

**SUBSIDIES, EXTERNALITIES, AND CLIMATE CHANGE:
WHETHER ELIMINATING ENERGY TAX SUBSIDIES AND TAXING CARBON IS ENOUGH**

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I. INTRODUCTION – WOULD ELIMINATING ENERGY TAX SUBSIDIES AND TAXING CARBON BE A GOOD IDEA?

The Role of Energy and the Carbon Tax Efficiency Thesis. The energy industry is one of the most central components of the U.S. and global economies than energy – and it has led to extensive conflict and environmental impacts.¹ Energy policy in the U.S. has been pursued largely through incentives in the Internal Revenue Code.^{2,3} Recently, economists and those motivated by economic efficiency theory have argued that this system of tax breaks is misguided.⁴ Many of them have suggested that universally eliminating tax subsidies for specific energy sources and directly taxing externalities would be preferable.⁵ In particular, they have suggested that eliminating tax subsidies

¹ See, e.g., Daniel Yergin, *The Quest: Energy, Security, and the Remaking of the Modern World*, at 2 (2011), Michael J. Graetz, *The End of Energy: The Unmaking of America's Environment, Security, and Independence* [Kindle location 112 of 5033] (2011), Daniel M. Kammen, *Renewable Energy in U.S. Foreign Policy*, 36 G.G.U. L. Rev. 327, 328 & n. 4 (2008), citing International Energy Agency, IEA Energy Technology R&D Statistics, 1974-1995 (Int'l Energy Agency, Org. for Econ. Cooperation & Dev., Paris 1997), and citing Kammen, Kapadia & Fripp, *Putting Renewables to Work: How Many Jobs Can the Clean Energy Industry Generate?* (Renewable and Appropriate Energy Laboratory, University of California, Berkeley (2004).

² *Clean Energy Tax Incentives: The Effect of Short-Term Extensions on Clean Energy Investment, Domestic Manufacturing, and Job Creation*, S. Comm on Finance, Subcomm. on Energy, Natural Resources, and Infrastructure, 112th Cong., 1st Sess., (Statement of Molly Sherlock, Cong. Research Serv., at 10)(Dec. 14, 2011). See generally Staff of Joint Comm. on Taxation, 112th Cong., *Tax Expenditures for Energy Production and Conservation*, JCX-2S-09 (Comm. Print 2009).

³ The incentives began with those favoring domestic production of oil at the beginning of the twentieth century, when the U.S. was a net exporter. See Cong. Research Serv., *Tax Expenditures: Compendium of Background Material on Individual Provisions* S. Comm. on Budget, 111th Cong., S. Prt. 111-58, at 118 (Comm. Print 2010) (discussing percentage depletion and expensing of exploration and development costs); Energy Info. Admin., SR/CNEAF/2008-1, *Federal Financial Interventions and Subsidies in Energy Markets 2007* (hereafter, “EIA 2007 Report”), at 11 & n.29 (Apr. 2008) (referring to original provision for expensing intangible drilling costs); Charles O. Galvin, *Federal Income Tax – Percentage Depletion of Oil and Gas Wells*, 21 Tex. L. Rev. 410, 411 (1943).

⁴ Staff for the Joint Committee on Taxation for example, has noted that the present approach is “incoherent” and “lacking well-defined objectives.” Staff of Joint Comm. on Taxation, *Tax Expenditures for Energy Production and Conservation*, *supra* n. [2], at 1. See also Staff of the Joint Comm. on Taxation, 112th Cong., *Present Law and Analysis of Energy-Related Tax Expenditures and Energy-Related Expenditures Description of the Revenue Provisions Contained in H.R. 1380, the New Alternative Transportation to Give Americans Solutions Act of 2011*, JCX-47-11, at 1 (Sept. 20, 2011).

⁵ See Sherlock Statement, *supra* note [2], at 10; *Energy Policy and Tax Reform*, Hearing Before

and placing a tax on carbon would be more efficient and equitable.⁶ Many believe that nuclear power would have a role to play if this were done.

Among those who have argued that eliminating tax subsidies and imposing a carbon tax would be more efficient are William Gale and Benjamin Harris of the Tax Policy Institute, who note that all tax expenditures, including those for energy, are inefficient, and that:

An energy tax, . . . a carbon tax . . . would include the social cost of producing and consuming carbon in the price of goods, reduce the U.S. economy's dependence on foreign sources of energy, and mitigate economic effects of environmental deterioration. Furthermore, a tax on carbon . . . would create better market incentives for the production of energy-efficient goods, and could be used as a mechanism to phase out the panoply of targeted energy incentives.⁷

Molly Sherlock of the Congressional Resource Service has made the same point, perhaps more subtly:

From an economic perspective, energy prices would ideally reflect the full social cost of energy production and consumption. . . . The most economically efficient way to achieve this outcome would be to tax energy resources that have negative external costs, such as pollution. . . .

The history of U.S. energy tax policy indicates a preference for subsidies, rather than direct taxes.⁸

House Comm. on Ways and Means, Subcomm. on Select Revenue Measures, 112th Cong., 1st Sess. (Statement of Donald B. Marron, Urban-Brookings Tax Policy Center) (Sept. 22, 2011); William G. Gale and Benjamin P. Harris, Tax Policy Center, *Reforming Taxes and Raising Revenue: Part of the Fiscal Solution* (May 1, 2011), reprinted at 2011 Tax Notes Today, 2011 TNT 109-39 (June 7, 2011); John M. Broder, *Obama's Bid to End Oil Subsidies Revives Debate*, N.Y. Times A14 (Jan. 31, 2011), avail. at http://www.nytimes.com/2011/02/01/science/earth/01subsidy.html?_r=1 (last viewed June 1, 2012)(quoting David W. Kreutzer, Heritage Foundation, and H. Jeffrey Leonard, Global Environment Fund, and Douglas Koplow, Earth Track, as supporting end to all energy subsidies); Jeffrey Leonard, *Getting the Energy Sector Off the Dole*, Washington Monthly (Jan./Feb. 2011), avail. at <http://www.washingtonmonthly.com/features/2011/1101.leonard-2.html> (last viewed June 1, 2012).

⁶ See, e.g., Marron Statement, *supra* note [5].

⁷ Gale & Harris, *supra* note [2], at 11 (discussing tax expenditures), 29 (energy taxes). Gale and Harris' paper provided a global analysis of tax reform in light of the impending fiscal cliff, and had a section on energy policy and the possibility of the carbon tax as a revenue source.

⁸ Sherlock, *supra* note [2], at 8.

Others have argued that simply eliminating the tax subsidies, which largely favor oil and gas and nuclear power, could get us a long step forward. When the Obama Administration repeated its calls for eliminating some oil subsidies, the New York Times reported,

Mr. Obama’s proposal rekindles a long running debate over federal subsidies for energy of all kinds, including petroleum, coal, hydropower, wind, solar and biofuels. Opposition to such subsidies . . . spans the ideological spectrum, from conservative economists, who believe such breaks distort the marketplace to environmentalists who believe that renewable energy subsidies will always lose out in subsidy fights.⁹

The Theory Is Only Partial. Whether the putative goal is to eliminate all energy tax subsidies, or to do so and to impose a carbon tax, the commentators likely have adopted it as a rhetorical suggestion rather than as a global solution. As they note, there must be a tax on “pollution.” Carbon emissions are only one source of that. And though they largely focus on tax subsidies, there are many other subsidies that must be taken into account. This paper merely serves to make that point.

Review of the Theory Applied to Three Energy Sources. In the body of this paper the author reviews federal subsidies and externalities for three energy sources¹⁰ and concludes that the present landscape provides a number of tax and *non-tax* expenditures,¹¹ and leaves untaxed a number of important externalities beyond simply carbon. It briefly analyzes the tax subsidies in terms of their efficiency. The paper

⁹ See Broder, *Obama’s Bid*, N.Y. Times, *supra* note [2] (quoting conservative economists and environmentalists). See also Marron Statement, and Leonard, *Getting the Energy Sector off the Dole*, *supra*, note [5].

¹⁰ Other energy sources – such as coal, biofuels, and natural gas – receive significant federal subsidies, and have externalities, but the author has chosen to focus on only three in this paper. There are also *state* subsidies for many energy sectors including solar, but while they are relevant to the overall picture, state subsidies are also beyond the scope of the author’s capabilities here.

¹¹ For definitions of tax and non-tax expenditures, see Section II.B. For a definition of externalities, see Section II.A.

ultimately concludes that the carbon tax efficiency proposal could unduly favor nuclear power and oil and gas by disregarding other significant externalities those sources cause and by understating the non-tax subsidies those energy sources have received.

Appendix I provides a review of multiple government and nonprofit studies that assess relative subsidies to energy sources. Because the author is a Rawlsian who has performed undertaken an economic efficiency / utilitarian perspective for the purpose of this paper's analysis, Appendix II offers a critique of nuclear power, focusing on the experience of the Navajo Nation with uranium mining and milling, using a Rawlsian and environmental justice perspective.

Interim Conclusion. The purpose of this author's paper is fairly simple: to argue, based on economic theory (or environmental justice, as discussed in Appendix II), that oil and gas and nuclear power are excessively subsidized, and that a rational energy policy favors a transition to truly renewable, low-carbon energy sources.

II. TAX SUBSIDIES, OTHER SUBSIDIES, AND EXTERNALITIES – EFFICIENCY THEORY AND APPLICATION IN THREE CASES

A. THE EFFICIENT MARKETPLACE PREMISE AND THE THEORY OF THE SECOND BEST

Neoclassical macroeconomists assume that an efficient marketplace will maximize total increases in welfare by reason of exchanges in that marketplace, and that government intervention will lead to a loss of efficiency and that it will distort behavior, leading to losses in consumer or producer surplus or both. Taxes are bad, they contend, but tax expenditures are worse, as they create an uneven playing field. A tax subsidy to one energy source presumes that that source is preferable, when it may not be (if one assumes the market is working and consumers have the ability to pick the winning energy type).¹²

Many economists do believe that there are cases of “market failure,” where the economy does not work, one such failure is in the case of externalities.¹³ An externality occurs “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 . . . , a negative externality exists.”¹⁴ Carbon pollution is one

¹² See, e.g., Goodwin, Nelson & Harris, “Useful Economic Tools and Concepts,” Tufts University Global Development and Environment Institute, available at <http://ase.tufts.edu/gdae> (downloaded Aug. 16, 2013), at 24.

¹³ See, e.g., Preston McAfee (Professor of Business, Economics & Management, California Institute of Technology), *Introduction to Economic Analysis* (Version 2.0, July 24, 2006), at 6-213 (describing “Externalities” under “Market Imperfections”), available at <http://www.mcafee.cc/Introecon/IEA.pdf> (last downloaded Aug., 2013).

¹⁴ *Tax Expenditures for Energy Production and Consumption*, *supra* note [2], at 113. See generally, Stiglitz, *The Economics of the Public Sector*, “Externalities” (excerpted in Pratt & Seto, *Honors Tax Policy Colloquium: Readings for the Course* at 18 (Loyola Law School Los Angeles, Jan., 2011)), and see McAfee, *supra* note [13], at 6-213.

kind of externality. As noted above, many economists have argued that we should eliminate tax subsidies and impose a carbon tax (the “carbon tax efficiency thesis.”)

The carbon tax efficiency thesis is highly theoretical, as it seems unlikely that all tax subsidies would be repealed. And in fact, all tax, and other, subsidies would have to be repealed for us to know that this approach would work. Under the “General Theory of the Second Best:”

It is well known that the attainment of a Paretian optimum requires the simultaneous fulfillment of all the optimum conditions. The general theorem of the second best optimum states that if there is introduced into a general equilibrium system a constraint which prevents the attainment of one of the Paretian conditions, the other Paretian conditions, although still attainable, are, in general, no longer desirable.¹⁵

Translated to the world of tax subsidies, the General Theory of the Second Best was summarized as follows:

1. Even in a world in which the only distortion were a tax and one tax expenditure which were then eliminated, the overall increase in social welfare is expected to be much less than the amount of the tax expenditure.
2. If a distortion exists in one sector, “it is no longer generally desirable to employ the first-best optimality condition in other sectors.”
3. If a distortion exists in a market where there are more than two, there is no certainty that the competitive equilibrium that results from eliminating one distortion is preferable to the competitive equilibrium that existed previously.¹⁶

¹⁵ R.G. Lipsey R.K. Lancaster, “The General Theory of the Second Best,” *Review of Economic Studies* 24(1): 11-33 (1956-1957), at 11.

¹⁶ See Mark A. Delucchi & James Murphy, “Tax Expenditures Related to the Production and

The General Theory of the Second Best does not necessarily justify inaction: “we are obliged to strive only for the possible,”¹⁷ so creating a more economically efficient tax system should be a goal.

While a number of other articles address carbon taxes and what it would take for them to be effective, this paper seeks to address the other end of the equation: would the elimination of all energy tax subsidies leave us with a level enough playing field on which to start? The paper concludes that a number of direct subsidies to nuclear power and oil and gas, and a number of unaddressed externalities from those power sources, have allowed us to rely upon them unduly.

B. TAX SUBSIDIES AND THEIR RELATIONSHIP TO DIRECT EXPENDITURES AND EXTERNALITIES

The Effect of Tax Subsidies. Before simply listing tax expenditures, other government expenditures, and externalities, it is valuable to consider how they relate to each other in an economic model.

A tax expenditure is what the government foregoes as the result of giving preferential treatment to a taxpayer.¹⁸ An “other government expenditure” is a public sector expenditure in excess of the user fees obtained.¹⁹ Simply summing tax expenditures, other expenditures, and externalities might seem an appropriate means for

Consumption of Motor Fuels and Motor Vehicles, Report #18 in the Series *The Annualized Social Cost of Motor-Vehicle Use in The United States, Based on 1990-1991 Data*, at 5-6 (U.C.Davis, Aug. 2006 rev. 1), citing and quoting J.J. Laffont, *Fundamentals of Public Economics* (I.P. Bonin and H. Bonin, trans.) (1990), and citing Lipsey & Lancaster, “The General Theory of the Second Best,” *supra* note [12], O.A. Davis and A.B. Whinston, “Welfare Economics and the Theory of the Second Best,” *Review of Economic Studies* 32: 1-14 (1965).

¹⁷ Free Exchange Economics Blog, “Making the Second Best of It,” Aug. 21, 2007, available at http://www.economist.com/blogs/freeexchange/2007/08/making_the_second_best_of_it/print (citing and discussing recent article by R.G. Lipsey making the same observation).

¹⁸ See generally, Joint Committee on Taxation, *Estimates of Federal Tax Expenditures for Fiscal Years 2011-2015* (JCS-1-12) (Jan. 17, 2012), at 3. A tax *subsidy* is what the taxpayer gains as a result. Delucchi & Murphy, *supra* note [16], at 1 n.1.

¹⁹ Delucchi & Murphy, *supra* note [16], at 1.

approximating a total “social cost” for an energy source under optimal tax theory – but it may not be, because eliminating a tax expenditure will probably not yield a social benefit reaching the quantity of the tax expenditure itself.²⁰ In a series of papers analyzing social costs from the production and consumption of motor vehicles and motor vehicle fuels, economists Mark Delucchi and James Murphy argue that some consideration of relative tax expenditures among different energy modalities is appropriate to shed light on fairness in taxation across industries, but that simply adding tax expenditures to the other two categories is inappropriate.²¹ They contend that direct government outlays and externalities can both be included as social costs, and that tax expenditures must be considered separately.²²

The conclusion from this is important: other government expenditures and unremedied externalities addressed in this paper take a higher magnitude than the tax expenditures which many propose to eliminate. The author might favor the elimination of those tax expenditures, across the board, but only after the other government expenditures and externalities are dealt with fully.

Ranking the Efficiency of Tax Expenditures. Staying within the realm of tax expenditures, it is also possible to rank them in terms of their theoretical efficiency: First, incentives aimed at the broader policy objective rather than enabling a particular technology are more likely to be effective. Second, tax incentives need not be made available for a behavior that would occur anyway.²³ Third, it is more efficient to reward

²⁰ Delucchi & Murphy, “Tax Expenditures Related to the Production and Consumption of Motor Fuels and Motor Vehicles,” *supra* note [16], at 5.

²¹ Delucchi & Murphy, *supra* note [16], at 6. Of course, differences in taxation among energy modalities also would have a bearing on tax efficiency.

²² *Id.*, at 7-8.

²³ Sherlock statement, *supra* note [2], at 8-10.

production rather than investment.²⁴ Finally, tax-exempt financing is the least efficient approach, as private bond investors are likely to capture some of the benefits of tax-exempt debt.²⁵

C. SUBSIDIES AND EXTERNALITIES IN THREE SECTORS: OIL AND GAS, NUCLEAR, AND SOLAR

Introduction: Studies Quantifying Subsidies. This paper draws on a number of government and independent studies that seek to quantify tax and other subsidies for energy sources. To summarize Appendix I,²⁶

- The Joint Committee on Taxation and Office of Management and Budget Tax Expenditure Budgets attempt to quantify tax expenditures from a presumed “normal” baseline. The tax expenditure estimates they come up with cannot be equated with federal revenues foregone because of interactive effects among tax provisions, and the inability to predict taxpayer behavior in the absence of any given tax expenditure provision. They provide flat dollar amounts of subsidies.
- One study by the nonprofit Environmental Law Institute also calculates subsidies in flat dollar amounts, including some tax and some non-tax, and includes some subsidies not addressed in the federal documents.
- The Department of Energy’s Energy Information Administration has prepared analyses of “Federal Financial Interventions in Energy Markets” for FY 2007 and FY 2010. These analyses cover some

²⁴ Sherlock Statement at 11; Marron Statement, *supra* note [5], at par. 6.

²⁵ Marron Statement at par. 6.

²⁶ Appendix I discusses a variety of government and independent analyses of subsidies to different energy sectors and provides full citations to the reports discussed.

direct federal subsidies as well as tax subsidies, but they measure value by comparing that fiscal year's subsidy to that fiscal year's production of the energy in question. For renewable energies that are relatively new to the market, such a same-year measure is inherently unfavorable relative to how that measure would apply to a subsidy to an established (and thus already substantially productive) energy source.²⁷ The EIA Reports are traditionally requested by Republican lawmakers; some have contended that the way the Reports compare energy sources appears to reflect this bias.²⁸

- Finally, a couple of studies, one by the Congressional Research Service and one by a private think tank, compare effective marginal tax rates. These studies are helpful in that they provide a basis for comparing the degree to which an energy source is favored, but they are limited in that they do not address a number of non-tax subsidies.

D. ENERGY SUBSIDIES AND EXTERNALITIES – THREE CASES

This section surveys subsidies and externalities for three different energy sources: oil and gas, nuclear, and solar.

1. OIL AND GAS

Since at least the beginning of the last century, oil and gas have been a centerpiece of U.S. energy policy.²⁹ Originally, when the U.S. was a net oil exporter,

²⁷ See, e.g., Molly F. Sherlock, Cong. Research Serv., CRS Report R41953, *Energy Tax Incentives: Measuring Value Across Different Types of Energy Resources*, (Aug. 10, 2011), 11-14 and Tables 4 and 5.

