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CLEAN ENERGY:
REVISITING THE CHALLENGES OF INDUSTRIAL POLICY

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1. INTRODUCTION

"We're in a competition all around the world, and other countries -- Germany, China, South Korea -- they know that clean energy technology is what is going to help spur job creation and economic growth for years to come. And that's why we've got to make sure that we win that competition. I don't want the new breakthrough technologies and the new manufacturing taking place in China and India. I want all those new jobs right here … in the United States of America, with American workers, American know-how, American ingenuity."

President Barack Obama
May 6, 2011
Remarks at Allison Transmission Headquarters, Indianapolis, Indiana

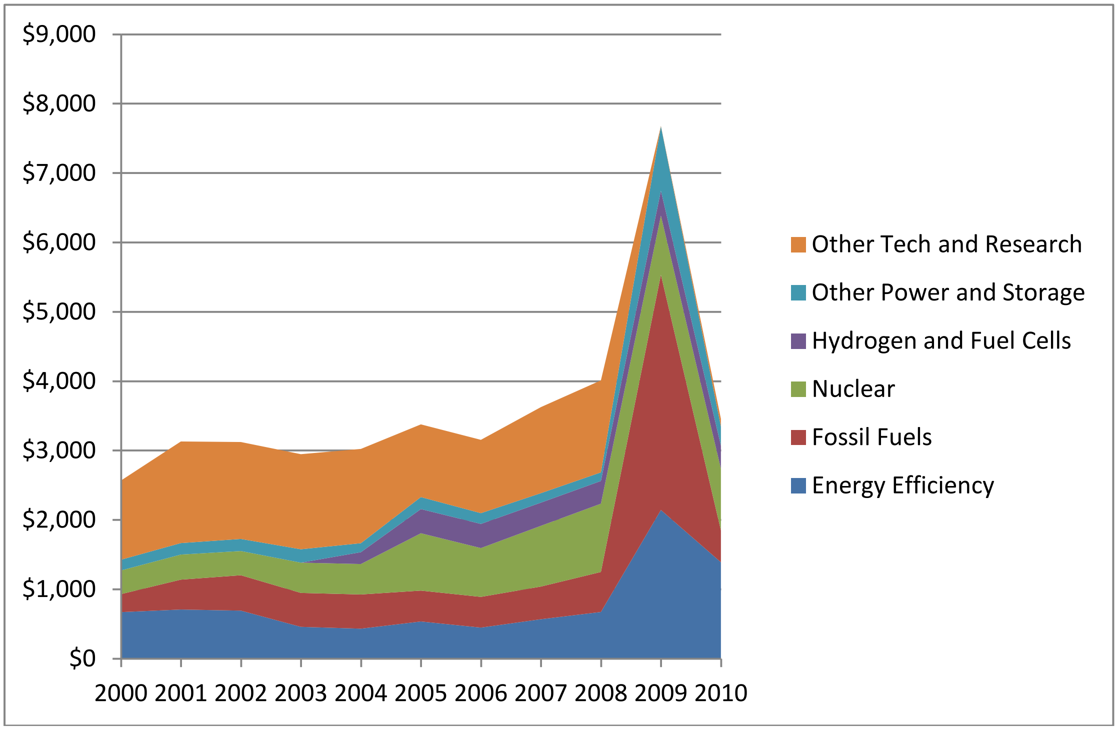
Governments in most industrial countries have stepped up their promotion of clean energy technology in recent years. No longer a laggard, the U.S. government increased energy subsidies from $17.9 billion in fiscal year (FY) 2007 to $37.2 billion in FY 2010, according to the U.S. Energy Information Administration (EIA).[1] The total includes a mix of direct expenditures, tax expenditures, the subsidy associated with loan guarantees, and research, development and deployment (RD&D) spending.

The Energy Improvement and Extension Act (EIEA), passed in late 2008, and the American Recovery and Reinvestment Act of 2009 (ARRA) account for much of the increase. The EIEA expanded or extended tax credits for renewable energy, energy-efficient appliances, plug-in electric vehicles, and liquid biofuels. ARRA, a broad fiscal stimulus package, included $35.2 billion to the Department of Energy (DOE) and added $21 billion in energy tax incentives over the life of the legislation.[2] Using ARRA authority, cumulatively from September 2009 through November 2011, DOE underwrote $35.9 billion in loan guarantees for a range of energy-related technologies.[3]

Figure 1 displays the U.S. spending stream on energy-related research and development over the last decade. The graph shows the dramatic impact of the ARRA package.

[1] U.S. Energy Information Administration, "Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2010," August 1, 2011. http://www.eia.gov/analysis/requests/subsidy/
[2] $11 billion went to grants to state and local governments for weatherization and other programs and $600 million in new research funding.
[3] U.S. Department of Energy (DOE), Loan Programs Office website, accessed November 29, 2011. https://lpo.energy.gov/?page_id=45. The overall value of loans guaranteed by DOE is much larger than the appropriations necessary to account for the value of the subsidized interest rate on the guaranteed loan.

Figure 1. U.S. Energy-Related R&D Spending 2000-2010 (in millions of $2010)[4]



Public investments of these magnitudes, targeted at specific industries, arguably constitute an industrial policy, albeit a sectoral one, unlike the earlier proposals of the 1980's —that is, a government strategy to steer resources toward select producers or technologies. The rationale and efficacy of these clean-energy expenditures call for scrutiny.

