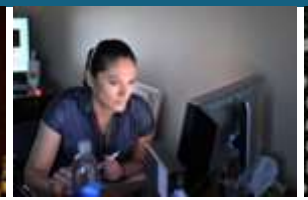
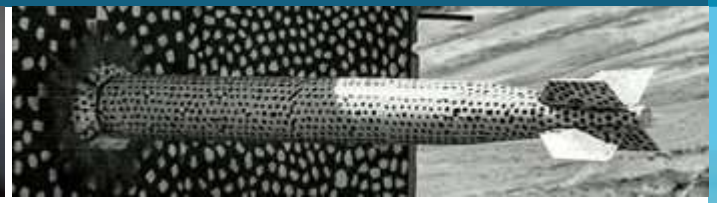
Energy Storage Evaluation Tools: How do you value energy storage?





PRESENTED BY

Ricky Concepcion

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

SAND2019-2630 C

OUTLINE

- Introduction
- Value streams
- Value stacking
- Project modeling and software tools
- Sandia's QuESt
- Conclusions

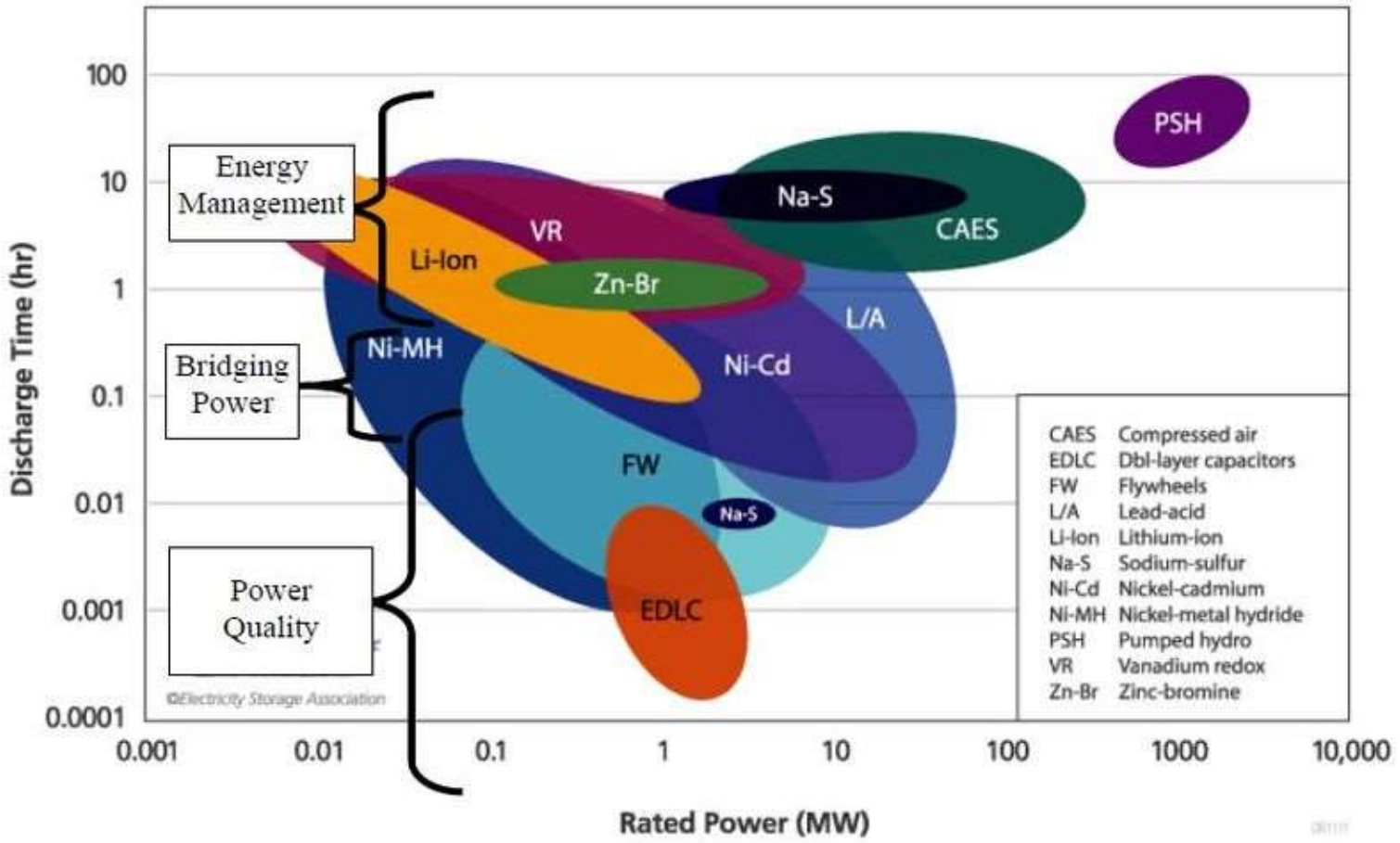
Source: Sandia National Laboratories (Flickr)

