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EMERGING TRENDS SERIES | State & Federal Perspectives on Energy Storage

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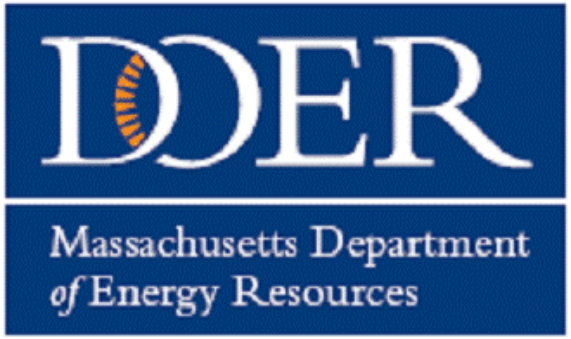
Agenda

8:30 a.m. - Networking
8:50 a.m. - Welcome & Opening Remarks
9:00 a.m. - Panelists Presentations:

Commissioner Judith Judson, DOER
Andrew Kaplan, Pierce Atwood
Phil Giudice, Ambri
Doug Staker, Demand Energy Network

9:50 a.m. - Moderated Questions
10:00 a.m. - Questions from the Audience
10:25 a.m. - Closing Remarks
10:30 a.m. - Event Ends



Energy Storage in Massachusetts

DOER Commissioner Judith Judson

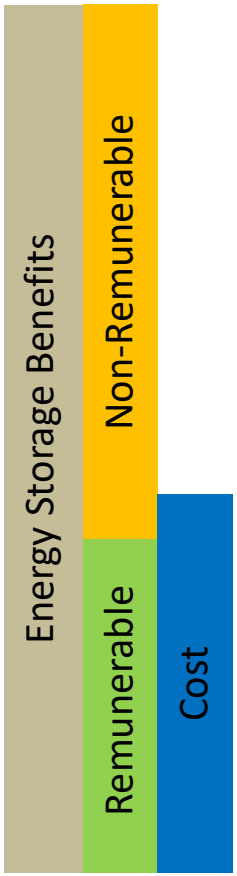
Energy Storage Initiative

- **$10 million** initiative launched in 2015
  - *State of Charge* study
  - Demonstration projects
- Robust stakeholder engagement
- Study details:
  - Technology and market landscape
  - Comprehensive modeling of the cost and benefits of deploying storage
  - Economic use cases of specific storage applications
  - Economic development opportunities
  - Policy and program recommendations to grow storage deployment and industry in MA

"Massachusetts will continue to lead the way on clean energy, energy efficiency, and the adoption of innovative technologies such as energy storage."
- Governor Baker, Feb 2016, Accord for a New Energy Future Press Event

"Given the recent advances in energy storage technology and cost-effectiveness, it is hard to imagine a modern electric distribution system that does not include energy storage."
Utility stakeholder perspective

Study Findings



Opportunities:

Energy Storage has potential to provide benefits to the Massachusetts ratepayers, including:

- Reducing the price of electricity
- Lowering peak demand and deferring investment in new infrastructure
- Reducing the cost to integrate renewable generation
- Reducing greenhouse gas (GHG) emissions
- Increasing the grid's overall flexibility, reliability and resiliency
- Generating nearly $600 million in new jobs

Barriers:

- Business models for storage in very early stages
- Energy storage systems need a way to be compensated for a greater portion of their cost benefit in order to achieve market viability

Study Recommendations

The Commonwealth can nurture the energy storage industry and grow the deployment of storage in Massachusetts through programs and initiatives

- Funding for Demonstration projects
- Establish and Clarify Regulatory Treatment of Utility Storage
- Grant and Rebate Programs
- Storage in State Portfolio Standards
- Paired with Clean Energy procurements
- ISO Market Rules

If adopted, the Study recommendations have the potential to yield:

- **600 MW of new energy storage by December 31, 2025**

Status of ESI and State of Charge Study

	Recommendations	Status
Grants and Rebates	ESI Funding for Storage Demonstrations - $10 million	✓
	Increase demonstration funding from $10m to $20m	✓
	Resiliency Grants	✓
	Solar Plus Storage Feasibility Studies	✓
	Peak Demand Reduction Grants	✓
	Storage in Green Communities and Leading by Example grants	✓
	MOR-Storage rebates	TBD
RPS/ APS	Include Storage in the new SMART Solar Program	✓
	Add Storage (beyond Flywheels) to the Alternative Portfolio Standard	✓
Regulatory Treatment	Energy Efficiency Programs for Peak Demand Savings	✓
	Clarify regulatory treatment of Utility ownership of energy storage (rate case, solar ownership, grid mod)	✓
	Energy Storage in Renewable Procurements • Clean Energy Procurement (~1,200 MW) • Off-shore Wind Procurement (1,600 MW)	✓

Energy Storage Initiative
Advancing Commonwealth Energy Storage

$10M Advancing Commonwealth Energy Storage (ACES) Grant

Objectives include:

- Demonstration of broadly replicable use cases and business models for energy storage in Massachusetts
- Quantification of non-monetizable benefits provided to all ratepayers through the deployment and operation of energy storage in various use cases
- Inform state policy and stakeholders on best practices for energy storage development in MA

Schedule

- Proposals were due 6/9/2017
- Anticipate awards fall 2017 and operational within 18 months

Clean Energy Legislation

"An Act Relative to Energy Diversity" (H. 4568)

Governor Baker signed bi-partisan, comprehensive energy diversification legislation on August 8, 2016.

Energy Storage

- Provides a definition for energy storage;
- Clarifies utility ownership of storage;
- Allows storage to be paired with clean energy procurements;
  - 1,200 MW hydropower, 1,600 MW offshore wind
- Authorizes DOER to set an energy storage target.

Chapter 188 of the Acts of 2016
Section 15

SECTION 15. (a) **On or before December 31, 2016, the department of energy resources shall determine whether to set appropriate targets for electric companies to procure viable and cost-effective energy storage systems to be achieved by January 1, 2020**. As part of this decision, the department may consider a variety of policies to encourage the cost-effective deployment of energy storage systems, *including* the refinement of existing procurement methods to properly value energy storage systems, the use of alternative compliance payments to develop pilot programs and the use of energy efficiency funds under section 19 of chapter 25 of the General Laws if the department determines that the energy storage system installed at a customer's premises provides sustainable peak load reductions on either the electric or gas distribution systems and is otherwise consistent with section 11G of chapter 25A of the General Laws.

(b) **The department shall adopt the procurement targets, if determined to be appropriate under subsection (a), by July 1, 2017. The department shall reevaluate the procurement targets not less than once every 3 years.**

(c) **Not later than January 1, 2020**, each electric company entity shall submit a report to the department of energy resources demonstrating that it has complied with the energy storage system procurement targets and policies adopted by the department pursuant to this section.

200MWh Target

DOER solicited Stakeholder Comments

- DOER received unanimous support to adopt a target
- DOER received more varied responses on the format and size of target

On June 30, 2017, DOER adopted a 200 Megawatt-Hour energy storage target for the three electric distribution companies.

- Achievement by January 1, 2020
- Annual reporting by electric companies on achievement
- In line with 600MW State of Charge goal by 2025

Next Steps

Achieve the 200 Megawatt-Hour energy storage target Achievement by January 1, 2020

