FINAL REPORT

"Market Aware" High Performance Buildings – Participating in Fast Load Response Utility Programs with a Single Open Standard Methodology

ESTCP Project EW-201401

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14. ABSTRACT

Objective: Implement an open standard web services-based system to allow machine to machine communication between DOD facilities and energy providers that enables secure participation in the demand response and ancillary services markets using end point hardware certified for DoD networks.
Technology Description: Our solution consists of two parts: a cloud-based server (EISS®) to distribute market signals from an ISO or utility according to a standard format and client-side end points (EISSBox) to convey standard market signals to facility energy management systems. The end points allow existing energy management systems to interface with these open standard web services rather than requiring expensive building upgrades.
Expected Benefits: DOD facilities can participate in demand response programs requiring automated signals. Much of the DOD focus in recent years has been in energy efficiency. This proposal focuses directly on reducing present energy costs. While net-zero investment and solar projects can take decades to recoup savings, participation in demand response programs, especially those requiring rapid response, can yield a payback with dramatic savings in all future years as the project is expanded. Additional savings can be driven by installation of appropriate technology and metering solutions to enable participation in various ancillary services markets.

15. SUBJECT TERMS

OpenADR 2.0; Demand Response; Automated Demand Response

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ACRONYMS AND ABBREVIATIONS

ASD (HD&ASA)	Assistant Secretary of Defense for Homeland Defense and Americas' Security Affairs
ATC	Authority to Connect
ATO	Authority to Operate
ATR	Advanced Technology Resource
AutoDR	Automated Demand Response
BAH	Booze, Allen, and Hamilton
BIP	Base Interruptible Program
BMS	Building Management System
CAISO	California Independent Systems Operator
CONUS	Continental United States
COTS	Commercial off the Shelf
DAA	Designated Accreditation Authority
DIACAP	DoD Information Assurance Certification and Accreditation Process
DoD	U.S. Department of Defense
DoDD	Department of Defense Directive
DoDI	Department of Defense Instructions
DOE	U.S. Department of Energy
DPW	Directorate of Public Works
DR	Demand Response
DUSD (I&E)	Deputy Under Secretary of Defense for Installations and Environment
E. O.	Executive Order
EI	Energy Interop™
EISA	Energy Independence and Security Act of 2007
EISS®	Energy Interop Server & System
EISSBox	OpenADR 2.0b-compliant end point/ESI
EPAct 2005	Energy Policy Act of 2005
ERCOT	Electric Reliability Council of Texas
ESI	Energy Service Interface
ESTCP	Environmental Security Technology Certification Program
FERC	Federal Energy Regulatory Commission
HVAC	Heating, Ventilation, and Air Conditioning
IA	Information Assurance
IAM	Information Assurance Manager
IATO	Interim Authority to Operate
IATC	Interim Authority to Connect
IATT	Interim Authority to Test

IAVM	Information Assurance Vulnerability Management
IOU	Investor Owned Utility
IoT	Internet of Things
IP	Internet Protocol
ISO	Independent System Operator
LAN	Local Area Network
LBNL	Lawrence Berkeley National Laboratory
NAVFAC	Navy Facility Engineering Command
NECPA	National Energy Conservation Policy Act
NIST	National Institute of Standards and Technology
NIST SP	NIST Special Publication
OASIS	Organization for the Advancement of Structured Information Standards
OpenADR	Open Automated Demand Response
PI	Principal Investigator
PIT	Platform Information Technology
PJM	PJM Interconnection, LLC – large RTO with operations in the Mid-Atlantic and Midwest states
PKI	Public Key Infrastructure
PO	Post Office
POC	Point of Contact
PSNET	Public Safety Network
RMF	Risk Management Framework
RSA	Rivest-Shamir-Adleman Cryptosystem
RTO	Regional Transmission Organization
SDG&E	San Diego Gas and Electric
SSL	Secure Sockets Layer
STIG	Security Technical Implementation Guides
TLS	Transport Layer Security
USD (AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics
USMC	United States Marine Corps
VEN	Virtual End Node
VFD	Variable Frequency Drive
VTN	Virtual Top Node
XML	Extensible Markup Language

ABSTRACT

INTRODUCTION AND OBJECTIVES

Motivation: Building performance improvement is not just about consuming less energy it is also about managing when this energy is consumed. The next area of gains will be in participation in demand management programs. Renewables like wind and solar are by their very nature intermittent dealing with this excess generation when not needed and how to fill the gaps when it is not present is a significant challenge. Recent Smart Grid standards sponsored by NIST and managed by OASIS have created a single open standard solution for energy communications called Open Automated Demand Response version 2.0 (OpenADR 2.0.) These standards use the latest Secure Service Orientated Architecture.

Objectives: Demonstrate the feasibility of using OpenADR 2.0 – an open standard web services-based system to allow machine-to-machine communication between DoD facilities and energy providers – to enable secure participation in the new grid balancing/demand management programs.

TECHNOLOGY DESCRIPTION

Our solution consists of two parts: a cloud-based server to distribute market signals from an energy provider according to a standard format and client side end points to convey market signals to facility energy management systems and/or DR assets. The server and end points are connected via OpenADR 2.0 web services over an IP network connection. The end points allow existing energy management systems to interface with these open standard web services rather than requiring expensive building upgrades.

PERFORMANCE AND COST ASSESSMENT

The meter data was reviewed and fed into the model, no other performance assessment was performed. AutoDR costs are all up front. Ongoing costs are only incurred if the building management system is changed or updated. These costs are typically nominal. Camp Pendleton would receive approximately $60,000 per year with a $20,000 one-time implementation cost.

IMPLEMENTATION ISSUES

We have learned during this demonstration that the most critical step is the cyber accreditation. New instructions from the OSD CIO to cover IoT types of devices were introduced during this demonstration. Since most of these IoT devices require network access, they present a potential vulnerability and the assessment of risk can vary. We saw that a simple change in personnel at Picatinny Arsenal resulted in a decision to withdraw due to the potential risk / reward analysis that every facility ISSM must perform.

To successfully navigate this evolving landscape, we believe these three items are required:

1) Endorsement from command that has the capability to accept risk for the facility.
2) Buy in from the facility ISSM before starting.

3) A complete understanding of the difference between the DoD and the commercial world.

PUBLICATIONS

NA

EXECUTIVE SUMMARY

INTRODUCTION

Building performance improvement is not just about consuming less energy it is also about managing when this energy is consumed. Historically, federal mandates have been about reducing the energy consumption per square foot and integrating renewable generation. Significant improvements in efficiency have been accomplished. However, the current budgetary climate will require further reductions in operational energy spending and this will be difficult to accomplish purely with further attempts at efficiency gains.

The next area of gains will not be in efficiency but in participation in demand management programs that reward changes in the timing of energy use and participation in rapid response energy markets, such as regulation and spinning reserves. This discussion about the timing of energy consumption is made more relevant by the increased use of renewable energy. Renewables like wind and solar are by their very nature intermittent whereas the consumption of energy does not follow this same pattern. What to do with this excess generation when not needed and how to fill the gaps when it is not present is a significant challenge. Electrical storage technologies are one potential area to mitigate this issue but currently are cost prohibitive and will require more time and research in order to make them cost effective.

To deal with this issue, the federal government and the Department of Energy have undertaken many studies to see if end use consumption can be quickly changed to match the intermittency provided by these renewables. Programs like real time retail pricing, migration to wholesale markets; peak demand charges, solar cutoff programs, etc. have shown that it is possible to balance the grid by signaling load. Participation in these programs typically results in financial incentives and lower utility bills. Grid stability and economic incentives will be the driver for the new "market aware" high performance building.

Unlike legacy demand response programs, which would only be called a few times a year, these new demand management programs may require daily and/or hourly changes to consumption. Manual curtailment will not be able to meet utility program response requirements and provide the reliability needed to maintain grid stability. What is needed is a machine-based direct connection between energy providers and consumers.

Legacy methods to accomplish these machine-to-machine interactions are both proprietary, expensive and lack cyber security controls. In the absence of federal standards for energy communications, each company developed their own proprietary solutions. Recent Smart Grid standards sponsored by NIST and managed by OASIS have created a single open standard solution for energy communications called Open Automated Demand Response version 2.0 (OpenADR 2.0.) These standards use the latest Secure Service Orientated Architecture based web services to allow non-propriety, secure communications of energy market information. For example, the OpenADR 2.0 standard includes the following:

a. Secure Socket Layer (SSL)/Transport Layer Security (TLS)-supported encryption – using either Rivest-Shamir-Adleman (RSA) or Elliptical Curved Cypher sets

b. TLS 1.2 – the latest version of Transport Layer Security for secure end-to-end transmission of data between server and end points

c. X.509 Public Key Infrastructure (PKI) certificates for mutual authentication on both the server and end points. The standard requires that an end point may connect to one, and only one server for its OpenADR 2.0b signals. Mutual authentication insures that an end point may connect only to a server that has its PKI certificate on file.

This new standard has been adopted for use by the Investor Owned Utilities (IOU) in California and Hawaii and is being used in pilots in Texas and the U.S. east coast. This standard provides a single secure bi-directional method for energy providers to signal energy consumers' equipment directly while still providing user choice.

OBJECTIVES

Demonstrate the feasibility of using OpenADR 2.0 – an open standard web services-based system to allow machine-to-machine communication between DoD facilities and energy providers – to enable secure participation in the new grid balancing/demand management programs.

A baseline comparison of the OpenADR 2.0 compared to legacy DR systems and to no DR.

EISS® and OpenADR 2.0 help DoD drive greater grid stability by participation in a number of new demand response and energy market programs – some of which require automation as a condition of participation. The technology also has the potential of helping DoD to monetize its microgrid investments by signaling when energy prices make it more cost efficient to sell power to the grid and when it is better to use a microgrid to supplement the needs of the DoD installation. Key measurements associated with the demonstration include: reduced vulnerability to power grid disruptions, signal optimal times to increase use of renewable energy generation, and reducing energy intensity (kWh/ft^2).

TECHNOLOGY DESCRIPTION

Description: Our solution consists of two parts: a cloud-based server to distribute market signals from an energy provider according to a standard format and client-side end points to convey market signals to facility energy management systems and/or DR assets. Optionally, a stateful firewall of type and capability required by the Designated Accreditation Authority may be included as well, although this component was not used in the project. The server and end points are connected via web services over an IP network connection. The end points allow existing energy management systems to interface with these open standard web services rather than requiring expensive building upgrades. All system components are commercial-off-the-shelf (COTS).

- Visual Depiction: See Figure 6, below, depicting the building blocks of a typical IPKeys Energy Interop Server & System (EISS®) deployment.