INTRODUCTION

- Project development is an exercise in risk management
- Understanding the performance of the energy storage project is essential
- Technical performance impacts economic performance
- Can the system perform to generate value to outweigh capital and operating costs and make the project financially viable?

Source: Sandia National Laboratories (Flickr)

ENERGY STORAGE PERFORMANCE



Source: Energy Storage Association

"Energy storage systems are not simply reversible energy sinks; they are a highly engineered system with the innate ability to be the most flexible and valuable asset on the power grid."

- Generally, electricity generated must be immediately consumed
- Energy storage comes in a diverse array of varieties to fill different roles in the grid

VALUE STREAMS BY CATEGORY

Value streams can generally fall into three categories:

Discrete

- Tied to actual services or products in formal electricity markets
- Easily and publicly contracted
- ex: frequency regulation

Definable

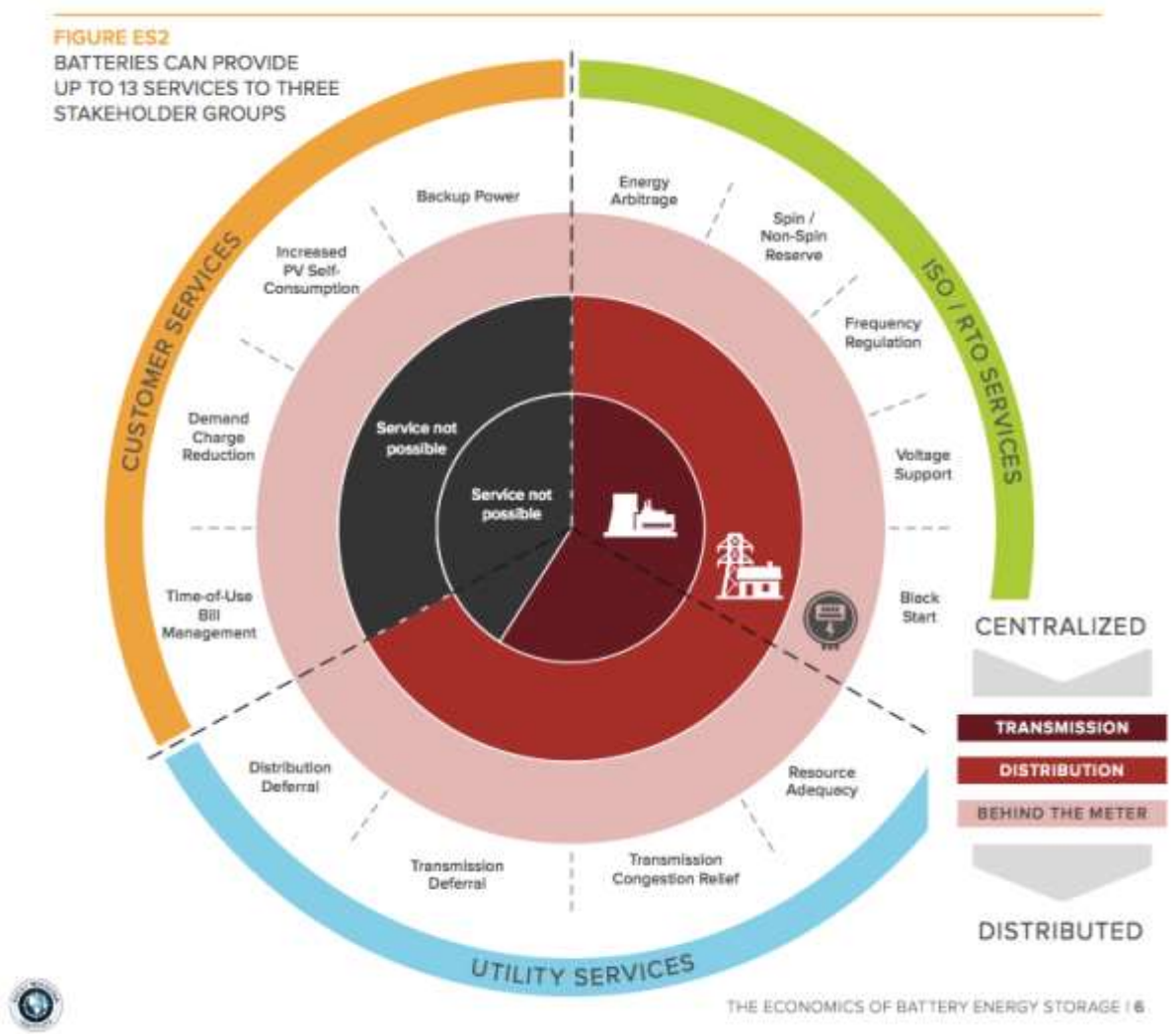
- Have value to another market participant but is typically location-specific
- Difficult to generalize to an entire market
- ex: black start

