Business and Policy for Plug-In Vehicle Grid Uses

NIST/DOD PCS Workshop

June 13, 2011

Outline

- Frequency regulation and spinning reserves provides significant revenues for existing storage projects
- Current rules allow non-generating resources (even loads and charge-only EVs) to provide frequency regulation
- Bidirectional applications face technical constraints
- Variable charging may provide a sufficient business case

Frequency Regulation Revenues from Storage

Existing commercial deployments show promising performance

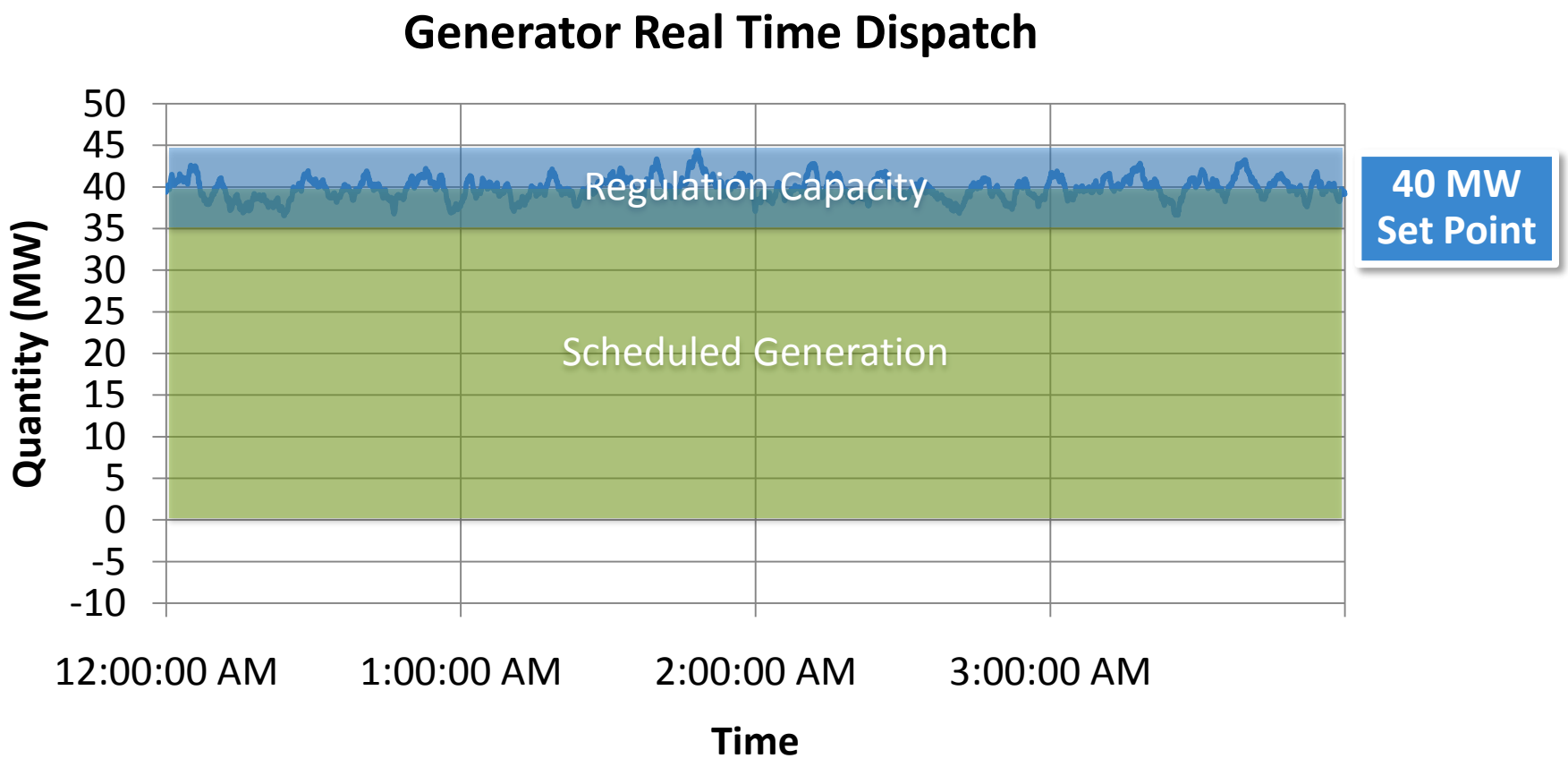
Ancillary Services from Non-Generators

Most markets exhibit few policy barriers

- FERC Order 890 (2007):
