NAESB Energy Storage Task Force
Briefing Document

November 13th, 2020

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Standards Development in Energy Storage

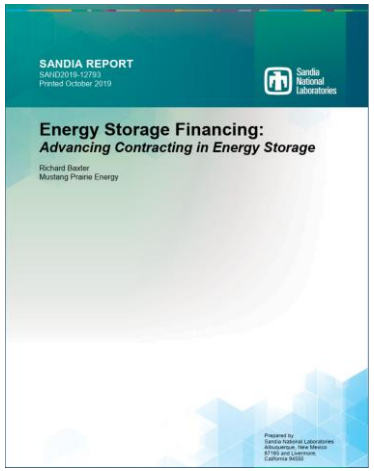
Standards Development Path as Industry Matures

Safety	UL 9540 NEC 480 NFPA 1, 70	• Fire Safety • Electrical Installation • First Responders • National Electrical Code
Reliability & Performance	IEEE 1547 NEMA ESS 1 NECA 416	• Interconnection & Interoperability • Performance Measurement • Installation Recommended Practices
Business Practice (Proposed)	**NAESB**	• Data Formatting • Payment Process • Contract Structure

Reduce Transaction Time, Cost, and Risk through Standardized Business Practices

Background Report

Energy Storage Financing: *Advancing Contracting in Energy Storage*



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U.S. DOE Funded Study Series: Energy Storage Financing

Energy Storage Financing Study Series

Goals

- Support Emerging Storage Technologies
- Lower Project Development Costs
- Highlight Risk Adjusted Return Drivers

Energy Storage Financing: (Reports)

- *A Roadmap for Accelerating Market Growth*
- *Performance Impacts on Project Financing*
- *Advancing Contracting in Energy Storage*
- *Project & Portfolio Valuation*
- *Operations & Strategy (Currently Underway)*

DOE Energy Storage Financing Summits

- Outreach to the Financial Industry
- DOE Engages Directly with Leaders Shaping the Industry
- Promote Networking: Financial and Storage Industry Leaders

U.S. DOE Energy Storage Financing Summits & Workshops

• 2020 – Sept 22nd & 23rd	Virtual	150 Attendees
• 2020 – Jan 14th	New York, NY	170 Attendees
• 2019 – Oct 22nd	San Francisco, CA	74 Attendees
• 2019 – Jan 23rd	New York, NY	146 Attendees
• 2018 – Oct 6th	San Francisco, CA	104 Attendees
• 2018 – Jan 18th	New York, NY	124 Attendees
• 2017 – June 7th	Washington, D.C.	84 Attendees
• 2017 – Jan 11th	New York, NY	68 Attendees
• 2014 – Dec 16th	New York, NY	65 Attendees

Next Summit & Workshop

- January 26th & 27th, 2021 – Virtual (Kirkland & Ellis)
- Free, Invitation Only

➢ **Invitations Can Be Sent to Interested NAESB Members**

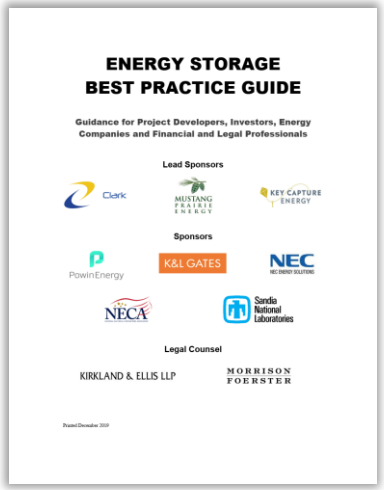
Industry Led Efforts to Improve Contract Development

Advancing Contracting in Energy Storage (ACES) Working Group: Energy Storage Best Practice Guide

A Free Resource to Help you Ask the Right Questions When Developing an Energy Storage Project

Key Points

- 18 Months Process
- 317 Pages
- 8 Sections / 37 Chapter
- Chapter Sections:
  - Background
  - Challenges
  - Best Practice
  - Resources
- 70+ Groups involved
  - 8 Committee Coordinators
  - 25 Chapter Leads
- Released: December 2019



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Lingering Issues

Revenue Recognition and Assurance

- Performance of Storage Systems Not Well Understood
- Optimizing Impartial Contracts Based on Differing Energy Storage Capabilities is Difficult
- Maximizing Uncontracted Project Revenue with High Assurance is Difficult

Insurance

- Liquidated Damages Have Limited Experience Providing Restitution
- Operation Risk Currently Held on Balance Sheets

