Exh. JES-4C
Dockets UE-170033/UG-170034
Witness: Jennifer E. Snyder
CONFIDENTIAL VERSION

BEFORE THE WASHINGTON
UTILITIES AND TRANSPORTATION COMMISSION

WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION, **Complainant,** **v.** **PUGET SOUND ENERGY,** **Respondent.**	**DOCKETS UE-170033 and UG-170034 (*Consolidated*)**

EXHIBIT TO
TESTIMONY OF

Jennifer E. Snyder

ON BEHALF OF STAFF OF
WASHINGTON UTILITIES AND
TRANSPORTATION COMMISSION

PSE Response to Staff Data Request No. 252, Attachement A.

June 30, 2017

December 10, 2013

Mr. Tony Usibelli
State Energy Office
Washington Department of Commerce
1011 Plum Street SE
Olympia, WA 98504-2525

Dear Tony:

Snohomish PUD and Puget Sound Energy have submitted complimentary grant proposals to the Clean Energy Fund. Our utilities have benefited from working closely together as we prepared our submissions. We have also developed shared views on how best to grow the market for utility-scale energy storage systems. In particular, we see a need for common standards for the energy storage supply chain. Just as modularity and interoperability have lowered costs and increased performance in the personal computer industry, so too can common standards help make energy storage more cost-effective and move it into the main stream of utility operations.

Our two utilities are advocates of a developing standard called Modular Energy Storage Architecture or MESA. Together with our industry partners, we are working to develop open standards for the connections between major system components including batteries, power conversion systems, energy storage control systems, and utilities' existing supervisory control and data acquisition (SCADA) systems. Standards for the physical, electrical, and communication interfaces among these components will reduce one-off engineering and lower costs. The attached white paper describes MESA in more detail.

MESA is also a significant opportunity to grow the energy storage cluster in Washington. Through the demonstration and growth of MESA, Washington can become a showcase for innovative, cost-effective deployment of energy storage systems with key components and systems supplied by our own in-state companies.

We encourage you to fund both of our proposals so we can continue to collaborate to deploy energy storage systems, promote MESA standards throughout the country and the world, and advance this evolving business cluster in our state. As the largest public utility district and the largest investor owned utility in the state, we have the resources, the capacity, and the commitment to help Commerce achieve all of your objectives for the Clean Energy Fund.

Sincerely,

Steven J. Klein
General Manager
Snohomish PUD

Kimberly Harris
CEO
Puget Sound Energy

PSE GRID-SCALE ENERGY STORAGE PROJECT:
ENERGIZING A CLEAN ENERGY FUTURE

PROJECT SUMMARY

PSE envisions energy storage becoming a valuable distributed generation resource that can address multiple system issues from a single device. PSE's proposed project consists of two core components:

1. Develop a proven 2.0MW/4.4MWh grid scale system, dispatched with innovative software from PSE's control room for grid balancing, outage mitigation, and other key services to solve actual grid problems.
2. Add 1Energy's control software functionality to the 0.5MW Primus Project already funded and under development by PSE as part of a Bonneville Power Administration (BPA) Technology Innovation Project.

PSE has identified several feasible sites for this project. The preferred site is "Glacier-12," where energy storage in combination with a small run-of-river hydro facility would be used to create a rural microgrid in order to virtually eliminate transmission-related outages for the community. PSE will work with Pacific Northwest National Labs (PNNL) on location evaluation and detailed cost-benefit analysis in Phase I.

PSE has selected RES Americas as its engineering, procurement, and construction (EPC) partner. The system will be installed by Battery Power Systems (BPS), a Washington-based company that is the leader in the field of industrial batteries in the Western U.S. 1Energy, a Seattle company, will provide innovative software that will communicate between the storage system and PSE's control room. Assuming a project start in Q2 2014, PSE believes that the system will be constructed and operational by June 30, 2015. PNNL will provide system operational testing and system performance evaluation after completion.

In addition, PSE has committed to working with Snohomish PUD (SnoPUD) in developing a standard called Modular Energy Storage Architecture (MESA). Through the demonstration and growth of MESA, Washington can become a showcase for innovative, cost-effective deployment of energy storage systems.

CERTIFICATION OF ORGANIZATION OFFICIAL

I commit to adhere to the Federal and State laws and regulations that are applicable to the Smart Grid Grant Program and the proposed project. The primary applicant has all necessary current business licenses in the State of Washington. The project proposed in this application could not go forward at the scale or on the schedule proposed without the requested funding. We are not supplanting/replacing other funds with this request.

Kimberly Harris	12-11-13
Signature	**Date**
KIMBERLY J. HARRIS	PRESIDENT AND CEO
Print Name	**Title**

CONTACT

Patrick Leslie, Emerging Technologies Program Manager, patrick.leslie@pse.com, 425-457-5739

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

PSE envisions energy storage becoming a valuable distributed generation resource that can address multiple system issues from a single device. PSE seeks to understand and demonstrate the operational realities of grid-scale energy storage systems and to gain valuable first-hand experience. PSE's proposed project consists of two core components:

1. Develop a proven 2.0MW/4.4MWh grid scale system, dispatched from PSE's control room for grid balancing, outage mitigation, and other key services to solve actual grid problems.
2. Add 1Energy's innovative control software functionality to the 0.5MW Primus Project already funded and under development by PSE as part of a Bonneville Power Administration (BPA) Technology Innovation Project.

The primary goals of this project are to:

- Automatically dispatch the system from PSE's control room
- Enhance service reliability and optimize generation and delivery to enable PSE to integrate more renewable generation at lower cost.

PSE has identified several possible sites for this project. The preferred site is "Glacier-12," where energy storage in combination with a small run-of-river hydro facility would be used to create a rural microgrid in order to virtually eliminate transmission-related outages for the community while also increasing revenues for the independent hydro generator. PSE will work with Pacific Northwest National Labs (PNNL) on location evaluation and detailed cost-benefit analysis. PNNL will also provide system operational testing and system performance evaluation after completion.

PSE has selected RES Americas as its engineering, procurement, and construction (EPC) partner. Based on a review of technologies conducted by RES Americas, PSE's intention for this project is to utilize lithium-iron phosphate batteries from BYD, one of the largest battery OEMs globally. The system will be installed with a local, experienced battery systems company: Battery Power Systems (BPS), a Washington-based firm that has engineered, furnished and installed industrial battery systems for nearly thirty years, and is the leader in the field of industrial batteries in the Western U.S. 1Energy, a Seattle company, will provide innovative software functionality that will communicate between the storage system and PSE's control room and will eventually dispatch the system autonomously. Assuming a project start in Q2 2014, PSE believes it will have the system constructed and operational by June 30, 2015.

In addition, PSE has committed to working with Snohomish PUD (SnoPUD) in developing a standard called Modular Energy Storage Architecture (MESA). The evolving MESA standard allows for the standardized design and assembly of batteries, power conversion systems (PCS) and control software, to create replicable, scalable, component-based energy storage systems, and reliably and consistently integrate them into utility IT/OT systems. Through the demonstration and growth of MESA, Washington can become a showcase for innovative, cost-effective deployment of energy storage systems with key components and systems supplied by our own in-state companies.

A. Project Categories

PSE is proposing a project that addresses two of the required criteria:

- Integrate intermittent renewable energy projects through energy storage and information technology (IT)
- Demonstrate dispatch of energy storage resources from utility energy control centers

2. APPLICANT RESPONSES FOR THRESHOLD CRITERIA

A. Eligible Applicant

PSE is a private utility that serves 1.1 million customers in Washington.

B. Eligible Project

1. Eligible Energy Storage and Smart Grid Utility Projects

PSE is proposing a project that will be implemented in Washington, and that addresses two of the required criteria:

- Integrates intermittent renewable energy projects through energy storage and information technology (IT)
- Demonstrate dispatch of energy storage resources from utility energy control centers

2. Eligible Project Assets

The energy storage system, including batteries, power conversion systems, major electrical components, communications, and software, is expected to last at least fifteen (15) years per manufacturer design life and field experience with similar systems , and considering PSE's expected operating regimes.

C. Sufficient Matching Funds

PSE is proposing a project with 1.41 to 1 non-State to State funding. PSE has secured internal approval for the funds requested.

D. Smart Grid Program Funding Request

PSE estimates a total project cost of $12,002,652, and requests $4,975,943 in matching grant from the State (41% of total).

E. Timely Expenditure of Funds Milestone Plan

PSE anticipates completing construction of the project and spending approximately 95% of the total budget by June 30, 2015. The remaining budget will be spent on PNNL operational testing and fully implementing 1Energy's software functionality. See Section 3.A.2 'Project Management' for more detail on the project schedule and budget.

F. Statement of Need for Funding

PSE is required to pursue projects that are prudent and lowest reasonable cost. Given the current cost for energy storage systems and the total installed cost involved for our leading-edge storage project, this endeavor would not currently be cost-effective without matching funding. The signed statement regarding funding need is on the cover page.

G. Business Case

A business case analysis has been included and is described in detail in section "3. Application Response for Scoring Evaluation" under the sub heading titled "3. Business Case."

3. APPLICANT RESPONSES FOR SCORING EVALUATION

A. Project Plan, Management, and Business Case Evaluation

1. Innovation

Project Description

The energy storage industry is evolving rapidly and PSE envisions energy storage becoming a valuable distributed generation resource that can address multiple system issues from a single device. PSE seeks to understand and demonstrate the operational realities of grid-scale energy storage systems and to gain valuable first-hand experience. The overarching goals of this project are to successfully develop and build the storage system, automatically dispatch the system from PSE's control room, and enhance customer service and optimize generation and delivery. This project will set the foundations necessary for storage to enable PSE to integrate more renewable generation at lower cost.

Grid-scale batteries are an active area of research and development, funded by both the government (here and abroad) as well as a large number of private enterprises. While promising, many of these battery technologies have significant technical hurdles to overcome at this time to realistically be suitable for commercial deployment in grid applications. This project seeks to utilize a proven battery technology in order to focus on proving innovative uses and applications for energy storage.

PSE's proposed project consists of two core components:

- Develop a 2.0MW/4.4MWh grid scale system, dispatched from PSE's control room for grid balancing, outage mitigation, and other key services to solve actual grid problems.
- Add 1Energy's software dispatch functionality to the 0.5MW Primus Project already funded and under development by PSE as part of a Bonneville Power Administration (BPA) Technology Innovation Project. This is an important component as will demonstrate the integration of multiple battery units under the same software system. We are not seeking matching funding for the cost of the Primus system itself.

In addition, PSE has committed to working with Snohomish PUD (SnoPUD) in developing a standard called Modular Energy Storage Architecture (MESA). PSE sees a need for common standards for the energy storage supply chain. Just as modularity and interoperability have lowered costs and increased performance in the personal computer and consumer electronics industries, so too can common standards help make energy storage more cost-effective and move it into the main stream of utility operations. The evolving MESA standard allows for the standardized design and assembly of batteries, power conversion systems (PCS) and control software, to create replicable, scalable component-based energy storage systems, and reliably and consistently integrate them into utility IT/OT systems. Standards for the physical, electrical, and communication interfaces among these components will reduce one-off engineering, lower costs, and drive scale in the storage industry. The attached white paper Appendix G describes MESA in more detail.

Background

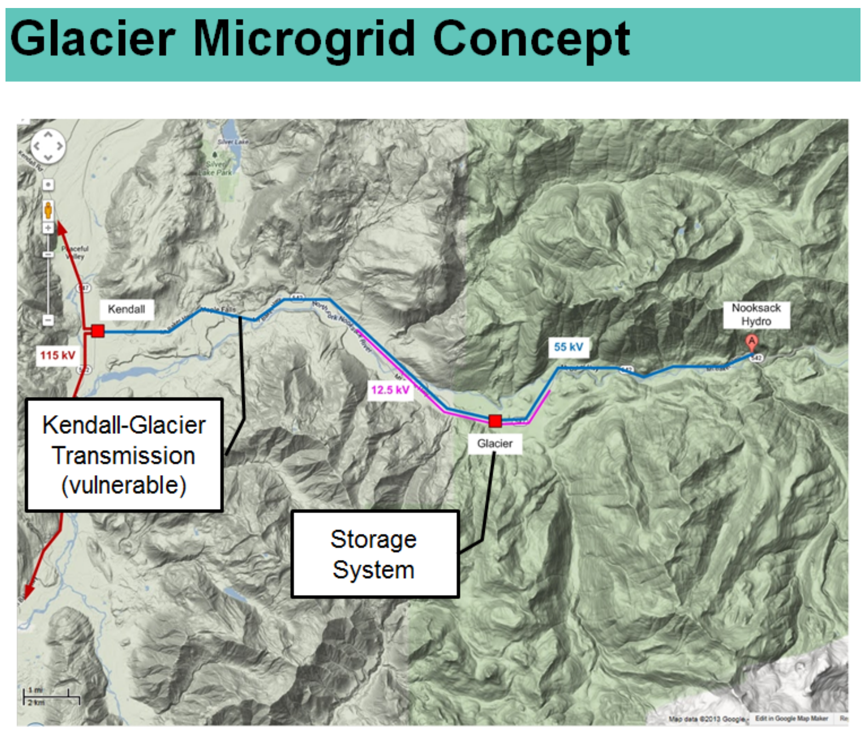
In 2013, PSE and PNNL studied the feasibility and cost-effectiveness of storage (the "Primus Project") and the results suggest that energy storage may soon become a cost-effective resource for PSE. As a result, PSE has committed to develop a 0.5 MW battery storage project with partial funding from the Bonneville Power Administration. This project is underway and funds have been committed for system installation and for basic testing and operations. This will be one of the first full-scale deployments of Primus' technology.

While much will be learned from the 0.5 MW Primus Project, its diminutive size limits its potential grid impact – at this size it is not generally considered “grid-scale.” By developing a 2.0MW/4.4MWh system (2.2 hours of sustained peaking capacity), PSE seeks to demonstrate that energy storage is ready for larger scale and more widespread deployment. PSE is pursuing CEF funding to fully demonstrate the many capabilities of grid-scale energy storage in a size large enough to have meaningful impact on our system.

