DRAFT

March 27, 2015

Energy Storage Subcommittee Report

Activities and Plans

Presented by the Subcommittee Chair, Merwin Brown, CIEE

Energy Storage Subcommittee 2015-2016 Plans

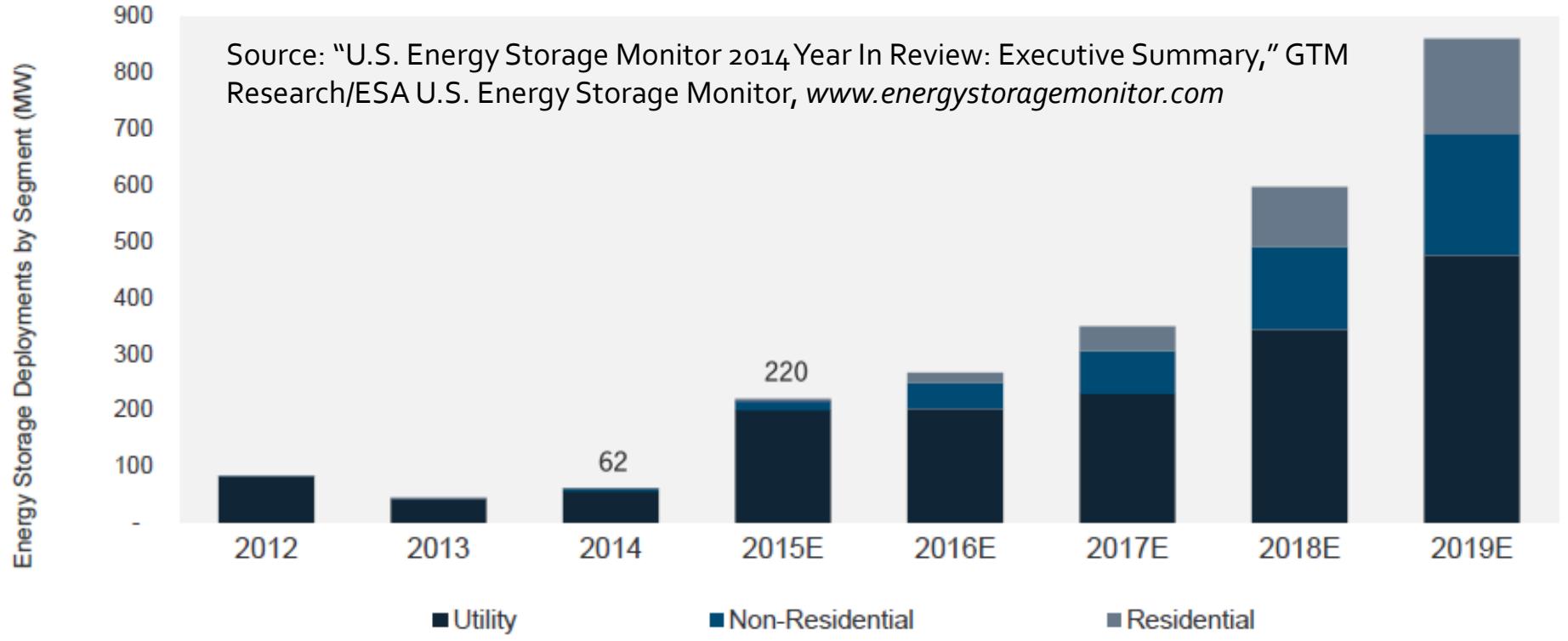
a. "National Strategy for Distributed Energy Storage in the Electric Grid " White Paper – a joint effort by the EAC Smart Grid (lead) and Energy Storage Subcommittees. – *Finish in 2015*

b. "Implications of High Penetrations of Energy Storage into Electric Transmission and Distribution Systems" White Paper – *Proposed for 2015 - 2016*

c. Biennial Storage Program Assessment for 2016

Proposed Work Product: "Implications of High Penetrations of Energy Storage into Electric Transmission and Distribution Systems" White Paper

