Notrees Wind Storage Project Description

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Project objective: Provide validation that energy storage increases the value and practical application of wind generation, alleviates intermittency issues, and is commercially viable at utility scale

The Energy Storage System will:

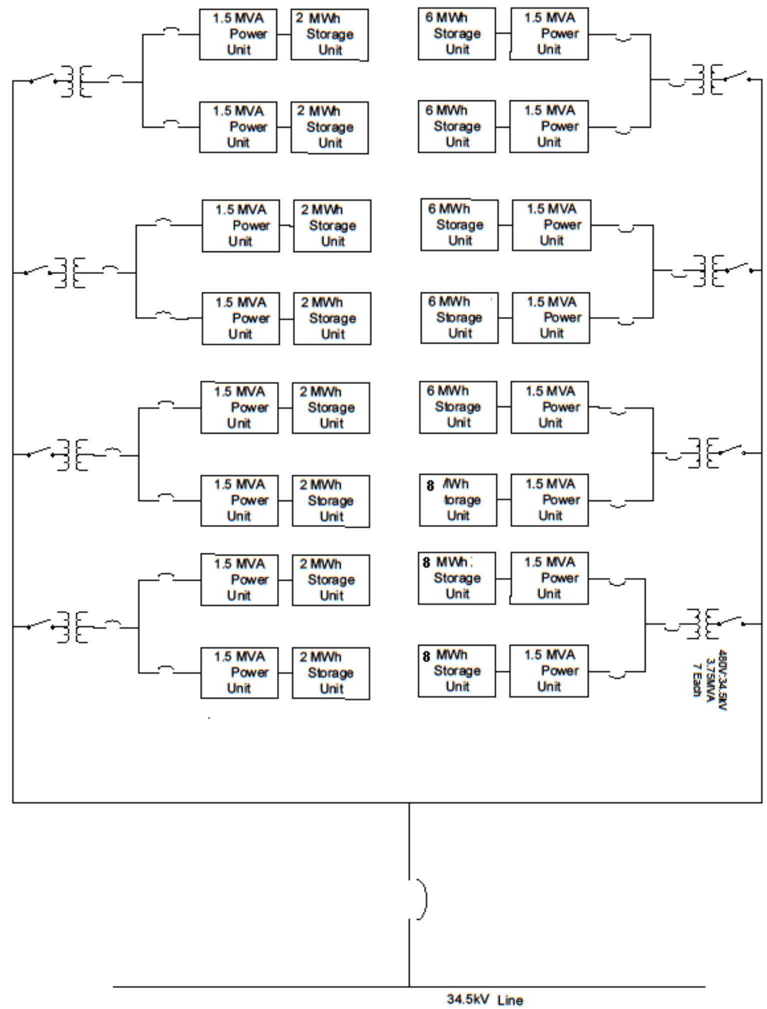
- Integrate with intermittent renewable energy production
- Improve use of power-producing assets by storing energy during non-peak generation periods
- Demonstrate benefits of using fast response energy storage to provide ancillary services for grid management
- Confirm that the solution can dispatch according to market price signals or pre-determined schedules utilizing ramp control
- Verify that energy storage solutions can operate within the ERCOT market protocols

Project site

- Notrees wind farm, owned and operated by Duke Energy Generation Services
- Located in west Texas – Ector and Winkler Counties
- 156MW total wind generation capacity
- Energy Storage System (ESS) will be located at the substation and tied on the distribution side