²⁸ See generally Doug Koplow, Earth Track Inc., *EIA Energy Subsidy Estimates: A Review of Assumptions and Omissions* (March 2010).

²⁹ See generally Daniel Yergin, *The Prize: The Epic Quest for Oil, Money & Power* (Free Press Books rev. ed. 2008) (3d prtng. 2008).

subsidies for their production and consumption were believed to be in the country's strategic interests. Many have argued that this is no longer the case.³⁰

a. TAX SUBSIDIES.

Exceptions to the Limit on the Foreign Tax Credit for Oil & Gas Royalty Extraction Payments. Arguably the most significant tax subsidy for oil and gas is one that is recognized in neither the Department of Treasury nor the Joint Committee on Taxation's Tax Expenditure Budget: Treasury Regulations and Tax Court case law that allow royalty payments to foreign governments for natural resource extraction to be treated as foreign income tax payments eligible for the foreign tax credit under IRC § 901. The study commissioned by the Environmental Law Institute ("the ELI Study") concluded that the characterization of royalty payments to foreign governments for oil and gas extraction – as "income taxes" or "in lieu" taxes – resulted in a tax expenditure of approximately \$15.3 billion for oil and gas in the period FY 2002-2008.³¹ If a tax expenditure is a provision of federal tax law which provides "a special exclusion, exemption, or deduction from gross income or which provide a special credit, a preferential rate of tax, or a deferred tax liability,"³² regulations and Tax Court case law

³⁰ Since this paper was started, there has been a resurgence of oil and gas (as well as natural gas) production as a result of the use of hydraulic fracturing ("fracking") in the U.S. Fracking has been criticized by some based on water safety concerns and because it can release methane, a potent greenhouse gas. At the moment the practice is not subject to strict uniform regulation. *See, e.g.,* Joe Nocera, "A Fracking Rorschach Test," N.Y. Times (Op. ed. Oct. 4, 2013).

³¹ Adenike Adeyeye, James Barrett, Jordan Diamon, Lisa Goldman, John Pendergrass & Daniel Schramm, Environmental Law Institute, "Estimating U.S. Government Subsidies to Energy Sources: 2002-2008," at 10-11 (Sept. 2009) (hereafter, "*ELI Study*").

³² Congressional Budget and Impoundment Control Act of 1974, Pub. L. No. 93-344, sec. 3(3), *codified at* 2 U.S.C. 622(3) (statutory definition of a tax expenditure for purposes of the Tax Expenditure Budgets).

that allow “Dual Capacity Taxpayers” to claim as creditable foreign income taxes royalty payments for the extraction of oil and gas would seem to qualify.³³

IRC § 901 allows for a foreign tax credit to directly offset a taxpayer’s liability for U.S. income taxes. The foreign tax credit was implemented to protect U.S. taxpayers from double taxation of the same income: if the rate of tax abroad was less than what it would be here, the U.S. would tax the difference, but if the tax abroad was the same or more than the U.S. rate, the taxpayer could claim the credit up to the amount of what would have been the U.S. tax liability for income of that character. The credit is meant for what is an “income tax in the U.S. sense.”³⁴

Firms making royalty payments typically would deduct those payments as ordinary and necessary business expenses such that they would reduce a taxpayer’s liability only as the product of the expense multiplied by the taxpayer’s marginal rate – in the case of a U.S. corporation, 35%. To the extent that oil companies can claim foreign tax credits for “disguised royalty payments,” the system goes beyond capital-export neutrality, since domestic production does not get this major advantage. The grant of excessive credits worsens the U.S. trade deficit, and allows increased payments to foreign governments for oil extraction to directly reduce the collection of U.S. tax revenue.

Domestic Tax Preferences for Oil & Gas Proposed for Elimination by the Obama Administration. The FY 2011, 2012, and 2013 Green Books proposed eliminating eight tax preferences for oil and gas: the enhanced oil recovery credit, the credit for oil and gas produced from marginal wells, the expensing of intangible drilling costs (IDCs), the deduction for tertiary injectants, the exemption to the passive loss limitation rules for

³³ This issue and the ELI Study are discussed further in the Appendix.

³⁴ See, e.g., Treas. Reg. § 1.901-2(a).

working interests in oil and natural gas properties, the allowance of percentage depletion for oil and natural gas wells, the shortened amortization period for geological and geophysical costs for independent producers, and the 6% domestic production deduction for oil & gas.³⁵ Of these, the rules allowing expensing of IDCs and percentage depletion are projected as the largest tax expenditures; the total projected revenue from the repeal of all the provisions for the period FY 2013-2017 was approximately \$17.3 billion.³⁶ Alternatively, if one measures the effective tax rate on marginal capital investment in domestic oil and gas production, studies have concluded that incentives available to nonintegrated firms provide a tax rate of between (-13.5%) and (-42%).³⁷

As with the proposed changes to the rules relating to Dual Capacity Taxpayers, the Administration has not implemented these proposals;³⁸ however, in the case of the Administration's proposals, the changes would require Congressional action.

Other Tax Subsidies. The Treasury apparently has not included in its Green Books a proposal to eliminate the "Pool of Capital" doctrine used in the industry, although its use defers recognition of income to the drilling enterprise or the providers of goods or services upon the exchange. This practice has been criticized as a subsidy, contributing to a negative effective tax rate for independent domestic firms engaged in drilling.³⁹

³⁵ See, e.g., FY 2013 Green Book at 30, 111-119, 201-202 (Table 1). The proposal to end the 6% domestic production allowance for oil and gas was not projected to raise revenue as the allowance would be increased for other domestic manufacturing activities. *Id.* at 30, 201.

³⁶ FY 2013 Green Book at 203 (Table 1).

³⁷ Gilbert E. Metcalf, Manhattan Institute for Research Policy, *Taxing Energy in the United States: Which Fuels Does the Tax Code Favor?*, at 5 (Table 2) (Jan. 2009); Calvin H. Johnson, *Accurate and Honest Tax Accounting for Oil and Gas*, 125 Tax Notes 573 (2009). Both authors were apparently assessing the effects of tax incentives for nonintegrated domestic producers.

³⁸ FY 2011 Green Book at 151, FY 2012 Green Book at 147, FY 2013 Green Book at 203. In each instance, Table 1 reflects no change in revenue for previous year.

³⁹ See Johnson, *supra* note [37], 125 Tax Notes 573, Patrick O'Daniel, Note, *Muddy Waters in the*

Arguments for the Present Tax Incentives. The primary justifications advanced for the present tax incentives are that (1) they encourage domestic production and thereby reduce or eliminate dependence on foreign oil, (2) they help keep oil and gas prices low, and (3) some of the subsidies assist independent domestic producers, allowing them to compete better with integrated oil companies.⁴⁰ Several studies addressed further in the Appendix analyze these incentives and the arguments made to justify them.

With regard to domestic production, government analysts and independent economists contend that oil prices are determined on a world market, such that elimination of the incentives would not significantly reduce U.S. production or significantly increase oil and gas prices to the consumer – or certainly not when prices are near record highs.⁴¹ Analysts do seem to agree that elimination of tax preferences would shift domestic oil and gas production away from small independent operators toward large integrated firms.⁴² Proponents of the Treasury’s position have argued that the preferences are improperly distorting the structure of the industry, and that production domestically would decline by 0.5% or less.⁴³

Pool of Capital: ZuHone and the Abolition of the Doctrine, 70 Tex. L. Rev. 243 (1991).

⁴⁰ See, e.g., *Oil & Gas Tax Provisions: Consideration of the President’s FY 2010 Budget Proposal*, Hearing Before the Subcomm. on Energy, Natural Resources & Infrastructure, Senate Comm. on Finance, S. Hrg. No. 111-955, 111th Cong., 1st Sess. (Sept. 10, 2009), at 11 (Statement of Larry Nichols, American Petroleum Institute), 17 (Statement of Henry Kleemeier, Independent Petroleum Ass’n of America),

⁴¹ Maura Allaire and Stephen Brown, Resources for the Future, *Eliminating Subsidies for Fossil Fuel Production: Implications for U.S. Oil and Natural Gas Markets*, Issue Brief 09-10 at 8 (Dec. 2009); Nathan S. Balke, Stephen P.A. Brown, and Mine K. Yucel, *Oil Price Shocks and U.S. Economic Activity: An International Perspective* (Resources for the Future, Discussion paper 10-37), see also Gilbert E. Metcalf, National Bureau of Economic Research, *Using Tax Expenditures to Achieve Energy Policy Goals*, at 5, 6 (Dec. 28, 2007) (noting that increased domestic production would not reduce U.S. vulnerability to oil price shocks, and that incentives for increased domestic production works “at cross purposes” with such a goal.) Allaire and Brown note that domestic production incentives could be necessary to assure domestic supply when world prices are low rather than high, but that phased-in incentives for this scenario, enacted in advance, would provide for a more stable tax policy. Allaire and Brown, *Eliminating Subsidies*, *supra*, at 5.

⁴² Allaire and Brown, *supra* note [41], at 7.

⁴³ S. Hrg. No. 111-955, 111th Cong., 1st Sess. (Sept. 10, 2009), *supra* note [30], at 4, 5-6 (Statement of Hon. Alan Krueger, U.S. Dept. of Treasury).

b. DIRECT SUBSIDIES.

Tax subsidies have been a major vehicle for U.S. energy policy, but at least two additional legal regimes can be characterized as subsidies for oil and gas production and development.

Oil Pollution Act Liability Cap. First, the Oil Pollution Act of 1990, enacted after the *Exxon Valdez* spill in Alaska, creates strict liability for removal and certain other response costs, but it limits liability for damages from oil spills.⁴⁴ In the case of the BP *Deepwater Horizon* disaster, the cap was \$75 million. BP voluntarily waived this cap, depositing \$20 billion into escrow for the Gulf Coast Claims Facility to make payments for damages to third parties.⁴⁵ As the Presidential Commission wrote, the arguments in favor of raising or eliminating the cap on liability are straightforward: “The amount of potential damage caused by a major spill clearly exceeds the existing caps, and one cannot fairly assume that the responsible party causing a future spill will, like BP, have sufficient resources to fully compensate for that damage.”⁴⁶ Congress has so far failed to enact changes to the cap, out of apparent concern that independent oil producers will not be able to insure themselves.⁴⁷ Arguably the only reason this cap did not absolve BP for the billions of dollars in damages to multiple third parties in the Gulf was that BP voluntarily agreed to waive it. As the Presidential Commission on the disaster wrote, “Increasing liability limits [under the Oil Pollution Act] would serve as a powerful

⁴⁴ 33 U.S.C. § 2704.

⁴⁵ See National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, *Deep Water: The Gulf Oil Disaster and the Future of Offshore Drilling – Report to the President* 287 (Jan. 2011) (hereafter, “*Deep Water Report*”). As of November 10, 2010, BP had also paid \$581 million in response costs to the federal government. *Id.* at 135 (footnote).

⁴⁶ *Deep Water Report*, *supra* note [45], at 245-246.

⁴⁷ *Id.* at 246.

incentive for companies to pay closer attention to safety, including investing more in technology that promotes safer operations.”⁴⁸

Below-Market Leasing of Federal Lands for Oil Development. The second probable non-tax subsidy is below-market leasing of federal lands for oil development. The ELI Study concluded, based on Department of Interior Minerals Management Service analysis, that royalty relief for onshore and offshore leasing exceeded the gains that relief likely created at lease auctions, resulting in an aggregate subsidy of slightly over \$7 billion over the period FY 2002 – FY 2008.⁴⁹

c. EXTERNALITIES.

Many observers believe that U.S. dependence on oil is the direct result of policies that prevent the U.S. market from fully capturing its price;⁵⁰ they contend that the production and consumption of oil and gas results in a variety of externalities. The externalities in the U.S. most commonly associated with oil use include vulnerability to oil price volatility (due to oil dependency),⁵¹ some portion of U.S. military and geopolitical costs (to the extent they relate to oil dependency),⁵² wealth transfer concerns

⁴⁸ *Id.*

⁴⁹ *See ELI Study, supra* note [31], at 12-13.

⁵⁰ *See, e.g., Graetz, The End of Energy, supra* note [1], at [Kindle position 116 of 5033] and [positions 2310-2352 of 5033] (2011), Delucchi & Murphy, *supra* note [16], at 1.

⁵¹ *See, e.g., Ian W. H. Parry, Margaret Walls, and Winston Harrington, Resources for the Future, Automobile Externalities and Policies* (RFF DP 06-26) (2d rev., Jan. 2007), at 2-10. Various studies address the degree to which oil price volatility has led to recessions in the U.S., reaching different conclusions. *Compare* Stephen P.A. Brown and Hillard G. Huntington, *Estimating U.S. Oil Security Premiums* (June 2010) (citing multiple prior studies and stating that “10 of the 11 U.S. recessions since World War II have been preceded by sharply rising oil prices”) *with* Nathan S. Balke, Stephen P.A. Brown, and Mine K. Yucel, *Resources for the Future, Oil Price Shocks and U.S. Economic Activity: An International Perspective* (RFF DP 10-37) (July 2010) (presenting more nuanced view of causal relationship).

⁵² *Parry et. al, supra* note [51]; Mark A. Delucchi and James Murphy, *U.S. Military Expenditures to Protect the Use of Persian-Gulf Oil for Motor Vehicles*, Report #15 in the Series *The Annualized Social Cost of Motor-Vehicle Use in The United States, Based on 1990-1991 Data* (U.C. Davis, Mar. 2008, rev. 3).

(as a result of dependency on oil from governments with differing interests),⁵³ local air pollution,⁵⁴ global air pollution and its contribution to climate change,⁵⁵ traffic congestion and traffic accidents.⁵⁶ One 2007 study concluded that the per-gallon cost of these externalities was \$2.28;⁵⁷ another conducted nine years earlier (which included tax and program subsidies as well as externalities) placed the per-gallon cost between \$4.60 and \$14.14.⁵⁸

Both of these studies were conducted before the BP Deepwater Horizon incident, which killed 11 people and released approximately 210 million gallons of oil over the course of 87 days in 2010, which dispersed throughout the Gulf of Mexico.⁵⁹ The Deepwater spill was almost 20 times larger than that of the Exxon Valdez; when the EPA barred BP from seeking further contracts with the US in November 2012 based on how BP handled the spill, EPA called Deepwater “the largest environmental disaster in US history.”⁶⁰ According to the New York Times, the extent of the spill from its start in May through Aug. 7, 2010, looked like this:

⁵³ See Graetz, *supra* note [1], at [Kindle location 2345 of 5033]. Graetz at [location 4396 of 5033] cites the testimony of Dr. David L. Greene, Oak Ridge National Laboratory, at the Senate Finance Committee Hearing *Technology-Neutral Incentives Low Greenhouse Gas Vehicles* (Apr. 23, 2009), who notes that some of these effects are the result of monopoly power by the OPEC cartel, and not technically externalities, but for the sake of simplicity the author will place this effect under the general heading of “externalities.”

⁵⁴ Parry, *et. al, supra* note [51], at 2-3 (citing further studies).

⁵⁵ Parry, *et. al, supra* note [51], at 4-5, *citing, inter alia*, William D. Nordhaus & Joseph Boyer, *Warming the World: Economic Models of Global Warming* (2000), Nicholas Stern, *Stern Review: The Economics of Climate Change* (2006), David Pearce, “The Social Cost of Carbon,” in *Climate Change Policy* (Dieter Helm, ed. 2005).

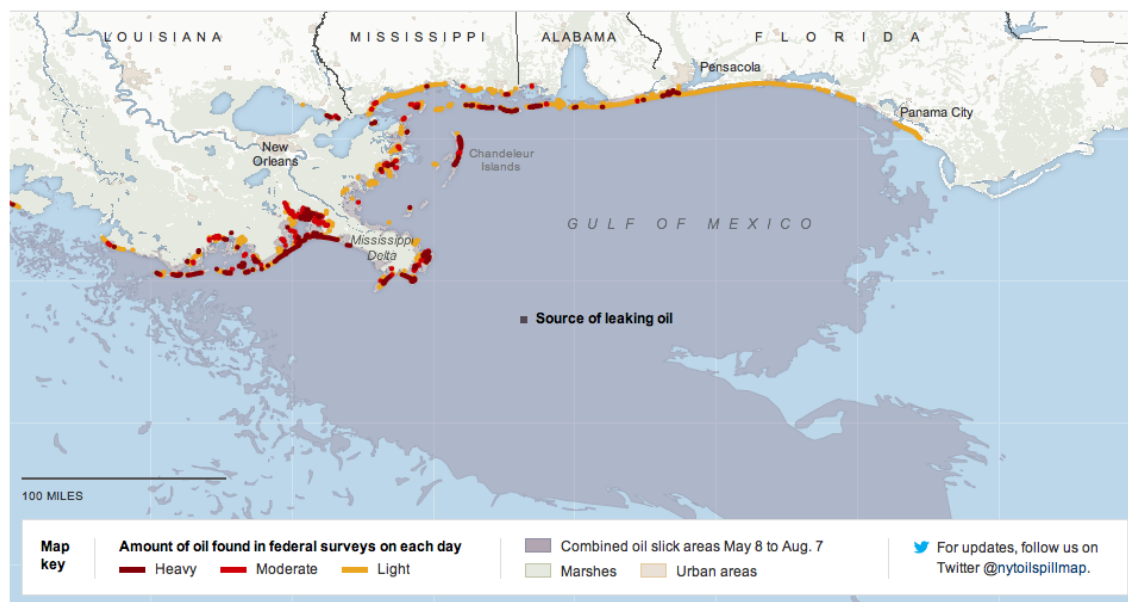
⁵⁶ Parry, *et al., supra* note [51], at 7-9.

⁵⁷ Parry, *passim*.

⁵⁸ International Center for Technology Assessment, “The Real Price of Gasoline,” Report No. 3 – An Analysis of the Hidden External Costs Consumers Pay to Fuel Their Automobiles (1998). See also B. Roach, J. Harris, and A. Williamson, Global Development and Environment Institute, Tufts University, “The Gulf Oil Spill: Economics and Policy Issues” (2010), available at <http://ase.tufts.edu/gdae>, at 23-26 (discussing the two analyses) (last accessed Aug., 2013).

⁵⁹ On Scene Coordinator, “Report on the Deepwater Horizon Spill” at 33 (Sept. 2011) (estimating 4.9 million barrels of oil released, before containment, with ± 10% uncertainty).

⁶⁰ S. Goldenberg & T. Macalister, “BP Suspended from New US Federal Contracts Over Deepwater



Combined oil slick areas May 8 – Aug 7, 2010, and extent of oil reaching shores⁶¹

Thus, drilling and refinery⁶² accidents and oil spills must be added to the previous list of externalities not incorporated into the costs for energy from oil and gas. To the extent these effects are not adequately compensated by economic models including natural resource damages assessments, or due to liability caps such as the Oil Pollution Act, they must be treated as externalities.