Indeterminate

- Not easily quantifiable in a systematic valuation basis
- In the conversation as a market driver but cannot contract for
- ex: resiliency

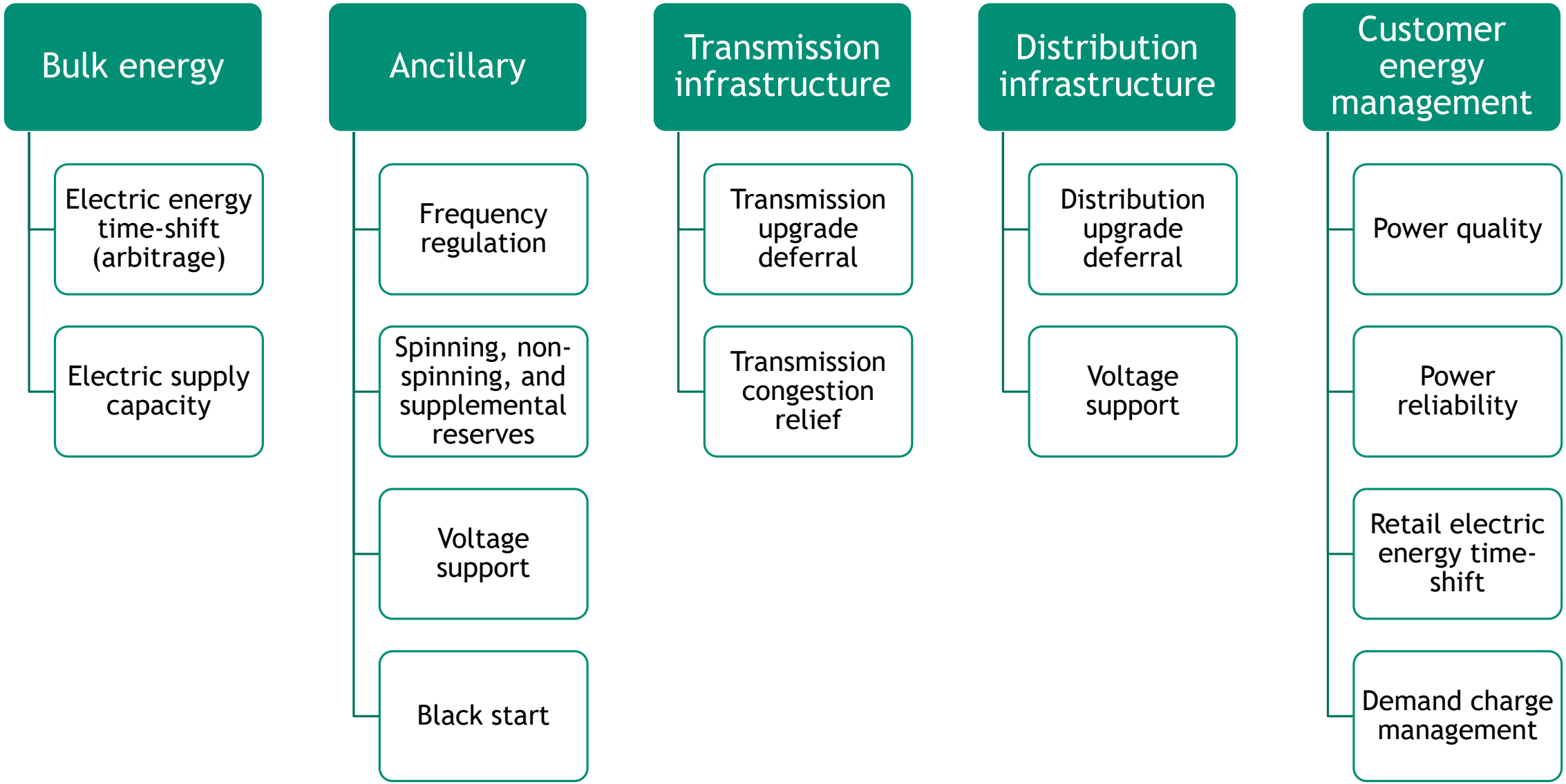
VALUE STREAMS BY STAKEHOLDER

- Energy storage can provide services at different levels on the grid
- Different applications are appropriate for different technologies



Source: Rocky Mountain Institute, *The Economics of Battery Energy Storage*

