FLUENCE

A Siemens and AES Company

Transforming the way you power your world.

FLUENCE
A Siemens and AES Company

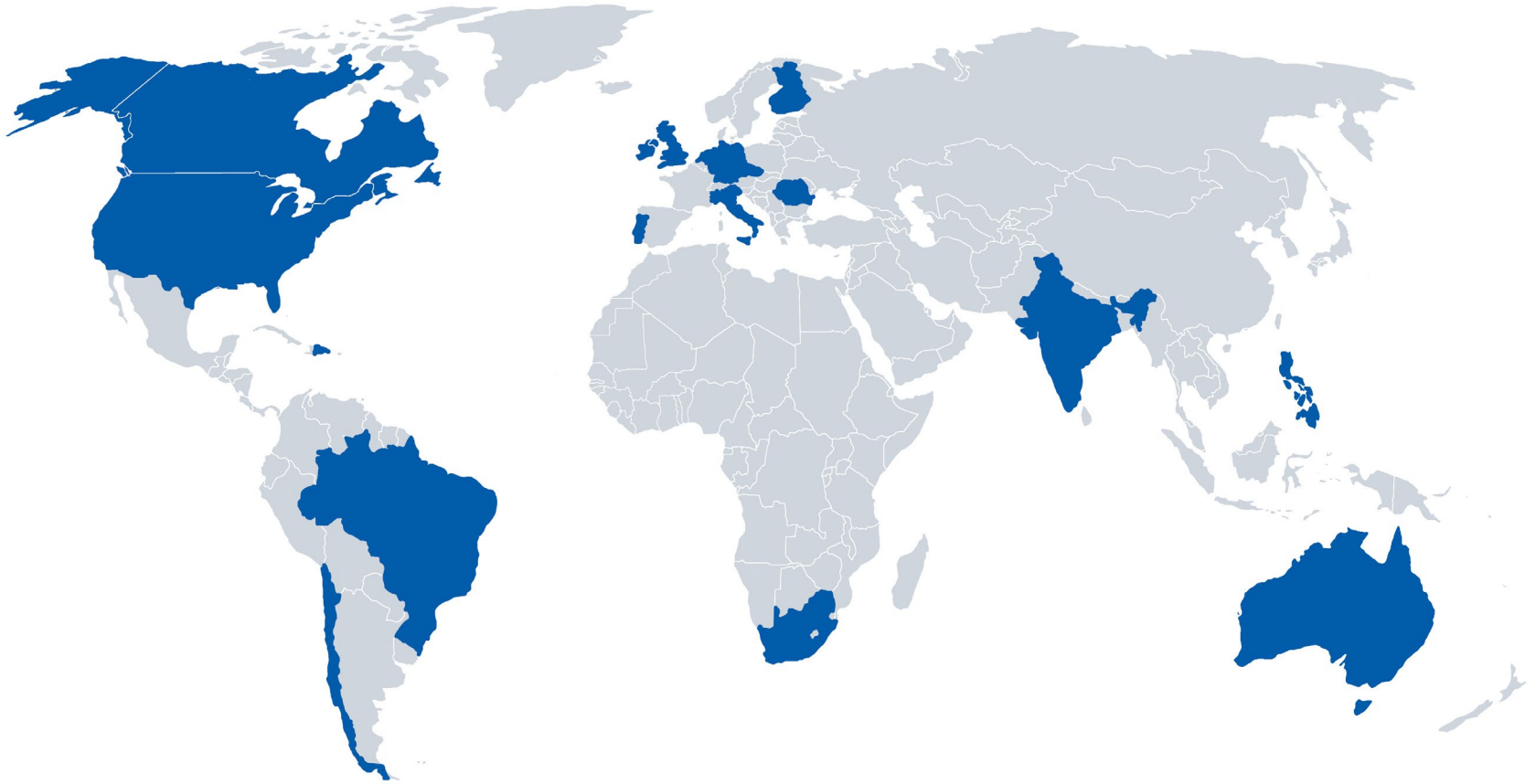
Fluence is the global leader in energy storage

760+
TOTAL MW

80+
PROJECTS

17
COUNTRIES

11+
YEARS



30 MW of energy storage for San Diego Gas & Electric, California, United States

Largest deployed energy storage project in North America

- Flexible Peaking Capacity
- 30 MW / 120 MWh
- Contract to online in 6 months
- Sited on 1 acre, where a power plant could not be permitted

Flexible Peaking Power

AES Alamitos

Long Beach, California, United States

100 MW / 400 MWh

SERVICES

- Capacity, local reliability
- Peak power/off peak mitigation
- Ancillary services

IMPACT

- Competitive bid vs thermal peaker, cost effective
- Replaces environmental retired units
- Meets flexibility (duck curve)

Topic for Today: Risk Mitigation for Energy Storage Deployment

- Split overall risks related to energy storage into two categories:

1. Technical (Risk related to action)

   ➢ Related to storage solution performance over time and other risks related to design and engineering of solution platform.