Disaster,” *The Guardian* (Nov. 28, 2012).

⁶¹ See “Map of How Much Oil Is On the Gulf Coast,” *New York Times* online interactive graphic, available at http://www.nytimes.com/interactive/2010/05/27/us/20100527-oil-landfall.html?_r=0 (accessed Aug. 18, 2013).

⁶² In the case of BP alone, the company’s Deep Water Horizon disaster was preceded by an accident at its Texas City Refinery in March 2005 which killed 15 and injured over 170. The company was also responsible for the largest leak ever into the North Slope at Prudhoe Bay. As the Presidential Commission’s report noted, a culture focused on cost-cutting was an evident cause in all three incidents. *Deep Water Report*, *supra* note [45], at 218-225. As the Commission also noted, the failure of U.S. regulators to implement a “safety case” approach to risk probably explained why fatalities in the offshore oil and gas industry “were more than four times higher per person-hours worked in U.S. waters than in European waters, even though many of the same companies work in both venues.” *Deep Water Report* at 225. See also Richard T. Ainsworth & Andrew B. Shact, *Transfer Pricing in Business Restructurings – Reasoning from Implausible Assumptions Issue Note 2 (OECD, Discussion Draft)*, Boston University School of Law Working Paper No. 10-19, at 8 (July 19, 2010), available at <http://ssrn.com/abstract=1645404> (discussing failed attribution of risk in BP restructuring, as losses were borne by BP plc in London rather than the U.S. corporate entity, BP Exploration & Production).

2. NUCLEAR ENERGY

a. INTRODUCTION.

Nuclear power is likely the energy sector having received more federal government subsidies than any other given its history.⁶³ The use of nuclear fission for power in the U.S. developed out of government research following its development for weapons use. By the early 1960s the federal government “had already spent billions of dollars aiding the design of light water nuclear reactors.”⁶⁴

Despite those subsidies, no orders for nuclear power plants were placed in the U.S. between 1978 and 2007, largely in reaction to the Three Mile Island accident in Pennsylvania. In 2005 Congress passed the Energy Policy Act of 2005,⁶⁵ which included a number of specific new incentives for nuclear power, and talk of future regimes to limit carbon emissions fueled new interest.⁶⁶ As of June 2012, applicants had filed over 30 requests for combined construction and operation licenses with the Nuclear Regulatory Commission (NRC).

Public concern over the safety or desirability of nuclear power was likely affected by the accidents at the Fukushima Daichi nuclear complex that occurred in Japan in March, 2011. *Nevertheless, the Obama Administration reaffirmed its support of nuclear power thereafter, and the NRC approved four new reactors licensing applications in*

⁶³ A widely cited figure is that the nuclear industry received approximately \$145 billion in subsidies between 1947 to 1999, using 1999 dollars. See Benjamin K. Sovacool and Christopher Cooper, *Nuclear Nonsense: Why Nuclear Power Is No Answer to Climate Change and the World's Post-Kyoto Energy Challenges*, 33 Wm & Mary Env'tl. L. & Pol'y. Rev. 1, 44 (2008); see also Arnold W. Reitze, Jr., *Federal Control of Carbon Dioxide Emissions: What Are the Options?*, 36 B.C. Env'tl. Aff. L. Rev. 1, 46 & n. 323.

⁶⁴ Graetz, *supra* note 1, at [location 825 of 5033].

⁶⁵ Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (2005).

⁶⁶ See Mark Holt, Cong. Research Serv., CRS RL33558, *Nuclear Energy Policy 2* (June 20, 2012).

March of 2012, after the Fukushima accident.⁶⁷ Five plants are now under construction in the U.S.⁶⁸ Additionally, plans for new mining in the Southwest U.S. continue unabated.⁶⁹

The NRC did issue some new safety requirements for reactors in March of 2012 as the Fukushima reactors are of similar design to many in the U.S.⁷⁰ But many attribute the fact that the “nuclear renaissance” has involved less construction than anticipated to the boom in natural gas development and reduced prices for it due to hydraulic fracturing rather than to the experience of Fukushima.⁷¹

b. SUBSIDIES AND EXTERNALITIES ASSOCIATED WITH THE NUCLEAR FUEL CYCLE

The following subsections review externalities and direct and tax subsidies for civil nuclear power, following the steps in the entire nuclear fuel cycle. The fuel cycle can be divided into five stages: (1) uranium mining and enrichment, (2) plant construction, (3) energy plant operation, (4) spent fuel processing, interim storage and permanent sequestration, and (5) plant decommissioning and land reclamation.⁷²

1. URANIUM MINING, MILLING AND ENRICHMENT

Mining and Milling. Between 1953 and 1980, the U.S. was the principal producer of uranium.⁷³ Mining has occurred, and continues to occur, throughout the Western

⁶⁷ *Id.* at 2, 5. See also “NRC Approves New Reactors at Plant Vogtle,” 4058 PUR Util. Reg. News 1 (Feb. 17, 2012) (noting that NRC Chairman Jackzo abstained out of concerns raised by Fukushima).

⁶⁸ See “The Nuclear Renaissance: what went wrong,” CNN.com (posted Nov. 6, 2013), available at <http://www.cnn.com/2013/11/06/us/atomic-economics/index.html> (accessed Dec. 17, 2013).

⁶⁹ Manuel Quinones, “As Cold War Abuses Linger, Navajo Nation Faces New Mining Push,” *E&E News* (Dec. 13, 2011). And see oral interview with Anna Marie Rondon, activist with DINE CARES (exchange with author, October, 2013, confirming that mining plans continued unabated).

⁷⁰ *Nuclear Energy Policy*, *supra* note [66] at 1, 9.

⁷¹ See “Nuclear Renaissance,” *supra* note [68]. This conclusion is further supported by the fact that new nuclear plants have been approved, and construction has begun, since the occurrence of Fukushima.

⁷² Sovacool & Cooper, *supra* note [63], at 7-11.

⁷³ OECD Nuclear Energy Agency, *Uranium 2003: Resources, Production and Demand*, at 238 (2004).

U.S.⁷⁴ Much of the mining has been for weapons uses, but the same mines have produced uranium for enrichment as fuel. Indeed, up to 1971, the U.S. government was the only permitted purchaser of uranium domestically. Both the mining and the milling of uranium have, and have had, significant environmental and health effects, as discussed in more detail in Appendix II detailing the experience of the Navajo Nation.

Radon and radium, both decay products of uranium which result from the mining and milling of uranium, are known to cause bone, liver, breast and lung cancer,⁷⁵ inhaled by miners and their families, the compounds are known to have caused other fatal lung ailments as well (and this was statistically documented in the case of the Navajo miners⁷⁶).

As discussed in Appendix II, it was known to the U.S. ahead of time that lung diseases and cancers would result from uranium mining, but precautions were not taken to reduce these risks, and a compensation scheme was not passed by Congress to address the harms caused until 1990. Compensation for miners (and, since 2000, millers) who can establish that their illness was related to their exposure is sometimes available under the Radiation Exposure Compensation Act,⁷⁷ but the compensation scheme has been criticized on a number of grounds.⁷⁸ In any event, to the extent that there is

⁷⁴ See, e.g., Energy Info. Admin., *2011 Domestic Uranium Production Report*, at 6-7, Tables 4 and 5 (May 2012) (providing recent data for U.S. uranium mill and in situ leach plant production by location).

⁷⁵ See “ToxFAQs for Radium,” Agency for Toxic Substances & Disease Registry Toxic Substances Portal, available at <http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=790&tid=154>; see also “Radon,” Agency for Toxic Substances & Disease Registry Toxic Substances Portal, available at <http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=71>.

⁷⁶ See Robert J. Roscoe, MS, James A. Deddens, PhD, Alberto Salvan, MD, PhD, and Teresa M. Schnorr, PhD, “Mortality among Navajo Uranium Miners,” 85 *Am. J. Pub. Health* 535, 537 (Table 3) (reporting significantly elevated deaths from tuberculosis, pneumoconiosis and other respiratory diseases in PHS Study monitored cohort). See also Appendix II (discussing PHS Study).

⁷⁷ Pub. L. No. 102-426, 106 Stat. 2174 (Oct. 19, 1992).

⁷⁸ See, e.g., Doug Brugge and Rob Goble, “The Radiation Exposure Compensation Act: What Is Fair?,” in *The Navajo People and Uranium Mining* 137-153 (Brugge, Benally, and Yazzie-Lewis, eds., 2006). Among the multiple criticisms of RECA are the requirement of proof of exposure, which can be

compensation under RECA, it is not reflected as a subsidy in EIA's 2007 or 2010 Reports;⁷⁹ to the extent there was no compensation, or inadequate compensation, it is clearly an externality of the mining and milling processes.⁸⁰

Leach-mining for uranium uses significant quantities of water, and water from uranium mining has been left contaminated.⁸¹ At least in the U.S., “[n]o aquifer leach-mined for uranium has ever been restored to the water quality levels specified in the original uranium recovery permit.”⁸² As noted in Appendix II, water bodies on the Navajo reservation were left contaminated with heartbreaking results.

Once mined, uranium has to be milled. Mill tailings retain radioactive elements which make them “for all practical purposes, a perpetual hazard” because they will emit radon for up to a billion years.⁸³ In 1978, Congress passed legislation intended to require presently active private milling operations (“Title I sites”) to remediate their sites at their own expense,⁸⁴ however, cleanup has generally been subsidized by the government, and, as noted in Appendix II, there are both mine and mill sites not yet remediated on Navajo lands.

difficult many years after the exposure occurred, the fact that only claims by miners and millers are permitted, when family members were also directly exposed to uranium dust brought home on workers' clothing, the fact that miners' claims have been denied on the ground of their ceremonial smoking even though the causal connection of such smoking to lung disease is minimal, and the amount of compensation granted even when it was allowed was often barely enough to pay hospital bills.

⁷⁹ The EIA 2007 Report includes Environmental Management costs of \$350 million and “Termination Costs and Program Direction” at \$253 million for that year; these costs appear to be for DOE's cleanup and maintenance of specific sites for which it is responsible. EIA 2007 Report at 47 (Table), 48.

⁸⁰ The affected Navajo themselves would use terms other than “externality” to describe their experience; some of their oral history is excerpted in Appendix II.

⁸¹ See Christopher E. Paine, *The Nuclear Fuel Cycle, Global Security, and Climate Change: Weighing the Costs and Benefits of Nuclear Power Expansion*, 44 U. Rich. L. Rev. 1047, 1102 (2010).

⁸² *Id.*

⁸³ See House Interior and Insular Affairs Comm., H.R. Rep. No. 95-1480(I), “P.L. 95-604, Uranium Mill Tailings Radiation Control Act of 1978,” at 11 (Aug. 11, 1978).

⁸⁴ See Pub. L. 95-604, Uranium Mill Tailings Radiation Control Act of 1978, 92 Stat. 3021, *codified at* 42 U.S.C. 7901 *et seq.*

Under the 1978 legislation, first, DOE was to cover cleanup costs for the twenty-four milling sites that were already inactive (with an expected ten percent contribution from affected states); as of 1995 DOE estimated that the cleanup cost for these sites was \$2.4 billion (in 1995 dollars).⁸⁵ Second, at least one large milling concern that was still operational and that should have covered its own remediation costs (Atlas Minerals Corp.) declared bankruptcy and reorganized, leaving the cleanup of its large site to be handled at federal expense.⁸⁶ In 2009 DOE estimated that the past and projected cost for remediation of the Atlas mill tailings pile and groundwater cleanup alone would approximate \$1 billion at a minimum (in 2009 dollars).⁸⁷ It does not appear that the EIA included any of the costs for mine or mill tailings cleanup as a subsidy in its 2007 or 2010 Reports.⁸⁸ Much of this cleanup work remains undone; cost appears to be a factor.⁸⁹ As

⁸⁵ See General Accounting Office, GAO/RCED-96-37, "Uranium Mill Tailings: Cleanup Continues, but Future Costs are Uncertain," at 6 (Dec. 1995) (Executive Summary, noting that DOE estimate was in present-value 1995 dollars although Title I site cleanup would not be completed until 2014).

⁸⁶ See, e.g., MoabTailings.org website, "History" page, available at www.moabtailings.org/history.htm (information site for Moab UMTRA Project maintained by Grand County, Utah, stating that title to Moab site was transferred to DOE by Congress in 2000 to permit cleanup operations to begin) (last accessed July 23, 2012); Department of Energy, *Record of Decision for the Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah*, 70 Fed. Reg. 55358, 55359 (Sept. 21, 2005) (original Record of Decision) (recounting history of UMTRA and transfer of Moab to DOE). See also Department of Energy, "Moab Utah, UMTRA Project" website, available at www.gjem.energy.gov/moab/ (last accessed July 23, 2012). See also Department of Energy, DOE/EIS-0355, *Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, Utah, Final Environmental Impact Statement*, vol. 1, at I-2 to I-5 (stating that Atlas Minerals Corp was required to decontaminate the site under a Nuclear Regulatory Commission (NRC) license, but that it went bankrupt shortly thereafter, leaving DOE to limit hazardous emissions from the site and to develop a plan to remediate the site and prevent further leaching of contaminants into the Colorado River); Department of Energy, *Amended Record of Decision for the Remediation of the Moab Uranium Mill Tailings, Grand and San Juan Counties, UT*, 73 Fed. Reg. 11103, (Feb. 29, 2008) (stating that DOE amended its decision to permit transportation of the tailings pile primarily by rail to accelerate the process).

⁸⁷ See Department of Energy, Office of Environmental Mgmt., DOE/EM-0004, *Report to Congress: Status of Environmental Management Initiatives to Accelerate the Reduction of Environmental Risks and Challenges Posed by the Legacy of the Cold War* (hereafter, "Status of Environmental Management Report 2009") (Jan. 2009), Appendix B, at B-6 (Life-Cycle Costs by Project Baseline Summary, entry for Moab soil and groundwater remediation).

⁸⁸ It appears that both the 2007 and 2010 Reports specifically excluded direct expenditures for energy sources that should have been covered by Trust Funds. See EIA 2010 Report, Executive Summary at x, EIA 2007 Report at 4 (each noting that direct subsidies could result if federally-mandated private trust funds were not sufficient). Nevertheless, DOE's Office of Environmental Management asked for

noted in Appendix II, cleanup on the Navajo Nation of abandoned mines and mills is far from complete, despite proposals to begin mining and milling operations anew.

As discussed in Appendix II, by far the largest nuclear accident in the United States occurred at a mill site adjacent to Navajo territory; a breached dam released 95 million gallons of liquid, and 1100 tons of solid, radioactive waste into a river used for drinking and animal grazing by families living adjacent to it; the river was rendered unusable.

Enrichment. Federal subsidies for uranium enrichment include federal loan guarantees for enrichment plant construction, discussed immediately below,⁹⁰ and direct federal expenditures for the decontamination and decommissioning of domestic enrichment plants that provided fuel for nuclear power, discussed in the section on decontamination and decommissioning.⁹¹

2. PLANT CONSTRUCTION

Plant Construction: 80% Loan Guarantees. The Energy Policy Act of 2005 authorized federal loan guarantees for up to 80% of construction costs for advanced energy projects that reduce GHG emissions.⁹² The Federal Credit Reform Act requires that loan guarantees receive advanced appropriations, and the present ceiling on such guarantees under the Energy Policy Act is \$18.5 billion for nuclear power plant projects,

appropriations of \$1.2 billion for FY 2008 to cover federal expenses relating to the Uranium Mill Tailings Remediation Act. *See* DOE, Office of Environmental Management, FY 2008 Congressional Budget Request, DOE/CF-018, Vol. 5, at 371, 393.

⁸⁹ *See* L. MacMillan, “Uranium Mines Dot Navajo Land, Neglected and Still Perilous,” N.Y. Times (Mar. 31, 2012) (referring to highly contaminated mine site in Cameron, Arizona discovered by a Navajo cattle rancher in 2010 that was left unattended and without cleanup as of the date of publication).

⁹⁰ *See infra* section II.D.2.b.2.

⁹¹ *See infra* section II.D.2.b.5.

⁹² Energy Policy Act of 2005, Pub. L. No. 109-58, Section 1703.

and \$4 billion for uranium enrichment plants.⁹³ As of June 2012, two of the four reactors having received new NRC licenses had obtained loan guarantees totaling \$8.3 billion, and the other two were still under consideration.⁹⁴ Additionally, two firms had announced plans to build enrichment plants and applied for loan guarantees in the amount of \$4.8 billion; one of them received a \$2 billion guarantee.⁹⁵

The EIA 2007 Report did not include the value of the 80% loan guarantee in its analysis of subsidies to nuclear power.⁹⁶ EIA's 2010 Report did include a figure for the cost of such guarantees in the amount of \$265 million for 2010.⁹⁷ Analysis of the cost of the subsidy to the government and its value to the entities receiving guarantees is admittedly complicated. Under Section 1703 the loan recipient is to pay the Credit Subsidy Cost (CSC), which theoretically would cover the cost of the guarantee and eliminate any federal subsidy. However, the Congressional Budget Office concluded that loan guarantees under Section 1703 still contained a subsidy because the estimated CSCs were too low.⁹⁸ It appears that the EIA only included estimates costs for the guarantees actually issued for nuclear facilities in 2010.⁹⁹

⁹³ *Nuclear Energy Policy*, *supra* note [66], at 24, 25. The \$4 billion for enrichment plants includes \$2 billion in guarantee authority that the Department of Energy (DOE) announced it would reprogram from an earlier appropriation. The Obama Administration requested that the ceiling for nuclear power plants be nearly tripled to \$54.5 billion in its FY11, FY12 and FY13 budgets but this has not gotten the approval of both houses in a simultaneous appropriations act. *Id.* at 24.

⁹⁴ *Id.*

⁹⁵ *Id.*

⁹⁶ *EIA 2007 Report.*, *supra* note [3], at xiii (stating that effect of subsidies under the Energy Policy Act of 2005 were not considered).

⁹⁷ See U.S. Dept. of Energy, Energy Information Administration, *Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2010* (July 2011) (hereafter, "*EIA 2010 Report*,"), at xviii.

⁹⁸ *Nuclear Energy Policy*, *supra* note [66] at 23 & n.86. See also *EIA 2010 Report*, *supra* note [97] at 68.

⁹⁹ See *EIA 2010 Report*, *supra* note [97], at 67 (stating that "only [loan guarantees] that received conditional or final approval in fiscal year 2010 will be included in this analysis.")