Many utilities have demonstrated one or two use cases from a storage system (i.e. frequency regulation, islanding, peak shaving), but this project will be one of the first in the nation to implement three to four use cases from one system. The 2MW system is small but can provide meaningful benefits; however, the system must be automated. To this end, the proposed system will utilize sophisticated automated control systems that will allow for the capture of multiple value streams. Successfully demonstrating this automatic dispatch will be critical for PSE and other utilities to begin adding many distributed storage systems into the grid, and to control them as we do centralized generation.

Site Alternatives

Energy storage systems create value through multiple use cases. Some of these use cases create value independent of their location, such as system peaking capacity, spinning reserve, load/generation following, and/or frequency regulation. Other use cases, such as islanding and T&D infrastructure deferral depend highly on location. Leveraging our existing work with PNNL, PSE has identified several highly promising sites for the proposed 2MW system (Table 1: Potential Locations).



PSE’s preferred site is “Glacier-12,” where energy storage in combination with a small run-of-river hydro facility would be used to create a rural “microgrid” in order to virtually eliminate transmission-related outages for the community in Glacier.

In order to expedite location selection in case of an award, PSE will continue to collect necessary information and data on the sites listed in Table 1 so that PSE and PNNL can perform a comprehensive yet rapid analysis in Phase I to select a final location and specific site. PSE and PNNL’s previous experience means the analytical tools and frameworks exist and this analysis will be completed in six weeks or less.

Table 1: Potential Locations

Location	System Issues	Opportunity for Storage
Glacier-12 (preferred site)	Glacier is a remote community in the N. Cascade foothills that suffers from frequent and extended transmission line outages due to heavy vegetation, and remote access. No good solution exists to remedy this problem. Glacier is a recreational destination for the Mt. Baker ski area and businesses are disrupted during outages. Several small hydro generation facilities interconnect to this circuit and lose revenue during outages.	Energy storage and the existing hydro generation on the circuit can create a microgrid that could "island" customers during transmission outages. This microgrid will virtually eliminate transmission-related outages, and may increase revenues and reduce cost for the small hydro projects.
Baker River-24	Baker River-24 is a rural distribution circuit running from Concrete to Rockport and Marblemount. BRS-24 is one of PSE's least reliable distributions circuits with a high penetration of businesses along a prominent tourism route. The majority of line failures occur between Concrete and Rockport due to dense vegetation.	An energy storage system located in Rockport, downstream of the problem area, to "island" customers in Rockport and Marblemount. Depending on loads at the time of an outage, the storage system will be able to provide backup for 2-6 hours. It may be possible to integrate a trailer-mounted diesel generator for extended outages.
Bainbridge Island – Winslow-15	Bainbridge Island faces many distributions system challenges. Two of the Island's three substations are currently overloaded, and several circuits suffer from poor reliability. In addition, circuit 15 on the Winslow substation has the 3rd highest penetration of distributed solar among PSE's circuits. While not currently a problem, this could pose challenges in the near future.	Energy storage could be used to shave peak load, potentially deferring the need for a new substation. If located near the end of a distribution feeder, the storage system could provide backup power to a portion of the circuit for a limited time. Storage could also smooth intermittent solar generation, allowing greater penetrations of distributed solar.

Storage Technology Selection

As the largest single cost component of the project, prudent battery technology selection is critical for a successful project. Utilities, especially those regulated by state utility commissions, typically proceed with caution when implementing new technologies. PSE is not yet deeply experienced with grid-scale battery systems and has partnered with an experienced EPC (engineering, procurement, and construction) partner to expedite the project and reduce risks to both PSE and the State. PSE issued an RFQ to this end, received four responses, and ultimately selected RES Americas. More information about RES' qualifications can be found later in this proposal.

Based on a review of technologies conducted by RES Americas, PSE's intention for this project is to utilize lithium-iron phosphate batteries from one of the largest battery OEMs globally: BYD. RES Americas has evaluated over 120 battery and energy storage product developers and manufacturers covering a wide range of technologies including battery designs based on various chemistries, flow and hybrid-flow batteries, Zinc-Air, Aqueous Sodium, high temperature (NaS and NaNi) and advanced lead acid. RES Americas' preferred vendor for lithium ion batteries is BYD. BYD is the largest and most experienced Lithium Iron Phosphate (LiFePO4) battery manufacturer with $8 billion in revenue for 2012 and 180,000 employees. BYD operates a completely robotic manufacturing factory allowing for rigid quality control which RES has visited and inspected. BYD's previous projects include the world's largest lithium battery, located in Zhangbei, China (36 MWh). BYD's lithium battery chemistry is considered one of the safest Lithium battery chemistries and is used extensively in busses and automobiles.

The battery systems will be installed with a local, experienced battery systems company. Battery Power Systems (BPS), a Washington-based company that has engineered, furnished and installed industrial battery systems for nearly thirty years, and is the leader in the field of industrial batteries in the Western U.S. BPS is the intended subcontractor to this project, using exclusively Washington State employment to satisfy their commitments. The Project will be operated and maintained under a management services agreement with RES and BPS.

PSE has given substantial consideration to the potential to use of batteries from Washington-based UniEnergy Technologies (UET). We believe UET's technology could be promising but their current pricing is high relative to alternatives and the technology is in an early stage of development and commercialization. PSE plans to continue to evaluate UET's technology. If UET is able to match the pricing we have received from BYD and PSE is able to get comfortable with UET's technology readiness and/or commercial arrangements to mitigate risk, PSE remains open to sourcing the eventual batteries for this project from UET.

Storage System Technical Details

The energy storage system will consist of four containerized units, each unit being 8' x 8' x 40' long. Each unit is will provide 500kW of power and 1.1MWh of battery capacity (2.2 hours of storage), for a total system capacity of 2MW and 4.4MWh. Major components include:

- **Battery**: sealed 200AH UL-Listed Lithium Iron Phosphate battery cells in 8-cell packs, mounted in racks, complete with a hierarchical Battery Management System (BMS).
- **Power Conversion System (PCS)**: four BYD model BEG500KTL-U 500kW Inverter systems, one per container.
- **Transformer**: 2.2MVA 480VAC/12.xkV pad mount
- **Environmental Operating Range**: -27F to 106F
- **Warranty**: 10 years on-site replacement, parts and labor.
- **Operating Characteristics**: System will respond within 50mSec, and can swing from full charge to full discharge within 50mSec. Maximum ramp rate consists of a full swing from full 2MW charge to full 2MW discharge within 50mSec, or a rate of 1200MW/minute.
- **Monitoring & Controls**: Full SCADA control of all operations, full remote monitoring of all alarms, breakers, cell and container temperatures, cell, module, and bus voltages, bus currents, and other parameters. Internal video monitoring of battery containers also available.
- **Environmental & Safety**: Lithium Iron Phosphate is the only lithium battery chemistry that is not subject to internal thermal runaway, a safety issue that is well known from the Boeing Dreamliner battery fires. The battery cells are UL listed, and the MSDS safety rating is 0-1-0, the safest rating for any battery. In the very unusual case of a cell leaking electrolyte, any electrolyte leakage is fully contained within the module units. Additionally, there is remote monitoring of voltage and temperature for every single cell in the system.

- **Transportability**: A feature of this system is that each of the four system modules is a separately operable 500kW/1.1MWh energy storage system, and each module, or all modules, can be easily moved to another location should PSE find greater value in siting at a different location.
- **Layout**: A simplified layout is shown in Figure 1. A detailed engineering layout is found in Appendix C.
- Representative image of a similar project is in Figure 2.

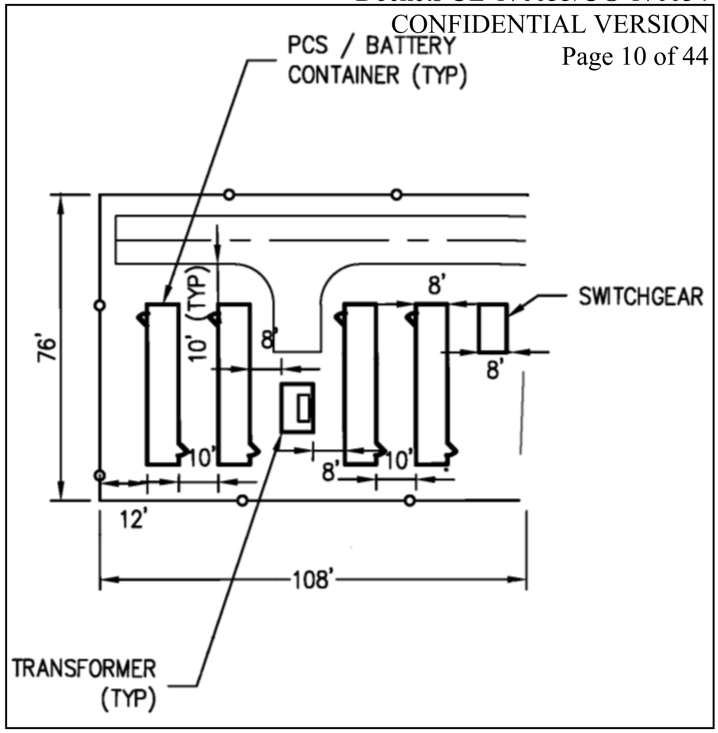


Figure 1: Simplified system layout

Figure 2: Example 2MW/4MWh BYD system provided for Chevron, Santa Rita, CA

Integration & Control Software

As previously mentioned, a key goal of this project is demonstrating multiple use cases and automatic dispatch from the control room, for both the 2MW system and also the 0.5MW Primus Project. 1Energy Systems will provide the Site Dispatch Controllers (SDCs) and necessary hardware within the storage system. The SDC will enable automatic dispatch of the storage systems for the use cases envisioned by PSE. The 1Energy Systems SDC is using proven Microsoft .NET software development platform and Windows Embedded OS on a utility-grade hardened PC, creating a novel controls platform that allows batteries to serve multiple use cases and thereby increase their value to utilities. The SDC will interface with PSE's existing SCADA and control room Energy Management System (EMS). The platform will enable utilities or other third parties to customize, and rapidly test and deploy, operating modes for energy storage based on the location and grid needs. A prototype of this capacity was first demonstrated in October 2013 with the first field deployment of the 1Energy algorithms platform at Duke Energy in Charlotte, North Carolina, and enabled Duke to simultaneously smooth fluctuations in active and reactive power introduced by a 1.2MW photovoltaic array.

2. Project Management

Strong project management will be essential to deliver an innovative and complex storage project by Q2 2015. PSE has the experience and resources to make this happen.

Project Phases
PSE recommends the following phased approach to balance speed with necessary due-diligence.

Phase	Tasks	Estimated Completion*
Phase I – Final Design:	Site selection, detailed engineering, definitive cost estimates, contracting, Notice to Proceed	May 2014
STAGE GATE 1		
Phase II – Development	Interconnection process, Community engagement, Permitting, system procurement.	Jan 2015
STAGE GATE 2		
Phase III – Construction, Operations & Testing	Construction, commissioning, operational testing, commercial operations, phased deployment of functionality	Jun 2015
	• Enable peak shaving and/or outage mitigation	Jan 2016
	• Enable dispatch for spinning reserve	Nov 2016
	• Enable system load/generation following	Nov 2017
*Assumes contracting with Commerce complete by end of Q1 2014		

Stage Gates
Between each phase, there is a stage gate where the project will be evaluated to determine whether to continue to the next stage. *PSE is highly confident that the project will pass all stage gates, but for due-diligence and prudence, we propose the following stage-gates.*

Stage Gate 1: Site selection and cost-benefit hurdle

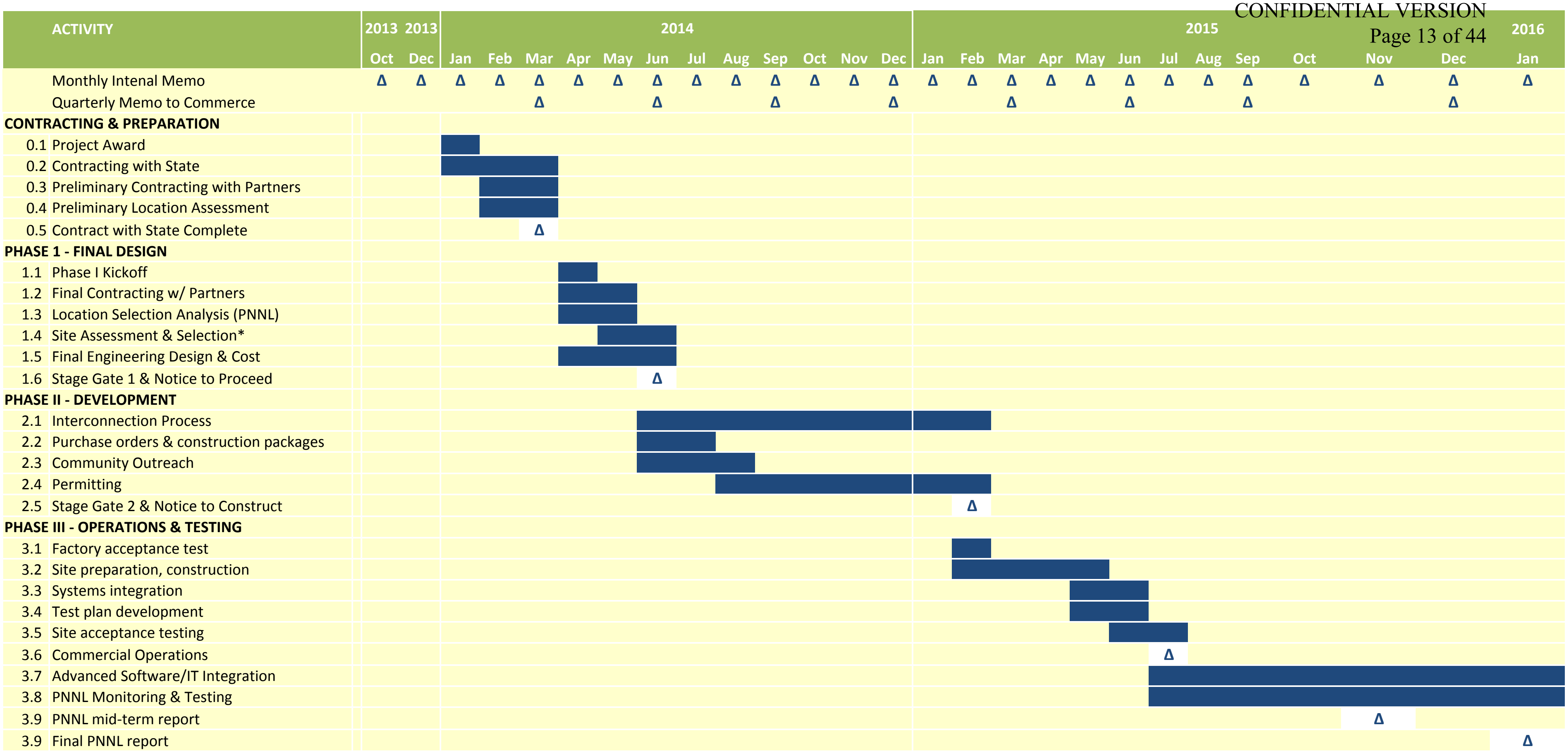
- Site: Has a location been selected and is it technically feasible?
- Cost-benefit: Has it been demonstrated that energy storage can create value for PSE and the State, such that the project remains a valuable effort to pursue? PSE and Commerce will determine if the project is cost-effective and should therefore proceed to Phase II. If doubt exists about the value proposition for moving forward, PSE and Commerce will evaluate alternatives.

