

Outline

- 1 Alternative Energy Storage Technologies Work Product
- 2 Energy Storage for Resilience & Reliability Work Product
- 3 Rate, Tariff, and Market Design for Energy Storage Work Product
- 4 2018 Biennial Storage Review

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Background

- There are numerous energy storage technologies
- EAC has historically focused on electricity-in/electricity-out storage
- Recognition that this focus should be expanded
- Purpose of this work product is to provide definitional and scoping information to the Department on alternate storage technologies
- Recommendations for helping with definitional issues and updating guidance documents to better reflect these technologies
- Follow-on work products may provide more recommendations and identify opportunities and challenges for the Department to pursue

Technologies Surveyed

- Thermal Storage
 - Direct load control of resistive electric water heaters
 - Direct load control of electric heat pump water heaters
 - Chilled-water storage
 - Ice storage
 - Chilled energy storage for inlet air cooling
 - Space heating
 - Molten salt
 - High-temperature phase-change materials
- Chemical Storage
 - Hydrogen (H_2)
 - Ammonia (NH_3)

Overview

- Uses electricity to heat or cool a storage medium, which is used to serve subsequent cooling or heating needs
- Historical use to flatten load curves
 - Electric co-operatives control electric water heaters to manage power flows on rural T&D systems
 - France uses electric-water-heater controls to manage relatively inflexible nuclear-dominated power supply
 - Large customers use thermal storage to flatten load profiles and manage demand charges
- Use cases are adaptable to a system and market environment with variable renewables as a significant supply source

Technologies

1 Direct load control of resistive electric water heaters

- Controls ensure that water is heated when electricity is inexpensive and delivered on-demand from a storage tank
- More sophisticated systems can provide fast-response services to the grid (*e.g.*, voltage support and frequency regulation)
- Pilot-scale programs in Hawaii, Minnesota, and Maryland
- Full deployment in France, Australia, and Sweden (for district heating)

2 Direct load control of electric heat pump water heaters

- One-third as much electricity use as resistive electric water heaters, but with sizable storage tanks
- Even with lower energy use, heat pumps can be controlled to shift water-heating loads
- Experimental, but residential-scale heat pumps can be installed with tanks to enable operations to be concentrated into low-cost periods

3 Chilled-water storage

- Mature technology for large campus facilities
- To date a small percentage of appropriate candidate sites have large-scale storage of this type installed

Technologies

4 Ice storage

- Mature technology deployed globally for large central-chiller systems (common in large commercial buildings)
- More expensive to build and maintain than chilled-water storage, but significantly lower land area requirement
- Currently a small fraction of candidate facilities have ice storage installed

5 Chilled energy storage for inlet air cooling

- Chilled thermal energy storage (*i.e.*, chilled water or ice) cools inlet air for industrial processes
- Common example is cooling inlet air for a gas or other turbine

6 Space heating

- Store heat in a medium to displace space-heating load
- Commonly used storage medium, which has been used in New England, is ceramic bricks

Technologies

7 Molten salt

- Used for high-temperature heat storage, as molten salts store heat at relatively high temperatures
- Stored heat can be pumped to a steam generator
- Especially suitable with thermal solar plants
- Technology has been installed in California and Spain

8 High-temperature phase-change materials

- Thermal energy storage with valuable material properties
- Example:
 - Molten silicon has a phase-change temperature of over 1400 C and an energy density of more than 1 MWh/m³
 - Thus, may allow residential customers to store a month of thermal load in a form factor comparable to a clothes-washing machine
- Potentially great value for serving high-temperature industrial heat loads

Overview

- Uses electricity to produce a chemical
- Chemical later used to serve a thermal load or for electricity generation

Technologies

1 Hydrogen (H_2)

- Can be created by water electrolysis
- Stored hydrogen can be used as a feedstock for ammonia and other chemicals or as direct-process heat fuel
- Can also be recombined with oxygen in a fuel cell or combustion unit to generate electricity
- Electrolysis produces oxygen as a byproduct, which can be used for industrial purposes
- Challenges include being hazardous, storage difficulty, and costly transport

2 Ammonia (NH_3)

- Can use low-cost or variable renewable energy to meet existing demand for ammonia-based fertilizer
- Stored ammonia can be used as a fuel for transportation, industrial process, or electricity generation
- Thousands of existing miles of ammonia pipelines in the United States, mostly used for transporting fertilizer feedstocks
- Ammonia molecule is large, making storage in conventional tanks and pipelines straightforward
- Nitrogen oxide emissions and toxicity are concerns

Definitional Issue

- Lack of clear delineation between energy storage and demand response technologies
- Example: controlled water pumping may be demand response (electricity demand to operate water pumps is shifted in time) or energy storage (functionally equivalent to using a battery)

