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RESEARCH PAPER

Between innovation and industrial policy: how Washington succeeds and fails at renewable energy

Robert MacNeil

Department of Government and International Relations, University of Sydney, Sydney, Australia

ABSTRACT

During its eight years in office, the Obama administration undertook an ambitious effort to transition the US economy towards the use of renewable energy technologies, and promote American leads in the global 'cleantech' industry. While many of the strategies selected to achieve these goals rendered positive results, others proved unproductive and/or politically toxic. Approaching the issue from a critical innovation framework (which focuses on the political and economic conditions under which the federal government is best able to promote technological change), this paper argues that the administration ignored some of the key conditions that have historically allowed Washington to succeed in promoting the uptake of new technologies. The paper describes the nature of these mistakes, and suggests an alternative way forward based on historical precedent.

Introduction

The Obama administration's eight-year tenure was, in many ways, the first time a branch of the US federal government sought seriously and systematically to promote renewable energy technologies. While previous administrations had spoken for decades about the need to reduce CO_2 emissions and foster US leads in the budding 'cleantech' market, none had invested anywhere near the sort of political and financial capital invested by this administration. This effort would see the use of a series of policy strategies and instruments previously foreign to the federal government, as the White House strove toward a three-pillared goal consisting of greater investment in deploying renewables, fostering innovation and creating consistent demand for clean technologies through regulation.

While many of the chosen policies undeniably rendered great benefits, others arguably fell short. Reflecting back on this eight-year period, this paper aims to understand why certain aspects of the administration's strategy met with such complication. In so doing, it argues that, in their efforts to conceptualize renewable energy policy partly as a short-term job stimulus program, the administration deviated from the strategies that served the government so well in past efforts to facilitate technological change. The

CONTACT Robert MacNeil robert.macneil@sydney.edu.au
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paper focuses in particular on the program that became emblematic of this approach and its inherent dangers, the Department of Energy's Loan Guarantee Program – a program that ultimately shrouded the administration's broader renewable energy agenda in scandal.

The paper builds on a growing body of literature that aims, in particular, to understand the role of the US federal government in promoting technological change since the mid-twentieth century, and the conditions that have enabled and/or prohibited its success in doing this (e.g. Block and Keller, 2010; Atkinson and Ezell, 2012; Janeway, 2013; Weiss, 2014). While the paper does not offer anything like a comprehensive analysis of the administration's climate and renewable energy policies, applying a critical innovation lens brings into relief a few key missteps in its general approach and specific policies. The basic premise is that the federal government's historical success in fostering major technological change in a number of high technology sectors (such as information technology, semiconductors, software, medical engineering, defense and biotechnology) relies on two key principles.

First, the federal government focused almost exclusively on supporting basic research in the laboratory. It broadly provided the nation's scientific and engineering communities with funding, direction and coordination, and then used federal funds to procure resulting innovations. It thereafter worked the new technologies down the cost curve to a point where the private sector could profitably commercialize and build durable markets around them. Second, the policies working towards achieving these goals maintained a decidedly low profile. Block (2008) refers to this innovation apparatus in Washington as a 'hidden developmental network state', which has allowed this type of active intervention to endure in the midst of a powerful market fundamentalist bent in Congress.

The paper argues that, in key respects, the administration ignored these principles. Instead of focusing primarily on laboratory innovation (aimed at promoting radical and 'disruptive' technologies), some of its strategies moved into the realm of industrial policy, requiring new competencies (and creating new expectations) of the federal government that have historically not been its strength. At a political level, the administration did the opposite of what the hidden developmental network state had done so well in the past, and failed to deflect unwanted attention from many of its renewable technology efforts.

The analysis draws out these points in four sections. In the first, the policies employed by the administration are briefly outlined, along with an explanation of both the benefits and drawbacks of using these approaches. In the second section, a critical innovation framework is applied to show the nature of the historical missteps in the administration's strategy. In the third section, the paper provides insight into how the administration might otherwise have approached the issue had it been guided by Washington's past successes in fostering technological change. To do this, the paper focuses specifically on the role of the military in fostering renewable energy innovation and dissemination. The final section considers the ethics of using the military and other veiled methods to promote renewable energy innovation, and outlines a series of possible recommendations capable of implementing this type of strategy.

Renewable energy policy as a jobs program

Rationale

It is understandable why the administration would have conceptualized renewable energy in terms of immediate economic stimulus and job creation. By the time Obama took office in January 2009, the US economy had shed close to five million jobs since the onset of the recession, and GDP was declining more quickly and more steeply than at any time since the end of the Great Depression (Aldy, 2013). With monetary policy instruments nearly maxed out by the end of 2008 (and with effective demand rapidly drying up across the economy), the administration made the decision to enact arguably the strongest counter-cyclical stimulus program in US history. Signed into law in February 2009, the American Recovery and Reinvestment Act injected US$787 billion into the economy (Council of Economic Advisers, 2009).

While the bill allocated more than US$90 billion for clean energy investment – thus making it easily the largest energy bill in US history – it effectively dictated that all such funding would be used as a Keynesian job stimulus program. As Aldy (2013) notes, the priority in allocating the funds was all about immediacy and jobs, with the defining questions being: is the proposed investment 'shovel ready'; can it be commenced through existing authorities; and how many jobs is it likely to create?

The investments made by the Recovery Act and its individual programs were to be supplemented by two additional initiatives on the part of the administration. The first was an effort to ramp up federal R&D funding for renewable technologies. In particular, the administration sought to empower a nascent federal agency called the Advanced Research Projects Agency – Energy (ARPA-E), modeled on the famed Defense Advanced Research Projects Agency (DARPA) that oversaw many of the technological advances of the digital and IT revolutions. ARPA-E was created in 2007 to fund so-called 'blue-sky' energy breakthroughs that could radically disrupt conventional technologies, and provide the US with crucial leads in the twenty-first-century cleantech market. In so doing, it would make use of the same techniques used by DARPA over the years (such as multiple, small, well-funded research teams with competing approaches to solving specified problems; strong coordination among involved groups; and immense flexibility in adapting and shifting research approaches and priorities). To this end, the administration set the ambitious goal of putting aside US$150 billion over 10 years for R&D through ARPA-E and other agencies within the federal government (Aldy, 2013).

