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## **Hidden Costs: The Precautionary Principle, and Risks of Clean Energy Policy**

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Policy makers and commentators frequently cite the Precautionary Principle to rationalize public support for clean energy initiatives. The Principle holds that preemptive environmental protection is warranted, even if the nature of threats is not yet clear. Such action is said to offer, as former Secretary of State George Shultz has put it, a kind of insurance policy against environmental disaster. Adhering to the Principle can cause more harm than good, however. For every \$100 billion that the United States centrally directs to clean energy, GDP may decrease by over 0.4%. Compounded over a generation, this reduction approximates today's per capita income gap between the United States and Italy. In addition, the physics of climate variation may be such that little benefit will come from slowing our rates of carbon emissions. And in any event, centrally directing resources to clean energy can fuel environmental degradation by encouraging inefficiencies in the production of energy, which can cause people to consume more resources for any level of energy-use and spend more of their shrinking budgets on economic necessities rather than environmental amenities.

*Keywords:* Clean energy subsidies, environmental regulation, economic growth, environmental markets, environmental quality

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.<sup>1</sup>

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<sup>1</sup> Principle 15, quoted from the United Nations' report on the Conference on Environment and Development, Rio de Janeiro, June 3-14, 1992. Accessed June 15, 2013, from [www.un.org/documents/ga/conf151/aconf15126-1annex1.htm](http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm).

## 1. Introduction

Principle 15 from the United Nation's Rio Declaration, quoted above, offers a moderate interpretation of the Precautionary Principle.<sup>2</sup> Introduced as a catalyst for 1970's environmental policies in Europe, the Principle now receives reference in numerous international treaties and declarations, including the 1992 Treaty on European Union (Foster et al. 2000, p. 979).

A growing body of case law, including important decisions by the (European) Court of Justice, also refers to various interpretations of the Principle (Foster et al. 2000, p. 979). And while American case law contains few references to the Principle, arguments for clean energy policies contain many.<sup>3</sup> During a recent state visit to Germany, for example, President Barack Obama urged "all nations, not just some" to serve more of their energy demands "from clean sources like wind and solar power." The urgency for action was framed as an overdue precaution against the perils of continued carbon energy use:<sup>4</sup>

The grim alternative [to not capping carbon emissions] affects all nations — more severe storms, more famine and floods, new waves of refugees, coastlines that vanish, oceans that rise. This is the future we must avert. This is the global threat of our time. And for the sake of future generations, our generation must move toward a global compact to confront a changing climate before it is too late.

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<sup>2</sup> Foster et al. (2000, p. 979) characterize the Principle's "strongest formulations" as those that call for "absolute proof of safety before allowing new technologies to be adopted." Rupert Darwall (2013, p. 151) refers to the Rio Declaration's 15th principle as the "precautionary principle."

<sup>3</sup> While "few if any laws [in the United States] cite the Precautionary Principle," courts have nevertheless "upheld the ability of government to base regulatory decisions on substantial evidence that is 'less than a preponderance, but more than a scintilla.'" (Foster et al. 2000, p. 981)

<sup>4</sup> The Guardian (2013). Barack Obama's Berlin Speech – full text, June 19. Accessed June 20, 2013, at <http://www.guardian.co.uk/world/2013/jun/19/barack-obama-berlin-speech-full-text>.

Former Secretary of State George Shultz also referenced the Principle in a recent *Wall Street Journal* conference on ECO:nomics,<sup>5</sup> rationalizing clean energy subsidies as a necessary “insurance policy” against the catastrophic consequences of climate change. And according to some commentators, enjoying the benefits of precautionary measures like these may not cost much.<sup>6</sup>

This type of argument enjoys considerable appeal. After all, who wouldn’t insure against the “the grim alternative” of famines, floods, and other perils, especially if the insurance is cheap? Despite repeated characterization as a low-cost precaution against increasing temperatures and now climate variability, however, clean energy policies are not insurance and may themselves be creating considerable risks for the economy and environment. Indeed, while we frequently consider the cost of doing too little about carbon emissions, we infrequently consider the cost of doing too much. Both can be high.

In this introduction’s remainder, I review some of the science behind this more balanced view of carbon-based energy. The short story here is that no economically feasible slowing of carbon emissions may be capable of reducing our climate’s variability. Centrally directing resources to clean energy may thus be shrinking economic opportunities while returning relatively little in the way of environmental benefits. Even more, inefficiencies associated with such poorly informed and weakly incented allocation methods can damage our environment. Despite its characterization as a prudent exercise in precaution, publicly supporting clean energy may instead be exacerbating the very problems it claims to solve.

This opinion rests in part on relaxing a popular assumption that clean energy, if only produced on a more widespread basis, can mitigate climate variability.

