NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

SAVING GREEN: HOW THE DOD CAN BETTER MANAGE ENERGY EFFICIENCY INITIATIVES

December 2017

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REPORT DOCUMENTATION PAGE				*Form Approved OMB No. 0704–0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.				
1. AGENCY USE ONLY ***(Leave blank)***	**2. REPORT DATE** December 2017	**3. REPORT TYPE AND DATES COVERED** MBA professional report		
4. TITLE AND SUBTITLE SAVING GREEN: HOW THE DOD CAN BETTER MANAGE ENERGY EFFICIENCY INITIATIVES				**5. FUNDING NUMBERS**
6. AUTHOR(S) Zachary S. Wilson				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000				**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A				**10. SPONSORING / MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB number ____N/A____.				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release. Distribution is unlimited.				**12b. DISTRIBUTION CODE**
13. ABSTRACT (maximum 200 words)				
14. SUBJECT TERMS energy efficiency, Energy Savings Performance Contract, ESPC, Energy Conservation Investment Program, ECIP, energy planning, energy strategy				**15. NUMBER OF PAGES** 79
				16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified		**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

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The purpose of this study is to evaluate whether there are predictive factors that increase or decrease the probability of a particular class of energy related projects being adopted within the Department of Defense (DOD). A database of 372 approved projects is analyzed relative to 666 unique DOD sites to determine what factors influence project adoption. Tested hypotheses include internal factors like the ease of implementation and investment return as well as external factors like imitation and environmental friendliness norms. Ultimately, this research looks for ways to better equip managers to plan for and resource the adoption of energy-saving initiatives.

The conventional view holds that project adoption is primarily an internally driven process; however, this study finds that external factors significantly influence adoption. For example, imitation seems to be a crucial predictive factor. Also, whether consciously or not, DOD managers may feel increased pressure from environmentally conscious local stakeholders. Lastly, when it comes to project adoption, the DOD could be characterized as a learning, risk-averse culture. Recommendations from this study include the development of a tool for energy initiative prioritization and adoption, the merging of current infrastructure and energy reporting documents, and the designation of adoption leaders by region.

NSN 7540–01-280-5500 Standard Form 298 (Rev. 2–89) Prescribed by ANSI Std. 239–18

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SAVING GREEN: HOW THE DOD CAN BETTER MANAGE ENERGY EFFICIENCY INITIATIVES

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Submitted in partial fulfillment of the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
December 2017

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ABSTRACT

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LIST OF ACRONYMS AND ABBREVIATIONS

ASD(EI&E)	Office of the Assistant Secretary of Defense for Energy, Installations, and Environment
AT&L	Office of the Undersecretary of Defense for Acquisition, Technology and Logistics
BBTU	Billion British Thermal Units
DeCA	Defense Commissary Agency
DIA	Defense Intelligence Agency
DLA	Defense Logistics Agency
DOD	Department of Defense
DODIG	Department of Defense Office of Inspector General
DOE	Department of Energy
ECIP	Energy Conservation Investment Program
ECM	Energy Conservation Measures
ESCO	Energy Services Company
ESPC	Energy Saving Performance Contract
FAR	Federal Acquisition Regulation
FY	Fiscal Year
GAO	Government Accountability Office
MCAS	Marine Corps Air Station
MILCON	Military Construction
NAS	Naval Air Station
NDAA	National Defense Authorization Act
ODASD(IE)	Office of the Deputy Assistant Secretary of Defense for Energy, Installations, and Environment—Installation Energy
OSD	Office of the Secretary of Defense
PRV	Plant Replacement Value
SF	Square Footage
SIR	Savings-to-Investment Ratio

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EXECUTIVE SUMMARY

In the Department of Defense (DOD), energy use intersects nearly every national security challenge. Over the past decade, the DOD has awarded billions of dollars in appropriations and performance-based contracts to energy related priorities (Federal Energy Management Program, 2017 and Office of the Deputy Assistant Secretary of Defense for Energy, Installations, and Environment—Installation Energy, 2017). The DOD's adoption of these energy saving initiatives, can serve multiple goals, such as saving money, reducing operational dependence on foreign sources of energy, increasing infrastructure resiliency, and fostering social goodwill (Lovins, 2010). However, as this research finds, DOD managers may not be sufficiently equipped to plan for and resource the best mix of projects because they may not fully understand the factors that influence project adoption decision-making.

Competing funding priorities have the potential to create capital constraints that may impede project adoption (Andersen and Brown, 2010). To combat this phenomenon, the DOD has employed innovative financing techniques to accomplish energy conservation goals at its fixed installations. Energy Saving Performance Contracts (ESPC) are one such vehicle where the government finances infrastructure improvements via initial investments from private-sector energy services companies (Department of Energy, 2017). This process effectively transfers the financial risk of the energy-saving venture to the private investor. Over time, successful projects create energy-savings that provide a return on investment to both the private company and to the government (T. Unruh, 2014). A more traditional Military Construction (MILCON) energy-saving initiative is the DOD's Energy Conservation and Investment Program (ECIP). This program is funded by an annual appropriation of around $150 million (Jung, 2017). To isolate factors that influence the adoption of energy saving initiatives in the DOD this study analyzed a database of 372 ESPC and ECIP projects relative to 666 unique DOD infrastructure sites.

This study determined that **imitation is an adoption catalyst**. DOD managers seem to be learning passively, through observation of other site's actions, or actively,

through deliberate knowledge transfer between sites. As the number of adopters within a state increases, the probability of subsequent project adoption within that state increases. Similarly, adoption clusters were identified in a total of seventeen states. As Figure E1 indicates, the proportion of a state's total energy (all sites) covered by an adopted initiative is considerably higher within identified clusters (1.338) than the national average (0.531). This supports the idea that a site's proximity to an adopter influences future adoption at that site. When prioritizing future projects, DOD managers should leverage the potential for imitation by focusing efforts on sites with many neighbors. Success at these sites better positions surrounding sites to pursue and implement similarly successful projects.

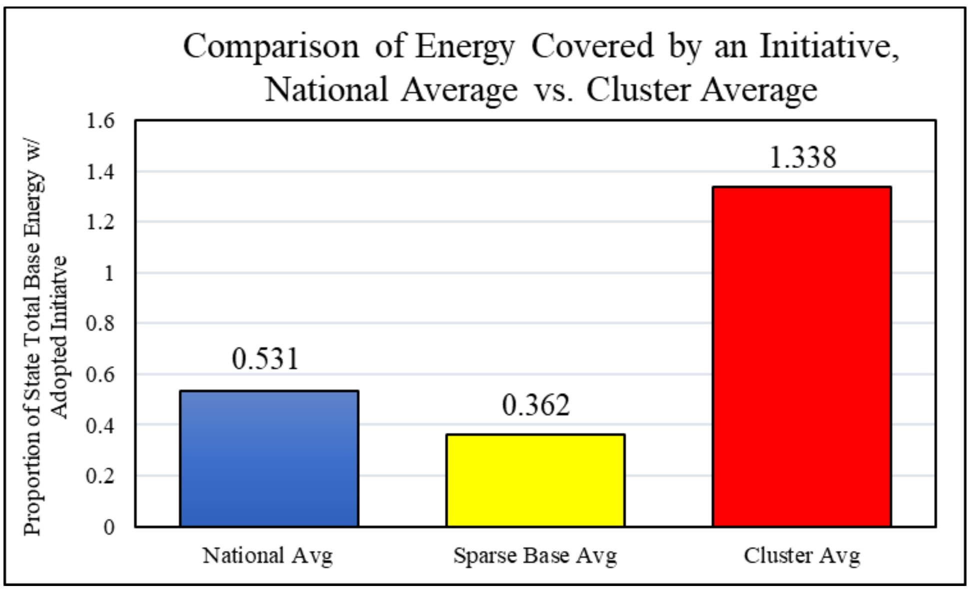

Figure E1. Comparison of Energy Proportions in Clusters and National Average

Prior research has shown that, in general, some managers feel indirect pressure from local stakeholder's environmental priorities (Berrone et al., 2010). In response to this pressure they tend to take actions to be good citizens in an effort to reap intangible, social benefits. This study also found that these local **environmental norms do matter** in the DOD. The results indicate that states with higher environmental friendliness norms, as measured by Sierra Club membership per capita, tend to have a higher quantity of adopted projects. Table E1 displays the results of a logistic regression model in which

Sierra Club membership per capita was found to be a significant predictor of project adoption (p = 0.0241). Furthermore, a modest increase in the strength of this environmental friendliness proxy (0.001) results in a 27.9% increase in the probability of adoption. This research indicates that DOD managers, whether consciously or not, seem to feel increased pressure from environmentally conscious local stakeholders.

Table E1. Logistic Regression Model of Sierra Club Membership Per Capita

Predictor	β	*Std E*	*Z-value*	Pr(>|z|)	*Exponentiated* β
Sierra Club Membership per Capita	2.46E+02	1.09E+02	2.255	**0.0241**	7.70E+106
Base Population	1.29E-04	3.94E-05	3.277	**0.0011**	1.00E+00
Total Site Delivered Energy (BBTU)	4.20E-04	4.08E-04	1.029	0.3034	
Intercept	-1.714	3.601E-01			
Pseudo R^2					
McFadden	0.608				
Cox and Snell	0.833				
Number of Observations					
Model	249				
Null	666				

How Change in Predictor Value Influences Adoption

	Increment Value	Adjusted Odds Ratio	Est. Change in Pr of Adoption
Sierra Club Membership per Capita	+0.001	1.279	27.9%

The premise of this research is that DOD managers will be able to more effectively implement the most beneficial projects if they actively incorporate more about what causes project adoption into their decision process. Currently, it may be tacitly understood within the DOD that project adoption is mainly an internally driven process. However, these results indicate that it is actually also an externally driven process. These results may also indicate that the projects being forwarded for adoption in the current DOD decision process may not be the most optimal for the DOD to adopt because they ignore these external factors. Overall savings from energy conservation might be greater if these factors were deliberately incorporated into the DOD's energy planning process.

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I. INTRODUCTION

Through the adoption of energy-saving initiatives, the DOD can save money, reduce its operational dependence on foreign sources of energy, increase infrastructure resiliency, and foster social goodwill (Lovins, 2010). Like the private sector, the Department of Defense (DOD) has been under pressure to increase its energy efficiency. This pressure has been applied by traditional stakeholders who are concerned about the department's energy use and liabilities. Congress, for example, is most interested in lowering the DOD's energy costs and reducing risk exposure to energy interruptions (10 U.S.C. § 2911, 2017). Regardless of your desired outcome, as Lovins argues, efficient energy use is good for the organization because it serves many different goals (Lovins, 2010).

Achievements in the private sector by companies like DuPont and Walmart serve as examples of how energy efficiency can serve multiple goals. Over the past decade, through a combination of focus, innovation, and incentive DuPont's energy strategy has saved the company $2 billion while simultaneously reducing its greenhouse gas emissions by 72% (Esty and Winston, 2006). Similarly, Walmart, the nation's largest retailer, operates several sustainability programs. These programs are guided by the company's three-pronged sustainability vision "to be supplied by 100% renewable energy, to create zero waste, and to sell products that sustain people and the environment" (Walmart, 2017b). Collectively, these programs have saved Walmart over $1 billion (Walmart, 2015). The achievements of these companies demonstrate that the business case for energy efficiency is growing stronger every day. As Walmart's Chief Sustainability Officer Kathleen McLaughlin puts it, "Ultimately, environmental, social and economic interests converge for all of us" (Walmart, 2017a).

A. PURPOSE

Over the past decade the DOD has awarded billions of dollars in appropriations and performance-based contracts to energy related priorities (Federal Energy Management Program [FEMP], 2017a and Office of the Deputy Assistant Secretary of

Defense for Energy, Installations, and Environment—Installation Energy [ODASD(IE)], 2017b). Because DOD managers execute public policy on behalf of the taxpayers, there is an expectation that outlays related to project prioritization should be based on efficient economic and managerial thinking. For instance, U.S. Secretary of Defense James Mattis recently stressing this concept by stating, “The department takes the responsibility of being wise stewards seriously” (Ferdinando, 2017). Furthermore, external organizations like the Government Accountability Office (GAO) are charged to cultivate both improved managerial performance and accountability within the DOD (Government Accountability Office [GAO], 2017). Similarly, the Department of Defense Office of Inspector General (DODIG) is charged to prevent fraud, waste, and abuse of taxpayer funding by maintaining statutory compliance throughout the department (Department of Defense Office of Inspector General, 2017). Based on this combination incentive and pressure, DOD managers should be actively seeking out the most effective energy-saving projects.

The link between the perceived benefits and costs of an energy-saving project and the reasons for that project’s actual adoption may, however, not necessarily be well understood within DOD. This poses challenges for the DOD and for those with policy oversight responsibilities because they may be failing to maximize the utility of existing programs by not incorporating all the significant drivers of adoption into the decision-making process. The purpose of this study is to evaluate whether there are predictive factors that increase or decrease the probability of energy-related projects being adopted within the DOD. Ultimately, this research looks for ways to make the best use of existing energy conservation programs by deliberately incorporated key factors into the decision-making process that make project adoption more efficient and effective.