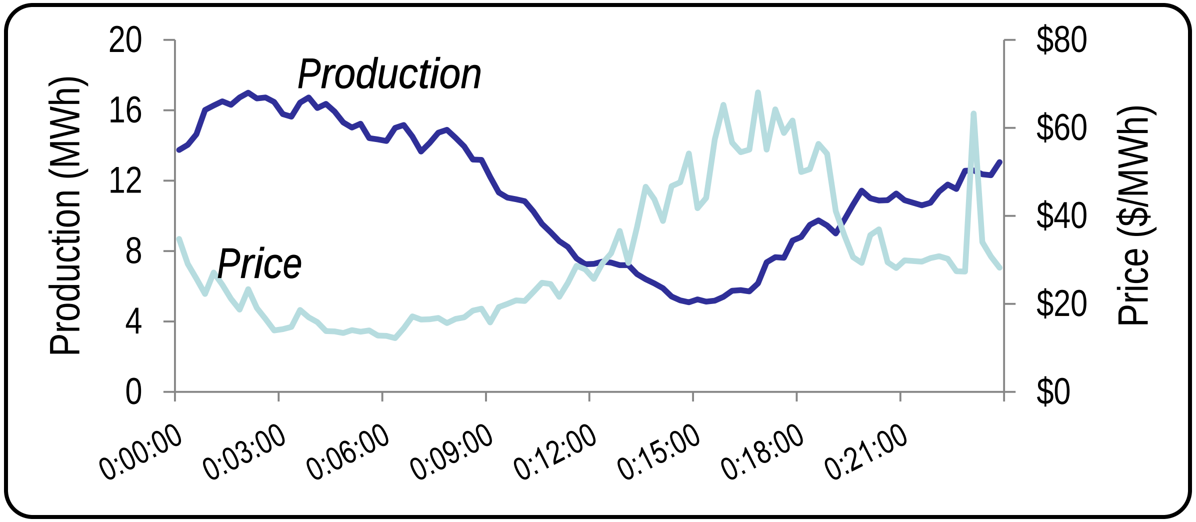
Project Scope – Energy Storage System

- Current battery configurations being evaluated are 25-35 MW/ 30-60 MWh
- Front runner is an advanced lead-acid solution
- Controls are designed to capture fast response ancillary services
- Battery life designed for use of 5-10 years, with a potential system operational life of 20-30 years (with battery cell replacement)

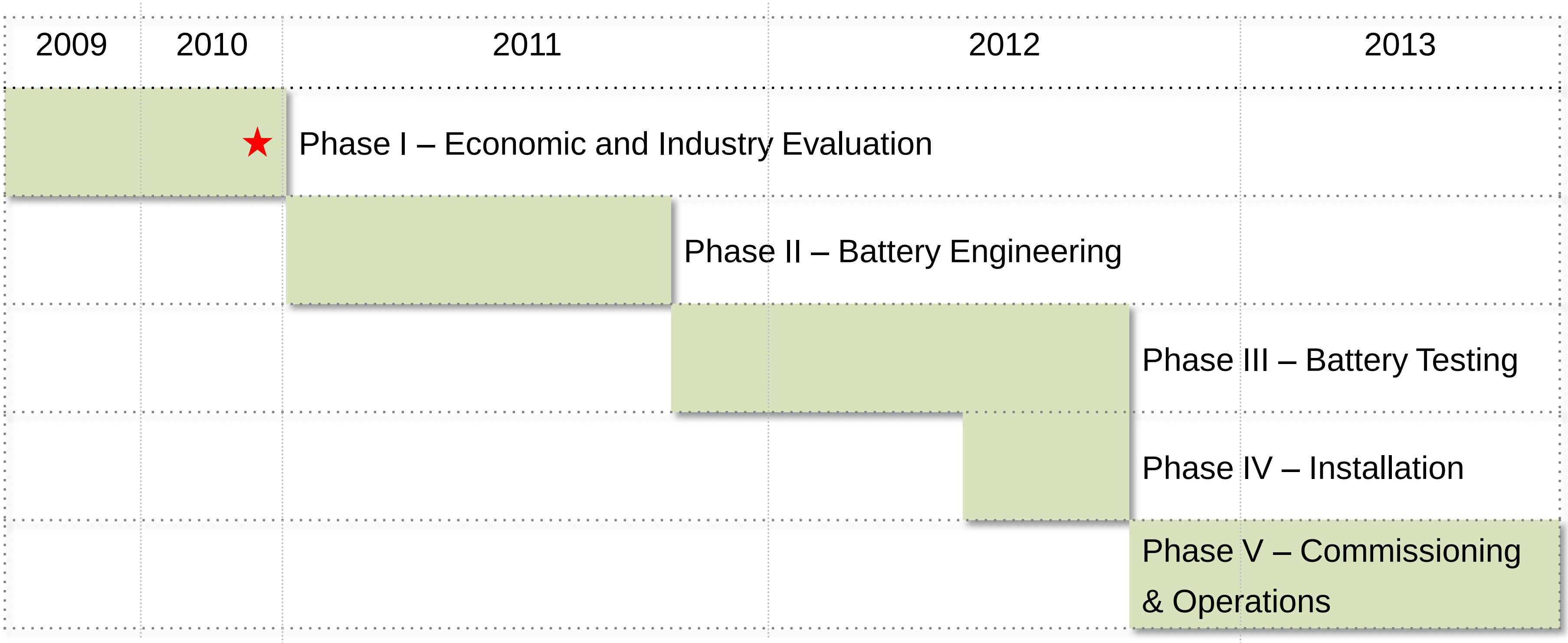


Project Scope – Dispatch Strategy

- Energy storage can maximize value of wind farm through multiple value streams
- Optimize bidding strategy into day-ahead ancillary services market and day-ahead and real-time energy market
  - Achieve increased understanding of how to bid into services markets given battery capabilities for storage and dispatch
  - Learning to optimize bid strategy and achieve optimal compliance with market rules will be a dynamic process