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<sup>5</sup> Comments during presentation of “A bipartisan approach to energy policy,” March 21, 2013, Santa Barbara, CA.

<sup>6</sup> The Nobel Laureate Paul Krugman (2009), for example, argued that “Saving the planet won’t...cost all that much either... the best available economic analyses suggest that even deep cuts in greenhouse gas emissions would impose only modest costs on the average family...And all of this, of course, ignores the benefits of limiting global warming...The claim that climate legislation will kill the economy deserves the same disdain as the claim that global warming is a hoax. The truth about the economics of climate change is that it’s relatively easy being green.”

The Nobel Prize winning physicist, Robert Laughlin, offers a stark alternative, arguing that whether we exhaust carbon-based fuels over 50 or 500 years doesn't matter when considered in terms of geologic time. According to Laughlin, *any* such time period constitutes "the bat of an eyelash as far as the earth is concerned."<sup>7</sup>

Laughlin's argument suggests that environmental benefits from publicly supporting clean energy (or discouraging conventional energy) are much smaller than what is popularly assumed.<sup>8</sup> Importantly, this less sanguine view of clean energy builds on the laws of physics, and thus obtains even if we ignore complications from the laws of politics. If we also account for efficiency losses from omnipresent incentives to divert resources toward building political coalitions rather than expanding economic opportunity, a more complete set of clean energy costs comes into view.<sup>9</sup>

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<sup>7</sup> Laughlin (2011, p. 8) observes that:

The earth has suffered mass volcanic explosions, floodings, meteor impacts, mountain building, and all manner of other abuses greater than anything people could inflict, and it's still here. It's a survivor.

Nonetheless, damaging the earth is precisely what's concerning a lot of responsible people at the moment...Governments around the world have become so alarmed at this prospect that they've taken significant (though ineffective) steps to slow the warming. These actions include legislating carbon caps, funding carbon sequestration research, subsidizing alternate energy technologies, and initiating at least one serious international treaty process to balance the necessary economic sacrifices across borders.

Unfortunately, this concern isn't reciprocated. On the scales of time relevant to itself, the earth doesn't care about any of these governments or their legislation...These actions simply spread the pain over a few centuries, the bat of an eyelash as far as the earth is concerned, and leave the end result exactly the same.

<sup>8</sup> To be sure, Dr. Laughlin is not unconcerned about environmental issues. He observes, for example, that "The real problem is human population pressure generally – overharvesting, habitat destruction, pesticide abuse, species invasion, and so forth." (Laughlin 2011, p. 10) It is important to note, however, that even these environmental problems may resist even the best of intentions when funneled through highly political institutions.

<sup>9</sup> Falaschetti (2009), among others, reviews the literature on why political processes are prone to inefficient distributive interests.

That such distributional forces are both strong and persistent is evident in the fact that the United States has subsidized clean energy since at least President Jimmy Carter's 1978 signing of the Public Utilities Regulatory Policy Act and the Energy Tax Act.<sup>10</sup> Today's Department of Energy also offers evidence that is easier to rationalize with a model where political inefficiencies create a sizable wedge between actual public actions and stated good intentions. It reports, for example, that a \$34.5 billion "Financing Force Behind America's Clean Energy Economy" created or saved about 60,000 jobs.<sup>11</sup> At this rate, each \$575,000 in loans is associated with only one green job created or saved.

To the extent that "climate is a profoundly grander thing than energy,"<sup>12</sup> reducing our rate of carbon emissions may have little effect on climate variation, and even the most productive politics would be incapable of improving environmental quality on this dimension. In this case, the politics of clean energy may primarily be directing resources to lower-valued uses, which not only weakens economic performance but also reduces environmental quality by increasing resource demands for any level of production. Rather than being a dominant strategy in the sense of reducing the possibility of harm with little if any downside, precautionary energy policies appear capable of inflicting considerable costs on both our economy and environment.

In the following section of this article, I estimate how costly public support for clean energy might be in terms of lost economic output, and build on these estimates to evaluate the economic impact of specific subsidies and regulations. In section three, I consider how this evaluation may be conservative in the sense that it ignores feedback channels between economic performance and environmental

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<sup>10</sup> These subsidies have increased over time with the Energy Policy Act of 1992, for example, as well as the creation of tax credits for clean energy investment and production. Standing at 2.2 cents (after taxes) per kilowatt-hour (kWh), for example, today's production tax credit (PTC) often exceeds the wholesale price of electricity (Lesser 2013, p. 23).

<sup>11</sup> U.S. Department of Energy, Loan Programs Office, [http://lpo.energy.gov/?page\\_id=45](http://lpo.energy.gov/?page_id=45). Accessed May 2, 2013.

