Clean Energy States Alliance

Energy Storage Technology Advancement Partnership (ESTAP) Webinar:

Commissioning Energy Storage

May 20, 2014

U.S. Department of Energy | Sandia National Laboratories | SunPower | UL

Housekeeping

All participants are in "Listen-Only" mode. Select "Use Mic & Speakers" to avoid toll charges and use your computer's VOIP capabilities. Or select "Use Telephone" and enter your PIN onto your phone key pad.

Submit your questions at any time by typing in the Question Box and hitting Send.

This webinar is being recorded.

You will find a recording of this webinar, as well as all previous CESA webcasts, archived on the CESA website at

www.cesa.org/webinars

State & Federal Energy Storage Technology Advancement Partnership (ESTAP)

Todd Olinsky-Paul

Project Director

Clean Energy States Alliance

Thank You:

Dr. Imre Gyuk
U.S. Department of Energy,
Office of Electricity Delivery and
Energy Reliability

Dan Borneo
Sandia National Laboratories

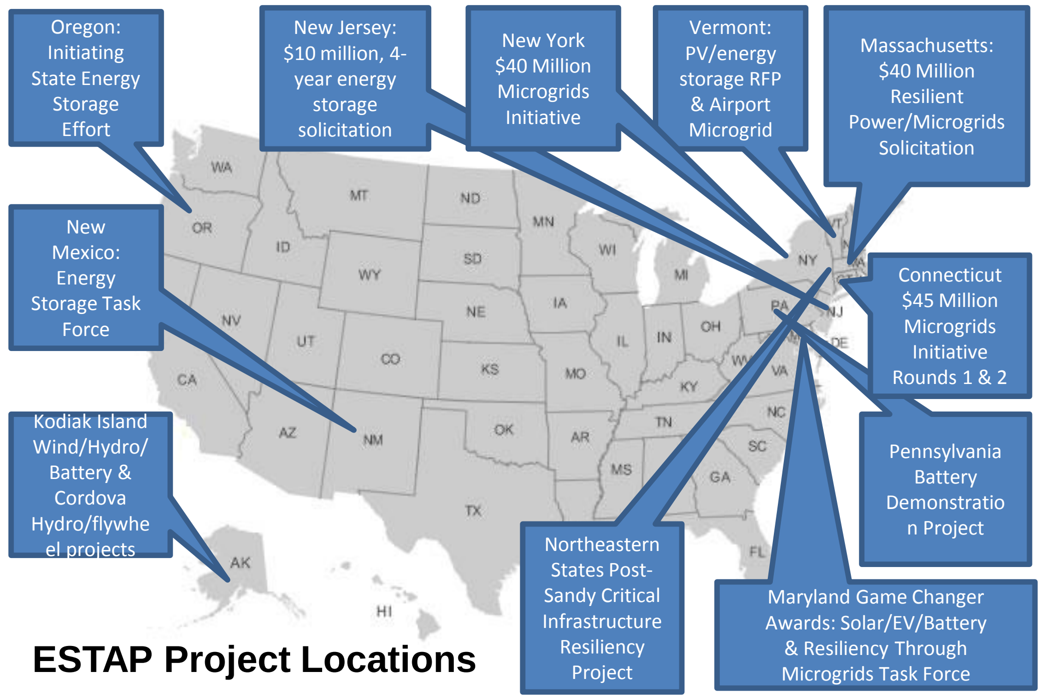
ESTAP is a project of CESA

Clean Energy States Alliance (CESA) is a non-profit organization providing a forum for states to work together to implement effective clean energy policies & programs.

ESTAP is conducted under contract with Sandia National Laboratories, with funding from US DOE.

ESTAP Key Activities:

1. Disseminate information to stakeholders
   - ESTAP listserv >500 members
   - Webinars, conferences, information updates, surveys
2. Facilitate public/private partnerships at state level to support energy storage demonstration project development



ESTAP Project Locations

Energy Storage Technology Advancement Partnership

Overview
Energy Storage Events
Energy Storage News
Energy Storage Links
Energy Storage Listserv Signup
Energy Storage Resources and Webinar Archives

Project Director: Todd Olinsky-Paul

Contact: Todd Olinsky-Paul, Todd@cleanegroup.org

SIGN UP FOR THE LISTSERV

The Energy Storage Technology Advancement Partnership (ESTAP) is a federal-state funding and information sharing project, managed by CESA, that aims to accelerate the deployment of electrical energy storage technologies in the U.S.

Project Objective

The project's objective is to accelerate the pace of deployment of energy storage technologies in the United States through the creation of technical assistance and co-funding partnerships between states and the U.S. Department of Energy.

ESTAP conducts two key activities:

1) Disseminate information to stakeholders through:

NEW RESOURCES

May 1, 2014
The Economics of Grid Defection
By Rocky Mountain Institute

April 4, 2014
ESTAP Webinar Slides: Microgrid Technologies
By ESTAP

April 4, 2014
ESTAP Webinar Recording: Microgrid

UPCOMING EVENTS

May 20, 2014
ESTAP Webinar: Commissioning Energy Storage,

More Events

LATEST NEWS

April 30, 2014
NYSERDA Announces Opening of Battery and

Today's Guest Speakers

Imre Gyuk, Program Manager, Energy Storage Research, Office of Electricity Distribution and Energy Reliability, U.S. Department of Energy

Dan Borneo, Engineering Project Manager, Distributed Energy/ Electrical Energy Storage, Sandia National Laboratories

Matt Galland, Principal, Renewable Energy Project Solutions, Grant Manager for Sunpower Corp.