Standardized Contract Structures

- Terminology Inconsistent
- Current Data Formatting Isolates Widespread Performance Information
- No Formal Link of System Performance to Market Performance

Next Steps: Application Performance Metrics

Application Performance Metrics

Definition

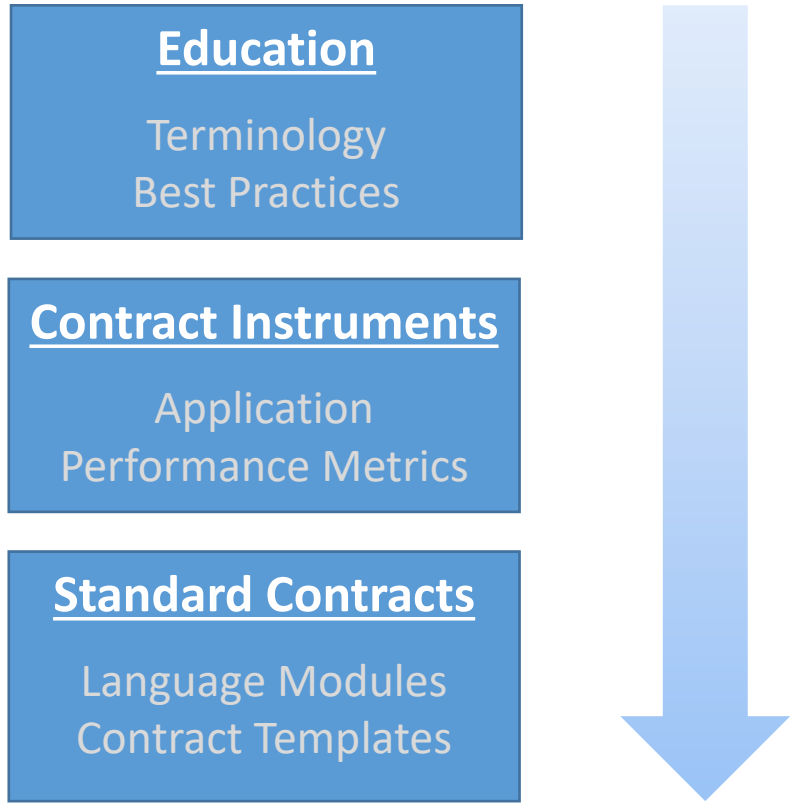
- Contract Instrument, Flexible to Different Market Needs
- Specific to User Performance Requirement
- Based on Regulatory Requirements and Unit Performance
- Project Operators Calculate Their Own Unit's "Score“ for a Specific APM
- Score is System and Application Specific
- Same System will Have Different Scores for Different APM
- Applications for APMs Can be the Same or Different than Existing Market Applications

Benefits

- Allows All Contract Parties to Independently Document System Performance
- Can Be Used to Ensure Greater Revenue Certainty for System Operation
- Allows Ranking of Providers in Their Provision of Services
- Can Be Used to Define Liability Responsibility in the Event of a Shortfall in Service

Where APMs Fit

The development of Application Performance Metrics is part of the industry’s movement toward developing standardized business practice for the energy storage industry



Current Market Applications for Energy Storage Systems

Market	Role	Applications	Oversight
Wholesale	Stand Alone Hybrid Operation	• Arbitrage • Peak Capacity Deferral • Reserves • Frequency Regulation • Ramping • Synthetic Inertia	FERC
Utility	Transmission Distribution Island / Microgrid Behind the Meter	• Transmission Deferral • Transmission Congestion Relief • Blackstart • Voltage Support • Microgrid / Islanding • Distribution Deferral	PUC
Behind the Meter	Industrial Commercial Hybrid Generation Residential	• TOU Energy Management • Demand Charge Management • Backup Power • Working Storage • Distribution Energy Management • Power Quality	PUC / FERC

Some BTM Units Active in Wholesale Markets

<u>Applications for APMs Can be the Same or Different than Existing Market Applications</u>

Power Industry Can Use APMs to Better Define Provision of Service

Existing Market Applications

Competitive Markets

- APMs will NOT rewrite ISO/RTO Product or Service Definition
- APMs Allow ISO/RTO to Develop New Product or Service Using Storage Systems with Different Requirements
  - Example: PJM RegA vs. RegD Frequency Regulation Market
- Payment Can be Ranked By Score