1. Research Questions

- Are there specific factors that influence the adoption of energy-saving initiatives within the DOD?
- What is the role of the external environment on the DOD’s adoption of energy-saving initiatives?

- Are there organizational or managerial actions that can make the adoption of energy-saving initiatives more efficient and effective?

B. SCOPE AND LIMITATIONS

This analysis does not include all energy related policies and programs within the DOD. Operational energy comprises nearly three-quarters of all energy consumed within the DOD (Schwartz, Blakely, & O'Rourke, 2012). This research, however, focuses on installation energy. Installation energy consumption comprises the remaining quarter of DOD's total energy consumption (Schwartz, Blakely, & O'Rourke, 2012). Similarly, the analysis of installation energy programs is not all-encompassing. The results and conclusions are based on analysis of 280 Energy Conservation Investment Program (ECIP) projects and 92 Energy Saving Performance Contracts (ESPC) relative to 666 unique DOD sites. Data regarding the Utility Energy Service Contract (UESC) program, another significant installation energy performance contracting initiative, was not readily available and is not included in this analysis.

This research does not attempt to provide a detailed description of specific procedures unique to the analyzed programs, nor does it examine the efficacy of the programs. Rather, the assessment is focused primarily on the managerial perspective. Lastly, the published data regarding the analyzed programs only lists approved projects. Direct analysis regarding trade-offs between adopted and non-adopted project alternatives is not possible, except through deduction. Adopted projects are examined relative to a population of sites where projects were not adopted (160 of 666 examined DOD sites had adopted projects).

C. ORGANIZATION OF THE REPORT

This paper is organized to introduce and evaluate hypotheses regarding the critical factors surrounding the adoption of energy-saving projects within the DOD.

Chapter II introduces the ESPC and ECIP programs. Additional background information is provided regarding installation energy concepts within the DOD, general barriers to energy initiative adoption, and public-private partnerships. This chapter is meant to facilitate an understanding of the subsequent hypotheses and to enable managers to understand the context of the energy initiative decision-making process.

Chapter III presents six hypotheses regarding the potential factors that may influence project adoption within the DOD. An abbreviated literature review is nested within the presentation of each hypothesis. These hypotheses form the basis for all data analysis and conclusions found within in this research.

Chapter IV provides a discussion of the data used to perform the analysis. This section is meant to better enable further research of this topic.

Chapter V details the employed research methods and provides a discussion of the results of the analysis.

Chapter VI lists the main conclusions and implications resulting from the analysis and provides specific recommendations to address the findings.

After reviewing this research, the reader will be better postured to make the best use of existing energy conservation programs through a better understanding of the factors that influence project adoption.

D. SUMMARY

Implementing energy-saving improvements at DOD facilities offers "synergistic benefits" because the best approaches to energy tend to serve a variety of goals simultaneously (Lovins, 2010, p. 41). DOD managers, guided by their stewardship of taxpayer dollars, should prioritize projects in a way that maximizes benefits. Currently, however, DOD managers may not be cognizant of all the factors that influence energy-initiative adoption. This research endeavors link the perceived benefits and costs of an energy-saving project with the reasons for that project's actual adoption. DOD managers may then use this knowledge to make the best use of existing energy conservation programs by deliberately incorporated key factors into the decision-making process that make project adoption more efficient and effective.

II. BACKGROUND

The DOD's infrastructure portfolio is comprised of over 500 disparate sites containing a total of over 500,000 buildings across the globe, and costs around $4 billion each year to operate and maintain these facilities (ODASD(IE), 2017a). Energy costs are the largest single driver of facility cost and the DOD has been committed to lowering these costs (U.S. Department of Defense, 2013). To lower these costs and operate its facilities more efficiently, DOD has been pursuing projects to reduce energy usage.

A. ENERGY SAVING PERFORMANCE CONTRACTS

ESPC's are performance contracts that are designed to circumvent capital constraint obstacles through innovative financing techniques. The purpose of an ESPC arrangement is to enable the implementation energy-saving initiatives at no initial cost to the government. Per the Department of Energy (DOE), an ESPC is a unique contract vehicle in which an "energy services company (ESCO) designs, acquires, installs and finances energy and/or water conservation projects at an existing federal facility" (Department of Energy [DOE], 2017). An ESPC is defined for a specific period, usually between 10 and 25 years. The crux of the ESPC program is that the contractor must guarantee energy-savings that fully fund the initial private investment (National Association of Manufacturers, 2014). Over time, the ESCO receives a return on investment through the resulting energy savings, directly related to the implemented projected (Unruh, 2014). Typically, energy-savings persist after the conclusion of the contract term, to the benefit of the government. Table 1 provides a breakdown of DOD ESPC projects by fiscal year (FY), since FY 1999. This table indicates the scope of the DOD's use of the program by listing cumulative totals for dollar amounts and energy savings among all DOD ESPCs by FY.

Table 1. Cumulative DOD ESPC Projects by FY. Adapted from Federal Energy Management Program (2017a).

FY	***Quantity of DOD Projects***	***Cumulative Project Investment***	***Cumulative Cost Savings***	***Total Energy Savings (BTU x 10^6)***
1999	2	$2,320,794	$5,526,712	39,995
2000	4	$19,777,104	$40,620,487	255,768
2001	8	$66,739,140	$126,393,053	325,046
2002	5	$51,231,880	$179,164,653	752,300
2003	12	$107,178,792	$219,756,066	1,090,411
2005	3	$42,945,409	$99,191,301	255,241
2006	11	$58,957,882	$137,980,711	489,970
2007	6	$47,887,746	$154,899,181	488,747
2008	7	$68,810,652	$164,313,850	281,259
2009	3	$62,511,169	$172,869,127	187,771
2010	12	$188,259,833	$499,308,542	1,372,551
2012	1	$80,559,242	$173,828,084	493,652
2014	4	$87,149,329	$212,582,844	276,018
2015	2	$25,713,080	$48,734,358	44,035
2016	4	$201,772,558	$555,327,218	832,336
2017	8	$436,839,363	$1,116,624,683	1,477,899

ESPCs have been utilized by every branch of the military. Table 2 further indicates DOD's scope of commitment to the ESPC program by displaying the quantity of ESPCs adopted by each military branch from FY 1999 - FY2017.

Table 2. Quantity of Adopted ESPCs by Military Branch Over Time. Adapted from Federal Energy Management Program (2017a).

	1999	*2000*	*2001*	*2002*	*2003*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2012*	*2014*	*2015*	*2016*	*2017*	**Total**
Air Force					2	2	5	3	2		1	1				2	**18**
Army		3	2	4	3	1	2	1	2		5		1	1			**25**
Marine Corps			1	1	3		2		1		1				1	1	**11**
Navy	2	1	5		4		2	1	2	3	5		1	1	3	5	**35**
Other								1					2				**3**
Total	**2**	**4**	**8**	**5**	**12**	**3**	**11**	**6**	**7**	**3**	**12**	**1**	**4**	**2**	**4**	**8**	**92**

ESPC policy is found in the Federal Acquisition Regulation (FAR), section 23.205, which directs agencies "to make maximum use of ESPCs when it is life-cycle cost-effective to reduce energy use and cost in the agency's facilities and operations"

(Federal Acquisition Regulation [FAR], 2017). FAR section 2.101 further defines ESPCs by what they require from a contractor:

- Perform services for the design, acquisition, financing, installation, testing, operation, and where appropriate, maintenance and repair, of an identified energy conservation measure or series of measures at one or more locations;

- Incur the costs of implementing the energy savings measures, including at least the cost (if any) incurred in making energy audits, acquiring and installing equipment, and training personnel in exchange for a predetermined share of the value of the energy savings directly resulting from implementation of such measures during the term of the contract; and

- Guarantee future energy and cost savings to the Government (FAR, 2017).

The ESPC program is a federal program run by the DOE. The DOE's Federal Energy Management Program (FEMP) is responsible for managing ESPC policy, collecting and maintaining data, and creating services and guidance to ensure agencies implement successful projects (Unruh, 2014 and DOE, 2017). EPSCs have been implemented by numerous federal agencies at sites throughout the United States and overseas (FEMP, 2017a). Figure 1 displays where a sample of ESPC projects from across the entire federal government, not just the DOD, have been adopted within the United States. This figure indicates the pervasiveness of the ESPC program and demonstrates that projects have been adopted in a variety of locations.

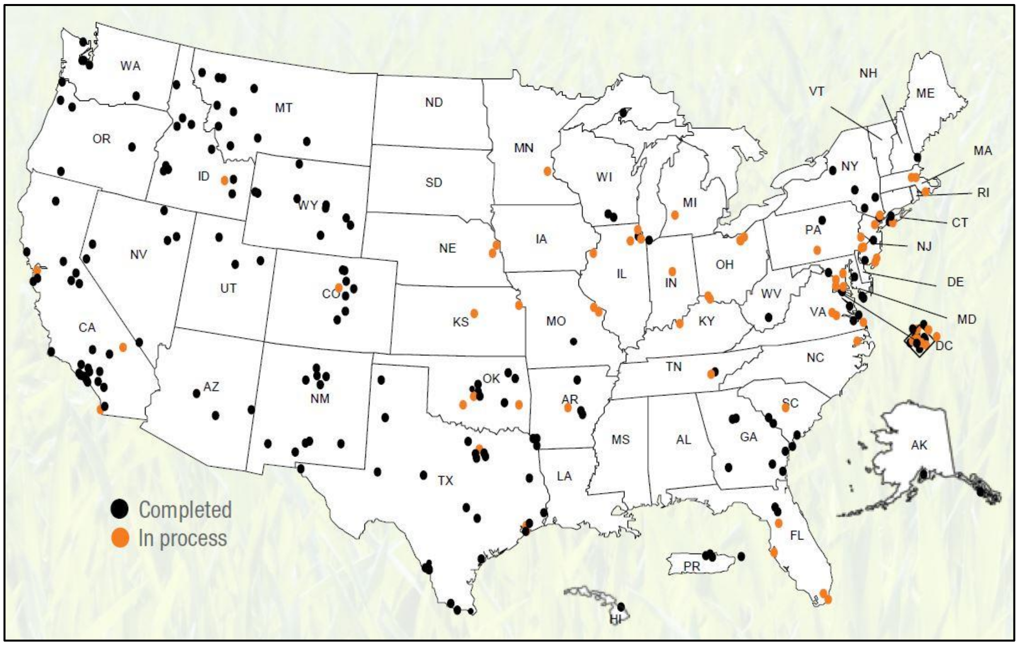

Figure 1. Federal Government ESPC Projects in the United States (2009-2014). Source: National Association of Manufacturers (2014).

In 1998, the DOE competitively awarded indefinite delivery/indefinite quantity (IDIQ) contracts to several qualified ESCOs to streamline the ESPC contract award process (DOE, 2017). The majority of federal ESPC investment has been through task orders issued under the DOE IDIQ contract. Current holders of 2017 IDIQ contracts from FEMP can be found in Table 3.

Table 3. Holders of 2017 FEMP ESPC IDIQ Contracts. Adapted from FEMP (2017c).

Organization	Contract Number
ABM Government Services, LLC	Contract: DE-EE0008025
AECOM Technical Services, Inc.	Contract: DE-EE0008026
Ameresco, Inc.	Contract: DE-EE0008027
The Brewer-Garrett Company	Contract: DE-EE0008028
CEG LLC	Contract: DE-EE0008029
Consolidated Edison Solutions Inc. (CES)	Contract: DE-EE0008030
Constellation NewEnergy, Inc.	Contract: DE-EE0008031
EDF Renewable Energy	Contract: DE-EE0008032
Energy Solutions Professionals, LLC	Contract: DE-EE0008033
Energy Systems Group, LLC	Contract: DE-EE0008034
Honeywell	Contract: DE-EE0008035
Leidos Engineering, LLC	Contract: DE-EE0008036
Lockheed Martin Corporation	Contract: DE-EE0008037
Noresco United Technologies	Contract: DE-EE0008038
OpTerra Energy Services	Contract: DE-EE0008039
Schneider Electric	Contract: DE-EE0008040
Siemens Government Technologies, Inc.	Contract: DE-EE0008041
SmartWatt Energy	Contract: DE-EE0008042
Southland Energy	Contract: DE-EE0008043
Trane U.S. Inc.	Contract: DE-EE0008048
WGL Energy Systems, Inc.	Contract: DE-EE0008049

The process for selecting an ESCO to develop and implement an ESPC project is not the same as selecting a contractor for a standard design-build project (Unruh, 2014). Section 828 of the National Defense Authorization Act of 2011 directs agencies to notify all ESCOs of the opportunity to compete for a potential project with the agency (Ike Skelton National Defense Authorization Act for Fiscal Year 2011 [NDAA], 2011). After a determination of the competitive range and further eliminations of contractors for efficiency, agencies select one ESCO to conduct surveys and studies to enable the contractor to submit a "firm-fixed-price proposal to implement specific energy conservation measures" (NDAA, 2011).

From this research observes, there seems to be no active screening process of ESPCs at the Office of the Secretary of Defense (OSD) level. Meaning, projects that meet the minimum statutory requirements of the program are very likely to be approved.