Stage Gate 2: Notice to Construct

- Successful permitting, interconnection
- Supplier Performance: is PSE confident that supplier will be capable of delivering the storage system on time and budget? Are there any technical, safety, or other questions/concerns that would prevent notice to construct?
- Cost: Are there any wildly increased costs that might warrant terminating the project?

i. Schedule

PSE is prepared to move quickly to ensure that the project is substantially complete and the majority of funds spent by June 30th, 2015. This is an aggressive but feasible schedule. This schedule assumes a shortlist notification in January 2014 and contract negotiation complete by end of Q1 2014. We have included a high-level timeline below. A detailed timeline is in Appendix D.



*Site selection means the specific piece of property where the storage will be located. Location means the general area (e.g. Glacier vs. Bainbridge).

ii. Lead Times

Interconnection

A critical path item is the interconnection process. If all parties move expeditiously, the project can be operational by June 2015. PSE will begin to prepare to file the interconnection application after award notification in order to expedite the process. FERC requires that PSE follow its own interconnection process, even though it is interconnecting the storage system to its own network. PSE intends to interconnect following the FERC-jurisdictional Small Generator Interconnection Procedure (SGIP) which will allow PSE to connect and dispatch the storage system from its control center to provide ancillary services. PSE is currently working through the interconnection process with the Primus Project, giving us valuable experience to expedite the process for the 2MW proposed project.

Permitting

Storage projects are likely to hold a favorable permitting profile given that they have no emissions, do not consume water, require no fuel, and have low noise and view-shed impacts. Accordingly, they may be easier to site relative to more visible, emitting and noisy power generation projects. In addition, the storage system uses sealed battery cells capable of being transported commercially and does not require special chemical handling procedures or reporting.

Despite the above mentioned advantages, because storage is new and therefore little understood by local permitting agencies and municipalities, there is some schedule risk involved in permitting these projects. RES Americas has successfully permitted and is constructing storage projects in Ohio and Ontario, Canada, all of which were or will be fully permitted, constructed, and operating within a 12 month period.

Dependent of the site location and governing agency the following permits will likely be required.

- Land Use Permit (Conditional Use): Includes SEPA. Land use permits will likely take a year as most jurisdictions require a conditional use permit be obtained for electrical substations, and this will be similar in size and scope to a small substation.
- Clearing and Grading Permit (includes stormwater report and facilities)
- Wetland Mitigation (possible)
- Soils Report

Construction

Procurement of major equipment would take place just after completion of contract negotiations with site construction scheduled to begin in mid Q1 2015. Development and construction for this type of project is substantially less complex than for say, a large wind facility. Site construction is expected to require 5-6 months, and schedule contingency has been added to account for potential delays.

Control Room Dispatch

A critical component of this project will be connecting and dispatching the storage system from PSE's control center. PSE has recently completed major upgrades to the Alstom Energy Management System (EMS), implemented a new outage management system (OMS), and is currently adding more generating units onto automatic generation control (AGC). Several major projects are being implemented including "economic dispatch" (automatically dispatches generation at most efficient setpoints), and a "unit commitment" system that will optimize the dispatch of our generation fleet. These large projects will consume significant time and attention. The dispatch functionality of the storage system will be implemented in phases alongside these major projects.

iii. Organizational Capacity

PSE is deeply experienced with project development, most notably through our development of the 343 MW Lower Snake River wind facility – an $830 million development project that was developed and managed in-house with our partner RES Americas as the construction partner. PSE routinely delivers on major infrastructure projects in the hundreds of millions of dollars, and many smaller projects every year. PSE's typical capital expenditure budget is $500 million annually. As such, PSE has a strong project management and controls team, and the talent pool to shift resources as needed due to project challenges, or loss of key personnel, contractors, etc. PSE also has the financial resources to absorb potential cost-overruns, though we anticipate firm-price contracting for the major components of the storage system to reduce budget risk.

PSE has also completed many emerging technology and smart grid projects, including the Primus Energy Storage Project, Bainbridge Island Residential Demand Response Pilot, Wild Horse Solar Project, and several Smart Grid projects dating back to 1998. See Appendix A for full details on PSE's experience with innovative projects.

iv. Project Budget

PSE estimates a total project cost of $12,002,652, and requests $4,975,943 in matching grant from the State (41%).

This project, if selected, will be supported by three cost-share contributing members:

- **PSE**, which will contribute in-kind program management and will cover all future maintenance of the system.
- **Department of Energy, Office of Electricity**, which will contribute cash to fund 50% of the analysis and support services provided by the Pacific Northwest National Laboratory.
- **Washington Department of Commerce**, which would provide cost share for the installation and optimization of the project.

PSE developed the detailed cost estimate assuming a flat, greenfield site, no existing road and no major site challenges. This budget is based on a firm price estimate from RES Americas, and other costs were developed from consulting with internal specialists within PSE related to siting, electrical, site and civil works, installation, communication, information technology (IT), overheads, state sales taxes, and contingency funds. Groups consulted include Substation Engineering, Communication, IT Applications, the Control Center, Permitting, Project Management, and Transmission Contracts. For a detailed budget with assumptions, see Appendix B.

The summary budget is shown below. Please note that budget below does <u>not</u> include the approximately $1.1 million PSE is already spending on the Primus Project, nor is PSE requesting matching funding for this existing commitment.

TOTAL PROJECT	Grant	PSE Cash Match	PSE In-Kind Match	DOE Match	Total
Personnel	88,920	108,680	118,186	-	315,786
Contractual services	2,959,777	3,385,282	765,388	190,000	7,300,447
PNNL	190,000	-	-	190,000	380,000
1Energy	225,000	275,000	-	-	500,000
RES Americas	2,497,527	3,052,532	-	-	5,550,059
Other	47,250	57,750	765,388	-	870,388
Goods/services	369,000	451,000	-	-	820,000
Other	-	-	-	-	-
Overhead/indirect	1,442,384	1,762,913	103,649	-	3,308,946
Contingency	115,863	141,610	-	-	257,474
TOTAL	**4,975,943**	**5,849,486**	**987,223**	**190,000**	**12,002,652**
Percent of Total	**41%**	**49%**	**8%**	**2%**	**100%**
Match:Grant Ratio	**1.41**				

PHASE 1 - FINAL DESIGN	Grant	PSE Cash Match	PSE In-Kind Match	DOE Match (PNNL)	Total
Personnel			14,773		14,773
Contractual services					-
PNNL	90,000			90,000	180,000
1Energy					
RES Americas					-
Other					
Goods/services					-
Other					-
Overhead/indirect			12,956		12,956
Contingency					
TOTAL FOR PHASE 1	**90,000**	**-**	**27,729**	**90,000**	**207,729**

PHASE 2 - DEVELOPMENT	Grant	PSE Cash Match	PSE In-Kind Match	DOE Match (PNNL)	Total
Personnel	88,920	108,680	59,093		256,693
Contractual services	603,005	737,006			1,340,012
PNNL					
1Energy	56,250	68,750			125,000
RES Americas	499,505	610,506			1,110,012
Other	47,250	57,750			
Goods/services	369,000	451,000			820,000
Other					-
Overhead/indirect	1,442,384	1,762,913	51,824		3,257,121
Contingency	115,863	141,610			257,474
TOTAL FOR PHASE 2	**2,619,172**	**3,201,210**	**110,917**	**-**	**7,166,311**

PHASE 3 - CONSTRUCTION, OPERATIONS & TESTING	Grant	PSE Cash Match	PSE In-Kind Match	DOE Match (PNNL)	Total
Personnel			44,320		44,320
Contractual services	2,266,771	2,648,276			4,915,047
PNNL	100,000			100,000	200,000
1Energy	168,750	206,250			375,000
RES Americas	1,998,021	2,442,026			4,440,047
Other			765,388		
Goods/services					-
Other					-
Overhead/indirect			38,868		38,868
Contingency					-
TOTAL FOR PHASE 3	**2,266,771**	**5,296,552**	**848,576**	**100,000**	**10,013,282**
Note: $765,388 in-kind match is future cost of O&M, 15-years.					

3. Business Case

i. Market Impact

PSE's view for energy storage's future in the grid is not just for ~2MW systems in the distribution system. While there is significant opportunity for smaller scale systems, large (10+ MW) plants that could serve as an emissions-free peaking fleet, integrate renewables, improve T&D system reliability, and defer large, capital-intensive, and challenging T&D projects are especially interesting and promising.

PSE will be facing a capacity shortfall starting in 2017, and growing to approximately 100 MW by 2020. Meanwhile, integration of renewables will become more challenging with the expiration of inexpensive and highly flexible contracts for Mid-C hydro generation. The region is also facing several major transmission constraints which will require expensive (and generally unpopular) upgrades. Locating large energy storage systems in areas with both distribution system and transmission constraints, while providing peaking capacity and ancillary services, may prove to be extremely valuable. The market opportunity for energy storage may for PSE alone be in the 10's to possibly even the hundreds of MW, if it is considered proven, reliable, and a least-cost resource.

If we wish to be confident in our ability to deploy such large systems, *we must start today*. It is especially important to demonstrate how the advanced communications and IT infrastructure needed to dispatch distributed storage resources. Successfully demonstrating the deployment and business case of a grid-scale energy storage system will yield direct and indirect benefits for the Washington clean energy sector in several key ways. This project drives multiple short and long run benefits for the Washington clean energy economy.

In the short term, this project will create direct benefits to several Washington companies. Most notably, 1Energy will gain a contract to develop and implement their innovative control software. 1Energy is leveraging a key strength in Washington -- software and information technology. Beyond the financial value, having a project with a large utility will be a valuable reference for 1Energy to secure future sales. Finally, Alstom Grid, based in Redmond, is the vendor for PSE's energy management system, and may be directly involved in ensuring a smooth systems integration between 1Energy's systems and PSE's control room software.

Two other Washington-based partners engaged in the clean energy sector will benefit directly. Battery Power System (BPS) is a full-service electrical contractor based in Sumner, WA that specializes in battery backup power systems for telecom, wireless, utility, UPS, broadband, and industrial applications. BPS is the preferred subcontractor for battery installation as well as ongoing maintenance. This award will give BPS valuable project experience with grid-scale energy storage. Finally, this project maintains job opportunities for PNNL, and gives PNNL even greater experience and exposure with energy storage, furthering PNNL as a center of academic and commercial excellence for energy storage nationally.

This project maintains and expands jobs at PSE to develop, manage, and support this complex project. PSE views this as a valuable learning experience and also a project that crosses many departments and units within PSE, creating cross-functional learning and exposure for many employees.

The proposed project will create substantial direct financial benefits for the State. In the breakdown of expenditures shown below, note that 64% of the total will be spent on balance-of-plant, operations and maintenance, overheads, sales tax, and contingency. Much of this 64% will be spent in-State.

Project Budget Breakdown			
Storage System	$	4,320,059	36%
Balance of Plant	$	2,852,600	24%
PSE In-Kind (PM, O&M)	$	987,223	8%
OH, Sales Tax, Contingency	$	3,462,771	29%
PNNL	$	380,000	3%
Total	**$**	**12,002,652**	**100%**

64%

The estimated sales tax cost is $627,000, exclusive of any potential sales tax exemption incentives that the project may be eligible for.

ii. Host Utility Benefit

Energy storage has the ability to provide many benefits to utilities, and the industry is just beginning to understand and quantitatively assess the business cases analyses for storage. PSE has been studying the benefits of energy storage in collaboration with PNNL and has developed a strong understanding, as well as specific models and frameworks to evaluate the economics of storage for PSE's system. While these tools remain imperfect, they are a valuable tool to ensure that PSE is developing cost-effective projects. The following applications are highest value to PSE:

<u>Renewables Integration & Ancillary Services</u>
Wind and other variable intermittent renewables generally increase the requirements for other generation resources to balance the system. While hydroelectric generation can address much of this increased balancing requirement, the run-of-river nature of most Northwest hydro resources, combined with the obligation to meet other hydro operational objectives (e.g. flood control, irrigation, etc.) limits this capability. Additionally, during the spring runoff, conditions of excess generation from the combined hydro and wind resources, has caused curtailment of wind resources with significant financial impacts and legal conflicts.

Unlike conventional gas-fired generation, energy storage is always synchronized to the grid, can respond extremely quickly, and has no minimum load requirement; it is an ideal balancing and "ancillary service" resource. Most storage systems can move from full discharge to full charge in a matter of seconds, if not sub-seconds, providing a highly flexible resource. PSE is increasingly dispatching gas-fired combustion turbines for balancing reserves. PSE, along with many other utilities in the PNW, is experiencing a trend of increased peaker starts and more frequent operation at partial loads, which leads to increased air emissions and significant maintenance impacts on these machines. Energy storage can provide these balancing services extremely accurately, and incur no cost while standing by to provide those reserves, unlike a gas turbine dispatched at low load. Energy storage could both reduce air emissions and wear and tear on other generators and enable the integration of more variable renewable generation. PSE calculates the balancing benefit provided by storage with a proprietary production cost model that simulates PSE's generation operations with and without energy storage in the resource stack.