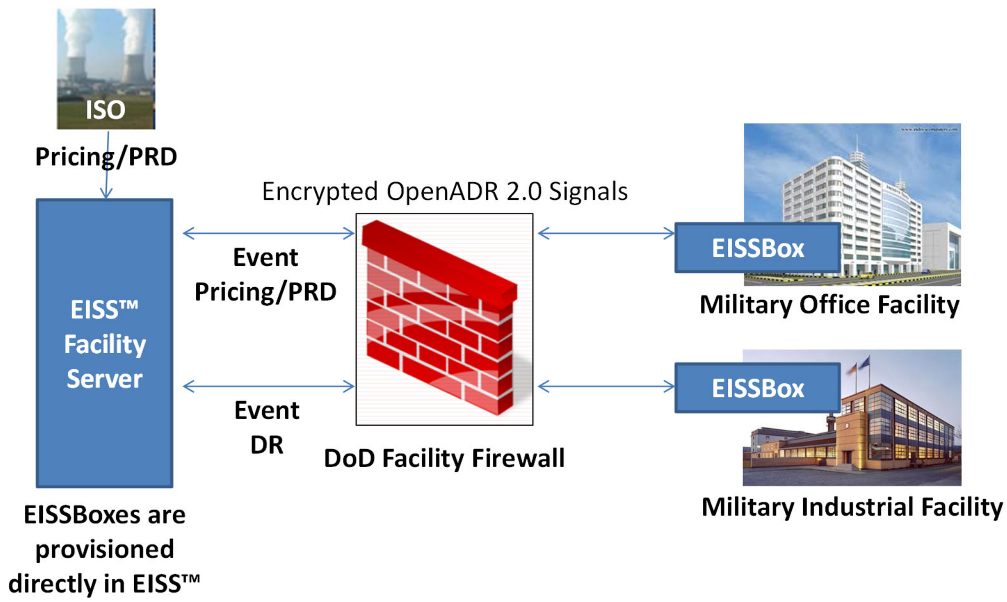

Figure 1. EISS® Server Facility Edition – Typical Deployment

- Components of the System:
  - EISS® 2.0 Server or OpenADR 2.0b Virtual Top Node (VTN) – the EISS® server is a cloud hosted VTN that is the heart of any OpenADR 2.0 deployment. The EISS® server is deployed in two components: the OpenADR 2.0b-certified EISS® 2.0 VTN and EISSPoint – an end point element manager. EISSPoint is used to configure and maintain all EISSBox devices logically attached to it via the Internet. The EISS® server is also a temporary repository for event and meter data collected from fielded EISSBoxes via OpenADR 2.0b's EiEvent and EiReport web services. (The EiEvent and EiReport web services are used to collect responses to calls to perform issued by the VTN server and load shed (kW and kWh) from any attached electric meter or sub-meter.) The EISS® server may be configured to send collected event and meter data to a backup location of the government's choice.
  - EISSBox 2.0 or OpenADR 2.0b Virtual End Node (VEN) – the EISSBox is an energy services interface that receives OpenADR 2.0 messages from a VTN and converts those messages into signals actionable by the DR assets under review. IPKeys' EISSBoxes present OpenADR 2.0 signals as either "dry contact" values or Modbus registers.
  - Stateful Firewall – if required by the DAA, IPKeys can supply "firewall" technology to perform inspection of all signals sent to endpoints on a DoD installation to insure the security and integrity of the communication. This safeguard, usually implemented with additional hardware, provides an additional layer of security in that it inspects the XML payload of each packet sent to the end point for conformance to the OpenADR 2.0b XML specification.

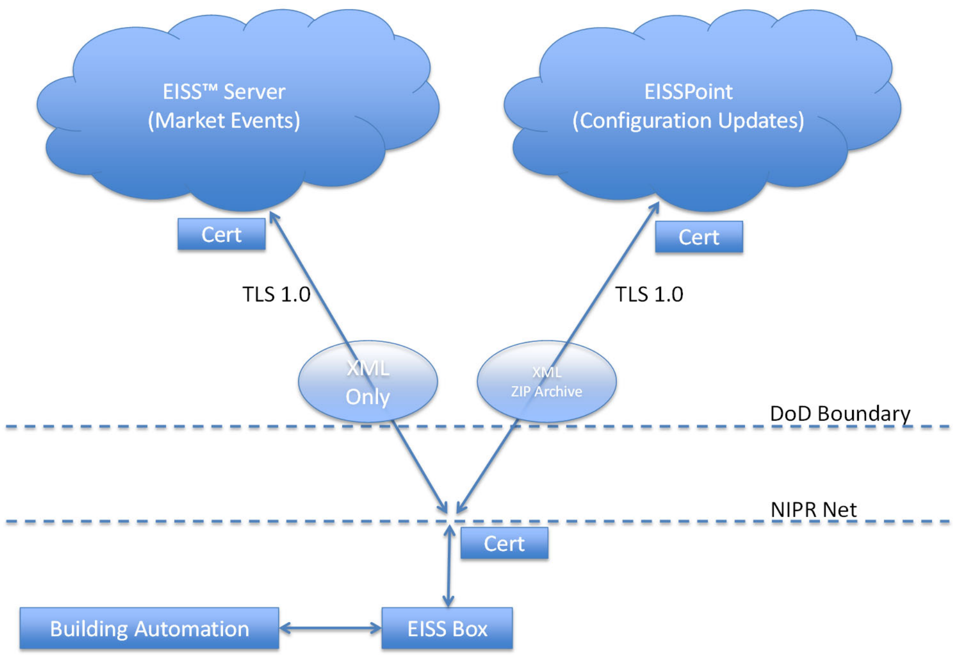

Figure 2. EISS® Component Interaction DiagramError! Reference source not found. depicts the various components and web services available on IPKeys' EISS® VTN or server. Also shown is the flow of data between components.

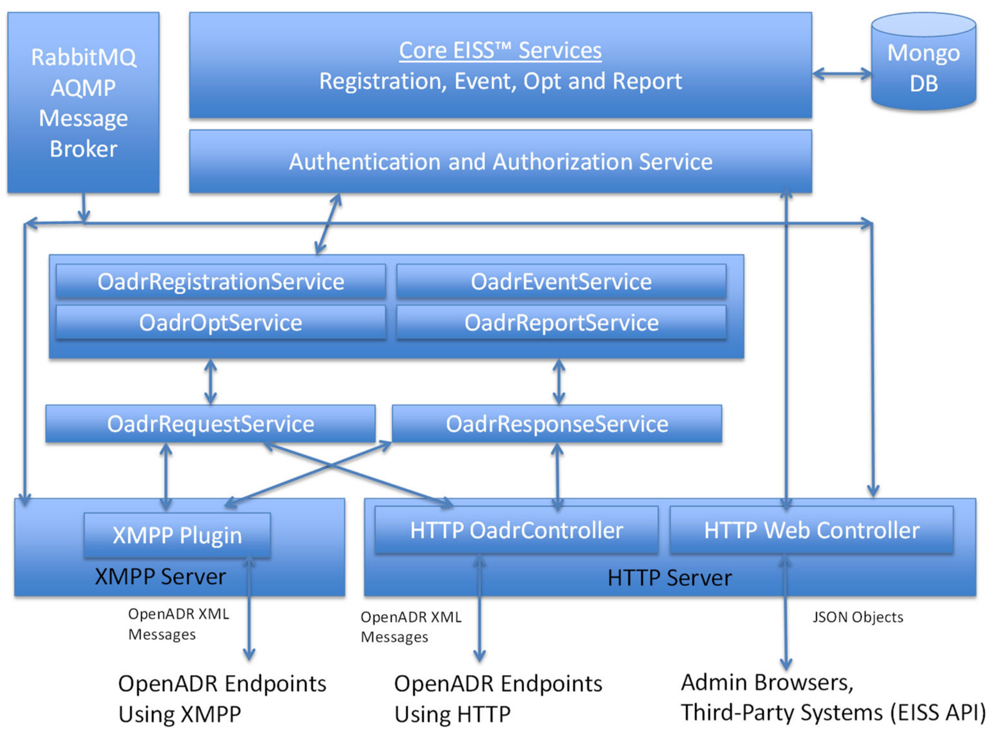

Figure 3. EISS® Server Services

Figure 9 depicts the various components and web services available on IPKeys' EISSBox 3.0 VEN or similar end point hardware. Also shown is the flow of data between components.

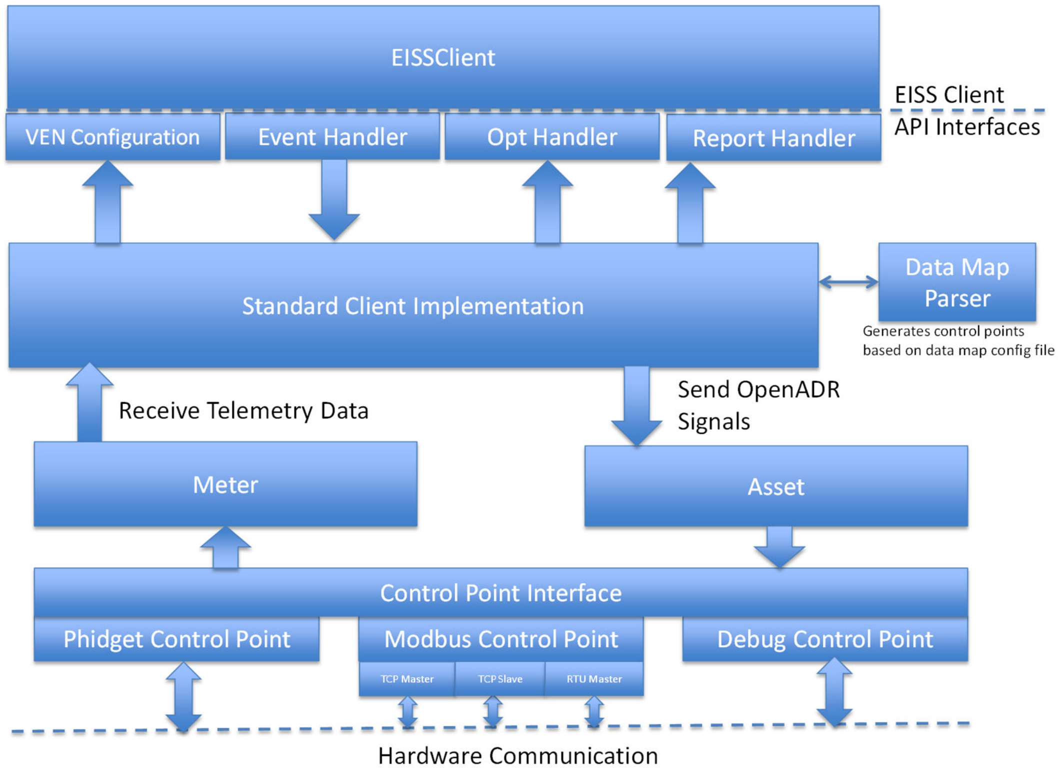

Figure 4. EISSBox Client Services

PERFORMANCE ASSESSMENT

The meter data was reviewed and fed into the model, no other performance assessment was performed. A conservative rule of thumb is 10% of the peak load. We have seen facilities who can even go to 40% but that is unusual. Typically, sites can shed at least 10% with a stretch goal of 20%.