Loan guarantees for construction costs are “widely considered crucial by the nuclear industry to obtain financing for new reactors.”¹⁰⁰ Construction costs on the most recent nuclear projects in the U.S. have been “far higher than [those for] commercial fuel technologies.”¹⁰¹ Moreover, the accuracy of any cost estimates are subject to uncertainty: for the phase when all presently active reactors in the U.S. were built, in the 1960s and 1970s, all reactors cost at least double the estimated projection and the average overrun was four times the projection made in the initial authorization to build.¹⁰² Some independent analysis concludes that the difference between market loan rates and those available with a federal guarantee would be 10% or more;¹⁰³ it appears that this estimate is in line with the CSC calculated by the Office of Management & Budget on a recently cancelled “merchant plant.”¹⁰⁴ One analysis concludes that the 80% loan guarantee may provide a production subsidy equivalent to roughly 26 to 31 cents per kilowatt hour – “much more than the subsidy required to make wind, thermal solar, photovoltaic solar or geothermal into economically viable low-carbon alternatives able to compete with coal and natural gas.”¹⁰⁵

Plant Construction and Operation: Permit Delay Guarantees. The Energy Policy Act of 2005 also provided for “standby support” – regulatory risk insurance for operators to help pay the cost of regulatory delays at up to six new plants. The risk

¹⁰⁰ *Nuclear Energy Policy*, *supra* note [66], at 22.

¹⁰¹ *Id.* at 4.

¹⁰² Bernell K. Stone, *Using Fair Return Prices to Assess the Value and Cost of Financial Guarantees for New Nuclear Power Plants*, 6 B.Y.U. Int’l L. & Mgmt. Rev. 83, 100 (2009).

¹⁰³ Richard Caperton, Center for American Progress, *Protecting Taxpayers from a Financial Meltdown*, at 2 (Mar. 8, 2010), Bernell K. Stone, *Using Fair Return Price*, *supra* note [102], at 99.

¹⁰⁴ *Nuclear Energy Policy*, *supra* note [66], at 24 (discussing CSC figure of 11.6% percent for Constellation Energy for a plant at Calvert Cliffs). The *Nuclear Energy Policy* report notes that the CSC under negotiation with the lead investor for the approved Vogtle Plants appears to be between 0.5% and 1.5%, and it speculates that this much lower rate was justified by the fact that the investor was rate-regulated such that it “is allowed to pass all prudently incurred costs through to utility ratepayers.” *Id.*

¹⁰⁵ Stone, *supra* note [102] at 103.

insurance is to be provided for by contract with the DOE after payment of subsidy costs by the applicant – but the Office of Management & Budget has yet to approve any subsidy cost estimates,¹⁰⁶ and no subsidy estimate was included in the EIA 2007 or 2010 Reports.

Plant Construction and Operation: Tax Credit for Production from Advanced Nuclear Power Facilities. The Energy Policy Act of 2005 provided a 1.8 cent per kilowatt hour credit for up to the first 6,000 megawatts of new nuclear capacity for the first eight years of operation, up to \$125 million annually per 1,000 megawatts.¹⁰⁷ Since applications for new power plants exceeding the first 6,000 megawatts of construction have already been filed, and the Department of Treasury has taken the position that the incentive should be prorated among the reactors for which applications had been filed by the end of 2008, the tax subsidy may be less favorable.¹⁰⁸ Nevertheless, as a highly respected resource economist notes, the effect of these limitations is obviously to encourage applicants to move quickly to take advantage of the credit.¹⁰⁹ Combined with new NRC rules designed to limit public comment by providing for design review in separate generic proceedings, the rush of new site applications has been criticized as haphazard and economically ill-founded.¹¹⁰

Plant Construction: Tax Subsidy for Advanced Energy Property Investment. The Advanced Energy Property Credit is a 30% investment credit available for manufacturing of “qualified” property for use in the production of renewable energy, or energy that

¹⁰⁶ *Nuclear Energy Policy*, *supra* note [66] at 21.

¹⁰⁷ I.R.C. § 45J (2012) was added by Section 1306 of the Energy Policy Act of 2005, Pub. L. No. 109-58), to provide for a credit for the production of electricity from advanced nuclear power facilities. *See generally EIA 2007 Report*, *supra* note [3], at 155.

¹⁰⁸ *See Nuclear Energy Policy*, *supra* note [66], at 20 & n.74, *citing* Dept. of Treasury, Internal Revenue Svc., Notice 2006-49 (May 1, 2006), *reprinted in* Internal Revenue Bulletin 2006-18 at 855.

¹⁰⁹ Metcalf, *Taxing Energy*, *supra* note [37], at 13.

¹¹⁰ *See Paine, Nuclear Fuel Cycle*, *supra* note [81], 44 U. Rich. L. Rev. at 1063-1066.

reduces GHG emissions; it was included in section 1302 of ARRA – the 2009 Recovery Act.¹¹¹ To be “qualified,” the property must be certified upon application to the Secretary.¹¹² The EIA 2010 Report concluded that \$8 million in advanced energy property credits were awarded for investments in property for nuclear power production for FY 2010.¹¹³

Summarizing the subsidies for plant construction, a number of them are not tax related, and are significant.

3. PLANT OPERATION

Plant Operation Subsidies: Liability Cap. The Price-Anderson Act provides a two-tier system to address potential public liability for accidents at commercial nuclear reactors. First, each operator must obtain primary insurance of the maximum available, which as of 2010 was approximately \$375 million.¹¹⁴ Further liability would be covered by a fund to which operators must contribute based on the number of reactors they own at up to \$111.9 million per reactor (plus a possible 5% surcharge) beyond which liability is capped.¹¹⁵ Since the number of reactors operating in the U.S. was last at 104, this means liability for any one accident is capped at approximately \$12.6 billion. With more reactors, the cap would go up – but so would the risk.

The Price-Anderson Act was last extended in the Energy Policy Act of 2005 as to new reactors, and its extension “was widely considered a prerequisite for new nuclear

¹¹¹ See American Reinvestment and Recovery Act of 2009 (hereafter, “ARRA” or the “Recovery Act of 2009”), Pub. L. No. 111-5, § 1302, 123 Stat. 115, 345 (2009), *codified at* I.R.C. § 48C(c)(1)(A) (2012).

¹¹² See I.R.C. § 48C(c)(1)(A)(ii), (d)(2) (2012).

¹¹³ *EIA 2010 Report*, *supra* note [97] at 21.

¹¹⁴ See *EIA 2010 Report*, at 3.

¹¹⁵ Since the fund pools the retroactive contributions of utilities, most of whom can pass on their costs to customers, reliance on the Price-Anderson Fund is effectively a rate-payer subsidy.

reactor construction in the United States.”¹¹⁶ However, as the Congressional Research Service has noted, the damages to the public from the Fukushima accident “has prompted new calls for reexamination” of Price-Anderson’s limits on liability.¹¹⁷ As of 2012, even the low-end estimate that Fukushima’s operator, Tokyo-Electric Power Co (“TEPCO”) anticipated paying in damages to residents and former residents - \$32 billion – far exceeded the single-accident cap in Price-Anderson.¹¹⁸ In the summer of 2013 TEPCO and the government of Japan revealed that contaminated groundwater was leaking from Fukushima into the ocean at the rate of roughly 300 tons per day; the government and TEPCO announced unprecedented plans to fund a wall of frozen earth a mile long as well as new water treatment technologies at an estimated cost of an additional half a billion dollars (apparently not including the cost for its continued operation).¹¹⁹ The ice wall

¹¹⁶ *Nuclear Energy Policy*, *supra* note [56], at 19.

¹¹⁷ *Id.* at 19, citing Ellen Vancko, Union of Concerned Scientists, “The Impacts of Fukushima on the U.S. Nuclear Power Industry,” presentation to the Center for Strategic and International Studies Conference on Nuclear Safety and Fukushima, at 5 (April 7, 2011), *available at* https://csis.org/files/attachments/110407_vancko_nuclear_safety_0.pdf.

¹¹⁸ See Chico Harlan, “Japan’s Nuclear Victims Seek Compensation, But Not Their Day In Court” *Washington Post* (Jan. 25, 2012) (Stating that TEPCO’s then-estimate of its liability for compensation was at \$32 billion, but noting that approximately 120,000 individuals have applied to TEPCO for an initial round of compensation, and that TEPCO had indicated it would voluntarily pay \$1250 to \$1500 per month indefinitely for mental anguish to any evacuee from the 12-mile mandatory evacuation zone. The article further indicated that 500 victims a month had been going to government-sponsored mediation centers in Tokyo and Fukushima because they were dissatisfied with TEPCO’s proposed settlements.)

There is apparently no limit on potential recoveries for victims under Japanese law; the liability of TEPCO is technically limited to 120 billion yen it was required to deposit into a government security fund, but the government is charged with contributing to the operator to cover additional compensation. The cap on operator liability used to be 1 billion yen, but after a 1999 incident involving radiation exposure and two worker fatalities at a reprocessing plant, the parent company of the operator paid claims totaling 15.4 billion yen out of “moral responsibility.” See Eri Osaka, *Corporate Liability, Government Liability, and the Fukushima Nuclear Disaster*, 21 Pac. Rim L. & Pol’y J. 433 (2012). The scope of the Fukushima accident was much larger and the government has already contributed to TEPCO to cover claims. Harlan, “Japan’s Nuclear Victims,” *supra*.

¹¹⁹ See, e.g., “Can an Ice Wall Stop Radioactive Leaks from Fukushima?,” *National Geographic Daily News* (Aug. 19, 2013), *available at* <http://news.nationalgeographic.com/news/energy/2013/08/130819-japan-ice-wall-for-fukushima-radioactive-leaks/>, and Alan Boyle, “How Japan’s Ice Barrier Will Seal Off Fukushima’s Nuclear Ruins,” NBC News, *available at* <http://www.nbcnews.com/science/japan-build-ice-barrier-around-fukushima-nuclear-ruins-8C11067684> (both last accessed Sept. 24, 2013). It does not appear that the half-billion dollar figure includes the ongoing cost for powering the ice wall. Neither the cost of the ice wall nor the

was projected to require 9.8 megawatts to maintain, or the power required for daily use by about 3,300 Japanese households.¹²⁰

The EIA 2007 and 2010 Reports both made note of the Price Anderson Act limits, and did not estimate any federal subsidy associated with them.

4. SPENT FUEL PROCESSING, INTERIM STORAGE, AND PERMANENT SEQUESTRATION

Spent Fuel Processing, Temporary Storage, and Permanent Sequestration. Under the Nuclear Waste Policy Act (NWPA), the federal government assumed responsibility for the disposal of commercial spent fuel – along with federally-generated radioactive waste – in a deep underground repository. Congress declared Yucca Mountain as the only eligible site for the repository in 1987 and required DOE to begin accepting waste from commercial plants in 1998. Under the NWPA, funding for commercial waste at Yucca Mountain was to come from fees paid by the nuclear utilities into the Nuclear Waste Fund.¹²¹

DOE did not file a license with the NRC for Yucca Mountain as a repository until 2008, and the Obama Administration declined to seek funding for the site, establishing a Blue Ribbon Commission to develop alternative waste management strategies. Seventy-four commercial nuclear utilities entered into contracts with DOE whereby DOE agreed to dispose of the waste by 1998; most if not all of these utilities have successfully sued DOE for violation of this contractual liability.¹²² DOE has estimated that its liability payments would ultimately reach \$20.8 billion assuming it began taking spent fuel from

cost for its maintenance is a part of the earlier low-end \$32 billion TEPCO damages estimate noted above.

¹²⁰ *Id.*

¹²¹ *Nuclear Energy Policy*, *supra* note [56], at 33.

¹²² *See* Department of Energy, Office of Civilian Radioactive Waste Mgmt., DOE/RW-0596, *Report to Congress on the Demonstration of Interim Storage of Spent Nuclear Fuel from Decommissioned Nuclear Power Reactor Sites* (hereafter, “*Interim Storage Report*”), at 5 (Dec. 2008) (stating that as of the time of the report more than 70 lawsuits had been filed, and more than fifty were still pending).

operators by 2020 (the date previously set for the opening of Yucca Mountain).¹²³ DOE has already paid approximately \$1 billion toward this liability;¹²⁴ it also assumed responsibility for the payment for interim storage for commercial spent nuclear fuel in 2000, which it estimates will cost \$500 million annually.

The EIA 2010 Report did not address past or future federal liability – it explicitly stated that matters relating to the federal administration of trust funds including the Nuclear Waste Fund were outside the scope of the report.¹²⁵ In fact, the \$1 billion in past damages and the ongoing annual obligation of \$500 million annually do not come from the Nuclear Waste Fund fees and they are not reflected in appropriations to DOE at all.¹²⁶ Although there have been proposals for the federal development of an Interim Storage facility so that DOE’s liability going into the future could be reduced, DOE has opposed them, and has argued that these proposals could have a “negative impact” on the nuclear waste disposal fee.¹²⁷

Even if the controversy regarding Yucca Mountain were resolved, the current level of spent nuclear fuel from existing reactors exceeds that which the NWPA would

¹²³ *Nuclear Energy Policy* at 33-34.

¹²⁴ James D. Werner, Cong. Research Serv., *Spent Nuclear Fuel* (CRS Report R42513), at 7 (May 24, 2012).

¹²⁵ *EIA 2010 Report*, *supra* note [97], at x.

¹²⁶ The \$1 billion already paid and future annual payments come from “the Judgment Fund” managed by the Department of Justice pursuant to 31 U.S.C. § 1304, *not* from DOE annual appropriations. *See* Werner, *Spent Nuclear Fuel*, *supra* note [124], at 7 & n.41. In *Alabama Power Co. v. U.S.*, 307 F.3d 1300, 1306, 1312-1315 (11th Cir. 2002), the Eleventh Circuit ruled that the DOE was not permitted to negotiate with nuclear utilities that “set off” fees owed to the Nuclear Waste Fund against DOE’s liability for breach of contract in not taking their waste starting in 1998. Since DOE’s payments for interim storage were to remedy its breach of contract, fees paid by the utilities to the Nuclear Waste Fund for permanent storage under the NWPA should not be used.

¹²⁷ Department of Energy, *Interim Storage Report*, *supra* note [122], at 15.

permit to be stored there,¹²⁸ so that “extended storage for longer than previously anticipated is virtually assured”¹²⁹ – along with the associated federal annual liability.¹³⁰

5. PLANT AND SITE DECONTAMINATION AND DECOMMISSIONING

Decontamination and Decommissioning - Overview. After nuclear plants are closed, they are supposed to be disassembled and the sites where they were located are supposed to be made safe for other uses in a process called “decontamination and decommissioning,” or simply “decommissioning.” When nuclear *power* plants are decommissioned, the process is supposed to be paid for by funds put on reserve by the nuclear utility while the plant is in service.¹³¹ When uranium *enrichment* plants are decommissioned, the nuclear utilities that have relied on those plants for fuel are supposed to cover some of the costs.¹³² When nuclear fuel *reprocessing* facilities are used by commercial nuclear power plants, theoretically the same result should occur. However, in all three situations, as discussed below, there are hidden federal subsidies not recognized in the EIA 2007 or 2010 Reports – or other governmental analysis.

¹²⁸ Werner, Cong. Research Serv., *Spent Nuclear Fuel supra* note [124], at 5.

¹²⁹ *Id.*, at 1.

¹³⁰ The lack of a permanent repository may ultimately place additional practical limits on the ability of utilities to develop new nuclear power plants. In May of 2012, the District of Columbia Court of Appeals ruled that an NRC rulemaking resulting in a “Waste Confidence Decision” to the effect that facilities could safely store spent nuclear fuel onsite for up to sixty years was a “major federal action” under the National Environmental Policy Act (NEPA), requiring the preparation of either an Environmental Impact Statement or a Finding of No Significant Impact. *See New York v Nuclear Regulatory Comm’n*, 681 F.3d 471 (D.C. Cir. 2012).

¹³¹ *Nuclear Energy Policy, supra* note [66], at 17. *See also* Government Accountability Office, GAO-12-258, *Nuclear Regulation: NRC’s Oversight of Nuclear Power Reactors’ Decommissioning Funds Could Be Further Strengthened* (Apr. 2012) (discussing NRC regulations and oversight of nuclear utilities’ decommissioning set-asides).

¹³² *See generally* General Accounting Office, GAO-04-692, *Uranium Enrichment: Decontamination and Decommissioning Fund is Insufficient to Cover Cleanup Costs* (July 2004), and Government Accountability Office, GAO-08-277T, *Uranium Enrichment: Extension of Decontamination and Decommissioning Fund May Be Needed to Cover Cleanup Costs* (Nov. 15, 2007).

General Tax Subsidy for Decommissioning. As noted below, most of the subsidies relating to decommissioning are direct subsidies. There is one tax subsidy. The Energy Policy Act of 2005 relaxed rules relating to contributions to nuclear decommissioning trust funds under IRC 468A,¹³³ ostensibly to facilitate sales of nuclear plants after placing funds into a decommissioning trust.¹³⁴ This tax subsidy would not be limited to nuclear power plants so is mentioned here. The rules now allow for a current deduction of contributions into a qualifying trust, and the rate of tax on income to the trust is also reduced to 20%.¹³⁵ The EIA 2007 Report valued this tax expenditure at \$199 million for FY 2007.¹³⁶ The EIA 2010 Report valued the expenditure at \$900 million for FY 2010 and revised the value of the expenditure for FY 2007 to \$600 million.¹³⁷

Power Plant Decommissioning. With regard to nuclear power plants, the utilities are required to set aside revenue for decommissioning and it appears that such funds have covered the costs of the work the utilities are presently able to do.¹³⁸ However, power

¹³³ I.R.C. 468A (2012), provides the rules for the funding of qualified decommissioning trust funds and was modified by Section 1310 of the Energy Policy Act of 2005 (Pub. L. No. 109-58). *See generally EIA 2007 Report, supra* note [3], at 158.

¹³⁴ *See EIA 2007 Report* at 158.

¹³⁵ *See* Joint Comm. on Taxation, JCX-25-09R, *Tax Expenditures for Energy Production and Conservation – Scheduled for a Public Hearing Before the S. Comm. on Finance on April 23, 2009* (Apr. 21, 2009) at 17 (Summary of Other Energy Provisions Table, regarding I.R.C. 468A).

¹³⁶ *EIA 2007 Report* at 14 (Table 1, Estimates of Tax Expenditures by Fiscal Year), 21, 158.

¹³⁷ *EIA 2010 Report* at 7 (Table 1). The basis for the new FY 2007 figure is unclear. The *EIA 2010 Report* apparently relied on the JCT's tax expenditures estimates report for 2010-2014 for the FY 2010 data. *See EIA 2010 Report* at 8 (Table 1, citing Sources); *see also* Joint Comm. on Taxation, JCS-3-10, *Estimates of Tax Expenditures for Fiscal Years 2010-2014* (Comm. Prt Dec. 15, 2010) at 41 (Table 1, noting \$0.9 billion tax expenditure for "Special Tax Rate for Decommissioning Reserve Funds"). The *EIA 2010 Report* apparently relied on the JCT's 2007-2011 report for the FY 2007 data. *See* Joint Comm. on Taxation, JCS-03-07, *Estimates of Tax Expenditures for Fiscal Years 2007-2011* (Comm. Prt. Sept. 24, 2007), at 26 (Table 1, noting \$0.6 billion tax expenditure for "Special Tax Rate for Nuclear Decommissioning Funds" for FY 2007). It appears the *EIA 2007 Report's* \$199 million figure relied on an earlier JCT estimate and not a Tax Expenditure Budget. *See EIA 2007 Report* at 105 (Table 34) (citing various sources), 158.