T&D Peak Shaving

Strategically placed storage can alleviate constraints on PSE's distribution system and defer the need for expensive and generally unpopular upgrades (e.g. new transmission lines, substations, etc.). The storage system discharges during critical load periods, effectively shaving off the peak and reducing the system constraint. The battery is then recharged during off-peak hours. The value of the deferral is calculated by comparing the NPV difference of the revenue requirement of the upgrade in question before and after deferral (e.g. 2016 vs. 2022).

Outage Mitigation

Utilities are using energy storage to keep customers energized during outages due to system incidents upstream. The duration that the energy storage device can serve the customers will vary depending on customer load. This benefit has been quantified by considering the reduction to customer outage frequency and duration using values from PSE's internal model used to select and optimize the portfolio of distribution projects undertaken each year. The outage mitigation benefit can be further leveraged by potentially incorporating existing distributed generation or a portable trailer-mounted generator to form a "microgrid" that could extend the life of the storage system and further reduce outages.

System Capacity

Energy storage can count towards PSE's total capacity resources. These systems could soon be aggregated and dispatched as a fleet. Under this scenario, ten 3 MW systems could be dispatched similar to a 30 MW generation unit. This functionality will allow distributed energy storage units to compose a meaningful component of a utility's capacity resource stack. The value of this benefit is calculated assuming that in the short run, the storage system frees up transmission to Mid-C for resale, and post 2017 when PSE is projected to have a capacity deficit, the incremental avoided cost of a new gas-fired combustion turbine at costs stated in PSE's 2013 IRP.

Cost-Benefit Analysis

PSE has developed a basic analytical model that quantifies the values listed above for energy storage at specific locations. A comprehensive model is currently being finalized by PNNL under the Primus Project. Below is a ***preliminary*** estimate of the cost-benefit of a 2MW/4.4 MWh system at located at Galcier-12. *The storage system cost is net of the requested grant amount.*

GLACIER-12 VALUATION RESULTS		
Use Case	**2014$**	**Notes**
System Capacity Value	2,217,300	Avoided incremental peaker cost
System Flexibility Value	1,806,200	Resource Integration analysis
Outage Mitigation	4,652,166	PSE iDOT Model
Storage System Cost (Rev Req.)	(6,733,400)	
TOTAL VALUE (COST)	**1,942,266**	

The project is NPV positive *with the contribution from the grant*. This valuation does not consider the risk associated with this type of new technology class. We expect that the value proposition for storage will improve markedly as the technology improves and as utilities become familiar with the technology and find ways to wring out fixed costs from integration, balance of plant, etc., and economies of scale take hold.

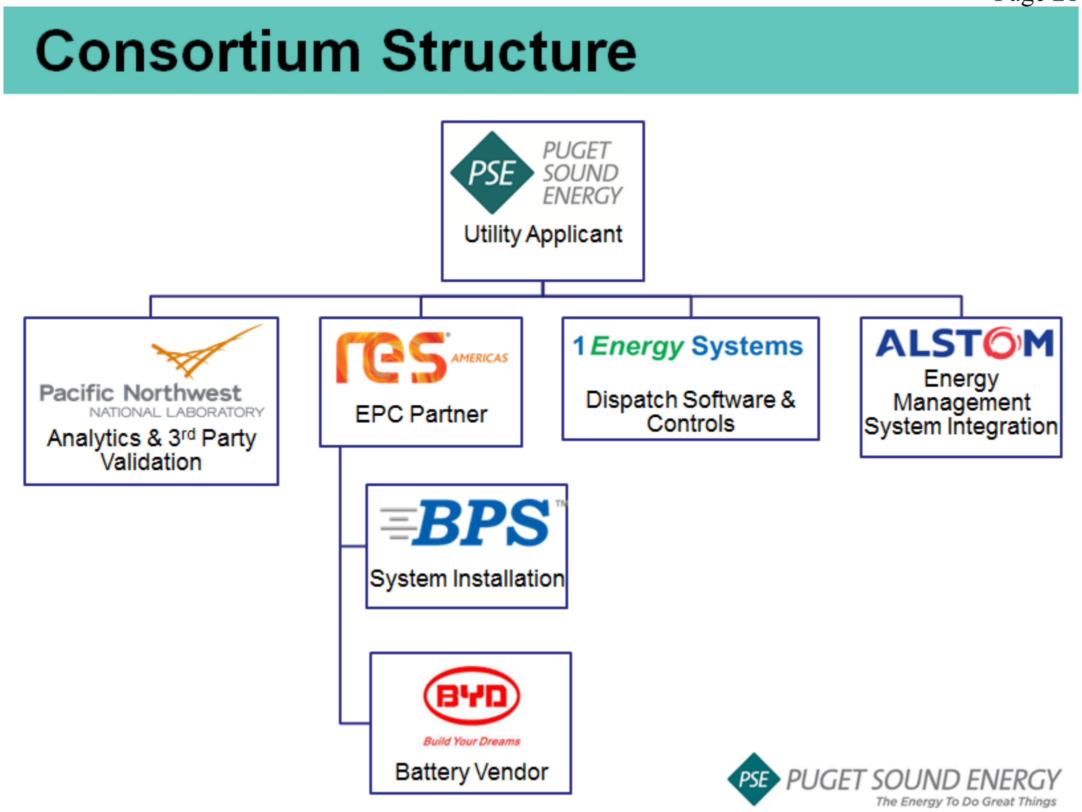
iii. Qualitative Response

Though there is significant regional interest in storage, the technology is often perceived as expensive and unproven. The results of this project will deepen the understanding of the economics and operational realities of storage on PSE's system, and the learning will be applicable to the regional utilities and BPA. If this project is successful, it will spur demand for more and larger systems not just from PSE, but from other regional utilities as well, creating further opportunities for Washington clean energy companies.

This project will create opportunities for local vendor partners to expand beyond the Washington market. This project will give local vendors like 1Energy and BPS the proof-of-concept and experience needed to pursue opportunities in other states and countries, which is especially valuable as the California energy storage mandate comes into effect.

Finally, developing the MESA standard is a significant opportunity to grow the energy storage cluster in Washington. Through the demonstration and growth of MESA, Washington can become a showcase for innovative, cost-effective deployment of energy storage systems with key components and systems supplied by our own in-state companies.

B. Project Team



Qualifications of Core Team

Patrick Leslie, Emerging Technologies Program Manager, Puget Sound Energy
Patrick has been focused nearly exclusively on energy storage for the past year and is leading the Primus Project for PSE. Prior to the Emerging Tech. role, he worked on large-scale power plant acquisition and development projects. Before PSE, Patrick was a project manager for solar and wind power company in the Bahamas. Patrick has an MBA with a concentration in finance from the Foster School at UW, and a BA from Dartmouth.

Victor Babbitt, Director, Energy Storage, RES Americas
Victor helped launch the Energy Storage group in 2010. Mr. Babbitt previously founded and served as CEO to Battery Power Systems of Seattle, Washington, the premier provider of industrial batteries and DC power solutions to the Telecom, Utility, and government markets in the Western USA. Mr. Babbitt has also served as program manager at Microsoft Advanced Technologies, and co-invented the electronic voting systems used by voters to cast ballots in more than 20 States. Mr. Babbitt holds 4 US patents and several patents pending.

Tom Melling – Vice President, Operations, 1Energy
Melling is responsible for all non-engineering aspects of the company's business, including business development, customer support and strategic partner relationships. He has more than a decade of experience as a software executive and successful startup entrepreneur. At Serengeti Law, as Vice President of Product Management, he helped lead the company from its inception in 2001 through its acquisition by Thomson Reuters in 2010. Melling served as President of the Serengeti Law division of Thomson Reuters from the merger until 2012.

Dr. Michael Kintner-Meyer, PNNL

Dr. Kintner-Meyer is leading PNNL's grid analytics for energy storage and electrification of transportation for the DOE, Office of Electricity Delivery and Energy Reliability. The thrust of the energy storage activities is to establish methodologies and advanced approach for estimating the optimal size, placement, and operational requirements of energy storage system in local and regional power grids.

Full consortium team members and their qualifications are in Appendix A.

C. Matching/Leveraging Funds

PSE and its consortium partners are providing 1.41 dollars of non-State funding per dollar of State matching funding requested. This does not include approximately $1.1 million that PSE has already committed to construct the Primus Project. See Budget section for more detail.

4. CONTACT PERSON

Patrick Leslie, Emerging Technologies Program Manager
patrick.leslie@pse.com | office: (425) 457-5739 | mobile: (207) 400-2452

5. FISCAL YEAR

PSE's fiscal year runs on a calendar year basis, from January 1 to December 31.

6. OTHER DOCUMENTS

- Appendix A – Detailed Consortium Qualifications & Team Member Biographies
- Appendix B – Detailed Cost Estimate
- Appendix C – Sample Detailed System Layout
- Appendix D – Detailed Project Schedule
- Appendix E – Technology Selection Considerations
- Appendix F – PSE Annual Report 2012
- Appendix G – MESA White Paper

Puget Sound Energy
Washington State's oldest local energy utility, Puget Sound Energy serves 1.1 million electric customers and more than 750,000 natural gas customers in 11 counties. The Emerging Technologies group (approximately three full time employees) has been investigating energy storage since 2008. The group has visited several energy storage providers manufacturing facilities and works closely with the Renewable Resource Integration team (three full time employees) to evaluate the cost-benefit of various storage technologies for wind integration. We have built hourly system simulation models to evaluate previous storage proposals and our modeling continues to improve. In our last RFP we received two large-scale battery energy storage proposals from large developers. PSE has studied energy storage in detail with PNNL and is developing the 0.5 MW Primus Project to demonstrate an innovative zinc-bromide flow battery.

Experience with New Energy Technologies

Wind Generation
Puget Sound Energy has been a leader in developing wind power. PSE is the Pacific Northwest's largest utility producer of renewable energy. We own and operate three large wind farms in Washington: the Wild Horse, Hopkins Ridge, and the Lower Snake River Wind Facility. Our three current wind facilities produce up to 773 megawatts of electricity, enough to meet the power demands of approximately 230,000 homes, making us the second-largest utility generator of wind power in the U.S.

Wild Horse Solar Demonstration Project
In 2007, PSE committed $4.5 million to develop the 500 kW Wild Horse solar facility -- the largest utility-scale solar project in the Pacific Northwest, which provides for much of Wild Horse Wind Facility's on-site energy needs.

Bainbridge Island Demand Response Pilot Project
In 2007 we launched a residential demand response pilot project with in conjunction with the Bainbridge Island Community Energy Task Force. The pilot was designed to test the flexibility of the electrical system on the island with equipment installed at up to 700 homes that can automatically reduce residential customer electrical space and water heating use at peak usage times.

Smart Grid Initiatives
In 1998, when Puget Sound Energy (PSE) began implementing automated meter reading (AMR), few were talking about "smart grid." At that time, PSE recognized that AMR technology would improve the way we operated and deliver greater value to our customers. Similarly, when PSE began building an automated transmission system over three decades ago, it was driven by the need for enhanced real-time monitoring and system visibility for our operators as well as improved reliability. Today, this self-healing transmission system is considered a smart grid component.

Currently, PSE is actively engaged in several projects that improve system reliability and provide more information and choice to customers.
For example:

- Our automated meters collect energy usage information that enables customers to check and manage their daily energy usage via the Internet;
- Automated transmission and distribution (T&D) systems improve service reliability; and

- New or upgraded back-end systems (EMS, OMS, GIS, etc.) are building the foundational core of smart grid enablement making a major improvement in data reliability and transport.
- PSE has implemented a new customer information system (CIS), outage management system (OMS), and geospatial information system (GIS), and upgrading the data transport capability of our operations network. With these systems, PSE has the foundational technology to explore new smart grid applications like demand response and TOU pricing.

PSE Team

Jennifer Tada, Director of System Planning

Jennifer is responsible for the development of the PSE's natural gas and electric T&D infrastructure plans, and gas and electric Standards. Since joining Puget Sound Energy in 1982, Jennifer has held a broad range of engineering and operations positions including project management, budgeting, and construction; as well as positions serving the customer, including energy efficiency, builder services and business development. Jennifer has a BS in civil engineering from Stanford University and a master's degree in construction engineering and management from the University of Washington.

Patrick Leslie, Emerging Technologies Program Manager

Patrick evaluates technologies such as energy storage, electric and natural gas vehicles, fuel cells, solar, etc., and seeks opportunities for pilot projects and innovative services. Prior to the Emerging Tech. role, he worked on power plant acquisition and development projects. Before PSE, Patrick was a project manager for solar and wind power company in the Bahamas. Patrick has an MBA with a concentration in finance from the Foster School at UW, and a BA from Dartmouth.

Nathan Adams, Manager of Strategic Initiatives

Nathan has over 13 years of experience in the energy industry spanning from power generation valuation, acquisition and development to energy efficiency program evaluation. Prior to his work at PSE, Nathan worked for Weyerhaeuser Corp. managing mergers and acquisitions and major energy projects, and at E Source where he consulted to various energy companies on energy pricing and asset valuation. He holds a BA from the University of Vermont and an MBA from the Ross School of Business at the University of Michigan.

Charles Daitch, Energy Resource Analyst

As part of the Strategic Initiatives team at PSE, Charley works to develop energy infrastructure projects necessary to meet the region's changing energy landscape. Charley's background in engineering, combined with experience modeling financial impacts of new projects at PSE, brings a balanced perspective to assessing new technologies. Charley holds a B. Eng. in Mechanical Engineering with concentration in Controls and Energy Systems from Cornell University.