To estimate earnings, take 10% of the peak load and multiply it by $6.54/kW to get annual earnings. The $6.54 factor is a blended number based on CONUS capacity programs at PJM and SDG&E's BIP program that are on the lower end of the spectrum. This number, with the conservative 10% assumption, gives a safe assumption of what can be earned. A useful report prepared in 2012 by staff at Lawrence Berkeley National Laboratory provides a CONUS-level, view.

We can apply this approach to data from the utility meter used to capture the interval data used to invoice Camp Pendleton, shown in Figure 12.

Monthly Usage	Max	Min	Average
Jan-16	2890.5	1551.0	2150.3
Feb-16	3105.0	1494.0	2162.3
Mar-16	2710.5	447.0	2057.3
Apr-16	2767.5	1492.5	1977.1
May-16	2479.5	1447.5	1956.1
Jun-16	3400.5	1540.5	2177.1
Jul-16	3402.0	1720.5	2356.9
Aug-16	3315.0	1834.5	2432.8
Sep-16	3633.0	1755.0	2314.7
Oct-16	3064.5	1630.5	2137.1
Nov-16	3523.5	1584.0	2046.5
Dec-16	2629.5	1434.0	2019.0

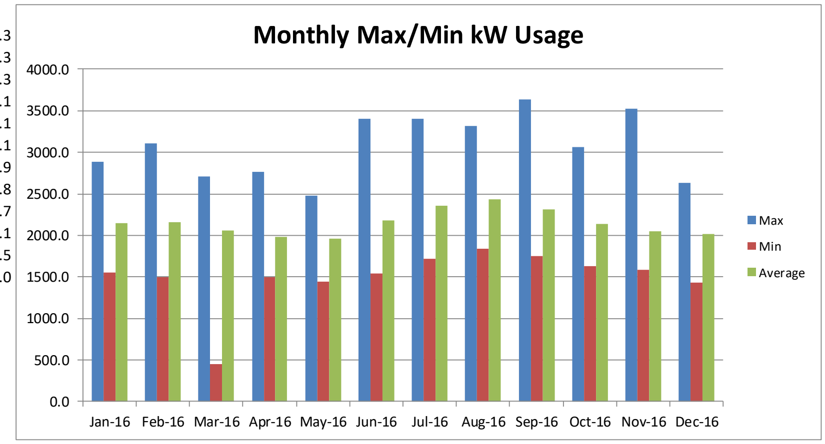

Figure 5. Camp Pendleton Max/Min/Average Usage for 2016

COST ASSESSMENT

Table 1. Cost Model for OpenADR 2.0-enabled DR Program Participation

Cost Element	Data Tracked During the Demonstration	Estimated Costs	Comments
Hardware capital costs	OpenADR 2.0b-certified VEN or endpoint (EISSBox)	$2500	
Installation costs	Install gateway	$1200	Gateway installation is $1200 BMS programming can range from $5,000 to $20,000 based on our experience in other deployments. The price dependence is based on the presence of predefined scenarios that are present in some BMS systems which make the process of programming of demand response event actions easier.
Consumables	No consumables anticipated		
Facility operational costs	No operational costs anticipated		
Maintenance (Annual)	Cost of maintenance for endpoint. Security logs checked monthly. (This was to be provided as part of the aggregator package during FOC.)	$2430	Endpoint maintenance estimated at 18% of retail cost per year. Included in aggregation package, assume use of a security engineer for one hour per month to review security logs at an estimated rate of $165 per hour.
Hardware lifetime	10 Years +		
Operator training	None		

AutoDR costs are all up front. Ongoing costs are only incurred if the building management system is changed or updated. These costs are typically nominal.

IMPLEMENTATION ISSUES

We have learned during this demonstration that the most critical step is the cyber accreditation. The emergence of energy IoT devices that can save the DoD labor and potentially earn revenue is an emerging topic.

New instructions from the OSD CIO to cover these types of devices were introduced during this demonstration. Since most of these IoT devices require network access, they present a potential vulnerability and the assessment of risk can vary. We saw that a simple change in personnel at Picatinny Arsenal resulted in a decision to withdraw due to the potential risk / reward analysis that every facility ISSM must perform.

To successfully navigate this evolving landscape, we believe these three items are required:

1) Endorsement from command that has the capability to accept risk for the facility. Facility maintenance personnel are typically the first point of adoption but are not able to make these facility-level command decisions

2) Buy in from the facility ISSM before starting.
Without the continual support of this team this process starts and stops constantly. A POAM and specific personnel must be assigned at the start of the project

3) A complete understanding of the difference between the DoD and the commercial world. We must always keep in mind that the mission of the DoD is to protect this country, not save energy. Anything that could impact their Title 10 responsibilities will be resisted. Our requirements for North American hardware and a Windows operating system show that the closer you can be to a known good deployed system, the easier it is for DoD managers to accept. Anything that can be a gateway for bad actors will be carefully analyzed.

PUBLICATIONS

NA

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1.0 INTRODUCTION

Motivation: Building performance improvement is not just about consuming less energy it is also about managing when this energy is consumed. Historically, federal mandates have been about reducing the energy consumption per square foot and integrating renewable generation. Significant improvements in efficiency have been accomplished. However, the current budgetary climate will require further reductions in operational energy spending and this will be difficult to accomplish purely with further attempts at efficiency gains.

The next area of gains will not be in efficiency but in participation in demand management programs that reward changes in the timing of energy use and participation in rapid response energy markets, such as regulation and spinning reserves. This discussion about the timing of energy consumption is made more relevant by the increased use of renewable energy. Renewables like wind and solar are by their very nature intermittent whereas the consumption of energy does not follow this same pattern. What to do with this excess generation when not needed and how to fill the gaps when it is not present is a significant challenge. Electrical storage technologies are one potential area to mitigate this issue but currently are cost prohibitive and will require more time and research in order to make them cost effective.

To deal with this issue, the federal government and the Department of Energy have undertaken many studies to see if end use consumption can be quickly changed to match the intermittency provided by these renewables. Programs like real time retail pricing, migration to wholesale markets; peak demand charges, solar cutoff programs, etc. have shown that it is possible to balance the grid by signaling load. Participation in these programs typically results in financial incentives and lower utility bills. Grid stability and economic incentives will be the driver for the new "market aware" high performance building.

Unlike legacy demand response programs, which would only be called a few times a year, these new demand management programs may require daily and/or hourly changes to consumption. Manual curtailment will not be able to meet utility program response requirements and provide the reliability needed to maintain grid stability. What is needed is a machine-based direct connection between energy providers and consumers.

Legacy methods to accomplish these machine-to-machine interactions are both proprietary, expensive and lack cyber security controls. In the absence of federal standards for energy communications, each company developed their own proprietary solutions. Recent Smart Grid standards sponsored by NIST and managed by OASIS have created a single open standard solution for energy communications called Open Automated Demand Response version 2.0 (OpenADR 2.0.) These standards use the latest Secure Service Orientated Architecture based web services to allow non-propriety, secure communications of energy market information. For example, the OpenADR 2.0 standard includes the following:

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b. TLS 1.2 – the latest version of Transport Layer Security for secure end-to-end transmission of data between server and end points

c. X.509 Public Key Infrastructure (PKI) certificates for mutual authentication on both the server and end points. The standard requires that an end point may connect to one, and only one server for its OpenADR 2.0b signals. Mutual authentication insures that an end point may connect only to a server that has its PKI certificate on file.

This new standard has been adopted for use by the Investor Owned Utilities (IOU) in California and Hawaii and is being used in pilots in Texas and the U.S. east coast. This standard provides a single secure bi-directional method for energy providers to signal energy consumers' equipment directly while still providing user choice.

Intent: Demonstrate the feasibility of using OpenADR 2.0 – an open standard web services-based system to allow machine-to-machine communication between DoD facilities and energy providers – to enable secure participation in the new grid balancing/demand management programs.

1.1 BACKGROUND

Current Technology State of the Art: The National Institute of Standards and Technology (NIST) sponsored Smart Grid Interoperability Panel has completed action on a set of standards for conveying energy market information and demand response signaling called the OASIS Energy Interoperations (Energy Interop™) standard, version 1.0. OpenADR 2.0 is a profile of the Energy Interop™ standard.

The OpenADR Alliance was formed to create a test and conformance framework to insure interoperability. Alliance members (see http://www.openadr.org) are implementing products using EI's OpenADR 2.0 Profile for grid balancing, and demand management signaling. Hardware and software driver upgrades to existing energy management system equipment from such manufacturers as Honeywell and Connexx Energy are now available. This availability will insure that this standard is widely adopted and becomes the *defacto* standard of energy market communications worldwide. Conformance testing to insure interoperability has resulted in many certified products. The California Public Utility Commission has required OpenADR conformance for all facility upgrade equipment funded through its Technical Assistance/Technology Incentive Program since 2012. Effective July 2014, California changed its building code (Title 24) to require all new and retrofit space over 10,000 square feet in area be capable of participation in DR programs[i]. On 9 May 2018, the California Energy Commission adopted updates to the California Energy Code (California Code of Regulations Title 24, Part 6) that specify OpenADR 2.0 as the required default demand response communication protocol for new construction in the state. These changes go into effect on January 1, 2020.

IPKeys offers its EISS® – Energy Interop™ Server & System – server and client hardware. This system has been fully tested and has been certified by the OpenADR Alliance. This system implements price conveyance and demand management signaling portions of the standard. Our system is currently being implemented at the utility level and we have participated in several Advanced Technology Resource (ATR) pilots using our technology with PJM Interconnection, a large regional transmission organization (RTO). The Phase 2 ATR tested signaling for wholesale ancillary services markets including synchronous reserves and regulation under a subcontract with Lawrence Berkeley National Laboratories.

Current State of Technology in DoD: The project team is unaware of any significant use of automated demand response (AutoDR) technology within DoD. While a significant number of DoD facilities participate in demand response (DR) programs of various types, the programs are typically older, "DR 1.0" programs used to shed load in grid emergencies. These legacy DR programs typically have notification intervals measured in hours (and sometimes, days) and can thus be manually implemented.