Typically, these projects are identified at the lowest levels, typically by installation energy managers (Daniel Magro, personal communication, September 8, 2017). In this way, middle managers, particularly at the local level seem to be prioritizing and deciding what projects the DOD is pursuing.

B. ENERGY CONSERVATION AND INVESTMENT PROGRAM

Per the GAO, the "Energy Conservation and Investment Program (ECIP) is DOD's primary source of directly appropriated military construction funding for energy conservation projects" (GAO, 2016, p. 8). As DOD guidance for the program states, "ECIP is a critical element of DOD's strategy to improve the energy performance of its fixed installations" (Jung, 2016, p. 1). ECIP is a design-build Military Construction (MILCON) program that is funded by a total annual appropriation of around $150M (Jung, 2016). The GAO defines a MILCON project "as including all military construction work necessary to produce a complete and usable facility or a[n] improvement to an existing facility" (GAO, 2016, p. 6). Table 4 provides a breakdown of ECIP projects by FY, since FY 2010. This table indicates the scope of the DOD's use of the program by listing cumulative totals for dollar amounts and energy savings among all DOD ECIPs by FY.

Table 4. ECIP Projects by FY, Sample from FY 2010 to FY 2016. Adapted from ODASD(IE) (2017b).

FY	***Quantity of DOD Projects***	***Cumulative Project Investment***	***Cumulative Cost Savings***
2010	68	$117,762,000	$272,377,630
2011	48	$103,733,000	$262,453,900
2012	33	$120,400,000	$189,253,320
2013	29	$103,200,000	$263,988,500
2014	35	$116,257,968	$251,669,881
2015	42	$137,828,000	$292,342,500
2016	25	$130,331,000	$288,570,800

ECIPs projects have also have been pursued and implemented by every branch of the military. Table 5 displays the quantity of ECIP projects adopted by each military branch from FY 2010 - FY2016. Based on the relative similarity in total projects adopted by each military branch, this information seems to indicate there is a degree of competition for ECIP funding.

Table 5. Quantity of ECIP Projects by DOD Agency, Sample from FY 10 to FY 16. Adapted from ODASD(IE) (2017b).

	2010	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	**Total**
Air Force	21	10	5	2	10	14	13	**75**
Army	16	16	12	10	9	12	5	**80**
Marine Corps	5	2	2	2	1	2	2	**16**
Navy	19	13	8	10	10	9	4	**73**
DeCA	3	2						**5**
DIA	3	1	1		1			**6**
DLA		2	3	1	2	1		**9**
Other	1	2	2	4	2	4	1	**16**
Total	**68**	**48**	**33**	**29**	**35**	**42**	**25**	**280**

The program is currently under the purview of Office of the Deputy Assistant Secretary of Defense for Energy, Installations, and Environment—Installation Energy (ODASD(IE)) who solicits for project proposals each year by issuing guidance to eligible DOD entities (Jung, 2016). Installation managers create project proposals based on ODASD(IE)'s guidance which are submitted to the military service for review—this is step 1 (GAO, 2016). There is no specific dollar threshold for projects to qualify for ECIP funding. However, the DOD requires that its annual selections of ECIP projects have a collective minimum average return on investment (as measured by savings-to-investment ratio) of 2.0 (Jung, 2016). Table 4 lists the quantity of adopted ECIPs by military service over time.

Potential ECIP projects are thoroughly vetted prior to implementation. To be considered for approval, per the GAO and ODASD(IE) guidance, an ECIP proposal must provide estimates of the following:

- Project Cost

- Payback (number of years until the project recoups its projected costs)

- Savings-to-investment ratio (SIR), or return on investment. A return on investment of 2.0, for example, means that the completed project eventually realizes $2 in savings for every dollar spent (GAO, 2016 and Jung, 2016).

The military services evaluate the submitted proposals, based on their own evaluation factors, and submit worthwhile candidates to ODASD(IE)—this is step 2 (GAO, 2016). ODASD(IE), constrained by the programs annual appropriation, then competitively selects the best mix of available projects—this is step 4 (GAO, 2016). ODASD(IE)'s guidance states that the ECIP approval process "will elucidate the complex tradeoffs between key financial and energy metrics, enabling exploration and analysis of a broader set of portfolio options" (Jung, 2016, p. 3). ODASD(IE) then notifies Congress about the selected projects—this is step 5 (GAO, 2016). Figure 2, depicts the process flow of ECIP selection and adoption, as discussed. The selection process for ECIP adoption seems to be more formalized than the ESPC program. This is likely because the ECIP program, though focused on smaller scale projects, uses appropriated funding that tends to be more hierarchically controlled.

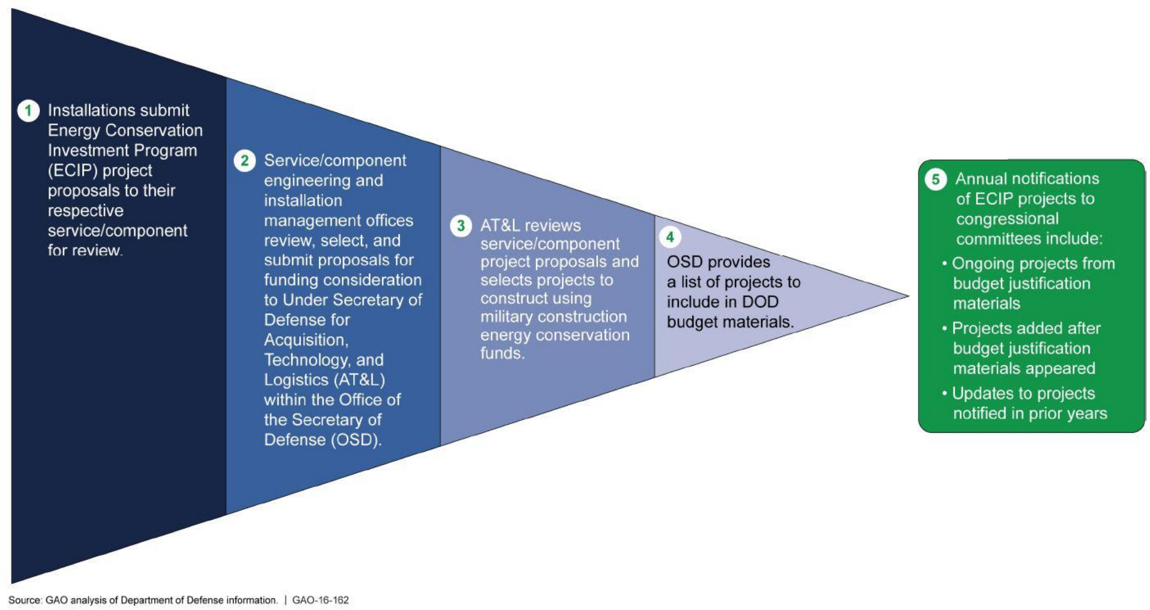

Figure 2. ECIP Project Process Flow. Source: GAO (2016).

ECIP funding is expected to remain constant at an annual appropriation of $150M for FY 2018 to FY 2022 (Jung, 2016). As Jung states in the program's annual guidance memo, "At this funding level, the program will provide less than 10% of DOD's projected investment required to meet the legislative, executive, and agency requirements for energy use" (Jung, 2016, p. 1). Despite its smaller scale in terms of dollars committed relative to the ESPC program, the ECIP program is designed to supplement DOD's ability to comply with energy conservation mandates.

C. DOD INSTALLATION ENERGY

Fixed installations enable the DOD to perform its operational mission, and investments in energy-efficient technology at these installations are critical to the sustainment of the DOD's operational capacity (ODASD(IE), 2015). Currently, most of the energy consumed by the DOD "to heat, cool, and provide electrical power to infrastructure is fossil fuel based (coal, oil, natural gas, or electricity produced from these), often from foreign sources" (Chisom and Templeton, 2013, p. 4). The DOD's Annual Energy Management Report states that the DOD consumed 211,095 billion British thermal units (BBTU) of installation energy in FY 2015 (ODASD(IE), 2015). As

ODASD(IE) points out, "This infrastructure is largely dependent on a commercial power grid that is vulnerable to disruption from aging infrastructure, weather-related events and direct attack" (ODASD(IE), 2017a). Typical energy-related infrastructure improvements projects pursued by the DOD to become more efficient and resilient, as described by ODASD(IE) include: "retrofits to incorporate improved lighting; high-efficiency heating, ventilation, and air conditioning (HVAC) systems; double-pane windows; energy management control systems; and new roofing" (ODASD(IE), 2017a). Through the implementation of energy saving projects at installations DOD benefits both from lower energy costs and from better working environments for its employees.

D. BARRIERS TO ENERGY-EFFICIENCY ADOPTION

There are specific barriers that tend to impede the adoption of energy conservation initiatives. Figure 3 displays the general process flow of the decision-making and planning processes leading to the implementation of a generic energy initiative.

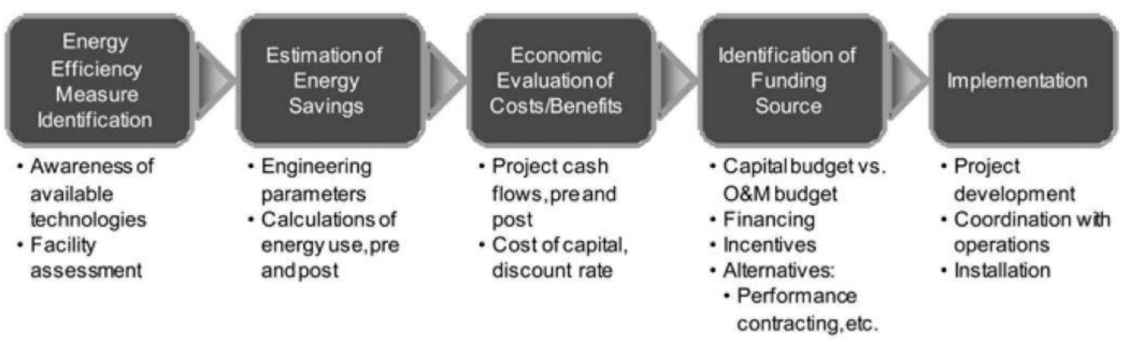

Figure 3. Energy-Saving Project Adoption Process Flow.
Source: Andersen and Brown (2010).

At each gate in this process flow, organizational barriers must be identified and surmounted. The DOE divides these obstacles into three main categories: economic and financial, regulatory, and informational (DOE, 2015). Andersen and Brown also cite the lack of capital as a primary barrier to adoption (Andersen and Brown, 2010). Volatile energy prices also tend to delay energy project decisions due to uncertainty regarding investment returns (DOE, 2015). In response to this obstacle, Anderson and Brown encourage initiative champions “to look for innovative financing solutions to ensure positive cash flow and mitigate the risk of uncertain payback expectations that come with similar capital budgeting decisions” (2010, p. 8). The DOE also states that the aggregation of regulations including complex contractual terms and the administrative burden required for successful oversight of a project may also deter some decision-makers (DOE, 2015). Lastly, informational gaps like insufficient knowledge of federal and state utility regulations and incentives; a lack of data regarding energy consumption; and a dearth of required expertise to evaluate such data can dictate negative outcomes for some opportunities (DOE, 2015). This research examines whether similar barriers or factors influence energy initiative decision-making in the DOD.

E. PUBLIC-PRIVATE PARTNERSHIPS

Prior research has demonstrated that governments use contractual arrangements as organizational tools in the implementation of policy on behalf of citizens (Cohen and Eimicke, 2008). Buchanan, Cabell, & McCrary define public-private partnerships, a type of contractual arrangement, as cooperative relationships that allow a public agency to “pool resources” with the “private sector’s technical expertise, knowledge, insight, and capital to achieve mutually beneficial goals” (2006, p. 1). Public-private partnerships, as authorized by Congress, may be used to facilitate energy conservation and resiliency projects. Partnerships can be used by governments to finance capital improvements with little to no initial financial cost of the part of the agency. The government’s transfer of risk to the private entity is also a major advantage of public-private partnerships.

However, as the GAO cautions, the implementation and monitoring of such arrangements simultaneously becomes more important and more complex (GAO, 2005). Maintaining accountability of a private entity acting in a public capacity in the performance of any contract can be a challenge for a government manager. This challenge is particularly poignant in a public-private partnership, like an ESPC, because the government may not have the technical expertise to provide sufficient oversight of the contractor. To be successful in such arrangements, Cohen and Eimicke argue that contract management should be treated the same as internal management (Cohen and Eimicke, 2008). Specifically, government managers must maintain control of "strategic planning, leadership, human resource management, financial investment, financial allocation and control, work process analysis improvement, and performance measurement" (Cohen and Eimicke, 2008, p. 17). Despite the challenges, public-private partnerships are a critical tool enabling the DOD to implement energy-saving measures through innovative financing solutions.

F. LEGISLATIVE AND EXECUTIVE OVERVIEW

A mix of incentive and statutory direction have pushed the DOD to become more energy efficient and use performance contracting to do so. Congress passed legislation in 1986 that permitted agencies to use performance contracts solely to achieve energy savings and ancillary benefits (GAO, 2015). President Bush's Executive Order (EO) 13423, prompted the Office of Federal Procurement Policy's (OFPP) acquisition guidance entitled "Acquisition of Green Products and Services" which recognized performance contracting as the preferred mechanism to meet statutory requirements for energy efficiency (Executive Order No. 13423, 2007 and Hull, 2015).