1Energy Systems

1 Energy Systems provides software for grid-connected energy storage systems (ESS) and other electric energy assets. Our products enable clean energy resources, such as wind and solar power, and solve an important problem for scaling up energy storage at electric utilities. The 1Energy platform, based on MESA technologies, creates scalable, modular energy storage systems from industry-standard batteries, power conversion and software. We partner with electric utility customers and technology suppliers. Our technology partners deliver MESA-compliant hardware: battery energy storage units (ESU), power conversion systems (PCS), and other components. We deliver MESA-compliant software.

David Kaplan – CEO

Kaplan is CEO and founder of 1Energy Systems, responsible for company leadership, strategy and execution. In 2006, he founded V2Green to deliver the first technology platform connecting electric vehicles with the power grid. V2Green achieved national recognition as a leading clean tech company and was acquired by Gridpoint in 2008. Subsequently, he served as Grid Technologist for Snohomish County PUD, advising the General Manager and staff on new technology initiatives. Kaplan has over 30 years of technology experience in fields such as database management, web services, and radio-frequency identification (RFID). At Microsoft, he helped to create SQL Server, Access, and the company's internet services platform.

Tom Melling – Vice President, Operations

Melling is responsible for all non-engineering aspects of the company's business, including business development, customer support and strategic partner relationships. He has more than a decade of experience as a software executive and successful startup entrepreneur. At Serengeti Law, as Vice President of Product Management, he helped lead the company from its inception in 2001 through its acquisition by Thomson Reuters in 2010. Melling served as President of the Serengeti Law division of Thomson Reuters from the merger until 2012.

Andrew Miller – Vice President, Engineering

Miller is responsible for all aspects of engineering and product development. He has over 20 years of software and services development experience with database management systems, web services, service-oriented architectures (SOA), and software as a service (SaaS). At Microsoft, Miller delivered multiple versions of Microsoft Access, helped shape the user experience in Microsoft SharePoint, and led the global engineering team responsible for Microsoft CRM and Microsoft CRM Online.

Jason Yedinak, P.E. – Power Systems Engineer

Yedinak specializes in renewable energy interconnection and operational integration into power systems. He brings power systems expertise including electrical and communication design, control system modeling, algorithm development, control room integration, project management and grid interconnection. Previously a Senior Engineer at Puget Sound Energy in Bellevue, Washington, Mr. Yedinak spent seven years developing and integrating large scale wind, gas, and hydroelectric generating facilities.

RES Americas

RES Americas will be providing the engineering, procurement, and construction services as part of the PSE consortium. RES Americas is a renewable energy development, engineering, construction, and operations company active in wind, solar, transmission, and energy storage. RES Americas has developed and/or constructed over 6,500MW of renewable wind and solar projects, including over 10% of all USA wind energy. RES Americas parent, RES Group, is active in renewable energy in Europe, Africa, Australia, and parts of Asia, including offshore wind and biomass projects. RES Americas has extensive experience with PSE having constructed more than 770 MWs of wind energy plants for PSE. When the 267MW Tucannon River project is completed, RES and PSE will have completed 1+ gigawatt of renewable energy work together in the state of Washington. Along with investment into Washington’s clean energy sector, this work has created both temporary construction jobs and permanent operations jobs for the state of Washington.

RES Americas has moved strongly into energy storage and is involved in several projects including two 4MW/2.6MWh battery projects that are currently under construction. These projects will be used to supply frequency regulation to the grid in Ohio, PJM balancing area, and Ontario, Canada in the IESO balancing area.

RES Energy Storage Experience

Completed:

- **New Mexico/Texas Border** – Integrated grid-scale wind energy and SCADA with the local utility for the world's first non-fuel Compressed Air Energy Storage (CAES) plant, located in Texas, capable of storing 500MWh of energy. The project is owned by General Compression.

Under Construction:

- **Columbus, OH –** RES has developed, fully engineered, procured, and are now finalizing construction of a 4MW/2.6MWh battery-based project near Columbus, Ohio to provide merchant Frequency Regulation in the PJM market. RES believes this to be a unique, standalone battery system. The system is not behind the meter of another facility, did not receive any grant funding and will be connected to the distribution system. RES has developed its own controller to optimize revenue while managing battery state of charge and degradation. The OH project will be owned and operated by Battery Utility of Ohio, LLC a direct subsidiary of Renewable Energy Systems Americas. Commercial operation is scheduled for May 2014.

- **Ontario, Canada** – RES is constructing a 4MW/2.6MWh battery-based project to provide Frequency Regulation for the Ontario grid operator IESO who plans to use this pilot-project experience to design a market for storage-based regulation services. Engineering and procurement for this project is complete and commercial operation is expected in May 2014. The project was awarded to RES through a public RFP process after scoring highest for Technical expertise. The project will be owned by RES Americas.

Under Development:

- **PJM –** RES is currently developing an additional 40MWs of projects in PJM to participate in the merchant Frequency Regulation Market. The projects are currently in the PJM interconnection queue with three different local distribution utilities; commercial operation is expected in 2015.

- **Other Development –** RES is also actively developing projects in response to utility RFPs for energy storage as well as market applications such as upgrade deferral, energy storage peaking plants, and mitigation of distributed generation issues on distribution circuits.

RES Americas has a well-established safety culture and documented safety policies that are contained within the RES Safety Management System (SMS). The comprehensive SMS addresses all aspects of work undertaken by RES Americas and all of its subcontractors and consultants. The RES SMS has been written to meet or exceed federal OSHA requirements. RES Americas' parent company, RES Ltd., is ISO 9001 certified and relevant quality management systems (QMS) practices are used company wide, including on all RES Americas Construction projects.

RES Team

Dr. Andrew Oliver, Senior VP, Technical & Commercial Analysis

Dr. Oliver has been with RES for 16 years and has been directly involved in the siting of over 2,500MW of operational wind plants in the U.S. and Canada. Andy has a strong understanding of North American electricity market design and is responsible for technology implementation within RES. In 2009 Andy formed the Energy Storage division within RES and is now responsible for RES' worldwide strategic entry into this market. Andy holds a Bachelor's degree in Aeronautical Engineering and a PhD in Wind Turbine Aerodynamics from City University, London.

Mr. Victor Babbitt, Director of Energy Storage

Victor helped launch the Energy Storage group in 2010. Mr. Babbitt previously founded and served as CEO to Battery Power Systems of Seattle, Washington, the premier provider of industrial batteries and DC power solutions to the Telecom, Utility, and government markets in the Western USA. Mr. Babbitt has also served as program manager at Microsoft Advanced Technologies, and co-invented the electronic voting systems used by voters to cast ballots in more than 20 States. Mr. Babbitt holds 4 US patents and several patents pending.

Battery Power Systems

Battery Power Systems, Inc. (BPS) is a full-service electrical contractor specializing in backup power systems for telecom, wireless, utility, UPS, broadband, and industrial applications. Originally founded in the Seattle area as a DC Power Services company in 1984, BPS has expanded over the years to include AC electrical and generator divisions. Today, BPS is a licensed electrical contractor in Washington, Oregon & Idaho, making BPS the Northwest leader in critical power applications. BPS has a solid reputation of assuring projects are on time and on budget.

James C. Clifford, Chief Operating Office, Principal

Mr. Clifford is consistently striving for innovative ways to serve the changing needs of our customers. In Mr. Clifford‘s 29 years of experience in the DC power industry, he has encountered extraordinary changes in the demand for reliable power as demonstrated by the growth of the telephony, utility, and UPS industries. His wide array of experience includes operational management, sales and marketing, technical services and project management. Mr. Clifford holds a master electrician license in Washington State and also holds administrator licenses in Washington, Oregon, and California.

Pacific Northwest National Laboratories (PNNL)

PNNL, located in Richland, WA, is a multi-program U.S. Department of Energy Laboratory operated by Battelle Memorial Institute since 1965. As a part of its mission for the US Department of Energy, the over 4,500 staff at PNNL has conducted research for the U.S. government and industry for more than 45 years.
PNNL has an extremely diverse set of scientific and technical skills ranging from fundamental sciences, to environmental, power generation, nuclear, biofuels, etc. Focusing on power systems, PNNL has broad expertise and experience in systems engineering with significant experience in renewables integration, energy storage and transmission planning. PNNL is applying our grid integration capabilities to pave the road for a wider penetration of renewables into national energy production without compromising reliability of power supply. Activities and capabilities include renewable integration tools & methods, power system transmission planning (power flow, stability, reliability, production cost optimization, etc.), operations (control performance criteria, quality, regulation, impacts of intermittent resources, etc.), and analysis. PNNL was a seminal force in establishment of smart grid architectures and analysis tools (e.g. GridLab-D), led the first smart grid field test (the Olympic Peninsula Study), and, as Battelle Pacific Northwest Division, leads the largest smart grid demonstration project in the U.S., the Pacific Northwest Smart Grid Demonstration Project.

PNNL conducts a wide range of energy storage research including technology development relying on fundamental scientific understanding and focused materials science and engineering. These capabilities are focused on redox flow batteries, sodium-based batteries, next-generation lithium-based and magnesium-based batteries. PNNL also develops analytic tools and conducts studies to guide cost reduction and realization of the full suite of benefits storage can provide in the electric enterprise. PNNL has conducted a number of studies examining the applications and market potential for grid energy storage. PNNL has completed, and will soon publish, a large DOE study evaluating the potential for energy storage for providing arbitrage and balancing services in various regions of the country including the Pacific Northwest, under assumptions of increased renewable deployments. Under BPA Technology Innovation projects with Primus Power and Puget Sound Energy, PNNL completed a value analysis that included evaluation of optimized multi-value grid service for storage at the distribution level; and with Powin Energy, Energy Northwest, and City of Richland, development of control strategies for firming wind power schedules, and providing substation reliability services. Analyses of storage for application in support of high penetrations of residential PV in Hawaii have also been conducted, utilizing GridLab-D (a tool for design and analysis of the smart grid). Finally, PNNL is active in development of performance test protocols for grid energy storage.

Dr. Michael Kintner-Meyer
Dr. Kintner-Meyer is leading PNNL's grid analytics for energy storage and electrification of transportation for the DOE, Office of Electricity Delivery and Energy Reliability. The thrust of the energy storage activities is to establish methodologies and advanced approach for estimating the optimal size, placement, and operational requirements of energy storage system in local and regional power grids.

Mr. Patrick Balducci
Mr. Balducci is a Senior Economist at the Pacific Northwest National Laboratory where he has been employed since 2001. His areas of expertise include benefit-cost and return on investment analysis, economic impact analysis, economic modeling, environmental valuation, energy economics and utility financial analysis. Patrick has led economics analysis and modeling for recent energy storage valuation studies for the U.S. Department of Energy and for the BPA co-funded project led by Primus Power with Puget Sound Energy on grid energy storage.

Dr. Chunlian Jin
Dr. Chunlian Jin is an Electrical Engineer. She has served as a Primary Investigator or Key Contributor for multiple energy storage projects, including the PNNL Energy Storage sizing tool development, BPA/Primus/PSE/PNNL Zinc-Bromide Battery Storage demonstration project, BPA/Powin/Energy Northwest/City of Richland/PNNL Li-ion Battery Storage demonstration project, Energy Storage National Assessment, PNNL Energy Storage Regional Case Study for the NWPP, and energy storage controller project.

Alstom Grid
Alstom is a global leader in the world of power generation, power transmission and rail infrastructure and sets the benchmark for innovative and environmentally friendly technologies. Alstom builds the fastest train and the highest capacity automated metro in the world, provides turnkey integrated power plant solutions and associated services for a wide variety of energy sources, including hydro, nuclear, gas, coal and wind, and it offers a wide range of solutions for power transmission, with a focus on smart grids. The Group employs 93,000 people in around 100 countries. It had sales of over €20 billion and booked close to €24 billion in orders in 2012/13.

David I-Ho. Sun, Chief Scientist, Network Management Solutions (NMS)
David is currently the Chief Scientist for Network Management Solutions, and has served many roles within Alstom from Network Management to Power Automation and Controls, and Manager of Electricity Market Applications. David has a Ph.D. in Major in Power Systems and Minor in Operations Research, University of Texas at Arlington

Appendix B – Detailed Cost Estimate

Please note that the detailed budget included here estimates the cost for the storage system, and does not include the cost for PNNL, nor PSE's in-kind contributions.