Grid Support

- Utilities Can Define Services with Different Unit Performance Requirements Based on Locational Technical Requirements
- Utilities Outside ISOs/RTOs Can Use APMs to Define Better Bilateral Contracts with Standardized Requirements
- Grid Reliability Services can be Provided with Greater Dependability and Accountability

Distributed Providers

- Distributed Energy Storage Systems Are Targeting ISO/RTO Markets
- APMs Provide Tools for ISOs/RTOs to Define Performance of Services to their Needs
- APMs Provide Tools for ISOs/RTOs to Define Payment of Services Based on Specific Unit Performance

Potential Market Applications

New Market Applications

- APMs Basis of New Services in Existing Markets Utilizing Energy Storage Capabilities
- Examples: Ramping, Synthetic Inertia (Inverters)

Renewable Energy

- APMs Allow for Contracted Dependability and Accountability of Storage
  - From Storage System Integrator (Standardized Usage Profile)
  - To Customer
- Hybrid Storage – Developers Create New Green Products with Enhanced Reliability
- Manage Distributed Storage Components in Community Solar Array

Peer to Peer

- APMs Provides Tools for Standardized Service Provision
- Support Higher Reliability of Service Provision and Accountability

Technical Performance Metrics

Technology Performance

Technology-Based Performance Characteristics Based on Unit Manufacturing Design

- Cycle-Life
- Calendar Life
- Ramp Rate (Power)
- Response Time
- Reactive Power Ramp Rate
- Reactive Power Response
- Round Trip Efficiency (RTE)
- Self-Discharge Rate
- Standby Energy Loss

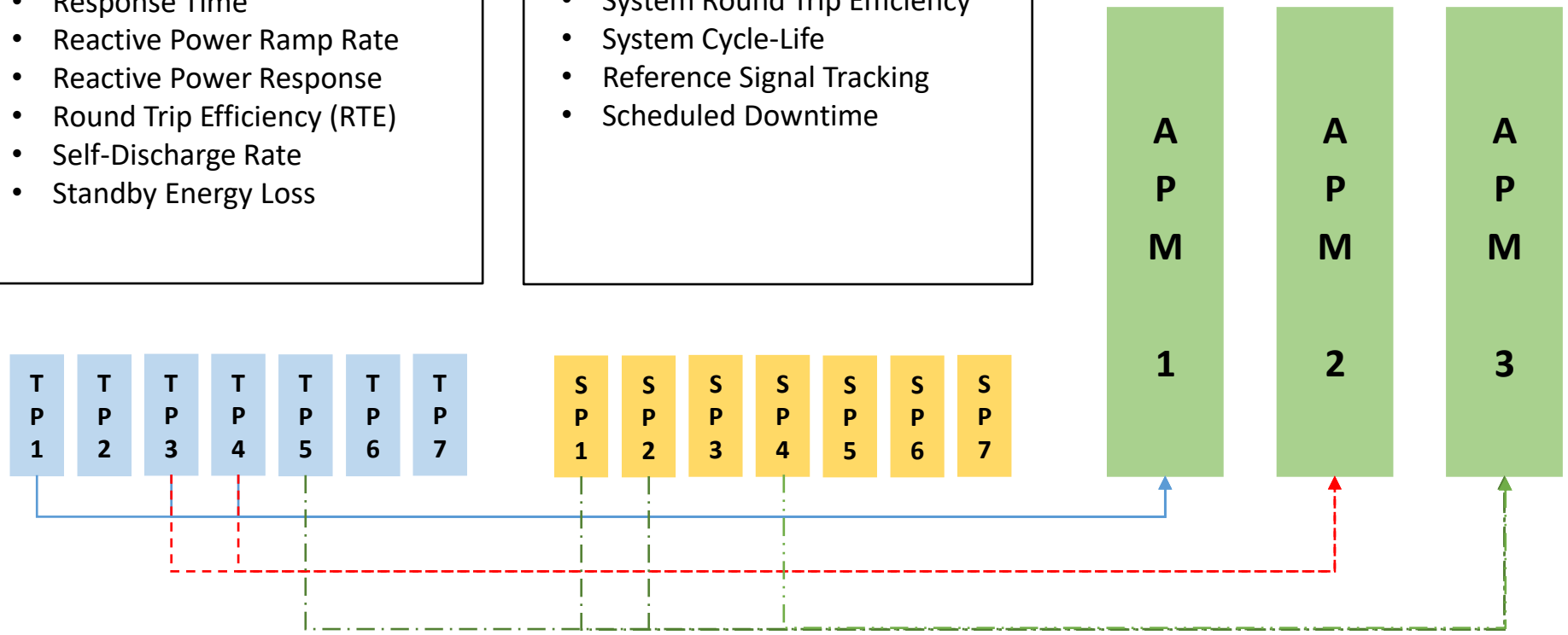
System Performance

System Operating Characteristics Based on Multiple Technical Performance Measurements