Proponents offer numerous reasons for scaling up particular energy technologies at the taxpayer's expense. One set of reasons involves the need to remediate market failures that have not been corrected by other policies. For example, clean-energy technologies are said to emit fewer greenhouse gases than do traditional sources per unit of energy produced. The United States does not have an economy-wide policy to control greenhouse gases, most notably, one that puts a price on CO_2 that reflects the environmental harm associated with use of fossil fuels.

A far more effective policy than subsidies for clean energy research, development and demonstration would be a tax or a cap-and-trade regime that would put an appropriate price on carbon and other greenhouse gases.[5] Properly implemented, this alternative approach would help level the playing field for greener energy sources, for it would require emitters to pay prices that reflect the costs their emissions impose on society. The enhanced efficiency

[4] International Energy Agency, Detailed Country RD&D Budgets. Data downloaded November 29, 2011 from http://wds.iea.org/WDS/ReportFolders/ReportFolders.aspx.
[5] A carbon tax and a cap-and-trade program are theoretically very similar. We favor a carbon tax based on our assessment of the likely actual implementation.

that would result has been widely recognized by economists. [6] True costs would flow to purchasers of goods and services that require energy, suitably inducing conservation. Emitters would have incentives to invest in equipment and new production techniques, use alternative fuels, and seek other methods to reduce emissions. And America's innovators would channel their efforts into inventing, scaling up, and marketing competitive forms of clean energy. However, because existing market signals do not suffice to encourage climate-friendly technologies, carefully targeted federal funding seems warranted. But as we explain later, it is ironically only after incorporating the social costs of energy into market prices that many clean energy subsidies will succeed in deploying new technologies.

Some clean energy technologies, such as electric vehicles and biofuels, are also said to wean the economy from its inordinate dependence on oil, which is both volatile in price and supplied in part from unstable foreign sources. Like environmental damage, the security risks of relying on oil are not fully embedded in its price, and therefore, the argument goes, policies to reduce its use could be efficiency-enhancing.

A second set of reasons for sustaining clean-energy subsidies is less about correcting inefficient market outcomes than about tilting the market toward U.S. interests. In this view, strategic investments in clean energy technologies would increase U.S. firms' market share of a growing industry and thus help American firms and workers win a larger portion of global business. Although the projected market growth of cleaner energy derives from the international community's efforts to protect the environment, the objective here is economic. Proponents imply that capturing a larger market share would boost long-term U.S. "competitiveness" and create jobs in American firms that manufacture the exportable products.

Are these justifications sound? And even if convincing in theory, what happens in practice? That is, can the American political process successfully carry out the envisioned strategy? Section 2 of this paper reviews the history of industrial and energy technology policy since the 1970s. Section 3 examines the environmental and energy- independence rationales, and Section 4 analyzes claims about the potential role for government backing of clean energy to ensure U.S. competitiveness and save or create jobs. Section 5 explores the administrative and political challenges of implementing an efficient clean-energy research and development portfolio, and Section 6 sketches our recommendations.

2. INDUSTRIAL AND ENERGY TECHNOLOGY POLICY, THEN AND NOW

Industrial Policy in the 1970s and 1980s

The years between the mid-1970s and the mid-1990s were a troubled time for most of the world's advanced economies. Inflation averaged higher than in earlier postwar years, and productivity growth slowed. The era saw two deep recessions. These conditions spawned a new economic doctrine that purported to explain the malady and sought to offer a remedy:

[6] For example: Greenstone, Michael and Adam Looney, *A Strategy for America's Energy Future: Illuminating Energy's Full Costs*, The Hamilton Project, The Brookings Institution, May 2011.

industrial policy. It largely arose outside the mainstream of professional economics, gathering support among union leaders and Democratic-leaning thinkers and policymakers. The term meant different things to different people, but enthusiasts accepted several underlying propositions about the faltering economy:

- The share of national output produced by high valued-added American manufacturing industries was declining.
- America was losing its leadership in cutting-edge technology and suffering the decline of critical older industries.
- These developments transpired because the private market was directing investment to the wrong industries, compounded by a mismatch between the skills of dislocated workers and the skills required in growing industries.
- To remedy these problems, wrote two influential advocates, "U.S. companies and the government should develop a coherent and coordinated industrial policy whose aim is to raise the real income of our citizens by improving the patterns of our investments rather than by focusing only on aggregate investment levels." [7]

Industrial-policy adherents contemplated considerable expansion of the federal government's role in the private economy. They believed that in consultation with industry, the federal government could improve investment in new technologies and protect waning manufacturers like steel and automobile companies. In lieu of large direct subsidies, the promotional schemes proposed during the 1980s offered a range of indirect measures to nudge private investment in the "right" direction. The measures included tax breaks, subsidized loan facilities, trade policies (including "voluntary" import quotas, export loans, and other trade actions to obtain better market-shares abroad). For declining industries, some changes in union work rules and wages were countenanced as preconditions for federal assistance.

