EAC Energy Storage Subcommittee

Update

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Electricity Advisory Committee
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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

Outline

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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

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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

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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

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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/m^3
     - 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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Outline

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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

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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

Outline

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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

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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

Outline

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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.'

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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

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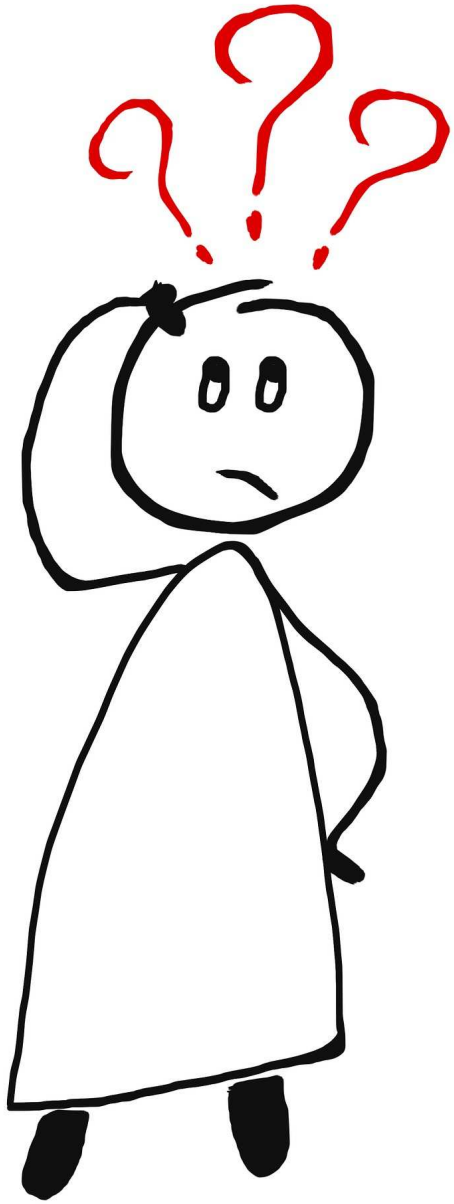
Questions?



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