  - *"Ancillary services by load resources should be permitted where appropriate on a comparable basis to services provided by generation resources."*
- PJM Demand Response Programs
  - Curtailment Service Providers can aggregate loads
  - Eligible to bid into Energy, Capacity, Day-Ahead Scheduling Reserves, Synchronized Reserve and Regulation
- CAISO Regulation Energy Management (2/2011)
  - Specific implementation allowing storage to sell frequency regulation
  - Provides an energy set point to manage state of charge
  - Could be used to charge an EV battery while providing regulation

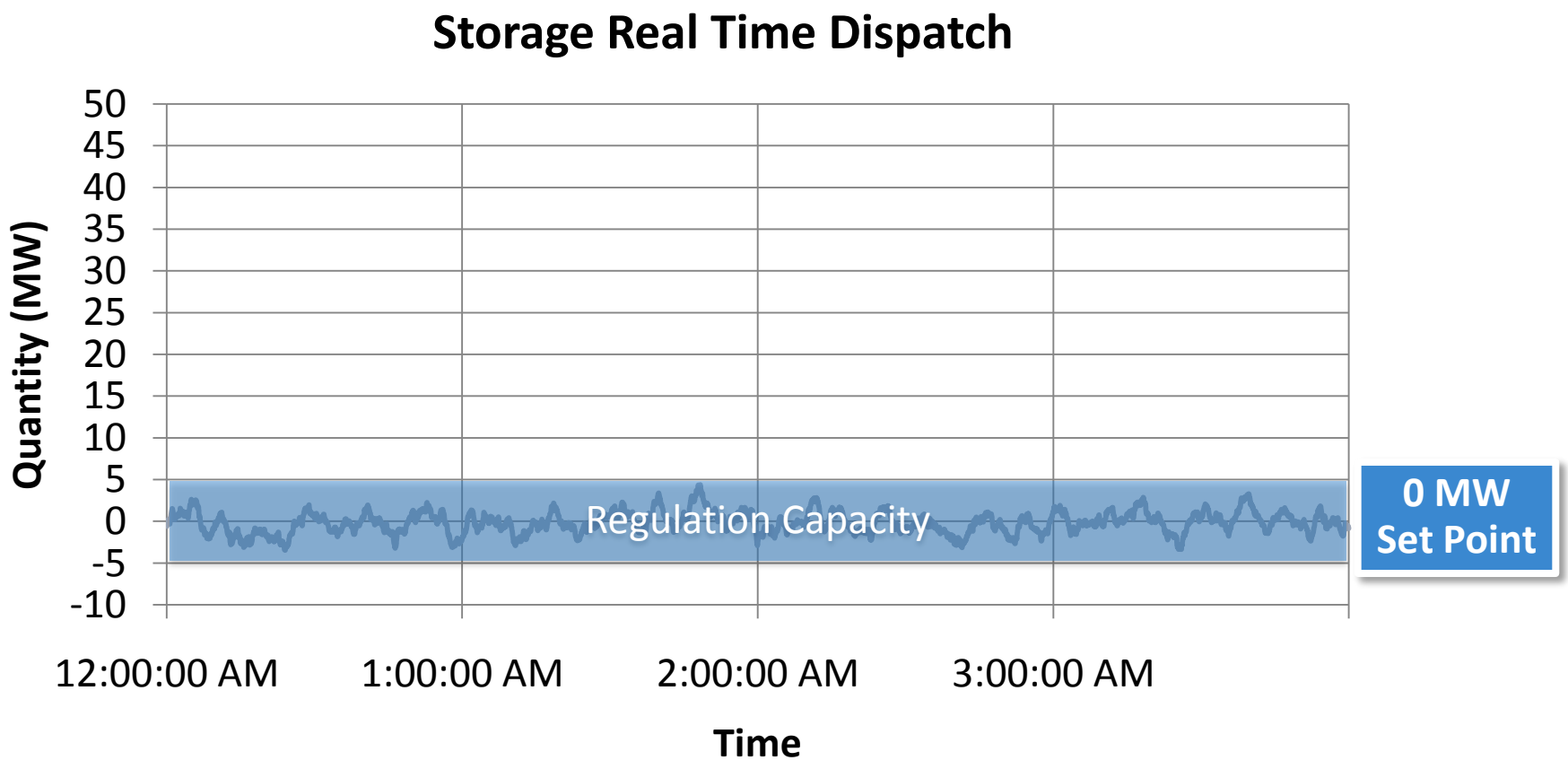
Frequency Regulation from Generators

Revenue = Freq. Reg. Capacity + Hourly Energy "Block"