The third component was to generate long-term demand for clean energy technologies through the passage of an economy-wide, 'cap-and-trade' scheme that would seek emissions reduction of more than 80% by 2050. Along with a series of other federal regulatory measures, it was hoped that these three pillars (initial investments through the Recovery Act, ramped-up R&D funding and a cap-and-trade program) would provide a clear path toward the administration's clean energy goals.

Benefits

While the second and third pillars would not come to full fruition (see below), it is important to note that the administration's renewable energy policy did have numerous strong features that rendered positive results. This paper is not intended to impugn these initiatives. Notable examples include:

- the market-creating effects of the administration's regulatory policies (for example, the Department of Energy's efficiency standards, increased fuel economy standards and the Environmental Protection Agency's power plant pollution standards);
- facilitative tax policies that created certainty about federal support and thus enabled longer-term planning for the industry (for example, the wind production tax credit, solar investment tax credit and the renewable power production tax credit);
- generous siting policies that opened up federal land to large renewable demonstration projects;
- various financial investments now coming to fruition (for example, updating the grid with 'smart' technologies, investing in high-speed rail, mass transit, advanced vehicles and battery technologies, 'weatherizing' more than 600,000 low-income homes, and the creation of the '1603' program, which provided a subsidy for investment in new renewable generation capacity); and
- the creative use of grants, subsidized bonds, accelerated depreciation arrangements and other tools to help this budding industry get off the ground.

In light of these policies, the administration has claimed significant gains for clean energy and resulting declines in CO_2 emissions (see Office of the President, 2013). Across the country, the Energy Information Administration (2014) reports that wind capacity more than doubled in the administration's first term alone (and since 2008, investment in wind power has exceeded all other forms of power on a megawatt basis), while the Solar Energy Industries Association (2014) notes that solar investment in 2014 had reached 7000 megawatts nationally – an order of magnitude greater than it was in 2008. Moreover, by 2013, the administration's investments had leveraged more than US$100 billion in private and non-federal government capital for renewable energy manufacturing and generation, and had created approximately 720,000 job-years in the so-called 'green-collar' sector (Aldy, 2013).

Indeed, evidence suggests that, on the whole, many of the administration's programs and policy instruments functioned well and rendered positive results in terms of technological innovation, emission reduction and job creation (Department of Energy, 2015).[1] To an extent, however, the partial conceptualization of renewable energy as a short-term jobs program had consequential drawbacks that are important to acknowledge. In many key respects, it caused the federal government to move beyond a strategy that had proved immensely successful historically in promoting innovation and technological dominance (that being subtly veiled innovation policy), and onto the hazardous political terrain of open industrial policy. One program in particular became emblematic of the limits of this approach, and ultimately shrouded the administration's broader clean energy agenda in scandal and incompetence.

Risks: the Loan Guarantee Program

The Loan Guarantee Program had a simple logic. When companies attempt to commercialize a new technology, they often face what is referred to as a 'valley of death' as they attempt to commercialize a product that does not yet have sufficient or consistent demand. Many technologies and companies falter at this stage and often die. To remedy this, the Loan Guarantee Program underwrote project debts incurred by privately-owned cleantech companies, guaranteeing private lenders that the federal government would pay the outstanding balance in the event of a default. In theory, this would not only make private lenders more willing to lend, but (given that the interest rate of a loan reflects the perceived risk) would also allow the company to obtain a much lower interest rate over the life of the loan.

The program was established under the George W. Bush administration – spurred primarily by pro-nuclear Republicans in Congress – and signed into law as part of the Energy Policy Act of 2005. Though the program remained dormant for its first four years, the Obama administration perceived it as a good venue for achieving some of its goals of deploying renewables and creating manufacturing and construction jobs. With an initial allocation of US$25 billion through the Recovery Act, the program would instantly make the federal government the largest cleantech venture capital group on the planet (Homans, 2012).

Between 2009 and 2011, the program issued 38 individual loans, and underwrote US$35.9 billion worth of investments (see Table 1). This represents more investment in clean energy than the entire American private sector made in 2009 (which was US$10.6 billion) (Recovery.gov, 2015). The program consisted of three sub-sections: Section 1703 aimed to support technologies that could reduce or sequester CO_2 emissions; Section 1705 would support renewable technologies, electric power transmission and biofuels; while the ATVM section would support the development of advanced technology vehicles.

Table 1. Loan guarantee recipients.

Program	Recipient	Sector	Loan guarantee
1703	AREVA	Nuclear	US$2B
1703	Georgia Power	Nuclear	US$8.3B
1703	Red River Enviro	Energy efficiency	US$245M
1703	SAGE Electro	Energy efficiency	US$72M
1705	Abengoa Solar	Solar	US$1.4B
1705	Abound Solar	Solar	US$400M
1705	AES Corporation	Storage	US$17M
1705	Agua Caliente	Solar	US$967M
1705	Beacon Power	Storage	US$43M
1705	BrightSource	Solar	US$1.6M
1705	Caithness	Wind	US$1.3M
1705	Cogentrix	Solar	US$90.6M
1705	Diamond Green	Biofuels	US$241M
1705	Kahuku Wind	Wind	US$117M
1705	LS Power	Transmission	US$343M
1705	Nevada Geothermal	Geothermal	US$78.8M
1705	Nordic Windpower	Wind	US$16M
1705	Record Hill Wind	Wind	US$102M
1705	Solar Trust	Solar	US$2.1B
1705	SolarReserve	Solar	US$734M
1705	SoloPower	Solar	US$197M
1705	Solyndra Inc	Solar	US$535M
1705	SunPower	Solar	US$1.1B
1705	US Geothermal	Geothermal	US$97M
ATVM	Fisker	Advanced vehicles	US$529M
ATVM	Ford	Advanced vehicles	US$5.9B
ATVM	Nissan	Advanced vehicles	US$1.44B
ATVM	Tesla	Advanced vehicles	US$465M
ATVM	Vehicle Production Group	Advanced vehicles	US$50M

Recovery.gov.