The Energy Independence and Security Act of 2007 was not only meant to increase energy efficiency in federal facilities, but it also included a preference for performance contracts (Energy Independence and Security Act of 2007, 2007). Federally mandated energy-conservation goals, such as the Obama administration's goal of $2 billion awarded for energy-related performance contracts by 2013, have continued to further incentivize proactive use of ESPCs and similar partnerships (Unruh, 2014). In May 2014, President Obama expanded this challenge to a total of $4 billion by the end of 2016 (GAO, 2015). As Lovins has argued, national energy policy has been shifting for a variety of reasons including economic recovery, competitive advantage, and climate protection (Lovins, 2010). Future legislation regarding the DOD's energy use is likely to continue along this trend.

III. THEORY AND HYPOTHESES

A significant way government employees can serve the public good is in the way they spend the taxpayer's money. The term "public service" itself implies government employees should place the interests of the taxpayers (or customers) first (Cohen and Eimick, 2008). In the DOD, the pursuit of the "best value product or service" should be the bedrock of any decision-making process (FAR, 2017). Capital constraints among competing operational priorities can also motivate managers in the DOD to think creatively about efficiency. Furthermore, the DOD experiences pressure from the watchdogs at GAO and the DODIG to be accountable for their management practices. It is not enough that bureaucrats merely endeavor to avoid fraud, waste, and abuse, they should strive for constant improvement in managerial performance.

FAR Section 1.102, for instance, is written to "empower local procurement officials to take independent action based on their professional judgment" in order "to achieve efficient operations" (FAR, 2017). Also, some of the top strategic goals of the Office of the Assistant Secretary of Defense for Energy, Installations, and Environment (ASD(EI&E)), who oversees both ESPC and ECIP initiatives for DOD, are directly related to efficient management practices. Specifically, ASD(EI&E) endeavors to "eliminate waste in DOD installations and infrastructure" and to "develop smarter contracts and manage contracts smartly" (Office of the Assistant Secretary of Defense for Energy, Installations, and Environment [ASD(EI&E)], 2017). If energy efficient practices and financial performance are in fact positively related (Esty and Winston, 2006), then it would seem logical to anticipate that the DOD is pursuing initiatives in a way that maximizes benefits to all involved stakeholders.

A. THE EFFECT OF PROJECT RISK

Generally, projects with lengthy time commitments and high dollar values tend to provoke caution because they create more risk. Uncertain financial and opportunity-cost factors, such as initial cost or a project's payback period, may increase a project's risk and should thus influence a firm's decision-making. However, as FAR Sub-section

1.102-2(c) states, “The cost to the taxpayer of attempting to eliminate all risk is prohibitive” (FAR, 2017). To realistically achieve efficient operations, the federal acquisition workforce must shift its focus from “risk avoidance” to “risk management” (FAR, 2017). Economic theory suggests risks associated with costs, rather than benefits, wield greater decision-making influence because they are experienced sooner and are not dependent on uncontrollable factors like future energy prices (King and Lennox, 2002).

Anderson and Newell (2002) argue that “firms are more responsive to implementation costs than to energy savings,” (2002, p. 24) thus, “projects with a longer payback period (i.e., a larger ratio of costs to annual benefits) are less likely to be adopted” (2002, p. 16). Due to perceived risk increases, managers may also be reticent to employ novel initiatives and/or unproven energy technologies in large-scale infrastructure projects (Olsen, 2014). The DOE states that mitigation of risk in the ESPC program relies on a balance between short-payback and long-term initiatives (FEMP, 2017d). DOE’s ESPC program guidance specifically states, “To maximize savings and minimize overall life-cycle cost, the best strategy is to fund as many [projects] as possible, beginning with ECMs with the shortest paybacks” (FEMP, 2017d). In an ESPC arrangement, the risk calculus may be different because initial “costs” are not outlays of hard dollars by DOD, rather, they represent the potential degree of financial liability resulting from miscalculation or project failure. Nonetheless, the required initial investment and the length of a project’s payback period are likely to influence perceived project risk and influence decision-making.

- Hypothesis 1 (H1): Projects that are the easiest for the DOD to implement (shortest contract lengths and smallest initial cost) are more likely to be adopted first.

B. THE ROLE OF INFRASTRUCTURE VALUE

DOE guidance specifically states that ideal ESPC projects may be found at “any large building or group of buildings” (DOE, 2017). Prior research also indicated that small facilities are not generally ideal candidates for extensive infrastructure retro-fits (Olsen, 2014). This is in part due to smaller marginal benefits, in terms of costs savings, relative to the administrative overhead necessary to award and oversee a single project. If the size of a site is related to its value to the DOD, then the odds of an optimal return on invested capital has the potential to be higher at larger bases than at smaller bases, especially when considering the larger number of stakeholders resident at larger, mission essential bases. It could be expected that the DOD may have initially shown a preference for bases deemed to possess higher value, operating under the assumption greater energy and cost savings could be reaped for a similar amount of overhead.

- Hypothesis 2 (H2): Projects tend to be approved at bases where the DOD has demonstrated higher infrastructure value.

C. THE EFFECT OF BENEFITS

The most efficient option for the DOD could be to prioritize projects with the largest cumulative benefits. According to the DOE, ESPC projects tend to be the most beneficial when facilities contain aging equipment that may be nearing the end of its useful life because there is more opportunity for savings by replacing old, inefficient equipment (FEMP, 2017d). Also, the infrastructure at some bases may be less efficient due to both design and age. This prioritization could effectively minimize overhead and administrative costs while maximizing tangible and intangible benefits. Thus, if two projects are competing for approval, it would be logical to assume that the project which maximizes total benefits to the DOD and the taxpayer will be approved first. The "best value product or service," as discussed in FAR Sub-part 1.1, could be an adoption strategy that provides the greatest cumulative benefit to the government, as measured by energy or cost savings.

- Hypothesis 3 (H3): Projects that guarantee either the most cost savings or largest cumulative energy savings will be implemented first.

D. THE ROLE OF LOCAL ENVIRONMENTAL NORMS

Prior research indicates widespread acceptance of the notion that local norms influence firm's decision-making, particularly regarding decisions that involve social and environmental responsibility (Dowell and Muthulingam, 2017). In other words, managers may feel indirect pressure from local stakeholder's environmental priorities and take actions to be good citizens and reap intangible, social benefits. Scholars have also suggested that environmental norms can rebalance the totality of perceived value of an initiative (Dowell and Muthulingam, 2017). Similarly, Berrone et al. have argued that smaller, family-firms tend to care about their reputation within the local community more than larger firms, therefore they are more responsive to local stakeholder priorities, in this case environmental preferences (Berrone et al., 2010). It would be reasonable to assume this phenomenon is occurring within DOD. For instance, a key strategic goal of ASD(EI&E) in the management of the DOD's real property portfolio is community collaboration with local military bases (ASD(EI&E), 2017). This hypothesis examines whether there is a preference for approving projects in regions that exhibit a more favorable view of environmental stewardship.

- Hypothesis 4 (H4): The stronger the environmental norms are in a given region, the greater the probability that the initiative will be adopted.

E. THE ROLE OF IMITATION

Managers can learn about an initiative or program's effectiveness by observing proximate successes. Anderson and Newell posit that a central reason firms fail to adopt environmental initiatives is due to the risk associated with the uncertainty of new technology and a lack of proven performance information (Anderson and Newell, 2002). Prior research has also argued that the level of perceived uncertainty is reduced as the number of adopters increases (Dowell and Muthulingam, 2017). Cluster theory, as described by Greve, suggests that "competitive advantage is created in the interfaces between firms and their customers and suppliers, and thus one can find clusters of capable firms near each other" (Greve, 2009, p. 2). Thus, one should expect a ripple effect of project adoption as gaps are bridged by demonstrated successes by the early adopters of an initiative (or technology) and the widespread implementation of similar projects at other DOD sites (Moore, 1994).

Similarly, network theory, also described by Greve, postulates that "certain network positions give privileged access to knowledge and resource flows" (Greve, 2009,

p. 2). For example, as Williams argues, “Replication and adaptation lead to successful knowledge transfer, which leads to improved performance of the receiving unit” (2007, p. 867). Successfully demonstrated projects not only reduce perceived risk, but they also transfer valuable knowledge regarding administrative requirements and the suitability of certain types of projects. Thus, it is reasonable to assume, due to imitation factors, that there are regional “clusters” of bases with a heightened proportion of approved projects because evidence tends to support the idea that innovation diffusion is more rapid over shorter distances (Greve, 2009).

- Hypothesis 5 (H5): The more local adopters there are of an initiative, the higher the probability that it will be adopted.

F. THE ROLE OF INVESTMENT RETURN

Projects with higher return on investment, instead of gross savings, may represent the “best value” to the DOD because they have the potential to maximize benefits relative to financial commitment (or risk). Projects that manifest a high investment return may also be considered “low-hanging fruit” because managers can achieve outsized benefits relative to the risk (Berchicci and King, 2007). Thus, it would be useful to evaluate the differences in investment return performance between the ESPC and ECIP programs. Historically, ECIP has funded smaller projects that promise an ideal return on investment in reduced energy costs, as measured by SIR (ODASD (IE), 2017b). ECIP managers seem to place an increased emphasis on investment return (Jung, 2016). ESPC projects on the other hand, are not constrained by the typical appropriations process or by investment return goals. It is expected that ESPC arrangements tend to be used for larger, longer-term projects. This hypothesis will examine whether current investment return strategies have any tangible effect on outcomes between the programs.

- Hypothesis 6 (H6): Relative to ECIP projects, ESPC initiatives will be more costly projects with greater cumulative cost savings but a lower investment return (measured by SIR).

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IV. RESEARCH DATA

This research is modeled on the work of Dowell and Muthulingam (2017). I analyze the implementation of individual energy saving initiatives using hypothesis testing (primarily t-Tests) and regression analysis to isolate factors that influence the DOD's project adoption decisions. I examine whether the DOD is responding as predicated by economic theory regarding internal incentives like payback, initial cost, and cumulative cost savings. Also, I analyze the impact of external factors like environmental friendliness norms and imitation. The significant findings are then formulated into recommendations for use by DOD managers.

Data regarding approved projects was compiled along with a database of DOD site characteristics. Information regarding approved ESPC projects, since the program's initiation of IDIQ task-orders in 1998, is publicly available via the DOE (FEMP, 2017a, 2017b). Analysis was performed on 92 DOD ESPC projects (out of a total of 379 projects for the entire federal government). Data regarding approved ECIP projects was compiled from Congressional notifications publicly available from ODASD (IE) (ODASD (IE), 2017b). A total of 280 ECIP projects were examined. The ECIP program was initiated in 1976; however, publicly available data only exists back to 2010 (GAO, 2016 and ODASD (IE), 2017b). Because it cannot be determined what ECIP projects were originally adopted, ECIP data will be excluded from any analysis regarding the timing of initial adoption.

Energy use per base was compiled from the DOD's FY2015 AEMR (ODASD (IE), 2015). This report details delivered energy for a total of 666 active DOD sites. The quantity of personnel assigned to each site (Active, Reserve, and Civilian grand total as of FY2015) was compiled from a report generated from the Defense Manpower Data Center (Defense Manpower Data Center, 2017). Lastly, data regarding infrastructure value was compiled from the DOD's FY2015 Base Structure Report (BSR) (ASD(EI&E), 2015). A challenge in this data consolidation effort was the reconciliation of inconsistent nomenclatures for the same site by different agencies. For instance, the DOE may refer to "Navy Station San Diego" whereas the DOD's AEMR may refer to the same location as “NAVBASE San Diego CA.” Data was included in the analysis only if it could be verified beyond a reasonable doubt across each of the individual datasets.

A. DEPENDENT VARIABLE

The dependent variable in this analysis is simply whether an initiative was adopted or not. An indicator variable of 1 is listed if an ESPC or ECIP initiative was adopted, and is 0 otherwise. As previously mentioned, adoption occurs at active DOD sites. It is common for multiple, unique initiatives to be adopted at a single base. Including these bases multiple times during the analysis could disproportionally weight the demographics of these bases. Therefore, a site will only be listed once as a dependent variable rather than multiple times as separate initiatives are adopted at the same site.

B. INDEPENDENT VARIABLES

The following independent variables will serve as indicators of project adoption influence:

1. Economic Characteristics of an Approved Project

H1 and H3 posit that economic characteristics, or the internal benefits of an initiative, influence its adoption. Thus, initial project investment, anticipated cost savings, contract length, and cumulative energy savings are analyzed relative to their effect on the dependent variable.