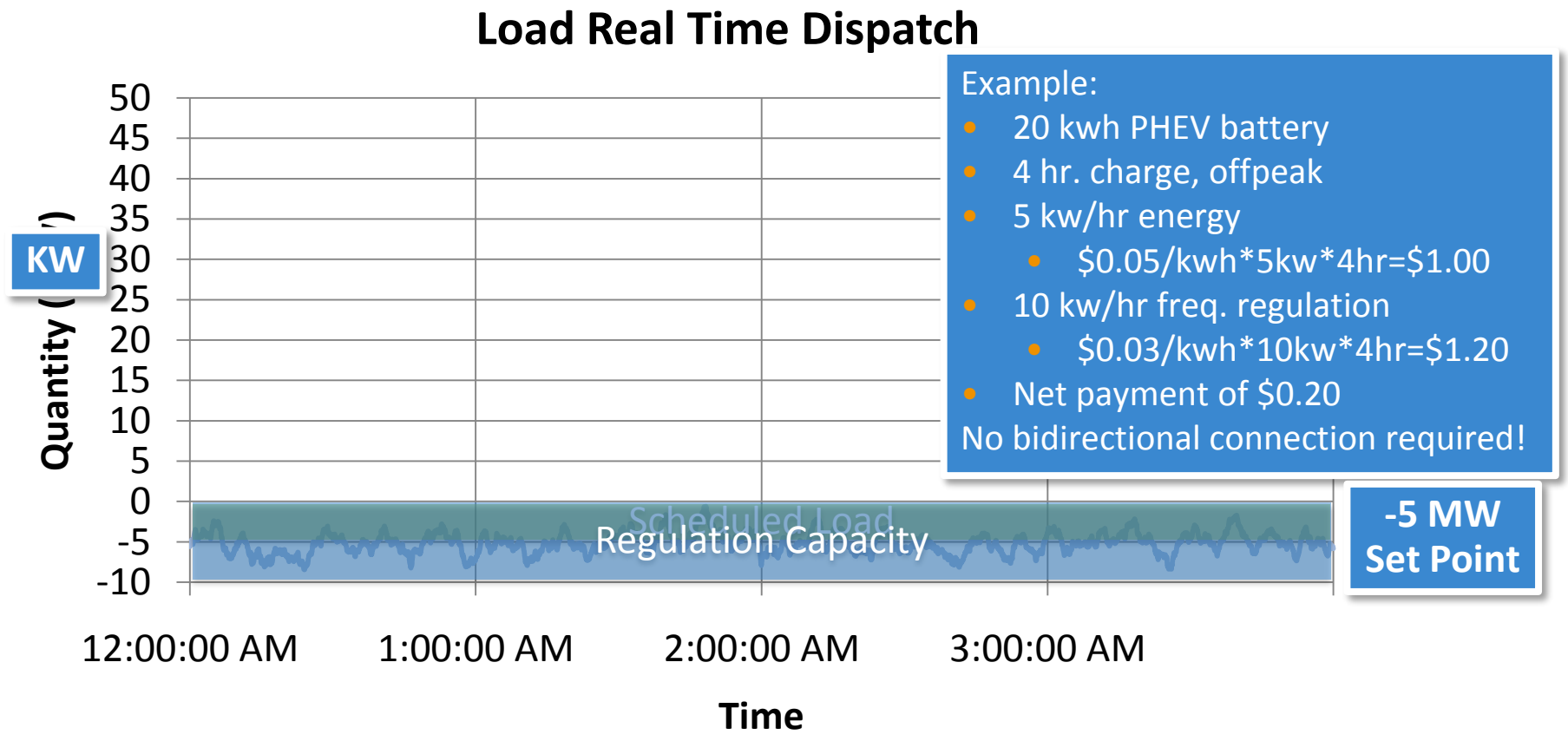
Frequency Regulation from Storage

Revenue = Freq. Reg. Capacity