Beginning in the 1970s and continuing into the 1980s, Japan's formidable growth in output and exports was imputed to that country's supposed strategic government policies, which were suspected of buoying her prosperity at the expense of ours. The machinations of the Ministry of International Trade and Industry, some thought, explained Japan's outstanding economic success during the 1980s. Japan, supposedly, had implemented a smart industrial policy.
As output and employment rebounded from the severe recession of 1982, U.S. productivity growth returned to the higher level of the 1950s and 1960s, and Japan's economic performance ceased being exemplary; thus, the allure of industrial policy dimmed by the mid-1990s.[8] However, since its inception, stubborn economic problems have occasionally revived the notion that the government should play a strategic role in the allocation of private investment.

U.S. Energy Technology Policy

The energy sector has long been an object of industrial boosterism. While policymakers have had some successes, the history of the Department of Energy's (DOE) RD&D projects has been

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[7] Ira Magaziner and Robert Reich, *Minding America's Business* Harcourt Brace Jovanovich, New York, 1982, p.4
[8] The U.S. government has bailed out individual firms (e.g., Chrysler in 1979, and GM, Chrysler, and financial institutions in 2009) but has arguably never had an economy-wide industrial policy.

checkered since the early 1970s. For example, after the first Mideast oil shock in 1973, various alternative fuel programs were proposed. They proved problematic. President Carter and Congress, for example, created the Synthetic Fuels Corporation that was envisaged to spend up to $88 billion ($200 billion in 2007 prices) and to produce an ambitious two million barrels a day by 1992.[9] Some plants were completed at a cost of $9 billion (2007 dollars) but they never operated commercially.[10] The Clinch River breeder reactor project cost taxpayers $1.7 billion. It was abandoned in 1983; none of the subsidized reprocessing plants became commercial operations.[11] Some more recent federal efforts to fund energy technology have seen similar failures and false starts. For example, from 2004 to 2008 the federal government sank $1.2 billion into hydrogen vehicle programs that so far have resulted in no commercial deliverables.[12]

Budget analysts and technical experts have debated the policy implications of this experience. The Congressional Budget Office (CBO) annually identifies options for spending cuts. Its 2011 report includes a 75 percent reduction in DOE funding for energy technology development, with the cuts concentrated on funding for later stages of development, demonstration projects, and the deployment of new technologies.[13] In contrast, a 2001 National Academy of Sciences (NAS) report reviewing DOE research and demonstration projects takes what appears to be a more upbeat view of their value.[14] The report examined costs and benefits of two categories of DOE programs (17 energy efficiency programs and 22 fossil energy programs) over the period 1978 to 2000. NAS concluded that the projects yielded returns of about $40 billion dollars while spending $17 billion. About $30 billion in benefits came from energy-efficiency projects and $10 billion from fossil fuel projects.

Despite the large net benefits, the report suggests that the overall investment portfolio has not been sound. Just three of the energy efficiency programs produced 75% of the benefits. Taken as a whole, the fossil fuel programs merely broke even. The highest benefit-cost ratios predictably came from initiatives related to residential and commercial construction, an industry not known for rapid energy-saving and environmental innovation. In contrast, DOE's efforts to commercialize large capital-intensive technologies like coal liquefaction have been beset by cost overruns and low net benefits. The report notes that this tendency is not confined to DOE projects, however.[15]

Clean Energy after the Financial Crisis

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[9] Mufson, Steven, "Before Solyndra, a History of Failures," *The Washington Post*, November 13, 2011, p. B4.
[10] See Linda Cohen and Roger Noll, *The Technology Pork Barrel*, The Brookings Press, 1991 and Peter Z. Grossman, "The History of U.S. Alternative Energy Development Programs, September 16, 2008, Searle Center on Law, Regulation, and Economic Growth; Lyons, Richard D., "Corporation for Alternative Energy Sources Set Up", May21, 1980.
[11] Congressional Budget Office (CBO), *Comparative Analysis of Alternative Financing Plans for the Clinch River Breeder Reactor Project*, September 20, 1983.
[12] Mufson, op. cit.
[13] CBO, *Reducing the Deficit: Spending and Revenue Options*, pp. 101-102, March 2011. http://www.cbo.gov/ftpdocs/120xx/doc12085/03-10-ReducingTheDeficit.pdf.
[14] National Academy of Sciences (NAS), *Energy Research at DOE: Was It Worth It?,* The National Academies Press, 2001.
[15] NAS, op. cit. p. 63.

Inspiration for recent clean-energy assistance reflects environmental concerns but also some of the old economic arguments of the 1980s. For example, once again we hear claims that aiding the development of certain technologies can ameliorate unemployment, stimulate growth, and stem the "offshoring" of manufacturing. The thought is that clean energy investments can improve the pace of the current weak recovery and raise the long run growth of national income, productivity, and U.S. competitiveness by driving resources toward a fast-growing sector of the world economy.

The desire is understandable. In late 2007, the U.S. and most other advanced countries suffered the largest drop in gross domestic product (GDP) since the Great Depression. After two years of declining output, GDP growth gradually began to improve, but the recovery has been sluggish and marked by particularly slow employment growth. Unemployment in the United States rose to 10 percent of the labor force and after two years of recovery is still above 8 percent. The persistence of high unemployment and the record increase in the fraction of the labor force out of work for at least six months has put pressure on public officials to try to generate more jobs. At the same time, legislation to control greenhouse gas emissions with a cap-and-trade program failed in the Senate in 2009, and there is no prospect of a climate policy initiative in the current Congress.