Despite the critique of the program that follows (and despite all the political controversy surrounding the ensuing bankruptcies), the government's loan portfolio actually fared well. At the time of writing, only two loans have defaulted (Solyndra and Beacon Power), and the federal government has had to cover only approximately US$780 million of the US$35.9 billion in guarantees issued since 2009. This represents 2.3% of the total portfolio, and less than 13% of the original funds allocated by Congress to cover bankruptcies (Recovery.gov, 2015). If the interest payments on loans are taken into account, by early 2016 the program had actually earned the government close to US$30 million in new revenue. The government claims, moreover, that these loan guarantees created 9719 full time jobs, 18,995 temporary jobs and prevented over 33,000 job losses at Ford (Recovery.gov, 2015). Ironically, these overwhelming successes have been ignored in public discourse, and seem to underscore how slight the margin of error is when government takes on this sort of role.

Fallout: Solyndra's backlash

Among the first candidates to receive a loan guarantee through the 1705 program was a solar technology manufacturer called Solyndra. The company was seeking US$500 million to build a new factory in California to scale-up production of its unique lightweight cylindrical solar cells, capable of operating without the use of silicon. This appeared to be an attractive technology given that, to a large extent, it was the high price of silicon throughout the early 2000s that contributed to the poor competiveness of the photovoltaic industry.[2] However, while Solyndra was working towards scaling-up production, growing global demand for silicon had begun to spur investment in new production around the globe. The resulting glut of silicon (in conjunction with the economic slowdown following the global financial crisis) caused the price to plummet after 2009, making Solyndra's proprietary technology uncompetitive. The competitive pressure from China's photovoltaic industry was likewise crippling, with Beijing providing large amounts of capital to numerous domestic production facilities capable of operating at much higher economies of scale than a relatively small operation like Solyndra (Hounshell, 2013). In September 2011, Solyndra filed for bankruptcy and laid off more than 1100 workers (Mulkern, 2011).

In the months that followed, the political firestorm unleashed by Republicans was (considering the relatively small size of the loan guarantee) almost unimaginable. GOP (Grand Old Party – the Republican Party) lawmakers began holding relentless hearings to scrutinize top officials involved in the program, subpoenaed thousands of White House documents (which provided a series of embarrassments for the White House), and demanded the resignation of top officials in the Department of Energy and the White House. It accused top officials of criminal misconduct in their treatment of Solyndra (one of its main investors was a donor to Obama's 2008 campaign), passed a bill in the House (entitled the 'No More Solyndras Act') that aimed to defund the loan program, launched a national campaign invoking Solyndra and the Loan Guarantee Program as symbols of the administration's waste and excess (with conservative group Americans for Prosperity spending millions on the campaign), and worked tirelessly to uncover the 'next Solyndra' from the DOE's funding recipients (Vlasic and Wald, 2012).

The attacks proved to be consequential at both a practical and discursive level. In addition to grinding the program to a halt, the affair did undeniable damage to the administration's broader energy and climate agenda, shrouding it in an air of scandal, incompetence and potential corruption. In principle, this was an odd development given that, from the very beginning, a major presupposition of the program was that some of the loans *would* fail. Indeed, this was the whole idea of the program – the government would provide *high-risk* loans to help new businesses get established in the market. To that end, Congress set aside billions of dollars to cover these losses. Yet, the program also rested on an equally important assumption that turned out to be wrong: that Republican lawmakers would not pounce on a small setback like Solyndra and mobilize it into an all-out attack on the government's broader renewable energy agenda.

Historical mistakes

Blurring the line between innovation policy and industrial policy

The first complication that the Loan Guarantee Program brought into relief was that, as part of a broader approach that conceptualized renewable energy in terms of immediate economic activity and growth, it overstepped a mark in blurring innovation and industrial policy. As noted above, in the context of a tanking economy, there was an obvious logic to this approach. Yet, precedent suggests a very different general approach – one that sees renewable energy as a decades-long strategy aimed at promoting disruptive innovation, intellectual property dominance and advanced manufacturing, rather than the creation of instant jobs by providing targeted capital to individual firms taking established technologies to market.

Indeed, while the strategy had an obvious logic, given the context, it nevertheless represented a major deviation from the technology policies that had served the federal government and American industry so well in the past. In the digital revolution, Washington did not provide capital to targeted firms or specific technologies, nor did it attempt to directly create jobs from the technologies it was supporting. Rather, its primary function was basically threefold: (1) to provide large amounts of funding for basic and applied research at the laboratory level (primarily through universities, the military and the national laboratory system); (2) to provide direction and coordination for the teams of scientists and engineers working on various problem sets; and then (3) to act as a generous and collaborative customer, procuring early generations of the resultant technologies from private firms (Block and Keller, 2010; Weiss, 2014).

In this process, once the federal government had laid the groundwork by funding early laboratory research, it would license its patents to the private sector, and then begin working these technologies down the cost curve through aggressive procurement. In this process, Washington would set a specification and begin accepting proposals from research teams or private sector companies (for a certain type of microprocessor, laser, cellular telephone, etc.). Whoever met the specification (whether it was General Electric or a couple of kids working out of their parents' garage) would be issued an extremely generous purchasing order (Janeway, 2013). Federal government agencies (mostly the military, but several others as well) would then thoroughly test the prototypes, request further revisions, buy another order of the subsequent generation, and slowly pull the competitive sector down the learning and cost curves. After several repetitions of this process, the technology would reach a point where the private sector could fully commercialize the product without government help. As Janeway (2013, p.230) sums up:

> From microelectronics and semiconductor devices through computer hardware and software and on to the Internet, development of all of the components of digital and communications technology reflected state policies for both R&D and procurement that encouraged the entry of new firms and inter-firm technology diffusion. In addition, federal procurement supported the rapid attainment by supplier firms of large production runs, enabling faster rates of improvement in quality and cost than otherwise would have been realized.