Laurie B. Florence, Principal Engineer for Large Batteries & Fuel Cells, UL

Energy Storage Commissioning:
--
Making sure it works!

IMRE GYUK, PROGRAM MANAGER
ENERGY STORAGE RESEARCH, DOE

ESTAP 05-20-14

Commissioning is essential!

Increasing Number of Installations
Increasing number of Technologies
Need to build Confidence in Customers
Failed or Faulty Systems hurt the entire Industry!
In the Factory and in the Field
Commissioning Experience cuts Cost!

Need for a Standardized Approach / Manual

Sandia National Laboratories

Exceptional service in the national interest

Electrical Energy Storage Start-up & Commissioning Overview

Daniel Borneo, P.E.

Presentation for

Clean Energy States Alliance (CESA)

May 2014

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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SAND Number: 2014-3334C SAND Doc # 5335182

Acknowledgments:

Sandia National Laboratories

DOE and our Sponsor – Dr. Imre Gyuk, Program Manager for the Office of Electricity's Stationary Energy Storage Program

Presentation Outline

- Introduction to Energy Storage (ES) commissioning
- Overview of Project implementation and Commissioning Process
- Commissioning Activities During Design and Construction
  - Team and Commissioning Program Development
  - Factory testing/Procedures/Inspections/Training
- Electrical Energy Storage System Commissioning Process
  - Operational Acceptance testing (OAT)
  - Start-up
  - Function Acceptance testing (FAT)
  - Shakedown
- Case Study
- Recap

Note:

This presentations will cover only the commissioning process, NOT the actual tests. The focus is on Stationary Electrical Energy Storage.

Since the actual tests and checklists are project specific please contact Dan Borneo drborne@sandia.gov for more information or assistance.

INTRODUCTION TO COMMISSIONING

Commissioning is one step in the project implementation plan that verifies installation and tests that the device, facility, or system's performance meets defined objectives and criteria.

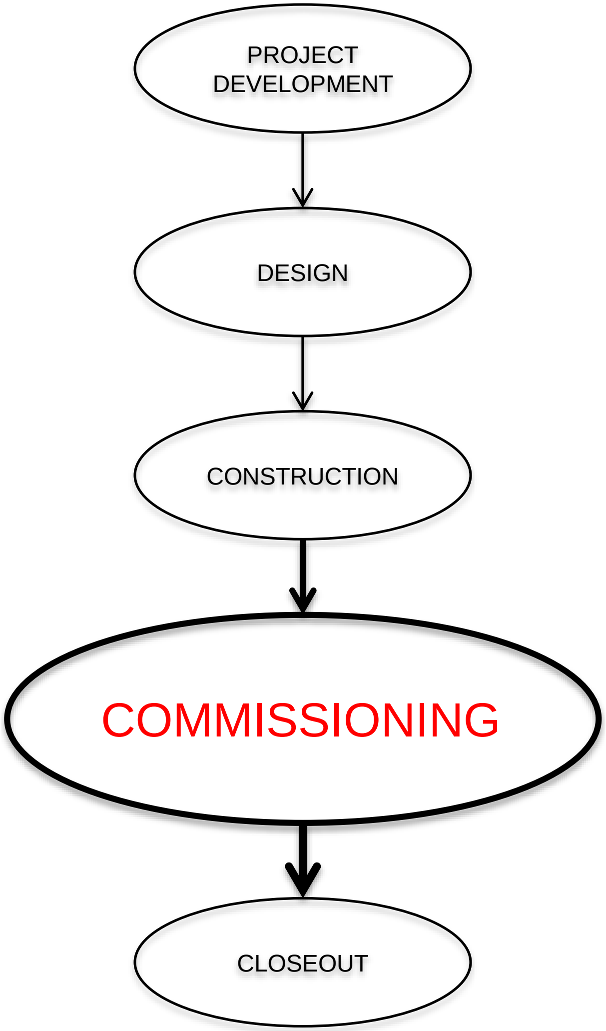
Significance

Commissioning helps insure that a system was correctly designed, installed and tested. The value of commissioning is to insure proper operation of the energy storage system, safety systems, and ancillary systems. **ALSO, Commissioning is an excellent means to help familiarize the Operation & Maintenance (O&M) staff with the system, how it operates, and how to respond in an emergency.**

Process

Commissioning is an orderly series of events to **demonstrate**, **measure** and record component and system performance. It is a process that develops and implements a set of **tests** tailored to a specific design. The commissioning process uses checklists, specifications, codes, standards, engineered drawings, and procedures to validate performance and to discover and correct problems before the system goes "online".

Project Implementation Process



GOAL: To Ensure a **Safe and Reliable** System is Specified, Designed and Installed

Commissioning Process

U.S. DEPARTMENT OF ENERGY | Sandia National Laboratories

GOAL: To Ensure a **Safe and Reliable** System is Installed as designed and is verified operational.

