

## A “Manhattan Project” for climate change?

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Climate change is a chronic yet unprecedented threat to civilization. Large scale abatement of greenhouse-gas emissions would require not only replacing carbon-intensive fuels (like coal and oil) with low-emission or carbon-free energy alternatives, but also replacing much of the infrastructure that uses primary and secondary energy. As a political issue, the scale of the problem makes carbon mitigation unique and difficult to resolve. Its chronic nature is another obstacle to implementation of policy in the near term. It would take decades to displace fossil fuels even if the technologies to do so were available. Furthermore, disagreement has arisen on whether currently available technologies are sufficient to significantly reduce emissions over the next several decades (Pacala and Socolow 2004; Hoffert et al. 2002). The notion of developing new technologies *before* mandating emissions reductions has gained currency in response to these complexities. The Bush Administration climate policy favors this line of thinking, rejecting any Kyoto-style arrangement involving mandatory targets and proposing the development of new technologies as an alternative (Bush 2005). Here we argue that such approaches are based on the misconception that innovations needed for carbon mitigation can be effectively and efficiently developed without carbon regulations.

One concrete version of the “technology first” view has been expressed almost daily by scientists, political leaders, and others: Global warming problem can be solved in a timely fashion only through a crash research and development program similar to the Manhattan Project (Clinton 2005; Friedman 2005) or Apollo Project (See <http://www.appolloalliance.org>). The target of a “Manhattan Project” on Climate Change would be low-carbon technologies for energy generation and use. A common rationale for this approach is that the fossil-fueled greenhouse effect cannot be regulated away, an assertion that ignores the potential affect of regulation on innovation.

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Using the Manhattan Project as a rhetorical symbol might make sense to create a rallying point for the body politic. But good politics is not equivalent to wise policy. While the financial scope of the Manhattan Project might be appropriate, its style of operation is fundamentally mismatched to the climate problem. We argue that adopting a Kyoto-style approach is a more effective way to develop climate-friendly technologies than initiating a Manhattan Project for climate change.

The Manhattan Project had many characteristics that are unique to wartime conditions. The requisite timescale for building the bomb was a few years; in contrast, climate change mitigation takes at least decades. The Manhattan Project was top-secret, centrally planned, high-priority, well-funded and beyond the reach of Congressional inspection. Moreover, participating private companies were offered cost-plus contracts, in which the government pledged to absorb all costs and pay an additional service fee (Hertsgaard 1983). The companies were guaranteed profits with no risk at all. Such generous arrangements made sense in 1943, when winning was considered a matter of national survival. Compared to the perceived urgency of beating Germany to build a bomb, budget was a much lesser concern.

However, an open purse naturally led to an extremely expensive product (Schwartz 1998). High price was not a problem, because the government was the only buyer and the sale was guaranteed. Insulation from political interference, centralization of authority, dedicated scientists with a joint mission perceived as vital, guaranteed sale and large government subsidies were among the secrets to the success of Manhattan Project.

A policy designed for a peacetime market economy differs in many ways from this wartime military program. The budget has to be approved by Congress. Interest groups, media, and public opinion all play important roles in determining ultimate acceptability of the product. Because the technology eventually must be employed by the private sector, no sale is guaranteed. The decision-making authority in a market economy is inevitably dispersed. Consumer's preferences are pivotal, no matter how irrational or fickle they are, even given the opportunity for government procurement. Insulation from political interference, centralization of authority, and guaranteed sale are impossible and undesirable. The only remaining element in a peacetime Manhattan-style project that is comparable to one of the original elements is generous government subsidy.

Will generous government subsidies alone accelerate technological innovation? Yes, probably. Economists call the subsidy in research and development (R&D) a technology push (Scherer 2002). However, because the decision-making authority is dispersed in a market, a technology push cannot guarantee that the innovations will be adopted extensively. The path of technology development is full of surprises, and the market is difficult to predict. It would be daunting to plan the entire path from basic and applied research through engineering development all the way to market acceptance. Technology push on its own is an unreliable means of achieving environmental objectives.

Economists identify two market failures hindering the development of environmental-friendly technologies: an R&D market failure which leads to underinvestment in R&D (Arrow 1962), and an environmental externality which leads to little or no incentive to adopt environmental-friendly technologies. Even absent policies to address the R&D market failure, innovation still happens at a less than desirable speed. But without regulations to internalize the environmental externality, environmental mitigation may not happen at all. Therefore, the second failure is far more problematic in the context of the climate problem than the first one. Technology push partially compensates the first market failure without addressing the second failure. Therefore, many have pointed out that R&D subsidies rarely work by themselves on improving the environment (Schneider and Goulder 1997; Jaff et al. 2004; Fischer and Newell 2004; Popp 2006).