Recommendations

- Alternative energy-storage technologies may be viable to address energy-related needs
- May be difficult for individuals, companies, policymakers, legislators, and regulators to track and evaluate such solutions
- Department has expertise to produce and encourage use of screening tools to assess such technologies
- Specific recommendations:
 - 1 Evaluate the benefits of updating existing guidance documents (or suggesting updates for documents not owned by the Department), including checklist of technologies to consider under different circumstances; target documents to policymakers, legislators, and regulators to ensure understanding of benefits
 - 2 Serve as an unbiased arbiter in classifying technologies as playing predominantly demand response or energy storage role; surveying past treatments and developing best practices

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Background

- Electricity service is necessary to the national economy, security, and citizen wellbeing
- Need for attention and definition of storage's role as a component of the power system as a reliability/resilience/backup solution, while concurrently serving the system's routine needs
- Storage-cost reductions and high-value use cases support the prospect of storage providing backup/resilience/reliability services when the system is 'down' and other services when the system is 'up'
- Purpose of this work product is to survey these potential use cases for storage and make recommendations to the Department on how it can facilitate such use of storage
- Work product builds off of a day-long workshop on this topic held during the June, 2017 EAC meeting

Progress and Next Steps

- Workshop material, transcript, and notes compiled
- Work product drafted with initial feedback from working group
- Updated draft disseminated to full Energy Storage Subcommittee for further review and comment
- Expected completion for approval at July, 2018 EAC meeting

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Background

- Energy storage is a unique power system asset that can ‘behave’ like a generation, load, transmission, and/or distribution asset
- Some services that storage can provide are priced in markets, others are not
- Traditional regulatory and market approach treats assets as **either** being market- or rate-based, which may not be suitable for energy storage

Aims

- Raise the problems created by historical market, rate, tariff, and regulatory designs as they pertain to energy storage
- Survey what has been implemented in practice and proposals on the table to address these issues
- Make recommendations for further work or study
- Help the Department assist state regulators and legislators determine how to address energy storage within their regulatory proceedings
- Department should not be prescriptive, but provide input and options based on current and past regulatory decisions and evolving storage-related science, applications, and research
- Timely, given Secretarial Directive on Regulatory Reform

Progress

- Working group drafted a starting (*e.g.*, moonshot) list of topics/issues that are pertinent to this work product
- Conversation with the Department to see how the topics and work product should be shaped to provide a high-value white paper
- Outline and topic list were pared down to make it more manageable

Outline

- 1 Executive Summary
- 2 Introduction
 - 1 Background and rationale
 - 2 Summary of findings
 - 3 Summary of recommendations to the Department
- 3 Issues with Monetizing Storage Value Under Today's Market and Regulatory Paradigms
 - 1 Not all value streams are priced in wholesale markets
 - 2 Issues with allowing ratebased storage to participate in wholesale markets
 - 3 How should market benefits be passed to ratepayers
 - 4 Treatment of bundled and unbundled services
 - 5 Allocating storage cost to market-priced and unpriced services
 - 6 Providing incentives for efficient operation of storage
 - 7 Treatment of storage cost as CAPEX or OPEX
 - 8 Retail rate design to incentivize good use of customer-owned storage
 - 9 Potential biases in industry planning practice against storage

Outline

- ④ Survey of Storage-Related Market, Rate, and Tariff Designs
 - ① FERC Storage NOPR
 - ② California
 - ③ New York
 - ④ Arizona
 - ⑤ Massachusetts
 - ⑥ Maryland
 - ⑦ Nevada
 - ⑧ Hawaii
 - ⑨ Washington
 - ⑩ Oregon
 - ⑪ Vermont
- ⑤ Recommendations to the Department
- ⑥ Summary and Conclusions

Next Steps

- Panel Session: Rate, Tariff, and Market Design for Energy Storage
- Working group meeting tonight to discuss next steps
 - Modify outline
 - Information gathering
 - Expert interviews
- Follow-on in-person subcommittee meeting tomorrow

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Background

- Energy Independence and Security Act of 2007 (EISA)
 - Energy Storage (Technologies) Subcommittee of EAC formed in March 2008 in response to Title VI, Section 641(e)
- Title VI, Section 641(e) has two parts pertaining to this subcommittee
 - 1 Section 641(e)(4): ‘... every five years [the Energy Storage Technologies Subcommittee], in conjunction with the Secretary, shall develop a five-year plan for... domestic energy storage industry for electric drive vehicles, stationary applications, and electricity transmission and distribution.’
 - 2 Section 641(e)(5): ‘... the Council shall (A) assess, every two years, the performance of the Department in meeting the goals of the plans developed under paragraph (4); and (B) make specific recommendations to the Secretary on programs or activities that should be established or terminated to meet those goals.’

Progress and Next Steps

- Been awaiting the Department's response to the 2016 Biennial Storage Review before beginning work on the 2018 review
- We will begin work on the 2018 review, to try and deliver the work product by the end of the year
 - ➔ Special WebEx EAC meeting may be needed for formal approval

Questions?

