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Red Dirt, Red Alert: How Oklahoma State Energy Policy Harms National Security

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Abstract
In 2008, the Defense Science Board released a report that found multiple points of vulnerability in the U.S. electrical grid, which include cascading power outages caused by accidental overload, severe weather, and sabotage. Despite its frailty, domestic military installations derive nearly all of their electricity from the commercial grid. By conducting an analysis of pertinent government and private-sector reports, this paper argues that the state of Oklahoma can have a substantial effect on installation energy security by changing its utility regulation and renewable energy policies. Because of its inadequate renewable energy policy and critical military installations, Oklahoma provides a telling example of how individual states can affect both national and international security. This paper finds that renewable energy sources are uniquely suited to provide energy security to military bases.

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Introduction

In 2008, the Defense Science Board (DSB) released a report, *More Fight, Less Fuel,* that found multiple points of vulnerability in the commercial electrical grid. These include cascading power outages from accidental overload; severe weather; and acts of sabotage such as a cyber-attack, electro-magnetic pulse (EMP), and terrorist attacks on critical infrastructure. Castillo (2012) provides reasons why on-site solar photovoltaic (PV), which converts sunlight into electricity, could potentially shield U.S. military installations from the devastating effects of a prolonged black-out. Unfortunately, neither the DSB nor Castillo (2012) discuss the role individual states could play to ensure energy security for the Department of Defense (DOD).

The literature on DOD energy security in Oklahoma is sparse. Nesse et al. (2011) examines the possibilities for alternative energy sources at Fort Sill. However, this report only focuses on one of Oklahoma's five military installations, barely mentions the role of state energy policy, and does not approach renewable energy as a tool to provide energy security. At the time of this writing (October 2013), I could not find any scholarly articles discussing how Oklahoma's renewable energy policy can help or hinder DOD's energy security goals.

Through a thorough analysis of DOD, private sector, and various think-tank reports, this paper outlines a theoretical basis to support the claim that the State of Oklahoma can have a significant effect on national and state security by making changes to its utility regulation and renewable energy policies. This paper argues that the State of Oklahoma should reform its renewable energy policy to protect U.S. military installations.

In order to support my contention that renewable energy technology can contribute to installation energy security, I make three fundamental assumptions. First, DOD will harden any on-site wind or solar PV systems against cyber or EMP attacks. Second, the Nesse et al. (2011) report's claims of the viability of on-site renewable resources for Fort Sill are applicable to the entire State of Oklahoma. Third, DOD will attempt to integrate on-site renewable energy if project economics improve.

The Impact of Grid Disruption on Oklahoma's Military Installations

The Grid: Scope and Future

The electrical grid is a marvel of modern engineering, and has been called the "supreme engineering achievement of the 20th century" by the National Academy of Engineering (MIT 2011, 1). The grid consists of about 6 million miles of transmission and distribution lines, which are owned by over 3,000 different public, private, and cooperative institutions. This complex system provides power to around 145 million users, such as homes, factories, and offices (MIT 2011, 1).

However, the state of the electrical grid is rapidly deteriorating, as evidenced by the steadily rising rate of grid outages. Amin analyzes the total number of power outages of 100 Megawatts or more during consecutive five-year periods from 2000-2009, and finds that:

> Adjusting for a 2 percent per year increase in load to 2000 levels, these outages reflect a trend. First, there were 147 outages of 100 megawatts or more during 2000-

> 2004; such outages increased to 230 during 2005-2009. Second, assuming the same 2 percent annual demand growth, the number of U.S. power outages affecting 50,000 or more consumers increased from 140 during 2000-2004 to 303 during 2005-2009 (Amin 2011).

The grid is also increasingly vulnerable to both natural and intentional disruptions. These vulnerabilities do not stem from a lack of energy, as the United States has large reserves of critical energy resources, such as coal and natural gas. Rather, the problem stems from the frailty of the grid itself, and its susceptibility to acts of sabotage (Defense Science Board 2008, 11; Sameras and Willis 2013, xi). The DSB (2008) isolated four scenarios for grid collapse. First, overload, which makes power lines sag and overheat, can create cascading power outages. Second, natural disasters, such as tornados and hurricanes, may severely impact the grid. Third, and potentially most damaging, are targeted terrorist attacks using physical, cyber, or EMP weapons that can disable the grid for months. Fourth, interruption of fuel supplies from natural, terrorist, or economic forces can disrupt electrical generation.