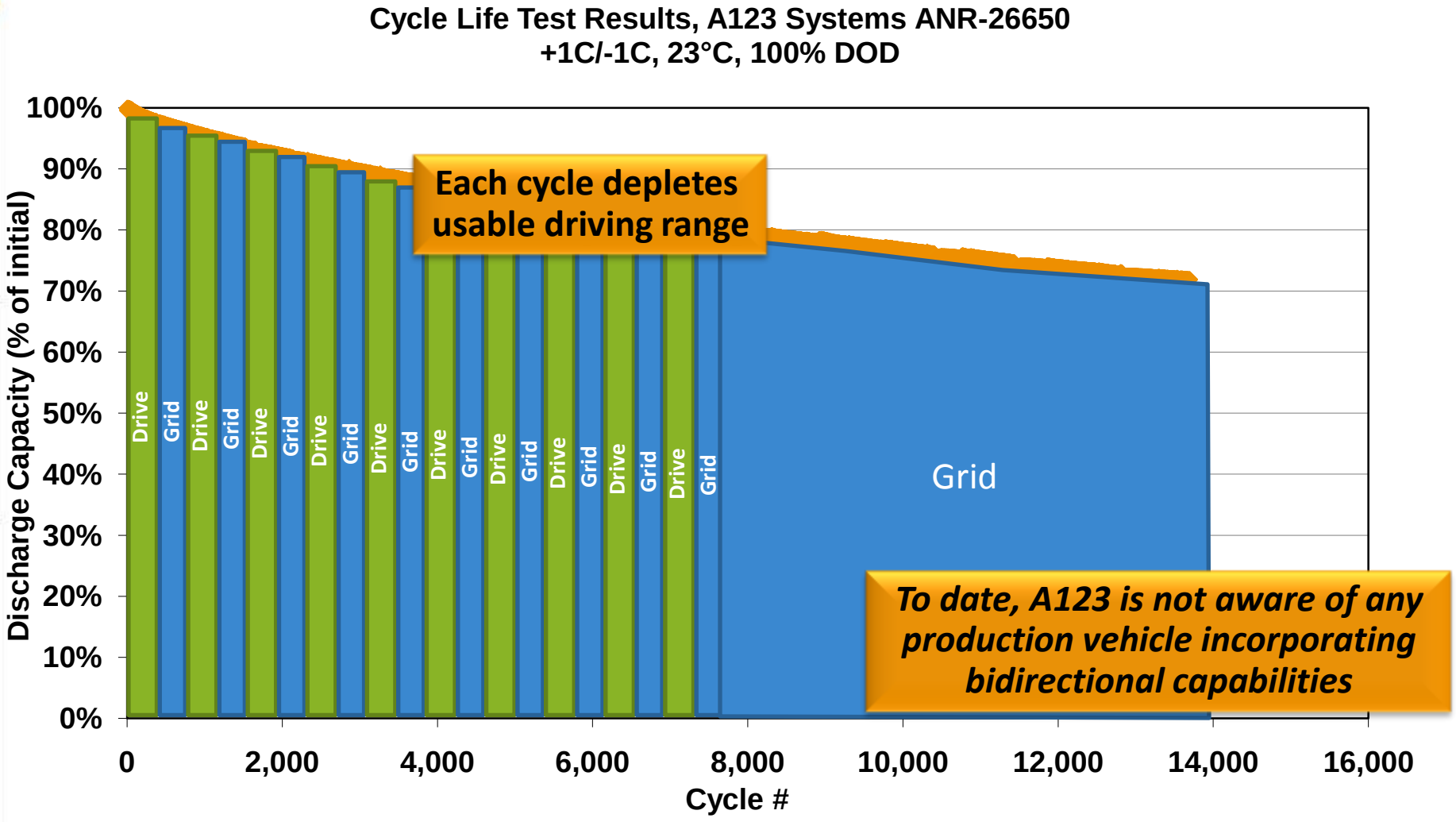
Frequency Regulation from Loads

Net Revenue = Freq. Reg. Capacity – Hourly Energy "Block"