Current DoD facility participation in DR programs tends to be manually implemented, with focus principally on compliance with Federal Energy Regulatory Commission (FERC) grid reliability regulations as well as participation in "good neighbor" initiatives like the PJM Emergency Grid Response program. Lack of automated DR capabilities at the installation and facility level limit DoD's ability to participate in short notice programs where lack of performance is penalized. Such ancillary services programs offer participants significant compensation, often for "standing by.[ii]"

New "DR 2.0" programs may have notification intervals measured in minutes or – for regulation markets – seconds, and thus require an AutoDR capability in order to respond timely to a call to perform. DoD does not currently have an accredited and certified signaling technology in place to permit participation in these new programs, which limits DoD's ability to drive significant savings and incentives otherwise available to "DR 2.0" program participants.

Technology Opportunity: Federally sponsored studies and pilots have all shown that real market energy pricing automatically regulates energy consumption naturally through market forces. DoD installations have unique implementation and security requirements due to the nature of their responsibility to protect our nation. Our pilot will allow the selected DoD installation to shape the methodology and procedures to allow wide spread secure implementation of this technology on DoD installations CONUS wide. It will also result in approved equipment to allow the various DoD facilities to directly connect their energy management systems to the local energy markets.

The widespread penetration of renewables and the ongoing pressure to reduce energy costs will require the DoD to participate in fast load response programs. We believe that this transition is unavoidable in light of ongoing funding pressures and need by DoD installations to maintain capabilities to meet their responsibilities under Department of Defense Directive (DoDD) 4180.01, April 16, 2014. Of particular interest is the guidance provided to the Deputy Under Secretary of Defense (Installations and Environment) (DUSD(I&E) to.

> "Under the authority, direction, and control of the [Under Secretary of Defense for Acquisition, Technology, and Logistics] (USD(AT&L)), the DUSD(I&E): a. Implements policies and provides guidance to the DoD Components for managing facility energy resources and investments and serves as the primary adviser for facility energy matters in accordance with [Department of Defense Instructions] (DoDI) 4170.11 (Reference (i)). b. Ensures cost-effective investments are made in facility infrastructure to reduce energy demand, increase on-site distribution (including renewables), and enhance the power resiliency of installations. c. In coordination with the Assistant Secretary of Defense for Homeland Defense and Americas' Security Affairs (ASD(HD&ASA)), manages energy-related risks to support mitigation of commercial electric grid challenges for DoD infrastructure and missions. d. Oversees facility energy technology programs. Identifies and supports the demonstration of energy technologies to address installations needs. e. Collaborates with other governmental organizations and the private sector on facility energy matters.[iii]"

1.2 OBJECTIVE OF THE DEMONSTRATION

A baseline comparison of the OpenADR 2.0 compared to legacy DR systems and to no DR.

EISS® and OpenADR 2.0 help DoD drive greater grid stability by participation in a number of new demand response and energy market programs – some of which require automation as a condition of participation. The technology also has the potential of helping DoD to monetize its microgrid investments by signaling when energy prices make it more cost efficient to sell power to the grid and when it is better to use a microgrid to supplement the needs of the DoD installation. Key measurements associated with the demonstration include: reduced vulnerability to power grid disruptions, signal optimal times to increase use of renewable energy generation, and reducing energy intensity (kWh/ft^2).

- Validate: The project will validate the performance, costs and benefits of the technology by installing the technology in "real world" DoD facilities, using (where approved) actual government networks to connect the various test buildings to the market. The project will track system performance, implementation costs, and model benefits from participation in various "FastDR" programs where automation is required in order to mitigate program participation risk.

- Findings and Guidelines: Insights from the demonstration may influence DoD policy in the following areas:
  - Information assurance (IA) accreditation of OpenADR 2.0 end point devices
  - DoD practices concerning program participation
  - Guidelines for estimating potential load shed for various building types.

- Technology Transfer: The demonstration will assist rapid transfer of this technology within DoD by driving the IA accreditation of the technology, so it may be used on government networks. This step eliminates a significant barrier to DoD participation in DR programs requiring rapid response to a call to perform.

- Acceptance: The demonstration will help to drive acceptance in the DoD facilities community by providing a set of "how to" guides to ADR-enable existing loads. By focusing on the OpenADR 2.0 profile, the demonstration permits the certification of end point technology for use on government local area networks (LANs), reducing a heretofore significant barrier to program participation.

A baseline comparison of the OpenADR 2.0 compared to legacy DR systems and to no DR.

EISS® and OpenADR 2.0 help DoD drive greater grid stability by participation in a number of new demand response and energy market programs – some of which require automation as a condition of participation. The technology also has the potential of helping DoD to monetize its microgrid investments by signaling when energy prices make it more cost efficient to sell power to the grid and when it is better to use a microgrid to supplement the needs of the DoD installation. Key measurements associated with the demonstration include: reduced vulnerability to power grid disruptions, signal optimal times to increase use of renewable energy generation, and reducing energy intensity (kWh/ft^2).

- Validate: The project will validate the performance, costs and benefits of the technology by installing the technology in "real world" DoD facilities, using (where approved) actual government networks to connect the various test buildings to the market. The project will track system performance, implementation costs, and model benefits from participation in various "FastDR" programs where automation is required in order to mitigate program participation risk.

- Findings and Guidelines: Insights from the demonstration may influence DoD policy in the following areas:
  - Information assurance (IA) accreditation of OpenADR 2.0 end point devices
  - DoD practices concerning program participation
  - Guidelines for estimating potential load shed for various building types.

- Technology Transfer: The demonstration will assist rapid transfer of this technology within DoD by driving the IA accreditation of the technology, so it may be used on government networks. This step eliminates a significant barrier to DoD participation in DR programs requiring rapid response to a call to perform.

- Acceptance: The demonstration will help to drive acceptance in the DoD facilities community by providing a set of "how to" guides to ADR-enable existing loads. By focusing on the OpenADR 2.0 profile, the demonstration permits the certification of end point technology for use on government local area networks (LANs), reducing a heretofore significant barrier to program participation.

1.3 REGULATORY DRIVERS

The Energy Policy Act of 2005 (EPAct 2005) set conservation guidelines and renewable energy goals through the use of on-site installations. The EPAct 2005 (Public Law 109-58), was signed into law on August 8, 2005. Subtitle A of H.R. 6, Federal Programs, re-established a number of federal agency goals and amended portions of the National Energy Conservation Policy Act (NECPA). Additional federal energy conservation policy and guidelines are the Energy Independence and Security Act (EISA) 2007, Executive Order (E.O.) 13423. Executive Order 13514, and DODD 4180.01.

Section 203 of the EPAct 2005 requires that of the total amount of electric energy the federal government consumes during any fiscal year, that after 2013, 7.5% be from renewable sources, with extra compliance credit given for renewable energy produced on the land of a federal facility. The OpenADR 2.0 technology being demonstrated in this project will assist DoD in more reliable integration of renewables, in that renewable energy sources can, depending on market conditions, be used to meet facility needs or sold back to the grid.

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2.0 TECHNOLOGY DESCRIPTION

2.1 TECHNOLOGY OVERVIEW

Description: Our solution consists of two parts: a cloud-based server to distribute market signals from an energy provider according to a standard format and client-side end points to convey market signals to facility energy management systems and/or DR assets. Optionally, a stateful firewall of type and capability required by the Designated Accreditation Authority may be included as well, although this component was not used in the project. The server and end points are connected via web services over an IP network connection. The end points allow existing energy management systems to interface with these open standard web services rather than requiring expensive building upgrades. All system components are commercial-off-the-shelf (COTS).

- Visual Depiction: See Figure 6, below, depicting the building blocks of a typical IPKeys Energy Interop Server & System (EISS®) deployment.

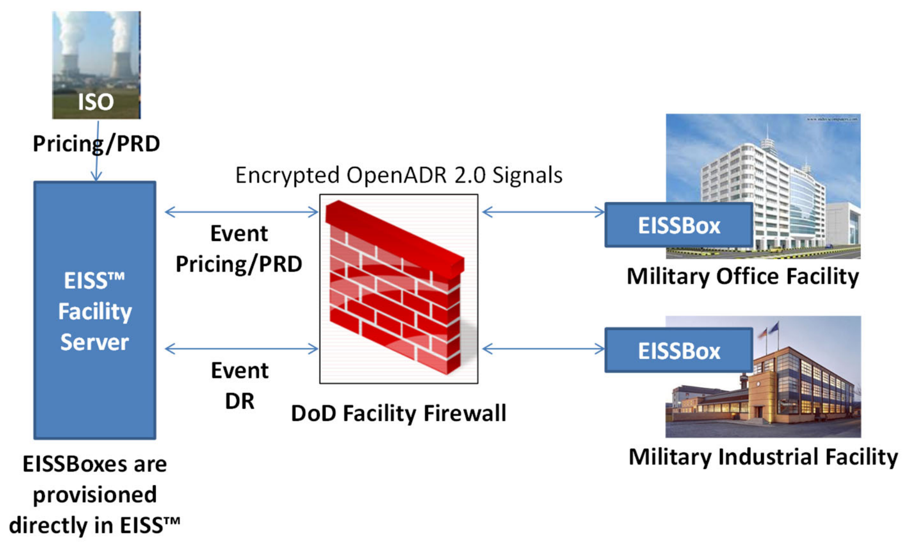

Figure 6. EISS® Server Facility Edition – Typical Deployment

- Components of the System:
  - EISS® 2.0 Server or OpenADR 2.0b Virtual Top Node (VTN) – the EISS® server is a cloud hosted VTN that is the heart of any OpenADR 2.0 deployment. The EISS® server is deployed in two components: the OpenADR 2.0b-certified EISS® 2.0 VTN and EISSPoint – an end point element manager. EISSPoint is used to configure and maintain all EISSBox devices logically attached to it via the Internet. The EISS® server is also a temporary repository for event and meter data collected from fielded EISSBoxes via OpenADR 2.0b's EiEvent and EiReport web services. (The EiEvent and EiReport web services are used to collect responses to calls to perform issued by the VTN server and load shed (kW and kWh) from any attached electric meter or sub-meter.) The EISS® server may be configured to send collected event and meter data to a backup location of the government's choice.

– EISSBox 2.0 or OpenADR 2.0b Virtual End Node (VEN) – the EISSBox is an energy services interface that receives OpenADR 2.0 messages from a VTN and converts those messages into signals actionable by the DR assets under review. IPKeys' EISSBoxes present OpenADR 2.0 signals as either "dry contact" values or Modbus registers.
– Stateful Firewall – if required by the DAA, IPKeys can supply "firewall" technology to perform inspection of all signals sent to endpoints on a DoD installation to insure the security and integrity of the communication. This safeguard, usually implemented with additional hardware, provides an additional layer of security in that it inspects the XML payload of each packet sent to the end point for conformance to the OpenADR 2.0b XML specification.

