 is that the prospects for new nuclear projects have dimmed considerably, and that existing reactors are being outbid in competitive power markets and begging for massive new subsidies at the state or public utility commission level.[1]

The major drivers of these changes include the Fukushima accident, poor performance around the world of both new build projects and even operating reactors (with sizeable shutdowns in France), and continued pricing pressure in the US primarily from fracked gas.

Tax subsidies are relevant to US nuclear energy, though less so than other forms of support. Tax preferences include a lower tax rate on investment earnings from trust funds established to pay for future plant decommissioning, and production tax credits for new reactors. Uranium mining has long received percentage depletion benefits, though the related tax expenditures have been immaterial. In decades past, utility investments, and nuclear in particular, received generous investment tax credits. Interest incurred during the construction of reactors could also be deducted from taxable income rather than capitalized (Koplow 1993).

[1] Subsidies in New York are perhaps the furthest along, and estimated to cost nearly $8 billion; a similar approach nationally would generate more than $150 billion in subsidies to nuclear between now and 2030 (Judson 2016).

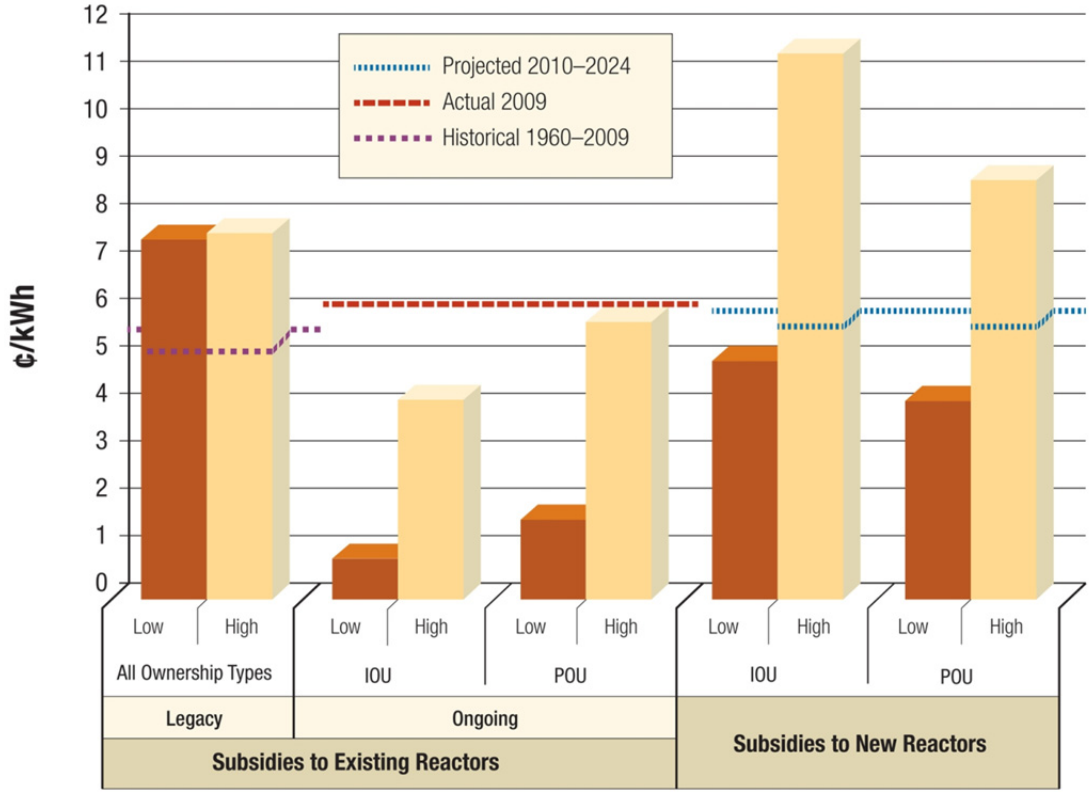
But non-tax forms of support were, and continue to be, critical. Long-tail risks that are difficult to predict but can escalate sharply over time cause heartburn for investors, leading them to withdraw funding or escalate minimum return requirements. It is hard to find a longer-term obligation than the management of high-level radioactive waste. These risks have been nationalized in return for a small fee, in effect removing it as a long-term investor concern.

