

Exponent[®]

ENGINEERING MANAGEMENT CONSULTING
ENERGY AND UTILITIES

70TH ANNUAL NECPUC SYMPOSIUM

Batteries Not Included: The Risk and Reward of Storage

June 6, 2017

Our Mission:

*A multi-disciplinary consulting firm dedicated to solving important science, engineering,
and business problems for clients*

About us

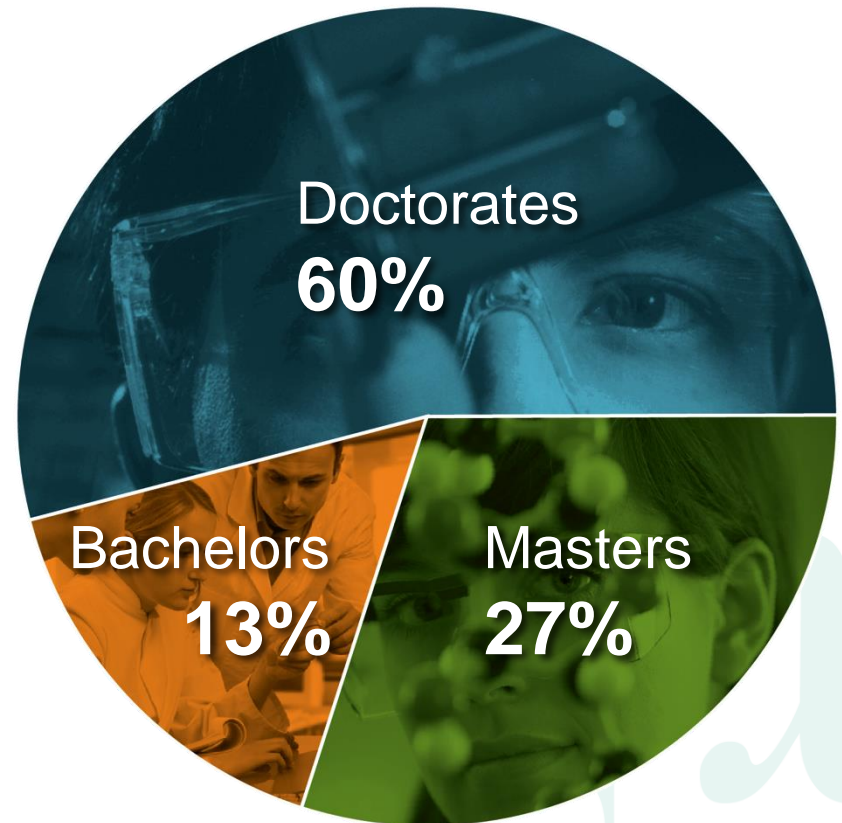
History:

- Founded in 1967 as “Failure Analysis Associates”
- Premium engineering & scientific consulting
- Long history with EPRI, industry, and others
- More than 900 employees

Business and Staff:

- ISO 9001 certified QMS
- Authorized by GSA for Federal services
- Consulting staff background (see chart)

Staff: Experienced, industry-active, top-shelf practitioners



Exponent has been testing and conducting performance testing of battery cells for over 7 years at labs in Arizona and Massachusetts

- Testing Capabilities on Storage
 - Performance level testing at the cell and pack level
 - Manufacturing and technology audits
 - System level design review of storage technologies
 - Cell vent chambers to assess safety issues
 - Combustion mitigation technology
 - Simulation of module and pack thermal management, system-level failure analysis
 - Failure analysis of cells, electronics and systems, standardized and custom abuse testing

