AMERICAN PUBLIC POWER ASSOCIATION

Powering Strong Communities

Energy Storage Accessibility for Public Power Utilities

DE-FE0032026

Presented by Carole Plowfield, American Public Power Association
At 2023 FECM / NETL Spring R&D Project Review Meeting

Wednesday, April 19, 2023
2:15 – 3:15 PM Eastern Time

Today's Agenda

- Introductions
- Project Year 1 Accomplishments
- Project Year 2 Plan
- Project Year 2 Work in Progress
- Q & A and Closing

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Energy storage project key personnel

Jason Hissam – Federal Project Manager, Department of Energy, National Energy Technology Laboratory

Paul Zummo – Director of Research & Development, APPA

Ji Yoon Lee – Manager, Research & Development, APPA

Carole Plowfield – Clean Energy Strategy Manager, APPA

Christopher Kelley – Contractor, and Vice President, Beam Reach Consulting Group, LLC

Emmanuel Taylor– Contractor, and Senior Energy Consultant, Beam Reach Consulting Group, LLC

Project overview

What is the objective?

Work with public power utilities to lower barriers to energy storage integration with the operation of electric systems under funding APPA received from the Department of Energy's Office of Fossil Energy and Carbon Management. Public power utilities that own and operate fossil-fueled assets, along with those that rely on them to ensure regional grid stability, will experience direct benefits from this work, while the development of ideal strategies and frameworks for implementing energy storage at community-owned electric utilities will assure mutual benefits for everyone connected to the electric grid.

What is our approach?

- Facilitate and convene municipal utilities to define barriers to energy storage deployment and work with DOE and other stakeholders to mitigate these barriers;
- Develop tools, educational resources, case studies, guidelines, best practices, and training on common strategies for integrating energy storage technologies with fossil power plants and enhancing organizational capacities at utilities.

Energy Storage Working Group (ESWG)

Mission

To promote the successful deployment of energy storage technologies within public power utilities and evaluate opportunities to integrate them with the operation of fossil generation assets, through collaborative discussions, data capture, analysis, and shared best practices.

Scope

The working group will focus particularly on the intersection of energy storage and fossil generation within public power utilities, and the integration of energy storage with fossil generation assets.

Timeline

During the first year of operation, the working group met from April to September of 2022. During its second year, the working group will meet from February to September of 2023.

Participant

Public power utilities, joint action agencies, and state/regional association member who are contemplating energy storage, has started the process, or already implemented energy storage technology.

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Year 1 accomplishments

Goal	Goal Description	Accomplishments
Goal 1	**Convene an energy storage working group** and **conduct regular meetings** to start the dialog and receive feedback from members.	• Hold 7 monthly meetings with Energy Storage Working Group (ESWG) and gathered feedback on fossil asset management challenges and energy storage value propositions. • 14 public power utility representatives participated in the working group. • Continued outreach to APPA members to gather their feedback on the feasibility of developing high resilience and low emission electric delivery systems using energy storage to enhance fossil generation. • Conducted individual member discussions on completed/in-progress/incomplete energy storage projects.
Goal 2	**Develop a list of findings and recommendations** that includes a knowledge gap analysis	• Developed a report of findings and a cross-sectional gap analysis based on ESWG discussion and literature review. • Shared the report with DOE/NETL and the ESWG members • Published on APPA website.
Goal 3	**Build case studies**. Publish and post on APPA website and notify members through existing communications channels.	• Continue developing case studies. • Studying energy storage projects and technical innovations made by public power utilities.