<sup>12</sup> "The geologic record as we know it...suggests that climate is a profoundly grander thing than energy." (Laughlin 2011, p. 16)

quality. This broader lens view highlights how big of a wrong turn, for both our economy and environment, public policies may be making by encouraging clean energy development. I conclude in section four by highlighting that, rather than being an abstraction that invites loose storytelling, economies fueled by organic energy were the norm in our not too distant past.<sup>13</sup> Policies that risk pushing us back to this future may also be hastening a return to inferior living standards and poorer environmental quality.

## 2. Can “Precaution” Create Risks? Yes, to the Economy and the Environment

### 2.1 *On the high cost and low benefit of clean energy*<sup>14</sup>

Absent considerable policy support, clean energy may have little economic viability. Laughlin (2011, p. 32), for example, observes that

Carbon is just too superior in portability, lightness, and safety to all other energy storage media, at least here on earth.

Given this superiority, he concludes that,

without subsidies...cost-conscious buyers will choose conventional engines, which are simple, reliable, and cheap (2011, p. 37).<sup>15</sup>

Cruz and Taylor (2012, p. 2) add that “many energy economists today debate the role green power can play in powering a modern developed economy in the future.”

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<sup>13</sup> Energy consumption in the United States was exclusively sourced from biomass until about 1850, for example, and biomass continued to be the States’ main source of energy until about 1890 (Cruz and Taylor 2012, p. 8).

<sup>14</sup> “Clean energy” refers to energy produced from purportedly low-emission sources like solar and wind.

<sup>15</sup> Laughlin (and others) observe that carbon-based fuels enjoy a remarkable energy-efficiency and, given our self-interest, we are unlikely to forego these fuels until the fundamental costs of production become prohibitive. California’s electricity shortage in the early 2000s is illustrative. While residing in Berkeley, California during this period, I didn’t hear anyone characterize the large-scale blackouts as having a silver lining – that is, the considerable reduction in carbon-based energy consumption was helping the environment. Rather, anger about the sporadic supply of reliable power was so strong that voters recalled the state’s governor – only the second time ever in U.S. history. Laughlin offers a related story and others to illustrate how economic forces are likely to overwhelm support from clean energy regulations and subsidies. He goes further, arguing that energy may not be clean even after carbon based energy is gone.

And even self-described environmentalists have voiced skepticism about clean energy's efficiency problem.<sup>16</sup> In addition to facing challenges from the laws of physics, centrally directed resources to clean energy must overcome political inefficiencies. Both hurdles are formidable, and put public support for alternatives like solar and wind at risk of consuming more resource inputs to produce less energy. Realizing this risk is clearly bad for economic performance, and viewed through an environmental lens, appears inconsistent with the principles of sustainable use or conservation. Rather than supporting a win-win reallocation of economic resources for jobs and the environment, precautionary energy policies can fuel a lose-lose race to the bottom.<sup>17</sup> By effectively increasing the resource cost of producing goods and services, public support for clean energy can shrink economic opportunity in general while weakening demand for environmental amenities as people allocate more of their tightening budgets to economic necessities.

## *2.2 A methodology for measuring the economic cost of clean energy support*

While researchers like Laughlin (2011) and Cruz and Taylor (2012) question the potential for clean energy to create environmental benefits, public support for clean energy could be shrinking our economic opportunities. To estimate how much economic wealth may be squandered from centrally directing resources to clean energy, I consider how productive those resources could have been if employed elsewhere. In particular, I assume that a competitive market would have directed associated resources to the carbon-based energy sector. I then estimate how much more (or less) value those resources would have created by calculating the

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<sup>16</sup> Nordhaus and Shellenberger (2013), for example, appreciate that end-of-the-world scenarios can fuel support for clean energy. They also argue, however, that “anyone truly concerned about climate change will need to reconsider their opposition to nuclear.”

<sup>17</sup> Former Michigan governor Jennifer Granholm emphasizes the importance of highlighting job creation benefits when lobbying for alternative energy, Tweeting that it is “Important 2 couch climate change in terms of jobs that can be created in the globe’s fastest growing sector:clean energy” (@JenGranholm, May 8, 2013). Also see Lesser (2013, p. 22).

differences between financial rates of return from private oil and gas investments versus those from publicly supported projects.