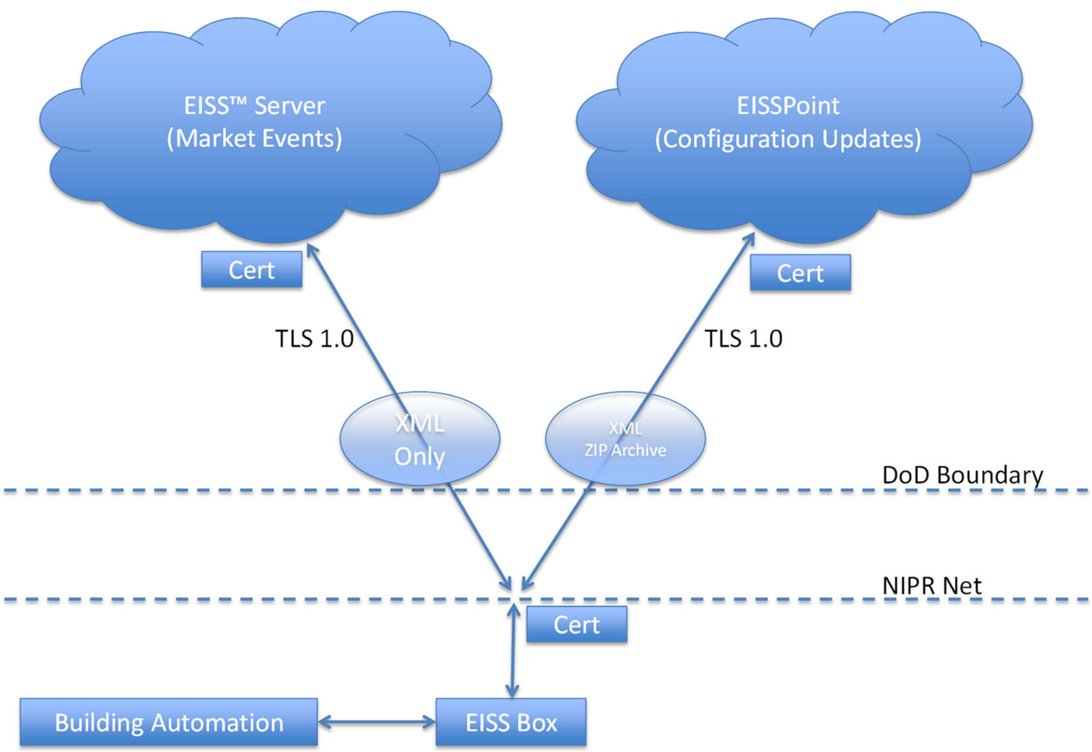

Figure 7. EISS® Component Interaction Diagram

Figure 8 depicts the various components and web services available on IPKeys' EISS® VTN or server. Also shown is the flow of data between components.

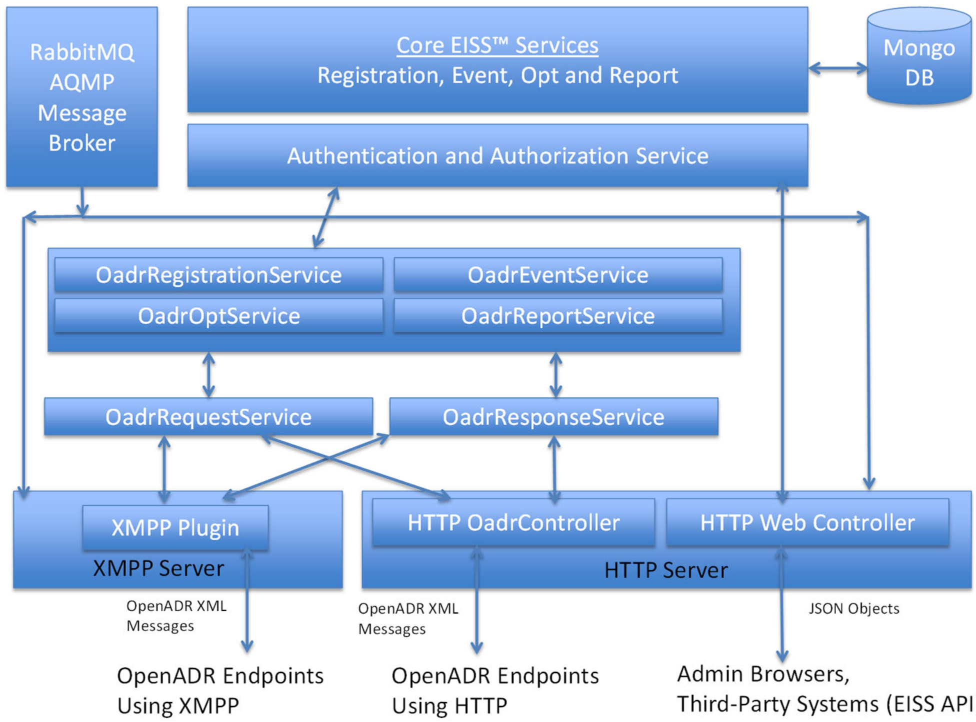

Figure 8. **EISS® Server Services**

Figure 9 depicts the various components and web services available on IPKeys' EISSBox 2.0 VEN or end point hardware. Also shown is the flow of data between components.

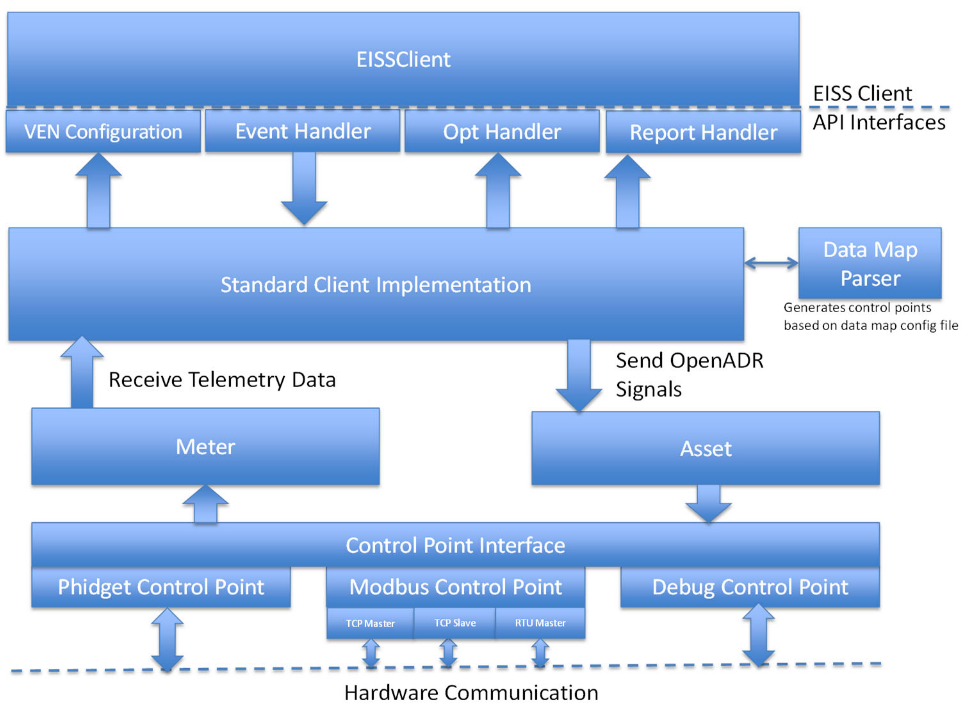

Figure 9. **EISSBox Client Services**

- Chronological Summary[iv]: OpenADR is an open and interoperable information exchange model and emerging Smart Grid standard. OpenADR standardizes the message format used for Auto-DR so that dynamic price and reliability signals can be delivered in a uniform and interoperable fashion among utilities, ISOs, and energy management and control systems. While previously deployed Auto-DR systems are automated, they are not standardized or interoperable.

  Initial work on OpenADR began in the early part of the century in a program for the California Energy Commission managed by Lawrence Berkeley National Laboratories. This standard became the basis of a NIST-sponsored Smart Grid initiative, which developed the OpenADR 2.0 profile of the Energy Interop™ standard, which was formalized in 2010.

  The OpenADR Alliance is a mutual benefit corporation created in 2010 to foster the development, adoption, and compliance of the OpenADR 2.0 Smart Grid profile. OpenADR-based solutions will standardize, automate and simplify the use of Demand Response (DR) worldwide – making DR a more reliable and cost-effective resource to help utilities meet growing demand for energy, and giving customers greater control over their energy future. While the benefits of widespread DR adoption are clear, the industry to date has lacked an organization responsible for the education, training, testing, and certification needed to bring this technology to market.

  The OpenADR Alliance currently has over 100 members including utilities, software suppliers, device manufacturers, national labs, DR aggregators, testing and certification labs, system integrators and consulting firms. Members get support from the Alliance's technical and marketing committees to enable shorter development cycles. Members get early access to specifications and have the opportunity to influence the evolution of the OpenADR standard. Members also have the opportunity to certify their products through an independent third-party laboratory as OpenADR-compliant. Over 60 utilities and controls vendors have already announced or deployed OpenADR-based systems across the U.S. and internationally.

- Future Potential for DoD: See section 2.2, Performance Advantages, for a brief discussion.

2.2 ADVANTAGES AND LIMITATIONS OF THE TECHNOLOGY

- Performance Advantages: EISS® and OpenADR 2.0 help DoD drive greater grid stability by participation in a number of new demand response and energy market programs – some of which require automation as a condition of participation. The technology also has the potential of helping DoD to monetize its microgrid investments by signaling when energy prices make it more cost efficient to sell power to the grid and when it is better to use the microgrid to supplement the needs of the DoD installation.

- Cost Advantages: OpenADR 2.0 permits Energy Managers to make their buildings "market aware" – reducing electrical use when energy prices are high, moving load to other times of day (when possible), or executing pre-cooling strategies early in the day to permit buildings to "ride through" the heat of the day.

- Performance Limitations: OpenADR 2.0 virtual end node (VEN) technology is lightweight and presents few technical challenges. DR deployments work best when DR signals can be consumed and acted upon by facility management or building management systems. These systems are well known. Consideration of the DR programs in which a facility chooses to participate along with thoughtful implementation of the way a utility or ISO call to perform is executed by the building management system (BMS) can optimize the economic benefits to the DoD facility from program participation while minimizing the effects on facility mission and staff.

- Cost Limitations: The most significant cost of implementation is not in the virtual top node (VTN) or VEN technology, but rather the programming of facility BMS systems to execute a DR program call to perform.