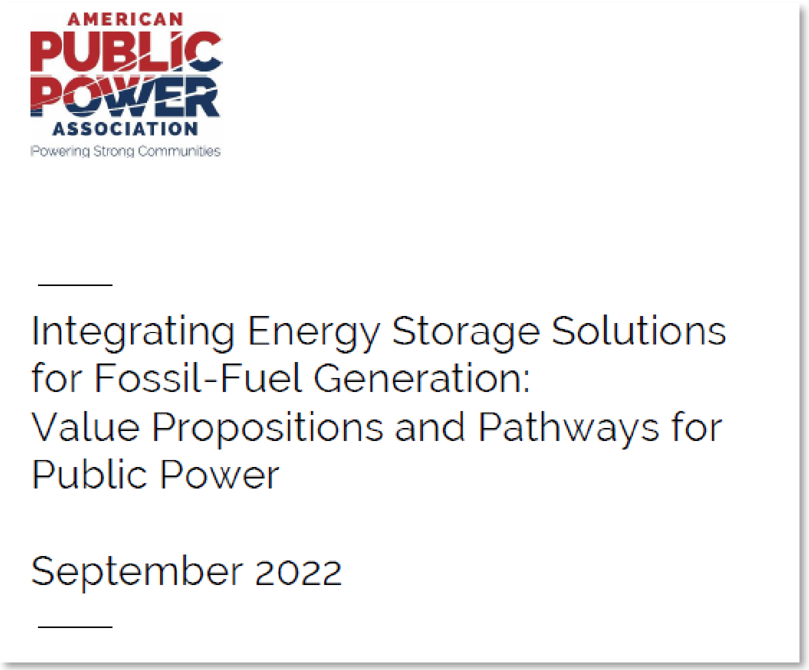
ESWG meetings and scope in year 1

Meeting Date	Purpose
April	Defined fossil generation asset management challenges
May	Identified energy storage value propositions
June	Identified challenges to fossil energy and energy storage integration
July	Identified pathways for resolution of challenges
August	Final review of reporting materials
September	Decided on next steps for the working group

Project findings and recommendations report

- This report summarizes a six-month effort to better understand the role that energy storage technologies can play in enabling the Public Power utilities to better manage its fossil generation assets.

- Contents:
    1. Fossil generation asset challenges
    2. Energy storage value propositions
    3. Fossil Assets and Energy Storage Technology Intersections
    4. Action plans
    5. APPA opportunities and suggested directives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Integrating Energy Storage Solutions for Fossil-Fuel Generation: Value Propositions and Pathways for Public Power

September 2022

ESWG| Year 1 | Foundation

Describe the primary challenge you see in the management of fossil generation assets.	Votes
Eliminating carbon and other GHG Emissions Many states moving toward carbon-free generation goals; concern in transitionary phase; operational challenges in the interim; maintaining reliability and eliminating emissions are often opposing ambitions.	8
Political pressure to divest from fossil fuels Many states and localities are transitioning away from fossil generation; utilities are mandated to replace traditional baseload with intermittent renewables and other solutions; what is best for the system and reliability differs from political will.	3
Managing system reliability in the face of changes Reliability of these resources compared to intermittent resources; control over fuel source with FE gen; controlled production, generation; less control with replacements; losing direct control over reliability; challenges in operating regional system with retiring resources; regional basis; having enough resources to fill in the gaps.	2
Providing non-energy generation services, such as ramping, load following, and black start Baseload restricted in flexibility, by design; producing more emissions when operated as not designed.	1
Handling generation cost dynamics Peak shaving assets are maintained; only generation assets managed; global supply chain constraints and impact on generation costs.	1

ESWG| Year 1 | Intersections

Storage Technology	Use Case	Fossil Asset	Problem Addressed	Value Proposition	Description
Battery Energy Storage	System Demand Reduction	Baseload Peaking Backup	Decarbonization Emissions Reductions Generation Cost Fossil Asset Optimization Managing Intermittency	Non-wires alternatives T&D investment deferral Reduced capacity obligations Reduced fuel / O&M costs	Energy arbitrage using batteries can lower system peaks, deferring transmission upgrades, and reducing fuel costs. Lowering system demand dynamically during periods of renewable energy intermittency can increase system reliability.
Ice Storage	System Demand Reduction	Baseload Peaking Backup	Decarbonization Emissions Reductions Generation Cost Fossil Asset Optimization	Non-wires alternatives T&D investment deferral Reduced capacity obligations Reduced fuel / O&M costs	Energy arbitrage using ice storage systems to supply cooling loads during peak hours. This approach can ease the operation of fossil generators, preventing emissions, and lowering fuel consumption.
Controllable Thermal Loads	System Demand Reduction	Baseload Peaking Backup	Generation Cost Fossil Asset Optimization Managing Intermittency Decarbonization Emissions Reductions	Non-wires alternatives T&D investment deferral Reduced capacity obligations Reduced fuel / O&M costs	Demand response utilizing thermostatically controlled customer loads. This approach can be used for short duration demand reductions, and needs to be coordinated with customers, to prevent dissatisfied utility customers.
Battery Energy Storage	Ramp Rate Control	Baseload Peaking Backup	Managing Reliability Fossil Asset Optimization Emissions Reductions	Reduction in O&M costs Reduce generator stress. Support system stability.	Deploying battery storage can allow fossil generators to ramp at a natural rate, while batteries are discharged to meet the additional demand.
Ice Storage	Gas Inlet Pre-Cooling	Baseload Peaking	Generation Cost Decarbonization Emissions Reduction	Reduction in O&M costs	Ice-based cooling systems can lower the temperature of ambient air, prior to use in combustion. Pre-cooling increases the gas turbine operating efficiency, preventing increases in emissions, and reducing fuel consumption.
Hydrogen Production	Fuel Mixing	Baseload Peaking	Decarbonization Emissions Reductions Generation Cost	Reduce renewable energy curtailment. Reduce hydrogen production costs	Use hydrogen in gas turbine fuel mixing to reduce emissions. The cost to generate hydrogen can be lowered by using renewable generation that would otherwise be curtailed. Overall fuel costs may be lowered.