*The worst-case estimate from this exercise implies that, for every \$100 billion of resources publicly directed toward clean energy, GDP decreases by over 0.4%.<sup>18</sup> While appearing small on its face, this rate of inefficiency maintained for a generation could create a loss in per capita income on the scale of today's difference between the United States and Italy.<sup>19</sup> Income losses like this can cause considerable reductions in economic wellbeing while also taking away from other dimensions of human welfare by reducing life expectancies and increasing infant mortalities.<sup>20</sup>*

Nearby Figure 1 begins to show how estimates like this can be calculated. Valerie Ramey (2011) recently published an authoritative set of government spending multipliers, which ranges from 0.60 to 1.20. In words, Ramey's lower end estimate means that a one-dollar increase in U.S. government spending *reduces* the value of goods and services that are eventually consumed to \$0.60. Likewise, Ramey's high-end estimate implies that a dollar increase in government spending increases the value of resource inputs to \$1.20.<sup>21</sup>

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<sup>18</sup> This calculation assumes a GDP of \$15 trillion, which approximates the level of annual economic activity in the United States as of the date of this paper's writing (The World Bank reports a level of \$14.991 billion for 2011, accessed June 18, 2013, at <http://data.worldbank.org/indicator/NY.GDP.MKTP.CD>).

<sup>19</sup> The compounded rate of national income loss over 30 years approximates the percentage difference between the per capita gross domestic products of the United States and Italy in 2011. (Source for GDP statistics: The World Bank, List of countries by GDP (PPP) per capita, accessed June 14, 2013, at [http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?order=wbapi\\_data\\_value\\_2012+wbapi\\_data\\_value+wbapi\\_data\\_value-last&sort=desc](http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?order=wbapi_data_value_2012+wbapi_data_value+wbapi_data_value-last&sort=desc)).

<sup>20</sup> Oulton (2012) offers an accessible review of some such relationships.

<sup>21</sup> Any estimate of government spending multipliers is sensitive to assumptions about how that spending affects equilibrium labor hours (Ramey 2011, p. 674). The recent Great Recession has been followed by a large drop in labor hours worked and considerable substitution to other production inputs *despite* strong fiscal (and monetary) policy responses (Mulligan 2012, pp., 6, 33), a pattern consistent with any stimulus effect being at the lower end of estimates. Even more, these multipliers are modeled on the assumption that increased government spending is temporary (Ramey 2011, p. 673). As this article's introduction highlights, alternative energy subsidies have been in place since at least the 1970s, and have thus easily spanned across periods during which labor market slack might have been taken up by public spending. On this dimension too, multipliers that are available from the economic literature may overestimate those that would be tailored for the current application.

**Figure 1. GDP loss (gain) in dollars per \$1 billion subsidy, estimated for a range of public spending multipliers and private costs of capital**

		Costs of Capital for Oil and Gas Properties		
		15.0%	20.0%	25.0%
Government Spending Multipliers	0.60	\$550,000,000	\$600,000,000	\$650,000,000
	0.80	\$350,000,000	\$400,000,000	\$450,000,000
	1.20	\$(50,000,000)	\$0	\$50,000,000

To estimate how much value public spending on clean energy is subtracting from (or adding to) economic activity, I compare Ramey’s estimates of government spending multipliers to estimates of how productively private sector oil and gas ventures might have employed the same resources. The Property Tax Assistance Division of the Texas Comptroller offers a measure of this productivity for both actual transactions and property appraisals. Recently, it reported a range of about 8% to 28% (Combs 2010, Table 3).<sup>22</sup> In words, these costs represent the rate-of-return that is necessary to attract investors to a particular oil or gas venture.<sup>23</sup>

These estimates of dollars lost or gained from centrally rather than privately directing \$100 billion of resources can be expressed in terms of their GDP effects by calculating the percentage-subtraction from (or contribution to) the United States’ \$15 trillion economy. Except for one, the percentage differences reported in nearby Figure 2 are positive, offering a range of how much more national income might be if resources that are publicly directed to clean energy projects were instead privately directed to conventional energy projects.

<sup>22</sup> The lower end of this range comes from survey responses. The range of discount rates used in 78 oil and gas transactions runs from about 16.2% to 28.0%. The Property Tax Assistance Division of the Texas Comptroller typically assigns discount rates to future income in the range of 17.28% to 23.26% (Combs 2010, p. 3 and Table 3).

<sup>23</sup> A venture whose cost of capital is 15%, for example, means that suppliers of financial capital expect a return of at least \$1.15 per year for every dollar they invest up front (that is, they could have otherwise put their money into a similarly risky project with the reasonable expectation of earning a 15% return).

**Figure 2. Percentage of GDP lost (gained) per \$100 billion subsidy, estimated for a range of public spending multipliers and private costs of capital**

		Costs of Capital for Oil and Gas Properties		
		15.0%	20.0%	25.0%
Government	0.60	0.37%	0.40%	0.43%
Spending	0.80	0.23%	0.27%	0.30%
Multipliers	1.20	-0.03%	0.00%	0.03%

Analyses like that of Laughlin (2011) suggest that even successful clean energy projects are unlikely to offer much in the way of offsetting environmental benefits, at least on the dimension of climate variability. Viewed in this light, the estimated productivity differences reported in Figure 2 cannot easily be dismissed by citing the fact that national income accounts can ignore the benefits we enjoy from consuming environmental amenities. Rather, they suggest that for every \$100 billion in alternative energy subsidies, productive economic activity slows by as much as 0.43% (assuming a \$15 trillion economy).<sup>24</sup> Even the most optimistic estimate under these assumptions has subsidies adding only .03% to national income.