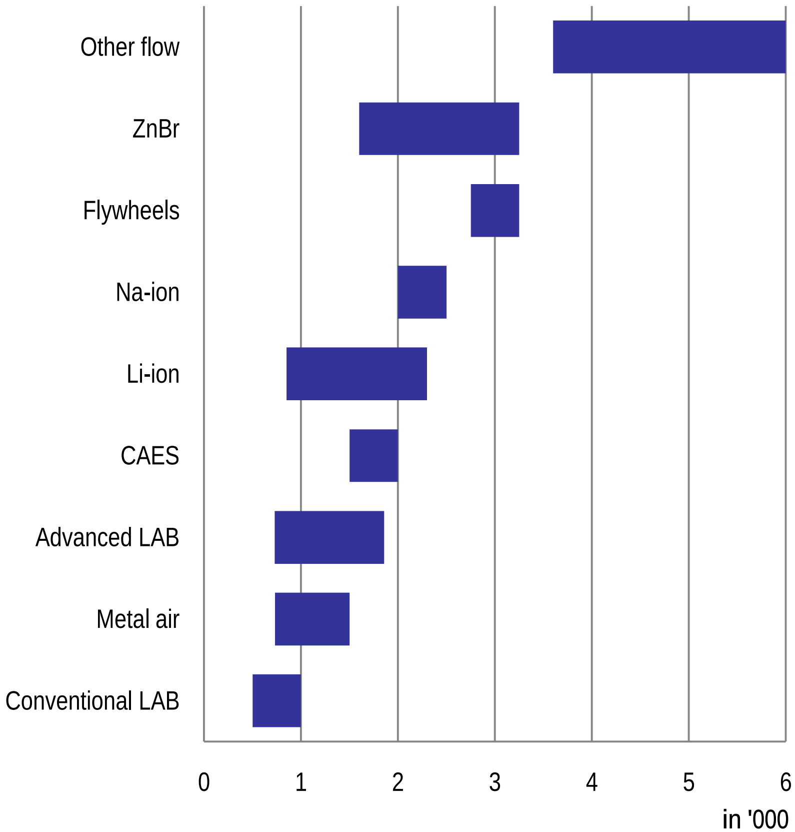
Current Project Timeline



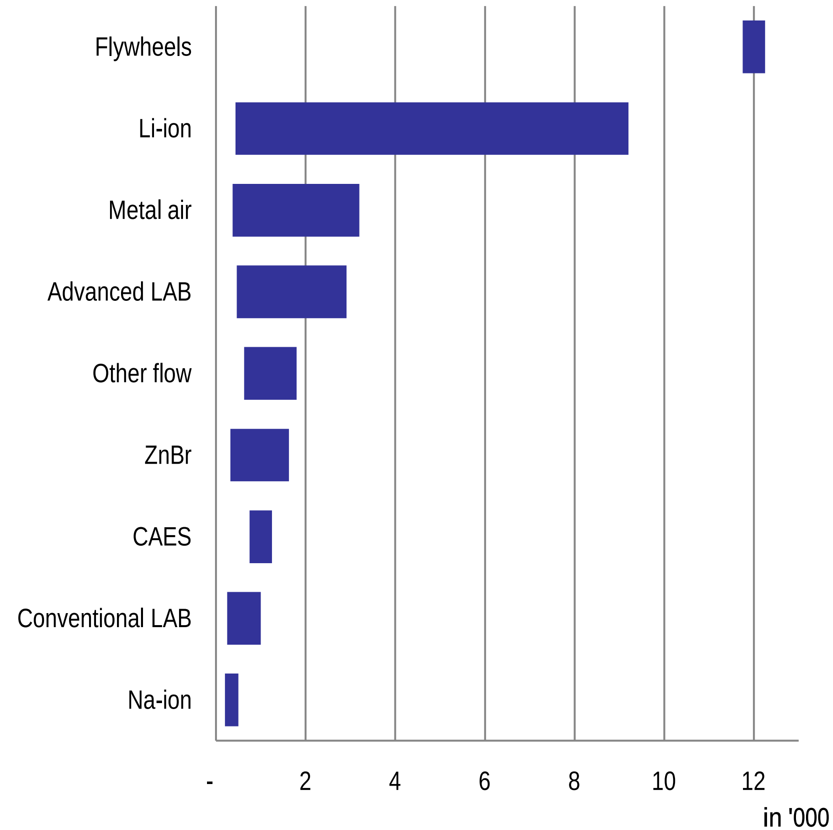
Initial lessons:

#1 - Installed cost of proposals have shown to be higher than anticipated

Capital Cost per kW

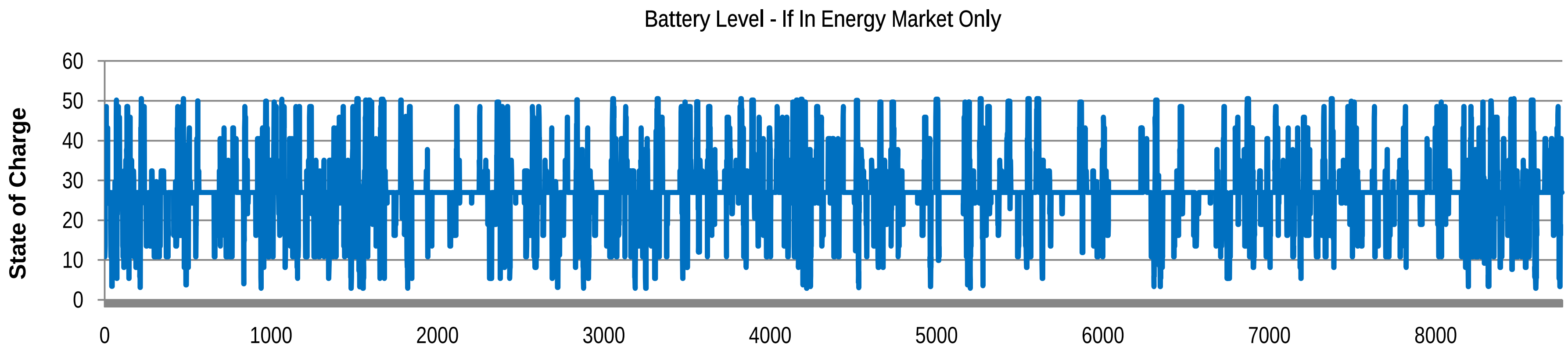


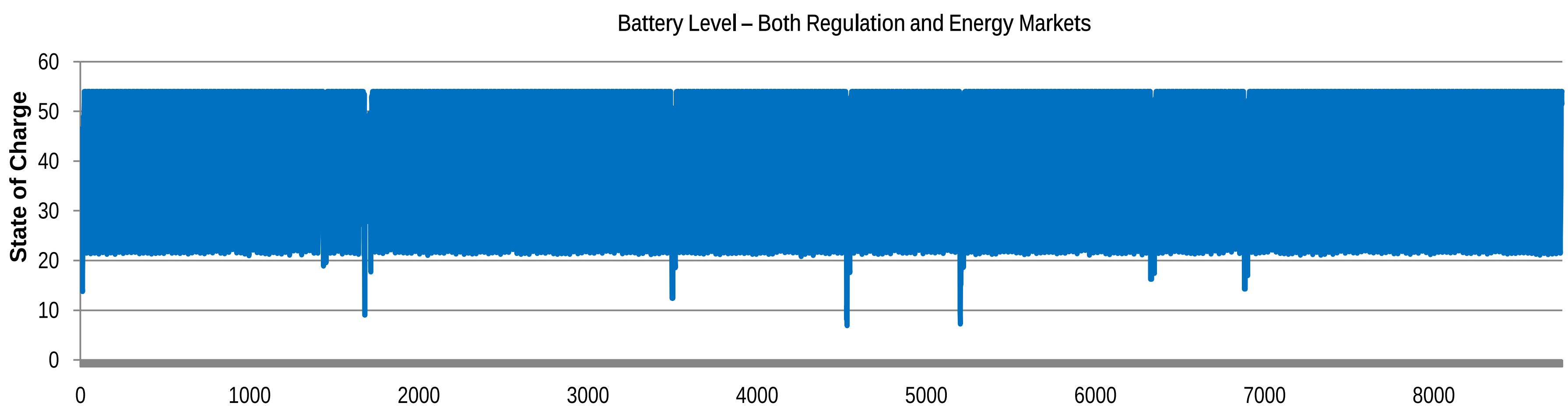
Capital Cost per kWh



Capital costs represent primarily storage technology cost
Installed cost will have a multiplier of 1.8x – 4x

Initial lessons:
#2 – Optimization indicates far more bias to regulation market than anticipated





Next Steps

- Confirm valuation and ESS design ability to meet valuation assumptions
- Award ESS contract
- Begin system integration and dispatch design
- EPRI will work with Duke Energy to:
  - Finalize project management plan
  - Assist with the technical design
  - Conduct system performance testing and analysis