VALUE STREAMS BY SERVICE TYPES



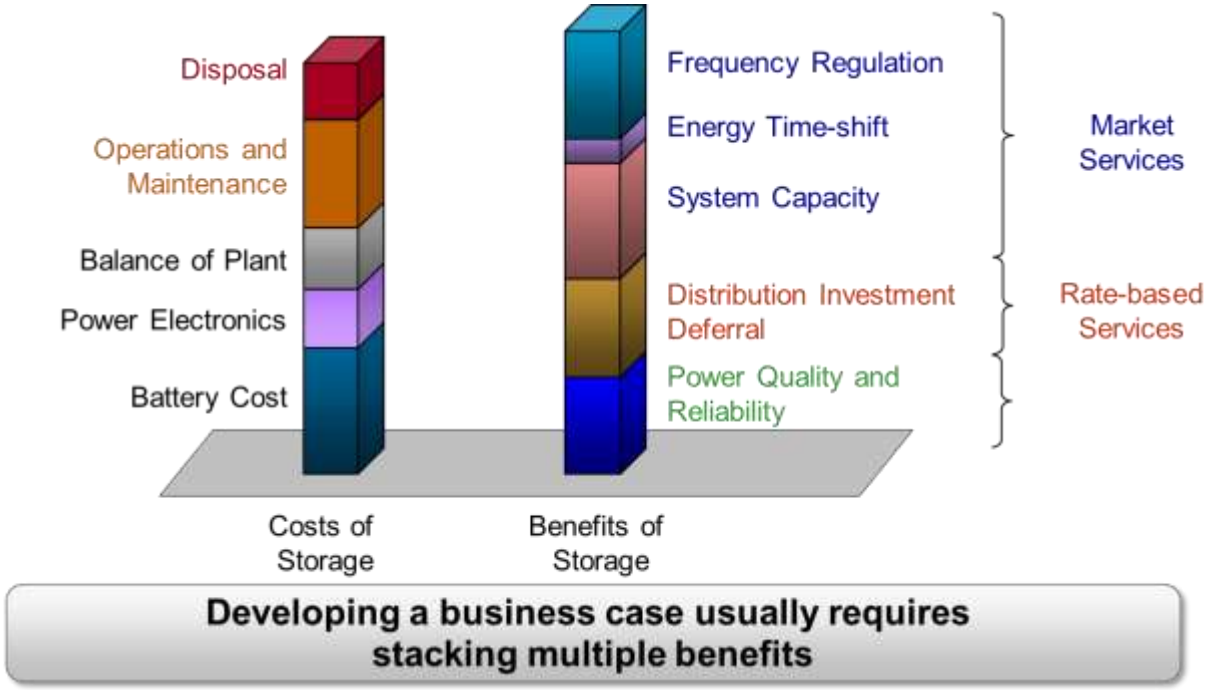
OTHER VALUE STREAMS

- Hybrid facilities with fossil units or renewable energy assets
- Colocation with large wind and solar facilities to alleviate interconnection limitations
- Onsite usage as backup power or coupling with onsite solar for self-generation
- Resiliency for mission critical loads
- Aggregation into “virtual power plants” for utilities; largely driven by solar