Accident risks are another area where a low-probability but very high impact exposure has been shifted to the public. Capped under the Price-Anderson Act more than sixty years ago, the industry claims it has no subsidy value yet fights like crazy to ensure it is renewed. Uranium enrichment was state-owned in the US for much of the industry's history (Koplow 1993, 2011) and most capacity even today remains government-owned, albeit not by the US government (Koplow, forthcoming).

Very large capital costs for new reactors, combined with a history of long delays and large cost overruns, have rightfully led capital providers to be quite wary of new reactor projects. As a result, credit support, pre-funding of capital costs by ratepayers (via favorable construction work in progress, or CWIP, rules), and take-or-pay contracts for customers even if costs rise and power is late, are key drivers of the handful of new reactors now being built in the country. These policies are a mix of federal and more local subsidies, though it is always the combined effects that drive market distortions.

At the federal level, credit support has been particularly important. While the $535 million loss on the Department of Energy's loan guarantee to the Solyndra solar project has gotten tremendous attention, its $8.3 *billion* loan guarantee (DOE 2015) to new nuclear reactors at Plant Vogtle in Georgia seem to get mostly overlooked – despite being more than fifteen times as large. Westinghouse Electric, Inc., Toshiba's US nuclear unit that was in charge of building the Vogtle reactors, is expected to declare bankruptcy next week (Hamada and Fuse 2017). The *Japan Times* (2017) noted sources "close to the matter" indicated that taxpayer costs due to the bankruptcy were likely.

Figure 4. Nuclear Subsidies Compared to EIA Power Prices



Note: Legacy subsidies are compared to the Energy Information Administration (EIA) average 1960–2009 industrial power price (5.4 ¢/kWh). Ongoing subsidies are compared to EIA 2009 actual power prices for comparable busbar plant generation costs (5.9 ¢/kWh). Subsidies to new reactors are compared to EIA 2009 reference-case power prices for comparable busbar plant generation costs (5.7 ¢/kWh).

Source: Koplow (2011).

3) Making subsidies more efficient

Long-term competitive dynamism can often provide a more robust, effective, and efficient impetus for energy market innovation than would federal subsidies of any type. Too often, even policies with noble intent become politicized once they wind their way through the Congressional process. Forcing key market signals with respect to technical, market, and safety risks; delivery reliability; and cost through into end-user prices should be a key goal.

Achieving accurate price signals necessarily includes proper recognition of negative externalities such as pollution, and the implementation of corrective measures such as pollution taxes, credits, or regulatory limits on emissions. Although the current administration seems intent on unrolling many of these controls, gains to industry will likely be short-lived and accrue to well-connected industry incumbents. Because many other countries will continue to enforce environmental regulations, their industrial base will continue to evolve to be less polluting and more energy-efficient. This could cause longer-term problems for the US. There are indications that prudent regulations have fairly small short-term impacts on jobs and competitiveness, and benefits over the longer-term (see, for example, Dechezleprêtre and Sato 2014).

Where Congress determines government subsidies are appropriate, it is incumbent on members to deploy them more efficiently and dynamically. This issue is discussed below.

a) Limiting subsidy exposure

A variety of techniques have been used, though not consistently, to limit taxpayer financial costs from energy subsidies and to reduce subsidy leakage. Pre-set expiration dates (sunsetting) is common with most renewable energy tax breaks, and to legislatively-mandated programs such as the Price-Anderson Act. However, many subsidies, including many tax subsidies to fossil fuels, lack expiration dates.

Capping the dollar value or eligible production capacity eligible for particular subsidies is fairly routine at the state level (where budgets are smaller), and also sometimes deployed at the federal level (the nuclear production tax credit, for example). New facilities may also be limited to a specific time period over which they can receive subsidies, ensuring that taxpayer exposure does not continue long after initial capital investments have been paid off. These constraints do make a difference. Of the wind power capacity built between the inception of the wind PTC in 1992 and 2016, nearly 60% of cumulative capacity will have aged out of PTC eligibility by 2018, and nearly two-thirds by 2020.[2]