A demand-pull approach is a more effective policy tool because it addresses the second market failure. Economic studies indicate that technological changes occur in response to market demand (e.g. Schmookler 1962; Newell et al. 1999; Popp 2002). The rapid improvement in energy efficiency during the oil crises of the 1970s is an example of the demand-pull effect. The dramatically increased demand for energy efficiency provided a strong stimulus for technological innovations. The causes for the changes in demand may include regulatory, economic and psychological incentives. The government can potentially trigger changes in market demand through mandatory policies or even the threat of regulation; the increased demand will in turn trigger R&D activities. As the Intergovernmental Panel on Climate Change (IPCC) put it, “government regulations may stimulate innovation that can contribute to GHG mitigation” (Sathaye and Bouille 2001).

A complexity with regard to demand-pull policies is that regulations (or the lack thereof) may have a “lock-in” effect on the demand for technology. Although lock-in occurs naturally in the market, additional regulatory lock-in is undesirable. If the regulation commands a specific device or technology, the lock-in effect may hinder progress on other technologies that might have been superior. In contrast, a performance-based environmental standard could reduce the possibility of additional lock-in effects. Performance-based regulation would produce persistent demand-pull for cleaner technologies on a level playing field. In his comparative study on national competitiveness, Michael E. Porter concluded that “subsidy is rarely associated with true competitive advantage.” On the other hand, “stringent standards for product performance, product safety, and environmental impact contribute to creating and upgrading competitive advantage (Porter 1990).” Some researchers are not as optimistic as Porter on regulation’s effect on national competitiveness, but mostly agree that regulation does induce innovation.

The government has historically adopted a variety of policy tools to produce a demand-pull, to name a few: direct procurement, product subsidy, tax, and regulation of markets. The pros and cons of these policy tools are well studied. Direct government procurement is often preferred politically because it can serve as a vehicle to distribute “pork” to constituents (Cohen and Noll 1991). However, in the case of global warming, the required change is too great to be brought about by government expenditure alone.

Greenhouse gases are emitted in almost every part of the economy. Most of them are in the private sector. While in theory the U.S. government could purchase a significant share of the carbon-free energy services (some countries do have nationalized energy sectors), this is highly unlikely to occur. Nevertheless, procurement might spur some markets, like that for hybrid cars. But previous attempts to use procurement to encourage alternate-fueled vehicles have floundered on the shoals of budgetary reality.

Government subsidy of commercial products can also produce a demand-pull (which may also be playing a role in the current US hybrid-car market). However, the subsidy approach faces the same problems as those in direct procurement. The required funding (or foregone tax revenue) is large and the effectiveness is highly uncertain.

There are many ways of regulating markets to produce a demand-pull without large government expense. Tax, cap-and-trade for emissions, and product standards are some of the common ones. In particular, incentive-based economic instruments, like tax and cap-and-trade, are expected to be economically efficient because they employ market mechanism to minimize the market-wide abatement cost. Taxing environmentally harmful commodities could shift demand toward environmentally beneficial ones. A disadvantage of the tax approach is that it is usually difficult to determine the tax rate corresponding to the desired environmental outcome. In the US at the current time, there are steep political obstacles to the implementation of new taxes.

A cap-and-trade system, applied with great success in regulating air pollution, allows policymakers to set a performance-based environmental standard and let the market determine the costs of mitigation (USEPA 2003). From the global perspective, the Kyoto Protocol is being implemented using precisely such an approach. One important caveat of the cap-and-trade approach is that the initial allocation of emission allowances is politically complex and controversial, especially when the allocation is among sovereign nations. The allocation controversy has been settled for Kyoto parties, but not for non-participating countries like the US. Appropriate allocation in a hypothetical regime involving future participation by developing countries certainly presents large difficulties (Oppenheimer and Petsonk 2004).

On the domestic front, the Kyoto Protocol allows national governments the flexibility to design their own regulatory demand-pull innovation policies. Unlike the Manhattan-project approach, where the government must pick winners, the government is free from such burden with demand-pull policies. The government sets the performance standards, with the general objective of solving the problem at hand and producing a new context within which the market will operate. Winners would emerge naturally.