Free of any direct concerns about immediate job creation or economic return, the federal government funded multiple competing research agendas and procured prototypes from many competing firms (thereby underwriting the costly search for technological breakthroughs at the laboratory level) before leaving the private sector free to sort out the finer details of commercialization and job creation.

Seen in this context, the Loan Guarantee Program crossed an important threshold between innovation policy and industrial policy. The latter has been politically and economically successful in the US, while the former has typically been viewed as beyond the state's purview. Atkinson and Ezell (2012) illustrate the difference between the two by describing a continuum of government engagement which increases from left to right in four steps (see Figure 1). On the far left of the spectrum is a staunch *laissez faire* policy that prescribes limited or zero government intervention in technology markets. The second step moves into the realm of innovation policy with strategies that support so-called 'factor conditions' for innovation (for example, basic research spending and facilitative tax environments). The third step goes further by targeting broad key technologies and industries, with the state coordinating various public–private collaborations and helping to commercialize technologies. In the final step, the state moves into the realm of industrial policy, and begins directly backing specific technologies and firms – as Republican detractors labeled it in the case of the Loan Guarantee Program, the state begins 'picking winners', and designating 'national champions'.

In American politics, given the strength of market fundamentalist ideology, the debate is generally framed as a choice between options one and four – either *laissez faire* capitalism or heavy-handed state intervention. Yet, these two options are the least ideal. *Laissez faire* technology policy produces low levels of innovation, given that private firms have neither the incentive to seriously undertake it (because they are unable to capture all the benefits of their R&D spending) nor the capacity to do it (basic research is very expensive and provides no guarantee of a profitable commodity at the end of the process). And providing targeted capital to specific firms is often economically inefficient (as it places finite limits on the industry's capacity to grow) and is politically vulnerable to accusations of overzealous state intervention.

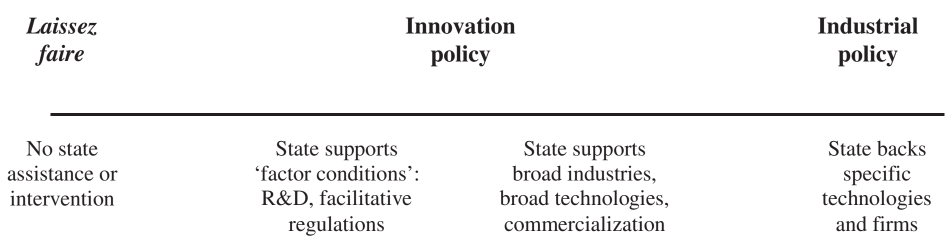

Figure 1. Spectrum of government support for new technologies. Source: Adapted from Atkinson and Ezell (2012).

Washington's success in sectors ranging from information technology to biotechnology came from concentrating on options two and three. In these contexts, Washington focused on providing strong 'factor conditions' for new technologies (basic research funding, supporting university technology transfer, etc.); placing early speculative bets on blue-sky technologies (such as the Internet); supporting nascent industries broadly (broadband, life sciences, software, etc.); and coordinating early collaborations between the public and private sectors (Block and Keller 2010; Atkinson and Ezell, 2012).

In the cleantech realm, by contrast, such initiatives as the Loan Guarantee Program show the federal government engaging in something akin to industrial policy, providing targeted capital to a series of individual firms and their selected technologies. If the government had followed the previously successful model, it would have used the bulk of its cleantech funding to support a wide and competing range of laboratories and technologies, acknowledging that the government cannot predict which companies or technologies will 'win' in the marketplace. It would probably not have backed established grid-scale technologies that were already going to market and whose low technology manufacturing was already moving massively towards East Asia (for example, China and Taiwan together now manufacture nearly 80% of the world's photovoltaic units, and a quarter of wind technologies (see Pinner and Rogers, 2015)). The government would have (as it did historically) focused on disruptive technologies still at the laboratory level, and used federal procurement to work them through their early generations. In the cleantech realm, this would mean, for example, backing distributed energy technologies capable of supplanting the centralized grid paradigm. This would enable US firms to hold the patents on these technologies, and collect intellectual property rents off their sale for decades to come (a portion of which could then be recouped by the state through corporate taxation).

Failing to keep a low profile

At a political level, the administration's second misstep was inadequately to shield its chosen programs from the harsh neoliberal climate of Congress. A key finding in recent studies of US innovation and technology policies is that their success rests largely on their capacity to maintain a decidedly low profile in Washington (see Block and Keller, 2010). Those policies that have succeeded over the long term have tended to maintain a certain nebulous quality that has allowed them to endure in the midst of the powerful market fundamentalist ideology that has dominated Congress since the 1980s. As Block (2008, p.170) notes:

> The hidden quality of the US developmental state is largely a result of the dominance of market fundamentalist ideas over the last 30 years. Developmental policies have lived in the shadows because acknowledging the state's central role in promoting technological change is inconsistent with the market fundamentalist claim that private sector firms should simply be left alone to respond autonomously and spontaneously to the signals of the marketplace.

Ever since the early 1990s, the Republican Party has taken aim at innovation and technology policies when they have become too visible, condemning them as wasteful, and subsequently defunding them (see Negoita (2010) for an excellent history of this dynamic). Once again, however, there was rationale for ignoring this lesson, given the extraordinary context of the financial crisis. Openly advertising its cleantech policies allowed the administration to appear responsive to the crisis (in terms of providing economic stimulus) and to tout job growth as a benefit of its clean energy investments.