Life

Capacity Uses: V2G vs. Second Life



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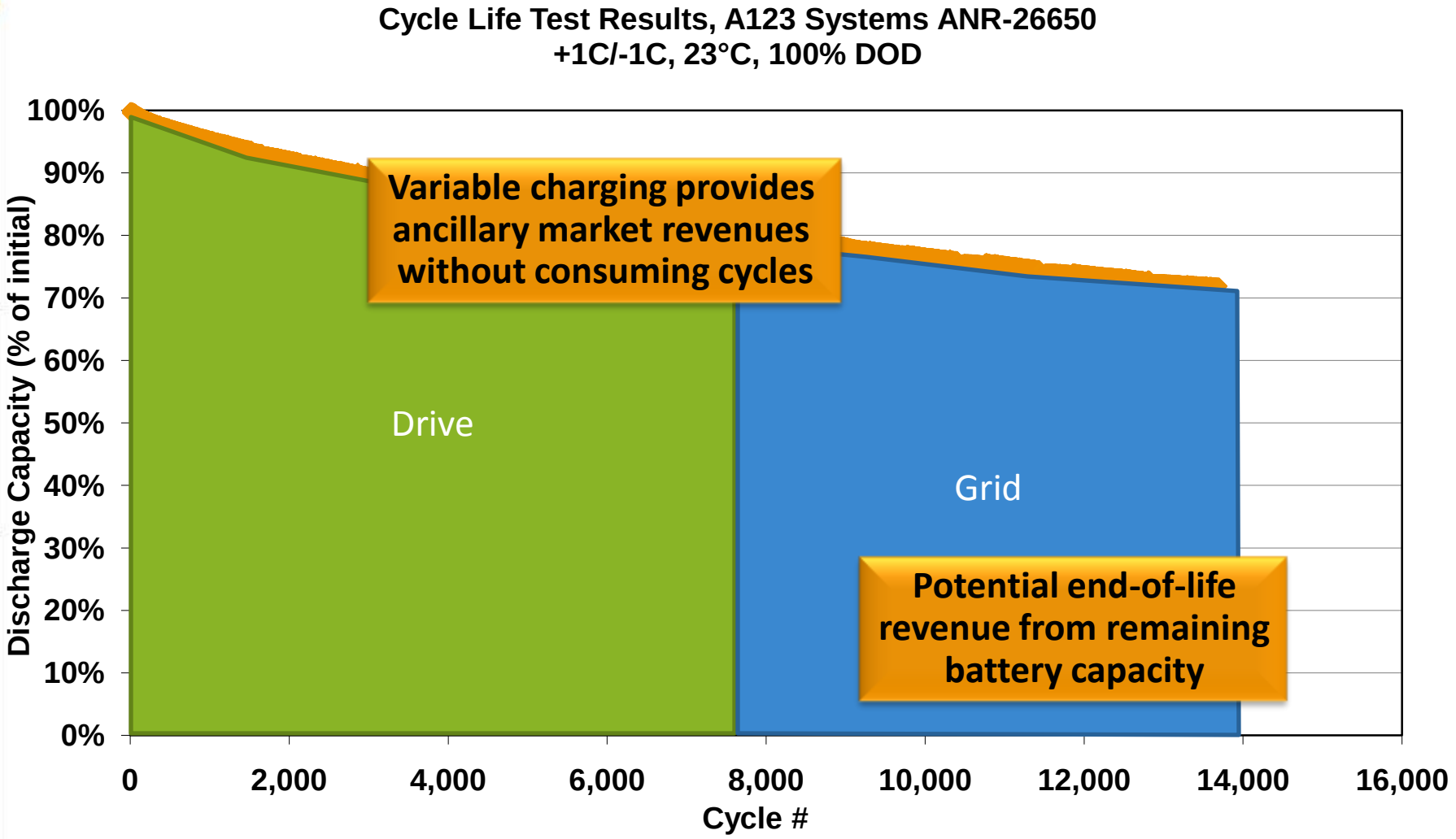