¹³⁸ The Congressional Research Service's *Nuclear Energy Policy* report addresses the cost of decommissioning in four recent cases and appears to presume that those costs were paid for by reserved utility trust funds. *See Nuclear Energy Policy, supra* note [66], at 17. The GAO Report *NRC's Oversight of Nuclear Power Reactors' Decommissioning Funds* addresses NRC's regulation of utility

plant sites cannot be fully decommissioned until spent nuclear fuel is removed, and, as noted immediately above, the maintenance of spent nuclear fuel is presently a financial responsibility being borne by the federal government.¹³⁹ There are at least ten sites where commercial reactors are no longer in service where spent fuel is being stored indefinitely, at the government's significant cost,¹⁴⁰ not included in the EIA Reports, as discussed in the section immediately above on interim storage.¹⁴¹

Additionally, the federal government is directly responsible for the decommissioning of at least one civilian nuclear power reactor, as well as facilities that supported its fuel cycle. The N-Reactor at the Hanford site produced weapons-grade plutonium, but also produced electricity for 21 years, which was provided to customers of the Washington Public Power Supply System (WPPSS, colloquially known as “Whoops”), and it is one of the reactors that must be decommissioned by DOE at Hanford.¹⁴² It is probable that significant costs relating to N-Reactor's decontamination

decommissioning fund development and maintenance, but does not address any past shortfalls. See GAO-12-258, *NRC's Oversight of Nuclear Power Reactors' Decommissioning Funds*, *supra* note [131].

¹³⁹ *Id.*

¹⁴⁰ See *Interim Storage Report*, *supra* note [122], at 6. The Report was issued in 2009. DOE's estimate of interim storage costs it would bear through 2020 if Yucca Mountain was opened on time was then “up to approximately \$11 billion,” but the estimate has since gone up to \$20.8 billion. See *Nuclear Energy Policy*, *supra* note [66], at 33-34, and see Government Accountability Office, GAO-11-229, *Commercial Nuclear Waste: Effects of a Termination of the Yucca Mountain Repository Program and Lessons Learned*, at 31 (Apr. 2011) (noting that DOE's estimated interim storage cost was roughly \$16.4 billion, including damages paid already, assuming Yucca Mountain would open in 2020, and noting that nuclear operators' contrasting estimate of the total DOE liability for damages could be \$50 billion).

¹⁴¹ As the Congressional Research Service has noted, the opening of Yucca Mountain by 2020 would have required significant funding increases, according to DOE, but DOE has instead moved to cancel the planned repository and cut all funding to it. See Mark Holt, Cong. Research Serv., R40202, *Nuclear Waste Disposal: Alternatives to Yucca Mountain* at 5 (Feb. 6, 2009) (noting DOE had asserted funding increases were necessary to achieve the 2020 deadline), and *Nuclear Energy Policy*, *supra* note [66] at 33 (discussing program and funding shutdown as of 2012).

¹⁴² See Department of Energy, *Hanford Projects and Facilities: N Reactor*, web page available at <http://www.hanford.gov/page.cfm/NReactor> (last visited July 8, 2012) (from DOE website for Hanford stakeholders, stating that N Reactor operated from 1963 to 1987 and is presently being cocooned); see also Department of Energy, DOE/DP-0137, *Plutonium: The First 50 Years – United States Plutonium Production, Acquisition and Utilization from 1944 through 1994* at 24-25 (Feb. 1996) (reporting that N-Reactor operated from 1963 to 1987 but generated electricity only from 1966 to 1987).

and decommissioning concern reprocessing activities at that site, so costs at Hanford will be addressed below.

Uranium Enrichment Plant Decommissioning. Commercial nuclear power plants have received at least some of their enriched uranium fuel from at least two federally-built uranium enrichment plants: a gaseous diffusion plant at Portsmouth/Piketon, Ohio, and a gaseous diffusion plant at Paducah, Kentucky.¹⁴³ The total cost DOE estimated for the decontamination and decommissioning of these facilities is between \$16.9 and \$30.8 billion, and the time required for the work is expected to last until at least 2044.¹⁴⁴

The EIA Reports do include *some* appropriations to the DOE Office of Environmental Management for the particular year in question.¹⁴⁵ However, many of the relevant appropriations have been excluded. Safety and security (to prevent access to the radioactive materials at the site) is not included, as this is considered a “defense” appropriation. And federal contributions to the Uranium Enrichment Decontamination and Decommissioning Fund (which are meant for the decommissioning of Paducah and Portsmouth)¹⁴⁶ are not included. The total federal contribution to the Fund was approximately \$453 million for 2007, of which approximately \$199 million relates to

¹⁴³ The Paducah, Kentucky and Portsmouth, Ohio gaseous diffusion plants used to be used to create highly enriched uranium for military purposes, however they were ultimately used for the enrichment of uranium for commercial nuclear power plants. See Paine, *The Nuclear Fuel Cycle*, *supra* note [81], 44 U. Rich. L. Rev. at 1083-1084. See also Arjun Makhijani, Lois Chalmers, and Brice Smith, Institute for Energy and Environmental Research, *Uranium Enrichment: Just Plain Facts to Fuel an Informed Debate on Nuclear Proliferation and Nuclear Power* (Oct. 15, 2004), at 20 (Table 2, listing then-existing and planned uranium enrichment plants in the U.S.).

¹⁴⁴ See Dept. of Energy, *Status of Environmental Management Report 2009*, *supra* note [87], at 79 (Table 3.2).

¹⁴⁵ See *supra* section II.D.2.b.1.

¹⁴⁶ See Department of Energy, Office of Environmental Mgmt., *FY 2008 Congressional Budget Request*, *supra* note [88], at 99 (noting that the total appropriation of approximately \$559 million for FY 2007 is meant to fund Environmental Management cleanup at the nation’s three gaseous diffusion plants, including the Paducah and Portsmouth plants).

Paducah and Portsmouth.¹⁴⁷ Although both the federal government and the commercial nuclear utilities have contributed to this Fund, in 2004 the General Accounting Office concluded that it was insufficient to cover the costs for the decontamination and decommissioning of the Paducah and Portsmouth plants,¹⁴⁸ and as of 2007 the commercial nuclear utilities were no longer obligated to pay into it even though GAO concluded that their payments would be needed. The GAO concluded that the shortfall from the Fund for adequate cleanup at Paducah and Portsmouth (due to inadequate federal contributions in the past as well as the lack of utility contributions) would ultimately be up to \$6.6 billion.¹⁴⁹

Decommissioning or Cleanup of Sites Used for Nuclear Fuel Reprocessing Related to Civilian Nuclear Power. In the 1970's, after India exploded a nuclear bomb made with plutonium recovered from a research reactor using fuel reprocessing technology supplied by the United States, Presidents Ford and Carter adopted a non-proliferation policy opposing the civilian reprocessing of spent nuclear fuel.¹⁵⁰ The result has been that the U.S. nuclear energy industry has mostly relied on a “once through” “open” fuel cycle rather than a “closed” fuel cycle involving reprocessing since then.

¹⁴⁷ The total federal contribution was \$452 million. *Id.* at 544. The total appropriation to the Fund was \$559 million for FY 2007 but some of this sum comes from user fees from commercial power plants, *id.*, at 99. Of the total \$559 million appropriation, \$248 million, or approximately 44%, related to the Paducah and Portsmouth sites. *Id.* Accordingly, federal contributions to the Fund for the cleanup of Paducah and Portsmouth in FY 2007 was approximately \$199 million. Certainly some of this funding relates to enrichment for federal purposes at the site, but as noted immediately below, the GAO has determined that contributions from commercial reactors to the fund are not adequate – and those contributions apparently ceased in 2007.

¹⁴⁸ See General Accounting Office, GAO-04-692, *Uranium Enrichment: Decontamination and Decommissioning Fund is Insufficient to Cover Cleanup Costs* (July 2004).

¹⁴⁹ See Government Accountability Office, GAO-08-277T, *Uranium Enrichment: Extension of Decontamination and Decommissioning Fund May Be Needed to Cover Cleanup Costs* (Nov. 15, 2007).

¹⁵⁰ Sovacool & Cooper, *Nuclear Nonsense*, *supra* note [63], 33 Wm. & Mary Envtl L. & Pol’y Rev. at 32; Paine, *The Nuclear Fuel Cycle*, *supra* note [81], 44 U. Rich. L. Rev. at 1089; *see also* Cong. Research Serv., *Spent Nuclear Fuel*, *supra* note [124], at 47.

Given the lack of a resolution on a permanent repository, there has been renewed discussion in recent years of reprocessing to reduce the volume of spent fuel (although questions remain regarding whether this is cost-effective or safe given proliferation concerns¹⁵¹). Whether reprocessing of fuel from civil nuclear power continues or not, two former reprocessing plants that accepted fuel from civil nuclear plants are now being remediated at significant federal expense. DOE estimates that the cost will be in the billions – and potentially tens of billions – of dollars, and in one case is disavowing any intent to decommission the site, based on the cost of doing so.

The first reprocessing site now under DOE cleanup is West Valley, New York. The site was a short-lived privately-operated nuclear fuel reprocessing facility. The facility provided “commercial spent nuclear fuel reprocessing and waste disposal facilities” in West Valley, New York between 1966 and 1972.¹⁵² The site was returned by its operator to the control of New York State pursuant to a contract between them in 1976; at that time it contained 660,000 gallons of high level radioactive waste and sludge in underground storage tanks.¹⁵³ In 1980 in the West Valley Demonstration Project Act

¹⁵¹ Cong. Research Serv., *Spent Nuclear Fuel*, at 47.

¹⁵² See U.S. Department of Energy, *Final Environmental Impact Statement for Decommissioning and/or Long-Term Stewardship at the West Valley Demonstration Project and Western New York Nuclear Services Center*, Chapter 1, at 1-1, available at http://www.westvalleyeis.com/final/EIS-0226_F-Chapter01.pdf (last viewed June 1, 2012).

See Department of Energy, *Status of Environmental Management Report 2009*, *supra* note [87], at 75-78 and Table 3.1 (discussing causes and amounts of increase in DOE Environmental Management lifecycle cost estimates); and see Letter from Gene Aloise, Director, Natural Resources and the Environment, U.S. Government Accounting Office, to Congressional Committees re Nuclear Waste: DOE’s Environmental Management Initiatives Report is Incomplete (June 2, 2009), available at <http://www.gao.gov/new.items/d09697r.pdf>, (noting history of progressively higher cost estimates by DOE’s Office of Environmental Management, and delays in nuclear cleanup projects).

¹⁵³ U.S. Department of Energy, *Final Environmental Impact Statement for Decommissioning at West Valley*, Chapter 1, at 1-1, avail. at http://www.westvalleyeis.com/final/EIS-0226_F-Chapter01.pdf (last viewed June 1, 2012). See also U.S. Department of Energy, *Plutonium Recovery from Spent Fuel Reprocessing by Nuclear Fuel Services at West Valley, New York from 1966 to 1972* (Feb., 1996) (summary prepared by DOE of declassified documents), avail. at <https://www.osti.gov/opennet/document/purecov/nfsrepo.html#ZZ0> (last viewed June 1, 2012).

of 1980 (“WVDP Act”), Congress directed DOE to take over control of the site and to vitrify the high-level waste in the tanks.¹⁵⁴ The WVDP Act also called for the removal of the wastes (effectively decommissioning the site), but the DOE is apparently now evaluating long-term stewardship as an alternative, apparently to reduce costs.¹⁵⁵ The timeframe for the decommissioning or the starting period of the stewardship effort, which commenced last year, is at least 40 years, and site decontamination, should it be undertaken, was expected to cost \$6.5 to \$9.3 billion (in 2008 dollars).¹⁵⁶

The second reprocessing site is at Hanford. As noted above regarding nuclear power plant decommissioning, the N-Reactor at Hanford produced civilian nuclear power for over 20 years. Some of N-Reactor’s spent fuel was actually reprocessed at West Valley between 1966 and 1972,¹⁵⁷ but subsequently much of it remained at Hanford, where it was stored and reprocessed in underground tanks. Hanford is DOE’s most radioactively contaminated site nationwide; in 2009, the agency estimated that the total cost for cleanup and decommissioning at Hanford (including remediation of groundwater and protection of the Columbia River) would cost between \$115.5 and \$136.2 billion,¹⁵⁸ and would not be complete until the year 2050 at the earliest.¹⁵⁹ As of its 2009 report, DOE had already expended nearly \$17 billion on Hanford cleanup.¹⁶⁰ While certainly

¹⁵⁴ See Department of Energy, *Final Environmental Impact Statement for West Valley*, Chapter 1, at 1-2 to 1-3, available at http://www.westvalleyeis.com/final/EIS-0226_F-Chapter01.pdf (last viewed June 1, 2012).

¹⁵⁵ *Id.*

¹⁵⁶ See U.S. Department of Energy, *Final Environmental Impact Statement for West Valley*, Chapter 4, Table 4-55, available at http://www.westvalleyeis.com/final/EIS-0226_F-Chapter04.pdf (last viewed June 1, 2012).

¹⁵⁷ See Department of Energy, *Plutonium Recovery at West Valley*, *supra* note [153].

¹⁵⁸ See Department of Energy, *Status of Environmental Management Report 2009*, *supra* note [87], at B-2 and B-6 (Appendix B, providing low- and high-end lifecycle cost estimates for remediation projects; figures above represent totals of high and low estimates for both Hanford and River Protection projects).

¹⁵⁹ See Department of Energy, *Status of Environmental Management Report 2009*, *supra* note [87], at 79 (Table 3.2).

¹⁶⁰ Department of Energy, *Status of Environmental Management Report 2009*, *supra* note [87], at B-2

there were numerous activities at Hanford which did not relate to civil nuclear power production, one third of the irradiated fuel at Hanford was attributable to N-Reactor,¹⁶¹ and some part of the cleanup should be attributed to the 21 years of civil power production that occurred there.

While some “Environmental Management” budgeting was included in the EIA 2007 Report, it is apparent that none of the costs related to Hanford were, and it does not appear that the full extent of federally-sponsored decommissioning was included. Specifically, the EIA 2007 Report asserts that in Fiscal Year 2007, \$350 million of Research and Development subsidies to nuclear power were for “Environmental Management” activities relating to decommissioning of DOE-controlled sites,¹⁶² and another \$253 million for safeguards and security, infrastructure and staffing.¹⁶³ There is little explanation in the report as to how this figure was derived. However, the combined \$603 million in the EIA 2007 Report represents a small portion of the roughly \$2.3 billion appropriated to the Environmental Management Office for cleanup in FY 2007 for sites that fully or partially supported civil nuclear power plants.¹⁶⁴ It appears that all Hanford cleanup (as well as related “River Protection” cleanup efforts) was excluded as

and B-6 (Appendix B, combining past expenditures for Hanford Site and River Protection).

¹⁶¹ See Projects & Facilities: N Reactor, available at <http://www.hanford.gov/page.cfm/NReactor> (web page at DOE site for Hanford stakeholders) (last viewed July 10, 2012).

¹⁶² EIA 2007 Report at 47 (Table 15) and 48 (describing Environmental Management mission as “addressing the environmental legacy resulting from past nuclear energy and research activities,” with a goal of decommissioning and then long-term surveillance and maintenance).

¹⁶³ EIA 2007 Report at 47 (Table 15) and 48 (including \$253 million for “Other Allocated Expenditures”) under R&D and describing “Other Allocated Expenditures” as covering site-wide infrastructure and for Safeguards and Security “protect[ing] DOE interests.”

¹⁶⁴ See Department of Energy, Office of Environmental Mgmt., DOE/CF-018, Volume 5, FY 2008 Congressional Budget Request (Feb. 2007), at 7 (listing “FY 2007 CR” for “Non-Defense Environmental Cleanup” at approximately \$310 million), 50-52 (listing appropriations for Moab, Hanford, River Protection, Paducah, Porstmouth, and the West Valley Demonstration Project which total over \$2.2 billion for FY 2007).

“Defense Cleanup,” and that government contributions to the Uranium Enrichment Decontamination and Decommissioning Fund were left out as well.

c. ENERGY, WATER, AND PROLIFERATION COSTS

In addition to the subsidies and externalities that can be allocated among steps in the fuel cycle, there are some that are general to the use of the power source.

Further Costs: GHG Emissions and Water Use. Although it is not often discussed, significant greenhouse gas (“GHG”) emissions result from the entire cycle required to generate nuclear power:

When the energy required for construction of a nuclear facility is added to the energy consumed in decommissioning as well as the energy required to mine, mill and enrich the uranium fuel, the nuclear fuel cycle consumes nearly half of all the electricity that a typical reactor is expected to produce during its lifetime, and this number does not include the energy needed to store spent fuel for thousands of years.¹⁶⁵

While some might argue that some of the emissions projected might be avoided if increasing amounts of grid power came from nuclear energy, the transition could not occur fast enough to adequately reduce GHG emissions from electricity even with the nuclear industry’s optimistic plan of having 100 reactors online by 2030.¹⁶⁶ Additionally, both the operation of nuclear reactors¹⁶⁷ and the original mining of uranium¹⁶⁸ use significant quantities of water. Neither lost water quality nor the energy cost of

¹⁶⁵ Sovacool & Cooper, *supra* note [63], at 10. *See also id.* at n. 54 (citing Luc Gagnon, “Civilization and Energy Payback,” 36 *Energy Pol’y* 3317, 3317-20 (2008) for proposition that using an “energy payback ratio” of total energy produced relative to energy needed to build and operate an energy system, renewable technologies are at least 1.5 to twenty times more efficient than nuclear reactors).

¹⁶⁶ Travis Madsen and Tony Dutzik, Frontier Group, and Bernadette Del Chiaro and Rob Sargent, Environment America, *Generating Failure: How Building Nuclear Power Plants Would Set America Back in the Race Against Global Warming*, at 2 (Nov. 2009).

¹⁶⁷ Roberta Mann, *Like Water for Energy: The Water-Energy Nexus Through the Lens of Tax Policy*, 82 *U. Colo. L. Rev.* 505, 517 (2011).