- Potential Barriers to Acceptance: Barriers to acceptance of DR program participation come from at least two sources:

  - "Bad press" from older DR programs that were much less selective and tended to have longer duration times than the ancillary services programs that are the natural allies of smart buildings.

  - Well-placed concerns by facility managers as to the effect of program participation on building occupants and/or mission. Fortunately, these concerns can be mitigated by careful BMS programming (for example, participation in certain regulation programs consists of changing the frequency of one or more VFDs in an HVAC system, rather than turning the HVAC system off) and through education of facility managers in ways to opt out of programs when mission demands must come first.

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3.0 PERFORMANCE OBJECTIVES

Table 2. Performance Objectives

Performance Objective	Metric	Data Requirements	Success Criteria	Results
Quantitative Performance Objectives				
Increase System Responsiveness compared to no DR	Time required to process a DR event – receipt through confirmation	For manual DR programs, a time stamp from program originator confirming the time the event was initiated and a compliant OpenADR 2.0 test signal	For Ancillary Services Programs Sync Reserves < 30 minutes Regulation < 4 seconds	
Increase System Responsiveness compared to no DR	Time required to process a DR event – receipt through confirmation	For manual DR programs, a time stamp from program originator confirming the time the event was initiated and a compliant OpenADR 2.0 test signal	For all other same day programs < 2 hours	
Increase System Responsiveness compared to legacy DR	Time required to process a DR event – receipt through confirmation	For legacy DR programs, a time stamp from program originator confirming the time the event was initiated and a compliant OpenADR 2.0 test signal	For Ancillary Services Programs Sync Reserves < 30 minutes Regulation < 4 seconds	
Increase System Responsiveness compared to legacy DR	Time required to process a DR event – receipt through confirmation	For legacy DR programs, a time stamp from program originator confirming the time the event was initiated and a compliant OpenADR 2.0 test signal	For all other same day programs < 2 hours	
Increase System Pricing Accuracy	Comparison of energy price events to hourly ISO data	Prices received from EISS™ compared to hourly ISO web site averages	+/- 0.005%	
Increase System Metering Accuracy	Comparison of electrical load data reported to EISS™ from the building to data from a utility grade meter	Meter data stream reported to EISS™ and utility meter records for the appropriate period	+/- 0.005%	
Qualitative Performance Objectives				
Reduce System Administrative Burden	The number of people located in a DoD facility it takes to process a DR event	Shift and overtime logs from the day of the event. Event confirmation logs from IPKeys test coordinator	Buildings enrolled in a manual program were curtailed in a timely fashion	

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4.0 FACILITY/SITE DESCRIPTION

Table **3**, below, is a summary of the selected installations and facilities used for the demonstration.

Installation	Facility	Comment
Camp Pendleton	"Cleanspark" Microgrid Test Site in Area 52	
Picatinny Arsenal	DPW HQ – Building 3006	
	Energy Services Group – Building 3002	
	Refurbished Lab/Lab Administration – Building 65	
NAVFAC	Dahlgren	Building TBD
	Patuxent River	Building TBD
	Washington Navy Yard	Building TBD

Table 3. Facility/Site Description

Sites listed in Table **3** were chosen for the following reasons:

1. They represented three of the four services giving us a useful selection of the different approaches of each service
2. They had a past track record of ESTCP participation
3. They had building management systems already in place
4. There were in place demand response programs to which they might transition after the project was completed

4.1 FACILITY/SITE LOCATION AND OPERATIONS

This section describes the location and relevant physical characteristics of the host installations for the demonstration and any relevant portion (range, training area, or cantonment area) or facility (particular building) on the installation that will serve as the demonstration site.

- Demonstration Site Description: With the exception of the Camp Pendleton Area 52 Microgrid Site, all facilities participating in any part of the demonstration are general use office building structures.
- Key Operations: There are no military operations known to IPKeys occurring in the vicinity of the demonstration sites.
- Location/Site Map: See Figure 10, below, for a map of the Camp Pendleton area.

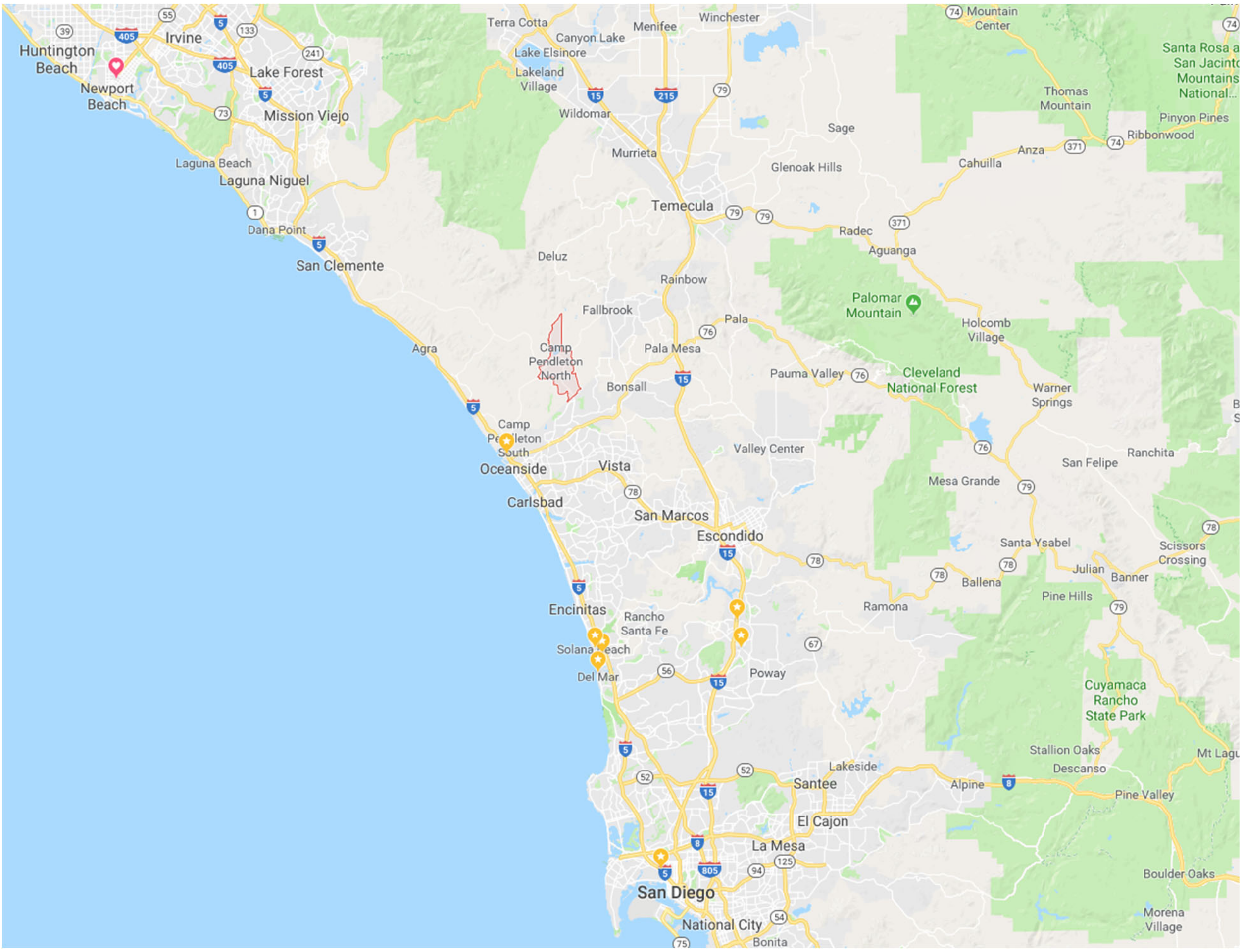

Figure 10. Camp Pendleton Area

4.2 FACILITY/SITE CONDITIONS

Camp Pendleton is located near San Diego, CA, USA. It enjoys a reasonably temperate climate being located on the Pacific Ocean. The Camp consists of a central headquarters area and several remote "camps" which are used by units as needed. These camps are occasionally empty when units are deployed.

The strong endorsement by San Diego Gas and Electric (SDG&E) of demand response and energy efficiency make Camp Pendleton a participant in many utility programs. SDG&E is also a long-time user of OpenADR for demand response signaling.

Camp Pendleton has a central building management system manufactured by Johnson Controls. Camp Pendleton uses more than 20MW of energy and is capable of a one MW load shed.

5.0 TEST DESIGN

This section provides the detailed description of the system design and testing procedure to address the performance objectives described in Section 3.0.

- Fundamental Problem: The demonstration test design as a baseline comparison of OpenADR compared to legacy DR systems and no DR

- Demonstration Question: The demonstration seeks to characterize the efficiencies of various approaches to AutoDR in delivering secure, scalable, and accurate readings from the field to permit DoD facilities to participate in new short notice/high reward DR and Energy Market programs such as ERCOT's ERS-10 program and PJM's Real Time Energy Market

5.1 CONCEPTUAL TEST DESIGN

- Hypothesis: OpenADR 2.0 will permit DoD to expand the limits of its energy market participation by:
  - Increased System Responsiveness, i.e., it requires less time to respond to a DR event and that response is scalable over many more buildings than manual alternatives
  - Increase System Pricing Accuracy, permits buildings and assets within them to be "market aware." This, in turn, permits BMS to be programmed to execute pre-cooling steps in advance of a hot day, or dim lights in the afternoon of a hot day, or start heaters early to prepare for arriving staff on cold winter mornings, etc.
  - Increase System Metering Accuracy, permits DoD to better document the amount of load shed in a DR event for settlement purposes. All too often current systems do not keep a contemporaneous record of an event synchronized with the DR call to perform. OpenADR 2.0 has this capability
  - Reduce System Administrative Burden, i.e., Fewer people are needed to administer the installations energy market program, making it possible to participate in more programs, if appropriate

- Independent variables: Pricing data as received from the ISO, utility meter data for each building under test

- Dependent variables: Time to process a DR event from notification to confirmation, Number of staff assigned to DR response, pricing data received over a test interval at an EISSBox end point, kWh load of assets under test

- Controlled variables: Volume of area under test in each building, building temperatures, humidity, Market Context in which each building simulates activity, and program level "call to perform" time standards

- Test Design: Each hypothesis will be tested according to Table 2, above, collecting data and subjecting them to statistical analysis needed to provide the metrics identified in the table

- Test Phases: Test phases, further described below, include baseline measurements, equipment installation, calibration, commissioning, data collection, and data analysis. Not all of these phases are executed for each test
  - Baseline characterization is described below
  - Equipment installation will occur after the project receives PIT/DIACAP IATT, IATC, and IATO authorization from the cognizant Designated Accrediting Authority (DAA). One EISSBox will be attached to the BMS controlling the building(s) under review at a facility or directly to the DR asset via "dry contact" or Modbus connections
  - Calibration of the EISSBox is required if it is reading KYZ pulse data from a meter, based on parameters supplied by the utility
  - All EISSBox commissioning is done from an EISSPoint Server.
  - Data collection and analysis are further described, below.