The 2003 Northeastern power outage is a particularly instructive example of electrical grid weakness. This outage caused a loss of power to over 50 million customers in both the Unites States and Canada. Moreover, over 500 power generation facilities were taken off-line, including 22 nuclear power stations (MIT 2011, 36; Defense Science Board 2008, 54). The task force sent to investigate this incident found that the blackout originated from an Ohio utility's failure to distance a power line from a nearby tree. Simply put, 50 million people lost power for up to two weeks because of an untrimmed tree branch. What is most surprising, however, is that precautionary load-protection measures were primarily to blame for the grid's failure. Differences in load (electrical demand) and supply can severely damage the electrical infrastructure. This suggests that seemingly small failures can have a cascading effect on the entire system. (MIT 2011).

DOD has a massive domestic presence. It occupies more than 300,000 structures with a combined building space of 2.2 billion square feet, three times Wal-Mart's total retail and support space. (Robyn 2012; "Department of Defense Annual" 2011; Sameras and Willis 2013; Marqusee 2012). Furthermore, DOD installations use immense amounts of power. In fact, DOD alone consumes more energy than Nigeria, which has a population of 140 million (Castillo 2012, 2). Facility energy needs represent about 25 percent of this usage, while the rest is for operational needs. However, this balance is likely to shift with the recent and continuing drawdowns in Iraq and Afghanistan (Robyn 2010). Even with a relatively low share of total DOD energy use, facility energy costs DOD nearly $4 billion annually. (Kleber 2009; Department of Defense Annual" 2011; Robyn 2010).

Despite the grid's frailty, the U.S. military's domestic installations are almost entirely dependent on it, with about 99 percent of all power used by DOD coming from the grid (Defense Science Board 2008; Sameras and Willis 2013; Aimone 2012). There are few methods to provide external electrical support to military installations, and the military only retains enough mobile energy capability to sustain a few large bases at any one time. Even worse, many units responsible for this task are located too far away or are too small to provide adequate support to domestic installations (BENS 2012). This means many installations must rely on power produced on-site.

Some on-site power capability exists on nearly all military installations. However, this energy comes from diesel generators, which were not built for long-term operation. As such, most bases typically keep enough fuel for only three days of operation (Broekhoven et al. 2013). Additionally, there are numerous problems associated with reliance on diesel generators. First, these generators usually provide power to individual buildings, and therefore cannot be re-tasked to feed power to mission-critical loads. This lack of energy management means some large installations can have over one hundred generators not well-integrated with other sources of power (Broekhoven et al. 2013; Defense Science Board 2008). Second, diesel generators require increasingly more maintenance as they are used, which implies that bases may have to temporarily power down for major repairs (Castillo 2012, 27). While an operational lapse may have been acceptable when these generators were first installed, this system is not feasible for modern military operations that require real-time support from domestic military installations. Third, diesel generators have proven vulnerable to cyber-attacks, as evidenced by a Department of Homeland Security test that caused a generator to self-destruct (Castillo 2012). Finally, the same factors that can destroy the electrical grid can also disrupt the transportation of petroleum. This suggests it would be difficult to resupply generators after their stored fuel supplies are exhausted (Defense Science Board 2008).

The Importance of Domestic Installations

Domestic bases, regardless of geographic location, are critical to U.S. military activities at home and abroad. This is because advanced technologies have fundamentally shifted the role of domestic installations from training and deploying forces, to providing real-time support and intelligence to U.S. forces. For example, predator drone missions in Afghanistan are frequently piloted from bases in Nevada (Robyn 2010, 3; Aimone 2012, 3). Furthermore, domestic bases often provide critical command and control and strategic deterrence functions (Defense Science Board 2008; Sameras and Willis 2013).