- Each individual revenue stream is generally insufficient to economically support the energy storage project
- Value stacking is virtually essential to generate sufficient value

Source: Clean Energy Group, *Sterling Municipal Light Dept. Energy Storage System*

VALUE STACKING



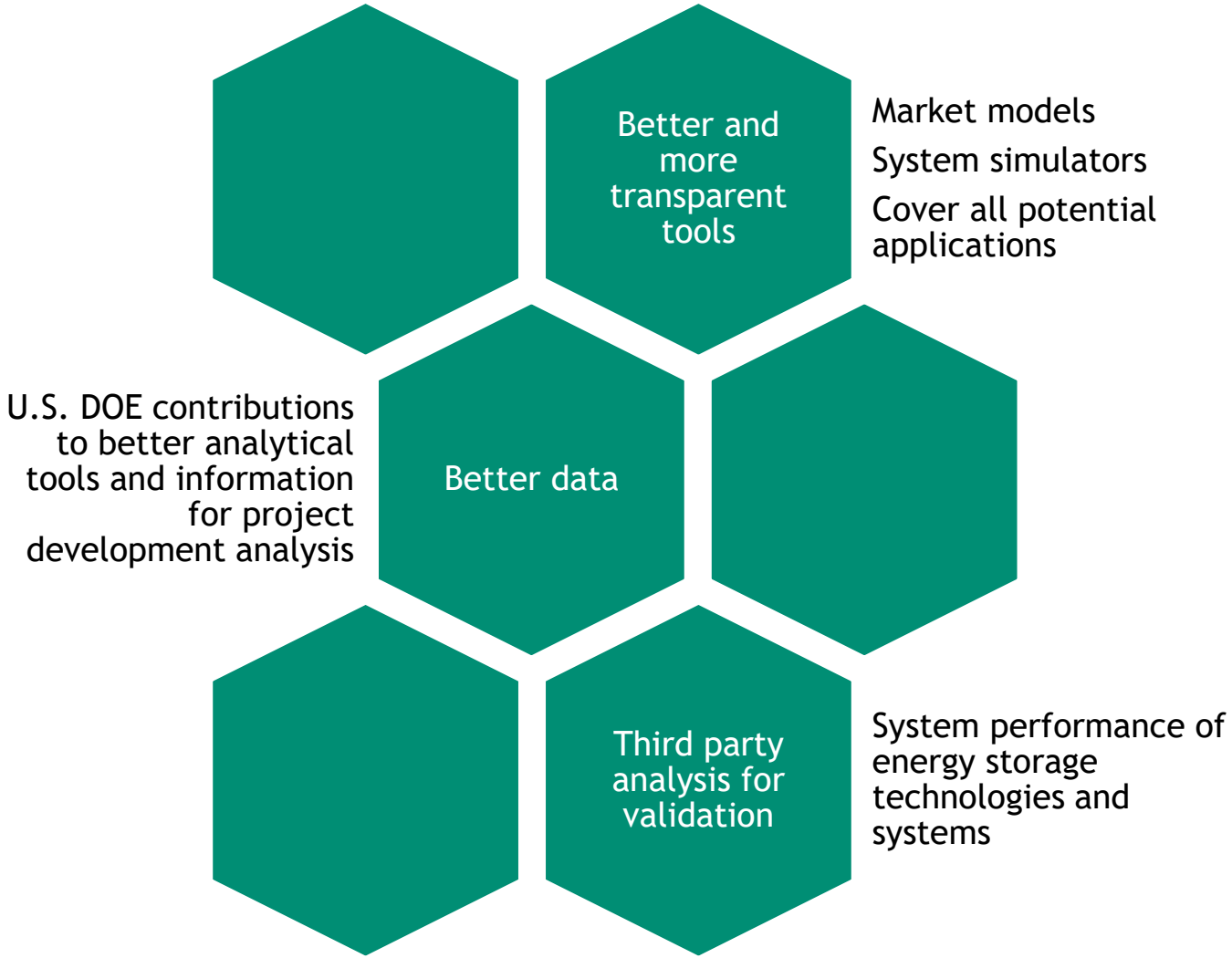
Source: EPRI

Optimizing the mix of potential applications and operating over it is complex.