COST ESTIMATE

Assumptions		
System Size (nominal)	2.00	MW
System size (peak)	2.00	MW
Energy (at peak discharge)	4.00	MWh
40' Containers	4	
Contingency	15%	

Results	Total	$/kW-peak	%	$/kWh
Total Project Cost	$ 10,635,430	$ 5,318	100%	2,659

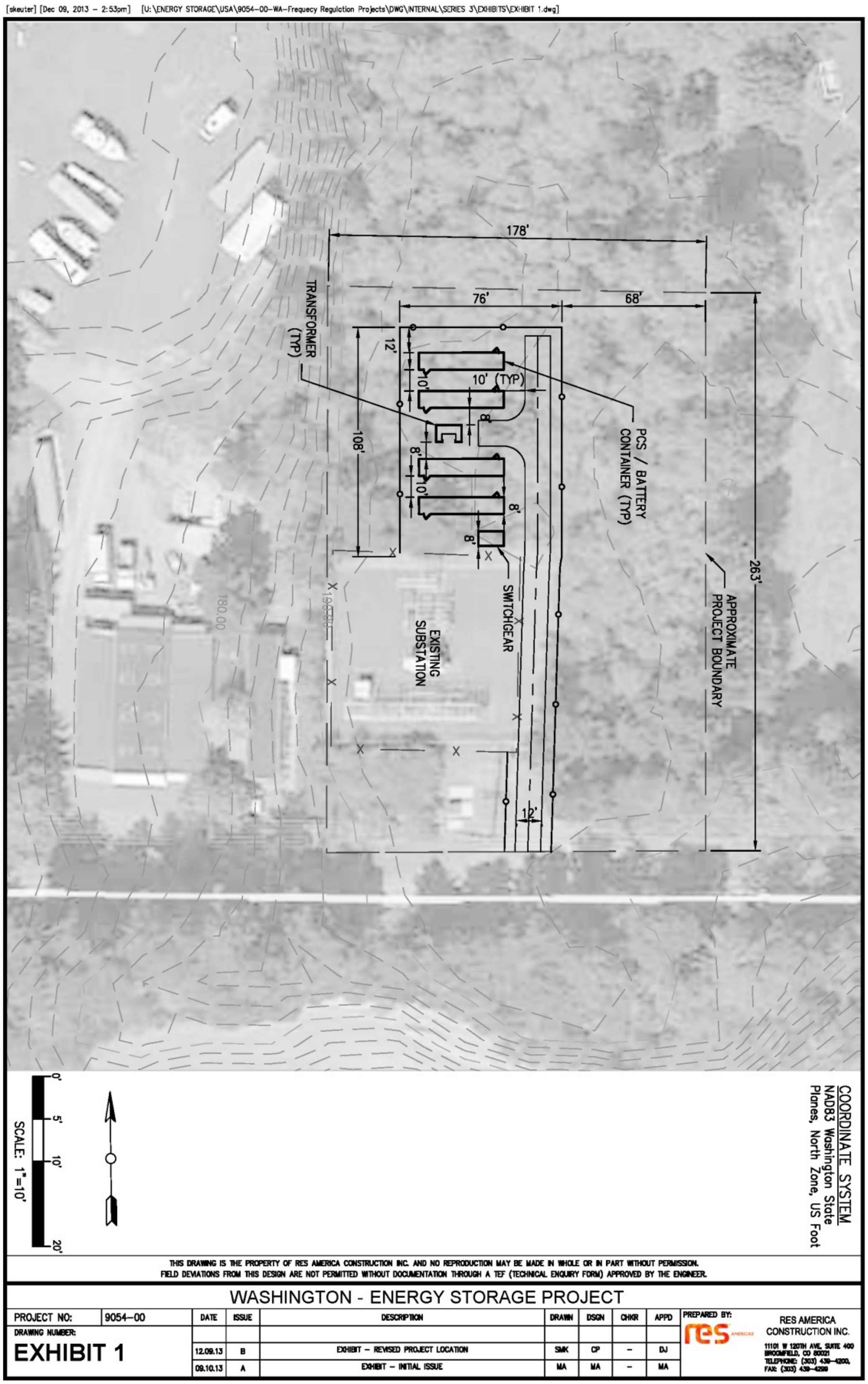
Category	Party	Qty.	Units	Unit cost	Total cost	% of Total	Class	Notes
EPC Contract								
RES EPC Contract	RES	1.00			$ 5,550,059	52.2%	Contract-RES	Firm
Indirects		*Rate*		*Applicable Total*				
Construction OH		17%		$ 5,550,059	$ 943,510	8.9%	OH	
WA Sales Tax		9.8%		$ 5,550,059	$ 543,906	5.1%	OH	
SubTotal Indirects					$ 1,487,416			
CATEGORY TOTAL					**$ 7,037,475**	**66.2%**		
Siting, Permiting, Interconnection								
Land	PSE				$ 300,000	2.8%	Goods	Assume land acquisition. Depends highly on site.
Environmental: Permitting & soils study	PSE	1	Study	$ 65,000	$ 65,000	0.6%	Contract-Other	Per Substation Engineering
Building Permit	RES	1		$ -	$ -	0.0%	Contract-Other	
Interconnection: Feasibility Study	PSE	1	Study	$ 2,500	$ 2,500	0.0%	Personnel	Standard rate
Interconnection: System Impact Study	PSE	1	Study	$ 10,000	$ 10,000	0.1%	Personnel	Standard rate
Interconnection: Facilities Study	PSE	1	Study	$ 12,000	$ 12,000	0.1%	Personnel	Standard rate
Indirects		*Rate*		*Applicable Total*				
Construction OH		17%		$ 389,500	$ 66,215	0.6%	OH	
Contingency	PSE	15%		$ 455,715	$ 68,357	0.6%	Contingency	
SubTotal Indirects					$ 134,572			
CATEGORY TOTAL					**$ 524,072**	**4.9%**		
Electrical								
Engineering Studies: Protection, Elec., Comm	PSE	5	weeks	$ 10,000	$ 50,000	0.5%	Personnel	
Distribution Line Ext.	PSE	0.50	Miles	$ 300,000	$ 150,000	1.4%	Goods	Site dependent
Electrical peripherals								
Transformer	RES	0	MVa	$ 33,333	$ -	0.0%	Goods	
Wire, conduit	RES	0	Boxes	$ 1,000	$ -	0.0%	Goods	
Switches	RES	0		$ 75,000	$ -	0.0%	Goods	
Breakers	RES	0		$ 75,000	$ -	0.0%	Goods	
Other	RES	0		$ 50,000	$ -	0.0%	Goods	
Vaults, Conduits	RES	0		$ 25,000	$ -	0.0%	Goods	
SCADA Recloser	PSE	2		$ 85,000	$ 170,000	1.6%	Goods	Per Communications group
Indirects		*Rate*		*Applicable Total*				
Engineering Labor OH		184%		$ 50,000	$ 91,800	0.9%	OH	
Materials Stored OH		9%		$ -	$ -	0.0%	OH	
WA Sales Tax		9.8%		$ 170,000	$ 16,660	0.2%	OH	
Construction OH		17%		$ 478,460	$ 81,338	0.8%	OH	
Contingency	PSE			$ 559,798	$ 83,970	0.8%	Contingency	
SubTotal Indirects					$ 273,768			
CATEGORY TOTAL					**$ 643,768**	**6.1%**		
Site/Civil								
Civil Engineering Labor	RES	-	hours	$ 50	$ -	0.0%	Personnel	
Civil Engineering Labor	PSE	150	hours	$ 50	$ 7,500	0.1%	Personnel	
Consultant Reports/Design	PSE	1.0	acre	$ 40,000	$ 40,000	0.4%	Contract-Other	Includes soils study
Clearing and grading	RES	-	acre	$ 120,000	$ -	0.0%	Goods	
Site preparation	RES	-	acre	$ 320,000	$ -	0.0%	Goods	

Category	Party	Qty.	Units	Unit cost	Total cost	% of Total	Class	Notes
Drainage	RES	-	acre	$ 100,000	$ -	0.0%	Goods	
Fencing	RES	-	acre	$ 50,000	$ -	0.0%	Goods	
Landscaping	PSE	0.5	acre	$ 100,000	$ 50,000	0.5%	Goods	Highly dependent on final site
Access Road Surfacing	RES	-	acre	$ 40,000	$ -	0.0%	Goods	
Electrical Grounding	RES	-	acre	$ 20,000	$ -	0.0%	Goods	
Security	RES	-	acre	$ 65,000	$ -	0.0%	Goods	
Indirects		*Rate*		*Applicable Total*				
Engineering Labor OH		184%		$ 7,500	$ 13,770	0.1%	OH	
Materials Stored OH		9%			$ -	0.0%	OH	
WA Sales Tax		9.8%		$ 90,000	$ 8,820	0.1%	OH	
Construction OH		17%		$ 120,090	$ 20,415	0.2%	OH	
Contingency	PSE	15%		$ 140,505	$ 21,076	0.2%	Contingency	
SubTotal Indirects					$ 64,081			
CATEGORY TOTAL					**$ 161,581**	**1.5%**		
Installation								
Freight	RES	4	40' container	$ -	$ -	0.0%	Goods	
Installation labor	RES	0	man-hrs	$ 100	$ -	0.0%	Personnel	
Equipment	RES	0		$ 150,000	$ -	0.0%	Goods	
Indirects		*Rate*		*Applicable Total*				
Crew Labor OH		128%		$ -	$ -	0.0%	OH	
Construction OH		17%		$ -	$ -	0.0%	OH	
WA Sales Tax		9.8%		$ -	$ -	0.0%	OH	
Contingency		15%		$ -	$ -	0.0%	OH	
SubTotal Indirects					$ -			
CATEGORY TOTAL					**$ -**	**0.0%**		
Communications								
Equipment & Housing	RES	1	all equip	$ -	$ -	0.0%	Goods	
IT Engineering Labor	PSE	200	hours	$ 50	$ 10,000	0.1%	Personnel	
Comms/Controls for Nooksack Generator					$ 150,000	1.4%	Goods	
Indirects		*Rate*		*Applicable Total*				
Engineering Labor OH		184%		$ 10,000	$ 18,360	0.2%	OH	
Materials Stored OH		9%		$ -	$ -	0.0%	OH	
WA Sales Tax		9.8%		$ 150,000	$ 14,700	0.1%	OH	
Construction OH		17%		$ 193,060	$ 32,820	0.3%	OH	
Contingency	PSE	15%		$ 225,880	$ 33,882	0.3%	Contingency	
SubTotal Indirects					$ 99,762			
CATEGORY TOTAL					**$ 259,762**	**2.4%**		
IT/Software								
Software - 1Energy	PSE	1		$ 500,000	$ 500,000	4.7%	Contract-1E	Per 1E proposal
Alstom	PSE	1		$ -	$ -	0.0%	Contract-Other	TBD during Phase II
PSE IT Labor	PSE	960	hours	$ 50	$ 48,000	0.5%	Personnel	50% FTE for 1 years
Indirects		*Rate*		*Applicable Total*				
Engineering Labor OH		184%		$ 48,000	$ 88,128		OH	
WA Sales Tax		9.8%		$ 500,000	$ 49,000		OH	
Construction OH		17%		$ 685,128	$ 116,472		OH	
Contingency	PSE	5%		$ 801,600	$ 40,079.99	0.4%	Contingency	
SubTotal Indirects					$ 293,680			
CATEGORY TOTAL					**$ 841,680**			
Other								
Construction PM	PSE	1152	hours	$ 50	$ 57,600	0.5%	Personnel	40% FTE for 1 years
				$ -	$ -	0.0%		

Category	Party	Qty.	Units	Unit cost	Total cost	% of Total	Class	Notes
Indirects		*Rate*		*Applicable Total*				
Engineering Labor OH		184%			$ -	0.0%	OH	
WA Sales Tax		9.8%			$ -	0.0%	OH	
Construction OH		17%		$ 57,600	$ 9,792	0.1%	OH	
Contingency	PSE	15%		$ 67,392	$ 10,109	0.1%	Contingency	
SubTotal Indirects					$ 19,901			
CATEGORY TOTAL					**$ 77,501**			
TOTAL DIRECT EXPENSE					**$ 7,172,659**	**67.4%**		
TOTAL INDIRECT EXPENSE (NO AFUDC)					**$ 2,373,180**	**22.3%**		
AFUDC					**$ 1,089,591**	**10.2%**		
TOTAL PROJECT COST					**$ 10,635,430**	**100.0%**		

Appendix C - Sample Detailed System Layout

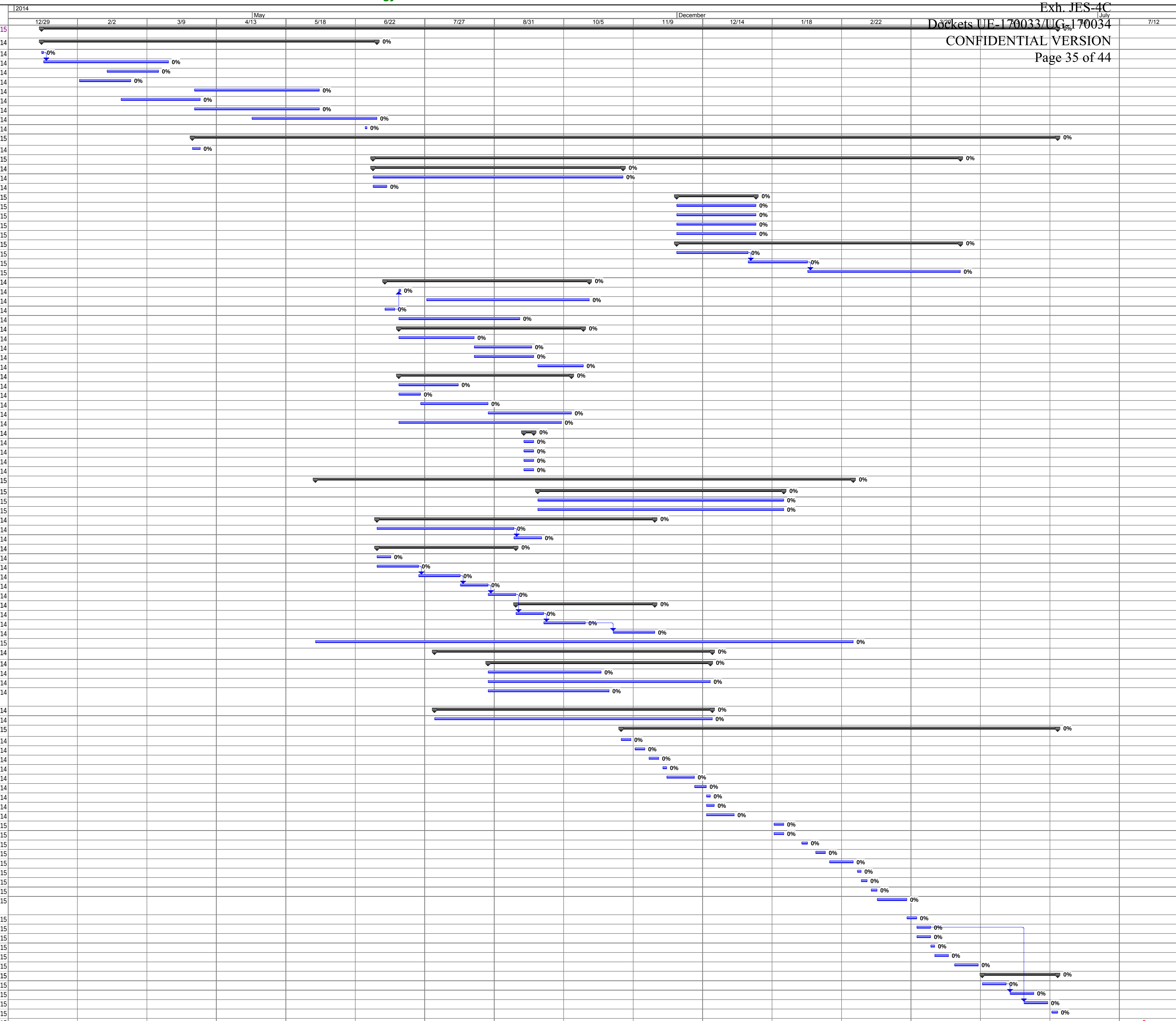
This is an example layout for illustrative purposes to show the system size relative to an existing 25MW substation.



