Energy Storage Subcommittee Report

High Penetration of Energy Storage Work Product

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To the Electricity Advisory Committee, June, 7, 2017

High Penetration of Energy Storage Resources on the Electricity System

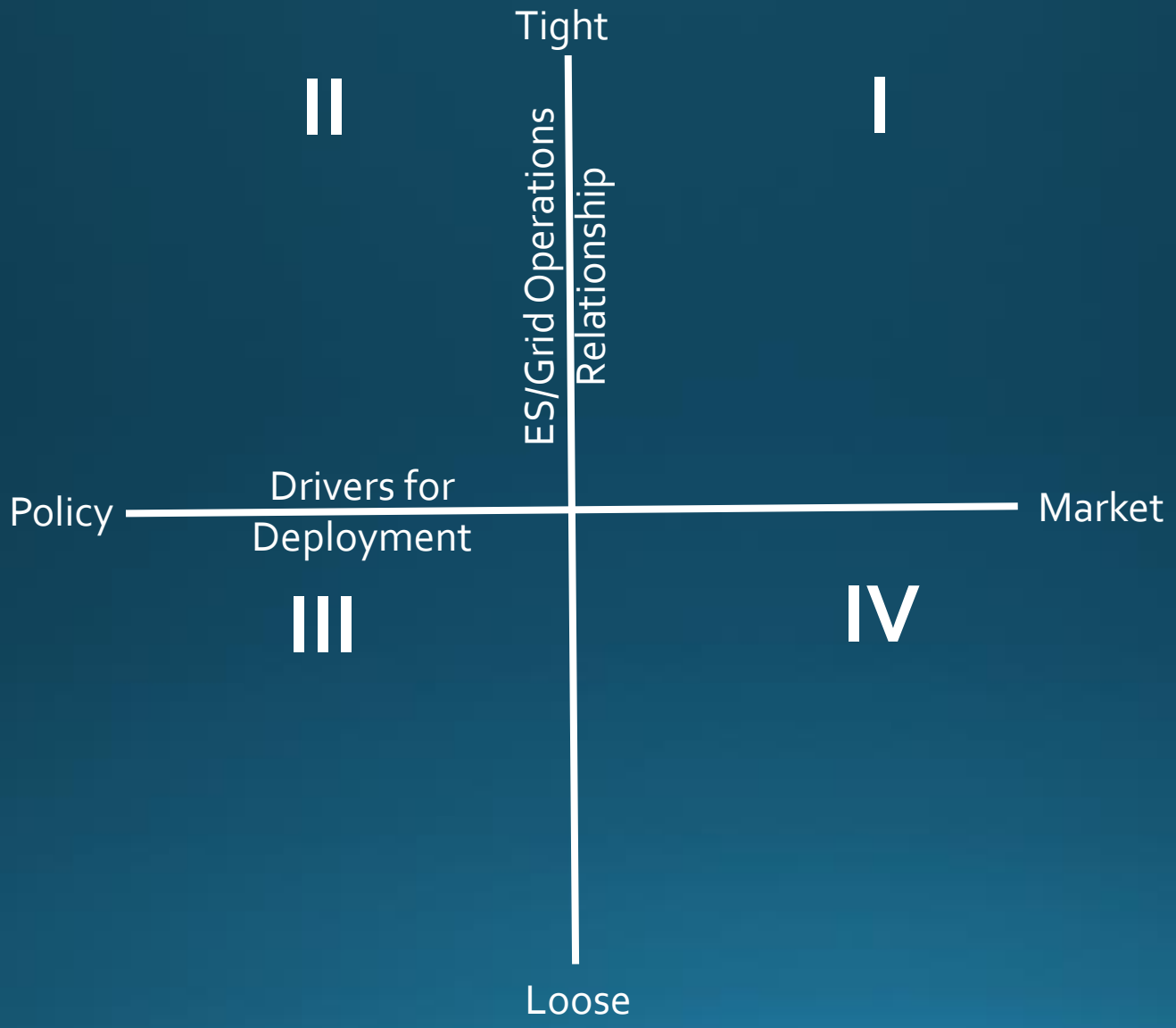
Grid needs better understanding of the potential benefits vs. dislocations of high penetrations of energy storage.