Thus, advocates of a clean-energy agenda not only hope that it will help address global warming and somehow promise greater "energy security," but also deliver thousands of "green jobs." [16] Indeed, the latter motif permeates ads in which sponsors tout their technologies more as job-growth strategies than as answers to the environmental shortcomings of fossil fuels. The claims find a receptive audience among those concerned about America's high unemployment and long term competitive edge. We explore those claims in Section 4 below.

Of course, the jobs projections for clean energy industries are not without counter-claims from their incumbent competitors. Fossil fuel producers cite their sector's strong performance in a weak economy. With propitious policies, they suggest, increased access to fossil reserves could create over a million jobs over the next ten years.[17] The producers point to the recent boom in natural gas made possible through three-dimensional seismic technology, horizontal drilling, and hydraulic fracturing. This development presumably exemplifies the kind of innovation that can drive American competitiveness as much or more than can unproven and expensive renewables. And, it is argued, there is great potential for job creation in policies that further exploit North American resources like Canadian oil sands, and in building a proposed Keystone XL pipeline. The push for government support is not just limited to clean-energy firms, but comes from almost every other kind of energy business as well.

3. MARKET FAILURE: PUBLIC GOODS, POLLUTION AND OIL DEPENDENCE

[16] For example: Pollin R., H. Garrett-Peltier, J. Heintz, H. Scharber, K. Batten and B. Hendricks, **"**Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy," Center for American Progress, September 2008. http://www.americanprogress.org/issues/2008/09/pdf/green_recovery.pdf.

[17] American Petroleum Institute, http://energytomorrow.org/job-creation#/type/all, accessed November 29, 2011.

Environmental and Public Goods Rationales

Perhaps a more persuasive case for clean-energy spending follows from the absence of emission charges on greenhouse gases. Currently, regulation under the Clean Air Act controls toxic and smog-related air pollutants, such as mercury and sulphur dioxide. The United States does not have an equivalent program to reduce greenhouse gas (GHG) emissions. Emerging Clean Air Act rules can mitigate some GHG sources, but the legal authority is not well-suited to GHGs, in part because the command-and-control rules are unlikely to result in prices that reflect the full social costs of emitting activities, including their environmental damage. Inasmuch as traditional energy sources are underpriced and thereby retain a competitive edge, the substitutes for them—many of which are infant industries—could warrant government policy to level the playing field.

Another market failure arises from the under-investment of firms in research and development activities that may produce positive spillovers for other firms and society generally. This phenomenon — under-provision of public goods — is not unique to the energy or environmental arenas, but in this case there is an interplay between the dual inefficiencies that poses novel policy questions. Jaffe and his co-authors (2005) examine the market failures of technology development and how they interact with market failures in the form of environmental pollution.[18] These observers note that technology policy is a poor substitute for directly pricing the external costs of emitting activities, but they emphasize that clean-energy technology policy can be worthwhile under certain conditions: namely, a market wherein carbon is properly priced. In Section 6 below, we offer conclusions about the economically justifiable role for federally funded RD&D in which we draw on this and related work.

Macroeconomic Risks from Oil Dependence

Another frequent justification for government intervention in energy markets is framed in terms of national security, energy security, or energy independence. Nearly forty years ago, Richard M. Nixon proclaimed that "our national goal" should be "to meet our own energy needs without depending on any foreign sources."[19] Even today it is hard to find a leading U.S. politician who does not accept more or less the same quixotic notion.

The only fuel the U.S imports in vast quantities is oil, so energy security as it relates to imports is really about oil. The degree to which oil dependence justifies government investments in clean energy technology is debatable. First, nearly 90 percent of U.S. oil demand is met by domestic wells and those of suppliers outside the unstable Middle East, chiefly Canada and Mexico which sell America more oil than do either Saudi Arabia or Hugo Chavez's Venezuela. Second, the net benefits of importing less oil as a share of total consumption and using less oil

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[18] Jaffe, A., R. Newell, and R. Stavins, "A Tale of Two Market Failures: Technology and Environmental Policy," Ecological Economics 54 (2005) pp 164-174.

[19] President Nixon, launching Project Independence in November 1973, quoted in John I. Moore, *Continuing Energy Crisis in America* (Washington, D.C.: CQ Press, 1975), p. 2.

in total are unclear.[20] The oil market is global. Even if Americans purchased *none* from abroad, they would remain vulnerable to any perturbation in the international market because they would still have to pay the world's price. In addition, the key inefficiencies from oil dependence derive from macroeconomic disruptions and market power by oil exporters. Policies that drive down oil consumption in periods without disruptions or significant monopoly pricing could burden consumers while not directly correcting market failures.

Third, the vulnerability of the U.S. economy to oil price fluctuations depends critically on policies outside the energy sector. Two kinds of significant macroeconomic costs arise from oil price spikes: (1) the simple loss of national income from a large jump in oil prices sustained for any length of time; and (2) the effects of large oil price shocks on inflation and output arising from "imperfections" and rigidities of the macroeconomic system. Experience from the past four decades shows that easily the most effective policy to reduce potential macroeconomic social costs from periodic oil supply shocks is the Federal Reserve's determination to respond promptly to any current or prospective inflationary threat. This means that even fairly large oil price increases are now much less likely to set off a wage price spirals.