2. Market (Risk related to inaction)

   ➢ Risk created to ratepayers because of lack of inclusion of storage in key planning analysis and subjecting customers to stranded costs across, G, T and D domains .

1 Technical and commercial flexibility are key aspects to ensure the project delivers on its lifetime value

TECHNICAL FLEXIBILITY

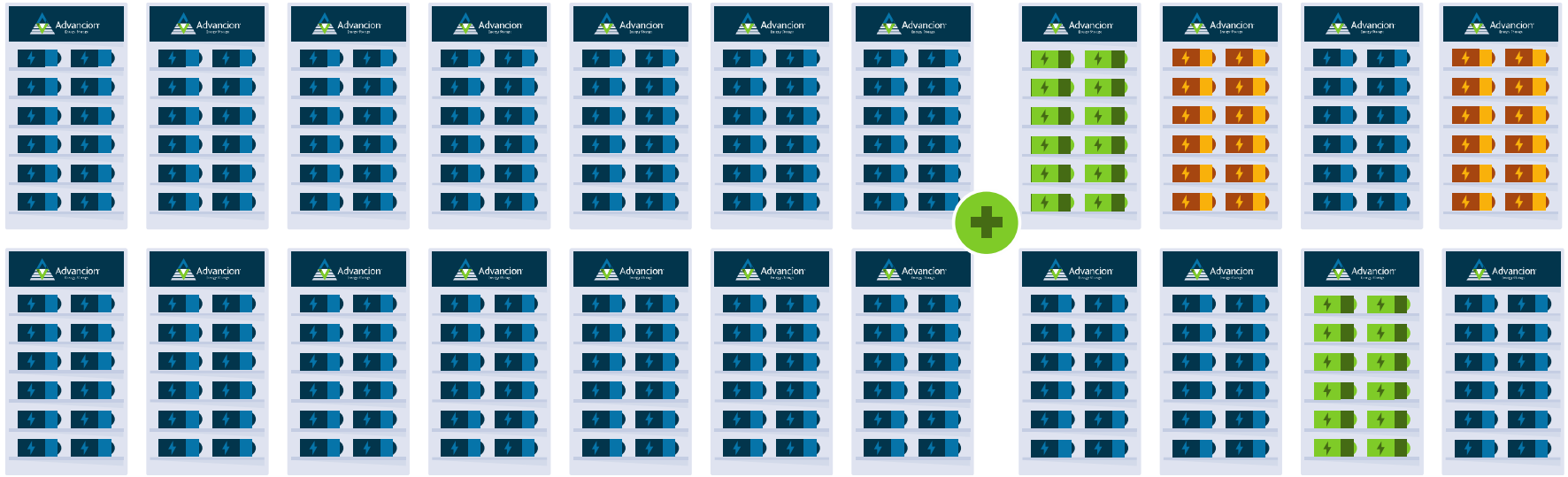
- Interchangeable software and hardware to maximize component flexibility
- Multiple product generations and years of experience – a platform designed for constant innovation

COMMERCIAL FLEXIBILITY

- Ability to offer on-site support enhances likelihood of commercial success
- Supplier who can be flexible across a range of O&M options, both at contracting and throughout project lifespan
- Willing to offer performance guarantees and able to stand behind them

The supplier landscape is shifting, and many storage solution providers struggle to adapt systems from one supplier to another. Knowing your solution provider can incorporate the most valuable components over time minimizes total system cost. Similarly, O&M needs can vary over course of project, a good solution provider will provide on-site support, and be open to shifting course as needed over project lifespan

1 Avoiding Single Supplier Lock-In and Modular Architecture are Key Factors to Consider in a Storage Solution (Potential Risks)