Oklahoma has two Army and three Air Force installations, which fill vital military roles. Altus Air Force Base (AFB), located in Southwest Oklahoma, hosts the 97th Air Mobility Wing, which commands the only heavy mobility and air fueling school in the U.S. Air Force (USAF). Altus also hosts the HQ Air Mobility Command Detachment 2 that certifies the performance of air training simulators. Fort Sill, in Southwest Oklahoma, is one of five army basic combat training sites – as well as the Army's premier field artillery training school. In Southeast Oklahoma, McAlester Army Ammunition Plant produces and stores conventional ammunition and missiles. Tinker AFB, located in Central Oklahoma, is a critical installation hosting several specialized units. Finally, Vance AFB, in Northwest Oklahoma, hosts the 71st Training Wing (Oklahoma Department of Commerce 2011).

Tinker AFB is arguably Oklahoma's most strategically important military installation because it hosts the Navy's Strategic Communications Wing ONE, which is responsible for the maintenance and support of the E-6B Mercury aircraft fleet (Office of Economic Adjustment 2013; Oklahoma Department of Commence 2011). These aircraft are tasked with allowing the President and Secretary of Defense to communicate with strategic nuclear forces, including bombers, missile silos, and nuclear submarines (Office of Economic Adjustment 2013; ACOG 2008). Presently, Strategic

Communications Wing ONE is the only one of its kind under the control of the Department of the Navy (ACOG 2008, I-4). Tinker was originally chosen by the Navy because its location, near the center of the continental U.S., ensured the E-6B aircraft could survive a nuclear attack. After such an attack, these aircraft are to provide communication capability to surviving U.S. nuclear forces (Schill 1995, 7). Unfortunately, the E-6B might be unable to take-off after a devastating attack on the electrical grid, since airfield communications, lighting, and approach systems require power to function (Sameras and Willis 2013, 21).

As a result of electrical grid vulnerability, Tinker, and other bases that hold similar strategic importance, may appear to be extremely vulnerable targets to an enemy. Further, during tense relations, a rival state could decide that a cyber or EMP attack on the electrical grid could entirely prevent a nuclear response, which would make the idea of a nuclear first-strike seem like a viable course of action. While this scenario is unlikely, state policy makers should be aware of the strategic role that their installations play, and the possible consequences of leaving those bases unprotected.

The strategic importance of these military installations depends primarily on how long the United States can maintain military readiness without their individual contributions. These bases also provide security in the form of available disaster relief to their local communities. In the aftermath of Hurricane Katrina, military bases played three critical roles: as bases of operation for relief and rescue missions, as command and control stations for various national resources, and as providers of skilled personnel to aid in rescue efforts. Oklahoma's military installations have undertaken similar operations. During both the 2013 Moore tornado and a 1999 tornado outbreak, Tinker AFB provided substantial relief aid (O'Brien 2013). And amid an ice storm in 2007, Tinker aided Oklahomans whose homes had lost power and heat (ACOG 2008, II-10). Furthermore, these bases would be required to ensure the well-being of civilians in the aftermath of a terrorist attack. But without a stable supply of electrical power, military bases will be unable to fulfill their disaster relief obligations (Defense Science Board 2008, 53). These obligations will become even more important as climate change increases the likelihood of natural disasters (President's Council of Economic Advisors 2013).

The Potential for Additional Installation Energy Security from On-Site Renewable Energy Sources

Considering the vulnerability of the commercial electrical grid, along with the unreliability of diesel generators and, to a lesser extent, natural gas generation, renewable energy sources appear best suited to provide energy security. Renewable energies offer a massive advantage over other conventional fuel sources. Namely, unlike diesel and natural gas, neither sunlight nor wind have to be trucked or pipelined to an installation, suggesting that only renewable energy can truly be considered on-site generation. Further, to provide critical support to deployed forces, military installations must be self-sustainable for months (BENS 2012). In the event of a catastrophic disruption to the electrical grid, conventional fuels will not be able to provide steady, high-quality power. Renewable energy sources, along with an advanced micro-grid system, can provide sustained power to critical military loads (Castillo 2012; "Department of Defense Annual" 2011). There are challenges associated with integrating renewable energy generation with a micro-grid. However, current technologies and technical understanding should prevent these issues from inhibiting the effectiveness of on-site renewable energy (BENS 2012).