¹⁶⁸ Paine, *Nuclear Fuel Cycle*, *supra* note [81], at 1102.

transporting water (and the associated GHG emissions) are considered in tax subsidies for any energy source, including nuclear power.¹⁶⁹

Proliferation. Uranium enrichment and reprocessing pose the greatest concern as to nuclear weapons proliferation, as the technology for making nuclear fuel can also be used to produce nuclear weapons.¹⁷⁰ In 2003 and 2004, it became clear that Pakistan's nuclear scientist A.Q. Khan had sold technology and equipment for uranium enrichment to Libya, Iran and North Korea.¹⁷¹ Although Libya and Iran have ratified the Nuclear Nonproliferation Treaty, North Korea has not, and Iran has been found to be out of compliance with it.¹⁷² Before Pakistan, India also obtained its nuclear weapons capability as a result of reprocessing technology it obtained through a U.S. supplier.¹⁷³ In the absence of new safeguards, expanded reliance on nuclear power and greater need for nuclear fuel are likely to lead to an increased risk of proliferation.¹⁷⁴

d. SUMMARY OF SUBSIDIES AND EXTERNALITIES FOR NUCLEAR POWER

Significant non-tax subsidies are not considered in government analysis of the cost of nuclear power. These include the Price-Anderson liability cap, and federal support for spent fuel storage costs, site remediations and decommissioning. These items are in some cases not included in the EIA Reports at all, or in other cases, they are not included fully.¹⁷⁵ To the extent that DOE has planned remediation efforts extending up

¹⁶⁹ See generally Mann, *Like Water for Energy*, *supra* note [167].

¹⁷⁰ Cong. Research Serv., *Nuclear Energy Policy*, *supra* note [66], at 34.

¹⁷¹ See *id.* at 35; see also Paul Kerr, Mary Beth Nikitin, Amy E. Woolf, and Jonathan Medalia, Cong. Research Serv., R41216, *2010 Non-Proliferation Treaty (NPT) Review Conference: Key Issues and Implications* 1-2 (May 3, 2010).

¹⁷² *Nuclear Energy Policy* at 35.

¹⁷³ Paine, *supra* note [81], at 1089.

¹⁷⁴ *Nuclear Energy Policy* at 35.

¹⁷⁵ See *EIA 2010 Report*, *supra* note [97], at x (noting that costs attributable to federally managed energy funds such as the Uranium Enrichment Decontamination and Decommissioning Fund are not

to 2050 and beyond, and to the extent that the costs are being picked up by the Judgment Fund rather than in any DOE appropriations, these subsidies are not readily noticeable in federal budget documents at all.

A highly respected economic scholar on energy taxes, Gilbert Metcalf, has argued that a better measure of subsidies is to review the effective rate of tax on capital investment for a given energy sector.¹⁷⁶ He concludes that “the production tax credit for new nuclear power plants is driving the large negative effective tax rate on new nuclear-power construction and is likely contributing to the resurgent interest in nuclear construction.”¹⁷⁷ For those plants that are able to take advantage of the production tax subsidy as well as accelerated depreciation, Metcalf concludes that the effective rate of tax on new nuclear plant investment is (99.5%). Metcalf does not analyze the direct subsidies mentioned above, nor the value of the public goods the power source consumes.

included, and noting that if the costs exceed contributions to such funds, there is an implicit subsidy).

To the extent that WPPSS’ liabilities were arguably transferred to the Bonneville Power Authority (BPA), the EIA 2010 Report notes also that federal utilities such as BPA are perceived by the financial community as effectively having federal government guarantees that could extend to plant decommissioning, although at least some of this subsidy has been quantified in estimates of subsidized interest rate to those federal utilities. *EIA 2010 Report* at 39-50.

¹⁷⁶ See Metcalf, *Taxing Energy*, *supra* note [37], at 4.

¹⁷⁷ *Id.* at 18.

3. SOLAR POWER

Solar power comes in two basic kinds – photovoltaic and thermal. Both types can be used in residences or businesses to replace utility-provided electricity, and both types can be used by utilities to generate electricity sold to customers, but the incentives are different.

a. DIRECT AND TAX SUBSIDIES

As with nuclear, solar power receives significant direct subsidies as well as tax expenditures. Those direct subsidies increased, at least briefly, as a result of ARRA – the 2009 Recovery Act. As with other power sources, multiple tax expenditures may be applicable such that an effective tax rate analysis is appropriate. As noted previously, the EIA Reports include direct subsidies, but no effective tax rate analysis. The Metcalf study, by contrast, has an effective tax rate analysis, but does not address subsidies, and predates the incentives (direct and otherwise) that were included in ARRA.

Metcalf Analysis. Metcalf’s pre-ARRA study analyzed incentives for solar thermal power in Fiscal Year 2007 and concluded that solar thermal power investment by a utility would face an effective tax rate of (-244%).¹⁷⁸ In this 2009 study, Metcalf recognized that his calculation “assume[s] . . . that the taxpayer has sufficient taxable income and taxes against which to take all energy-related deductions and credits,” and that “[t]o the extent that the firm cannot take all deductions or credits, the effective tax rate . . . is higher,” and that the availability of financing for renewables investors to take advantage of the high negative tax rate had “diminished . . . in the current credit

¹⁷⁸ Metcalf, *Taxing Energy*, *supra* note [37], at 5 (Table 2).

crunch.”¹⁷⁹ Metcalf also recognized that the effective tax rate on electricity transmission and distribution lines was little different from the statutory rate – at 34.0% and 38.5%, respectively,¹⁸⁰ and that this mitigated the investment incentives for renewable electricity sources like solar thermal:

[D]espite the urgent need to upgrade and expand the electricity transmission network, there is a lack of investment incentives that would encourage the flow of financial capital to this asset. This is particularly worrisome given the need to move electricity from remote sites that are well suited to renewable electricity generation to high-demand areas. Generous production and investment tax incentives for renewable energy are undermined to the extent that the domestic electricity transmission network cannot move the new power over the grid.¹⁸¹

This point is underscored to the extent that the interconnection cost is borne by the renewable project investor rather than the utility.¹⁸²

EIA 2007 and 2010 Reports. Both the EIA 2007 and 2010 Reports compared present-fiscal-year direct and tax subsidies to energy production; as noted previously, such a same-year comparison is inapt in the case of new technologies such as renewables. The 2010 Report included a significant number of direct one-time subsidies included in ARRA; among these was the Section 1603 program administered by the Department of Treasury, which provided grants in lieu of the production and investment tax credits normally available for renewable energy. In the case of the EIA 2010 Report analyzing FY 2010 subsidies relative to production, ARRA’s grant-in-lieu of subsidy approach made the EIA’s approach particularly opaque, as a multi-year subsidy for capital project

¹⁷⁹ *Taxing Energy*, at 18, endnote 5 (referring to the negative tax rate calculation for solar thermal electricity).

¹⁸⁰ *Taxing Energy* at 5 (Table 2).

¹⁸¹ *Id.* at 13.

¹⁸² See Felix Mormann, *Requirements for a Renewables Revolution*, 38 Ecology L. Q. 903, at 921-923 (2011) (noting that prevailing “deep” interconnection model whereby project proponent pays interconnection costs favors traditional energy sources such as coal, gas and nuclear power rather than renewable sources such as wind and solar).

development was compared to a present-year assessment of production (before the projects had been built).¹⁸³

i. NON-TAX SUBSIDIES

The major federal non-tax subsidies¹⁸⁴ for solar in were the section 1603 grant and DOE loan guarantee program. Both came into existence as a result of ARRA and were thus considered in the *EIA 2010 Report* but not the 2007 version.

Section 1603 Grants. The 2009 Recovery Act authorized tax-free grants for renewable energy projects in lieu of the 30% investment tax credit. In the case of solar, up to 30% of a project's cost could be covered. The program was available originally for projects placed into service between January 1 2009 to January 1 2011; Congress extended it in 2011 to cover projects through the end of that 2011. FY 2010 grants under section 1603 totaled \$4.2 billion; approximately \$444 million of this went to solar projects.¹⁸⁵

DOE Loan Guarantees. As noted in the discussion of loan guarantees for nuclear power plants, DOE received loan guarantee authority in section 1703 of the Energy Policy Act of 2005. These guarantees could cover loans for “new or significantly

¹⁸³ See *EIA 2010 Report*, *supra* note [97], at xvii (stating that the 1603 grant program in lieu of ten year tax credits “tended to lead to much higher overall electricity subsidy estimates for renewables in FY 2010 than would have occurred had they continued to rely on the existing production tax credit program, which does not front-load subsidy costs.”)

¹⁸⁴ The EIA Reports include R&D expenditures as a category of non-tax subsidies for all energy forms they analyze. These expenditures influence the total subsidy amount that the Reports use to weigh against the total production amount for the fiscal year in question. EIA recognized that R&D expenditures may not be the same as a true subsidy to an energy industry, *EIA 2007 Report* at 40-41, and none of the R&D programs mentioned relating to solar power appear to true “subsidies.” As noted previously, EIA discussed DOE Office of Environmental Management expenditures for cleanup as R&D expenditures for nuclear power. Cleanup expenditures relating to civil nuclear power would seem to be a direct subsidy (not an R&D expenditure).

¹⁸⁵ *EIA 2010 Report*, *supra* note [97] at xv, 15.

improved technologies” for renewable energy,¹⁸⁶ not merely nuclear power, but DOE did not issue any loan guarantees for solar under this program.¹⁸⁷

In ARRA, Congress amended the Energy Policy Act to include a new section 1705.¹⁸⁸ Guarantees under section 1705 did not require that the loan recipient pay the guarantee’s credit subsidy cost,¹⁸⁹ although Congress had to appropriate funds to cover those costs as a result.¹⁹⁰ Congress appropriated \$2.5 billion for such guarantees, and as of the EIA 2010 Report, DOE had issued guarantees for 14 projects covering approximately \$7 billion in loans, with about \$4.8 billion of those relating to solar generation or infrastructure investments.¹⁹¹ One of the Section 1705 guarantees covered loans to Solyndra, a company that planned to manufacture a new type of photovoltaic solar panel. A conditional commitment toward the guarantee covered \$534 million in credit to the company in 2009, Solyndra’s financial position worsened in 2010, and in 2011, after DOE refused to restructure its commitment and Solyndra’s investors refused to additional capital, the company declared bankruptcy.¹⁹²

Republican legislators and their staff have argued that Solyndra offers an example of the how the White House’s motivation for publicity trumped an orderly agency loan guarantee process.¹⁹³ This may be so - but more broadly, Solyndra is a prime example of

¹⁸⁶ See Energy Policy Act of 2005, § 1703, *codified at* 42 U.S.C. § 16513 (2010).

¹⁸⁷ *EIA 2007 Report* at 191-192. DOE had to issue rules for considering loan guarantee applications first as well. *Id.*

¹⁸⁸ ARRA, Pub. L. No. 111-5, *supra* note [111], § 406, 123 Stat. 145, (adding 42 U.S.C. § 16516) (2010) (new Energy Policy Act of 2005, § 1705).

¹⁸⁹ 42 U.S.C. § 16516(a).

¹⁹⁰ See *EIA 2010 Report*, *supra* note [97] at 65.

¹⁹¹ *Id.* at 65-66. Congress had to appropriate for the Credit Subsidy Cost, calculated to be about ten percent of the total amount of loans guaranteed. *Id.* at 65.

¹⁹² See Staff of the House Comm. on Energy and Commerce, Subcomm. on Oversight and Investigation, Internal Memorandum re Hearing on “Solyndra and the DOE Loan Guarantee Program,” (Sept. 12, 2011) (on file with author).

¹⁹³ See generally Staff of H. Comm. on Energy and Commerce, Majority Memorandum, “The Solyndra Story – How DOE and OMB Ignored Red Flags in Their Rush to Spend Stimulus Dollars” (Sept.

how picking “technology winners” is extremely economically inefficient as an energy policy. In the case of the loan guarantee program, DOE is not merely picking a technology, but picking a particular company to finance, having to spend considerable time evaluating the company’s business position and strategies. Indeed, in Solyndra’s case, shortly before the bankruptcy, DOE insisted on placing an “observer” on Solyndra’s Board of Directors to protect its loan guarantee investment.¹⁹⁴

Several analysts have forcefully argued that federal money would be well spent in offering financial prizes for clean energy innovations.¹⁹⁵ A loan guarantee for any technology is more like a grant than a prize – it protects the recipient from risk in an existing endeavor rather than spurring innovation.¹⁹⁶

In addition to the federal direct subsidies listed above, many states provide direct incentives as well as tax subsidies for solar power; those subsidies are not surveyed here – such subsidies exist for other energy sources at the state level as well, and are simply beyond the breadth of one paper, although they certainly are relevant to a comprehensive view of the subject.

14, 2011) (copy on file with author).

In its bankruptcy and beforehand, Solyndra attributed its weakening financial position to the oversupply of inexpensive solar panels from China, which made Solyndra’s technology (a new way to make panels less expensively) obsolete. *See id.* at 1. While there is considerable debate on whether the U.S. should react to China’s cheap solar panels on the grounds of “price dumping,” the situation certainly illustrates why DOE’s loan guarantee program is not the most efficient way to modernize U.S. energy infrastructure and competitiveness.

¹⁹⁴ *See* Staff of H. Comm. on Commerce, Subcomm. on Oversight, Internal Memorandum, *supra* note [192], at 6.

¹⁹⁵ *See, e.g.,* Jonathan H. Adler, *Eyes on a Climate Prize: Rewarding Energy Innovation to Achieve Climate Stabilization*, 35 Harv. Envtl. L. Rev. 1 (2011).

¹⁹⁶ Adler, *Eyes on a Climate Prize*, 35 Harv. Env. L. Rev. at 29 (noting that allocating grant money causes the grantor to pick *ex ante* “winners,” and the government pays the grantee whether or not it receives anything of value in return).

ii. TAX SUBSIDIES

1. THE PTC, ITC AND NEW TECHNOLOGY CREDITS

The Production Tax Credit has been intermittently available for solar energy since 2004; it provides a 1.5 cent per kilowatt hour payment, payable for 10 years, annually adjusted for inflation. Private investors and investor owned electric utilities are eligible for the credit.¹⁹⁷ The Investment Tax Credit previously was available under the Energy Policy Act of 2005 to provide a 30 percent personal tax credit of up to \$2000 for the purchase of solar electric or solar water heating property that was in effect during 2007 and 2008 for distributed generation; in 2008 Congress removed the \$2000 cap for solar and made the credit available to investors in lieu of the Production Tax Credit.

The Investment Tax Credit was valued at \$10 million for solar for Fiscal Year 2007.¹⁹⁸ The Production Tax Credit was valued at \$690 million for all renewable technologies for FY 2007;¹⁹⁹ EIA estimated based on Treasury Dept. figures that the tax expenditure for solar was only \$749,000 that year.²⁰⁰

Unlike tax incentives for oil and gas, which are in the Code permanently and have been there for nearly 100 years in many cases, incentives for renewables have mostly been enacted on a temporary basis, with sunset provisions.²⁰¹ The Production Tax Credit for wind, originally authorized in 1992, has been extended seven times, and in three of those cases, it expired and was re-enacted subsequently.²⁰² Several economists have

¹⁹⁷ *EIA 2007 Report* at 155-156.

¹⁹⁸ *EIA 2007 Report* at 112.

¹⁹⁹ *EIA 2007 Report* at 33, 156.

²⁰⁰ *EIA 2007 Report* at 33-34. The bulk of the tax expenditure for 2007 went to wind. *Id.*

²⁰¹ Sherlock Statement, *supra* note [2], at 2.

²⁰² *Id.*

concluded that boom-and-bust cycles in renewables installations are likely correlated to the expiration and reenactment of applicable tax incentives,²⁰³ and that uncertainty regarding the incentives can increase the cost of inputs for an affected technology.²⁰⁴ Additionally, retroactively providing the credit for investment or production for a period when the credit had been thought to expire can be criticized as inefficient, since it grants a windfall to taxpayers who did not alter their behavior to take advantage of the incentive.²⁰⁵

Analysts have also questioned whether the Production Tax Credit (PTC) and Investment Tax Credit (ITC) are needed in order to change behavior, given the presence of multiple state “renewable portfolio standards.” To the extent investor-owned utilities are obligated to diversify their energy production into renewable sources anyway, the PTC and ITC may simply be a windfall.²⁰⁶

As a result of the credit crisis in 2009, the vast bulk of renewable energy project funding disappeared, and in ARRA, Congress responded by offering “1603 grants” in lieu of the Production Tax Credit, as discussed in the section on direct subsidies.²⁰⁷

2. THE ADVANCED ENERGY PROPERTY CREDIT

ARRA section 1302 amended the Internal Revenue Code to provide a 30 % credit for investment in eligible property for a qualified advanced energy manufacturing project; as noted above, this credit is only available upon application to and then

²⁰³ See Metcalf, *supra* note [37], at 11 (regarding solar), and 10 (regarding wind, citing Ryan Wisler and Mark Bolinger, Dept. of Energy, “Annual Report on Wind Power Installation Cost and Performance Trends 2007” (2008); see also Sherlock testimony, *supra* note [2], at 2 (citing authority).

²⁰⁴ Sherlock Statement, *supra* note [2], at 7.

²⁰⁵ Sherlock Statement, *supra* note [2], at 7-8. To the extent that the production tax credit has actually been repeatedly renewed, and retroactively reenacted, over decades, the conclusion that a taxpayer was not relying on the incentive at all may have less force.

²⁰⁶ See, e.g. Sherlock Statement, *supra* note [2], at 11.

²⁰⁷ *EIA 2010 Report* at 15; see also Sherlock Statement, *supra* note [2], at 2.

certification by Treasury and DOE.²⁰⁸ EIA did not separately quantify the amount of this credit going to solar projects in its 2010 Report but stated that the total of the credit for all renewables projects for that year was \$125 million.²⁰⁹

3. CREBS, AND NCREBS

The Energy Policy Act of 2005 provided a tax credit for purchases of Clean Renewable Energy Bonds (CREBs). The provision allowed state and local governments, U.S. territories, tribal governments and rural electric cooperatives or mutual or cooperative electric entities to issue bonds the interest on which would not be taxed; this permitted the issuing entities to operate on the same footing as investor-owned utilities.²¹⁰ CREBs bonds received tax-exempt interest; the bonds were for issue dates between the passage of the Energy Policy Act in 2005 and 2008. The total value of the tax expenditure on CREBs in 2007 was computed at \$21 million, although this covered bonds for a variety of renewable energy projects.

In 2008 CREBs were replaced with New CREBs (“NCREBs”), which had a 70% tax credit against interest. They also were made convertible to direct subsidy bonds whereby the issuer paid investors a taxable coupon and received a direct payment from the U.S. Treasury. Treasury estimated that NCREBs had a tax expenditure value of \$70

²⁰⁸ ARRA § 1302, codified at I.R.C. 48C. See *supra* note [111].

²⁰⁹ EIA 2010 Report at 13 (Table 3). The 2010-2014 JCT Tax Expenditure analysis concludes that the aggregate expenditure was \$500 million for 2010. See Joint Comm. on Taxation, JCS-3-10, *Estimates of Tax Expenditures for Fiscal Years 2010-2014*, *supra* note [137], at 36 (Table 1); Treasury’s Tax Expenditure Analysis for FY 2012 calculated the aggregate expenditure at \$180 million. See Office of Mgmt. & Budget, *Fiscal Year 2012 Analytical Perspectives: Budget of the U.S. Government* (2011), at 241 (Table 17.1).