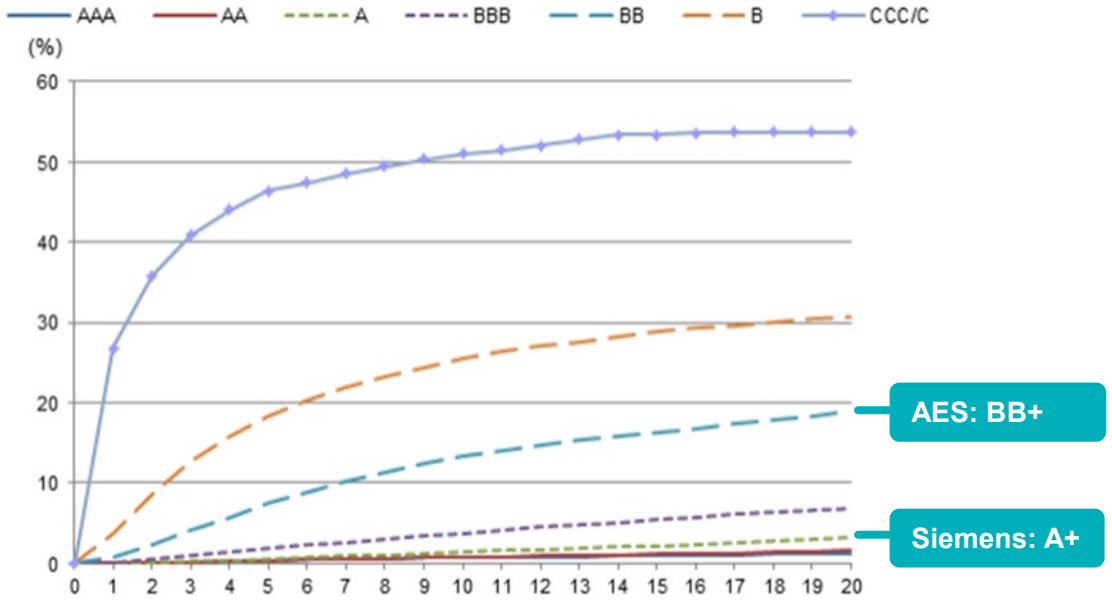
Previously deployed batteries in the system

Future additions of batteries (potentially from other suppliers)

When the need arises, storage platform should be able to integrate the latest battery technology, and function seamlessly with existing components.

1 A stable storage solution provider will reduce risk that BESS will become either an impaired or a stranded asset

Global Corporate Average Cumulative Default Rates By Rating (1981 – 2016)



Sources: S&P Global Fixed Income Research and S&P CreditPro®.

- **Financial stability varies widely** between solution providers and their guarantors
- Also, the degree to which a solution provider is **focused on energy storage** vs. pulled in multiple directions
- The risk that a solution provider could disband their storage business, or focus elsewhere due to financial pressure, raises the risk of a **costly-to-maintain**, **unsupported BESS**

1 Several “Key Questions to Ask” to Assess Capabilities of Energy Storage Solution Provider

Technology Platform

- What options exist within the technology platform for providing additional market services over time?
- Is the architecture of the system setup in a manner to provide long term risk diversification?
- Is there a demonstrated history of performance of the system?
- Have there been design improvements made to the platform based on historical experience and feedback from the market?

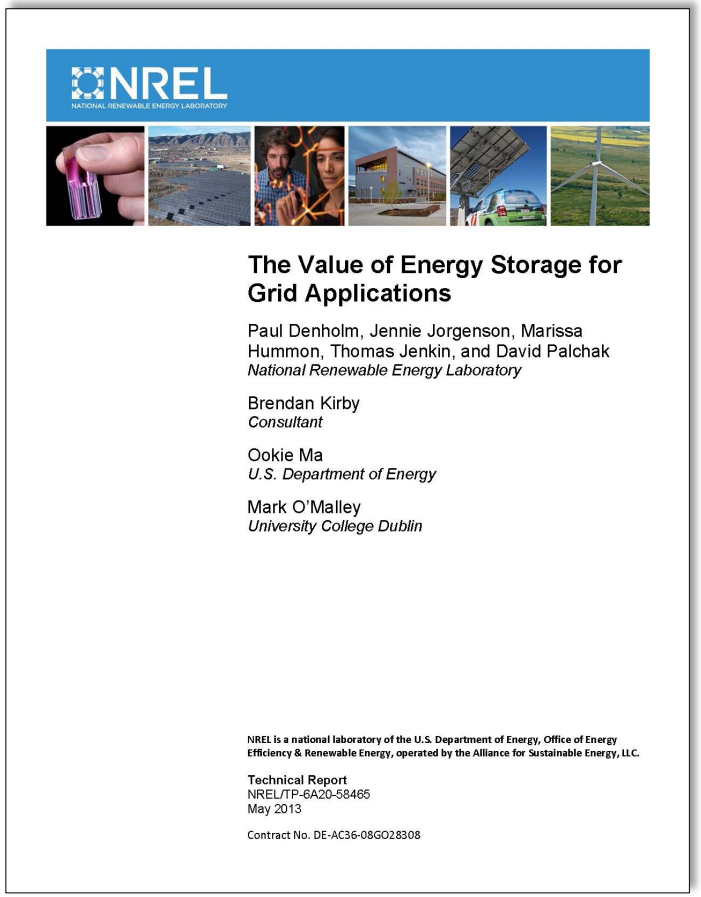
Solution Performance

- Whose job is it to perform a root cause analysis in case things go wrong? If the different suppliers aren’t in agreement, whose responsibility is it to fix the system?
- What type of risk exposure exists on the purchases?
- What happens if a battery component supplier goes bankrupt?
- What happens if the standards change and you can’t get access to specific spares needed for the system over the next 15-20 years?