2. Site Characteristics

H2 examines whether the unique internal characteristics of each site are a primary driver of initiative adoption. Thus, independent variables regarding specific base characteristics will also be analyzed relative to the dependent variable. Analyzed characteristics include: total site delivered energy (BBTU), energy intensity as measured by BTU per gross square foot of facility space (BBTU/SF), assigned personnel (Active, Reserve, and Civilian grand total), and an infrastructure value factor the DOD calls Plant Replacement Value (PRV). This normative value, as defined by the DOD, “represents the calculated cost to replace the current physical plant (facilities and supporting infrastructure) using today’s construction costs (labor and materials) and standards (methodologies and codes)” (ASD(EI&E), 2015, p. 5).

$$\textbf{Plant Replacement Value} = \text{Facility Quantity}^{1} \times \text{Construction Cost Factor}^{2} \times \text{Area Cost Factor}^{3} \times \text{Historical Records Adjustment}^{4} \times \text{Planning and Design Factor}^{5} \times \text{Supervision Inspection and Overhead Factor}^{6} \times \text{Contingency Factor}^{7}$$

1 Quantity of assets from the real property inventory database.
2 Construction cost as published in the DoD Cost Factor Handbook.
3 A geographic location adjustment for costs of labor, material, and equipment.
4 An adjustment to account for increased costs for replacement of historical facilities or for construction in a historic district; the current value of the factor is 1.05.
5 A factor to account for the planning and design of a facility; the current value of this factor is 1.09 for all but medical facilities and 1.13 for medical facilities.
6 A factor to account for the supervision, inspection, and overhead activities associated with the management of a construction project; the current value of the factor is 1.06 for facilities in the continental US (CONUS) and 1.065 for facilities outside of the continental US (OCONUS).
7 A factor to account for construction contingencies; the current value of the factor is 1.05.

Figure 4. PRV Formula. Source: ASD(EI&E) (2015).

3. External Environment

H4 and H5 explore the relative importance of environmental norms and imitation have on the probability of initiative adoption. The Sierra Club proclaims it is “the nation’s largest and most influential grassroots environmental organization” (Sierra Club, 2017b). As established by prior research, I use Sierra Club membership per capita as a reasonable proxy for the strength of environmental norms in each state (Dowell and Muthulingam, 2017). This data represents the annual count of Sierra Club members in the state of the site’s location, scaled by the state’s total population (per 2010 Census data). This data was obtained from a direct inquiry to the Sierra Club’s member services team (Sierra Club, 2017a).

To bolster this metric, I have also included data from Yale University’s Climate Change Communication Program. This model predicts relative support for climate change concerns at both the state and local level (Yale Program on Climate Change Communication, 2015, 2016). The chosen Yale data metric is a prediction of the estimated percentage of individuals who think that global warming is caused mostly by human activities. Also, a data string was created to count the cumulative number of other bases in a state who have previously adopted projects. This string of data will be used to analyze whether the probability of adoption increases as the number of other local adopters increases.

V. METHODOLOGY AND DATA ANALYSIS RESULTS

Tables 6 and 7 list the descriptive statistics and correlations of the analyzed data. From Table 6, we observe that nearly 25% of the 666 analyzed sites adopted either an energy-saving initiative. Moreover, there are differences in the mean values of ESPC and ECIP cost savings data that may indicate the scale of projects suitable for each type of initiative. The positive correlations from Table 7 suggest internal factors such as PRV, total site delivered energy, and base population (Active Duty, Reserve, and Civilian Grand Total) influence the probability of adoption to some degree. Also, the correlations indicate that external factors like other "local adopters," and environmental friendliness norms may positively influence the dependent variable.

Table 6. Descriptive Statistics

	Variable	Mean	Std dev	Min	Max	N
(1)	Adoption Status (1 = adopted)	0.240	0.428	0.00	1	666
(2)	Base Population (Active, Reserve, Civilian Grand Total)	6,588	9,056	1	62,804	289
(3)	Total Site Delivered Energy (BBTU)	272	505	0	3,908	666
(4)	Energy Intensity per Site (BTU/SF)	115,454	71,087	61	854,514	666
(5)	Plant Replacement Value ($M)	1,813	2,113	18	14,041	325
(6)	Sierra Club Membership per Capita	0.0025298	0.0012972	0.0005203	0.0063429	539
(7)	Yale 2014 Environmental Friendliness Proxy	49.27	3.94	42	61	539
(8)	Yale 2016 Environmental Friendliness Proxy	52.91	4.42	41.97	66.79	539
(9)	ESPC Contract Length (years)	17.29	4.06	8.00	24.00	92
(10)	ESPC Cost Savings ($)	42,468,705	79,252,309	1,874,423	649,333,834	92
(11)	ESPC Project Investment ($)	41,920,706	78,976,730	1,812,995	649,333,811	92
(12)	ESPC Project Cumulative Energy Savings (BTUx10^6)	1,779,518	2,687,572	50,952	14,103,518	92
(13)	ESPC Savings-to-Investment Ratio	2.344	0.843	1.254	8.140	92
(14)	ECIP Cost Savings ($)	6,502,345	9,177,839	0	95,445,540	280
(15)	ECIP Project Investment ($)	2,962,543	3,286,140	17,968	22,000,000	280
(16)	ECIP Savings-to-Investment Ratio	2.402	1.758	0.000	18.800	280
(17)	Other "Local Adopter"	4.168	5.694	0.000	20.000	666

Table 7. Data Correlations

	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	Adoption Status (1 = adopted)	1								
(2)	Other "Local adopters"	0.248	1							
(3)	Yale 2014 Environmental Proxy	0.225	0.681	1						
(4)	Yale 2016 Environmental Proxy	0.150	0.594	0.890	1					
(5)	Sierra Club Membership per Capita	0.110	0.547	0.688	0.746	1				
(6)	Base Population (Active, Reserve, Civilian Grand Total)	0.390	0.092	0.105	0.081	0.002	1			
(7)	Plant Replacement Value ($M)	0.466	0.103	0.145	0.125	0.078	0.781	1		
(8)	Total Site Delivered Energy (BBTU)	0.354	-0.013	0.003	-0.002	-0.062	0.768	0.661	1	
(9)	Energy Intensity per Site (BTU/SF)	-0.009	-0.165	-0.113	-0.071	-0.044	0.030	0.108	0.384	1

A. RESULTS

Subsequent paragraphs detail the results of the analysis by hypothesis:

1. Hypothesis 1

H1 examines whether projects that are the easiest to implement are approved first. H1 was tested for approved ESPC projects only due to missing data from early ECIP adoptions. First, initial investment was adjusted for inflation to 2017 dollars. The overall mean values for initial investment ($18,831,248 in $2017) and ESPC contract length (17.29 years) were then determined. Next, the data and the associated FY of project adoption was split into two sets of varying length based on these mean data points. Finally, t-Tests were performed on the fiscal years of each data set. Findings indicate whether the means are significantly different. Thus, supporting or refuting the claim of H1.

- Hypothesis 1 (H1): Projects that are the easiest for the DOD to implement (shortest contract lengths and smallest initial cost) are more likely to be adopted first.

Overall, the analysis supports H1. Table 8 and Figure 5 indicate ESPC contract lengths have been growing longer over time. The mean FY value associated with the data string of shorter length contracts (2006.16) is earlier than the mean value of longer length contracts (2008.49). The difference between these two means is significant (p = 0.033). Thus, the first premise of H1 is confirmed, shorter length contracts were adopted first.

Table 8. ESPC Contract Length, Two-Sample t-Test

	FY of > Mean Contract Length	*FY of < Mean Contract Length*
Mean	2008.49	2006.16
Observations	47	45
Hypothesized Mean Difference	0	
df	90	
t Stat	2.16	
P(T<=t) two-tail	***0.0334***	
t Critical two-tail	1.99	

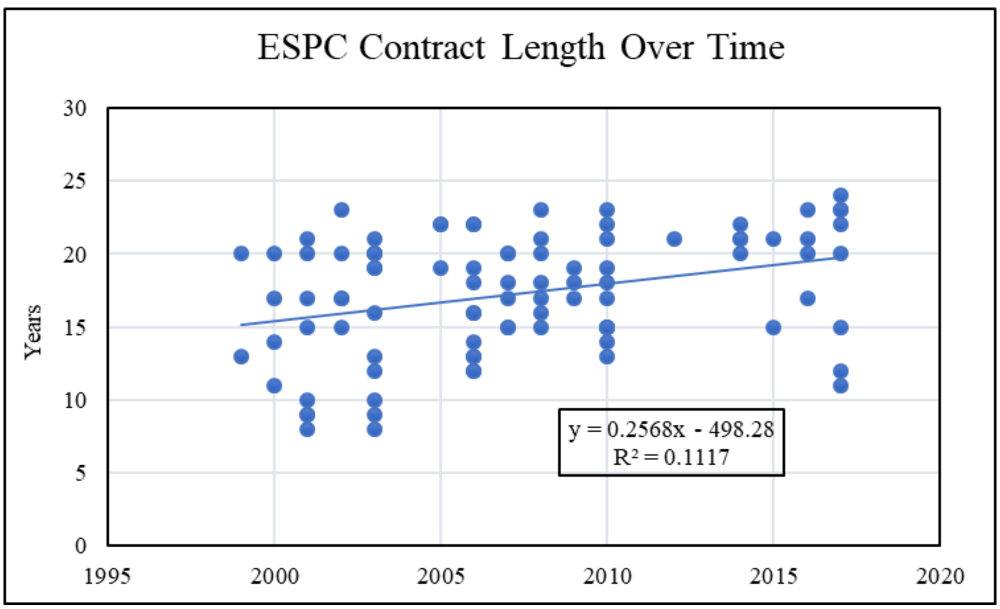

Figure 5. Linear Regression Demonstrating the Positive Relationship of Contract Length and Fiscal Year

Also, as Table 9 and Figure 6 indicate, ESPC initial investments have been growing over time. The mean FY value associated with the data string of smaller investment contracts (2006.41) is earlier than the mean value of longer length contracts (2010.32). The difference between these two means is significant (p = 0.0067). Thus, the second premise of H1 is also confirmed—contracts that required smaller initial investments were approved first.

Table 9. ESPC Initial Investment, Two-Sample t-Test

	FY of > Mean Investment	*FY of < Mean Investment*
Mean	2010.32	2006.41
Observations	22	70
Hypothesized Mean Difference	0	
df	31	
t Stat	2.91	
P(T<=t) two-tail	***0.0067***	
t Critical two-tail	2.04	

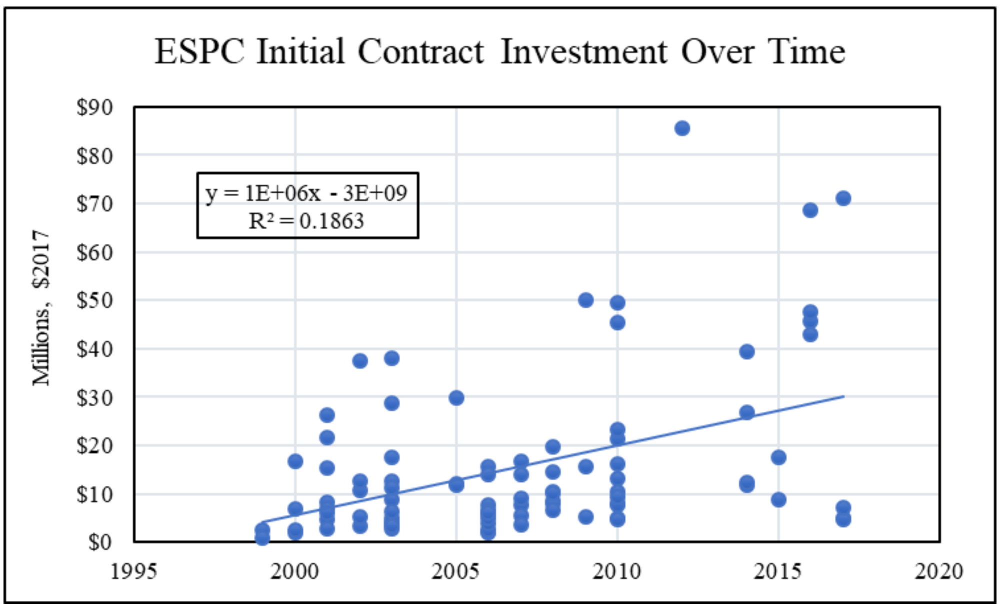

Figure 6. Positive Relationship of Initial Contract Investment and Fiscal Year

Evidence in support of H1 indicates the DOD may have taken a learning, risk mitigation approach to ESPC projects because they chose to award the easiest to implement contracts first. This reflects both the DOD's willingness to experiment as well as its risk averse culture. DOE guidance does state gaining experience through smaller projects may better facilitate an agency's ability to properly monitor performance, but it is not advantageous in all instances (FEMP, 2017c). When adopting projects, managers must balance the increased administrative overhead of multiple, smaller projects with the perceived risk of larger-scale, more holistic solutions.

2. Hypothesis 2

H2 examines whether infrastructure value influences project adoption. Logistic regression analysis, including both ESPC and ECIP data, is used to test H2. The model tests the probability of a dependent variable response based on the following independent variables: energy intensity per site (BTU/SF), base population, total site delivered energy (BBTU), and PRV. The model not only indicates significant factors but also demonstrates how a change in the value of the independent variables affects the probability of adoption.

- Hypothesis 2 (H2): Projects tend to be approved at bases where the DOD has demonstrated higher infrastructure value.