COMMISSIONING →

1. Operational Acceptance Test (OAT)
2. Apply YELLOW tag
3. Start-up
4. Functional Acceptance Test (FAT)
5. Apply GREEN tag
6. Shakedown

NOTES on Tags

Tags act as gates to advance pivotal and sequential events for the owner in the following manner:

(**Pick** a **Color**)
YELLOW Tag: Owner-Operated, Not Transitioned
GREEN Tag: Transition (Hand-Off) to operations completed

The yellow tag is removed once a green tag is applied.
The green tag may be removed at the owner's discretion AFTER the project is completed and signed off.

Daydreaming

Commissioning Activities During Design

- Identify commissioning team and roles and responsibilities and **integrate** with project team
  - Construction team
  - Energy Storage (ES) System integrator – (**Important position**)
  - Engineering designer – (**ES installation and balance of plant)**
  - Inspectors /EHS representatives/First Responders
  - Operations and Maintenance
  - Utility Representative – (**Point Of Connection**)
  - ES Equipment Vendor
  - Construction contractor?
- Review equipment specifications and applicable codes & standards
  - what is the KW/KWh rating, why?
  - Parameters that system needs to meet
- Develop and/or review the system Sequence Of Operations (SOO)
  - What application(s) will system be used for and Develop equipment list of items that will be commissioned
- Review and/or establish ESH requirements
  - What safety systems need to be installed
  - Develop Site Incident Prevention Plan-Authorization POC, LOTO, Hot-work

Commissioning Activities during Construction

- Factory Acceptance Tests
  - Vendor conducts factory Acceptance testing using SOO
- Develop start-up procedures
  - Based on equipment list, system manuals, SOO and operating specifications
    - Operating Specifications – Parameters that the system should operate within.
- Develop testing procedures
  - Based on SOO and applications
- Develop installation review checklists and perform inspections
  - Design Verification – Installed as designed & specified; labeling and signage in place, clearances,
  - Codes
  - Punchlist items noted
- Develop Training and emergency response procedures
- Implement Lock-out/Tag-out process

Commissioning Process- Operational Acceptance Testing (OAT)

Do the Individual components of the system operate?

- Verify and test that the electrical, mechanical components of the system are ready for start-up
  - Meggering, torqueing, rotation/phasing, covers and barriers
- Verify that the controls are in place and test operation
  - Point to point check
- Verify electrical protection and relays are coordinated and are operational
- Verify and test that all safety systems are installed and operating.
  - Temperature, leak, security, fire alarm, flow, pressure
- Verify and test that all communication systems are operating
- Emergency procedures are in place and Lock/out tag out process implemented
- **Tag and sign off – System is ready to operate**

Note: Is 3rd party testing required?

Commissioning Process– Start-up

Do the components operate as a system?

- Using start-up procedures initiate system and operate all components.
  - Record base-line data
    - Voltage, currents, temperatures, flows, pressures
    - Perform initial IR scan
  - Record and repair and punchlist items

Commissioning Process- Functional Acceptance Test (FAT)

Does the system perform its intended service?

- Using Testing plans and procedures test the system to see if it performs the functions/applications for which it was designed.
  - Are all components and sub-systems operating in unison
  - Do controls operate as intended
  - Is communication system sending and receiving data as intended- type and frequency. Are anomalies being annunciated
  - Is data collected adequate to determine system performance
  - Record and repair punchlist items
  - Is training complete for operators, maintenance and first responders
  - Is operation and maintenance plan in place
  - Is warranty in place
  - Is emergency response procedures in place- 1-800 number in the event of an emergency
  - Log additional baseline data
- **Tag and sign off that system is now owned and operated by customer/owner**

Commissioning Process-Shakedown

When any site utility is interrupted, and then restored (e.g., electricity, gas, water, data, communication, etc.), does the system operate in such a manner as to protect the people, the environment, the equipment, and the facilities?

- *Turn off major utilities serving the site.*
  - Determine if safety systems work as designed or needed.
  - Evaluate if systems fail in a safe mode.
  - Assess if back-up systems operate as needed.
  - Do alarms serve the purpose
- *Turn on major utilities*

  Determine if the systems come up in a safe manner.

  Assess if backup systems turn off in a safe/ready mode.

Case Study – Matt Galland

Recap:

1. Commissioning process needs to be started early in the project
2. Commissioning team needs representations from all the stakeholders, have clear R&R, and be partnered with project team (one and the same?)
3. The commissioning process may take 5 hours, 5 days or 5 weeks, but it must be done
4. Plan your work and work your plan

Questions?

Contact Information:

Dan Borneo - drborne@sandia.gov

PV & Advanced Energy Storage for Demand Reduction

Demonstration Program Case Study & Lessons Learned

May 20, 2014

Agenda

- Case Study Overview
- Program Lessons Learned
- Project Overviews & Lessons Learned
  - ZBB at UCSD
  - Ice Energy at Kohl's
- Project Team

PV+ES Program Overview

- In 2010 SunPower won a CSI grant to demonstrate PV integrated ZBB and Ice Energy storage systems
  – Site, design, install, operate and monitor systems for 2-years
  – Utilize existing installed PV systems
  – Assess operations and maintenance performance of ES systems
  – Measure impact on demand reduction and value proposition
  – Compare alternatives of deploying PV or ES separately
- In 2012-13, refined program objective to focus on energy storage technology demonstration; extended timeline
  – Mid-course change of demonstration partner (from Target to Kohl's and UCSD) forced siting delays, design changes and plan revisions
  – CPUC granted additional 2-year no-cost time extension to Q1-2015
  – Introduced integrated SunPower grid controller to ZBB system
  – M&V to be modeled from ES performance vis-à-vis PV production, site load data and rates that are provided by demonstration partners.