Supplier Relationships

- Do you have access to tier-1 suppliers to purchase at scale that can guarantee availability of components to deliver the project on a timely basis?
- Have you negotiated terms/conditions for purchasing with suppliers?
- Do those terms have provisions for handling warranty and usage of battery?

2 DOE/National Lab Efforts in Analytics on "Value of Storage as a Peaker" over the years have been critically important for growth.


NREL

The Value of Energy Storage for Grid Applications

Paul Denholm, Jennie Jorgenson, Marissa Hummon, Thomas Jenkin, and David Palchak
National Renewable Energy Laboratory

Brendan Kirby
Consultant

Ookie Ma
U.S. Department of Energy

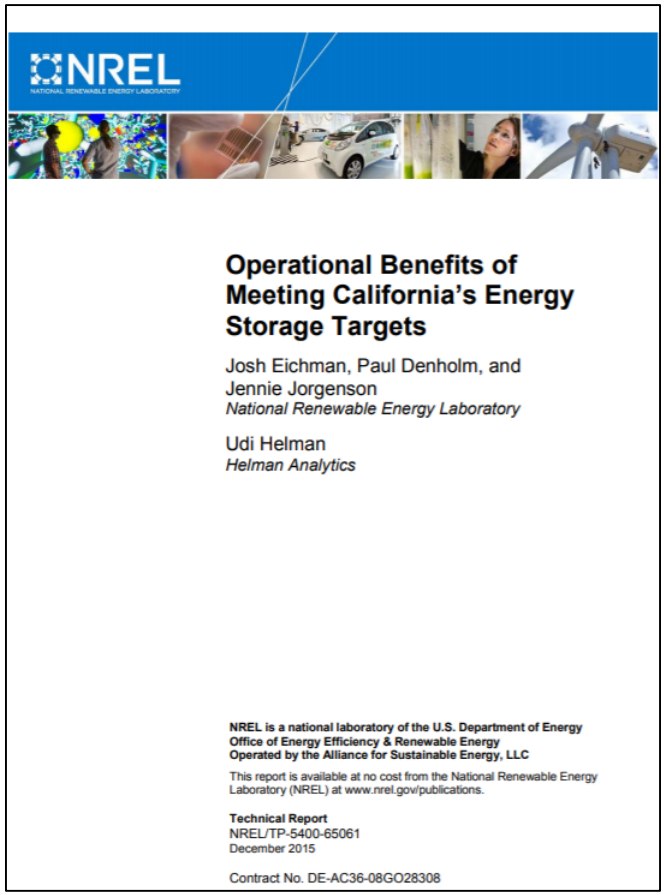
Mark O'Malley
University College Dublin

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

Technical Report
NREL/TP-6A20-58465
May 2013

Contract No. DE-AC36-08GO28308

2013


NREL

Operational Benefits of Meeting California's Energy Storage Targets

Josh Eichman, Paul Denholm, and Jennie Jorgenson
National Renewable Energy Laboratory