- Availability
- Available Capacity
- Capacity Degradation
- System Round Trip Efficiency
- System Cycle-Life
- Reference Signal Tracking
- Scheduled Downtime

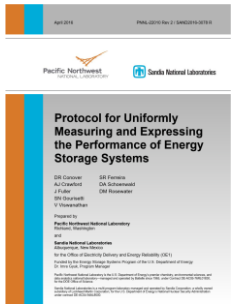
Application Performance Metric

Tailored Application Definition Can Be Based on Multiple Technology or System Performance Characteristics



Background Reports

Protocol for Uniformly Measuring and Expressing the Performance of Energy Storage Systems



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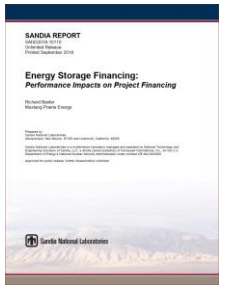
Energy Storage Financing: *Performance Impacts on Project Financing*



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APM Use and Structure

Market Use

- Project Operators Calculate Their Own Unit's "Score“ for a Specific APM
- APMs Can Provide Different Tier of Provider Qualification based on the APM Methodology
  - Delivery
  - Performance
  - Ranking
- Contract Revenue Can Be Based on a Specific APM Score
- Customer Can Define the Level of Score Acceptable for Service, Allowing the Ranking of Providers
- ISOs/RTOs Able to Utilize a Clearing Price for Ranked Providers for Market Services
- APM Data Format Can be Standardized (*e.g.*, XML/XBRL) to Facilitate Regulatory Compliance and Reporting (FERC EQRs, RTO/ISO settlements, etc.)
- Project Developers Can Replacing Liquidated Damages Covering System Performance With Contracted Performance

Tier

Delivery

- Certified Qualification of System for Service
- Minimum Capabilities Requirement for Service
- Provision of Service: (Yes/No)

Performance

- Qualification of System for Dynamic Service
- System Performance Level Requirement
- Market Factors Input
- Time Series of Metric Values

Ranking

- Comparing Multiple Systems
- Based on Unit Performance Metric
- Ranking of Various Providers
- Time Series Ranking Position
- Payment based on Degree of Performance

Performance Scores in Use Today: Frequency Regulation

PJM Performance Score

Evaluation of each Resource's accuracy in following the AGC signal based on Regulation signal data collected every 10 seconds and the resource's operating parameters.

$$\underset{Score}{Performance}(t) = \max_{i=0\ to\ 5min}\left[A * \underset{Score}{Delay}(t+i) + B * \underset{Score}{Correlation}(t+i)\right] + C * \underset{Score}{Precision}(t)$$

1. **Delay:** time between control signal and the resource's change in output
2. **Correlation:** a statistical correlation function that measures the relationship between the control signal and response signal
3. **Precision:** function of the difference in energy provided versus energy requested by the regulation signal

Other ISOs/RTOs

- Performance Scores for Frequency Regulation vary by Region
- Most use approach similar in concept, but with different formulae
- CAISO, MISO utilize their own Performance Score for Regulation Resources
- SPP Does Not utilize Performance Score in Regulation Resources

Possible APM Structure

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Utility Substation: Reliability (For Illustrative Purposes Only)

Performance Issue	Base Requirement	Bonus Score
Calendar Life	10 Year	N/A
System Cycle Life	100 Full Discharge per Year	1 point per Additional 10 Discharge per year
Availability	90%	1 Point per Additional 1% Availability 1
Reference Signal Tracking	95%	1 Point per Additional 1% Tracking Score
Ramp Rate	1 MW per 60 Seconds	1 Point per 100 kW per Second

Minimum Requirements

- Allows for a Standard Performance Requirement for System
- Verifiable by 3rd Party

Additional Score

- Allows Vendors to Benefit in RFP Ranking by Improved Performance

Customer

- Makes Decision based on Competing Offers with 2 Dimensions – Price and Score

Market Roles for APMs in the Energy Storage Industry

MUSTANG PRAIRIE ENERGY

Shared

- Industry Accepted Definition of Terminology
- Industry Accepted Definition of Applications and Measurement
- Improve Regulatory Compliance and Reduce Compliance Costs by Standardizing Data Measurement and Formatting