Price-triggers are also a useful tool, increasingly put into subsidy language so the subsidies decline or drop to zero during favorable market conditions for producers. This should also be standard. Ironically, some existing provisions work the opposite direction. Percentage depletion allowances, for example, are based on the market value of the extracted commodity. As a result, the subsidy value can surge just when it is needed least.

b) Subsidy duration should be long-enough to encourage innovation, but have pre-set stepped phase-outs

Setting the parameters to limit subsidy duration and cost needs to balance the ramp-up time needed to develop new technologies or industries with a fast-enough phase-out to avoid

[2] Earth Track calculations based on AWEA (2017).

the subsidy being treated by recipient industries like it is a property right. As shown in Table 3, many significant subsidies to energy have not met this balance. At one end of the spectrum, frequent lapses in enabling legislation followed by short renewal periods creates unpredictable investment signals and impedes development of a strong domestic industry, particularly for sectors requiring capital-intensive investments. The production tax credit for wind power has followed this pattern: though mostly in effect since 1992, the tax credit has lapsed and been renewed ten times during this period.

In contrast, although it has been somewhat narrowed over time, the expensing of intangible drilling and development costs for oil and gas producers is more than a century old. Other subsidies to oil and gas are nearly that old as well, some of which were controversial quite early on: the Joint Committee on Taxation launched an investigation into the percentage depletion allowance for oil in 1927 (JCT 1927). While the world was different a century ago, these provisions should now all have expiration dates.

Most expiring tax provisions have a “bright line” date where they drop immediately to zero unless otherwise extended. Particularly for subsidies intended to spur development of new industries that can eventually compete on their own, it makes more sense to have a pre-set, but phased and difficult to extend year-after-year, decline in subsidy levels as a way to transition the industry to full competition. This approach is being used with the termination of the wind production tax credit, phasing down by 20 percent per year until it is gone.

Table 3. Too many subsidies don’t expire

Provision (type)	First Implemented
Oil and Gas	
Expensing of intangible development costs (tax)	1913; narrowed over time, but no expiration.
Percentage depletion (tax)	1926; narrowed over time, but no expiration.
Expensing of geological and geophysical costs (tax)	1933; narrowed over time, but no expiration.
Coal	
Percentage depletion (tax)	1932; no expiration.
Excise tax for abandoned mine lands (user fee)	1977, but multi-billion dollar backlog.
External trust funds for reclamation (regulatory)	Never; recent coal mine bankruptcies create significant liability risks for taxpayers.
Wind and solar	

Provision (type)	First Implemented
Production tax credits (tax)	1992, with sunsetting in ~7 yrs; lapses and 10 short-term renewals to date.
Nuclear power	
Government-funded research and development (direct spending)	Data back to 1948; nuclear captured 73% of federal energy R&D spending through 1977; and 49% for the period 1948-2012.
Price-Anderson cap on nuclear accident liability (risk)	1957, with multiple extensions since then (presently through 2025); reactors and fuel cycle facilities covered for their operating life even if Act isn't renewed.
Nationalization of responsibility to manage high level nuclear waste (state ownership)	1982; all technical and management risks rest with the federal government. In theory, financial risks can be shared via increases in fees on industry; in practice, these plants will be closed well before critical cost and performance problems are evident.
External trust funds for decommissioning (regulatory)	1984; tax-favored investments and some risk of underfunding, but more secure than the post-closure funding available in most other countries.
Federal loan guarantees (risk)	2005; $8.3 billion authorization for nuclear (Vogtle Plant) in 2014-15; by far the largest project. An additional $12.5 billion to advance nuclear remains available.

c) Policies that keep development and delivery risks in the private sector should be preferred

If subsidies are to be provided, doing so in a manner that costs taxpayers nothing if the project or investment fails to meet the policy objective for which the subsidy was created should be strongly preferred.

For example, a production tax credit costs nothing if a plant is never built. If it is built, but doesn't work properly, costs will be lower as a result since output is below target. In stark contrast, the large federal loan guarantees to the Vogtle reactors under DOE's Title XVII program work in exactly the opposite direction. They will cost taxpayers billions of dollars if the plant is never completed. If it is completed and successful, the taxpayers who fronted the credit risk will have no share of the plant's upside. This system of socialized risks and privatized profits is among the poorest subsidy structures.