5.2 BASELINE CHARACTERIZATION

- Reference Conditions: IPKeys will collect baseline information for each building being reviewed, including:
  - Average, maximum and minimum energy loads (kWh) for each building asset under test and/or the building as a whole, if asset level utility meters are not available
  - Five (5) minute Locational Marginal Price (LMP) for each building under review as long as the Fielding Phase of the project is active – 22 May through 27 October 2014

- Baseline Collection Period: 22 May through 31 August 2016. (Camp Pendleton is a heat load)

- Existing Baseline Data: Existing data useful to the project may exist in three archives:
  - CAISO and PJM historical pricing data (known to exist)
  - CAISO and PJM historical DR event data (known to exist)
  - Utility billing data (Copies held at each DoD site will likely exist)

- Baseline Estimation: Estimation methods used by the project include basic statistical manipulation (i.e., average, moving average, maximum, minimum, etc.), correlation analysis, and regression analysis. Graphical support is provided via MS Excel, our EISS® Online User Portal, and the EISS® Cloud Server. Averages and other statistical treatments will be calculated over a base suited to the measurements being taken. Hourly, daily, and monthly statistics will most often be used.

- Data Collection Equipment: Data collection devices/sensors will include thermostats, humidistats, retail grade sub-meters (when required), and IPKeys' EISSBox.

5.3 DESIGN AND LAYOUT OF TECHNOLOGY COMPONENTS

- System Design: See section 2.1, above
- Components of the System: See section 2.1, above
- System Depiction: See section 2.1, above
- System Integration: The demonstration system will augment any current DR technology in place. Camp Pendleton has AutoDR equipment installed at this time
- System Controls: NA.

5.4 OPERATIONAL TESTING

This pilot was intended to document the process of enabling automated load shedding at DoD facilities using the OpenADR 2.0b standard. The phases were as follows:

1. Site Selection
2. Gaining an Authorization to Operate
    a. ISSM Verbal Agreement
    b. Package Preparation
    c. Package Submitted
    d. Package Approved
3. Connecting the OpenADR 2.0b Gateway (EISSBox) to both the network and building management system (BMS)
4. Programming the BMS with preprogrammed scenarios for load shed
5. Performing Test Events
6. Enrolling in an SDG&E OpenADR Demand Response Program.

Table 4. OpenADR 2.0 Implementation Status by Site

Phase/Site	Camp Pendleton	Picatinny Arsenal	NAVFAC
1. Site Selection			
2. Gaining an Authorization to Operate (ATO) a. ISSM Verbal Agreement		ISSM Denied Agreement	ISSM Denied Agreement
b. Package Preparation			
c. Package Submitted			
d. Package Approved	Awaiting Government Action		
3. Connecting the OpenADR 2.0b Gateway (EISSBox) to both the network and building management system (BMS)			
4. Programming the BMS with preprogrammed scenarios for load shed			
5. Performing Test Events			
6. Enrolling in an SDG&E OpenADR Demand Response Program			

Legend:

Green – Approved/Completed

Yellow – Awaiting Government Action

Red – Denied

Clear – Not yet started

Site Selection

Site selection initially had three locations sign up to participate. Picatinny Arsenal, The Washington Navy Yard NAVFAC Facility, and Camp Pendleton.

Gaining an Authorization to Operate

The Navy yard uses several networks, NMCI, PSNET. We reviewed the interconnections needed to go from an internal network, PSNET, to an internet accessible network and the cyber approvals needed. After several months of work, it was finally determined that the Navy, due to its network topology, was not able to allow a connection to the public internet to allow connections to a utility server. Cellular options were reviewed and discarded. The Navy Yard withdrew.

Picatinny Arsenal initially allowed test connections to their meters using cellular connections. We met with the Army ACA and showed him our system. They suggested several changes to the system to help facilitate its approval. Namely use hardware that has already been through the ATO process, use an approved operating system, in this case Microsoft Windows. They explained that what we were proposing was basically a government issued laptop with our software running on it. The more we could fit into the standard STIG's the easier the approval process. The commercial EISSBox uses a single board computer running a Debian Linux operating system. It was changed to a fanless hardened computer manufactured by a Canadian company which has been through the ATO process many times and a DISA approved Windows operating system with the appropriate STIG's applied. We finished the migration to the new DoD version of the EISSBox and brought it to the Picatinny ISSM. During this time the DoD was migrating from DIACAP to RMF and we were told that we were too late to clear the approval process for DIACAP and would have to wait for the RMF guidelines. RMF, although similar, has added procedures. With the rush to be approved under the old DIACAP guidelines, we were told to wait.

During the waiting time there were several personnel changes at Picatinny. Notably our POC Nick Stecky retired. When we reapplied to the replacement personnel we explained the history and asked what was needed to get the cyber package submitted. Since these personnel were new to the project the ISSM undertook a detailed review of the risks and benefits of allowing a device to access the public internet from the NIPRNet and determined that although the risk was small, the benefit of automated demand response did not justify the connection. They withdrew from the pilot but remain a participant in manual demand response programs.

Camp Pendleton during an initial meeting with facility and cyber personnel believed that the risk was small and in California the incentive justified the risk. The initial risk was judged to be low and we explained that we were changing our normal commercial version to the DoD specific one based on the guidance given by the Army ACA. They agreed to review the Army package and likely accept most of the work pending award of the ATO from Picatinny. With Picatinny's withdrawal from the program the ATO focus was moved to Camp Pendleton. Another meeting with the facilities personnel and the cyber personnel again judged that the system was of low risk, but the cyber personnel explained that they did not have the staffing to prepare the package and that if we desired to move forward we would have to do most of the work. IPKeys has produced several packages for systems to gain ATO but this was the first time we were doing it as a customer rather than a government contractor. It proved difficult to get the system formally classified and the needed controls identified. The ESTCP program office worked with IPKeys and a simple review of the use of the device determined that LOW / LOW / LOW classification applied. The system is not critical, it contains no PII and if compromised it can simply be unplugged.

The United States Marine Corp (USMC) uses a slightly different system to upload the accreditation packages, this is known as MCCAST. We were finally provided with the Microsoft Word documents with the selected controls representing all of the RMF sections. The documents were filled out and we gave them to our POC at Camp Pendleton. We found out four weeks later that this person had taken another position at a nearby facility and we were without a POC at Camp Pendleton. The ISSM was willing to review the package for completeness even without the POC. He gave us a list of items required which included a DADMS ID. We were unable to get someone to approve this ID for our system. Lacking a POC at Camp Pendleton we were unable to escalate.

The ESTCP program office provided that the OSD CIO has made this field not required for Facility Related Control System (FRCS). We have asked the ISSM at Camp Pendleton to process this accreditation package without the DADMS ID.

Since we have been delayed in the cyber accreditation phase of this project we are forced to perform similar tests or manual tests at other sites and use the data to show the “what would have happened results” to complete the pilot as completely as possible.

Connecting the OpenADR 2.0b gateway (EISSBox) to both the network and building management system (BMS)

This step involves connecting the EISSBox to an internet accessible network, only outgoing ports 443 and 123 are needed for this connection. The device uses TLS 1.2 with certificate authentication for both utility server and EISSBox.

This connection was made over a private network since a NIPRNet ATO is yet to be obtained. The device connected, and the TLS 1.2 types was verified by review of log files.

The connection to the BMS was to be via a Modbus TCP register. There are two registers of note: minutes to start and event active. The event active was intended to be connected to the input of the Johnson Control BMS.

A test event was performed, and the Event Active register moved from 0 to 1 during the test event. This value was verified with a Modbus simulator Modbus Master.

Programming the BMS with preprogrammed scenarios for load shed

IPKeys has worked with many BMS vendors to implement these types of strategies. The intended strategy was to perform a temperature setback of 5 degrees F. This level has proven sufficient for reasonably modern facilities with less than 5% windows. This variable is always field editable by the maintenance personnel without need of reprogramming, so it can be adjuring testing to preserve occupant comfort and maximize load shed. Although commonly used, cycling was not to be implemented at Camp Pendleton.

Performing test events

Without either automation or BMS programming in place, the Camp Pendleton personnel performed several test events on their own manually. They were able to achieve a one MW load shed from about a 20MW running load without occupant complaint. They were quite confident in their ability to hit this level and it was set as the level to use for calculations. IPKeys experience shows that up to a 10% load shed in similar buildings in similar climates is possible, so this was considered a safe number.

Enrolling in an SDG&E OpenADR demand response program

IPKeys has several customers enrolled in demand response programs with SDG&E. The process is to nominate the building for a certain load shed per month in the CBP program. This program uses a baseline methodology, so care must be used in selecting the actual load shed. Baselines attempt to predict the amount of consumption you would have taken. Weather variations can cause your load shed to be discounted. This kind of program can be participated in from month to month.

With successful results, we would then move them into a BIP program. This program uses a firm service level, under a certain kW level per hour during the event and is called much less frequently. It is a 12month commitment, so we would have to be sure of our ability to sustain this commitment before enrolling Camp Pendleton in this kind of program.

5.5 SAMPLING PROTOCOL

The SDG&E utility meter is used to measure results. The unit is revenue grade and is defined as:

> A **meter** specified as being **revenue-grade** is one that meets the requirements outlined in the ANSI standard C-12.1-2008. In this standard, the minimum **accuracy** of the **meter** is required to be +/- 2%.

Since this meter is used by SDG&E for billing, it is assumed to be the ground truth value and is maintained by the utility. Since load shed events occur in the midst of normal usage, it can also be assumed that even if the meter were slightly out of specification, it would apply to both baseline and load shed and thus be less critical. Since meter calibration is under the responsibility of SDG&E in their role as the electrical utility, for purposes of the demonstration it was assumed accurate.

5.6 SAMPLING RESULTS

Meter data was retrieved from SDG&E as authorized by Camp Pendleton. These data cover one year and was used to perform the modeling. No load shed was recorded as the Camp Pendleton personnel had performed their load sheds prior to the program start. We had hoped to complete the pilot as proposed which would have produced a load shed but with the delay in accreditation and the departure of the Camp Pendleton POC, it will not happen.

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6.0 PERFORMANCE ASSESSMENT

The meter data was reviewed and fed into the model, no other performance assessment was performed.