ESWG| Year 1 | Priorities

Technology	Use Case	Votes
Battery Energy Storage	System Demand Reduction	6
Controllable Thermal Loads	System Demand Reduction	3
Hydrogen Production	Fuel Mixing	2
Battery Energy Storage	Support Generator Ramp Rate	2
Battery Energy Storage	Enhance Load Following Capability	1
Ice Storage	Gas Inlet Pre-Cooling	1
Battery Energy Storage	Enabling Black Start Capability	1
Ice Storage	System Demand Reduction	0
Controllable Thermal Loads	Support Generator Ramp Rate	0

Primary Implementation Challenges:

- Legal and contractual considerations; ownership, leasing, terms and conditions;
- Cost analysis/optimization, project financing, value stacking, market options;
- Gaining an in-depth understanding of technologies, organizationally/
- Understanding/navigating regulatory req's
- Staff training, skilled engineers, SMEs;
- Understanding carbon footprint of solutions;
- System design; broader system impacts; operational considerations;

ESWG| Year 1 | Suggestions

- Providing training on technical topics
- Building the internal capabilities of staff
- Enhancing long-term advanced technology management abilities
- Increasing access to subject matter experts
- Supporting demonstration projects to validate technology performance

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Project goals for year 2

Goal	Methodology	Deliverables
Goal 3 **Build case studies**	Leverage findings from prior year, One-on-one discussions with working group members	Four case studies One handbook
Goal 4 **Develop a maturity model framework**	Independent Research, ESWG Facilitated Discussions	Framework Description Implementation Guide Test Runs Summary report

Project plan for year 2

Meeting Date*	Purpose	Expected Outcomes
February	**Maturity Model Baselines**	**Feature Identification**
March	Case Study Interviews	Data Gathering
April	**APPA ESMM Design**	**Usability Assessment**
May	Case Study Handbook	Publication Development
June	**ESMM Test Runs**	**Review Quality of Results**
July	Feedback and Refinement	Collect Final Inputs
August	**ESMM Findings Report**	**Publication Preparation**

* ESWG meet once every two months from February to August 2023.