Bilateral Contracts

- Allows 3rd Party Verification of Performance
- Allows Lenders to Contract with Insurance Firms to Provide Financial Backstop for Project Operation

Utility RFP

- Allows 3rd Party Verification of Performance
- Allows Ranking of Service Providers
- Qualification for Provision of Service can be Monitored by Utility DMS

Wholesale Market Clearing

- Allows Ranking of Service Providers
- Allows Asset Owners to Assess Whether the Market is Efficiently Monetizing Storage Resource Capability and Performance
- Allows 3rd Party Verification of Performance

Liability

- APMs Provides Metric for Insurance Firms to Assign Responsibility for Failure of Service to Parties Willing to Take Responsibility
- No Competing Proprietary Metrics from Different Firms
- Replace Liquidated Damages with Standardized, Contracted Performance
- APMs Can Help Improve Regulatory Compliance and Reduce Compliance Costs by Standardizing Data Measurement and Formatting

Stakeholders

Groups from across the industry to benefit:

FERC and ISOs/RTOs
- Use APMs in their own market-specific tariffs and market rules

Public Utility Commissions
- Use APMs to provide minimal performance requirements of system to support customer service (and choice, where available)

Manufacturers
- APMs allows equipment specifications to be designed around standardized market-oriented performance targets

Project Developers
- APMs allows system output to be incorporated into a revenue contract with specific performance stipulations
- Developers Require Specific Mix of System Performance for Bidding

Lenders / Private Equity
- APMs provide an ability to ensure system maintains performance relative to need of market for revenue recognition.

Insurance
- APMs allows insurance firms to provide financial backstop of a project meeting acceptable threshold
- Replace Liquidated Damages with Performance Based Contract to Project Developers

Intellectual Property Confidentiality

APMs allow for Data Confidentiality

OEM

- Product Performance Data and Measurement Can Remain Internal to System

Project Developer

- Bidding Strategy Based on System Data Can Remain Proprietary Without Release of Underlying Unit Performance Data

Unit Operator

- Internal System Performance Data and Measurement Can Remain Internal to System

Measurement

- 3rd Party engineering/testing Firms Can Measure Accuracy of APM Reporting but Retain Confidentiality of Data
- Performance Attributes That are Basis of Contract Can be Logged in a Secure Database for Auditing by Customer

Prior Performance Measurement & Standardization Efforts

Application Performance Metrics to be built off existing performance efforts

- **DOE/EPRI Electricity Storage Handbook in Collaboration with NRECA,**
  - https://prod-ng.sandia.gov/techlib-noauth/access-control.cgi/2015/151002.pdf
- **Protocol for Uniformly Measuring and Expressing the Performance of Energy Storage Systems,**
  - https://energymaterials.pnnl.gov/pdf/PNNL-22010Rev2.pdf
- **ACES Working Group, Energy Storage Best Practice Guide**,
  - https://www.newenergynexus.com/wp-content/uploads/2020/06/ACES-Best-Practice-Guide.pdf
- **Energy Storage Financing: Performance Impacts on Project Financing**,
  - https://www.sandia.gov/ess-ssl/wp-content/uploads/2018/12/ESF2-MustangPrairie_SAND2018-10110_final.pdf

NAESB's Role

Convening Process for APMs

Canvas Interest
- NAESB Member Interest
- Governing Bodies (FERC, PUC, RTOs, US DOE, etc.)
- Develop Scoping Report

Convene Working Group
- Define Market Needs for APMs
- Define Scope & Timetable

Development Process
- Define Applications
- Develop APM Methodology Structure
- Review with Market Organizations
- Develop Final

Socialize Standardized Agreement
- Industry Stakeholders
- Governing Bodies

Institute Update & Revision Schedule

Ready Technical Support

Technical Groups Stand Ready to Support NAESB's Efforts

U.S. Department of Energy – Office of Electricity
- Sandia National Laboratories
- Pacific Northwest National Laboratory

EPRI – Energy Storage Integration Council
- An open, technical forum for utilities, energy storage suppliers, research organizations, and other stakeholders to advance safe, reliable, and cost-effective energy storage.

State Energy Departments
- New York State Energy Research & Development Authority (NYSERDA)
- California Energy Commission (CEC)

International Organizations
- The World Bank
- International Finance Corporation (IFC)