Government-provided loans and loan guarantees may also introduce political pressures and selection bias regarding which projects are chosen, both of which increase the change of suboptimal loan performance. The alignment of incentives between the funder and the project is nearly impossible: long-term funding decisions for very large financial commitments are made by people with a relatively short expected job tenure and no personal exposure to investment performance, good or bad. As an illustration of this issue, the people who ran DOE and DOE's Office of Loan Programs while the Vogtle application was being evaluated and approved are gone.

d) Governments should be neutral with respect to how to meet a particular energy goal, and aim to allocate subsidies by competitive tender rather than political fiat whenever possible

Recipient industries will almost always favor subsidy carve-outs: for their industry, their technology, or their region. Politicians may favor these as well, in order to better target support to constituent interests. The exact opposite process is usually needed to achieve particular policy objectives efficiently and dynamically.

Consider the example of a justifiable interest that the US to diversify our transportation fuels away from a singular dependency on petroleum. Rather than have individual policies for a range of specific alternative fuels and vehicle drive trains, a competitive process to allocate the pool of subsidies to providers able to provide reduced petrol consumption per vehicle mile most quickly and at the lowest subsidy cost would make more sense.

If there is a policy interest in ensuring a handful of contending approaches, a tender process could have more than one winner. But rather than having the government trying to differentiate which providers are in the "leakage zone" (Figure 3), they would self-identify through the bidding process, reducing the subsidy cost to achieve the policy goals.

The important structural points would be that (a) the competitors must bid against each other for the lowest subsidy per unit delivered (as happens with many auctions to meet Renewable Porfolio Standard targets); (b) that these bids be redone every few years to ensure that unit subsidies fall as technical and other efficiency improvements bring down costs for producers; (c) that allowable bidders include the demand side and efficiency options, not just increased supply; and (d) that subsidy payments be distributed incrementally as services or products are delivered to ensure the taxpayer does not incur costs if the bidder fails.

References

APEC (2009). Asia Pacific Economic Cooperation, "2009 Leaders' Declaration," Singapore, 14 November.

AWEA (2017). American Wind Energy Association. "Wind Energy Facts at a Glance," accessed 27 March.

CBO (2015). U.S. Congressional Budget Office. *Federal Support for the Development, Production, and Use of Fuels and Energy Technologies*.

Clarke, L., Jiang, K., Akimoto, K., Babiker, M., Blanford, G., et al. (2014). Chapter 6: Assessing transformation pathways. In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. O. Edenhofer, R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, et al. (eds.). Cambridge University Press, Cambridge, UK, and New York. 413–510. https://www.ipcc.ch/report/ar5/wg3/.

Coady et al. (2015a). David Coady, Ian Parry, Louis Sears, and Baoping Shang. *How Large are Global Energy Subsidies?* WP/15/105. (Washington, DC: International Monetary Fund), May.

Coady et al. (2015b). David Coady, Ian Parry, Louis Sears, and Baoping Shang. "Country Level Subsidy Estimates" data files for *How Large Are Global Energy Subsidies?* (Washington, DC: International Monetary Fund), 29 June.

Comstock, Stephen (2014). ""The Truth on Oil and Natural Gas 'Subsidies,'" Energy Tomorrow blog (a project of the Americal Petroleum Institute), 29 January.

Dechezleprêtre, Antoine and Sato, Misato (2014). *The impacts of environmental regulations on competitiveness*, policy brief, (London: London School of Economics), November.

DOE (2015). U.S. Department of Energy, "Financing Vogtle: A Major Achievement for the Loan Programs Office," 24 June.

EIA (2015a). U.S. Energy Information Administration, *Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2013*, 12 March.

EIA (2015b). U.S. Energy Information Administration, *Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2013, "*Not All Subsidies Impacting the Energy Sector Are Included in this Report," 12 March.

Erickson, Pete, Adrian Downs, Michael Lazarus, and Doug Koplow (2017). *Effect of government subsidies for upstream oil infrastructure on US oil production and global CO2 emissions*. Working Paper 2017-02. (Stockholm: Stockholm Environment Institute).

G20 (2009). "Leaders' Statement," The Pittsburgh Summit, September 24 – 25 2009.