The analysis supports some aspects of H2 and contradicts others. Table 10 indicates that all independent variables in the model seem to be significant. This could be expected considering the positive correlations found in Table 7. However, the factors that seem to have the most influence on outcomes are total site delivered energy ($p = 2.72E-16$) and PRV ($p = 0.013$). This result supports H2 by suggesting that as a facility's PRV and delivered energy increase, its probability of adoption increases significantly. Specifically, as a facility's PRV increases by $1 billion (standard deviation of PRV is $2.1 billion), the probability of adoption increases by 30.1%. Similarly, as a site's delivered energy increases by 100 BBTU (standard deviation of delivered energy is 505), the probability of adoption increases by 32.2%. Energy intensity per site was also significant in this model ($p = 1.3E-04$). However, considering it seems to affect adoption to a much smaller degree that PRV and total delivered energy. Also, because energy intensity is merely a ratio (BTU/SF), it may not be a particularly useful predictor.

Table 10. Logistic Regression Model of Internal Infrastructure Characteristics

Predictor	β	*Std E*	*Z-value*	Pr(>|z|)	*Exponentiated* β
Energy Intensity per Site (BTU/SF)	-7.76E-06	2.03E-06	-3.827	**1.300E-04**	9.9999E-01
Base Population	-6.22E-05	2.72E-05	-2.288	**2.215E-02**	9.9994E-01
Total Site Delivered Energy (BBTU)	2.79E-03	3.41E-04	8.185	**2.720E-16**	1.0028E+00
Plant Replacement Value ($M)	2.63E-04	1.06E-04	2.481	**1.312E-02**	1.0003E+00
Intercept	-1.285	2.65E-01			
Pseudo R^2					
McFadden	0.241				
Cox and Snell	0.233				
Number of Observations					
Model	666				
Null	666				

How Change in Predictor Value Influences Adoption

	Increment Value	Adjusted Odds Ratio	Est. Change in Pr of Adoption
Energy Intensity per Site (BTU/SF)	1000	0.992	-0.8%
Base Population	1000	0.940	-6.0%
Total Site Delivered Energy (BBTU)	100	1.322	32.2%
Plant Replacement Value ($M)	1000	1.301	30.1%

Base population is also significant (p = 0.022) but in this model, it possesses a negative coefficient (Beta = -6.22E-05). Once the influence of delivered energy and replacement value are taken into account regarding adoption, the resulting population effect is negative. This finding is somewhat surprising considering the positive relationship of population with PRV, which is a strong predictor of adoption (see Figure 7). This result may simply be a misnomer due to the high standard deviation of the base population data set (9,056) relative to the mean (6,588).

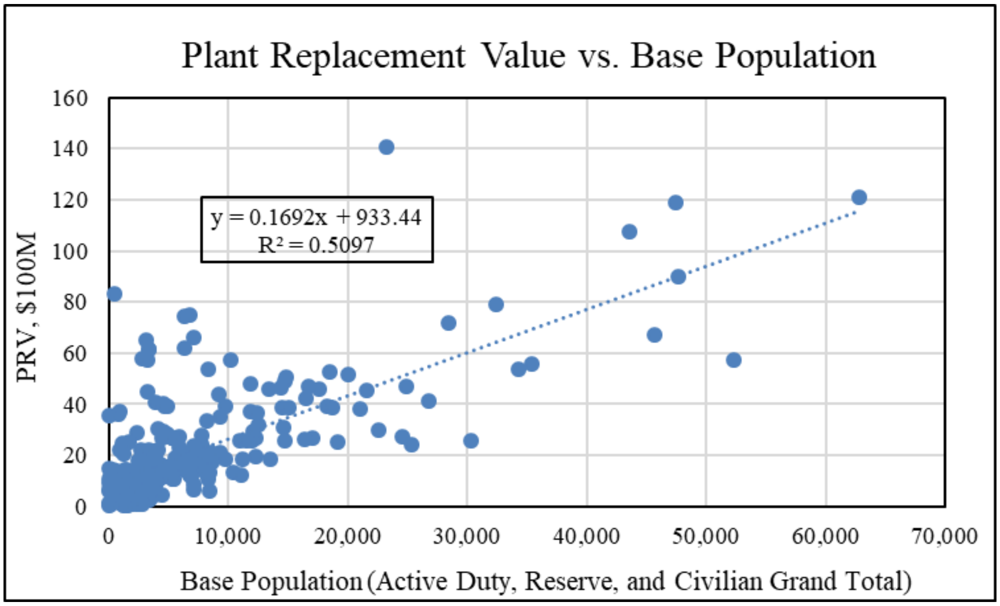

Figure 7. Positive Association of Base Population and PRV

Overall, this result is useful to managers because it reveals the most useful internal metrics by which to search for and prioritize future projects—total site delivered energy and PRV. Though PRV and total site delivered energy may not tell the full story regarding potential for future adoption, these factors should be central data points for manager's in the prioritization of future energy saving initiatives. For instance, bases without an adopted project but with above average PRV (e.g., Fort Campbell, Fort Sill, Travis AFB, MCAS Iwakuni, NAS Pensacola) should be candidates for future initiatives.

3. Hypothesis 3

Next, H3 was tested to determine the effect of benefits on project approval. Like the testing of H1, t-Tests were performed on the fiscal years of ESPC cost savings and cumulative energy savings data. First, cost savings data was adjusted for inflation to 2017 dollars. The overall mean values for ESPC cost savings ($47,347,274 in $2017) and ESPC cumulative energy savings (1,644,089 BTUx10^6) were determined. Next, the data and the associated FY of project adoption was split into two sets of varying length based on these mean data points. Finally, t-Tests were performed on the fiscal years of each data set. Findings indicate whether the means are significantly different. Thus, supporting or refuting the claim of H3.

- Hypothesis 3 (H3): Projects which guarantee either the most cost savings or largest cumulative energy savings will be implemented first.

The analysis does not indicate support for H3. Table 11 and Figure 8 indicate ESPC cost savings started small and have grown over time. The mean FY value associated with the data string of smaller cost saving projects (2006.28) is earlier than the mean value of smaller cost saving projects (2010.95). The difference between these two means is significant (p = 0.0009). Thus, the premise of H3 is rejected, projects that manifested smaller cost savings were adopted first.

Table 11. ESPC Cost Savings, Two-Sample t-Test

	FY of > Mean Cost Saving	*FY of < Mean Cost Saving*
Mean	2010.95	2006.28
Observations	21	71
Hypothesized Mean Difference	0	
df	31	
t Stat	3.67	
P(T<=t) two-tail	***0.0009***	
t Critical two-tail	2.04	

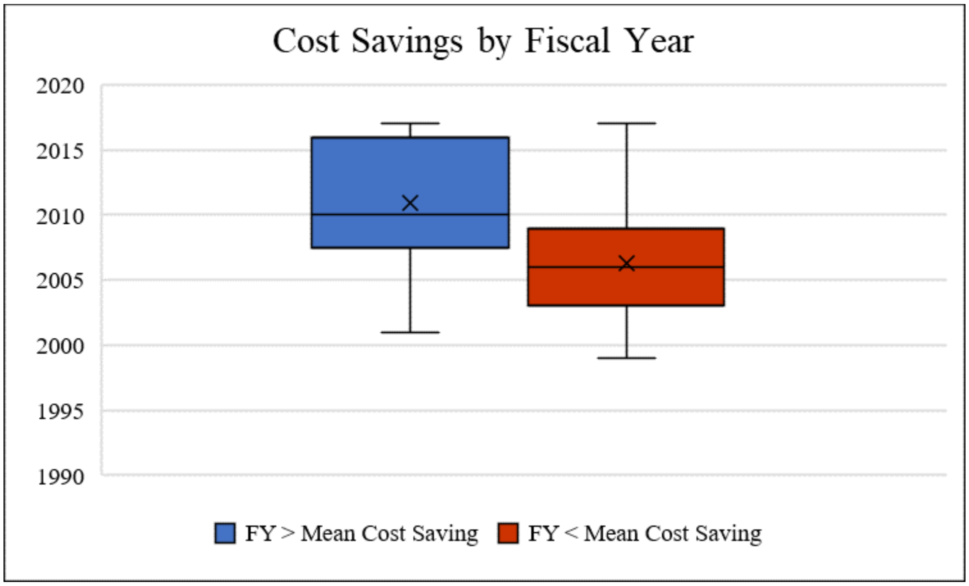

Figure 8. ESPC Adoption FYs Split by Mean Cost Savings

Similarly, Table 12 and Figure 9 indicate that the cumulative amount of ESPC energy savings have been growing over time. The mean FY value associated with the data string of lower energy-saving projects (2006.55) is earlier than the mean value of larger energy-saving projects (2009.17). The difference between these two means is significant (p = 0.0343). Thus, the second premise of H3 is rejected, projects that exhibited smaller energy savings were adopted first. ESPC Cumulative Energy Savings,

Table 12. ESPC Energy Savings, Two-Sample t-Test

	FY of > Mean En Saving	*FY of < Mean En Saving*
Mean	2009.17	2006.55
Observations	24	67
Hypothesized Mean Difference	0	
df	89	
t Stat	2.15	
P(T<=t) two-tail	***0.0343***	
t Critical two-tail	1.99	

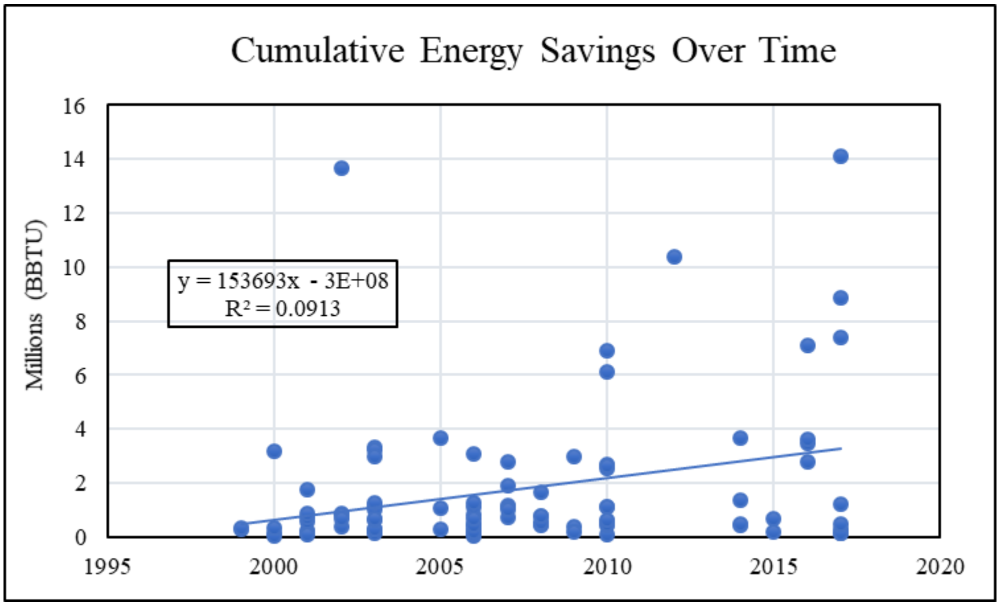

Figure 9. Positive Relationship of ESPC Energy Savings and Fiscal Year

This result is expected considering that, as Figure 10 demonstrates, energy savings are strongly related to cost savings. Thus, H3 is rejected in its entirety.

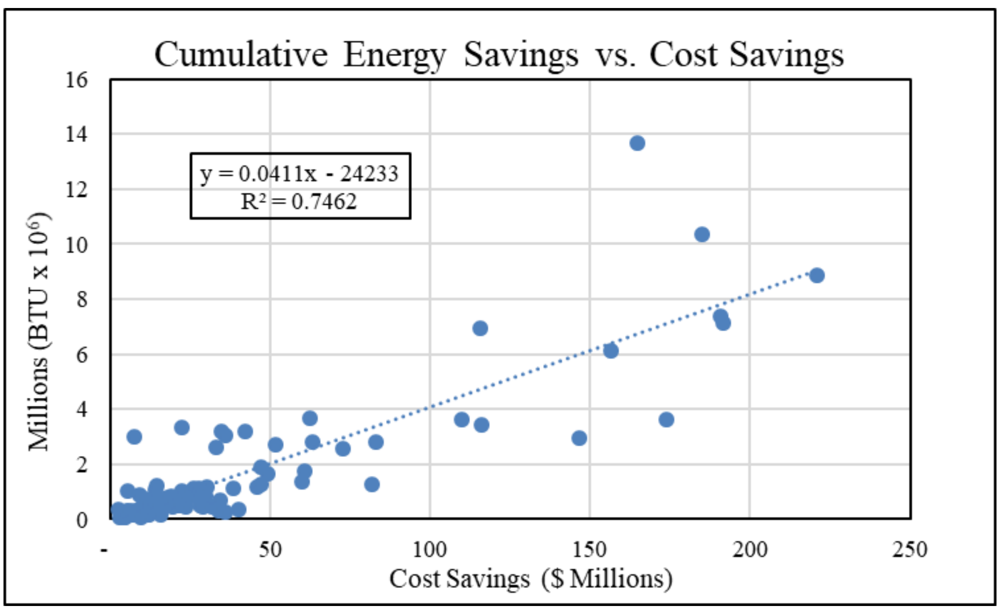

Figure 10. Positive Association of Cost Savings and Energy Savings

The analysis confirms projects that guarantee the most cost savings (and thereby energy savings) were implemented after smaller-scale projects. This is not surprising because cost savings are correlated with initial investment in ESPC projects, therefore this result bolsters support for H1. Because the DOD chose to award the easiest to implement contracts first, it should follow that these projects would provide smaller benefits in terms of cost and energy savings. Also, the rejection of H3 lends support to the idea that the DOD is a risk-averse culture that has taken a learning approach to ESPC adoption. It seems managers need to warm-up with smaller projects before adopting large-scale projects. This desire may, however, be met by leveraging external factors like imitation and knowledge transfer (analyzed later) to reduce the perceived risk of a project's adoption.