### 2.3 Application: The American Clean Energy Act

Estimates reported in Figure 2 of how public support for clean energy can discourage productive economic activity can guide a consideration of how proposed and actual public support for clean energy might influence economic performance. Consider, for example, what this methodology implies for economic opportunities that could have been lost if the American Clean Energy and Security

<sup>24</sup> Per Table 2, every \$100 billion that is centrally directed to clean energy projects causes a growth-loss of 0.43% (estimated at spending multiplier of 0.60 and cost of capital of 25%).

Act of 2009 became law.<sup>25</sup> The Congressional Budget Office (CBO) and Joint Committee on Taxation (JCT) estimated that, over the 2010-2019, the Act would have increased direct government spending by about \$821 billion and discretionary spending by about \$50 billion.<sup>26</sup> In the worse-case scenario for GDP effects (that is, where public spending creates only \$0.60 of value for every dollar spent while private spending creates \$1.25), and assuming that the Act's estimated spending of \$871 billion would have occurred evenly over 10 years (that is, \$87.1 billion per year), the first year subtraction from productive economic activity would have been almost 0.38%.

Again, fractions of a percent can appear small out of context. It can therefore be instructive to consider what such differences mean in terms of today's standards of living. Compounding this estimated GDP-reduction over a 30-year horizon, and assuming a 3% baseline growth rate, the per capita income loss for America's next generation approximates the percentage difference in incomes today between the United States and France.<sup>27</sup>

#### *2.4 Application: Energy permitting delays and cancellations*

The President's Climate Action Plan of 2013 outlines a non-legislative path to achieving some of the American Clean Energy Act's proximate goals. Proposed actions include accelerating the pace of clean energy permits to "protect our

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<sup>25</sup> On June 26, 2009, the House passed the bill by only seven votes (219-212). It was not taken up in the Senate, however (Hulse and Herszenhorn 2010). (Source for vote results accessed August 30, 2013, at <http://clerk.house.gov/evs/2009/roll477.xml>.)

<sup>26</sup> Source: Congressional Budget Office (2009).

<sup>27</sup> In this illustration, economic activity would grow at an annual rate of 3.38% without the public spending instead of 3.00% with it. Compounded over 30 years, this initial difference ultimately causes incomes to be 15% lower than they would have been without the public spending. France's per capita GDP in 2011 (\$34,975) is 27.31% lower than that in the United States (\$48,112). (Source for GDP statistics: The World Bank, List of countries by GDP (PPP) per capita, accessed June 14, 2013, at [http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?order=wbapi\\_data\\_value\\_2012+wbapi\\_data\\_value+wbapi\\_data\\_value-last&sort=desc](http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?order=wbapi_data_value_2012+wbapi_data_value+wbapi_data_value-last&sort=desc)) Leveraging information from the how economic performance responded to energy price shocks in the 1970s and 1980s, and reviewing other research, authors of the Economic Report of the President argued that substituting toward clean energy "could cut world economic growth in half." (ERP 1990, p. 215)

children's health and begin to slow the effects of climate change" (Executive Office of the President 2013, pp. 4, 7).

Both clean and conventional energy projects can encounter considerable delays while waiting for regulatory permission. And associated costs can rise so high that the permitting process effectively cancels projects before they can get started.<sup>28</sup> Steve Pociask and Joseph Fuhr Jr. (2011), for example, documented over 300 projects that are currently delayed or have effectively been canceled through such channels. Their sample of projects alone represents almost \$600 billion of investment that may be idling inefficiently (Pociask and Fuhr 2011, p. 4).

One way to estimate economic losses from these delays and cancellations is to simply extend the methodology described earlier in this section by characterizing permitting delays and cancellations as a channel for political rather than market forces to direct economic resources. The worst-case estimate that every \$100 billion subjected to such influence causes \$65 billion in lost economic opportunities, for example, implies that permitting delays and cancellations are scrubbing almost \$400 billion off GDP.<sup>29</sup> To put this number into context, supplemental appropriations for September 11, 2001 and Hurricane Katrina were \$40 billion and \$94.8 billion, respectively.<sup>30</sup>

Data from Pociask and Fuhr (2011) also lend themselves to analysis via standard capital budgeting methods.<sup>31</sup> Here, lost economic opportunities from permitting delays and cancellations can be estimated from revenues that are

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<sup>28</sup> Source: Introduction to Pociask and Fuhr (2011) and phone conversation with Steve Pociask, June 26, 2013.