GAO (2007). U.S. Government Accountability Office. *Federal Electricity Subsidies: Information on Research Funding, Tax Expenditures, and Other Activities That Support Electricity Production*, October, GAO-08-102.

GAO (2013). U.S. Government Accountability Office. *Wind Energy: Additional Actions Could Help Ensure Effective Use of Federal Financial Support*, March, GAO-13-136.

Hamada, Kentaro and Fuse, Taro (2017). "Toshiba's Westinghouse to file for U.S. bankruptcy Tuesday: sources," *Reuters*, 28 March.

IEA (2016). International Energy Agency. *World Energy Outlook 2016.*

Japan Times (2017). "Concerns emerge over guarantee for Toshiba's U.S.nuclear project," 10 March.

Judson, Tim (2016). *Too big to bail out: The economic costs of a national nuclear power subsidy*, (Washington, DC: Nuclear Information and Resource Service), November.

Kojima, Masami, and Koplow, Doug (2015). *Fossil fuel subsidies: Approaches and valuation*, (Washington, DC: World Bank Group), Policy Research Working Paper WPS7220.

Koplow, Doug (forthcoming). "Energy subsidies: An overview of global estimates, causes of variance, and gaps for the nuclear fuel cycle," in Mel Gurtov and Pete van Ness, editors*, Lessons of Fukushima: Nuclear Power in East Asia*. (Canberra: The Australian National University Press).

Koplow, Doug (2017). "Rex Tillerson: Oil and gas gets no subsidies," Earth Track blog, 12 January.

Koplow, Doug (2015b). "Subsidies to Energy Industries," in Scott Elias, editor, *Reference Module in Earth Systems and Environmental Sciences*, (Amsterdam: Elsevier Publishing).

Koplow, Doug (2011). *Nuclear Power: Still Not Viable without Subsidies,* (Cambridge, MA: Union of Concerned Scientists), February.

Koplow Doug (2010). *EIA Energy Subsidy Estimates: A Review of Assumptions and Omissions,* (Cambridge, MA: Earth Track, Inc.)

Koplow, Doug (1998). *Quantifying impediments to fossil fuel trade: An overview of major producing and consuming nations*. Paper prepared for the OECD Trade Directorate.

Koplow, Doug (1993). *Federal Energy Subsidies: Energy, Environmental, and Fiscal Impacts, main report and technical appendix*. (Washington, DC: Alliance to Save Energy

Koplow, Doug and Martin, Aaron. (1998). *Fueling Global Warming: federal subsidies to oil in the United States*, (Washington, DC: Greenpeace).

Kosnik, Renee Lewis (2007). *The Oil and Gas Industry's Exclusions and Exemptions to Major Environmental Statutes*, Earthworks and the Oil and Gas Accountability Project, October.

Lucas, Deborah, 2013. "Evaluating the cost of government credit support: The OECD context," Paper prepared for *Economic Policy*, Fifty-eighth Panel Meeting, Vilnius, 25–26 October.

OCI (2014). Oil Change International. *Cashing in on All of the Above: U.S. Fossil Fuel Production Subsidies under Obama,* July 2014.

OECD (2015). Organisation for Economic Co-operation and Development. *OECD Companion to the Inventory of Support Measures for Fossil Fuels 2015*, (Paris: OECD).

OECD (2011). Organisation for Economic Co-operation and Development. *Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels,* (Paris: OECD).

Stern RJ (2010). "United States cost of military force projection in the Persian Gulf, 1976–2007," *Energy Policy* . http://dx.doi.org/10.1016/j.enpol.2010.01.013.

US JCT (1927). US Joint Committee on Internal Revenue Taxation, Division of Investigation, *Volume 1, Part 1: Tentative Plan of Procedure Pursuant to Section 1203(b)(6) Revenue Act of 1926*.

United States (2015). *United States Self-Review of Fossil Fuel Subsidies*, December.

World Bank (2010). *Subsidies in the Energy Sector: An Overview*, Background Paper for the World Bank Group Energy Sector Strategy, July. (Washington, DC: The World Bank Group).

WTO (1995). World Trade Organisation. "Agreement on Subsidies and Countervailing Measures," entered into force in 1995.