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7.0 COST ASSESSMENT

7.1 COST MODEL

Table 5. Cost Model for OpenADR 2.0-enabled DR Program Participation

Cost Element	Data Tracked During the Demonstration	Estimated Costs	Comments
Hardware capital costs	OpenADR 2.0b-certified VEN or endpoint (EISSBox)	$2500	
Installation costs	Install gateway	$1200	Gateway installation is $1200 BMS programming can range from $5,000 to $20,000 based on our experience in other deployments. The price dependence is based on the presence of predefined scenarios that are present in some BMS systems which make the process of programming of demand response event actions easier.
Consumables	No consumables anticipated		
Facility operational costs	No operational costs anticipated		
Maintenance (Annual)	Cost of maintenance for endpoint. Security logs checked monthly. (This was to be provided as part of the aggregator package during FOC.)	$2430	Endpoint maintenance estimated at 18% of retail cost per year. Included in aggregation package, assume use of a security engineer for one hour per month to review security logs at an estimated rate of $165 per hour.
Hardware lifetime	10 Years +		
Operator training	None		

7.2 COST DRIVERS

AutoDR costs are all up front. Ongoing costs are only incurred if the building management system is changed or updated. These costs are typically nominal.

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8.0 IMPLEMENTATION ISSUES

We have learned during this demonstration that the most critical step is the cyber accreditation. The emergence of energy IoT devices that can save the DoD labor and potentially earn revenue is an emerging topic.

New instructions from the OSD CIO to cover these types of devices were introduced during this demonstration. Since most of these IoT devices require network access, they present a potential vulnerability and the assessment of risk can vary. We saw that a simple change in personnel at Picatinny Arsenal resulted in a decision to withdraw due to the potential risk / reward analysis that every facility ISSM must perform.

To successfully navigate this evolving landscape, we believe these three items are required:

1) Endorsement from command that has the capability to accept risk for the facility. Facility maintenance personnel are typically the first point of adoption but are not able to make these facility-level command decisions

2) Buy in from the facility ISSM before starting.

   Without the continual support of this team this process starts and stops constantly. A POAM and specific personnel must be assigned at the start of the project

3) A complete understanding of the difference between the DoD and the commercial world. We must always keep in mind that the mission of the DoD is to protect this country, not save energy. Anything that could impact their Title 10 responsibilities will be resisted. Our requirements for North American hardware and a Windows operating system show that the closer you can be to a known good deployed system, the easier it is for DoD managers to accept. Anything that can be a gateway for bad actors will be carefully analyzed.

8.1 HOW TO DETERMINE IF A SITE IS A GOOD CANDIDATE FOR AUTOMATED DEMAND RESPONSE?

1. Is there an organized market in this area?

   Figure 11, below, lists wholesale energy markets in North America.

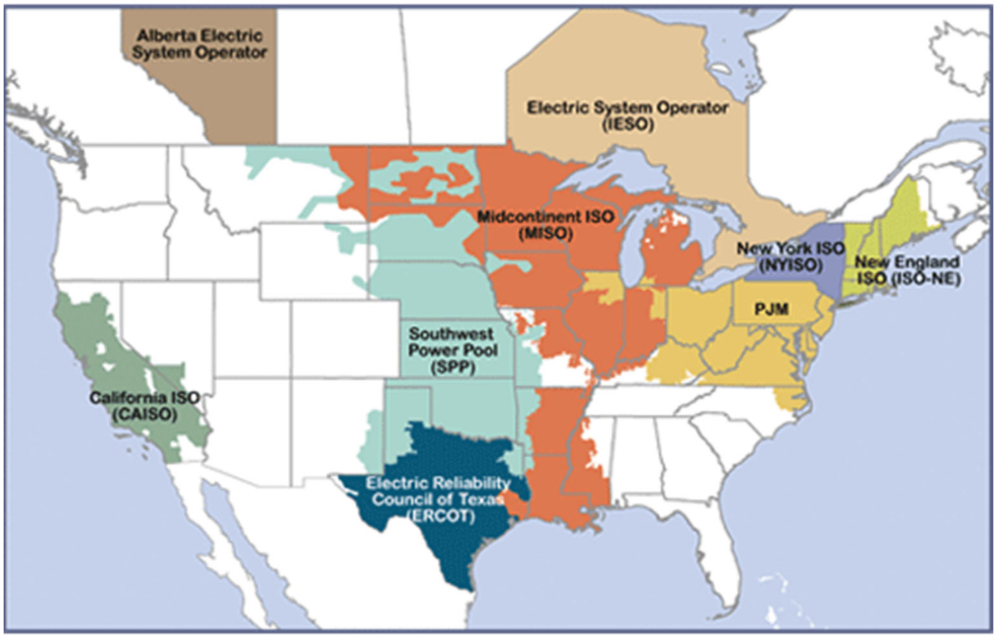

Figure 11. North American Energy Markets

Organized wholesale and retail markets usually offer some kind of incentive for demand response. Automated demand response is less common and is present either through an aggregator or through utilities where scarcity or high energy prices cause greater adoption of advanced technologies.

2. How much load can I shed?

A conservative rule of thumb is 10% of the peak load. We have seen facilities who can even go to 40% but that is unusual. Typically, sites can shed at least 10% with a stretch goal of 20%.

To estimate earnings, take 10% of the peak load and multiply it by $6.54/kW to get annual earnings. The $6.54 factor is a blended number based on CONUS capacity programs at PJM and SDG&E's BIP program that are on the lower end of the spectrum. This number, with the conservative 10% assumption, gives a safe assumption of what can be earned. A useful report prepared in 2012 by staff at Lawrence Berkeley National Laboratory provides a CONUS-level, view.

We can apply this approach to data from the utility meter used to capture the interval data used to invoice Camp Pendleton, shown in Figure 12.

Monthly Usage	Max	Min	Average
Jan-16	2890.5	1551.0	2150.3
Feb-16	3105.0	1494.0	2162.3
Mar-16	2710.5	447.0	2057.3
Apr-16	2767.5	1492.5	1977.1
May-16	2479.5	1447.5	1956.1
Jun-16	3400.5	1540.5	2177.1
Jul-16	3402.0	1720.5	2356.9
Aug-16	3315.0	1834.5	2432.8
Sep-16	3633.0	1755.0	2314.7
Oct-16	3064.5	1630.5	2137.1
Nov-16	3523.5	1584.0	2046.5
Dec-16	2629.5	1434.0	2019.0

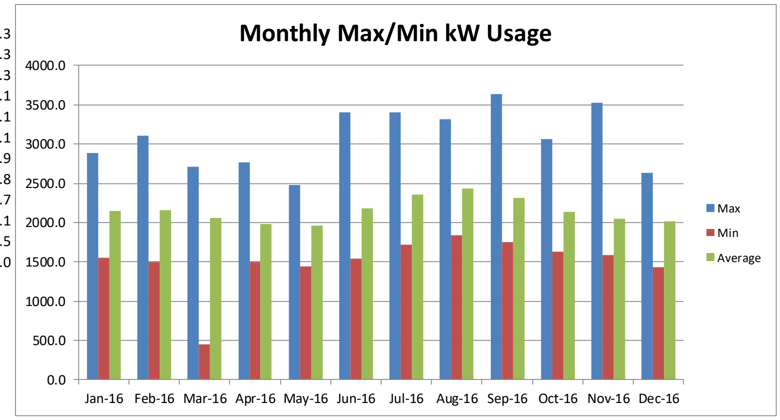

Figure 12. Camp Pendleton Max/Min/Average Usage for 2016

The total average monthly usage is 25,787.1 kW. Applying the factors defined above, 10% of 25,787.1 x $6.54 yields a value of $16,864.75 – the rough back of the envelope analysis of the value of a 10% shed for Camp Pendleton. The same data, applied to the SDG&E BIP model, yields an estimated value for BIP participation of $18,051. Our rough estimate is within 10% of the value of what it would have been if Camp Pendleton had participated in the SDG&E BIP DR Program.

3. Is this site a good candidate for Automated Demand Response?

    a. Does this site have a centralized building management system?

    Although automated demand response can be performed on discrete devices, it shows its best economies of scale when used in conjunction with a centralized building management system where demand response scenarios can be programmed, and the facility's response managed in a central way.

    b. Does automated demand response have high level support from command levels?

    Without high level endorsement, a facility manager will be unable to overcome the cyber policy roadblocks that are there to ensure facility security.

    c. Does the ISSM understand that you are requesting a public internet connection to their BMS?

    In years past the facility's heating and cooling systems were not considered a point of vulnerability. Recent attacks have shown that this is no longer true. Even internet-based systems with a separate connection to the BMS system with no connection to the NIPRNET are now going through the cyber security screening. The ISSM needs to understand this point right up front before moving forward. There are a number of methods to make sure that this connection is secure but the ISSM makes the risk/reward evaluation of all connections and may decide that this does not make sense for their facility. Ft Mead was an example of a general policy of NO external connections being allowed.

d. Does your aggregator or local energy provider offer OpenADR signaling?

Most wholesale energy markets have some machine to machine signaling. However, these vary in format and must be translated. Participation in these markets typically require an aggregator. Some aggregators offer a translated machine to machine signal based on OpenADR. California Investor Owned Utilities and utilities in Austin TX, Boston, MA, and Portland OR, and Hawaii are among the retail energy providers who offer OpenADR signals in their retail energy programs. A more comprehensive list can be found in http://grid4home.com/openadrmap/.

9.0 REFERENCES

Jason MacDonald, Peter Cappers, Duncan Callaway, and Sila Kiliccote, "Demand Response Providing Ancillary Services – A Comparison of Opportunities and Challenges in the US Wholesale Markets," Lawrence Berkeley National Laboratory, 2012, Document Number: LBNL 5958E.

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Robert Nawy and Jason MacDonald, "Latest Auto DR Platform Empowers Customers – New Energy Market Incentives & Advanced Management Opportunities," *Electrical Energy Transmission & Distribution Magazine*, July-August 2014.

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APPENDIX A POINTS OF CONTACT

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[i] See http://www.openadr.org/index.php?option=com_content&view=article&id=81:openadr-and-title-24&catid=21:press-releases&Itemid=121 for a brief discussion.

[ii] Jason MacDonald, Sila Kiliccote, Jim Boch, Jonathan Chen, and Robert Nawy, "Commercial Building Loads Providing Ancillary Services in PJM," FINAL Report, Lawrence Berkeley National Laboratory,2014, p. 10. See also Robert Nawy and Jason MacDonald, "Latest Auto DR Platform Empowers Customers – New Energy Market Incentives & Advanced Management Opportunities," *Electrical Energy Transmission & Distribution*. Pp. 5-6.

[iii] Department of Defense Directive 4180.01, dated 16 April 2014, p. 6.

[iv] The content of this section generally follows a discussion found in http://www.openadr.org/faq#3.