Interestingly, the decision to use the Loan Guarantee Program (instead of direct funding or loans) can be seen as a subtle acknowledgment on the part of the administration that their policies were wading into dangerous political territory. The program appeared to be much safer politically for a few reasons. First, it was, after all, just a loan *guarantee* – merely a promise to repay a portion of the outstanding debt *if* the company defaulted. This was much safer politically than providing direct handouts. Second, it allowed the administration to spend considerably less on the policy than it otherwise would have done. In a traditional loan, if the government wanted to lend US$36 billion, it would need to obtain and transfer the full amount. A loan guarantee is different. Given that not every loan will fail (in fact, statistically, very few were likely to fail), the government could merely calculate its risks and keep a small reserve fund available to cover its losses. Third, the program was a Bush-era initiative, signed into law by a Republican House, Senate and president, and thus it appeared less likely to generate indignation from the GOP. And finally, though the program was conceived as a vehicle for providing finance for high-risk ventures, the Obama administration effectively behaved like a piker, making mostly conservative bets on low-risk ventures in an effort to avoid defaults. Indeed, many of the recipients could probably have obtained finance without state assistance. This effectively defeated the purpose of the program, which was to provide loans for risky (but potentially very beneficial) firms and technologies.

While these factors made the program appear safer politically, it was ultimately a naïve judgment, and miscalculated the strength of conservative reaction. In particular, the administration underestimated the extent to which its cleantech policies would become conflated with the caustic politics of climate change, a partisan and regional wedge issue in US politics for decades. The GOP's ideological rejection of climate science and its embrace of traditional fossil energy have led many elements of the party to talk openly of climate change as a socialist conspiracy aimed at justifying government control over the economy (see MacNeil, 2013a, 2013b). In this context, all of the safety features built into the Loan Guarantee Program proved ineffective.

A similar misstep can be observed with regard to ARPA-E. While the program made use of several of the key proprietary features that have made its cousin DARPA arguably the most successful R&D agency in the world, it failed to make use of what is perhaps DARPA's fundamental feature – very few people know what it is or what it does. Instead of deflecting attention away from the agency and its activities, the Obama administration constantly praised it as the centerpiece of its cleantech agenda. ARPA-E became a target for Republican indignation over the administration's broader energy agenda, and has had to struggle against long odds to secure sufficient funding from year to year. With an operating budget of roughly US$200 million per year, it has been able to fund less than 1% of the applications it has received, leaving the administration's ambitious R&D agenda hopelessly deficient (Atkinson and Ezell, 2012; ARPA-E, 2016).

Of course, as noted above, the initial investments through the Recovery Act and the desire to inject billions into R&D spending were supposed to be buttressed by a third key initiative, a cap-and-trade program designed to generate consistent demand for renewables. Yet, on the heels of an extremely contentious battle over healthcare reform, the administration's appetite for another drawn-out policy fight eroded. While the American Clean Energy and Security Act narrowly passed in the Democrat-controlled House with tepid White House encouragement, the Democrat-controlled Senate would promptly abandon it. Sensing the administration's unwillingness to do any heavy lifting on the issue, more than half of the Democratic caucus came out against the bill, rendering it pointless to put the tattered legislation to a vote.

Given the complications with each of these three pillars, it is worth considering what a more conventional approach to renewable energy innovation and deployment might have looked like. The remainder of this paper makes the argument that, if one is morally and philosophically inclined to make use of it, the US military was (and remains) the most obvious and invaluable institution through which to achieve a host of renewable energy goals. With its unrivaled R&D capacity, strategic motivation and comparative insulation from the neoliberal bent of Congress, it may well be the most effective tool any administration could have in creating cleantech jobs over the long term, reducing emissions and allowing US firms to dominate the twenty-first-century energy industry.

Camouflage is the new green? The military and renewable energy

Innovative capacity

As an institution, the US military's record of successfully driving technological innovation is without parallel. Over the past century, it has underwritten (through basic research, applied research and aggressive procurement) the development of literally thousands of technologies. A short list includes the Internet, the modern computer, cellular telephones, global positioning systems, semiconductors, jet engines, radar, sonar, satellites, weather forecasting technology, lithium ion batteries, nuclear technology, a range of synthetic materials, artificial intelligence, and the foundational development of the modern robotics, chemical and aviation industries (see Alic *et al.*, 1992; Koistinen, 1997, 1998, 2004; Hacker, 2005). This capacity stems from a combination of its ability to fund and coordinate laboratory R&D, coupled with the size and efficacy of its procurement (which allows it to generate initial demand for the technologies it develops) (see Block, 2008; Weiss, 2014).[3]

Strategic ambition

Perhaps most important is the military's strong ambition to achieve radical advances in renewable technologies for its own strategic purposes. The reason for this heightened interest stems primarily from its experiences in the Iraq and Afghanistan wars. Among the most effective tactics employed by insurgent fighters in these theaters was the targeting of US fuel convoys with improvised explosive devices (IEDs) along main supply routes. With this tactic, insurgents effectively used the military's own counter-insurgency strategy against it by exploiting its need to supply fuel to far-flung regions as it 'covered down' on the enemy. So, the more fuel the military required, the more vulnerable it became. By 2006, IED attacks on supply routes had become commonplace throughout Iraq and Afghanistan as insurgents capitalized on the thousands of miles of unprotected roads that separated forward bases from their supply points.

Between 2003 and 2009, IED attacks on fuel convoys accounted for half of all American deaths in both wars (Deloitte Study, 2009). Internal military reports suggest that this reliance on oil (and the subsequent need to safeguard convoys and supply routes) dramatically reduced the military's overall efficacy as thousands of troops were required to babysit fuel routes (Mabus, 2011). As Closson (2013, p.311) notes, in Afghanistan, fuel convoys were referred to as 'Taliban targets' – 'a high-payoff target for insurgents using homemade bombs. If targeted, they were to leave immediately and not engage the enemy, making them not only a softer target, but reducing the war fighters' much needed fuel'.