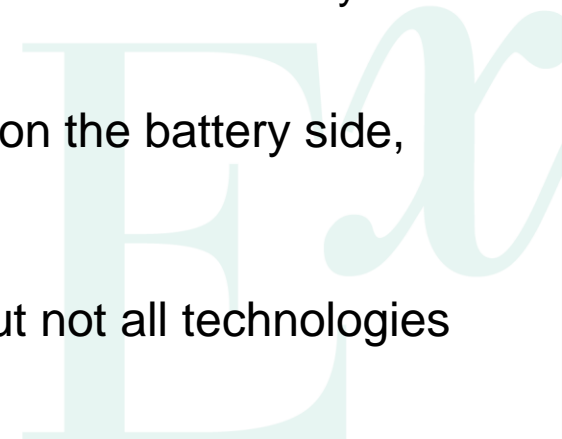


Exponent's Thermal and Storage Testing lab, Natick, MA

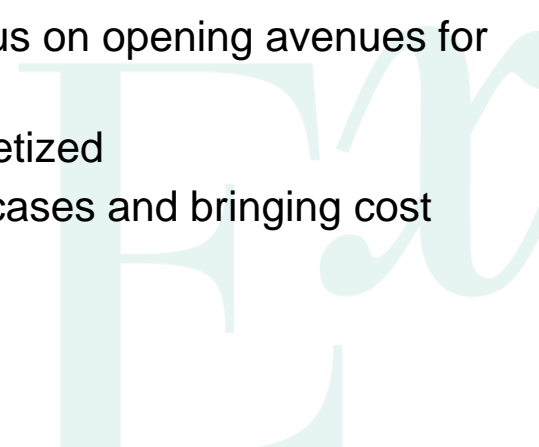


147 acre Phoenix, AZ Testing Facility

- Why is this complicated?
 - According to GTM Research, market expected to reach 2.6 GW by 2022
 - Complicated because stakeholders tend to lump activities at the wholesale, distribution, and behind the meter into one category – but all have separate drivers and needs
 - ...and is Safety an issue that needs more attention?
- Overall Trends – storage is seen as a solution to renewable adoption
 - Initially deployed for ancillary services (regulation)
 - Mitigates issues with intermittency of variable renewable technologies (Wind and Solar)
 - Mitigates “Duck Curve” problems – too much solar – that are now starting to manifest itself in Canada and Western U.S.
 - Being incorporated into solar-storage hybrid applications for behind the meter systems
- Technology selection – Storage is more than batteries, but on the battery side, lithium is beginning to dominate applications
- Cost – Trends are continuing down a rapid price decline, but not all technologies decline equally



- As States contemplate what actions to take on storage, what has happened in other States?
 - California: Clean Air = More Renewables = Anticipated need for storage
 - Created 1.325 GW Mandate that has been very successful and expanding
 - Hawaii: Less fossil-fuel generation = high renewable penetration = storage need
 - Proving theories about why high penetration of renewable needs storage flexibility
 - New York – Desire for high penetration of renewables = Anticipate need for storage
 - Relying on markets but adoption is slow and now trying to encourage through B-Case support – looking to REV to catapult deployments
- Is there a message for Policy makers regarding storage?
 - Most storage stakeholders will encourage policy makers to focus on opening avenues for storage to enable application of its potential capabilities
 - There are many benefits provided, but not all can be monetized
 - Let the manufacturers and developers figure out the business cases and bringing cost down whiles policymakers remove potential barriers
 - California did this with a roadmap to overcome barriers



- Energy Storage has been on a rapid price decrease
 - From DNV GL data – Price Floor in 2020, \$100/kWh battery, \$200/kWh System
 - Price decreases are not uniform...lithium systems are outpacing competitors
- Where is storage being applied today?
 - The business cases are still a challenge as opportunities expand from wholesale to distribution and retail applications
 - But retail is where all application and policy action lie
 - Solar + storage, non-wires solutions
 - Stacked application, letting behind the meter solutions contribute to grid operations – then pay them
- For Technologies, on battery side, lithium is beginning to dominate applications
 - Issue: How fast can lithium alternatives commercialize against the “Lithium Wall”
- Electric Vehicles and Charging Infrastructure needs to be part of conversation
 - Super charging stations (3kW to 150kW) and 200 mile range vehicles may have game changing impacts on grids – let’s not forget this area as there is convergence

For additional information, please contact....

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