- Annual reporting by electric companies on achievement progress

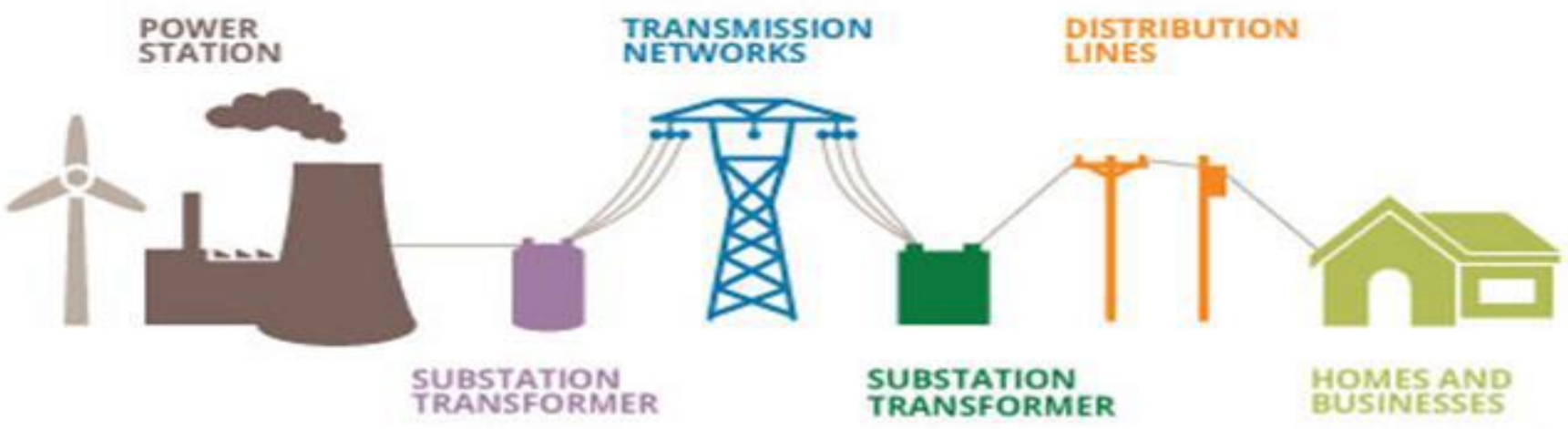
- In addition to the target adoption, DOER announced:
  - Up to $10 million in additional funding for demonstration projects
  - Examining including additional energy storage technologies in the Alternative Portfolio Standard (APS)

Continue progress on comprehensive suite of energy storage policies and programs

- Launch the SMART program which includes an incentive for energy storage paired with new solar installations
- Review Clean Energy and Off-shore Wind procurement bids
- Continue with Community Clean Energy Resilience Initiative demonstrations, which include pairing energy storage with solar and CHP
- Supported the energy efficiency plans which include energy storage

THANK YOU

STORAGE IS IN ALL PARTS OF THE GRID



The latest buzz about batteries . . .

- Newest and fastest growing storage type
- Costs declining rapidly
- Quick to deploy (less than 6 months from contract)
- Located on all parts of the grid
- Can provide multiple services interchangeably

Update on FERC's Storage Initiatives

- **RM16-23: Increase Market Availability**
  - would enable market participation of storage and DER aggregations
  - allow storage to provide service for all market products it is technically capable to offer
  - require ISOs/RTOs to implement appropriate storage modeling for optimization and dispatch
  - require at least 100 kW systems as minimum size for market participation
  - DER aggregation section would enable behind-the-meter storage to more effectively participate (i.e., not only as Demand Response)

AD16-25: Compensation for Storage Assets

- Allowing electric storage to be used as transmission assets, grid support services, multiple services

- Determining compensation mechanisms for each use (e.g., transmission rates?)

RM17-8: Reforms to Interconnection

- allow storage interconnection to be tailored to use case and avoid network upgrades
- improve ability of storage to use surplus interconnection service on system (*i.e.*, through co-location with existing generation)

PJM 206 Filings

- 2012: PJM implemented a RegD
- January 2017: PJM modified the RegD signal
- April 2017: 206 filings submitted by ESA and RES Americas and Invenergy Energy Storage Developers
- June 2017: PJM again modified the RegD signal

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Perspectives on Storing Electricity for Our Future