While officials sought to address the problem by re-routing fuel convoys and enhancing security along supply routes, these experiences underscored a much larger problem for the military: as long as it remains wedded to its exceptionally high use of fossil fuels, these problems become its Achilles' heel in modern warfare (presumed to consist primarily of counter-insurgency operations). Between 2003 and 2009, the average US forward-operating base in Afghanistan required as much as 30,000 liters of fuel a day, nearly 200 million liters a month across the country (Erwin, 2012). The US military used roughly 85 liters of fuel per soldier/per day. Delivery cost of *each* liter was as high as US$125 – from an initial purchase price of roughly US$1.10 (Bochman, 2009). The total cost of energy per soldier averaged more than US$100,000 annually (Closson, 2013).

Beyond the specific challenges of transporting fossil fuels in war zones, several of the military's broader energy concerns are also well documented. As the largest institutional consumer of fuel on the planet, the US military is highly vulnerable to shifting world oil prices, particularly as its energy needs are growing rapidly. Between 2000 and 2009, the military's operational energy consumption increased by over 500 million kilowatts (reaching 1.5 billion liters of fuel per year in 2009). Energy requirements per soldier have grown by more than 175% since the Vietnam War (Deloitte Study, 2009). When coupled with the immense volatility of world oil prices, fuel has stood as the single largest cost driver in the military's budget. As the price of oil went from US$25 per barrel in 2003 to US$147 in 2008, the military's energy costs increased by nearly 500% (to over US$19 billion) (Andrews, 2009), making it exceptionally difficult for the military to plan its budgets.

Secure access to petroleum in the future is also a problem. According to the Center for a New American Security, global supplies will have decreased so severely by 2040 that the military will not be able to rely on supply (Drummond, 2012). The final concern has to do with relying on petroleum from unfriendly parts of the globe. A structural reliance on hostile regions for petrol effectively places the fate of the military's arsenal of ships, tanks, planes and ground vehicles in the hands of the foreign nations that provide their fuel. The military spends as much as US$90 billion per year (up to 15% of its entire budget) defending oil supplies and sea routes throughout the Persian Gulf (Closson, 2013).

Acknowledging these realities, there has been a sustained push since 2008 to move the military toward distributed renewable energy, with the goal of obtaining 25% of its energy needs (roughly three gigawatts of power) from renewables by 2025 (Natter, 2012). To this end, the military has begun to establish a series of operational energy programs aimed at funding R&D and procurement for novel renewable technologies. With more than 500 individual projects underway or set to begin, the military could quickly become the largest institutional developer of renewable technologies in the world.

The main technologies being targeted by the military are all in sectors that have already been heavily targeted by the federal government. They are likely to be crucial in underpinning broader civilian markets for renewables. The military's first priority at the moment is energy storage, an area on which the development of renewables generally is dependent. The Defense Department has launched a series of programs to develop battery and fuel cell technologies capable of being charged in the field. Such programs as the soldier-worn integrated power equipment system, for example, are developing high-density zinc-air batteries capable of maintaining a continuous charge from a high-efficiency portable solar patch, roughly the size of a soldier's vest. Other programs, such as the rucksack-enhanced portable power system, look to foldable, portable battery charging stations that operate 62 watt solar panels weighing under 4.5 kilograms (Pew Charitable Trust, 2012; Simeone, 2013). Second, with the energy demand created by its fleet of planes, ships and ground vehicles, the military is striving hard to achieve technological breakthroughs in vehicles. This includes the development of advanced electric ground vehicles capable of being charged at operating bases, ultra-efficient combustion engines for ships and planes, advanced materials to improve efficiency, and a range of advanced biofuels (Department of Defense, 2010b).

Finally, with more than 500,000 buildings at bases and installations around the world, stationary power generation is another major priority. The vulnerability created by relying on power from local utilities and the cost of using diesel generators on bases (roughly US$1.40 per kilowatt hour) have led the military to focus on a range of renewable technologies capable of feeding independent microgrids. Experimental solar projects capable of generating up to 1000 megawatts of electricity are underway at bases throughout the US. These renewable systems will feed microgrids capable of rendering bases fully energy independent (Pew Charitable Trust, 2012).

Hiddenness

A final crucial advantage is the military's capacity to fund these innovations with minimal political interference. While other federal agencies with significant R&D budgets are consistently vulnerable to accusations of overstepping, the military is comparatively protected.[4] In many cases, it can hide its innovative endeavors in classified R&D budgets (for example, a US$11.23 billion budget line is simply titled 'classified programs' in the 2011 defense budget) (Wang, 2012).

At the level of procurement, the military's capacity to help US firms and start-ups work through early generations of these technologies is also unmatched. Given its enormous size and the demand it generates with its massive budget (roughly 4.5% of GDP), the military can single-handedly provide the underpinnings for a civilian market in a novel technology. As Weiss (2014) notes, the procurement power of the defense budget has played this role since the mid-twentieth century, helping to launch numerous industries and technology giants, including IBM, EDS, Boeing, Texas Instruments, GE, DuPont and Motorola, all of which found their first, most helpful and demanding customer in the military.

In the energy realm, this demand is impressive. The military uses more energy in the course of a day than any other organization on earth, and more than 100 individual nations. It accounts for more than 2% of total US energy usage, and spent more than US$19.4 billion on energy in 2011 (Natter, 2012). Consequently, when the military begins procuring novel renewable technologies to meet this need, it reshapes the entire industry in several ways: it scales-up the production of new innovations; field tests early generations of unproven technologies; transfers patented innovations to the private sector; builds new supply chains; demonstrates the technology's worth to the market; and ultimately brings the price of the technology down to a point where it can compete in the market without assistance.