²¹⁰ EIA 2010 Report at 16.

million and a direct outlay equivalent of \$10 million in 2010.²¹¹ Approximately 38% of the total value of NCREBs were allocated to solar projects in 2010.²¹²

Although the CREBs, and NCREBs may help equalize the playing field between investor-owned utilities and state and local agencies as to renewable projects, some have questioned whether the best way to go about this is to provide another tax expenditure rather than trimming those we already have. As discussed in Section II, if one were to rank existing clean energy tax tools based on efficiency, CREBs and NCREBs would likely be at the bottom, as some of the benefit of the subsidy would be absorbed by private bondholders.

b. EXTERNALITIES

Solar power is not always free of environmental externalities. In particular, solar thermal power projects generally require significant quantities of water. Since they are located in remote areas where the sun is the strongest, the energy cost of transporting water to the site can be significant.²¹³ Large-scale solar projects require significant quantities of land, which can displace agricultural uses or endangered species habitat.²¹⁴

Additionally, the manufacture of solar panels can lead to toxic emissions of heavy metals.²¹⁵

²¹¹ *EIA 2010 Report* at 16.

²¹² *EIA 2010 Report* at 17 (Table 5). Additionally, in late 2008, Congress provided for Qualified Energy Conservation Bonds (“QECBs”) to allow local governments to finance conservation projects and renewable projects primarily in public facilities; these function like NCREBs, but had no assigned value for any projects in 2010. *Id.*

²¹³ *See, e.g., Mann, Like Water for Energy, supra* note [167], 82 U. Colo. L. Rev. at 523.

²¹⁴ *See, e.g., Tracie Cone, Solar Development Absorbing California Farmland, Huffington Post* (Dec. 2, 2013), available at http://www.huffingtonpost.com/2013/02/02/solar-development-california_n_2607891.html (accessed Dec. 17, 2013), Todd Woody, *Catch-22: The Imperiled Desert Tortoise is Paying the Price for the Solar Boom*, Quartz.com (Oct. 23, 2013), available at <http://qz.com/138471/the-imperiled-desert-tortoise-is-paying-the-price-for-the-solar-boom/> (accessed Dec. 17, 2013) (noting that two First Solar farms scheduled for construction in the California desert could result in the “take” of as many as 2,117 desert tortoises and desert tortoise eggs located in their path).

²¹⁵ *Mann, Like Water for Energy, supra* note [167].

c. CONCLUSION – EXTERNALITIES AND SUBSIDIES, SOLAR POWER

Solar power has received significant tax and direct subsidies from the federal government. Clearly the Solyndra story shows that some of those subsidies have been inefficient. However, the scope of the governmental expenditures (tax and otherwise) is dwarfed by the expenditures provided to nuclear power and oil and gas – particularly when one also considers the relative public costs due to the externalities the different energy sources pose.

III. CONCLUSION – WE NEED TO DO MORE THAN ELIMINATE TAX SUBSIDIES AND IMPOSE A CARBON TAX

There are many good reasons to favor the carbon tax efficiency thesis. The year 2012 brought record-breaking average temperatures in the U.S. and continued average global temperature increases,²¹⁶ and in 2013, the International Panel on Climate Change (IPCC) issued its Fifth Report stating that further warming due to CO₂ emissions was “virtually certain” in the late 21st century and that such warming would occur even if further human CO₂ emissions stopped.²¹⁷ Multiple academics have argued that a carbon tax is a simpler and more effective way to regulate greenhouse gas emissions than a cap-and-trade regime,²¹⁸ and leveling out the present hodgepodge of tax subsidies would certainly make the results of a carbon tax more workable. Imposing a tax on carbon could not only limit the damaging effects of an externality – it could also help address the federal deficit.²¹⁹

Nevertheless, this paper has sought to demonstrate that even if economic efficiency is our guidepost,²²⁰ a number of long-standing federal subsidies outside the

²¹⁶ See, e.g., National Oceanic and Atmospheric Admin. (hereafter, “NOAA”), National Climatic Data Center, *Summary Information*, (Apr., 2012) (stating that as of report, the past 12 months and first third of the year were the warmest the U.S. had ever experienced since recording began), available at www.ncdc.noaa.gov/sotc/summary-info/natioanl/2012/4; Jon Erdman, weather.com, *Last 6 Months Hottest on Record* (Jul. 10, 2012) (reporting data from June 2012 “State of the Climate” report from NOAA), available at <http://www.weather.com/news/noaa-hottest-year-june-20120709>; “Climate Change: The Hottest Years on Record,” *The Economist Online* (Dec. 3, 2010), available at http://www.economist.com/blogs/dailychart/2010/12/climate_change.

²¹⁷ See Intergovernmental Panel on Climate Change, Working Group I Contribution to the IPCC Fifth Assessment Report, “Climate Change 2013: The Physical Science Basis: Summary for Policymakers,” at SPM-19, SPM-23 (Sept. 27, 2013).

²¹⁸ See, e.g., Roberta Mann, *The Case for the Carbon Tax: How to Overcome Politics and Find Our Green Destiny*, 39 *Envtl. L. Rep.* 10,118, 10,122 (2009), Reuven S. Avi-Yonah and David M. Uhlmann, *Combating Global Climate Change: Why a Carbon Tax is a Better Response to Global Warming than Cap and Trade*, 28 *Stan. Env'tl. L. J.* 3 (2009), Gilbert E. Metcalf and David A. Weisbach, *The Design of a Carbon Tax*, 33 *Harv. Env'tl. L. Rev.* 499 (2009).

²¹⁹ See generally Gale & Harris, *Reforming Taxes and Raising Revenue*, *supra* note [5].

²²⁰ The author favors a Rawlsian perspective on energy policy. In other words, we should not pursue

Internal Revenue Code, and a number of externalities, must be faced. Eliminating tax subsidies and imposing a carbon tax would be positive steps, but they should not be taken alone. A number of existing non-tax subsidies favor nuclear power and petroleum.

Continued extensive reliance on petroleum is not an option given carbon emissions alone, leaving aside the multiple other externalities discussed in this paper. We must find our way to other alternatives.

Plans for nuclear power generation seem to continue as well, despite the disaster at Fukushima (and at Chernobyl before it). These plans ignore the fact that nuclear power generation has incalculable costs (many of which the public is simply unaware) and exists due to massive unjustified subsidies.

policies that make the least advantaged among us worse off. As discussed in Appendix II, nuclear energy fails under this test.

APPENDIX I – REVIEW OF LITERATURE ON ENERGY TAX SUBSIDIES, THEIR RELATIVE SIZE, AND THEIR EFFECTIVENESS

The author has reviewed static analyses of tax expenditures and tax expenditures combined with other subsidies, as well as literature on the effective marginal rate of return for capital across various energy sectors.

I. STATIC ANALYSES OF TAX SUBSIDIES

A. ANNUAL TAX EXPENDITURE ESTIMATES

Treasury and JCT Tax Expenditure Budgets. Since 1972, the Department of Treasury and the Joint Committee on Taxation (JCT) have prepared “Tax Expenditure Budgets” meant to identify “revenue losses attributable to provisions of the Federal tax laws which allow a special exclusion, exemption or deduction from gross income or which provide a special credit, a preferential rate of tax, or a deferral of tax liability.”²²¹ The JCT Budget estimates future tax expenditures in five-year increments. The Tax Expenditure Budget from the Department of Treasury is contained in the Office of Management and Budget (OMB) *Analytical Perspectives* Budget for each Fiscal Year; it projects tax expenditures for a seven-year period. Tax expenditures are projected based on a tax incentive as against a “normal” baseline.²²²

Tax expenditure budgets cannot be reliable in predicting any increase in federal revenue that would result from repeal of the provisions analyzed because it is impossible to know how taxpayers would alter their economic behavior in the absence of the tax incentive.²²³ Tax expenditure budgets also are not a fully reliable measure of potential future federal revenue as a consequence of repeal because other provisions of the tax code may shelter affected taxpayers’ income.²²⁴

As corollaries to the above, the presence of a tax expenditure does not mean that it has caused the production of the targeted energy or energy technology: taxpayers might choose to engage in the targeted behavior anyway.²²⁵ And even if the expenditure has increased production of a fuel or technology, the line item does not disclose by how much,

²²¹ Congressional Budget and Impoundment Control Act of 1974, Pub. L. No. 93-344, sec. 3(3), *codified at* 2 U.S.C. 622(3).

²²² The Department of Treasury also produces a *Green Book* annually which details the Administration’s revenue proposals, but it appears that the *Green Book*’s revenue projections use the same OMB tax expenditure analysis.

²²³ Office of Mgmt. & Budget, *Fiscal Year 2012 Analytical Perspectives: Budget of the U.S. Government* 240 (2011).

²²⁴ *Id.*

²²⁵ Gilbert E. Metcalf, Manhattan Institute, *Taxing Energy in the United States: Which Fuels Does the Tax Code Favor?* 4 (Jan.2009)

or the dollar cost per unit of energy (since each fuel and technology has a different energy output).²²⁶

B. ANALYSIS OF TAX EXPENDITURES AND OTHER TAX OR DIRECT SPENDING SUBSIDIES

Independent researchers and government analysts have also compiled data on how tax expenditures, other subsidies in the tax code, and direct spending programs are spread among different energy sources and technologies.

1. GOVERNMENT ANALYSES

Energy Information Administration, *Federal Financial Interventions and Subsidies in Energy Markets 2007* (Report No. SR/CNEAF/2008-01). The Energy Information Administration (EIA) analysis assesses both tax expenditures and other tax subsidies, as well as direct outlays (including direct transfers, federal R&D and federal programs such as the Tennessee Valley Authority) to particular energy sources in total dollar amounts for FY 2007. The report reviewed subsidies related to electricity production as well as for transportation fuels, although its methodology in the two areas was different.

As to electricity production, the Report calculated net generation for the fiscal year and then summed the tax and other subsidies for that fuel to develop a “subsidy and support per unit of production” figure.²²⁷ This approach has been questioned where the subsidies are for capital investment that will not yield electricity in the same year in which the investment is made (or the subsidy is granted).²²⁸ As the Congressional Research Service has noted, this sort of approach results in figures that are more favorable for entrenched electricity fuels, such as coal.²²⁹ Indeed, the result was that the “subsidy and support per unit of production” was 0.44 for coal, 0.25 for natural gas and petroleum liquids, 1.59 for nuclear, 24.34 for solar, and 23.37 for wind.²³⁰

As to transportation fuels, the subsidies that were not “energy specific,” such as accelerated depreciation and the use of IRC 199 by the oil and gas industry, were not considered.

With regard to nuclear energy, the 2007 Report did not list any direct expenditures as subsidies: all support was from Tax Expenditures, R&D and Federal Electricity Support.²³¹ The 2007 Report did note that direct subsidies could exist as a

²²⁶ *Id.*

²²⁷ *EIA 2007 Report* at xvi (Table ES-5), 106 (Table 35).

²²⁸ See Molly Sherlock, Cong. Research Serv., *Energy Tax Incentives: Measuring Value Across Different Types of Energy Resources*, CRS No. R41953 (Aug. 10, 2011), at 11-14 and Tables 4 and 5. (The Sherlock Congressional Research Service study is addressed later in this section).

²²⁹ *Id.*

²³⁰ See *EIA 2007 Report* at 106 (Table 35).

²³¹ See *EIA 2007 Report*, at xiii.

result of liability limitations under the Price-Anderson Act and other laws,²³² but did not quantify them.

Regarding tax subsidies, the EIA 2007 study mentioned the Credit for the Production from Advanced Nuclear Power Facilities, but since the Report's methodology was to consider only subsidies and production for the 2007 Fiscal Year, it concluded that the subsidy was "0" since the Credit could not be claimed until new plants produce electricity.²³³ By contrast, Metcalf concluded that "the production tax credit for new nuclear-power plants is driving the large negative effective tax rate on new nuclear-power construction and is likely contributing to the resurgent interest in nuclear construction," including the applications for new power plants for which the NRC recently granted COLs.²³⁴ The only tax expenditure to which the EIA 2007 Report assigned value for 2007 was the Modification to Special Rules for Nuclear Decommissioning Costs, at \$199 million.²³⁵ The Report did include under "R&D" subsidies \$922 million, of which \$350 million for FY 2007 was for "Environmental Management." As noted in the text, there are questions as to how these R&D figures were derived and as to whether they truly cover all subsidies to civil nuclear power production.

The report calculated subsidies per unit of electricity production for the fiscal year in question, although it noted that this measure was simply a "snapshot taken at a particular point in time." As noted elsewhere in this paper the direct addition of tax expenditures and direct transfers may not be appropriate either).

Energy Information Administration, *Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2010 (July 2011)*. This report updated the EIA's 2007 Report above by looking at direct subsidies and tax expenditures for Fiscal Year 2010, at the request of several members of the House of Representatives. Its approach was the same although some subsidy calculations changed even for FY 2007.

Molly Sherlock, Cong. Research Serv., *Energy Tax Incentives: Measuring Value Across Different Types of Energy Resources*, CRS No. R41953 (Aug. 10, 2011) compared tax incentive values relative to levels of production across various energy industries, using a "tax expenditures plus" approach and an effective tax rate analysis. The report reviews the conclusions of the EIA studies mentioned above and notes the difficulty with the EIA's "snapshot" approach for subsidies and energy production from the same fiscal year.

²³² See, e.g., *EIA 2007 Report* at 197 (describing Price-Anderson Fund and noting that no while a subsidy may exist it is not quantified in the Report) and 201 n.275 (describing Uranium Facilities Maintenance and Remediation Fund and noting that the Report assumes that payments to the Fund will cover decontamination and decommissioning costs, although GAO Report concludes to the contrary).

²³³ *EIA 2007 Report*, at pages 14 (Table 1), and 18-19.

²³⁴ The Metcalf Report is discussed in this Appendix I in Section II.

²³⁵ See *EIA 2007 Report* at page 14 (Table 1).

2. ACADEMIC AND NONGOVERNMENTAL STUDIES

Adeyeye, et. al., Environmental Law Institute, *Estimating U.S. Government Subsidies to Energy Sources: 2002-2008*²³⁶, relied on Tax Expenditure Budget Data,²³⁷ but it sought to make the projections in those documents more reliable by using projections for the year closest to the date of issue of the report. The report reviewed tax expenditures and various other federal subsidies across energy industries in reaching the conclusion that for the period FY 2002 – FY 2008, tax and other subsidies and direct spending for fossil fuels (\$72.5 billion) far exceeded that on renewables (\$29.0 billion). The report noted that renewables other than corn ethanol received a far smaller share - \$12.2 billion – and questioned the efficacy of the corn ethanol subsidies toward reducing greenhouse gas emissions (GHG).²³⁸

Oil & Gas: Tax Expenditures Attributable to “Disguised Royalty Payments.” U.S. persons receive a foreign tax credit under IRC 901 to prevent double taxation of income. The credit is meant for the payment of foreign income taxes. U.S. companies extracting oil in foreign countries must pay for the privilege of doing so; it is in the companies’ interest if such royalties are characterized as creditable foreign income taxes. In the 1970s and early 1980s, the Department of Treasury issued regulations to prevent the crediting of what were in effect disguised royalty payments. Under those regulations, to the extent that a taxpayer receives a “specific economic benefit” not generally made available to those persons subject to the tax, such as a concession to extract government-owned natural resources, the payment for that benefit is not creditable as a “tax.”²³⁹ Regulation 1.901-2A was issued so that “Dual Capacity Taxpayers” (“DCTs”) that paid both income taxes and royalty payments to foreign governments could seek a credit for the income tax component either under a facts and circumstances test or under a “safe harbor.”²⁴⁰

The Obama Administration and a number of independent observers contend that the manner in which the DCT regulations have been applied does not achieve the stated goal of only crediting “income” taxes, and not the royalty component of such payments for a couple of reasons.²⁴¹ First, the regulation presently provides that if the country does not generally impose an income tax, the portion of the payment that does not exceed the applicable federal tax rate applied to net income can be treated as a creditable tax.²⁴² The Treasury in its Green Books for FY 2011-FY 2013 has proposed changing this rule, so that if income taxes were not generally imposed, payments by DCTs would not

²³⁶ *ELI Study, supra* note [31].

²³⁷ *ELI Study*, at 30.

²³⁸ Environmental Law Institute, “Energy Subsidies Black, Not Green,” graphic to accompany *ELI Study, supra* note [39], available at <http://www.eli.org/pressdetail.cfm?ID=205>.

²³⁹ Treas. Reg. § 1.901-2(a)(2)(ii)(B) (2012).

²⁴⁰ Treas. Reg. § 1.901-2A(c)(1) (2012).

²⁴¹ Dep’t. of Treasury, *General Explanations of the Administration’s Fiscal Year 2012 Revenue Proposals* 39 (Feb. 2011), reprinted at 2011 Tax Notes Today, 2011 TNT 31-21 (Feb. 15, 2011).

²⁴² Treas. Reg. § 1.902A(d) and (e) (2012).

automatically be converted to a foreign tax credit.²⁴³ However, no Temporary or Proposed Regulations have been issued and the proposal in the Green Book has been for a prospective change every year.²⁴⁴ In the FY 2013 Green Book, the projected revenue from eliminating this feature of the regulations was \$4.5 billion for FY 2013 – FY 2017.²⁴⁵

Second, if the tax imposed differs only as to the rate, but not the base, then it is not treated as a “separate levy” under the rules,²⁴⁶ and Tax Court decisions have treated the entire levy as applicable to DCTs as creditable.²⁴⁷ The ELI Study notes that numerous foreign governments impose income taxes at a significantly higher rate on petroleum income than other taxpayers, but use the same base, such that they are creditable under the Treasury Regulations as interpreted by the Tax Court. The Study concludes that for FY 2002- 2008, the difference between the present practice and limiting DCTs’ foreign tax credit to the rate of the generally applicable income tax would yield a \$15.3 billion federal tax expenditure.

The ELI Study did not include analysis of nuclear power.

II. STUDIES ON EFFECTIVE TAX RATES FROM TAX SUBSIDIES

Several economists have suggested that analyzing the effective rate of return on marginal investments of capital as a result of tax subsidy provisions may yield a better measure of the relative incentives among different energy choices. The process does not rely on a tax expenditure budget estimate – a calculation that is inherently inaccurate for the reasons stated in the previous section. However, the effective rate measure inherently focuses on incentives created for investors rather than effects on the Treasury. Additionally, a marginal effective rate analysis may not adequately reflect the barriers to entry for renewable sources for at least three reasons. First, renewable energy advocates have noted that existing, ingrained, providers of traditional energy sources are more likely to have capital to invest in new projects while renewables providers must seek outside investors who can take advantage of tax subsidies.²⁴⁸ Second, renewables providers are more likely to be constructing new projects rather than making additional investments to existing ones – an undertaking that can “exceed most outside investors’ patience.”²⁴⁹ Third, incentives for solar and wind have been short term and subject to

²⁴³ Green Book FY 2011 FY 2011 at 49, Green Book FY 2012 at 49, Green Book FY 2013 at 94. The Treasury proposals also would require that credits attributable to oil and gas income be accounted for in their own separate basket under I.R.C. § 904, so as to prevent “cross-crediting.” *Id.*

²⁴⁴ Green Book FY 2011 at 150 (Table 1), Green Book FY 2012 at 146 (Table 1), Green Book FY 2013 Tables, Table 1 at page 2.