July 2017

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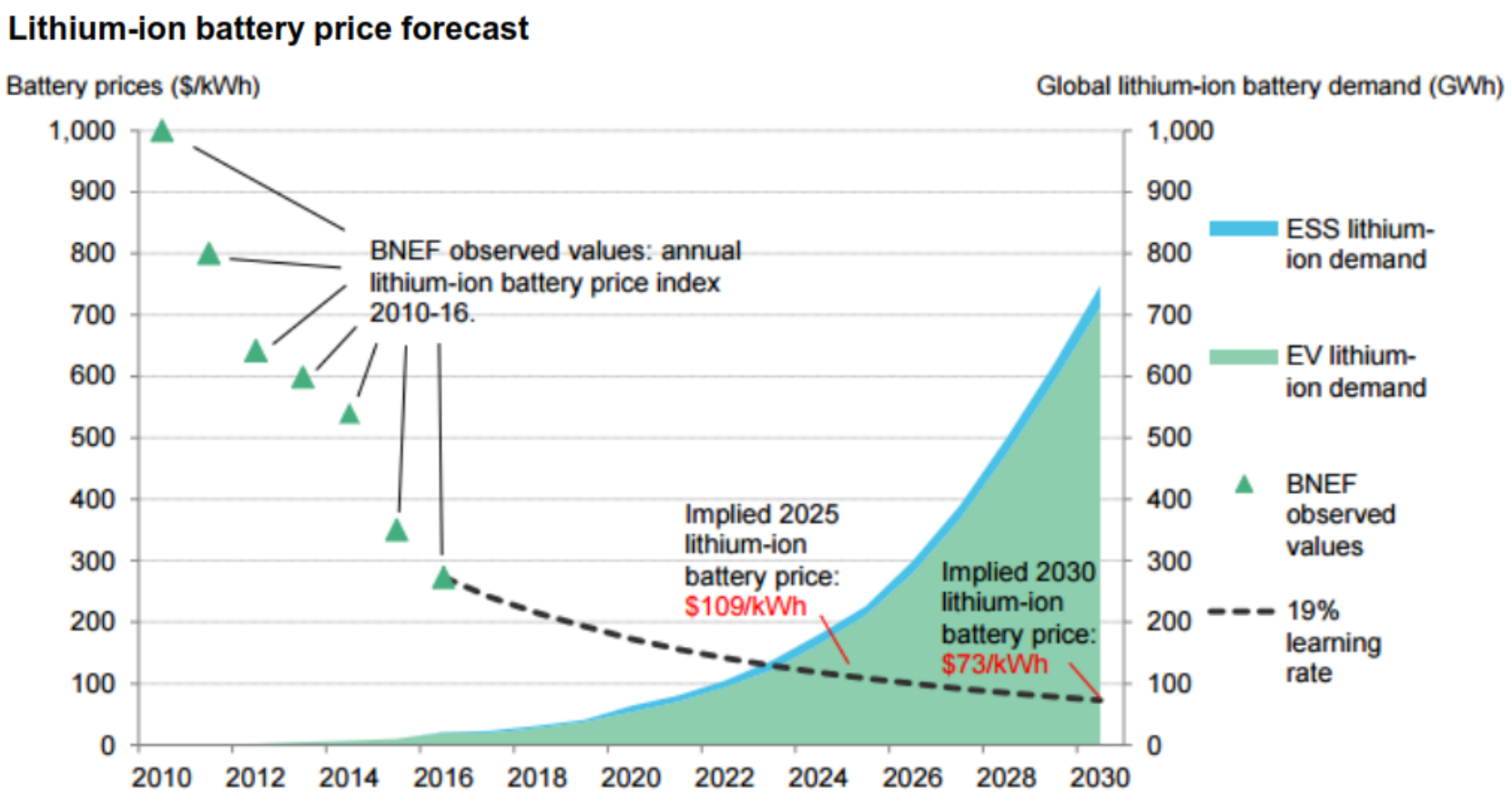
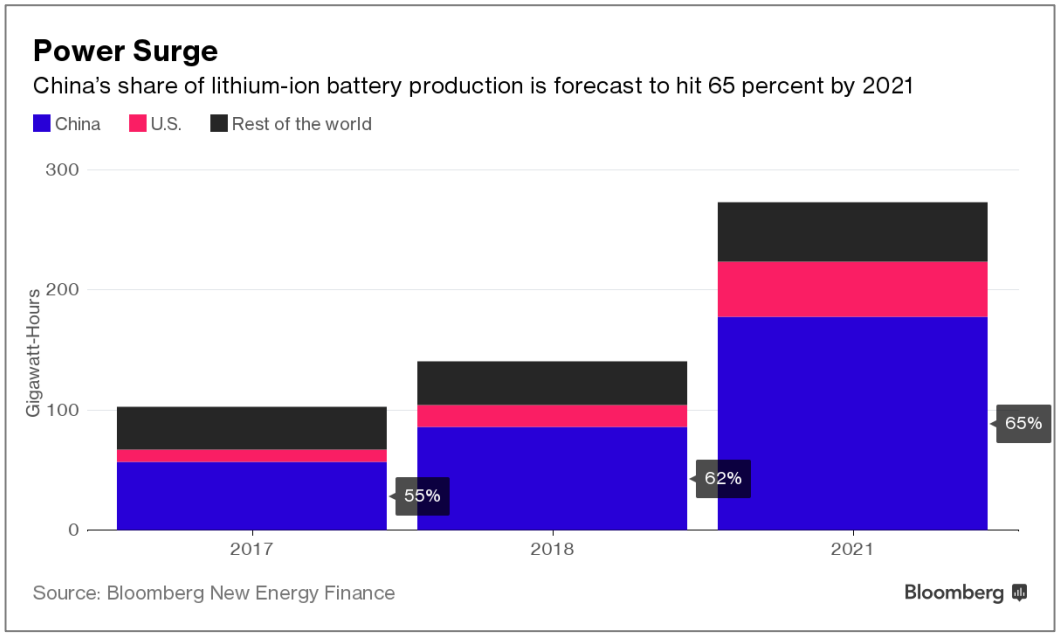
Li-ion dramatic price drop is creating grid market