Despite the military's strategic ambition to move toward distributed renewable energy, obstacles remain. These arise largely from lack of leadership and direction. As Closson (2013) argues, instead of going all out on renewable technologies, military leaders and the administration have hedged their bets by increasing efforts to secure supplies of oil at affordable prices, including ensuring the stability of oil producers and their supply routes. Recent purchases reflect the military's continuing addiction to fossil energy. Examples include the purchase of new littoral combat ships (which use more fuel than the frigates they replace), P8-A Poseidons (which use more fuel and have less carrying capacity than the P-3 Orions they replace) and the Boeing tanker (which is bigger and burns more fuel, yet delivers less cargo to operating bases than the EADS it replaces) (Closson, 2013). Neither does the budget earmarked for renewable energy R&D reflect a serious commitment to moving beyond oil, topping out at a mere US$1.2 billion in 2010 (Department of Defense, 2010a). This lack of leadership has allowed the culture of fossil fuels to maintain a foothold within the military and hinder sustained efforts to support renewables.

Conclusions and policy implications

While this paper makes an appeal to think seriously about the military's unique capacity to lead in developing renewables, the paper ends with a note of caution. The Pentagon has shown time and again that secrecy can be a double-edged sword. The issue underscores an enduring question in environmental studies: are democratic processes and environmental sustainability fully compatible? If they are not, which deserves priority (see Dryzek, 1997)? If one leans towards the sanctity of the democratic process, hiding renewable energy policy in the darker recesses of the Pentagon will seem undesirable. From this perspective, the difficulties encountered in the US Congress are a healthy part of the process, and disagreement over the future of energy and the environment is a vital part of what it means to live in an open, liberal democracy. If certain groups want to see climate and clean energy policy come to fruition, they ought to use the democratic process to overcome opposition – not simply circumvent their opponents through the military. Solving the environmental problems by violating democracy undermines the 'free' society they are trying to save.

In contrast, if one places a higher premium on addressing the environmental crisis and is skeptical about the effectiveness of the democratic process, the military strategy may appear legitimate. It would be ideal if US politics allowed the state to play this role in the open, but this would require a broad generational shift away from the politics of neoliberalism (and the dominance of special interests) that the immediacy of the crisis does not allow. Seen from this angle, centralizing energy innovation within the Pentagon is merely a pragmatic attempt to address the mounting climate crisis within the rigid parameters of contemporary neoliberalism. Commitment to democracy should not be a suicide pact.

If one is inclined to entertain the latter position, a few policy objectives seem worthy of consideration. First, programs that have any semblance of 'industrial policy' ought to be avoided. In the clean energy realm, they have served to inflame the Republican Party's ideological aversion to climate science and renewable energy, and broadly discredit the wider cleantech agenda. Renewable energy funding should not be thought of as a short-term jobs program, but rather a long-term competition for intellectual property dominance and advanced manufacturing.

Centralizing renewables development within the military has three key advantages: the military is immensely skilled at conducting R&D and coordinating procurement; it provides a level of political cover that no other agency can match; and it is highly motivated to engage in energy innovation as a means to achieve its strategic goals. As Janeway (2013, p.154) notes, innovation requires an entity that can 'invest in speculative science and technology before commercially motivated firms and their investors can envision either an economic or financial return'. The military may be the only agency left within the federal government that can fund innovation free of these concerns.

Within the military itself, a few key objectives seem worthy of consideration. The first is a need to empower those elements within the organization that are pushing for clean energy innovation, perhaps implementing changes in leadership at various levels. Second, at the level of R&D, the bulk of federal funding should perhaps flow through DARPA in light of its impressive efficacy and relative political impunity. Indeed, the lightning rod that is ARPA-E should probably be subsumed by DARPA. Third, net funding levels ought to be increased to at least US$25 billion per year, and requests for procurement funding for novel energy technologies should directly invoke the Defense Production Act of 1950, a law which guarantees the military's authority to purchase technologies required to ensure critical defense needs are met. Finally, once military-based innovation has enabled commercial exploitation, the state should resist the temptation to back specific firms, and leave the market to sort out the finer details of economic growth and job creation.

Notes

1. The Energy Information Administration (2009) evaluated the Recovery Act in terms of a counterfactual assuming no new clean energy policies. The evaluation found that the emission outcome greatly outpaced what would have been expected in the absence of the Act's investments.
2. Solar cells have traditionally been made from very low-grade ingot that does not meet the standards for producing computer chips. Thus, the relatively small quantity of rejects from the computer industry was typically used in the production of solar cells. As solar cells became more popular throughout the 1990s, this low-grade ingot fell into short supply, and the price subsequently soared, damaging the prospects for solar.
3. This is not to say that the military is uniquely 'good' at innovation or that it is the most efficient or desirable institution with which to pursue technological progress. The point developed here is that the reason for its tremendous historical success has much to do with the unique political and financial capacity that it maintains.
4. Acknowledging the extent to which the military could prove an exceptionally powerful force in developing renewable technologies, many GOP law-makers and Democrats from coal states have resisted military efforts to develop such technologies. In arguing for a halt to the military's shift to the use of biofuels, Senator James Inhofe (a notorious climate skeptic) lamented that President Obama had found in the military 'the one place where he can force [his renewable energy agenda] to happen' (Service, 2012).

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References

Aldy, J. (2013) 'A preliminary assessment of the American Recovery and Reinvestment Act's clean energy package', *Review of Environmental Economics and Policy*, 7, 1, pp.136–55.

Alic, J., Branscomb, L., Brooks, H., Carter, A. and Epstein, G. (1992) *Beyond Spinoff: Military and Commercial Technologies in a Changing World*, Harvard Business School Press, Cambridge MA.