Purpose of white paper, "*High Penetration of Energy Storage Resources on the Electricity System*," is to:

1. Examine qualitatively the implications of high penetrations of energy storage into electric transmission and distribution systems.
2. Provide a framework for …
   a. Identifying quantitative measures to more thoroughly characterize the vision of energy storage as an agent in the grid, both physically and institutionally, and
   b. Defining a grid technology R&D program that would enhance the benefits and mitigate the dislocations of high penetrations of energy storage.

The DOE is the focal audience for the white paper.

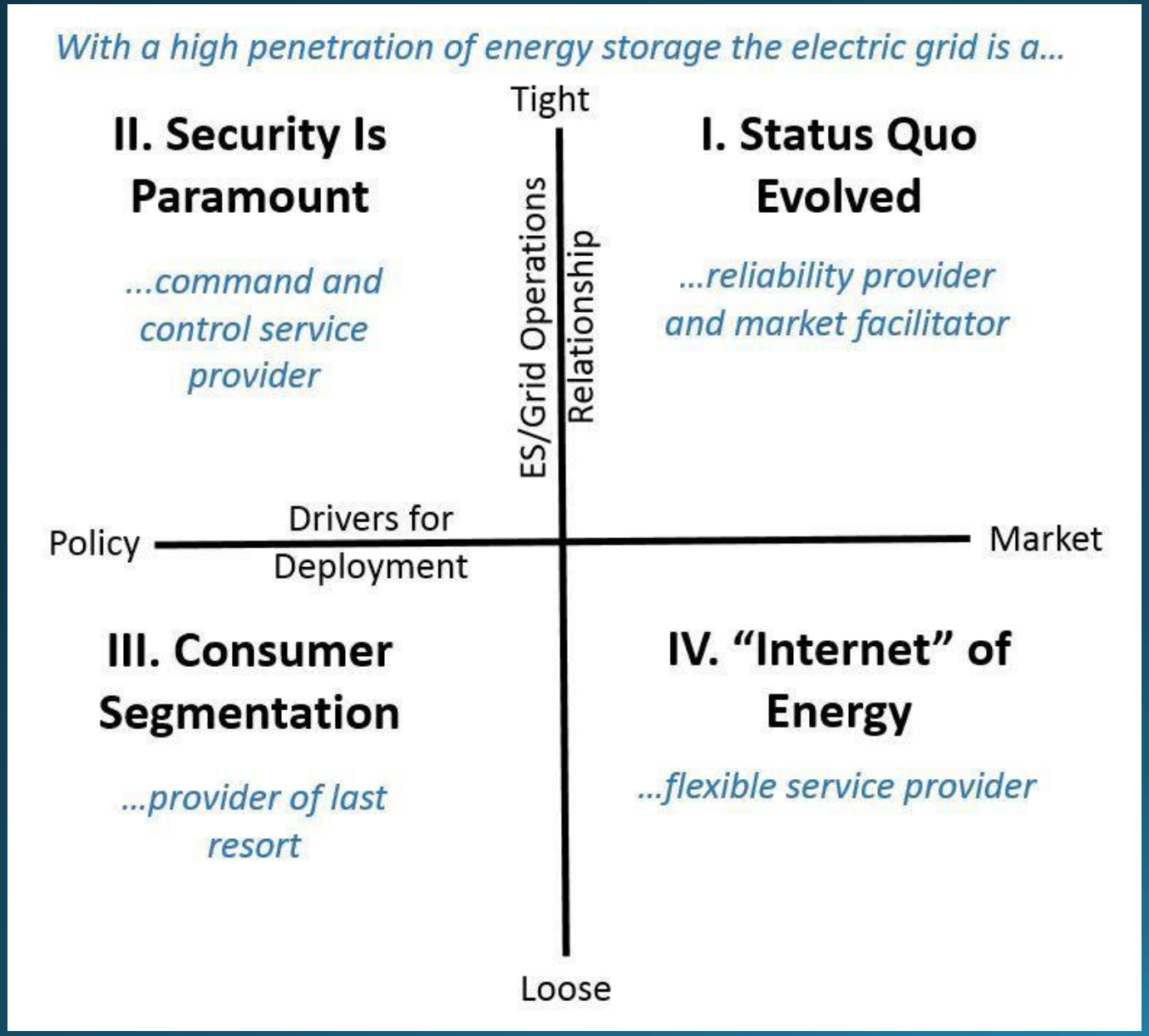
Scenario planning was used as a tool.



Some key assumptions were made about the future.