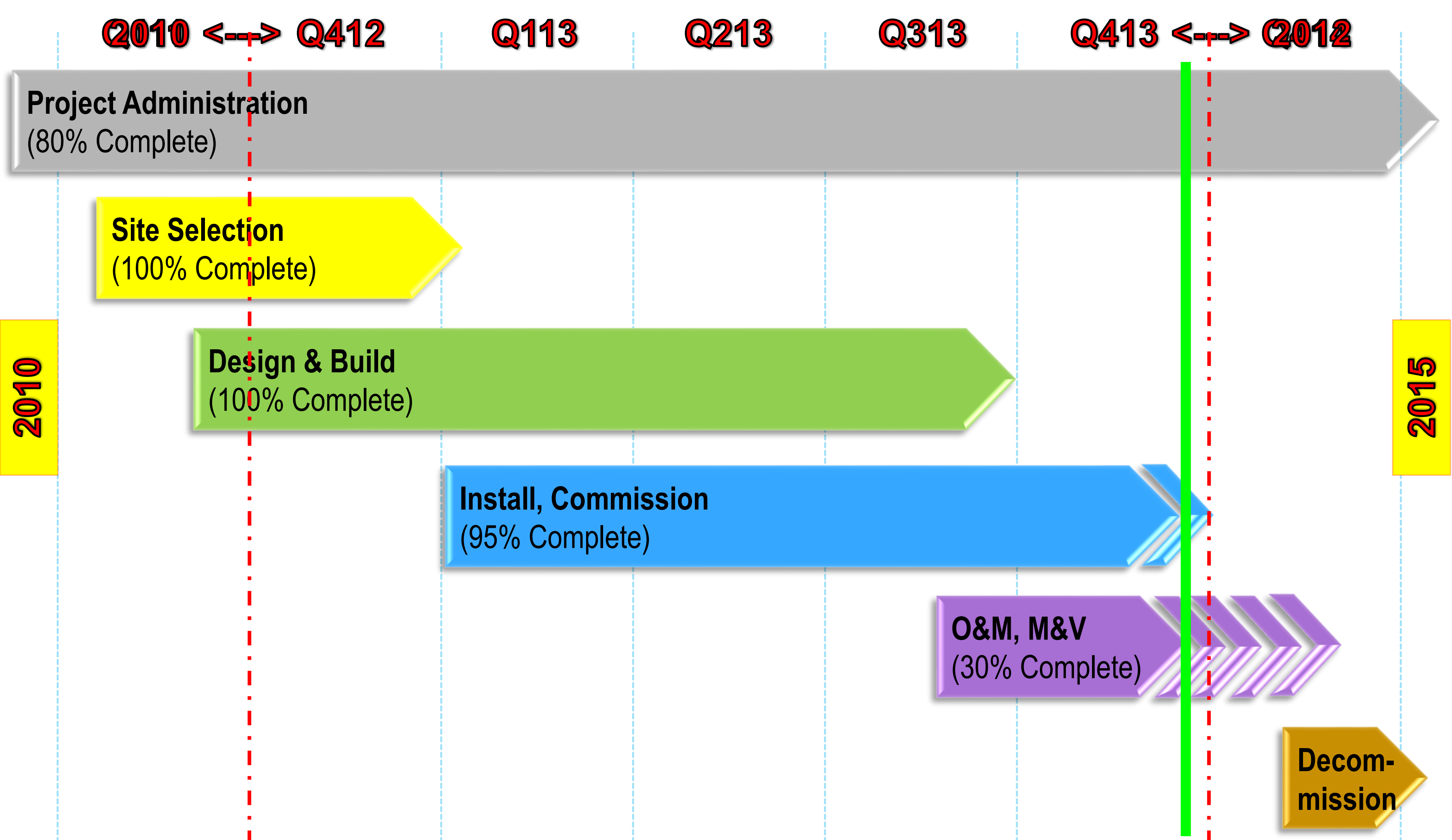
Vendor & Partner Scope

- ZBB at UCSD:
  - Manufacture and install 6x 50kW ZBB EnerStore flow-batteries, a ZBB 125kW inverter and an ZBB EnerSection control system
  - ZBB scheduled for commissioning in December 2013
  - Provide O&M services and performance data for term of program
- Ice Energy at Kohl's:
  - Manufacture, design and install 6x Ice Bear units integrated with existing HVAC systems
  - Manage all siting, construction, permitting and contracting logistics
  - Provide O&M services and performance data for term of program
- DNV-GL & Sandia, both sites:
  - Provide design, engineering and 3rd-party verification services
  - Perform site visits and ES system performance assessments at beginning, 6-month and 1-year intervals from commissioning
  - Provide reporting, public outreach and education programs