Andrews, A. (2009) *Department of Defense Fuel Spending, Supply, Acquisition, and Policy,* Congressional Research Service, 22 September, Washington DC.
ARPA-E (2016) *ARPA-E Budget*, available from http://arpa-e.energy.gov/?q=arpa-e-site-page/arpa-e-budget [accessed May 2017].
Atkinson, R. and Ezell, S. (2012) *Innovation Economics: The Race for Global Advantage*, Yale University Press, New Haven CT.
Block, F. (2008) 'Swimming against the current: the hidden developmental state in the US', *Politics and Society*, 36, 2, pp. 169–206.
Block, F. and Keller, M. (eds) (2010) *State of Innovation: The US Government's Role in Technology Development*, Paradigm, Boulder CO.
Bochman, A. (2009) 'The case for operational energy metrics', *Joint Forces Quarterly*, 55, pp.113–19.
Closson, S. (2013) 'The military and energy: moving the United States beyond oil', *Energy Policy*, 61, pp.306–16.
Council of Economic Advisers (2009) *The Economic Impact of the American Recovery and Reinvestment Act of 2009*, First quarterly report, Washington DC, September.
Deloitte Study (2009) *Energy Security: America's Best Defense*, RAND Corporation, Washington DC.
Department of Defense (2010a) *Strategic Sustainability Performance Plan*, Washington DC.
Department of Defense (2010b) *Annual Energy Management Report FY2009*, Washington DC.
Department of Energy (2015) *Revolution … Now: The Future Arrives for Five Clean Energy Technologies*, Washington DC, available from https://energy.gov/sites/prod/files/2015/11/f27/Revolution-Now-11132015.pdf [accessed May 2017].
Drummond, K. (2012) 'America's solar soldiers', *Global Post*, 1 November.
Dryzek, J. (1997) *The Politics of the Earth*, Oxford University Press, Oxford.
Energy Information Administration (2009) *An Updated Annual Energy Outlook 2009 Reference Case Reflecting Provisions of the American Recovery and Reinvestment Act and Recent Changes in the Economic Outlook*, available from http://www.eia.gov/oiaf/servicerpt/stimulus/pdf/sroiaf(2009)03.pdf [accessed May 2017].
Energy Information Administration (2014) *Existing Net Summer Capacity of Other Renewable Sources by Producer Type, 2004 through 2014*, available from http://www.eia.gov/electricity/annual/html/epa_04_02_b.html [accessed May 2017].
Erwin, S. (2012) 'Amid political backlash, Pentagon pushes forward with green energy', *National Defense Magazine*, 4 April.
Hacker, B. (2005) 'The machines of war: Western military technology 1850–2000', *History and Technology*, 21, 3, pp.255–300.
Homans, C. (2012) 'The experiment: how Steven Chu lost his battle with Washington', *New Republic*, January.
Hounshell, B. (2013) 'Chu unplugged: the former energy secretary on climate, politics and his toughest decisions', *Politico Magazine*, November, available from http://www.politico.com/magazine/story/2013/11/chu-unplugged-098986 [accessed May 2017].
Janeway, W. (2013) *Doing Capitalism in the Innovation Economy*, Cambridge University Press, Cambridge.
Koistinen, P. (1997) *Mobilizing for Modern War: The Political Economy of American Warfare, 1865–1919*, University Press of Kansas, Kansas City KA.
Koistinen, P. (1998) *Planning War, Pursuing Peace: The Political Economy of American Warfare, 1920–1939*, University Press of Kansas, Kansas City KA.
Koistinen, P. (2004) *Arsenal of World War II: The Political Economy of American Warfare, 1940–1945*, University Press of Kansas, Kansas City KA.
Mabus, R. (2011) 'Remarks by Ray Mabus, Secretary of the Navy', *Clean Economy Summit*, Washington DC, 25 January.
MacNeil, R. (2013a) 'Alternative climate policy pathways in the US', *Climate Policy*, 13, 2, pp.259–76.
MacNeil, R. (2013b) 'Seeding an energy technology revolution in the United States: re-conceptualising the nature of innovation in liberal-market economies', *New Political Economy*, 18, 1, pp.64–88.

Mulkern, A. (2011) 'Solyndra bankruptcy reveals dark clouds in solar industry', *New York Times*, 6 September, available from http://www.nytimes.com/gwire/2011/09/06/06greenwire-solyndra-bankruptcy-reveals-dark-clouds-in-sol-45598.html?pagewanted=all [accessed May 2017].

Natter, A. (2012) 'Republicans move to cut military alternative fuels', *Bloomberg Business Week*, 29 May.

Negoita, M. (2010) 'To hide or not to hide? The advanced technology program and the future of US civilian technology policy' in Block, F. and Keller, M. (eds) *State of Innovation: The US Government's Role in Technology Development*, Paradigm, Boulder CO, pp.122–51.

Office of the President (2013) *The President's Climate Action Plan*, June, available from https://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf [accessed May 2017].

Pew Charitable Trust (2012) *From Barracks to the Battlefield: Clean Energy Innovation and America's Armed Forces*, Pew Center for Climate Solutions, Washington DC.

Pinner, D. and Rogers, M. (2015) 'Solar power comes of age: how harnessing the sun got cheap and practical', *Foreign Affairs*, April.

Recovery.gov (2015) 'Contract, grant, and loan programs', available from http://www.recovery.gov/arra/Transparency/fundingoverview/Pages/contractsgrantsloans-details.aspx#EnergyEnvironment [accessed May 2017].

Service, R. (2012) 'Senate committee wants to sink military's biofuels program', *Science Insider*, May, available from http://news.sciencemag.org/scienceinsider/2012/05/senate-committee-wants-to-sink.html [accessed May 2017].

Simeone, N. (2013) 'DOD electric vehicles will supply power to local grids', *American Forces Press Service*, 25 March.

Solar Energy Industries Association (2014) *Solar Energy Facts: 2014 Year in Review*, available from http://www.seia.org/sites/default/files/Q4%202014%20SMI%20Fact%20Sheet.pdf [accessed May 2017].

Vlasic, B. and Wald, M. (2012) 'Solyndra blamed as clean energy loan program stalls', *New York Times*, 12 March.

Wang, U. (2012) 'US military's big plan for renewable energy', *Forbes*, 6 August.

Weiss, L. (2014) *America Inc.: Innovation and Enterprise in the National Security State*, Cornell University Press, Ithaca NY.