<sup>29</sup> If the opportunity cost for every \$100 billion of publicly directed resources equals \$65 billion, then the opportunity cost of having \$577 billion sidelined by the permitting process equals \$375.05 billion (that is,  $5.77 \times \$65$  billion).

<sup>30</sup> Source for 9/11 spending: Public Law 107-38 (2001 Emergency Supplemental Appropriations Act for Recovery from and Response to Terrorist Attacks on the United States), accessed July 15, 2013, at [www.gpo.gov/fdsys/pkg/PLAW-107publ38/html/PLAW-107publ38.htm](http://www.gpo.gov/fdsys/pkg/PLAW-107publ38/html/PLAW-107publ38.htm). Source for Katrina spending: Congressional Budget Office (2007). The Federal Government's Spending and Tax Actions in Response to the 2005 Gulf Coast Hurricanes. Accessed July 15, 2013, at [www.cbo.gov/sites/default/files/cbofiles/ftpdocs/85xx/doc8514/08-07-hurricanes\\_letter.pdf](http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/85xx/doc8514/08-07-hurricanes_letter.pdf).

<sup>31</sup> Brealey, Richard, Stewart Myers, and Franklin Allen (2010), among others, offer a textbook treatment of these methods.

necessary to competitively support their sample of \$577 billion sidelined investments. If investors require a 25% rate of return before supplying financial capital to these projects (Combs 2010), and all of the projects are cancelled, then the loss of annual revenues over an assumed twenty-year project life is over \$145 billion or almost a full 1.0% subtraction from a \$15 trillion GDP.<sup>32</sup> Alternatively, delaying these projects for a year (rather than cancelling them outright) could reduce GDP by over \$100 billion under these assumptions, or almost \$1,000 per U.S. household. The nearby Figure 3 estimates these lost economic opportunities for a range of required rates of return.

**Figure 3. Opportunity cost of permitting delays and cancellations for a range of private costs of capital**

<b>Required Rate of Return</b>	<b>Annual Revenue-Loss as Percent of \$15 Trillion GDP</b>	<b>Total Loss from 1-year Delay</b>	<b>Household Loss from 1-year Delay</b>
20%	- 0.79%	\$96.2 billion	\$794
15%	- 0.61%	\$75.3 billion	\$621
10%	- 0.45%	\$52.5 billion	\$433

The bottom line from this exercise is that, while the range of estimated costs is wide, even its low-end estimates highlight the risk of considerable economic harm from precautionary environmental policies. And if policies are becoming even more precautionary in nature, then this estimated range of “how bad can it get” becomes even less attractive. The U.S. government’s “social cost of carbon,” for example, recently increased by almost 60% (Drajem 2013). Such an increase could turn more of the permitting delays that Pociask and Fuhr (2011) documented into effective

<sup>32</sup> Annual cash flows of almost \$146 billion are necessary to rationalize an initial investment of \$577 billion on a Net Present Value basis (assuming 20 annual payments and an opportunity cost of capital equal to 25%).

cancellations, and thus move more of the opportunity costs reported in the above Figure 3 from the relatively low estimates for “delays” to the high estimates for “cancelations.”

### *2.5 Application: Clean energy loan guarantees*

Economic costs associated with loan guarantees are relatively easy to estimate, at least when a borrower defaults. In the highly publicized Solyndra bankruptcy, for example, taxpayers spent an estimated \$500 million to fill the gap between what lenders invested in Solyndra and what was left after Solyndra failed to put this financial capital to productive use (Broder 2012).

The full economic cost of such guarantees, however, likely exceeds such headline numbers. Publicly supported guarantees can weaken economic performance, even if they are never called upon. As noted in the present article’s introduction, centrally directing resources is prone to considerable influence by those who benefit more from producing votes than economic value. And according to an 18-month Congressional investigation, public support for Solyndra appears to have fallen into this foreseeable trap (Broder 2012). While Solyndra ended up losing taxpayers’ money in a rather transparent way, the risk of it doing so in ways that are harder to see was non-negligible from the start. A less well-publicized venture is illustrative.

Having received \$1.6 billion in clean-energy loan guarantees, a Google-supported investment team is now spending tens of millions of dollars to relocate and discourage the return of Mojave Desert tortoises. In addition to living on prime real estate for generating solar energy, the Mojave population of the desert tortoise is listed as threatened under the Endangered Species Act. Taxpayers are thus paying to both protect the turtles and put their habitat at risk. And while taxpayers are supporting both the problem and solution in this case, clean energy production at the Google-supported consortium remains at a standstill (Huggins and Currie 2013).