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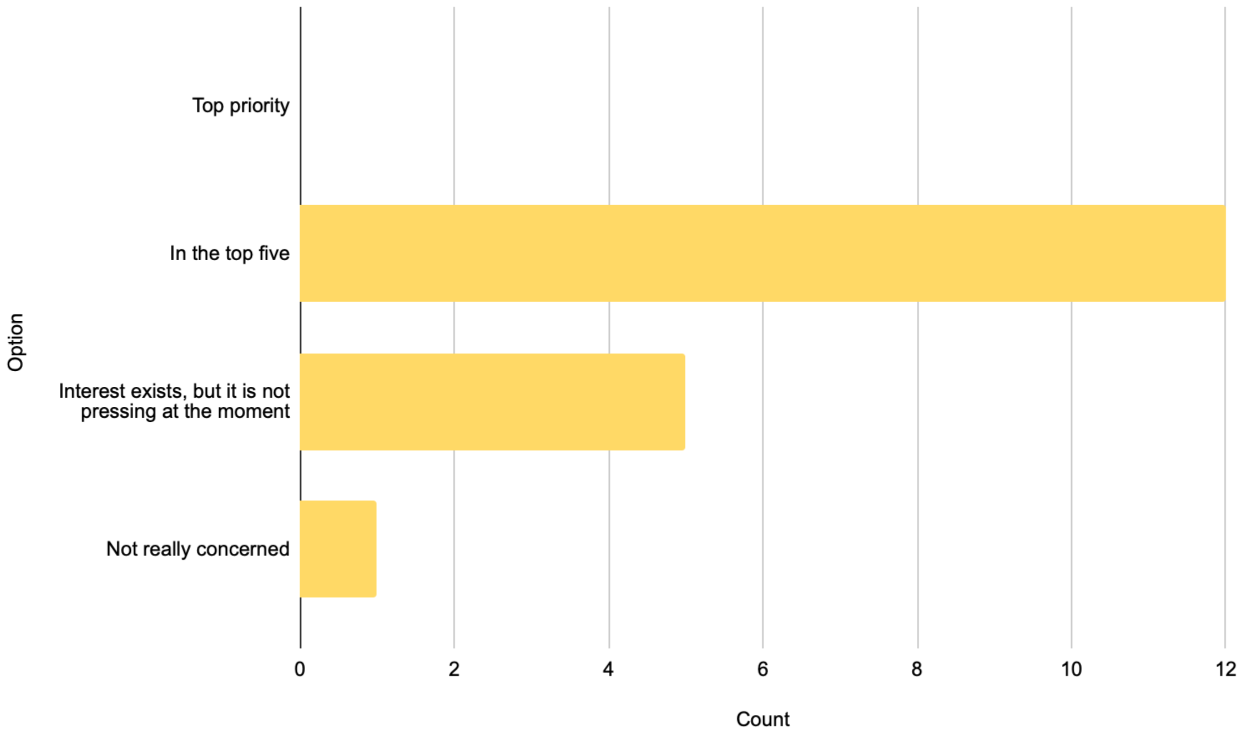
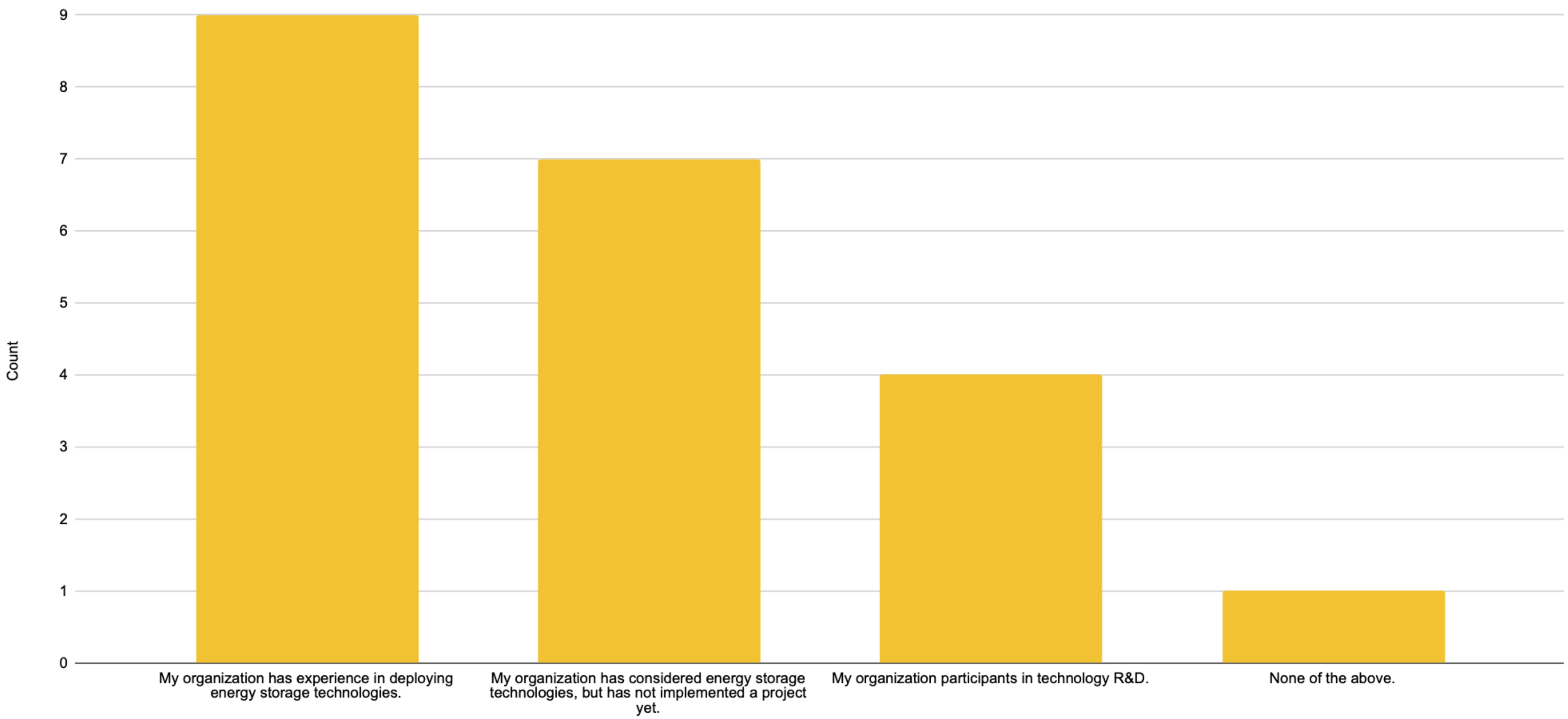
Energy Storage as an Organizational Priority