- Different technical capabilities for each installation
- Each application competes for the energy storage system's energy and power
- Operating in an inherently uncertain environment
- The best mix and operational strategy for revenue generation may not be the best value

PROJECT MODELING

What stakeholders in energy storage projects have indicated what they want…



SIMULATION MODELS

"The lending community in particular is eager for improved and standardized modeling tools so they can evaluate projects from different developers more easily."

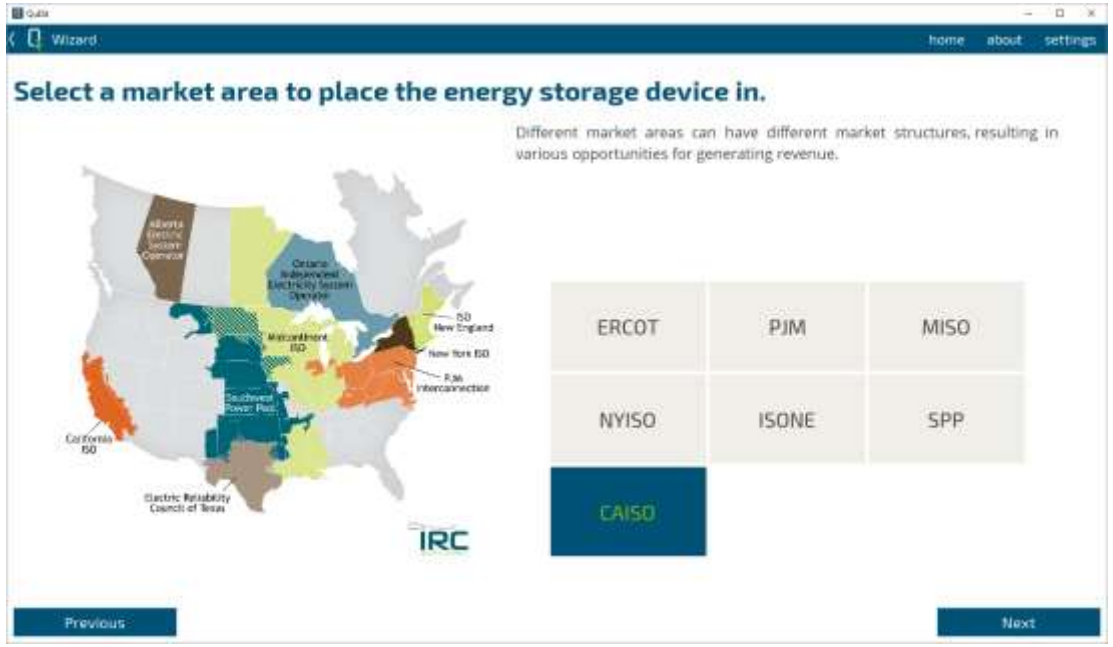
System Advisor Model (SAM)	Hybrid Optimization Model for Multiple Energy Resources (HOMER)	Storage Value Estimation Tool (Storage VET)	And more…
• Developed by National Renewable Energy Laboratory (NREL) • Project-based performance and financial model • Focused on renewable energy but can incorporate energy storage assets • Desktop application with software development kit	• Developed by Homer Energy, LLC (from NREL) • Microgrid design and operation/simulation software • Incorporates energy storage assets into microgrid • Desktop software or web application with commercial license and some free options	• Developed by Electric Power Research Institute (EPRI) • Energy storage simulation tool to estimate costs and benefits • Designed for site-specific energy storage projects • Free web-based application	• Pacific Northwest National Laboratory (PNNL) • Sandia National Laboratories (SNL) • …

QUEST: OPTIMIZING ENERGY STORAGE

- Developed by Sandia National Laboratories
- Initially released in September 2018
- Designed specifically for energy storage
- Emphasis on using publicly available resources
- Focus on valuation from the operation perspective
- Desktop application, free, open-source