Program: Lessons Learned

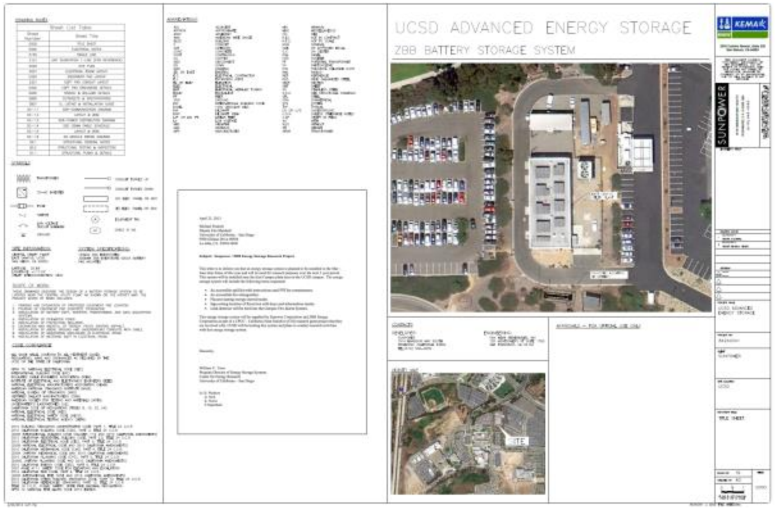
- Proposing is easy; contracting is not
  - Can add substantial time to project between award and actual start
  - Must balance public interest with intellectual property protections
  - May require last-minute or after-the-fact partner substitutions
- Ensure senior-level endorsements are in place, up front
  - Must have authority to sign contracts on behalf of partner agency
  - Keep informed and engaged through regular meetings and updates
- Refine and assign scope, roles and responsibilities early
  - Proposal team <> delivery team
- Be flexible
  - Resources and project constraints change with extenuated delays

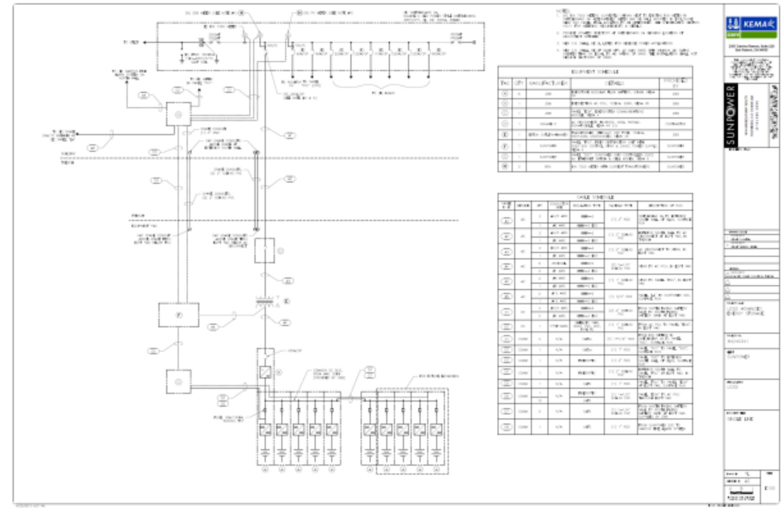
If project planed for two years, double it