Loan guarantees like these are administered through an almost \$80 billion Department of Energy (DOE) program (Ardani and Margolis 2011). Part of these guarantees' economic cost can be estimated from the Congressional Budget Office's valuation of historical Federal loan guarantees to America West Airlines and Chrysler, which are reported as 35.1% and 23.2% of the guaranteed loan amounts, respectively.<sup>33</sup> Using the higher cost estimate, the market value of DOE loan guarantees is \$76 billion X 0.351 = \$26.7 billion. The associated one-year GDP loss with a 0.60 public spending multiplier and a 25% private cost of capital is 0.12%, or \$17.4 billion (assuming a \$15 trillion economy). Compounding this loss over 30 years results in a generational income gap of about 8.31%.

While offering a worse-case scenario in one sense, this estimate is conservative in that it excludes consideration of political inefficiencies that are evident in the previous illustrations from Solyndra and Google's solar consortium. It also ignores how other centrally directed efforts to advance the solar sector can weaken economic performance. This methodology ignores, for example, opportunity costs of and economic distortions from investment tax credits, renewable energy grants, manufacturing tax credits, modified depreciation allowances, tax-favored financing mechanisms, block grants, and state and local initiatives.<sup>34</sup>

### **3. Can we Enjoy Economic Growth *and* Environmental Quality?**

The Nobel laureate Robert Solow (1956) highlighted a fundamental role for productivity in helping economies grow. Importantly, he showed why expanding economic opportunities in the long-run requires advances in technology that leverage how hard labor and capital can work. Simply putting in more hours, for example, can't facilitate long run growth — at most, we can work 24 hours per day, and that pace wouldn't last long. Something more than increasing levels of resource

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<sup>33</sup> Source: CBO (2004, Table 2).

<sup>34</sup> Ardani and Margolis (2010, Sections 4.1 and 4.2) review these programs. The manner in which these programs are structured, however, masks the data that are necessary to estimate their growth-effects via my spending-multiplier / cost-of-capital methodology.

inputs is necessary. According to Solow's model, an important reason why we enjoy so much more in terms of consumption opportunities today, while working considerably fewer hours than did people in past generations, is that technological advances now let us make more of what we enjoy consuming from each hour of that we work.

Federal Reserve economists, among others, offer empirical support for this hypothesis. They estimated that *over half* of today's economic growth comes from technological advances that economize on resource inputs to finished goods and services.<sup>35</sup> The evolution of skyscrapers is illustrative. For example, Chicago's Willis Tower (completed in 1974)<sup>36</sup> stands 200 feet taller than does New York's Empire State Building (completed in 1931). Materials that went into constructing Willis, however, weigh almost 40% less (Gort et al. 1999).<sup>37</sup> Viewed in the context of Solow's model, this conservation of resources was made possible by people who discovered how to make more from less and effectively put those discoveries to productive use.

Efficiency-gains like this not only illustrate an important force for expanding our economic wellbeing, they appear to also serve environmental demands for "sustainable use" and "conservation." If expanding economic opportunity requires increasing productivity, and increasing productivity means making more of what consumers demand from fewer resource inputs, then a growing economy can also be green in this important sense.<sup>38</sup>

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<sup>35</sup> Gort et al. (1999) conclude that "investment-specific technological advance accounts for more than half of economic growth. Evidently, Solow was right."

<sup>36</sup> At completion, today's Willis Tower was named the Sears Tower.

<sup>37</sup> Gort et al. observed that the "Sears Tower is 200 feet taller than the Empire State Building (circa 1931), but it weighs much less (223,000 tons versus 365,000)."

<sup>38</sup> Edward Glaeser (2011) offers another illustration of this relationship between economic efficiency and environmental quality in his chapter on "Is there anything greener than blacktop?"

In addition to this rather direct and desirable environmental consequence of a growing economy, an indirect channel may exist for environmental quality to increase with economic growth. Economists have found evidence, for example, that pollution decreases after incomes break through a sufficiently high level — a relationship known as the Environmental Kuznets Curve (EKC).<sup>39</sup> A highly cited contribution to this literature finds

no evidence that environmental quality deteriorates steadily with economic growth for most indicators. Rather, for most indicators, economic growth brings an initial phase of deterioration followed by a subsequent phase of improvement. (Grossman and Krueger 1995, p. 353)

This empirical pattern may reflect lower income households allocating a relatively large proportion of their small budgets to economic necessities, with higher-income households enjoying luxuries like those associated with environmental amenities.<sup>40</sup>

Consistent with this hypothesis, pollution abatement policies advanced in the name of environmental justice for poor renters and homeowners may have instead sparked environmental gentrifications. To the extent that such policy risks are realized, housing costs can increase for the very people who were supposed to receive a hand up.<sup>41</sup> Because housing prices can increase with the value of associated environmental amenities, individuals with relatively low incomes may choose to live in areas that are more polluted but cheaper.<sup>42</sup> According to this hypothesis, the quality of environmental amenities can also indirectly increase as economic opportunities expand in general.