Governments tend to have a poor track record for picking winning technologies, particularly the US in the energy arena. The historical patterns in the interrelations between government support for R&D and technical change in American industries have been studied for decades (Nelson and Langlois 1983). These include three types of successful policies and one type of clear-cut failure. The three successful types are (1) government R&D support for technologies in which the government has a strong and direct procurement interest; (2) decentralized systems of government-sponsored research in the “generic” area between the basic and applied; (3) a decentralized system of clientele-oriented support for applied R&D. The Manhattan Project and Apollo project are examples of the first type, which is not usually applicable for commercial purposes. Most of the research support from the National Science Foundation belongs to the second type, which is not supposed to fulfill goals other than creating knowledge. Clientele-oriented support allows the recipients to set their own goals, and ideally the R&D programs would be fully market-oriented and free from politically determined objectives. Failure has often occurred when, in order to ensure that subsidized technologies serve political goals, the government has selected leading technologies to support that are ultimately destined for commercial markets. The historical experience indicates many instances where government attempts to “pick winners” in commercial, applied R&D have been clear-cut failures.

The U.S. experience in synthetic fuels provides valuable lessons about the shortcomings of such an approach. In response to the energy crisis in the 1970s, the U.S. government proposed a crash program on synthetic fuel, which New York Times described as an “Apollo Project” for fuel (Shabecoff 1979). People hoped that the crash program would be another technological triumph to free this country from the dependence on imported oil. Upon the passage of the U.S. Synthetic Fuels Corporation Act of 1980, Senator J. Bennett Johnston wrote:

“As historians sort out the important technological achievements of the United States in the 20th century, attention will center on three triumphs—namely, the Manhattan project, the Apollo project and, I would predict, the achievements of the United States Synthetic Fuels Corporation.” (Hamilton 1980)

Unlike the original Manhattan Project and Apollo Project, the government was not the sole buyer of synfuels. Private demand for synthetic fuels vanished when oil prices

dropped. It became too expensive to push synthetic fuels into the market solely with subsidies. The programs were soon regarded as wasteful and eventually abolished (Viotor 1987; Deutch and Lester 2004). It has been argued that a centralized synfuels strategy has worked elsewhere, particularly in South Africa. The reality is that the South African government directly controlled and exerted great influence over almost every part of the liquid fuel industry (Hilsenrath 1991). It commanded the oil companies to shut down some capacity at their refineries and bought most of the synfuels output to assure stable demand (Hodge 2000). It is very unlikely that such direct command and control over the energy sector would be implemented in the U.S., or in other industrialized economies.

There is no denying the short-term political efficacy of choosing winners. But the hard lesson of previous experience in the energy arena is that such approaches either cost much more than necessary or fail to get the job done. As Edmonds and Smith have noted, “the history of technology development is nothing if not a lesson in forecaster humility. Technologies that were expected to develop have proved more difficult than expected, and technologies that were never envisioned have evolved to play a central role in the economy” (Edmonds and Smith 2005).

A demand-pull strategy does not preclude government R&D support. Government support for generic R&D, as a complement to the regulatory demand-pull policy, may foster an array of winners. The simultaneous imposition of performance-based regulations would tilt the outcome in the direction of the public good.

A recent report from the National Academy of Sciences suggested that an organization like the Defense Advanced Research Projects Agency (DARPA) called the Advanced Research Projects Agency-Energy (ARPA-E) be created in the Department of Energy (National Academy of Sciences, National Academy of Engineering, Institute of Medicine 2005). The idea is to emulate the successful DARPA experience in strengthening American competitiveness. DARPA was originally designed as a government R&D program for technologies in which the government has a strong procurement interest. It eventually evolved to become less mission-driven and more like the National Science Foundation. There are certainly lessons to be learned from the experience of DARPA which may help in designing and managing an R&D program, and we do agree that R&D in energy need to be expanded. However, the proposed ARPA-E should be seen as a complement, rather than alternative, to greenhouse gas regulations.

There are a host of available and potential technologies that might contribute to solving the global warming problem (Pacala and Socolow 2004). We agree that R&D should be pursued on an expanded scale (Kammen and Nemet 2005) but disagree that it should be pursued with the Manhattan Project’s style of governance. R&D has an important role to play, but the fossil-fuel greenhouse effect cannot be simply researched away.

The symbolism of the Manhattan Project is powerful yet its application to greenhouse gases is a serious mistake because it fails to reflect the broader socioeconomic context of the climate problem. Using a Manhattan Project for climate change as a metaphoric alternative to the Kyoto Protocol is likely to deflect policymakers in counterproductive directions. The lack of market demand is the greatest barrier for innovations in greenhouse gas mitigation technology. Ratifying and implementing a Kyoto-style approach to emissions mitigation is the best way to lower the barrier. In contrast, trying to pick winners and expanding the technology pork barrel (Cohen and Noll 1991) would have little impact on climate.

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