To what extent does energy storage represent a priority for your organization?



Experience Deploying Energy Storage Systems



ESWG participation goals

- Enhancing Information Sharing
- Exploring Finance Options
- Understanding Technical Operations and Challenges
- Planning Storage Projects
- Understanding Available Technologies
- Assessing Workforce Development Needs
- Understanding Non-Technical Barriers

Recommendations for future activities

Topic Area	ESMM	Case Studies	New Mechanisms
Enhancing Information Sharing		X	X
Exploring Finance Options	X	X	
Understanding Technical Operations and Challenges	X	X	X
Planning Storage Projects	X		
Understanding Available Technologies			X
Assessing Workforce Development Needs	X	X	
Understanding Non-Technical Barriers	X	X	

Any questions?

Thank you for joining!

Contact EnergyTransition@PublicPower.org with any questions.

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ESWG| Year 1 | Results

Battery Storage for Demand Reduction	
Anticipated Integration Challenges	**Required Improvements**
- High system implementation costs - Navigating contract limitations with generation suppliers - Justifying the cost vs. other options - Ensuring the storage duration is long enough to cover the totality of the peak load period, which is related to cost - Sizing batteries to ensure sufficient discharge capacity over desired demand intervals - Gaining access to appropriate project financing - Supply chain disruptions and cost impacts - Finding a common communication protocol so that multiple battery systems can be combined using an existing SCADA system - Accurately characterizing the differences between designed system capabilities verses actual performance - Organization-wide agreement on the use of battery assets	- Establishing a front end understanding of the energy storage technology, across the organization, collectively - Understanding and navigating regulatory requirements and cost - Retaining institutional knowledge during staff transitions; building organizational capacity. - Lobbying at state/federal level. Funding from the state can help with cost. - Materials innovations in batteries may lead to lower cost products that are produced domestically and are not subject to supply chain disruptions. - Standards improvements are needed, including enhanced communication protocols

Major Activities, Milestones, and Metrics	Resources Required	Key Stakeholders
- Organizational effort has to be made. Identify group/people that have different background to be educated. Have training, knowledge, experience - Get involved with other states or other utilities in the energy space	- Feasibility study at a high level to identify gaps - Power engineering to guide - Trained and knowledgeable staff - SME to fulfill knowledge gaps	- City Council - Public Utility Advisor Boards - Representative from each group within the utility - Regional Planning Commissions at the county level

ESWG| Year 1 | Results

Controllable Thermal Loads for System Demand Reduction

Anticipated Integration Challenges	Required Improvements
- Security of the demand/response networks and control - Ensuring the customer doesn't see unacceptable/unreasonable temperature swings - Being able to operate the demand reduction very quickly in response to other instantaneous load changes - Temperature mixing valves to avoid scalding (re: hot water heaters) - System impact studies could delay project up to one year - Customer pushback due to potentially better economic alternatives - These programs should be opt-in only and customers should be incentivized with lower energy prices	- Develop and deploy a robust education program to ease public concern about power being leveraged over residences, to provide transparency in technology use and benefits. - No incentive is large enough if the customer is concerned about what *exactly* you can do in their residence or business. - Communicate what the program can and can't do, and how that will impact the customer. - Implement temperature mixing valves to avoid scalding (i.e., with hot water heaters) - Improve understanding or predictive capabilities of market pricing to guide investments and determine when to engage thermal loads; insight into rate stability. - Define number and type(s) of customer overrides.