Renewable energy potential, such as sunlight and wind, must be adequate before renewable energy technologies can be considered feasible. In a report describing renewable energy project economics at Fort Sill, Nesse et al (2011) found that Oklahoma has moderate solar and moderate-high wind potential. However, DOD's Annual Energy Management Report (2011) found that the availability of renewable energy sources was not the primary inhibitor of renewable energy development. Rather, factors such as permitting, mission execution, and land ownership were the cause of limited renewable development.

Renewable Energy: Challenges and Potential

This paper focuses on the two most common renewable energy technologies, solar PV and wind. Solar PV seems the most viable technology for a number of reasons (Castillo 2012). First, there are numerous examples of the effectiveness of solar PV. Nellis AFB installed a 14-megawatt solar PV array that provides a quarter of its energy needs, reduces its CO2 emissions by 24,000 tons, and saves $1 billion annually (Robyn 2010, 6). Santa Rita Jail, the fifth largest in the United States, installed a 1.2- megawatt rooftop solar array that coupled with other technologies, saves the jail up to $20,000 per year and helps provide uninterrupted power. The Sendai Project in Japan was designed to test a micro-grids ability to control a complex electrical system. The Sendai micro-grid, augmented with a 25-kilowatt solar array, survived a two-day blackout caused by the 2011 Japan earthquake (Marney et al. 2012, 66).

A second advantage of solar is that during heat waves, which place tremendous stress on the grid, sunlight is abundant. As a result, solar PV would become much more effective and be able to reinforce grid stability In fact, the 2003 Northeastern blackout, caused in-part by a heat wave, would not have spread so far if the commercial grid had a moderate amount of solar PV generation (Perez et al. 2011). Third, solar PV technologies have a relatively long life-span. A properly maintained solar array will still produce about 60 percent of its initial rating after 50 years of operation (Perez et al. 2011). However, the promise of solar PV is reduced by its largest, and most obvious, flaw. It cannot produce electricity at night, which along with a lack of high-quality batteries, will undermine its contribution to installation energy security (Sadler et al. 2008, xx).

Wind power also has potential. Unfortunately, wind power has several serious problems that make it a sub-par choice. The wind power industry is not as mature as solar PV, since the solar industry has gained much experience on the residential level. Wind also has high up-front capital costs. Furthermore, siting large-scale wind farms is difficult because of environmental, military, and local concerns. The most daunting obstacle to the effectiveness of wind projects is the turbine's spinning blades. Wind turbines can severely disrupt radar tracking systems, since the spinning blades have a larger radar signature than a Boeing 747. While several agencies are attempting to find solutions to this problem, at present, wind technologies do not seem viable as an option to provide energy security to military installations (Scholtes 2013; Robyn 2010).

There is also a question of whether an on-site renewable system should be owned and operated by the military or the private sector. BENS (2012) finds that private sector ownership offers the better option. The first reason is because energy production is not currently a military competency. This implies that DOD does not have the expertise to manage renewable energy systems, especially large-scale systems (Broekhoven et al. 2013). Second, since DOD faces uncertainty in funding, it is unlikely to budget for developing electrical infrastructure without help from private sector financing (McAlister 2011; Nesse et al. 2011). Moreover, there seems to be a positive correlation between the presence of private industry and the quality of military electrical systems (BENS 2012, 30). Despite the promise of private ownership, BENS (2012, 29) has postulated that the private sector may not be able to function in many localities, such as Oklahoma, because of regulatory and siting concerns.

Resolving Barriers to the Deployment of On-Site Renewable Energy Technologies in Oklahoma

How PPAs Can Solve Cost Concerns

There are two main cost impediments to the introduction of on-site solar PV or wind power on U.S. military installations in Oklahoma. First, high up-front capital costs make it difficult for the Defense Department to afford on-site solar PV or wind projects, since these project may require hundreds of millions of dollars just to install (McAlister 2011, 9). Second, Oklahoma's electricity prices are far below the national average. In 2010, Oklahoma's average electricity price was 7.59 cents per Kilowatt hour (Kwh), compared to the national rate of 9.83 cent per Kwh (EIA 2012). These price trends have held relatively constant, with Oklahoma's July 2013 average retail price at 8.38 cents per Kwh compared to the national average retail price of 10.71 cents per Kwh (EIA 2013). Low electricity prices undermine the economic basis for renewable energy, since wind and solar PV are more costly than conventional fuels (Nesse et al. 2011, 6). Indeed, the Navy has stated it will only purchase renewable energy if it is competitive with other conventional sources of power ("Department of Defense Annual" 2011).