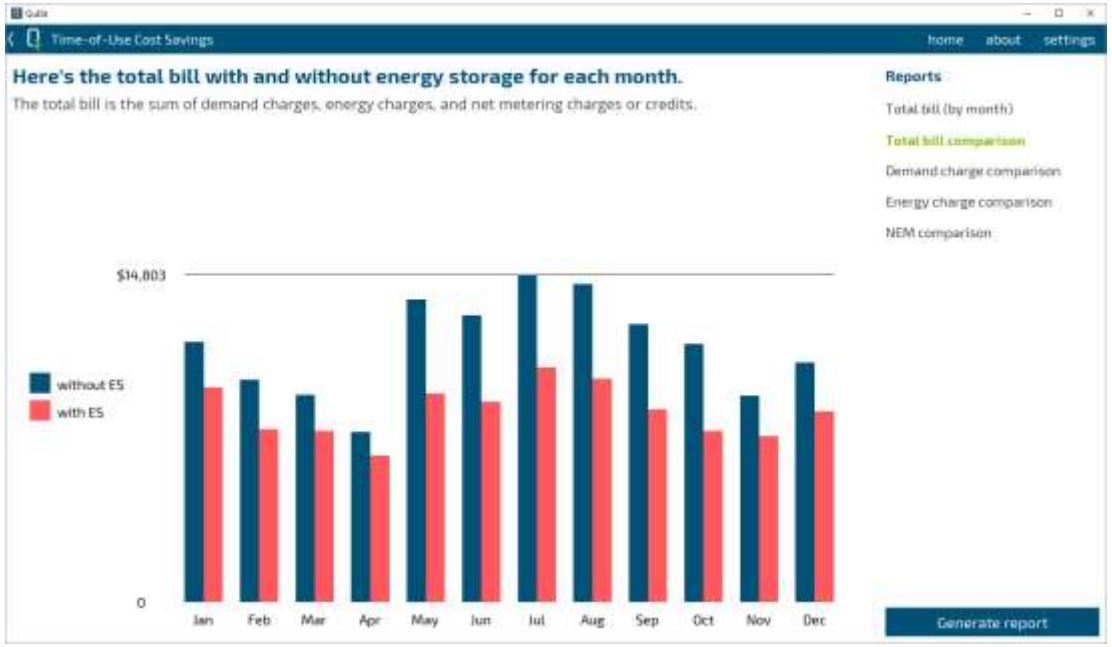
QUEST VALUATION: ISO/RTO SERVICES

- Front-of-meter energy storage system participation in ISO/RTO markets
- Value stacking with energy arbitrage and/or providing ancillary services
- Use historical market data to forecast revenue generation potential
  - Extrapolate system value using retrospective analysis



QUEST BTM: CUSTOMER SERVICES

- Suite of analysis tools for behind-the-meter (BTM) energy storage systems
- First release includes tool for estimating cost savings for time-of-use customers
  - Demand charge reduction, energy charge reduction, net metering credits
  - Support for onsite solar + storage facility configurations



CONCLUSIONS

- A successful energy storage system project requires understanding of all sources of risk
- The value provided by energy storage is necessary for an economic model of the project
- Value streams can be discrete, definable, or indeterminate with different degrees of ease in quantifying benefit
- Value stacking is imperative for financial viability, but knowledge of the technical capabilities of the proposed system is key for developing the optimal value stack
- Project modeling tools to standardize project comparisons are highly sought after and the U.S. DOE has been contributing to this space
- Sandia National Laboratories is developing QuESt to provide valuation analysis tools

Source: Clean Energy Group, *Sterling Municipal Light Dept. Energy Storage System*

THANK YOU

Ricky Concepcion

Member of Technical Staff

Electric Power Systems Research

Sandia National Laboratories

rconcep@sandia.gov

Acknowledgment

Special thanks to Dr. Imre Gyuk, the program manager for the U.S. Department of Energy Office of Electricity Energy Storage program, for guidance and supporting the energy storage program at Sandia.

References

- Baxter, Richard. “Energy Storage Financing: Performance Impacts on Project Financing.” SAND2018-10110, Sandia National Laboratories (2018).
- Akhil, Abbas A., et. al. “DOE/EPRI Electricity Storage Handbook in Collaboration with NRECA.” SAND2015-1002, Sandia National Laboratories (2015).
- Byrne, Raymond H., et al. “Energy management and optimization methods for grid energy storage systems.” *IEEE Access* 6 (2018): 13231-13260.
- Energy Storage Systems @ Sandia, www.sandia.gov/ess
- QuESt, www.github.com/rconcep/snl-quest

Source: Clean Energy Group, *Sterling Municipal Light Dept. Energy Storage System*