4. Hypothesis 4

H4 posits that the environmental norms of a region influence the probability of adoption. Logistic regression is primarily used to test the significance of the environmental friendliness proxy (measured as Sierra Club membership per capita) at all sites. A separate model will attempt to replicate the findings using data from the Yale Program on Climate Change Communication. Also, data regarding adopted projects by state will be normalized based on the intensity of DOD energy activity of its location. Normalization will be accomplished by dividing the cumulative amount of energy delivered to all of a particular state's bases by the cumulative amount of energy delivered to all bases DOD wide. The resulting value serves as a factor of intensity. The raw number of adopted projects per state was transformed via the intensity factor. To further explore H4, the raw and normalized data of the quantity of approved projects will be compared relative to each other and the environmental friendliness proxies.

- Hypothesis 4 (H4): The stronger the environmental norms are in a given region, the greater the probability that the initiative will be adopted.

The analysis consistently indicates support for H4. Per the correlations in Table 7, Sierra Club membership per capita and adoption outcome seem to possess a positive relationship. As this model displayed in Table 13 further indicates, Sierra Club membership per capita does seem to influence overall project adoption ($p = 0.0241$). An increase in the strength of a Sierra Club membership in a state significantly improves the chances of project adoption (27.9% based on a one standard deviation increase).

Table 13. Logistic Regression Model of Sierra Club Membership Per Capita

Predictor	β	*Std E*	*Z-value*	Pr(>|z|)	*Exponentiated* β
Sierra Club Membership per Capita	2.46E+02	1.09E+02	2.255	**0.0241**	7.70E+106
Base Population	1.29E-04	3.94E-05	3.277	**0.0011**	1.00E+00
Total Site Delivered Energy (BBTU)	4.20E-04	4.08E-04	1.029	0.3034	
Intercept	-1.714	3.601E-01			
Pseudo R^2					
McFadden	0.608				
Cox and Snell	0.833				
Number of Observations					
Model	249				
Null	666				

How Change in Predictor Value Influences Adoption

	Increment Value	Adjusted Odds Ratio	Est. Change in Pr of Adoption
Sierra Club Membership per Capita	+0.001	1.279	27.9%

Additionally, Figure 11 indicates there is a positive relationship between the proportion of a state's bases adopting an initiative and that state's level of environmental friendliness (as proxied by Sierra Club membership per capita). This outcome is more evidence in support of the model in Table 13 indicating the influence of environmental friendliness norms on adoption.

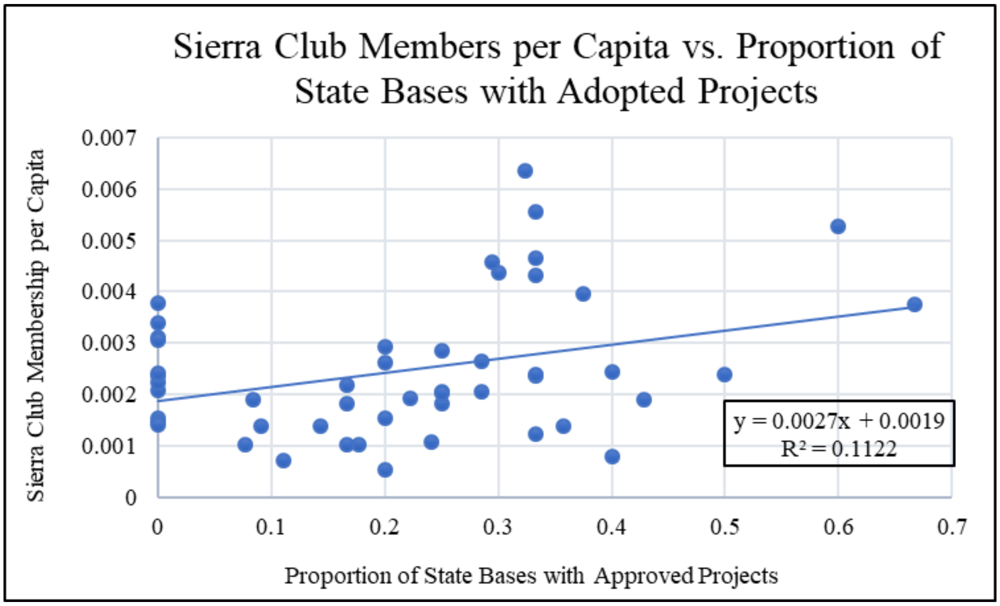

Figure 11. Positive Association of Sierra Club Members per Capita and the Proportion of States Bases with an Approved Project

Figure 12 indicates a positive relationship between the chosen proxies (Sierra Club membership per capita and the Yale Program on Climate Change Communication). Thus, models including these metrics should be confirmatory and reinforce overall conclusions.

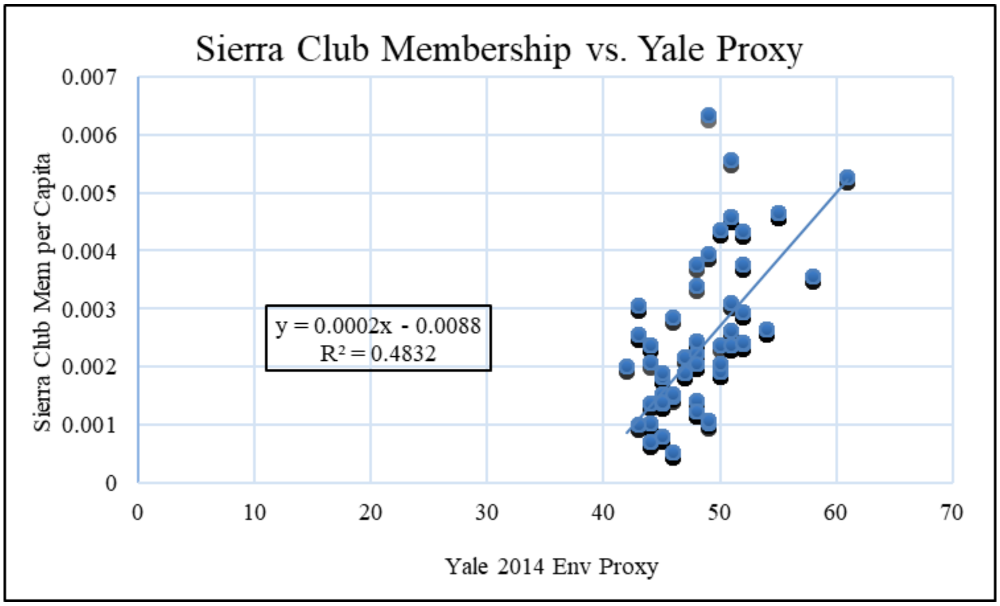

Figure 12. Positive Association of Sierra Club Membership Per Capita and the 2014 Yale Environmental Friendliness Proxy

Overall, the results from the Sierra Club model seem to be confirmed by the Yale model, per Table 14. The coefficient of the 2014 Yale data is positive and significant (Beta = 0.239, p = 0.0071). Furthermore, the model indicates that a 1% increase in the strength of the 2014 Yale value results in a 27% increase in the probability of adoption. However, the 2016 Yale data is neither positive nor significant (Beta = -0.127, p = 0.096). This is not unexpected because, for a proxy to be truly predictive, it must be accurate at the time of project adoption. The 2016 Yale data appears to be less applicable to decisions made during prior years. Nonetheless, on balance these results seem to indicate that as the environmental friendliness norms increase, the probability of initiative adoption seems to also increase.

Table 14. Logistic Regression Model of Yale Environmental Friendliness Proxy

Predictor	β	*Std E*	*Z-value*	Pr(>|z|)	*Exponentiated* β
Base Population	1.14E-04	4.02E-05	2.842	**0.0045**	1.00E+00
Yale 2014 Environmental Friendliness Proxy	2.39E-01	8.87E-02	2.694	**0.0071**	1.27E+00
Yale 2016 Environmental Friendliness Proxy	-1.27E-01	7.63E-02	-1.664	0.0961	
Total Site Delivered Energy (BBTU)	5.60E-04	4.20E-04	1.333	0.1826	
Intercept	-6.124	1.86E+00			
Pseudo R^2					
McFadden	0.616				
Cox and Snell	0.838				
Number of Observations					
Model	249				
Null	666				

How Change in Predictor Value Influences Adoption

	Increment Value	Adjusted Odds Ratio	Est. Change in Pr of Adoption
Yale 2014 Environmental Friendliness Proxy	1%	1.270	27.0%

Also, as seen in Table 15, the analysis of a normalized quantity of adopted projects per state also seems to confirm that environmental friendliness norms influence project adoption. Compared with the raw quantity of projects approved by state (with an average of 0.0027 Sierra Club Members per Capita), the states with the most normalized approved projects exhibit a larger amount of Sierra Club Members per Capita (an average of 0.0033 Sierra Club Members per Capita). In other words, when the data is normalized by DOD activity, the resulting states with the most approved projects have higher environmental friendliness norms than the raw data. Likewise, the states with the fewest number of approved projects (normalized) have a lower average number of Sierra Club Members per Capita (0.00217) compared with the raw quantity of approved projects (0.00232). This suggests, when DOD energy activity is considered, states with higher environmental friendliness norms tend to have a larger number of adopted projects.

Table 15. Comparison of Raw Data vs. Normalized Data Relative to Environmental Friendliness Norms

	Raw Data	*Data Normalized by Intensity of DOD Activity*
Top 10 States with most adopted projects		
(1)	CA	OR
(2)	VA	ID
(3)	TX	AR
(4)	FL	MA
(5)	GA	PA
(6)	PA	WY
(7)	SC	CA
(8)	WA	NH
(9)	AL	MT
(10)	MD	NV
Mean Sierra Club Members per Capita*	**0.002731**	**0.003262**
Bottom 25 States: Mean Sierra Club Members per Capita	0.002320	0.002171
Top 25 States: Mean Sierra Club Members per Capita	0.002636	0.002804

* Overall Sierra Club Per Capita mean is 0.002468

Collectively, these results lend support to the claim of H4. These results suggest that to some degree DOD managers seem to be influenced by stakeholder environmental friendliness attitudes in the local environment.

5. Hypothesis 5

H5 is tested via an analysis of potential adoption clusters and through logistic regression. First, a data string was created to count the number of "other" bases in a state who have adopted an initiative (mean 4.168 other "local adopters"). In other words, if a state adopts one project, the next adopted project will exhibit one other "local adopter." This data serves as the predictive variable for a logistic regression model. The dependent variable remains the same, 1 if a project was adopted at a base, 0 if not (both ESPC and

ECIP data were included). This model indicates whether a relationship exists between prior local adopters in a state and new project adoption in that state. Effectively, this is a test of imitation at the state level.

Next, clusters were identified and analyzed. Sites with the largest amount of delivered energy and any base within a 50 miles radius (as measured by driving distance) comprise a "cluster." Of note, not all states contain clusters based on this definition. A data string was then created for the residual (or "other," non-cluster) energy use. The hypothesis will be tested via t-Testing by analyzing the mean proportions of site energy within clusters relative to residual state and national averages. This will indicate whether there are differences in adoption when bases are "loners" (no surrounding bases to imitate) and when they have local "friends."

- Hypothesis 5 (H5): The more local adopters there are of an initiative, the higher the probability that it will be adopted.

Table 16 indicates a positive and significant relationship between the number of other "local adopters" (per state) and future adoption of an initiative (Beta = 0.0925, p = 0.0041). The predictive value of other "local adopters" seems to be strong as well. A one project increase in prior adoption increases the probability of future project adoption in that state by 9.7%. It is, however, unclear at what point this relationship will exhibit diminishing returns, considering there are a finite number of bases in each state. Regardless, this result lends support to the claim of H5 by indicating that the more other "local adopters" there are of an initiative, the higher the probability future projects will be adopted in that same state.