Finally, the issue of oil dependence and energy security is largely confined to the transportation sector. In the United States, most oil goes into the tanks of motor vehicles in the form of gasoline or diesel fuel. So renewables such as solar, wind, geothermal, and other electricity technologies contribute next to no "energy independence." These alternate sources are substitutes for coal or natural gas, both of which are burned in power plants and both of which are either produced domestically or supplied by America's NAFTA partners. So even if increasing U.S. self-sufficiency in energy were desirable, it does not follow that subsidies for electricity powered by renewable sources advances the goal.

In sum, while a case can be made that subsidizing clean energy policy might help address market failures, the case may be narrower than some assert, and turning theory into sound practice is no simple feat.

4. CLEAN ENERGY: COMPETITIVENESS AND JOBS

Champions of industrial policy for clean energy technologies submit that it serves the country's strategic economic interest. Such a policy, after all, would presumably spur export-led growth and employment. Without primacy in these industries, the advocates fear, the U.S. economy will become less competitive. Americans would forfeit larger market shares to foreign competitors, who would grow dominant thanks, presumably, to their own strategic investments. Framing their claims positively, the proponents argue that clean energy, promoted by subsidies and favorable regulations, will bolster the U.S. manufacturing sector and add to the nation's economic welfare overall.

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[20] For more see Pietro S. Nivola with Erin E. R. Carter, "Making Sense of 'Energy Independence'" in Carlos Pascual and Jonathan Elkind, eds., *Energy Security: Economics, Politics, Strategies, and Implications* (Brookings, 2010), pp: 105-118

Japan's success as an industrial exporter in the 1970s and 1980s was sometimes suspected of enhancing that country's prosperity to the detriment of the United States. Today, China is the focus of similar concern. China's booming alternative-energy industries, and the specter that they might come to dominate world markets, are deemed a long-range threat to American leadership and living standards. To those who share this apprehension, the answer is to go head-to-head with Chinese manufacturers and match them in kind with government assistance.

Clean Energy and U.S. Competitiveness

Let us first consider the supposed imperative of matching the Chinese, Germans or others in their quest to be "Number One" in clean energy technologies. In a 1994 essay, Paul Krugman wrote, "The idea that a country's economic fortunes are largely determined by its success on world markets is a hypothesis, not a necessary truth; and as a practical, empirical matter, that hypothesis is flatly wrong."[21] He makes the empirical case that improvements in U.S. living standards derive from the growth rate of domestic productivity -- not market share relative to competitors.

Krugman notes that, while the term "competitiveness" is meaningful when applied to individual firms, it makes little sense when applied to the economic relationships among countries. Coca-Cola and Pepsi struggle for market share, and one succeeds only to the disadvantage of the other. By contrast, international trade consists of transactions that are, by definition, mutually advantageous to the trading partners. Over the long haul, American living standards *improve*, rather than deteriorate, through freer trade. Growth of productivity and real incomes in countries with whom we trade redounds to our benefit, even if some individual domestic firms and workers may suffer in the short or intermediate term.

Advocates for taxpayers' investments to promote U.S. competitiveness often appear to misunderstand how trade affects U.S. output and employment. In periods of sustainable non-inflationary prosperity and high employment, supported by a competent and flexible monetary policy, losses of employment in sectors that are losing business to cheaper imports will tend to be offset by gains in other sectors through an appropriate adjustment in monetary policy. In a normal year the U.S. experiences about 14 million hires from new entrants to the labor force and people changing jobs, and a little under 13 million job separations, from retirements, quits, layoffs, and other causes (the difference is the growth in the labor force). In the churning there are losses and gains for individual workers. But overall, international trade tends to reallocate rather than add or subtract overall jobs in the economy. And if another country expands its exports by keeping its exchange rate with the U.S. dollar artificially low, that will increase the pace of job reallocation in this country, with the accompanying adjustment costs. But with appropriate monetary and fiscal policy it will not, except temporarily, worsen unemployment. Likewise, temporary subsidies to exporting firms won't improve the long run growth of exports.

But what if policies can be devised that enable U.S. firms to get a leg up on foreign competitors, develop the intellectual property, and thereby gain the advantage of being a "first mover"?

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[21] Krugman, P., "Competitiveness: A Dangerous Obsession", Foreign Affairs, March/April 1994.

Wouldn't that be a boon for the American economy by raising the profits of American firms and, in the current "jobless" recovery, reducing unemployment? Not necessarily. Firms already have the incentive to develop profitable technologies and use patent protection to maximize their payoffs. The question is whether there is a public-policy case for subsidizing these companies both to render them more profitable and maybe also yield a beneficial economic spillover. In theory, that outcome might be possible if, thanks to the government's support, U.S. companies could monopolize world markets at the expense of foreign rivals. Writing in 1993, Krugman explored this possibility thoroughly. He concluded that even if a so-called strategic trade policy could be crafted, and if that policy indeed could maximize the monopoly power of American firms (a big "if"), such a strategy would add less than one percent to U.S. national income. [22]

Finally, is there an indisputable first-mover advantage? It is just as plausible to imagine greater gains from following instead of leading. Going first runs risks. Why not mainly let others incur them? After all, the alternative—pushing home-grown technologies at taxpayers' expense—offers no guarantee that the eventual products ultimately won't be manufactured somewhere else.