Business Case Comparison

Minimal incremental benefit from bi-directional flows

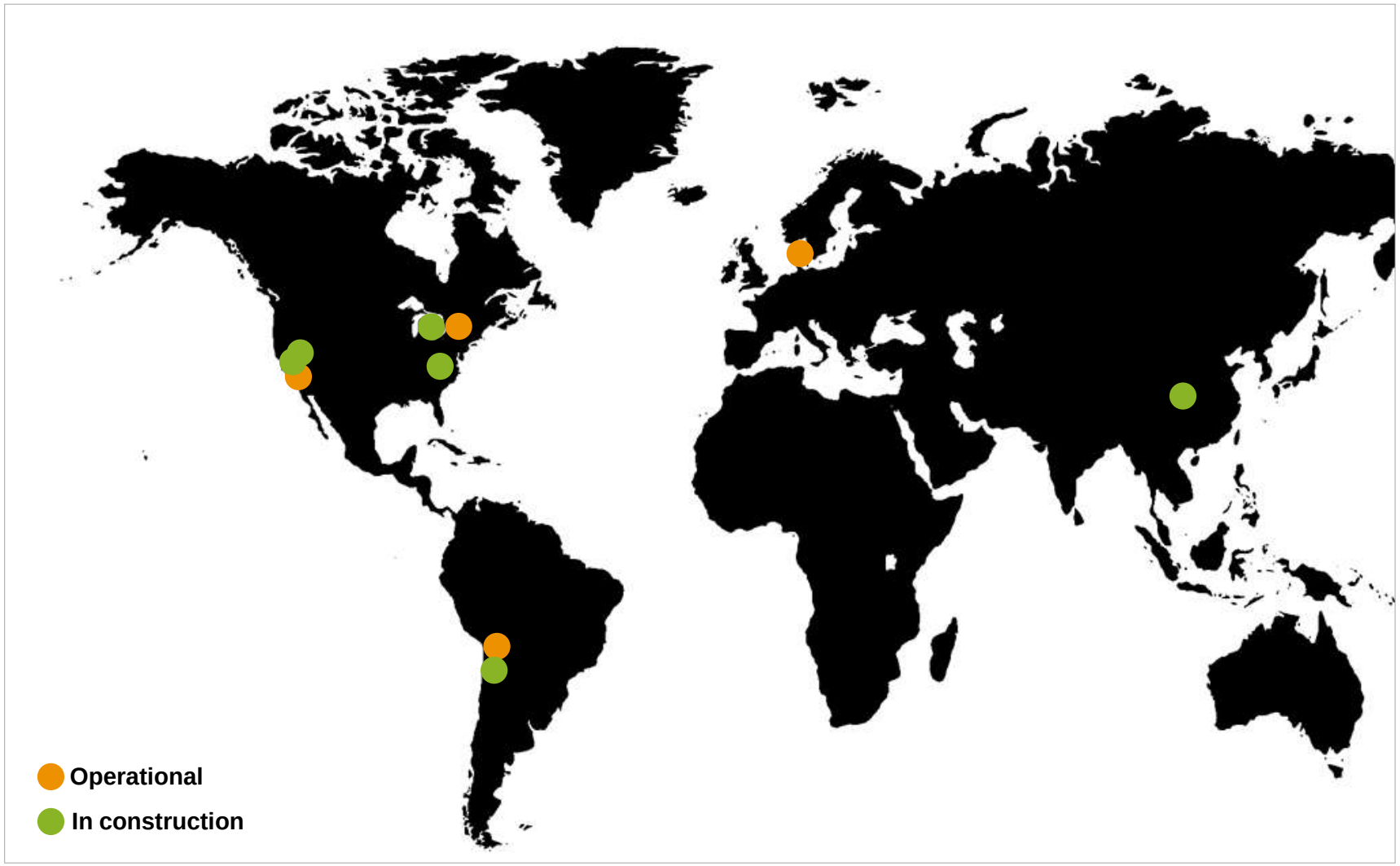
Highest-valued applications for today's standalone energy storage projects

	Frequency Regulation	Renewables Ramp Management	Spinning Reserve	Energy/Peak Shaving	Capacity
Steady State Charging	No	No	No	Partial (with dyna pricing)	
Variable Rate Charging	Yes	Yes	Yes	Partial (no arbitrage)	Partial
Bidirectional Flows	Yes	Yes	Yes	Yes (but faster battery life reduction)	Yes (but faster battery life reduction)

Likely sweet spot for near-term electric vehicles

A123 Selected Grid Deployments Worldwide

Over 40MW in service today



Conclusion

Full V2G may not be necessary

- Ancillary services (AS) provide sufficient revenue to spur commercial standalone storage projects
  - Frequency regulation (example of actual revenues)
  - Spinning reserves
  - Renewable ramp management
- Charge-only operation maximizes useful driving range
- EVs with variable charging can access AS markets with existing policy and market rules (EV acts like DR)
- Variable-rate charging likely to optimize vehicle performance and cost

Thanks!