Major Activities, Milestones, and Metrics	Resources Required	Monitoring
- Define and develop education/marketing program - Define the case for the customer--what benefits can they expect? What security concerns are there? Exposure of network? - Define overrides - Select good partner to work with and able to ensure project is accomplished - Develop an understanding of connected utility needs - Make financial case - Build pilot program to improve uptake--thermal demand management impacts quality of life of customer	- Good/skilled engineers - Legal help for contractual relationships - Financial help - Marketing and education outreach events for residents - Skilled data modeling--statistician	Metric: - Curtail installation of individual boilers using fossil heat and installation of new electric heat - MW reduction at time of peak - Percentage of water heaters signed up or customers enrolling in HVAC control - Penetration: how many applicable customers signed up - Demand reduction: how much demand was shed per customer - Customer experience: post-event surveys of participants to gauge their feelings about the program

ESWG| Year 1 | Results

Hydrogen Production for Fuel Mixing	
Anticipated Integration Challenges	**Required Improvements**
- Producing the hydrogen cost-effectively - Finding a way to transport the hydrogen that would leverage existing infrastructure as much as possible, - Ensuring that the generator can support a reasonable fuel mix to make it worthwhile, etc. - The hydrogen source and production method (grey, blue, green, etc.) impact the cost of hydrogen, which can vary significantly. The DOE Hydrogen Shot should help reduce costs. - Gas turbines have been replaced with newer models allowing up to 45% hydrogen mixing capability.	- Understand the costs, given the high cost of H2, could be significant concern - Need to present the costs to voting. members; learn and overcome. - Build understanding of the technology. - Environmental organizations' opposition to Natural Gas. - Education processes. - Cost of hydrogen: could be addressed through subsidization, collaboration with industry/government. - New England not at "duck curve" solar level, though there is a push for offshore wind. - Could lead to excess renewable generation capacity. - SW could have excess renewable generation within 4-5 years.

Major Activities, Milestones, and Metrics	Resources Required	Monitoring
- Conduct a pilot/demo. Consider a small hub. Utilize existing unused space within service territory. - Grant writing. - Seek infrastructure funding (identify programs, funding sources). - Education and awareness workshops.	- Availability of Hydrogen. Needs to be trucked in, or need to create a H2 production facility. - Evaluate the total carbon footprint of the solution. - For utilities that do not traditionally operate generation (esp. Hydrogen), need commitment. - Industry partners. - Internal agreement within the utility.	Metric: - Demonstrate that generation using a mix can be achieved. - Perform cost/benefit analysis. - Price environmental attributes. - Track activity completions. - Measure against sustainability initiatives, including carbon reductions. - Verify the safety of the fuel (incl. public perception) - Validation of design vs. actual performance

ESWG| Year 1 | Results

Battery Energy Storage to Support Generator Ramp Rate	
Anticipated Integration Challenges	**Required Improvements**
- Coupling gas turbines with a battery derives more value from quick start capability; but will the market provide enough of a reward to justify it? The problem is financial. - In western interconnect, regulation up and down is related to ramp control, but more profitable within the market. - In the California market construct, the SG&E Escondido battery project was intended for peak shaving, but found more value in operating as up and down regulation service. - ISO NE has a regulation market; energy storage operates behind the meter but still qualifies in the regulation market; - Challenge: making sure the battery is loaded up when needed, and able to follow the ISO regulation signal; - Making sure one value stream doesn't compromise the other; not easy!	- Cost optimizing tools; need tools to perform value stacking, manage battery charging and discharging - Modeling charging/discharging behavior of battery systems while capturing the energy stored and available at all times. - Owning vs leasing, warranties; performance restrictions related to warranty (operational); wear and tear vs warranty; lesser warranty or higher upfront cost

Major Activities, Milestones, and Metrics	Resources Required	Key Stakeholders
- Work with local investor-owned utility; perform system impact study; fully involve all stakeholders impacted. - Design protection schemes. - Share best practices; learning from others that are doing this; asking detailed questions from those with experience.	- Financing mechanism. Good agreement (similar to PPA) with partner. - Lending mechanism on system. - System changes, including reconfiguring substations, adding protections, integrating batteries, and updating control system strategies.	- Neighboring Utilities. - Equipment/ Warranty providers. - Lending Partners or Finance Providers. - State Government (Provided grants for a past project). - State Energy Office. - Good attorney!