The case for consigning clean-energy development to domestic manufacturers, many of which may be high-cost producers, can disappoint on environmental grounds as well. Minimizing the cost of abatement is central to achieving environmental goals. If other countries develop lower-cost clean energy, more of it will be adopted, here and abroad. Indeed, from the standpoint of environmental quality, the willingness of *other* nations to subsidize their clean-tech industries, thereby lowering the costs of clean energy, may ultimately enhance, not lower, U.S. welfare.

Recent anti-dumping cases brought by American firms are moving these very issues to the fore. The firm SolarWorld, along with a coalition of American solar manufacturers, claims that Chinese manufacturers are able to dump photovoltaic panels in the U.S. market because China is unfairly subsidizing its own solar industry. The counter-argument, however, is that the Chinese may actually be doing U.S. consumers a favor by artificially lowering the costs of solar power. [23]

Clean Energy and Green Jobs

Now let us consider the proposition that engineering clean energy programs will generate employment. The debate churns with gray literature studies and counter-studies about how many American jobs could be created or lost by various policies. Of course, energy policies can affect the fortunes and employment levels in individual industries. But will such policies boost employment overall?

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[22] Krugman, Paul "What do Undergrads Need to Know About Trade", American Economic Review, May 1993.
[23] Cho, Jennifer, "Foul or Fair: U.S. Solar Firms Debate China Solar Subsidies," *Forbes*, December 6, 2011. accessed December 7, 2011 at http://www.forbes.com/sites/jenniferkho/2011/12/06/foul-or-fair-u-s-solar-firms-debate-china-solar-subsidies/.

As mentioned above, during periods of normal high employment, energy policies that divert capital, labor, and materials from other industries claim resources that would otherwise go to providing other valued goods. A similar logic applies to employment in sectors that produce clean-energy technology, a potential export industry. The essential reality of international trade is that it changes the *composition* of jobs, not the total number, at least in the long run. Because output per worker in export industries—such as those that might produce clean high-tech energy products—may be higher on average than in import-competing industries, promoting the former is likely to subtract jobs from the latter. In sum, again, a net gain in employment from subsidizing clean-energy exporters may well prove elusive.

Clean Energy and the Great Recession

The U.S. at present is not at or near full employment. It is recovering slowly from a recession brought on by a severe financial crisis the likes of which have not been seen in ninety years. Might promoting green jobs and clean technology spur growth amid the current economic stagnation?

The implications for policy could, indeed, be different in periods with substantial idle labor and under-utilized industrial capacity. During periods of high unemployment, funding energy-related projects that create jobs which meet the definition of "green" is naturally less likely to disrupt jobs elsewhere in the economy. But the relevant question here is: How does spending related to energy stack up against other forms of fiscal stimulus, all things considered?

The goal of stimulus spending and tax relief is to shore up aggregate demand in a recession (or a tepid recovery). Afterward, natural forces of growth are supposed to kick in. The 2009 stimulus legislation professed to do exactly that. The Obama administration described the legislation as "timely, targeted, and temporary." "Timeliness" and "temporary" matter because resources are slack only during the downturn. If the spendout is too slow, it is not counter-cyclical. If the spending persists long into an economic upturn, the effect risks creating inflationary pressures—and a spike in interest rates. "Targeted" matters because different forms of tax cutting and spending programs absorb slack resources, including unemployed workers, differently. Some types of stimulus have a stronger and faster multiplier effect than others.

By these three criteria, ARRA's $32 billion for Department of Energy (DOE) programs falls short. Take the nearly $16 billion of the stimulus for research. Research is intrinsically ill-suited for a fiscal stimulus. It falters on timeliness grounds. A major research or demonstration project is unlike, say, a "shovel ready" highway project. Research programs require detailed proposals, competitive contract selection, and negotiations over the scope of work. Research also is not ideal for purposes of mobilizing the resources that are most likely to be idle or slack in a recession. Productive research projects are hard to scale up quickly, for they often run into a limited supply of skilled labor and of other specialized input costs. Moreover, obviously research demands skills that the neediest unemployed workers typically lack. A stimulus replete with research initiatives is unlikely to put money into the pockets of people who need it most—and whose marginal propensity to consume would be high if the money were forthcoming.

The imperative that stimulus spending be temporary also does not accord with a well-structured research portfolio. The point of public support for basic research activities is that the market alone tends to underfund them. Government *should* fill the gap, but the choice of projects to back ought to be based on other criteria—the long-range merits of the research activity per se, not how it fits in the business cycle. If there is an exception to this elementary rule, it is that extending federal research dollars in an economic downturn can help compensate for a temporary shortfall of research support by sub-federal entities such as state-funded universities. But even here, it is hard to see how funding "research" can create or save many jobs, at least not in the near-term.

Programs designed to promote the sustained commercialization of new technologies are seldom effectively counter-cyclical, either. Guaranteed loans for expanding commercial operations will help only those firms that are nearly competitive. Otherwise the loan guarantee is a subvention for potentially inefficient investments. In a recession, a temporary increase in risk-aversion by lenders may occur, and can strengthen the case for a federal role. But regardless of the macroeconomic conditions, will the loan guarantee reduce long-term costs and make the firm competitive?[24] According to the Government Accountability Office (GAO), the energy loan-guarantee system has suffered from competing objectives that are baked into the program. The GAO criticized DOE for its slow progress in making guarantees, but it also faulted DOE for its ad hoc program implementation (as well as inconsistent treatment of individual applicants, favoring some and disadvantaging others). [25]

5. INDUSTRIAL POLICY IN PRACTICE

All of which leads us to examine a little more fully the practical difficulties facing policymakers in the real world of American government as they struggle to choose and sustain the right enterprises.