Udi Helman
Helman Analytics

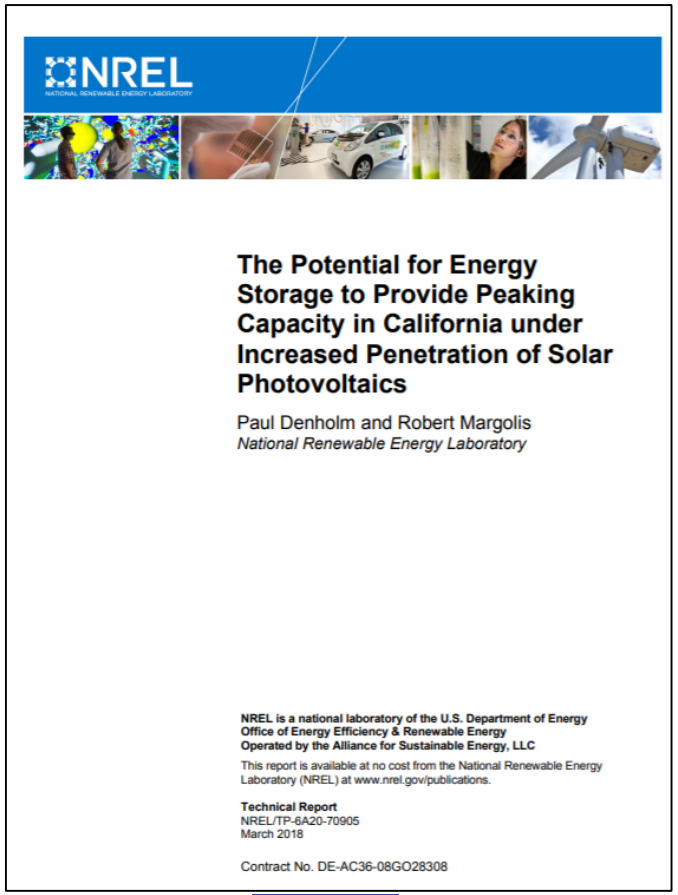
NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Technical Report
NREL/TP-5400-65061
December 2015

Contract No. DE-AC36-08GO28308

2015


NREL

The Potential for Energy Storage to Provide Peaking Capacity in California under Increased Penetration of Solar Photovoltaics

Paul Denholm and Robert Margolis
National Renewable Energy Laboratory

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Technical Report
NREL/TP-6A20-70905
March 2018

Contract No. DE-AC36-08GO28308

2018

2 Storage as Flexible Peaking Capacity Gaining Traction – Need to Accelerate for Greater Adoption Across all IRP's; If slow adoption, we carry risk of carrying higher cost for consumers and stranded assets.

Sample of utilities that have identified storage in their Integrated Resource Plans (IRP).

Not a comprehensive list, only meant to illustrate examples of select utility IRPs.

Utility	State
Arizona Public Service	AZ
Salt River Project	AZ
Tucson Electric Power	AZ
Southern California Edison	CA
Pacific Gas and Electric	CA
San Diego Gas & Electric	CA
Xcel	CO, MN
Florida Power & Light	FL
Georgia Power	GA
Hawaiian Electric	HI
Indianapolis Power & Light	IN
Kentucky Power	KY
Consumers Energy	MI
NV Energy	NV
El Paso Electric	NM
Duke Energy	NC
Pacific Power	OR
Portland General Electric	OR
Dominion Energy	VA
Appalachian Power	VA
Puget Sound Energy	WA
Avista	WA

- Not including energy storage as a capacity resource in IRP's is a key risk to consumers.
- On the generation side, any investment that can only be recovered on fixed-cost basis (capacity contract) has to be analytically compared against energy storage as an option.
- Continued focus of DOE/labs should drive duration requirement needed to satisfy peak capacity needs.

2 Analytic Tools to Study Storage for Congestion Relief should be developed further.

Storage Proposed in PJM 2019 Market Efficiency Window to Relieve Congestion on Key Transmission Interfaces

pjm

Hunterstown - Lincoln 115 kV (Met-Ed)

PJM ID	Proposal Description	Greenfield/ Upgrade	Project Cost (In-Service $M)	In-Service Date
021	Rebuild Hunterstown-Lincoln 115 kV. Build a new Peach Bottom-Graceton 230 kV circuit. Upgrade Face Rock 115/69 kV transformers.	Upgrade	$56.69	2023
830	Build a new Littlestown-Germantown 115 kV line.	Greenfield	$44.92	2024
892	Install a 50 MW 2-hour battery at Lincoln 115 kV substation.	Greenfield	$28.98	2021
453	Install a 25 MW 4-hour battery at Lincoln 115 kV substation.	Greenfield	$26.69	2021
402	Build a new Hunterstown-Lincoln 115 kV line. Install a 25 MW 2-hour battery at Lincoln 115 kV substation.	Greenfield	$25.81	2021
413	Build a new Hunterstown-Lincoln 115 kV line. Install a 10 MW 2-hour battery at Lincoln 115 kV substation.	Greenfield	$19.22	2021

Source: PJM

- Energy storage is a highly effective option to help transmission grid function better.
- Numerous limitations (N-1, N-1-1, voltage and transient stability) constrain ability to transfer power.
- Energy storage can help address these very effectively. Need more analytic studies and literature to propel this application forward.
- Modeling and analytic tool related limitations should be addressed immediately.

Thank You

Kiran Kumaraswamy
VP, Market Applications
Kiran.Kumaraswamy@fluenceenergy.com
+1-571-527-8498