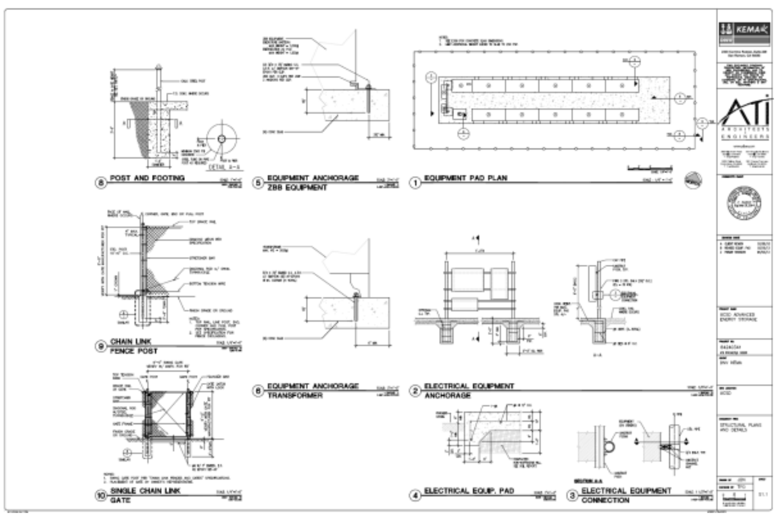


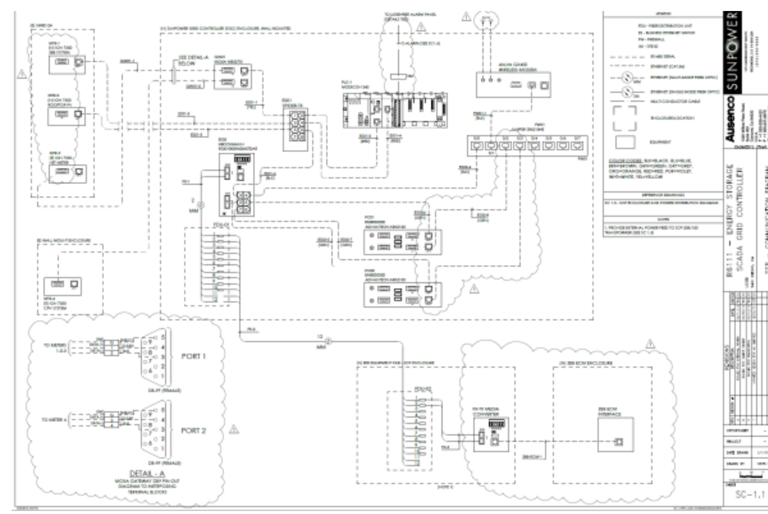
ZBB at UCSD: Plan & Design

- DNV/KEMA design and engineering plans









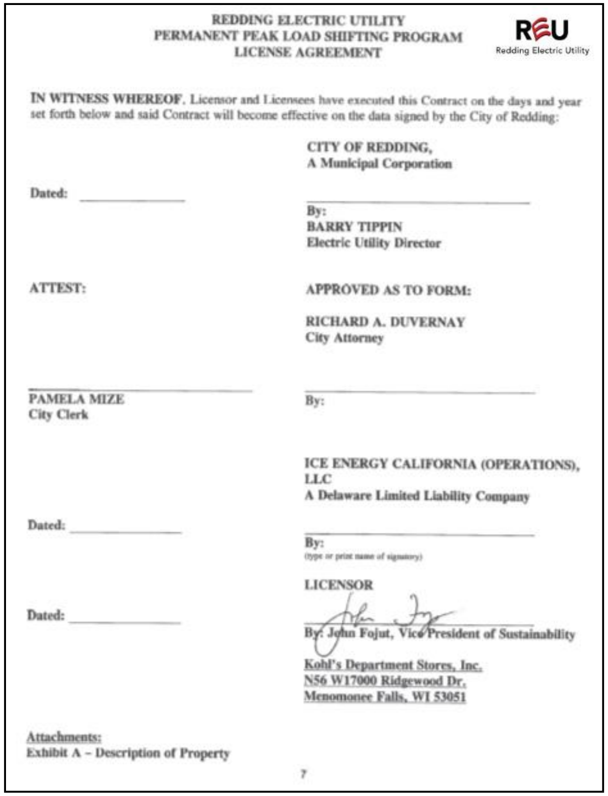
ZBB at UCSD: Install & Commission(ing)

ZBB at UCSD: Lessons Learned

- Identify collaborative host partner interested in research
  – Strictly commercial propositions (i.e. based on economic merit alone) impose logistical and operational limitations on pre-commercial demonstration projects
- Clarify siting capabilities and constraints early
  – Ensure adequate coverage for design, engineering, permitting, procurement, installation AND systems integration work
- Ensure essential permitting, certifications and education are explained and understood by the right stakeholders
  – ETL <> UL; CEO <> EHS; Construction Manager <> Operations
  – Vendor, installer, customer, inspector and fire marshal on same page
- Engage EHS through commissioning process, including:
  – Testing, acceptance/verification, communications and emergency response procedures.

Ice at Kohl's: Plan & Design

- Working through Redding Electric Utility, Ice Energy secured a site license with and developed plans for Kohl's, leveraging an existing 304kWp Sun Edison PV installation.



REDDING ELECTRIC UTILITY
PERMANENT PEAK LOAD SHIFTING PROGRAM
LICENSE AGREEMENT

REU
Redding Electric Utility

IN WITNESS WHEREOF, Licensor and Licensees have executed this Contract on the days and year set forth below and said Contract will become effective on the data signed by the City of Redding:

CITY OF REDDING,
A Municipal Corporation

Dated: ____________

By:
BARRY TIPPIN
Electric Utility Director

ATTEST:

APPROVED AS TO FORM:

RICHARD A. DUVERNAY
City Attorney

PAMELA MIZE
City Clerk

By:

ICE ENERGY CALIFORNIA (OPERATIONS), LLC
A Delaware Limited Liability Company

Dated: ____________

By:
(type or print name of signatory)