Identifying plausible candidates might be a more dependable process if the commercial prospects of emerging technologies could be accurately predicted. Too often, however, the predictions have foundered. Decades ago the government launched robust programs to develop nuclear breeder reactors and to facilitate synthetic fuels.

These did not appear to be fanciful schemes in the contexts of their times. But they proved to be premised on unreliable forecasts. In the first instance, experts were anticipating continued explosive growth of domestic demand for electricity. (Instead, demand, especially for baseload capacity, settled onto a much slower trajectory.) In the second, the forecasters assumed that the price of petroleum would not plunge far below \$40 a barrel, over \$100 a barrel in today's money. (Instead, it collapsed by the mid-1980s.) Similar unexpected twists have bedeviled

[24]The relevant costs are the firm's long run *marginal* costs.
[25] GAO, "RECOVERY ACT: Status of Department Energy's Obligations and Spending", GAO-11-483T, March 17, 2011, pp. 9,10.

attempts to foretell the potential market for various forms of cleaner energy. When prices tumble, as they do periodically, the government's best-laid plans get stranded.

The caprice of the marketplace frustrates energy planning. So does the fact that public decisions regarding which producers to favor are all but impossible to insulate from political pressures. For the sake of argument, let us suppose that technocrats in highly competent government agencies were able to foresee and then objectively compare the lead-times for commercializing the multiple options under consideration. With that knowledge, one might think, only the most viable green businesses would be tapped to receive public funds. The power of the purse, however, lies with Congress—and the irresistible temptation there is to distribute resources widely and often injudiciously, not to concentrate them on just a few worthy targets.

Following the energy shocks of the 1970s, the Carter administration mounted the most concerted and sustained campaign to enact national energy laws that, it was hoped, would moderate the use of fossil fuels, especially oil. Scrambling to build the coalitions needed to pass these measures, Congress heard from stakeholders of nearly every conceivable kind seeking a piece of the action. The queue of claimants even included opponents of school integration, who lobbied to graft anti-busing amendments onto bills on the grounds that these would conserve fuel.[26] In the end, not every supplicant got its appetite satisfied, of course, but the prospect of federal subsidies and dispensations had clearly invited a feeding frenzy by interest groups, many of whom would keep circling Washington for decades.

The political dynamics have been similar in nearly every subsequent effort to refine the nation's desultory energy agenda. Thanks to extensive logrolling, proposed legislation before Congress during the past decade has been rather indiscriminately stuffed with loans, loan guarantees, grants, procurement mandates, and tax advantages for seemingly all comers—small businesses, green-building retrofitters, railroads, bicyclists, and electric vehicle manufacturers, as well as renewable energy suppliers that include ethanol plants and planters, biodiesel producers, developers of hydrogen technology, and nuclear power.[27] Even coal producers seek to qualify as a clean energy source on the theory that coal-fired electricity generators might someday be equipped for carbon sequestration.

In short, the American political system seldom sticks to sponsoring and sheltering only genuine industrial winners, green or otherwise. For as the late Senator William Roth of Delaware observed years ago, "The trouble with picking winners is that each Congressman would want one for his district."[28]

Further complicating the situation is the role of new players who may learn to game a regime of subsidies or preferential regulations in unexpected ways. An example: "Tax equity" financiers

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[26] See, Pietro S. Nivola, *The Politics of Energy Conservation* (Brookings, 1986), Chap. 1

[27] See, as an illustration, the endeavor in 2007. Congressional Research Service, "Omnibus Energy Efficiency and Renewable Energy Legislation: A Side-by-Side Comparison of Major Provisions in House Passed H.R. 3221 and Senate Passed, H.R. 6," September 4, 2007.

[28] Quoted in Pietro S. Nivola, 'More Like Them? The Political Feasibility of Strategic Trade Policy," *Brookings Review*, vol. 9, no. 2 (Spring 1991), p. 19.

profit by charging homeowners slightly below-market electricity prices in exchange for installing residential solar PV systems for which a 30% tax credit applies. Some environmentalists hail the development as buying down the up-front cost of solar systems and making firms, homeowners, and the environment better off. [29] Critics contend, however, that "solar-backed securities," which bundle the returns from such investments into assets sold to third parties, drive demand for Chinese PV panels, risk creating a new financial bubble and encumber properties with uncertain effects on housing markets.[30] Whatever the case, policymakers should not be surprised if the consequences of industrial subsidies can wind up in unanticipated places or take unintended forms.

6. WHAT SHOULD BE DONE?

The functional equivalent of an industrial policy, explicit or de facto, is unlikely to spur an efficient or large scale conversion of the U.S. economy toward cleaner energy. "Getting prices right" is the first step, an essential precondition. The likes of a robust carbon tax or cap-and-trade regime, however, may not necessarily rule out certain supplementary measures, provided they are judiciously designed.