U.S. Energy Storage Deployment Projections



See Full Report for complete forecast data

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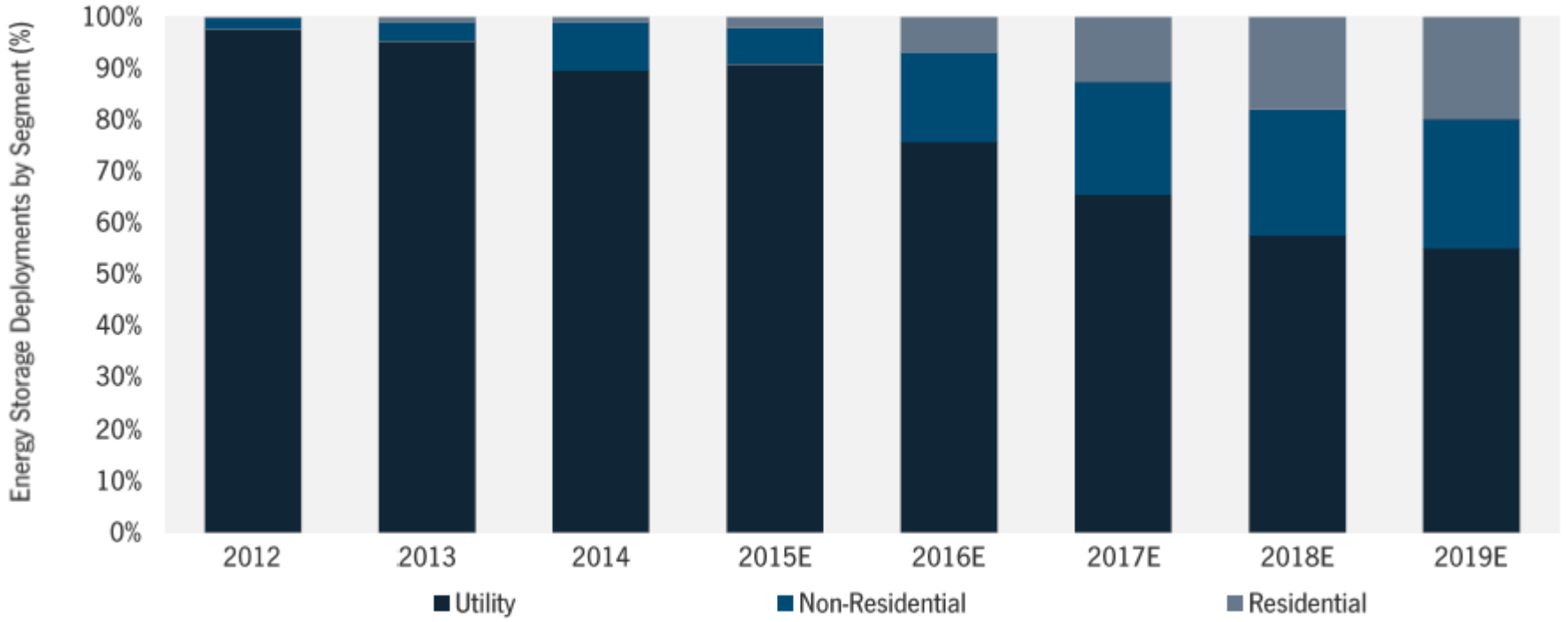
Proposed Work Product: "Implications of High Penetrations of Energy Storage into Electric Transmission and Distribution Systems" White Paper

Behind-the-Meter Storage Will Gain Market Share



See Full Report for complete forecast data

Source: "U.S. Energy Storage Monitor 2014 Year In Review: Executive Summary," GTM Research/ESA U.S. Energy Storage Monitor, *www.energystoragemonitor.com*

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Proposed Work Product: "Implications of High Penetrations of Energy Storage into Electric Transmission and Distribution Systems" White Paper

If energy storage deployments occur as expected, what would be the consequences?

1. Opportunities?
2. Challenges?
3. Unintended Consequences?
4. What, to whom, by who, for whom, when, where, how, how much and why?
5. In the context of energy storage technology as…
    1. A paradigm-shifting, disruptive technology
    2. A competitor in providing traditional conventional functions and services

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Potential Paradigm-shifting Role of Energy Storage in Temporal Power Flow Control in Electric Delivery Grid

1. In large part this vision probably warranted by the great temporal power flow capability inherent in energy storage in a disruptive technology context, which is largely unexplored in the electric grid.
2. Energy storage also exhibits attributes having little to do with temporal power flow control that might lead to paradigm shifts:
    1. Duality of being a generator source or a consuming load,
    2. Ancillary services device, such as voltage/VAR support and control.

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Proposed Work Product: "Implications of High Penetrations of Energy Storage into Electric Transmission and Distribution Systems" White Paper

Traditional Temporal Power Flow Control in Electric Delivery Grid

1. Has used only a few energy storage options for "warehousing the product" for temporal power flow control
    1. Hydro and customer emergency energy storage
    2. Inductors and capacitors with very limited storage capacities
2. Relies on just-in-time production of electricity because of two kinds of energy storage inherent in the electricity generators:
    1. "fuel stockpiles" and
    2. "flywheel inertia."
3. Also relies on centralized control and deterministic planning.

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Changes Affecting Effectiveness of Traditional Temporal Power Flow Control in Electric Delivery Grid

1. Power markets have reduced the scope of traditional deterministic planning for operations.
2. Variable renewable generators do not have the traditional inherent "fuel" storage and inertia, which is a first for the electric industry.
3. Changing customer behaviors, e.g., electronic loads, DG, DR, EV, are compounding uncertainty in power flows temporal profiles.

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Proposed Work Product: "Implications of High Penetrations of Energy Storage into Electric Transmission and Distribution Systems" White Paper

Current Status of Energy Storage in Electric Delivery Grid - Promise and Potential vs. Confusion and Controversy -

1. Energy storage features just described are sources of dichotomy.
    1. Energy storage sought as solution to many modern electric grid issues, amid economic concerns and policy debates around promoting an accelerated deployment.
    2. Currently being deployed incrementally application by application, largely driven by market needs and opportunities.
2. The former characterization tends to be intuitive, while the latter is revealing quantitative information regarding the intuitive assumption a bit at a time.

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Proposed Work Product: "Implications of High Penetrations of Energy Storage into Electric Transmission and Distribution Systems" White Paper

Purpose of white paper is to better characterize the more intuitive nature of energy storage potential by…

1. Providing a framework for intentionally performing additional quantitative measures to more thoroughly characterize the vision of energy storage as a transformative agent in the grid, both physically and institutionally.
2. Qualitatively examining the implications of high penetrations of energy storage into electric transmission and distribution systems.

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Proposed Work Product: "Implications of High Penetrations of Energy Storage into Electric Transmission and Distribution Systems" White Paper

1. Perhaps, exploring this subject in the context of energy storage being a temporal power flow device will reveal unexpected opportunities or challenges for deploying energy storage in high penetrations in transmission and distribution systems.
2. It is anticipated that this exercise will provide some guidance for performing measurements for better quantifying energy storage's potential.

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A Call for EAC Discussion and Recommendations