Appendix D - Detailed Project Schedule

PSE Clean Energy Fund

ID	Task Name	Duration	Start	Finish
1	**PSE Draft-FreqReg Schedule**	366 days?	Wed 1/15/14	Wed 6/10/15
2	**Project Award and Site Assessment**	121 days?	Wed 1/15/14	Wed 7/2/14
3	Project Award	1 day?	Wed 1/15/14	Wed 1/15/14
4	Contracting with State	45 days	Thu 1/16/14	Wed 3/19/14
5	Preliminary Contracting with Partner	20 days	Mon 2/17/14	Fri 3/14/14
6	Preliminary Location Assessment	20 days	Mon 2/3/14	Fri 2/28/14
7	Final Contracting w/ Partner	45 days	Wed 4/2/14	Tue 6/3/14
8	Preliminary Engineer to Support Site Selection	30 days?	Mon 2/24/14	Fri 4/4/14
9	Location Selection Analysis (PNNL)	45 days	Wed 4/2/14	Tue 6/3/14
10	Site Prospecting & Selection	45 days	Thu 5/1/14	Wed 7/2/14
11	NTP	1 day	Fri 6/27/14	Fri 6/27/14
12	**Engineering**	312 days?	Tue 4/1/14	Wed 6/10/15
13	Kick Off	4 days	Tue 4/1/14	Fri 4/4/14
14	**Project Design/Engineering**	212 days?	Tue 7/1/14	Wed 4/22/15
15	**System General Design**	90 days	Tue 7/1/14	Mon 11/3/14
16	System Drawings Design	90 days	Tue 7/1/14	Mon 11/3/14
17	Site Plan	5 days	Tue 7/1/14	Mon 7/7/14
18	**ESS Design**	30 days	Mon 12/1/14	Fri 1/9/15
19	Container Design	30 days	Mon 12/1/14	Fri 1/9/15
20	Battery Design	30 days	Mon 12/1/14	Fri 1/9/15
21	Communication, Distribution Cabinet, Power Distribution Cabinet	30 days	Mon 12/1/14	Fri 1/9/15
22	Fire Protection System Design	30 days	Mon 12/1/14	Fri 1/9/15
23	**Monitoring/Control System Design**	103 days	Mon 12/1/14	Wed 4/22/15
24	Monitoring System Proposal Design	26 days	Mon 12/1/14	Mon 1/5/15
25	Monitoring System Development	22 days	Tue 1/6/15	Wed 2/4/15
26	Monitoring system Debugging and Metering	55 days	Thu 2/5/15	Wed 4/22/15
27	**Survey Site**	75 days?	Mon 7/7/14	Fri 10/17/14
28	Underground Utility Locates	1 day?	Mon 7/14/14	Mon 7/14/14
29	ALTA	60 days	Mon 7/28/14	Fri 10/17/14
30	Site Plan (Final)	5 days	Mon 7/7/14	Fri 7/11/14
31	Geotechnical Works - Bearing Capacities, Resistivity Testing	45 days	Mon 7/14/14	Fri 9/12/14
32	**Civil**	67 days?	Mon 7/14/14	Tue 10/14/14
33	Civil Site Layout 100%	28 days?	Mon 7/14/14	Wed 8/20/14
34	Erosion Control	21 days?	Thu 8/21/14	Thu 9/18/14
35	Foundation Design 100%	22 days?	Thu 8/21/14	Fri 9/19/14
36	IFC Drawings	17 days?	Mon 9/22/14	Tue 10/14/14
37	**Electrical**	63 days?	Mon 7/14/14	Wed 10/8/14
38	Electrical Specification	22 days?	Mon 7/14/14	Tue 8/12/14
39	Electrical Layout	9 days?	Mon 7/14/14	Thu 7/24/14
40	Electrical Design	24 days?	Fri 7/25/14	Wed 8/27/14
41	Electrical IFC Drawings	30 days	Thu 8/28/14	Wed 10/8/14
42	**SCADA Design**	60 days	Mon 7/14/14	Fri 10/3/14
43	**Structural**	5 days	Mon 9/15/14	Fri 9/19/14
44	Foundations	5 days	Mon 9/15/14	Fri 9/19/14
45	Battery Container	5 days	Mon 9/15/14	Fri 9/19/14
46	Pad Mount Transformer	5 days	Mon 9/15/14	Fri 9/19/14
47	Switch Gear	5 days	Mon 9/15/14	Fri 9/19/14
48	**Permitting and Studies**	195 days	Mon 6/2/14	Fri 2/27/15
49	**Construction Permits (RES)**	90 days	Mon 9/22/14	Fri 1/23/15
50	Municipal, County, Building Permits	90 days	Mon 9/22/14	Fri 1/23/15
51	Municipal, County Road Permits	90 days	Mon 9/22/14	Fri 1/23/15
52	**Environmental and Wldlife Studies**	100 days	Thu 7/3/14	Wed 11/19/14
53	Avian & Bat Protection Plan (ABPP/BBCS) - Draft	49 days	Thu 7/3/14	Tue 9/9/14
54	BBCS to Commerce-DNR-USFWS for review	10 days	Wed 9/10/14	Tue 9/23/14
55	**Wetlands and Floodplains**	50 days	Thu 7/3/14	Wed 9/10/14
56	Wetland Desktop Review	5 days	Thu 7/3/14	Wed 7/9/14
57	Wetland Delineation	15 days	Thu 7/3/14	Wed 7/23/14
58	Wetland Report	15 days	Thu 7/24/14	Wed 8/13/14
59	Joint Permit Package/Mitigation Plan Prep	10 days	Thu 8/14/14	Wed 8/27/14
60	Joint Permit Application Submittal	10 days	Thu 8/28/14	Wed 9/10/14
61	**Mitigation Plan Review/Approval (if required)**	50 days	Thu 9/11/14	Wed 11/19/14
62	Completeness Review	10 days	Thu 9/11/14	Wed 9/24/14
63	Public Notice - 20-day Public Comment Period	15 days	Thu 9/25/14	Wed 10/15/14
64	Office/Field Review - after comments	15 days	Thu 10/30/14	Wed 11/19/14
65	**Interconection Procedures**	195 days	Mon 6/2/14	Fri 2/27/15
66	**Procurement**	100 days	Fri 8/1/14	Thu 12/18/14
67	**Electric Materials Purchasing**	80 days	Thu 8/28/14	Wed 12/17/14
68	Cablel Purchasing	41 days	Thu 8/28/14	Thu 10/23/14
69	Battery Management System Material Purchasing & SCADA	80 days	Thu 8/28/14	Wed 12/17/14
70	Communication Cabinet, Distributing Cabinet and Power Distributing Cabinet Material Purchasing	43 days	Thu 8/28/14	Mon 10/27/14
71	**Product Manufacturing**	100 days	Fri 8/1/14	Thu 12/18/14
72	BYD Battery Container Assembly	100 days	Fri 8/1/14	Thu 12/18/14
73	**RES Construction Activities**	158 days	Mon 11/3/14	Wed 6/10/15
74	Clean and Grub Site	5 days	Mon 11/3/14	Fri 11/7/14
75	Grade and Gravel Trailer Site compound	5 days	Mon 11/10/14	Fri 11/14/14
76	Mobilization (Trailer, Personnel, Toilets)	5 days	Mon 11/17/14	Fri 11/21/14
77	Install BMP's	2 days	Mon 11/24/14	Tue 11/25/14
78	Cable Trenching & Conduit Layout	10 days	Wed 11/26/14	Tue 12/9/14
79	Install Grounding Grid	4 days	Wed 12/10/14	Mon 12/15/14
80	Ground Testing Utilizing Slope Method	2 days	Tue 12/16/14	Wed 12/17/14
81	Install Fencing (Temporary)	4 days	Tue 12/16/14	Fri 12/19/14
82	Prep Compound and Pad Sites	10 days	Tue 12/16/14	Mon 12/29/14
83	Concrete Pads Form Works	5 days	Mon 1/19/15	Fri 1/23/15
84	Steel Works (Rebar Cage Build Out)	5 days	Mon 1/19/15	Fri 1/23/15
85	Concrete Pour Foundations	3 days	Mon 2/2/15	Wed 2/4/15
86	Electrical Cable Install (in conduit)	5 days	Mon 2/9/15	Fri 2/13/15
87	Set BYD Containers	10 days	Mon 2/16/15	Fri 2/27/15
88	Install Site Compound Gravel (First Lift)	2 days	Mon 3/2/15	Tue 3/3/15
89	Set Transformers	3 days	Wed 3/4/15	Fri 3/6/15
90	Set Switch Gear	3 days	Mon 3/9/15	Wed 3/11/15
91	Electrical Works and Terminations for Container Batteries, Transformers and Switch Gear	11 days	Thu 3/12/15	Thu 3/26/15
92	Install Riser Poles - Breakers	3 days	Fri 3/27/15	Tue 3/31/15
93	Grid and Telecom Connections	5 days	Wed 4/1/15	Tue 4/7/15
94	Fiber Optics - Telephone from SCADA to Road	5 days	Wed 4/1/15	Tue 4/7/15
95	Install Site Compound Gravel (Last/Final Lift)	2 days	Wed 4/8/15	Thu 4/9/15
96	Install Permanent Fencing and and Connect Grounding	5 days	Fri 4/10/15	Thu 4/16/15
97	Install Scada Equipment and Wiring, Terminations	10 days	Mon 4/20/15	Fri 5/1/15
98	**Comissioning**	28 days	Mon 5/4/15	Wed 6/10/15
99	Scada Testing, Diagnostics	10 days	Mon 5/4/15	Fri 5/15/15
100	Electrical Commissioning	10 days	Mon 5/18/15	Fri 5/29/15
101	SCADA Commissioning	10 days	Mon 5/25/15	Fri 6/5/15
102	Final Grading and Site Restoration	3 days	Mon 6/8/15	Wed 6/10/15
103	**Substantial Completion**	1 day	Fri 7/24/15	Fri 7/24/15



Appendix E - Technology Selection Considerations

GENERAL

RES Americas has been conducting continual analysis on energy storage vendors since 2009. RES Americas has conducted thorough analysis on 120 different energy storage providers, and in most cases has received proprietary information for these energy storage systems under NDA. The following is a brief outline of the Technology Selection process and criteria.

SAFETY

At RES Americas safety is the #1 concern. RES Americas comes from a culture of construction safety, which devolves from its corporate parent, McAlpine Construction. An example of our extreme culture of safety is the 2012 Olympic Stadium in London, which was constructed by McAlpine Construction **without a single lost time hour due to injury**. This is an unheard-of safety record for such a large project. RES Americas safety record far exceeds the industry norms. Energy Storage systems represent a special challenge to our culture of safety, and all potential systems were fully vetted for safety.

General Safety Issues found in Battery Systems:

- Chemistry/Toxicity/Environmental: Batteries often contain a wide variety of hazardous chemicals. Flow batteries, for example, contain thousands of gallons of Sulfuric or Hydrochloric acid for every MWh of storage, 10's of thousands of gallons for a 4MWh system. The safety and environmental issues in containment of these hazardous acids is a serious safety concern. Additionally, flow battery systems that can evolve Chlorine or Bromine gases upon overheating is an additional safety issue, as is the potential spill of Vanadium PentOxide used in Vanadium based flow battery systems. Certain Lithium battery chemistries contain hazardous materials such as Cobalt, and NiCAD and advanced lead acid batteries generally contain toxic metals such as lead and cadmium.
- Fire: High-temperature batteries such as Sodium-Sulfur and Sodium-Nickel battery systems have suffered fires which cannot be extinguished, due to the reactivity of the Sodium metals. Lithium batteries come in many different chemistries, and fires due to the phenomenon of "internal thermal runaway" is a serious issue, as has been noted in the Boeing Dreamliner cases and other fires.

Results of Safety Review for Selected Technology:

- Chemistry/Toxicity/Environmental: The BYD battery cell MSDS hazard classification of 0-1-0 is the best in industry. The BYD battery cell is UL Listed. The BYD batteries use a Lithium Iron Phosphate chemistry. As can be seen in this paper, this is the only Lithium chemistry not subject to internal thermal runaway: http://www.electrochem.org/dl/interface/sum/sum12/sum12_p037_044.pdf. RES conducted full audits of the BYD manufacturing process, including hiring IdaTech, and international third party review company, to conduct a parallel study.

COMPANY STABILITY

Large scale energy storage systems for grid applications are relatively new, and RES Americas and PSE are relying on the warranties provided by the manufacturer to reduce the technical risk of large energy storage projects.

General Concerns of Company Stability for Energy Storage Companies:

- Many energy storage companies are new, often venture-backed, start-ups, with limited resources and very short track records. While the company resources may suffice to cover the technical risk of a small demonstration project, they will often not be sufficient to cover the risks of a 10 year warranty for large multi-million dollar projects.

- Company Stability for Selected Technology: BYD Ltd, and BYD America is a 20 year old company employing 180,000 people worldwide, with over $8 billion in annual revenue, whose primary business line is batteries.

REFERENCE INSTALLATIONS/PRODUCT EXPERIENCE:
Large scale energy storage for grid applications are systems that are expected to last for 10-20 years. All new technologies have early design issues and flaws, and to reduce the extreme technical risk of these systems, it is important that these technologies be tested and vetted at a system size similar to that contemplated.

GENERAL CONCERNS ABOUT ENERGY STORAGE

Company Reference Installations and Product Experience:

- While demonstration projects are a vital part of bringing a new technology to market, when considering an application whose value depends on the reliability of the technology, a demonstration project cannot be depended upon for reliability. No company that has never installed a grid-scale system can be considered for applications where dependability and reliability are key values. Many new energy storage companies have yet to deploy their systems at scale. RES is tracking closely all large scale installations, and the testing results that have come from these installations.