For reasons described earlier, efficient prices alone are unlikely to generate efficient levels of basic research and development by private firms. As a consequence, analysts have argued that, alongside an appropriate, predictably rising price on GHGs, there is a place for government programs that serve to complement private investments in research and demonstration.[31] DOE's present model calls for considerable improvement.

First, inasmuch as DOE remains in the business of promoting technologies, we believe the agency should embrace only those that can demonstrably help meet the challenge of environmental externalities, principally climate change. In pursing this central objective, policymakers should back approaches that will minimize the cost of achieving environmental goals by addressing environmental and technology market failures. With this mission in mind, a stronger investment portfolio for clean energy could evolve.

What complicates attaining the goal, of course, is that political conditions in the United States could frustrate sensible carbon pricing for years. Thus DOE's policy portfolio arguably ought to support the kinds of research and investments that would have been taken by firms in the presence of an effective carbon price. It would both sponsor basic research and, until Congress gets around to setting a meaningful price on carbon, encourage investments analogous to those that firms would undertake if carbon were properly priced. In other words, federal RD&D

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[29] "Solar Service Companies Make Solar Affordable and Accessible," Climate Progress website, http://thinkprogress.org/romm/2011/06/15/245944/solar-service-companies-make-solar-affordable-and-accessible/.

[30] Rodgers, T. "Subsidizing Wall Street to Buy Chinese Solar Panels," *The Wall Street Journal*, December 8, 2011, p. A21.

[31] See: Congressional Budget Office, *Evaluating the Role of Prices and R&D in Reducing Carbon Dioxide Emissions.* September, 2006; *Environmental and Technology Policies for Climate Mitigation,* Carolyn Fischer and Richard G. Newell; *Induced Technological Change and Climate Policy,* February 200;, Lawrence H. Goulder, Pew Center on Global Climate Change , Washington DC , October 2004

efforts would invest in technologies with the lowest expected cost of abatement and the highest probability of market penetration.

But this does not appear to be current policy. Instead, of the nearly $40 billion in loan guarantees in the stimulus package, over 43 percent went to two sectors with some of the highest costs of carbon abatement and the lowest projected market shares: solar power and electric vehicles. In the most recent data available, DOE awarded 38 loan guarantees, 23 of them for solar power (19 generation, 4 panel manufacturing) and 9 others spread among wind, geothermal, biofuels, and electrical transmission, plus 6 to auto companies for fuel-efficient vehicles and electric vehicles.

The disproportionate emphasis on funds for solar power does not square with projections of its likely deployment. For example, EIA projects solar power to comprise only about 5 percent of all non-hydro renewable electricity and less than one percent of all renewable electricity by 2035.[32] That implies a very small fraction of all electric-power generation by 2035. In addition, $8.3 billion in loan guarantees (over 23 percent of the total) went to a single company to deploy two new nuclear power projects.[33] The most cost-effective technology category in the 2001 NAS report, energy efficiency, received less than one percent of the loan guarantees. Of course, what matters is the overall spending portfolio outside the unusual context of the stimulus package, but allocations such as those in the ARRA's loan program illustrate our point that resources should instead be directed towards investments that support innovations which minimize the cost of environmental protection.

Second, funding decisions ought to be insulated—as much as possible—from rent-seeking by interest groups, purely political distortions, and the parochial preferences of legislators. The National Institutes of Health and the National Science Foundation, who use peer reviews to screen proposals for research and clinical grants, are among the few federal operations to have achieved such independence— they are potential models.

Deutsch (2011) has addressed interestingly the problem of political demands on DOE.[34] To mitigate influences that reduce the effectiveness of energy RD&D, Deutsch suggests establishing an Energy Technology Corporation to select, manage and fund a limited number of federally supported technology demonstrations. The President would appoint a Board of Directors, and the Senate would confirm them. Congress would vote a ten year appropriation, and managers would be free from executive or congressional interference in project selection, program management, and salary determination. After ten years, an independent review would assess the corporation's success and recommend next steps. Such an arrangement could be less routinely buffeted by politics than DOE's current system.

Third, we agree with Jaffe and his colleagues who recommend "continuous, systematic, quantitative assessment" of technology funding with standardized data so that the relative

[32] EIA, *Annual Energy Outlook 2011*, Release date April 2011, http://www.eia.gov/forecasts/aeo/source_renewable.cfm.
[33] DOE, Loan Programs Office, op. cit.
[34] Deutsch, John, *An Energy Technology Corporation Will Improve the Federal Government's Effort to Accelerate Energy Innovation*, The Hamilton Project, The Brookings Institution, May 2011 p. 11.

effectiveness of alternative policy approaches can be compared over time and used to improve the program.[35]

Lastly, the choice of policy instruments to advance technologies (tax credits, loan guarantees, grants, and so on) can have a major impact on cost-effectiveness and the extent of unintended consequences.[36] A detailed examination of the relative merits of the various tools is beyond the scope of this paper, but it should be part of a reform agenda.

[35] Jaffe et al, op. cit. p. 60.

[36] For example, a modeling study showed that tax credits for energy efficient household capital produced 1/20 of the carbon emissions reductions that a similar-sized carbon tax produced. McKibbin, W., A. Morris. and P. Wilcoxen, "Subsidizing Energy Efficient Household Capital: How Does It Compare to a Carbon Tax?" *The Energy Journal*. Vol 32. 2011.

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