These barriers can be broken with the help of innovative financing mechanisms, such as a third-party power purchase agreement (PPA). A third-party PPA includes a customer, system owner, and utility. The system owner installs, operates, and maintains the on-site renewable energy system, usually solar PV. The customer (i.e., a military installation), purchases power by Kwh from the system owner, and may purchase additional power from a local utility if needed. Alternatively, if the system owner generates more power than the customer requires, it can be sold to the utility. Lastly, the system owner also gets to keep any federal or state incentives payments (Cory, Caravan, and Koenig 2009).

PPAs are attractive to DOD for a number of reasons. First, PPAs require little or no upfront capital from DOD, since the system owner is responsible for installation. Second, DOD pays a lower price for energy because the system owner passes down savings earned through government incentives, such as the Production Tax Credit (PTC), a refund for each Kwh the power producer generates. Third, the costs of power are more stable and predictable, since PPAs are usually long-term contracts. Fourth, DOD does not have to deal with system design and permitting. Fifth, since DOD does not maintain or operate the system, it can focus on its primary operations (Cory, Caravan, and Koenig 2009). Taken together, these advantages can dramatically reduce costs, and may make $100 million projects viable (Scholtes 2013, 64; McAlister 2011; Nesse et al. 2011). For example, White Sands Missile Range in New Mexico saves nearly $1 million annually through its twenty-five year solar PV PPA (Scholtes 2013, 80).

Unfortunately, third-party PPAs are impractical in Oklahoma (DsireSolar 2013). This impracticality derives from the Oklahoma Corporation Commission Code, Okla. Stat. tit. 17, §151 (2013):

> The term "public utility" as used in Sections 151 through 155 of this title, shall be taken to mean and include every corporation, association, company, individuals, their trustees, lessees, or receivers, successors or assigns, except as hereinafter provided, and except cities, towns, or other bodies politic, that now or hereafter may own, operate, or manage any plant or equipment, or any part thereof, directly or indirectly, for public use, or may supply any commodity to be furnished to the public.
> (a) For the conveyance of gas by pipeline.
> (b) For the production, transmission, delivery or furnishing of heat or light with gas.
> (c) For the production, transmission, delivery or furnishing electric current for light, heat or power.
> (d) For the transportation, delivery or furnishing of water for domestic purposes or for power…

While this regulation does not explicitly restrict the use of third-party PPAs, it does not distinguish between a system owner engaged in a PPA and a traditional utility. Therefore, a system owner is subject to a flood of administrative and regulatory restrictions, which may undermine profitability, and, as a result, partnership potential. (Scholtes 2013; McAlister 2011).

However, it remains unclear whether DOD is subject to state utility laws. United States Code 10 sec 2922a states that "...the Secretary of a military department may enter into contracts for periods up to 30 years for the provision and operation of energy production facilities on real property under the Secretary's jurisdiction or on private property and the purchase of energy produced from such facilities..." Still, the law does not clarify how to resolve state barriers to PPA adoption (McAlister 2011). DOD would probably be able to fend off legal challenges from the State of Oklahoma, but this legal uncertainty will likely dissuade private groups from participating in PPAs (Scholtes 2013).