LICENSOR

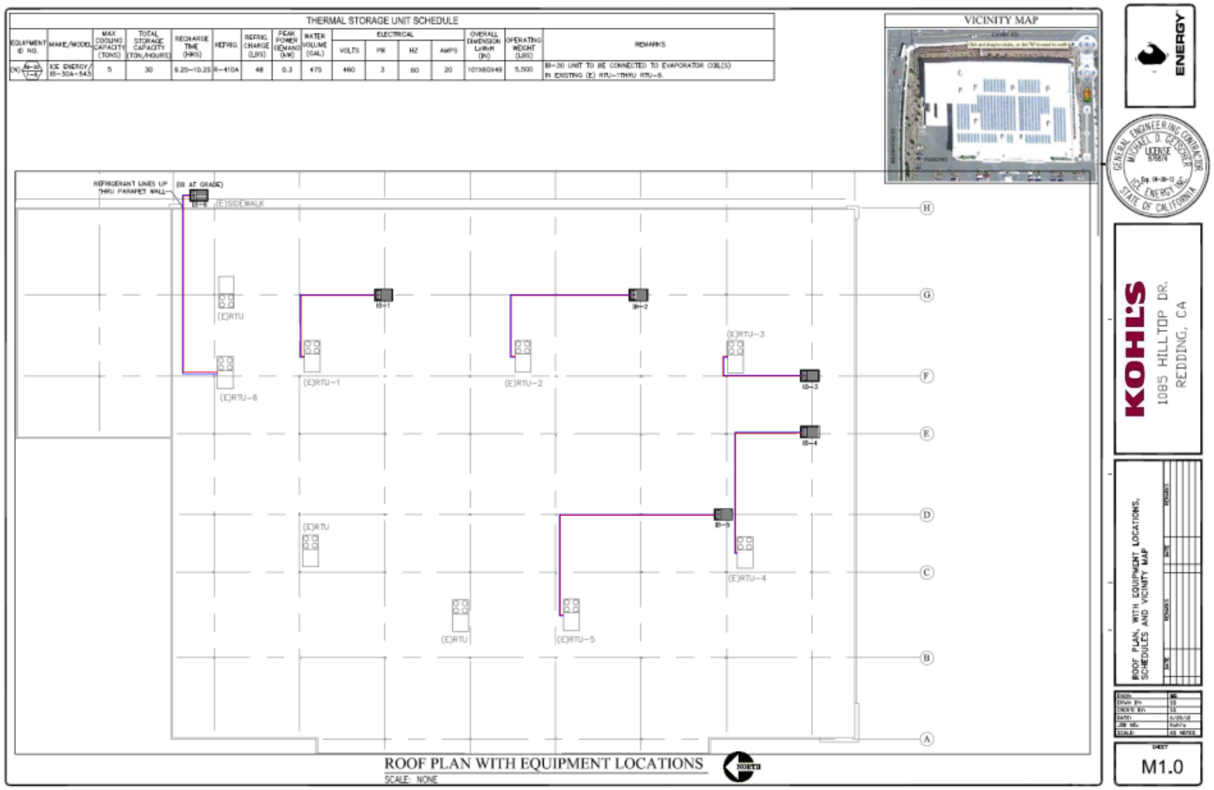
Dated: ____________

By: John Fojut, Vice President of Sustainability

Kohl's Department Stores, Inc.
N56 W17000 Ridgewood Dr.
Menomonee Falls, WI 53051

Attachments:
Exhibit A – Description of Property

7



Ice at Kohl's: Install & Commission

- Six Ice Bear units installed (Dec. 2012) and initial monitored data being received late 2013. REU installing additional meters for whole-site load data.

Ground mounted to mitigate rooftop weight loading

Rooftop and adjacent to HVAC load

Rooftop with onsite PV generation

Ice at Kohl's: Lessons Learned

- Best if energy storage vendor can assume all responsibility for design, engineering, permitting and installation
- Helpful when proposed solution already has an installed – and proven – base of commercial customers.
- Enlist vendor to identify candidate host partners
- Ensure metering, data acquisition and reporting are in place
  - You can't improve what you don't measure!

FYI: CSI2 PV+ES Program Organization

Grant Authority
Neil Reardon, CPUC

Grant Manager
Ann Peterson, Itron

CPUC Advisory Board
IOU's, Manufactures, SME's

PG&E Advisory Board
Matt Heling, PG&E

Program Manager
Matt Galland, SunPower

Executive Sponsor
Jack Peurach, SunPower

Technical Lead
Carl Lenox, SunPower

Contract Compliance
Joe Surprenant, SunPower

Project Controller
Jeff Triick, SunPower

Demonstration Partner 1
Kohl's / Redding Electric

Demonstration Partner 2
UCSD – Byron Washom

Construction Manager
Xina Lyons, SunPower

Ice Energy
Greg Miller

ZBB Energy
Tony Siebert

Storage Controller
Robert Johnson, SunPower

- Monitoring Data Analyst
- Design Engineer

Technical Validation
Rick Fioravanti, DNV-GL

- Chris Barker
- Dennis Flinn

Performance Testing
Dan Borneo, Sandia


California Solar Initiative
Research, Development, Demonstration, and
Deployment Program
Response to Grant Solicitation #2

PV AND ADVANCED
ENERGY STORAGE FOR
DEMAND REDUCTION
Priority Area 2.2
Improved PV Production Technologies

Prepared For
California Public Utilities Commission

Prepared by
SunPower Corporation

In partnership with
KEMA
Sandia National Laboratories

Storage Manufacturer Partners
Ice Energy
ZBB Energy

Demonstration Partners
Target Stores
Pacific Gas & Electric

February 16, 2010

For additional information...

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Renewable Energy Project Solutions
Program Manager for SunPower
Matt.Galland@SunPower.com
(510) 260-8499

Stationary Battery Energy Storage Systems – A Standards and Codes Overview

Laurie Florence

Principal Engineer

UL LLC

Laurie.b.florence@ul.com

Agenda

Terminology & Standards

Terminology

Key Standards & Other Documents (examples)

What dictates standards needed?

Application

Chemistry

Application + Chemistry

Regulations

Effect of regulations on standard choices

Codes (examples)

Adoption of Codes & Reference to Standards

Example

Terminology & Standards

Terminology

Code – A document that is a systematic collection of laws or regulations

Standard – A document established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context

Recommended Practice – A document that provides technical guidance, philosophy or preferred procedures regarding a given topic. A recommended practice may be similar in format to a standard but does not contain mandatory language.