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<sup>39</sup> The EKC takes its name after a similar relationship that esteemed economist Simon Kuznets found between economic development and income inequality.

<sup>40</sup> “Necessity” and “luxury” are used here as formal economic terms.

<sup>41</sup> Banzhaf (2008, p. 16), quoting the National Environmental Justice Advisory Council’s report to the U.S. Environmental Protection Agency.

<sup>42</sup> See Banzhaf (2008, 20-1) and references to related studies therein.

#### 4. Clean Energy Policy: Back to the Future?

Section two of this article describes how centralized support for clean energy may be taking away from our economic opportunities while doing relatively little to improve environmental quality. Section three goes further, highlighting how support for clean energy via political rather than economic markets may be reducing the quality of our environmental amenities, both directly and indirectly.

In this concluding section, I describe related insights from energy economists and economic historians. While their assumptions differ from those that support my earlier results, their conclusions appear similar — that is, clean energy policies advanced in the name of “precaution” may be accelerating us to a future where neither the economy nor environment is green.

Until the 19<sup>th</sup> century, renewables fueled *all* economic activity in the United States (Cruz and Taylor 2012, p. 8). Economic wellbeing during that period, however, pales in comparison to that of today. And both casual and scientific observations suggest that environmental quality walked in lock step with this dismal economic performance.<sup>43</sup> Precautionary measures that discourage productivity advances and thus resource conservation, or impede cities and countries from summiting the Environmental Kuznets Curve, may be slowing or even stopping the type of social progress that has seen economic and environmental performance improve together.

This unattractive history, and the risks it highlights for going back in the future, have also been attributed to the “density” advantage of fossil fuels over renewables (Cruz and Taylor 2012, Laughlin 2011). Density, in this context, offers a combined measure of a power-source’s energy richness and its geographic requirements. Oil, for example, enjoys a density advantage by packing a high-energy content while demanding little in the way of geographic area for extraction. Geographic demands from sources like wind-farms are considerably greater, and coupled with their

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<sup>43</sup> Air pollution in London, for example, reportedly deteriorated for over 300 years until the late 19<sup>th</sup> century (Lomborg 2001).

inferior energy content, reduce their density while increasing their economic and environmental opportunity costs.

Energy cannot improve economic wellbeing until it reaches people who can productively employ it. For an energy source to make economic sense, it needs to not only pack enough reliable power to efficiently fuel end-user activity, its density must be high enough to make transport worthwhile. By their nature, fuels that lack density cannot travel far — people must move to them, creating a type of energy sprawl. Dense sources like oil, on the other hand, can support their own transportation from miles below the oceans to fuel-tanks in our cars.<sup>44</sup>

Simply adding important issues like fuel-transport to an otherwise narrow focus on end-of-pipe emissions highlights difficulties for renewables on both economic and environmental dimensions. Cruz and Taylor's (2012) "density-creates-density" model supports observations from the economic history literature that not only does population density increase with that of available energy, so does economic welfare.<sup>45</sup> And perhaps independent of these rather direct links between energy/population density and economic performance, Harvard economist Edward Glaeser (2011) has argued that population-dense cities are important for both strong economic performance and environmental quality.

These models, like those developed and reviewed in earlier sections of this article, highlight economic and environmental risks from supporting clean energy in the name of precaution. This support can influence the relative prices we face when choosing how to fuel our economic activity. Its prospects for changing the laws of physics or economics, on the other hand, appear considerably weaker.

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<sup>44</sup> Villages in the Middle Ages rarely sourced fuel wood from more than a few miles away. Coal however has been transported hundreds of miles on barges, wagons and trains for much of the last two centuries. Today oil is sourced from some of the most inhospitable climates in the far reaches of the planet and from wells drilled literally miles deep below the ocean surface. (Cruz and Taylor 2012, pp. 14-15)

<sup>45</sup> "More dense energy sources produce greater peak consumption, support larger populations at these peaks, and present an obvious power density driven incentive for the agglomeration of economic activity." (Cruz and Taylor 2012. P. 59)

Cruz and Taylor (2012, p. 7), for example, observe that “humans have always turned to increasingly dense fuels.” By curbing our demand for such fuels, precautionary measures may be weakening economic performance and reducing environmental quality. Rather than encouraging prudent decision making in the face of uncertainty, adherence to an even moderate interpretation of the Precautionary Principle may be creating knowable and considerable costs for our environment and economy.

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