Oklahoma's Renewable Failure

Other than the restriction of PPAs, there is no single cause of Oklahoma's scant renewable energy economy. A 2003 Union of Concerned Scientists report, which graded states based on renewable energy generation, placed Oklahoma in the "hall of shame" because its renewable generation was paltry, despite adequate wind and solar potential. A number of political factors seem to contribute to Oklahoma's reluctance to support local renewable energy development. Wiener and Koontz (2010, 641-643), who conducted a qualitative analysis by interviewing prominent state employees, environmental advocates, and wind turbine installers, found that Oklahoma's political culture strongly supports oil and gas development, mainly because it was responsible for the state's early economic activity. As a result, the oil and natural gas lobby consistently undermines environmental and renewable interests. It is also possible that, even if the power of oil and gas interest is overstated, the very perception of such influence may discourage a supportive renewable energy agenda from coalescing. Further, Oklahoma is a politically conservative state, which evidenced by strong Republican majorities in both the state's House of Representatives and Senate. As a consequence of this conservative ideology, Oklahoma's citizenry strongly supports free-market principals, is 'very suspicious of change, especially if it is coming from the government', and is apathetic to environmental degradation.

Unfortunately, the level of state support and the strength of incentives are major factors in determining DOD renewable energy project economics (BENS 2012; Nesse et al. 2011). This is not likely to change as states take the lead in alternative energy (Williamson and Sayer 2012). This shift, from a federally led to state led renewable agenda, is likely to continue for many reasons. First, state governments have begun to associate renewable energy with long-term economic growth. Second, many states perceive that climate change may be responsible for violent storms and other natural disasters, and this perception may lead them to conclude that supporting renewable energy technologies is a necessary cost (Rabe 2008). Third, at 16 percent, renewable energy's share of federal R&D funding is low (Rosenberg 2009). Last, a comprehensive federal policy regarding renewable energy is not likely to appear in the near future (Rabe 2008). This suggests that if Oklahoma's military bases are to be secure, then the state must foster an energy environment conducive to their security.

A small, but potentially productive, step Oklahoma could take is strengthening its Renewable Portfolio Standard (RPS), which is a mandate requiring utilities to derive a certain percentage of their electrical load from specified renewables by a specified date (Rabe 2008). Though, there is some doubt as to whether an RPS is an effective policy tool. An empirical study on RPS effectiveness found that while they do not usually succeed in increasing the share of renewable energy production compared to conventional fuel sources, they do increase total renewable energy production (Carley 2009). Regardless, a mandate requiring an increase in renewable energy generation, along with financing schemes like the PPA, may drive more private entities to seek to develop on-site solar PV or wind.

Oklahoma currently has a voluntary goal, enacted by the legislature in 2010, of achieving 15 percent of electrical generation from renewable sources by 2015 (Brunette 2011; DsireSolar 2013). There are multiple problems with this goal. It is only voluntary and is to expire in 2015, so it is not clear whether Oklahoma will replace it with similar or more stringent requirements. Additionally, efficiency improvements can count toward up to a quarter of the 15 percent goal, which means the actual renewable energy generation target is just 11.25 percent (Nesse et al. 2011, A-4).

Conclusion

The U.S. electrical grid is a marvel of modern science and engineering. Unfortunately, the grid is falling into disrepair, and a large and prolonged power outage would nearly collapse U.S. military capability by disabling domestic military installations (Defense Science Board 2008). This paper advocates solar photovoltaic (PV) as the most versatile and effective technology to achieve energy security.

There are two main cost impediments to the introduction of on-site solar PV on U.S. military installations in Oklahoma: high up-front capital costs and electricity prices far below the national average in Oklahoma. Since DOD is facing a period of austerity, these low electricity prices effectively undermine the economic basis for renewable energy (Nesse et al. 2011). A third party PPA is the best way to mitigate the challenges associated with high costs. Unfortunately, third-party PPAs are impractical in Oklahoma due to regulatory measures.

Furthermore, the level of state support and the strength of incentives are major factors in determining DOD renewable energy project economics (BENS 2012; Nesse et al. 2011). A small, but potentially productive step Oklahoma could take is to strengthen its Renewable Portfolio Standard (RPS), which mandates that utilities derive a certain percentage of their electrical load from specified renewables by a set date (Rabe 2008).

The commercial electrical grid, along with other energy infrastructure, will be a vulnerable target for the foreseeable future. Unless the federal government creates a national renewable energy policy, states will have to encourage a private sector environment conducive to profitable renewable development and innovative financing mechanisms, such as the PPA. While the State of Oklahoma alone will not alone decide the security of the United States, it can take can positive steps to ensure both regional and national security.

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