²⁴⁵ Green Book FY 2013 Tables, Table 1 at page 2.

²⁴⁶ Treas. Reg. § 1.901-2(d)(1) (2012).

²⁴⁷ *Phillips Petroleum Co. v. Comm’r*, 104 T.C. 256 (1995), *Exxon Corp. v. Comm’r*, 113 T.C. 338 (1999).

²⁴⁸ See, e.g., Felix Mormann & Dan Reicher, *How to Make Renewable Energy Competitive*, NY Times (Op. Ed., June 1, 2012); Molly F. Sherlock and Mark P. Kneightley, Cong. Research Serv., R41893, *Master Limited Partnerships; A Policy Option for the Renewable Energy Industry* (June 28, 2011).

²⁴⁹ See Felix Mormann, *Requirements for a Renewables Revolution*, 38 Ecology L. Q. 903, at 918-919 (2011).

renewal, resulting in uncertainty for investors, while incentives in the oil and gas sector have been relatively stable.²⁵⁰

Gilbert E. Metcalf, Manhattan Institute, *Taxing Energy in the United States: Which Fuels Does the Tax Code Favor?* (Jan. 2009) reviewed the effective tax rates on marginal capital investment across a number of energy sectors for FY 2007, concluding that the share of subsidies to “renewables” had overtaken those for fossil fuel sources.²⁵¹

Oil and Gas. The study considers domestic incentives to integrated and nonintegrated producers, but not the foreign tax credit subsidy discussed above in the ELI Study. Additionally it does not take into account the pool of capital doctrine.²⁵² The study concludes that the effective rate of tax for oil drilling for independent nonintegrated producers was -13%, while it was a positive 15.2% for integrated firms.

²⁵⁰ See *Alternative Energy Tax Incentives*, Statement of Molly Sherlock, *supra* note [2], discussed in Section I.B.1 of this Appendix I.

²⁵¹ The report initially compiles aggregate, static tax expenditure and direct expenditure data from the *EIA 2007 Report*, in comparing renewables to other sources; here it groups biofuels into the renewable energy category. Then it argues for an effective tax rate analysis, looking separately at solar thermal and wind.

²⁵² See Johnson, *Accurate and Honest Tax Accounting*, *supra* note [37].

APPENDIX II: THE NAVAJO NATION'S EXPERIENCE WITH URANIUM – A RAWLSIAN PERSPECTIVE

Introduction. The Navajo Nation in Arizona, New Mexico and Utah, is the largest sovereign Indian nation in the world, and those four states in their entirety are home to approximately 20% of the total American Indian population.²⁵³ The Nation is also the site where the largest quantities of uranium have been mined and milled in the US.²⁵⁴ It remains the home to over 1,000 abandoned uranium mines and four former uranium mills,²⁵⁵ many of which have not been cleaned up. Most Americans do not know it, but the Navajo Nation was the site of the largest nuclear accident in U.S. history. The Navajo miners, their families, and families exposed to radiation due to their proximity to mines and mills have suffered devastating health effects.

Rawlsian Theory as Environmental Justice. John Rawls argued in his *Theory of Justice* that the principle of utility was “inconsistent with the idea of reciprocity implicit in the notion of a well-ordered society.”²⁵⁶ He contended instead that we should have to evaluate society’s allocation of rights and benefits from an “original position” in which no member of society knew where he or she would land. Under his approach, social and economic inequalities would be just “only if they result in compensating benefits for everyone, in particular the least advantaged.”²⁵⁷ Although Rawls did not have a particular focus on environmental justice, he understood that:

there are striking cases of public harms, as when industries sully and erode the natural environment. These costs are not normally reckoned with by the market, so that the commodities produced are sold at much less than their marginal social costs. There is a divergence between private and social accounting that the market fails to register.²⁵⁸

A Rawlsian perspective thus considers the costs of a policy choice as it affects the least advantaged rather than letting those costs be outweighed by material benefits for others who start out with more material advantage.

Navajo Land and Culture. Like other tribes, the Navajo Nation share a creation myth tying them back to their ancient Ancestors and their tribal lands.²⁵⁹ The Navajo

²⁵³ Brugge, Benally, and Yazzie-Lewis, “So A Lot of the Navajo Ladies Became Widows,” Introduction to *The Navajo People and Uranium Mining* (Brugge, Benally, and Yazzie-Lewis, eds., 2006) at xv.

²⁵⁴ Esther Yazzie-Lewis and Jim Zion, “Leetso, the Powerful Yellow Monster,” Chapter One of *The Navajo People*, *supra* note [253], at 1.

²⁵⁵ *Id.*

²⁵⁶ Rawls, *A Theory of Justice* at 14 (1st ed. 1971).

²⁵⁷ *Id.*

²⁵⁸ *A Theory of Justice*, *supra* note [256], at 268.

²⁵⁹ See “Return of Navajo Boy,” (Groundswell Communications, 2001). See also “The Long Walk,” Part 1, available at YouTube (nativeamerican19).

Other tribes also connected to their original lands in a way European settlers did not, but they did not have the opportunity to stay on that land. See, e.g., Theda Perdue, Historian, The American Experience: We Shall Remain – Episode 3: The Trail of Tears (original airdate Apr. 27, 2009) at 0:06:30

provide a rare example of a band of tribes actually inhabiting their original homeland: In the early 1860s, they were marched from their land by the U.S. military in an action that paralleled the forced exodus of other tribes such as the Cherokee's "Trail of Tears."²⁶⁰ While approximately 8,000 Navajo made it to the Bosque Redondo reservation in Texas, it is estimated that perhaps 2,500 perished. More died of starvation and disease in the barren conditions at Bosque Redondo. After word of the conditions at Bosque Redondo sparked a Congressional investigation, approximately 7000 Navajo were able to return to their original homeland starting in 1868 under a Treaty that sharply curtailed the land that was theirs but to some degree recognized their sovereignty within it.²⁶¹ The Treaty, like those with many other tribes, also gave the U.S. Government trustee responsibilities toward the Tribe.²⁶² Tribal members referred to the U.S. as the "Guardian."²⁶³

World War II and Uranium Mining in the Four Corners Region. Traditional Navajo culture disapproves of mining and disturbing the earth's surface with the use of machinery.²⁶⁴ Prior to World War II, the Navajo Tribal Council had rebuffed U.S. Government efforts to extract minerals from the Nation's lands.²⁶⁵ When the U.S. became involved in World War II, however, the Navajos enlisted in higher proportions than the general population,²⁶⁶ and Navajo Tribal Council passed a resolution of support for the U.S. The Navajo knew that vanadium, a mineral found on their lands, was helping strengthen U.S. ships, and they authorized the Secretary of the Interior to issue leases to the highest bidder on the Navajo's behalf.²⁶⁷

The U.S. was also seeking uranium, however, which was often found in the same place.²⁶⁸ The mining and milling of uranium on Navajo lands or lands nearby became the source of relatively high-paying and easily accessible work for the Navajo:

Benally: *So, when you first went to work there, was there any information about the dangers of this, and were there any safety devices given to you?*

("Christians had been cast out of their own Garden of Eden, but the Cherokees lived in their Eden: It's the land that they believed that their Ancestors had always inhabited.")

²⁶⁰ "Almost all native people that you could speak of had their trail of tears in terms of being removed in the face of white expansion." Dr. Jennifer Nez Denetdale, Historian, in Pacific Mountain Network, *et. al.*, "The Long Walk," *supra* note [259] available at [YouTube, nativeamerican19] (Segment 2).

²⁶¹ See, e.g. "The Long Walk," *supra* note [259] (Segment 4).

²⁶² Treaty of 1868, Article I, cl. 2.

²⁶³ See Judy Pasternak, *Yellow Dirt: A Poisoned Land and the Betrayal of the Navajos* 3, 7 & n.7 (2010).

²⁶⁴ Yazzie-Lewis and Zion, "Leetso, the Powerful Yellow Monster," in *The Navajo People*, *supra* note [253], at 6.

²⁶⁵ Pasternak, *Yellow Dirt*, *supra* note [263], at 4. One of the reasons the Navajo were forcibly exiled from their land during the Long Walk was that James Henry Carlton, U.S. Military Commander for New Mexico during the civil war, believed that the land was full of gold. Interview with Hampton Sides, "The Long Walk," *supra* note [245] (Segment 2).

²⁶⁶ "Leetso, the Powerful Yellow Monster," in *The Navajo People*, *supra* note [253].

²⁶⁷ *Yellow Dirt* at 4 & nn. 6-7 (to Prologue).

²⁶⁸ *Yellow Dirt* at 4.

George Tutt: None, even over here, where my father operated a mine. He never said he was ever told about uranium. No, he never said that. It was good! Work was available close to home. We were blessed, we thought. Railroad jobs were available only far off like Denver . . . But for mining one can just walk to it in the canyon. We thought we were very fortunate, but we were not told, ‘Later on, this will affect you in this way.’²⁶⁹

Based on experience with mines in Eastern Europe, it was known to the U.S. at the time that the mining of uranium could cause widespread lung cancer and other respiratory diseases among miners,²⁷⁰ but for decades precautions were not taken that might have better protected miners in the Four Corners region. It was known, for example, that providing adequate ventilation in the mines could protect workers’ health, and that requiring protective clothing and washing onsite could help protect the health of their families and prevent their exposure to uranium dust and radon gas. But advocates for these steps within the federal government were squelched. Instead, doctors for the U.S. Public Health Service monitored miners’ health without telling them why.²⁷¹

George Tutt: I have revisited the places where I used to work not too long ago. At Naturita there is a place called Long Park . . . That was the area where the work was really done. It was about 30 years ago when I first worked (there). I wanted to find out the name of the mine, but there was no one who I could ask because they have all died off. I worked with five or six people – some looked young, yet they are gone.

. . .
[He found one white man who had worked in the mines.] In inquired about some of the white men I worked with, and he told me they died, so many years ago. I thought one of the white men might remember the name of the mine, but they were also all gone.²⁷²

The risks of uranium were so little discussed that a number of families took rock from the mines and built their homes with it.²⁷³ Water in the regions of the open pit mines became polluted. Stomach cancer on the reservation increased by 82 percent

²⁶⁹ “I Have Revisited the Places Where I Used to Work,” Oral History of Former Miner George Tutt, Chapter Two in *The Navajo People*, *supra* note 253, at 14-15.

²⁷⁰ Doug Brugge and Rob Gobel, “A Documentary History of Uranium and the Navajo People,” Chapter Three in *The Navajo People*, at 26. Studies of these miners from the turn of the century concluded that between 50 to 75 percent of all miners died of lung disease, and Germany and Czechoslovakia had designated cancer in these miners as a compensable occupational disease by 1932. *Id.* at 26-27.

²⁷¹ *Yellow Dirt* comprehensively reviews the efforts made by the mining companies and the Atomic Energy Commission not to disclose the risks of uranium to the mine workers, despite measurement of and knowledge of the risks. *See, e.g., id.* at 68-92. Indeed, the federal Public Health Service began extensively examining miners for health effects before they occurred, but the miners were not told why. *Id.* at 92-98. *See also* “Documentary History of Uranium,” in *The Navajo People*, at 32 (discussing Public Health Study).

Eventually some more conscientious federal health officials were successful in bringing about state regulations that secured ventilation in some mines. *Yellow Dirt* at 34-35.

²⁷² Oral History of George Tutt in *The Navajo People*, *supra* note [253], at 16-17.

²⁷³ According to *Yellow Dirt*, an EPA radiation expert identified radioactive material built into seventeen of thirty-seven homes he tested.

between 1975 and 1987, and in the region of the mines and mills it was documented at fifteen to two hundred times the national average.²⁷⁴ Multiple family members exposed through these many different routes have perished of cancer²⁷⁵:

Minnie Tsosie: . . . When my children were growing up they were told [that uranium had affected them as well as their father, a miner who died of lung cancer.] Today, three of my daughters are told that. They are told they have cancer inside of them. The cancer has affected them in their uterus, this is what two of them are told. And they cannot have children. . . . My oldest daughter has been seen, [and she] was . . . told that there is something in her stomach, and they are thinking it to be uranium-affected.²⁷⁶

. . .

Joe Ray Harvey: Well, the way it is with us, it seems like everything has been ruined for us. We have been exposed to radiation. People have been exposed to it. It has contaminated the land and water. . . .

Because of that, in this Cove area [in Northeast Arizona] there are no menfolks. There are a lot of widows. None. There are no men. All of the uranium miners are gone. They have all died.²⁷⁷

Children in families have also been afflicted with syndrome now known as Navajo neuropathy:

Navajo neuropathy patients had liver damage, dimmed vision, and most dramatically, fingers and toes that gradually fused and stiffened into hooks. They tended to die young. The average age of death was ten.²⁷⁸

²⁷⁴ *Id.* at 142-143 & n. 31 (to Chapter 10), *citing* R.M. Auld, Jr. and W.S. Haubrich, Dept. of Gastroenterology, Scripps Clinic and Research Found., La Jolla, CA, “Rapidly Rising Incidence of Gastric Carcinoma in Navajo Indians and Its Relationship to Uranium Mining,” Abstracts of Papers, *Gastroenterology* 1301 (May 1987). The rate of stomach cancers as increased 200 times was documented not among miners but among women ages 20 to 40 living near open pit mines.

²⁷⁵ Between the 1970s and the late 1990s, the cancer death rate among Navajos doubled, while the cancer death rate in the U.S. overall registered a slight decline. *Yellow Dirt* at 136 & n. 16 (to Chapter 10), *citing* Pasternak, “A Peril That Dwelt Among the Navajos,” L.A. Times (Nov. 19, 2006), *available at* <http://www.latimes.com/news/la-na-navajo19nov19,0,5351917.story#axzz2nixQs96C> (last accessed Dec. 17, 2013).

²⁷⁶ Oral History of Widows Mary Louise Johnson and Minnie Tsosie, Chapter Eleven in *The Navajo People*, *supra* note [239], at 158.

²⁷⁷ Oral History of Miner Joe Ray Harvey, Chapter Nine in *The Navajo People*, at 133.

²⁷⁸ *Yellow Dirt* at 144 & n.36 (to Chapter 10), *citing* Pasternak, “Oases in Navajo Desert Contained a Witch’s Brew,” L.A. Times (Nov. 20, 2006), L.A. Times (Nov. 19, 2006), *available at* <http://www.latimes.com/news/la-na-navajo20nov20,0,1812957.story#axzz2nixQs96C> (last accessed Dec. 17, 2013).

The largest nuclear accident in U.S. history was not Three Mile Island but the rupture of the United Nuclear Corporation's Church Rock Dam released approximately 95 million gallons of liquid radioactive mill waste and 1100 tons of solid transuranic waste.²⁷⁹ The spill contaminated the Puerco River, leaving the only water source for a number of local families, unusable:

About 5:30 a.m. on July 16, 1979, the Navajos of the Church Rock chapter woke to the sound of running water, lots of it. They wondered where it had rained to the north to cause this flash flood in the Puerco.

But the torrents had nothing to do with rain. A twenty-foot breach had opening overnight in the United Nuclear dam. Some [95] million gallons of radioactive liquid poured from the pond into the arroyo, and from the arroyo into the riverbed. The water, filled with acids from the milling process, twisted a metal culvert in the Puerco and burned the feet of a little boy who went wading. Sheep keeled over and died, and crops curdled along the banks. The surge of radiation was detected as far away as Sanders, Arizona, fifty miles downstream.

The [Indian Health Service] and the state urged Navajos not to drink the water nor enter it nor let their animals do so, anywhere downstream from the spill. But the people by the Puerco didn't have many alternatives. United Nuclear distributed six hundred gallon-bottles of clean water, but the Church Rock chapter calculated that more than thirty thousand gallons a day were needed.²⁸⁰

Many of the sources of exposure on Navajo lands have yet to be cleaned up.²⁸¹

In the author's view, the voices of those who have been exposed to uranium should carry the most weight when decisions are made over the continuing use of this power source. The Navajo Tribal Council has sought to ban future uranium mining on its lands.

²⁷⁹ *Yellow Dirt* at 149; see also Doug Brugge, Jamie deLemos, and Cat Bui, "The Sequoyah Corporation Fuels Release and the Church Rock Spill: Unpublicized Nuclear Releases in American Indian Communities," 97 Am. J. Pub. Health 1595-1600 & Table 1 (2007) (estimating that the amount of radiation released at Church Rock was 46 curies, compared to 13 curies from Three Mile Island).

²⁸⁰ *Yellow Dirt* at 149 (book refers to 93 million gallons but subsequent studies concluded 95 million gallons as well as approximately 1100 tons of solid waste were released).

²⁸¹ See, e.g., "Uranium Mines Dot Navajo Land, Neglected and Still Perilous," N.Y. Times (March 31, 2012) (discussing highly contaminated and unmarked mine near Cameron, Arizona that "joins the list of hundreds of such sites identified across the 27,000 square miles of Navajo territory in Arizona, Utah and New Mexico that are the legacy of shoddy mining practices and federal neglect"), and Manuel Quinones, "As Cold War Abuses Linger, Navajo Nation Faces New Mining Push," *E&E News* (Dec. 13, 2011) (Reporting that "Despite an ongoing five-year plan to coordinate cleanup efforts among federal and tribal agencies, one high-priority site is clean and more than 500 polluted mine sites remain," and quoting U.S. the Regional EPA Administrator for Region IX as calling it "an untold story . . . The biggest hurdle is the sheer number of sites.")

George Tutt: . . . There are many people who died. When I am being questioned, it is emotional. When you think of the men you worked with, some were young. They were not even 40 years old. They have died. One thing I have to say is that it is not worth it.

In regard to this questioning, if it will help my fellow miners, then it will be good. When I am asked to talk about this and it is not going to be used, then it is not worth it.²⁸²

Minnie Tsosie: Today we are in mourning. In the future should it be that way again? It is for the safety of our children. They will be in the future saying the same thing. I think that way. [Uranium mining] should not be done. . . . It should not be, because it has taken many people. It has taken many fathers' lives, grandfathers' lives. Today we are encountering hardship from it. It bothers me and it hurts my heart.²⁸³

As the authors of a multi-year Navajo oral history and study of the effects of mining and milling contend, "Nuclear power must be recognized for what it really is – a power that comes from abuse."²⁸⁴

²⁸² Oral History of George Tutt, *The Navajo People* at 22-23.

²⁸³ Oral History of Widows Mary Louise Johnson and Minnie Tsosie, *The Navajo People* at 163.

²⁸⁴ Yazzie-Lewis and Zion, "Cultural Interpretation of Uranium Mining," *The Navajo People* at 9-10.