Guide - document giving general advice or recommendations

Key standards and other documents (examples)

ATIS-0600330
Valve-regulated lead-acid batteries used in the telecommunications environment

Telcordia GR-3020-CORE
Nickel cadmium batteries in the outside plant

Telcordia GR-3150-CORE
Generic requirements for secondary non-aqueous lithium batteries

Telcordia GR-4228-CORE
VRLA battery string certification levels based on requirements for safety and performance

UL 1973
Batteries for use in Light Electric Rail (LER) and Stationary Applications

UL Subject 9540
Safety of Energy Storage Systems

PNNL 22010
Protocol for Uniformly Measuring and Expressing the Performance of Energy Storage Systems

IEEE 484
Recommended Practice for Installation Design and Installation of Vented Lead Acid Batteries for Stationary Applications

IEEE 1184
Guide for Batteries for Uninterruptible Power Supply Systems

IEEE 1361
Guide for selection, charging, test and evaluation of lead-acid batteries used in stand-alone photovoltaic (PV) systems

IEEE 1375
Guide for the Protection of Stationary Battery Systems

IEEE 1661
Guide for Test and Evaluation of Lead-Acid Batteries Used in Photovoltaic (PV) Hybrid Power Systems

IEEE 1679
Recommended Practice for the Characterization and Evaluation of Emerging Energy Storage Technologies in Stationary Applications

IEC 60896-11
Stationary lead-acid batteries - Part 11: Vented types - General requirements and methods of tests

IEC 60896-21
Stationary lead-acid batteries –Part 21:Valve regulated types – Methods of test

IEC 61427-1
Secondary cells and batteries for renewable energy storage - General requirements and methods of test - Part 1: Photovoltaic off-grid application

IEC CD2 62619
Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications (not published)

IEC CDV 62620
Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications (not published)

IEC 62485-2
Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries

What dictates standards needed?

Application

- Grid applications: peak power shaving, frequency regulation, load following, time shift service
- ESS for renewable energy (i.e. wind farms, etc.)

Utility

- Data storage rooms
- UPS
- ESS for renewables (i.e. wind & PV)
- EV charging
- Community Energy Storage (CES)

Commercial & Residential

Application

Chemistry

Lead Acid

Nickel

Lithium ion

Sodium Beta

Flow Batteries

Electro-chemical capacitors

Application + Chemistry

Regulations

Local and regional regulations will dictate standards to be applied.

Effect of regulations on standard choices

Codes (Examples)

NFPA 1, Fire Code
NFPA 2, Hydrogen Code
NFPA 70, National Electrical Code
NFPA 30, Flammable and Combustible Liquids Code
NFPA 54, National Fuel Gas Code
NFPA 5000, Building Construction and Safety Code
ICC IFC, International Fire Code
ICC IBC, International Building Code
ICC IFGC, International Fuel Gas Code
ICC IMC, International Mechanical Code
ICC IPC, International Plumbing Code
ASME B & PVC (Section VIII), Boiler & Pressure Vessel Code
ASME B31 (series) Piping Code

Adoption of Codes & Reference to Standards

Local municipalities and regional governments

use the codes as the basis for their regulations

Codes require compliance to standards by:

Referencing standards directly in codes or

Requiring that certain equipment be "Listed"

- Listing infers, by definition, 3rd party certification to an appropriate standard

Example

Example

A 5 kW lithium ion energy storage system for use in a data storage center and installation location is city of Chicago, IL:

Regulations: Chicago Building Code Electrical Requirements

- Dated February 8, 2000
- Based upon NFPA 70 (1999 edition) and references NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*

18-27-90.7 Examination of equipment for safety

- "All equipment, devices, and appliances covered by the provisions of this chapter shall be tested by and bear the label of a recognized testing laboratory. Manufacturers or distributors of specialized, limited production, or custom built equipment for which there is no commercially available, test laboratory labeled substitute may apply for evaluation and recognition by the building commissioner. Self-certification of equipment or installations shall not be acceptable."

18-27-645.2 Special requirements for information technology equipment room.

- **18-27-645.2 (b)**Requires <u>Listed</u> information technology equipment be installed.
  - Certified to UL 60950-1 for example

Other Applicable Provisions of the CBC

- **i.e. 18-27-480** applicable criteria in the storage battery section, etc.

Example

ANSI UL 60950-1 Scope -

- **1.1.1 Equipment covered by this standard**:
- "This standard is applicable to mains-powered or battery-powered information technology equipment, including electrical business equipment and associated equipment, with a rated voltage not exceeding 600 V."
- **1.1.3 Exclusions:**
- "This standard does not apply to:
- Power supply systems which are not an integral part of the equipment, such as motor-generator sets, battery backup systems and transformers;
- building installation wiring;
- devices requiring no electric power."

ANSI UL 1973 Scope –

- **1 Scope**
- 1.1 "These requirements cover electric energy storage systems as defined by this standard for use as energy storage for stationary applications such as for PV, wind turbine storage or for UPS, etc. applications."

THANK YOU.

Laurie Florence
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Today's Guest Speakers

Imre Gyuk, Program Manager, Energy Storage Research, Office of Electricity Distribution and Energy Reliability, U.S. Department of Energy, imre.gyuk@hq.doe.gov

Dan Borneo, Engineering Project Manager, Distributed Energy/ Electrical Energy Storage, Sandia National Laboratories, drborne@sandia.gov

Matt Galland, Principal, Renewable Energy Project Solutions, Grant Manager for Sunpower Corp matt.galland@sunpower.com

Laurie B. Florence, Principal Engineer for Large Batteries & Fuel Cells, UL, laurie.b.florence.@ul.com

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

SUNPOWER

UL

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Webinar Archive: www.cesa.org/webinars

ESTAP Website: http://www.cesa.org/projects/energy-storage-technology-advancement-partnership/

ESTAP Listserv: http://www.cesa.org/projects/energy-storage-technology-advancement-partnership/energy-storage-listserv-signup/

Clean Energy States Alliance

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