Table 16. Logistic Regression Model of Other "Local Adopters"

Predictor	β	*Std E*	*Z-value*	Pr(>|z|)	*Exponentiated* β
Other "Local Adopter"	9.25E-02	3.22E-02	2.868	**0.0041**	1.10E+00
Base Population	6.36E-05	4.84E-05	1.314	0.1889	
Sierra Club Membership per Capita	-7.41E+01	1.50E+02	-0.493	0.6217	
Plant Replacement Value ($M)	8.28E-04	1.93E-04	4.300	**0.0000**	1.00E+00
Total Site Delivered Energy (BBTU)	-5.16E-04	4.63E-04	-1.116	0.2646	
Intercept	-1.880	4.12E-01			
Pseudo R^2					
McFadden	0.679				
Cox and Snell	0.882				
Number of Observations					
Model	233				
Null	666				

How Change in Predictor Value Influences Adoption

	Increment Value	Adjusted Odds Ratio	Est. Change in Pr of Adoption
Other "Local Adopter"	1	1.097	9.7%
	5	1.588	58.8%

To further investigate H5, the adoption clusters in Figure 13 were identified and analyzed relative to national averages. Clusters were identified in a total of seventeen states.

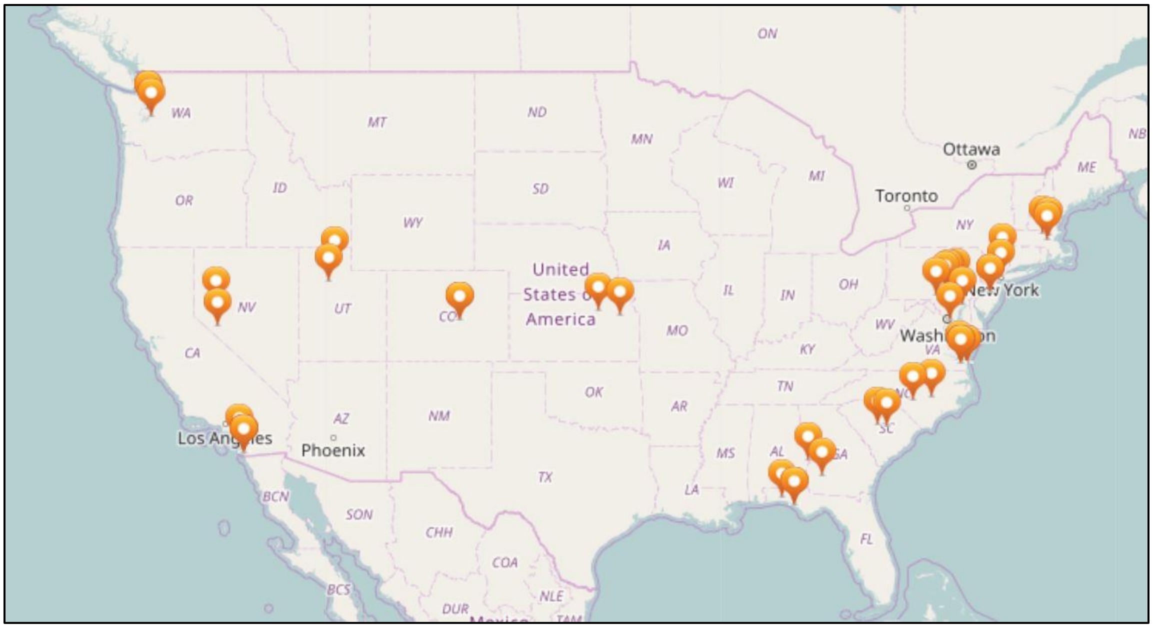

Figure 13. Locations of Analyzed Adoption Clusters

As Figure 14 indicates, the proportion of a state's total energy (all sites) covered by an adopted initiative is considerably higher within identified clusters (1.338) than the national average (0.531). The results in Table 17 indicate that the differences in the mean proportions are significant ($p = 0.0003$). In other words, this result indicates that adoption is considerably higher at sites within clusters than at bases with no proximate bases to imitate. This analysis also reveals that states with the lowest level of DOD energy activity also have the lowest proportion of energy covered by an initiative (0.362), as expected.

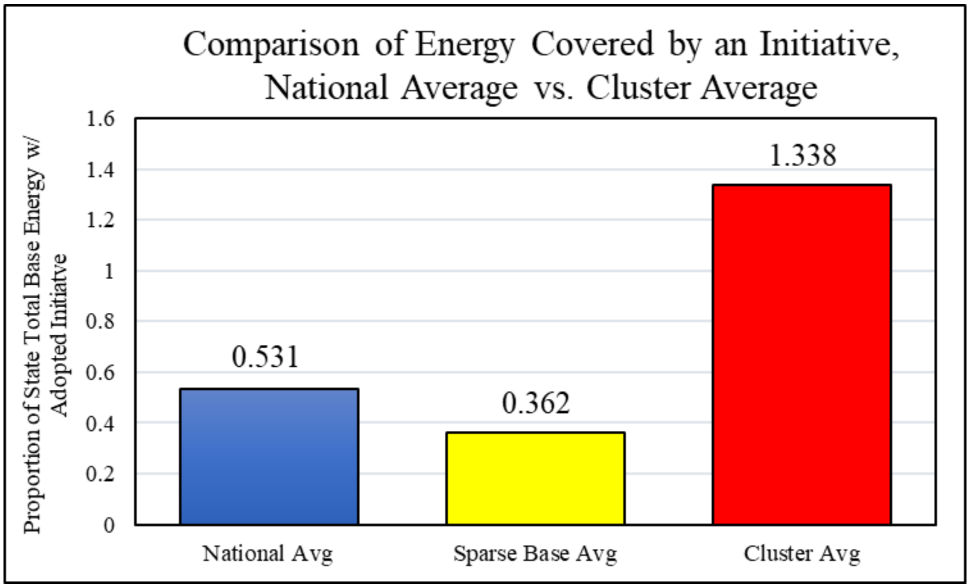

Figure 14. Comparison of Energy Proportions in Clusters and National Average

Table 17. Comparison of Energy Proportions, Two-Sample t-Test

	Proportion of Total Energy w/ Adoption	*Proportion of Cluster Energy w/ Adoption*
Mean	0.5225	1.2860
Observations	48	16
Hypothesized Mean Difference	0	
df	62	
t Stat	-3.8726	
P(T<=t) two-tail	***0.0003***	
t Critical two-tail	1.9990	

Collectively, these results support H5 because they suggest that there is an increased level of adoption at sites when they have local "friends" with adopted projects than at "loner" bases (no surrounding bases to imitate). This may reflect the risk averse nature of the DOD because managers seem to be more willing to adopt projects after a nearby manager has proven an initiative's worth. Thus, these results are of significant interest to high level managers because there seems to be a ripple effect of adoption. Managers must consider potential second and third order effects of project adoption. The results also indicate learning (i.e., through observation of other site's actions) which is consistent with adoption theory (Greve, 2009).

6. Hypothesis 6

Lastly, H6 examines the difference between ESPC and ECIP projects relative to investment return using t-Testing. Like H1 and H3, t-Tests were performed on the means of initial investment, cost savings, and investment return from the ESPC and ECIP data-sets (data adjusted for inflation to $2017 prior to analysis). Findings indicate whether the mean values for each of the analyzed characteristics are significantly different. Thus, supporting or refuting the claim of H6.

- Hypothesis 6 (H6): Relative to ECIP projects, ESPC initiatives will be approved for more costly projects with greater cumulative cost savings but a lower investment return (measured by SIR).

The analysis confirms some aspects of H6 and rejects others. Table 18 confirms ESPC vs. ECIP project investment (p = 3.0E-06) and ESPC vs. ECIP cost savings (7.3E-06) are significantly divergent. All things being equal, ESPC projects do seem to be of larger scope than ECIP projects in terms of project investment and cost savings.

Table 18. ECIP vs. ESPC Project Characteristics, Two-Sample t-Test

	ECIP Project Investment	*ESPC Project Investment*	*ECIP Cost Savings*	*ESPC Cost Savings*	*ECIP SIR*	*ESPC SIR*
Mean	$3,130,953	$18,831,248	$6,895,130	$47,347,274	2.4017	2.3444
Observations	280	92	280	92	280	92
Hypothesized Mean Difference	0		0		0	
df	92		92		322	
t Stat	4.9768		4.7571		0.4184	
P(T<=t) two-tail	***3.000E-06***		***7.253E-06***		***0.676***	
t Critical two-tail	1.9861		1.9861		1.9674	

As previously discussed, ECIP guidance considers investment return to be a key metric for approval (Jung, 2016). However, the analysis shows that there is not a significant difference in the investment return outcomes of each type of initiative. This result is surprising because one would expect a particular focus on the SIR metric would produce a noticeable difference in outcomes. However, this analysis finds no significant difference in investment return between ESPC and ECIP projects despite varying levels of attention to the metric between the programs.

VI. RECOMMENDATIONS AND CONCLUSIONS

A. CONCLUSIONS

This paper examined predictive factors influencing the adoption of energy saving initiatives at DOD installations. The premise of this research is that managers would be better able to plan for and resource projects if they know as much as possible about what influences adoption. Therefore, it is important to understand whether adoption drivers are different from what they are currently understood to be. Table 19 provides a summary of the data analysis results which form the basis for the listed conclusions.

Table 19. Hypotheses Results and Significant Findings

Hypothesis	Result	Significant Finding
H1	Confirmed	DOD may have taken a learning, risk mitigation approach to ESPC projects because they chose to award the easiest to implement contracts first.
H2	Inconclusive	The most useful internal metrics by which to search for and prioritize future projects—total site delivered energy and PRV.
H3	Rejected	Projects that guarantee the most cost savings (and thereby energy savings) were implemented after smaller-scale projects.
H4	Confirmed	As environmental friendliness norms increase, the probability of initiative adoption seems to also increase.
H5	Confirmed	There is an increased level of adoption at sites when they have local “friends” with adopted projects than at “loner” bases (no surrounding bases to imitate).
H6	Rejected	ESPC projects do seem to be of larger scope than ECIP projects in terms of project investment and cost savings, but that there is not a significant difference in the investment return outcomes of each type of initiative.

The results of this study indicate that both internal and external factors influence which projects are forwarded for adoption. It may be tacitly understood that DOD energy project adoption is an internally driven process. However, these results indicate that external factors also play a role. From what we know, specifically regarding the ESPC program, there is no active screening process at the OSD level. If a local installation manager has a project idea that meets the requirements of the program, the default assumption is that the project will be awarded and implemented (Daniel Magro, personal communication, September 8, 2017). In this way, decisions regarding adoption are really being made at the local level, not at the OSD. Inclusion of these relevant internal and external factors in the strategy decision-making process could help DOD managers maximize the benefit of existing energy initiatives.

Overall the key findings from this research are as follows:

1. Imitation is an Adoption Catalyst

This study determined that imitation is an adoption catalyst. DOD managers seem to be learning passively, through observation of other site's actions, or actively, through deliberate knowledge transfer between sites. As the number of adopters within a state increases, the probability of subsequent project adoption within that state increases. Similarly, adoption clusters were identified in a total of seventeen states. As this research found, the proportion of a state's total energy covered by an adopted initiative is considerably higher within identified clusters than the national average. This supports the idea that a site's proximity to an adopter influences future adoption at that site. When prioritizing future projects, DOD managers should leverage the potential for imitation by focusing efforts on sites with many neighbors. Success at these sites better positions surrounding sites to pursue and implement similarly successful projects.

2. Environmental Norms Matter

The significance of local environmental preferences on project adoption was a surprising finding. This study found that local environmental norms do influence initiative adoption in the DOD. The results indicate that states with higher environmental friendliness norms, as measured by Sierra Club membership per capita, tend to have a higher quantity of adopted projects. This research indicates that DOD managers, whether consciously or not, seem to feel increased pressure from environmentally conscious local stakeholders. Cultivating goodwill in the local community through the adoption of energy-saving technology at installations may relieve some pressure on the DOD in the performance of other activities in the community. Managers who possess an understanding of this increased pressure should be better postured to provide clear-eyed project recommendations regarding the most beneficial projects.

3. The DOD Is a Learning, Risk Averse Culture

This research indicates that the DOD has awarded the easiest to implement contracts first. When prioritizing projects, managers should analyze the history of adoption at the proposed location to better incentivize projects of manageable scope. The value of infrastructure to the DOD is also a useful metric to prioritize future projects. Bases without an adopted project but with above average infrastructure value (as measured by PRV) should be immediate candidates for future initiatives. Also, this finding further emphasizes the importance of observation and imitation of other site's actions. Risk may be reduced, and learning may be increased through imitation of another site's best practices regarding project adoption.

B. RECOMMENDATIONS

- The military services should each develop a tool for energy-saving initiative prioritization. As the saying goes, "What gets measured, gets managed." Project prioritization must be based on rational cost-benefit analysis of the best available opportunities for the DOD's finite oversight capacity. This process could help balance, isolate or leverage the influence of both internal and external factors, to achieve the best overall mix of projects.

- The DOD should merge the Base Structure Report and the Annual Energy Management Report. In doing so, infrastructure should be identified quantitatively, not by categorical, easy to misconstrue, base names. This will enable managers to take a holistic approach to energy efficiency analysis as it relates to the total infrastructure portfolio and the identified external factors.

- To leverage the power of imitation and clustering. OSD should identify, by state or region, the highest value bases that are surrounded by the most bases. The energy managers at these identified bases should be formally designated as the energy-efficiency adoption leaders for their region. Energy managers from this base will be charged with publicizing actions and sharing lessons learned with nearby bases in order to reduce perceived risk of initiatives at other sites and to maximize DOD's savings from energy projects of various kinds.

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