1. High penetration of energy storage
   a. Electric and non-electric forms of energy storage available
   b. Markets determine types of energy storage
2. Demand for electricity is price elastic
3. The grid offers at least a minimal level of reliability.

The scenarios are summarized below.



We looked for significant features that either were

- Robust across scenarios, or
- Singular but high consequence.

Some key conclusions/recommendations constant across scenarios.

1. Significant impacts to
   a. grid infrastructure, the utility role and business model, and
   b. the costs and flexibility facing customers
2. Substantial growth in the penetration of variable, distributed generation in driving the demand for storage;
3. The high penetration of storage establishes a critical need to clearly define who holds responsibility for resource planning and reliability;
4. A high penetration of storage will reduce the need for flexible generation and grid expansion; and
5. The interconnection of distributed storage resources calls for an increased focus on infrastructure security and energy reliability..

Many other conclusions/recommendations presented in a table in the paper.

Stakeholders Impacted	Recommendations for DOE's Research and Analysis Efforts
	** Indicates a recommendation resulting from multiple scenarios.* *I, II, III, and IV indicate which scenario resulted in the recommendation.*
Grid Owner/Operator	• Evaluate ways to expand electric system visibility, including visibility into available multi-use distributed energy storage capacity.* • Promote probabilistic forecasting and reliability modeling tools.* • Facilitate coordination and identify the operational needs between the reliability coordinator and the generation, transmission, and distribution operators that will enable transactive markets to function and support prosumer participation.* • Support research efforts into the cyber-hardening of grid technologies. • Evaluate how use of automation and AMI can support rapid response. (IV) • Support the development of planning and modeling tools that identify the "core grid characteristics," and optimize the types of storage and grid-access system requirements, which can be applied to wide areas, interconnection or microgrids. (II) • Promote research into energy-efficient storage technologies. (III) • Support development of tools and strategies to address challenges associated with the reduction in system inertia due to stiff loads and asynchronous resource connections (e.g., new control strategies, power electronic controllers, and protection systems to address the high-speed, un-damped reaction from grid disturbances, such as from routine events like weather-induced faults)* • Develop coordination algorithms to enable optimal charging of battery resources, while at the same time supporting local demand and grid essential reliability services.*
Policymakers and Regulators	• Develop frameworks to quantify and value reliability and resiliency.* • Research minimum technical and economic requirements that would enable greater DER interconnection or grid defection.* • Research and publish rate design, regulatory, and policy best practices ("dos" and "don'ts" to help avoid grid defection). (III) • Convene working groups to resolve conflicts between policy and free market behavior. (I) • Research market design that will allow transactive and flexible markets to develop. (IV) • Examine conflicts of interest between defector and disenfranchised consumers. (III) • Research business and regulatory models, roles, and platforms. (IV) • Evaluate novel subscription and spot distribution tariff alternatives. (IV) • Continue to produce and fund publicly available information on grid-connected storage deployment and policies.*
Stakeholders Impacted	**Recommendations for DOE's Research and Analysis Efforts**
Market Designers and Facilitators	• Review jurisdictional responsibilities for ensuring grid reliability.* • Formulate market designs that function according to the following:* ➢ In a highly regulated environment. (II) ➢ Where microgrids dominate the landscape. (III) ➢ In a transactive energy market. (IV) • Evaluate energy storage deployment in varied topologies and for a wide range of functions and uses. (I)
Consumers	Provide funding opportunities for pilot projects and testing to ensure storage products are safe, automated, and user-friendly.* • Develop standards to govern the operation and integration of energy storage assets that preserve cyber and physical security.* • Support development of storage technologies that can operate as part of a microgrid system.* • Research technologies that facilitate greater communication between participants in transactive energy markets. (IV)
All Electricity Market Players	• Develop detailed safety, performance, and consumer protection standards for storage technology.* ➢ Examine appliance standards that include storage for water heating and space heating. • Develop modeling tools and more elaborate scenario analysis methods (with a focus on storage) that yield greater system visibility and data transparency.* • Identify risk regions, utilities, and/ or sectors facing imminent grid defection.* • Develop integrated planning tools that model reliability.*

Grouped By Stakeholder

Finally, EAC recommends that:

1. DOE conduct scenario studies that are similar to the one completed by the ES Subcommittee, yet that are more robust and comprehensive;
2. DOE-led scenario studies address a wider range of subject questions and variable drivers, and include different sets of scenario planning participants from among electric gird stakeholders.

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EAC Discussion and Vote