Reference installations/Product Experience of Chosen Technology:

- BYD has installed many large grid-scale battery systems, including the largest lithium battery in the World, a 9MW/36MWh system in Zhangbei, China. BYD has also installed large projects in the USA, including a 2MW/4MWh system for Chevron, which is almost identical in size to the proposed project for PSE. Both projects are operating very well. In addition, BYD has supplied batteries for electric vehicles, taxis and buses, which have logged millions of miles of service.

OTHER GENERAL TECHNOLOGY SELECTION RESULTS
RES has conducted on-site inspections and visits of operating systems, including the 2MW/4MWh system for Chevron noted above, and have conducted thorough factory visits of BYD facilities, including hiring third party evaluator IdaTEK to provide parallel analysis. RES has purchased two 4MW systems from BYD, which will be fully owned and operated by RES.

Appendix F – Annual Report

PSE's annual report, containing detailed financial statements, can be downloaded online at:

http://phx.corporate-ir.net/phoenix.zhtml?c=63643&p=irol-sec

Appendix G – MESA White Paper

MESA
Open Standards for Energy Storage

MODULAR ENERGY STORAGE ARCHITECTURE (MESA)

Open, Non-proprietary Standards for the Energy Storage Industry

Grid-connected energy storage promises large potential benefits. However, to enable broader storage deployments, electric utility customers and their suppliers must first solve significant problems. Many of these problems boil down to a lack of standardization. Others result from the lack of a cohesive industry vision, impeding the entire industry's ability to organize for scale.

Standards are required for any technology to be deployed at scale. The personal computer industry grew from zero to millions of units per year, while dramatically improving price-performance, based on standards for processors, software, hard drives, monitors, USB ports and many other components. The Internet connects billions of devices around the world via standard TCP/IP communication protocols and IP addresses.

Electric vehicles (EVs), produced by the tens of thousands per year and growing, include advanced batteries delivered at a fraction of the per-unit cost of batteries in stationary applications. EV manufacturers, like PC manufacturers and Internet technology providers, have organized themselves and their supply chains for scale.

Like other industries, the energy storage industry needs to organize itself for scale, based on a cohesive industry vision and technology standards.

Current energy storage system (ESS) offerings are project-specific, and built using proprietary components (batteries, power conversion and software) that are neither modular nor interoperable. This drives up project costs, and decreases reliability and safety. Further, in today's nascent market, component vendors such as battery or power conversion suppliers may stretch to offer a complete ESS solution, losing focus on their own core competency. Instead of developing innovative, best-of-breed, modular components, such vendors simply re-invent yet another proprietary wheel.

Current ESS offerings also lack standardized ways of connecting to the utility's information technology (IT) and other grid assets (meters, relays, transformers, etc.). This leads to one-off, proprietary solutions, not easily scaled, with limited flexibility and limited operational control.

Because of all these factors, the utility customer becomes dependent on an ESS supplier with limited knowledge beyond its specific expertise, and has few options to upgrade, expand or re-purpose their energy storage investment. The lack of standards for energy storage components increases cost, decreases quality, limits innovation, complicates utility asset management and leads to "vendor lock-in."

Exh. JES-4C
Dockets UE-170033/UG-170034
CONFIDENTIAL VERSION
Page 40 of 44

Despite willing buyers (electric utilities) and willing sellers (battery, PCS and software suppliers), market growth is limited. Significant opportunities – for example, the potential for broad deployment of standardized ESS configurations at many utility substations – are beyond the industry's reach, in its current form. To fully enable broad deployment of grid-connected storage, and grow the market for all, standards are required to address these limitations.

MESA IS AN OPEN, STANDARDS-BASED SOLUTION FOR ENERGY STORAGE

Modular Energy Storage Architecture (MESA) is an open, non-proprietary set of specifications and standards for (i) the components of energy storage (software control systems, batteries, and power conversion hardware as shown in Figure 1 to the right) and (ii) the communication standards and connection of energy storage to supervisory control and data acquisition (SCADA) systems, distribution management systems (DMS) and other grid control and power scheduling systems. An industry consortium of electric utilities and technology suppliers has developed MESA to increase the choices available to utilities implementing storage solutions.

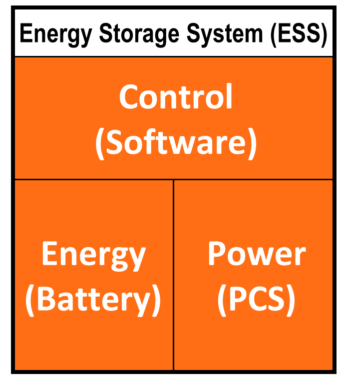


Figure 1

How MESA Enables Energy Storage within a Utility's Infrastructure
Energy storage must fit within existing utility Operational Technology (OT) and Information Technology (IT) environment.

On the OT side (represented in the bottom part of Figure 1 below), substation automation, distribution automation, intelligent electronic devices (such as digital relays), smart metering, and emerging assets such as energy storage and distributed solar PV, augment physical infrastructure, such as poles, wires and transformers, to help utility operators keep the lights on.

Utility IT is similarly complex and diverse, with many IT systems having direct OT counterparts. For example, substation and distribution automation must be connected to control room SCADA or DMS platforms. Utilities relying on external generation must integrate IT assets for power scheduling and market trading. All of these IT systems help the utility to better allocate resources, deliver timely information to employees and customers, and reduce operating costs.

As shown in Figure 2, energy storage becomes part of a utility's operational technology, and it must support field automation of other assets in the utility's grid. Within an energy storage system, the control software not only coordinates the communication and operation of the battery and PCS, it also connects the ESS with the utility's OT assets and IT systems.

Thus, MESA is organized into two sets of standards: (1) standards for connecting with the utility's operational technology infrastructure (including the components of the ESS), and (2) standards for connecting with the utility's information technology infrastructure. In Figure 2, those two standards are represented as follows:

MESA-Device — device interfaces to ESS internal components, and to support field automation of other assets in the utility grid

MESA-ESS — IT Interfaces to utility IT systems

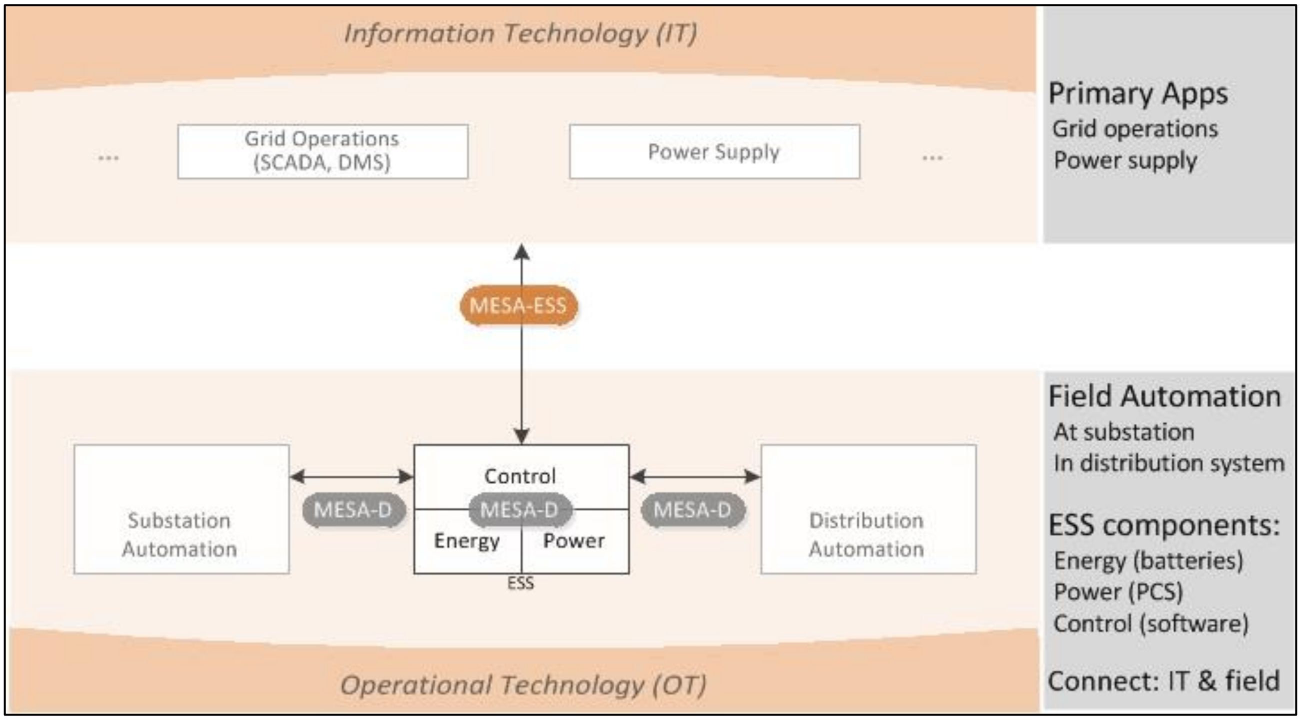


Figure 2

MESA-Device Standards. The MESA-Device standards address three aspects of system design for the components of energy storage:

- **Physical** – How energy storage components are physically packaged and arranged
- **Electrical** – How energy storage components are electrically connected
- **Communications** – How energy storage components communicate internally

With respect to communication, the current MESA standard supports Modbus and in some instances DNP3 for devices.

MESA-ESS Standards. The MESA-ESS standard specifies how an energy storage system as a whole communicates with a utility's grid control (SCADA/DMS) and power scheduling systems. These standards will also address how to implement scheduling using DNP3, validating and synchronizing multiple schedules, and communication protocols with multiple battery and PCS pairs within an ESS.

The current MESA standard supports DNP3 and Modbus, although it is likely that the standard will evolve beyond DNP3, for example to include an IEC 61850 object model.

KEY MESA GOALS

Standardize communications and connections, which will accelerate interoperability and scalability
MESA will provide a communication and information standard around which utilities can develop long-term infrastructure plans. Utilities need an information framework that allows them to easily add multiple energy storage systems from different vendors to their existing grid and know that their existing SCADA and DMS systems can manage and optimize those new energy storage units.

Give electric utilities more choice, by enabling multi-vendor, component-based ESS
MESA partners are delivering new control technologies and business models to fully enable the energy storage market. In a MESA-enabled market, energy storage system integrators will be able to buy grid-capable control systems, batteries and power converters the way utilities buy transformers and other electrical equipment today: plug-in compatible products built to open, industry-standard specifications. MESA supporters envision an ecosystem in which increasing deployments of standardized, component-based energy storage solutions are scaled and replicated across a utility's operating environment. At this scale utilities can reap the large potential benefits inherent in energy storage: renewable energy integration, deferral of system upgrades, peak shaving, load following, and ancillary services.

Modularity also offers the promise of future proofing. The energy storage industry is currently seeing rapid advancements in energy storage technologies, and it is reasonable to assume that tomorrow's energy storage subsystems (e.g. batteries, power conversion systems, etc.) will be significantly better than the subsystems that exist today. Modularity in system design should allow the energy storage customer to upgrade on a component-by-component basis to take advantage of these advances in technology.

Drive out non-recurring engineering (NRE) costs, enabling a more robust energy storage market
For the energy storage system integrator, MESA lowers costs by reducing the amount of time-consuming customization and design. Standards also help simplify long-term operations and thereby lower operating expense. Over time MESA will reduce the time to deploy new technologies and the expense of "rip-and-replace" when components need to be updated.

Enable technology suppliers to focus on their core competency, facilitating quality and safety
MESA allows each element of the energy storage supply chain to focus on what they do best. Battery manufacturers, power conversion system vendors, software control vendors, construction firms, and system developers/integrators can all focus on their particular area of expertise. That improves the quality and lowers the costs of the delivered systems. The MESA standard will also lower training costs and improve safety for field staff. Technicians and line staff who service energy storage units can manage multiple units across a diverse service territory knowing they can apply standardized procedures for safety and efficiency.

MESA Initiatives

There are multiple initiatives to advance MESA, including:

- Utilization of MESA-ESS standards to connect existing ESSs to SCADA, DMS, and other grid control and power scheduling systems
- Deployment of multiple ESSs built using MESA-Device compliant battery, power conversion and software components
- Publishing MESA interfaces via standards organizations such as IEEE 2030.2 Energy Storage Working Group, IEC TC-120 Electric Energy Storage technical committee, and other industry organizations

Public Release of MESA Standards

The MESA standards are in the process of being developed and tested. The MESA standards will first be publicly released and discussed at the Distributech 2014 conference in San Antonio, Texas, during the session titled: “Energy Storage: Technologies, Operations and Value Propositions,” Wednesday, January 29 at 9:30 am.

Department of Energy
Washington, DC 20585

Mr. Patrick Leslie
Emerging Technologies Program Manager
Puget Sound Energy
10885 N.E. 4th Street
Bellevue, WA 98004-5591

December 10, 2013

Dear Mr. Leslie:

The U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability (Office of Electricity), Energy Storage Program is pleased to make a commitment of $190,000 of in-kind participation by Pacific Northwest National Laboratory, over a two year period, as contribution to your proposed study entitled "PSE Grid-Scale Energy Storage Project: Energizing a Clean Energy Future". PNNL will contribute to this project primarily through identification of the system and site-specific benefits and the monitoring of system performance to validate benefits, particularly where the adoption of clean energy technologies for electric service can be enhanced. The Office of Electricity supports the exploration of storage as a technology that facilitates deployment of renewables, energy efficiency and reduced GHG emissions. Furthermore, we believe that energy storage will be a critical technology for facilitating such deployment, in combination with provision of many other grid support services. Understanding the role that storage can play, and the requirements for greater utilization of energy storage, are important contributions to helping us guide energy storage development and deployment.

We anticipate PNNL and Puget Sound Energy will implement a Cooperative Research and Development Agreement (CRADA) for this project. The commitment of DOE is subject to available funding resources enabled through appropriation by the U.S. Congress, and successful implementation of the CRADA.

We wish you success in your proposed study, and look forward to collaborating on this, and future, efforts to facilitate the deployment of clean energy and energy storage technologies.

With best greetings,

Imre Gyuk

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