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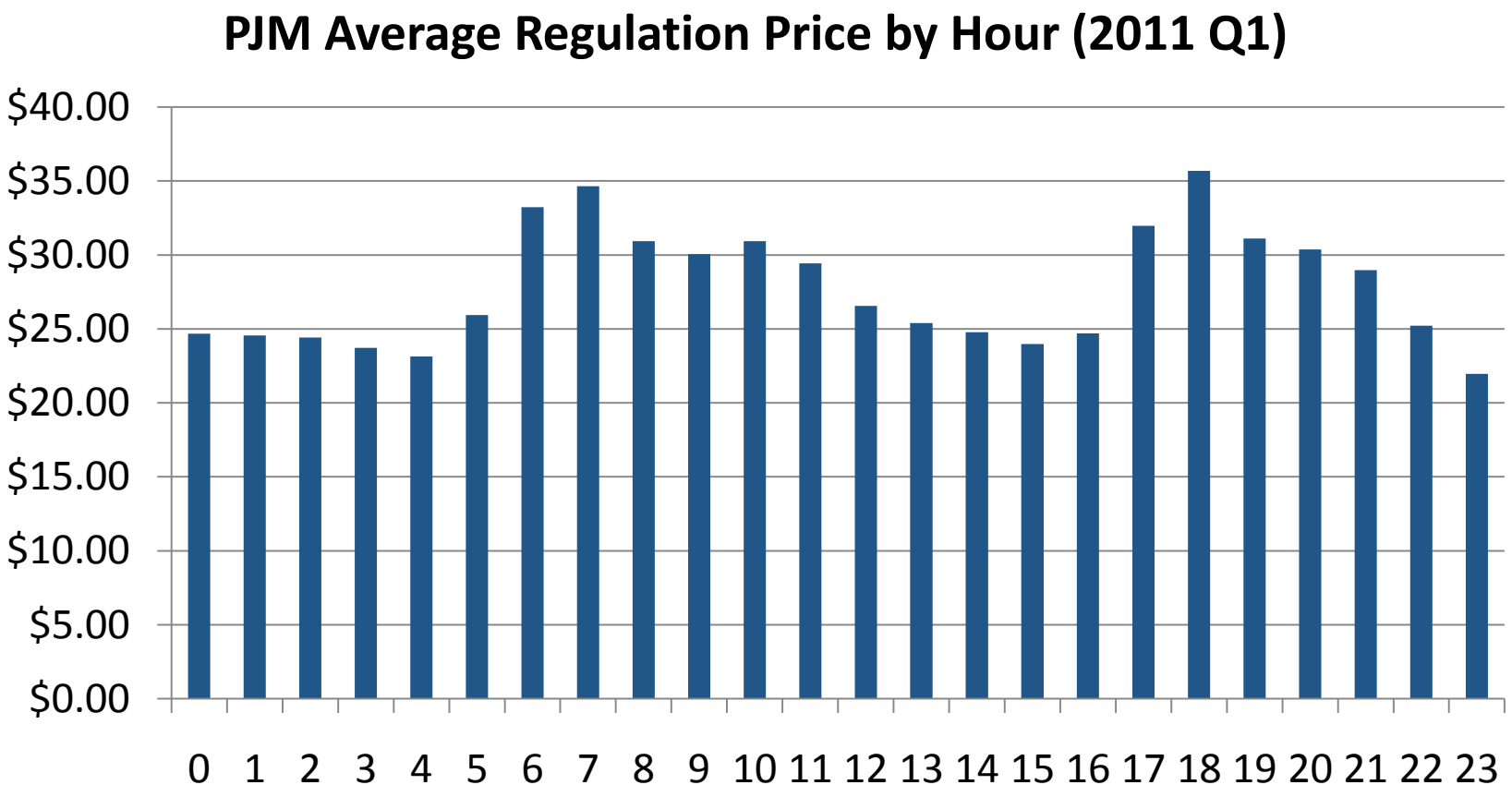
Hourly Regulation Prices

Highest value during morning and afternoon ramps



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