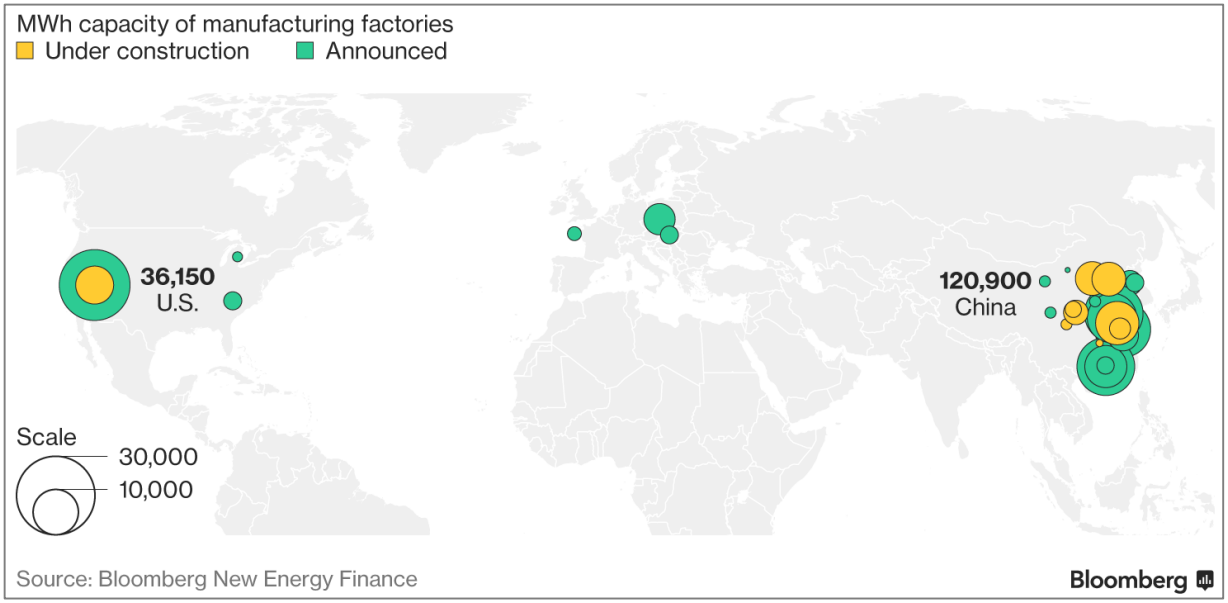
Lithium-ion battery pack prices will drop another 75% by 2030



Source: Bloomberg New Energy Finance

Global dynamics at work – China on track to dominate

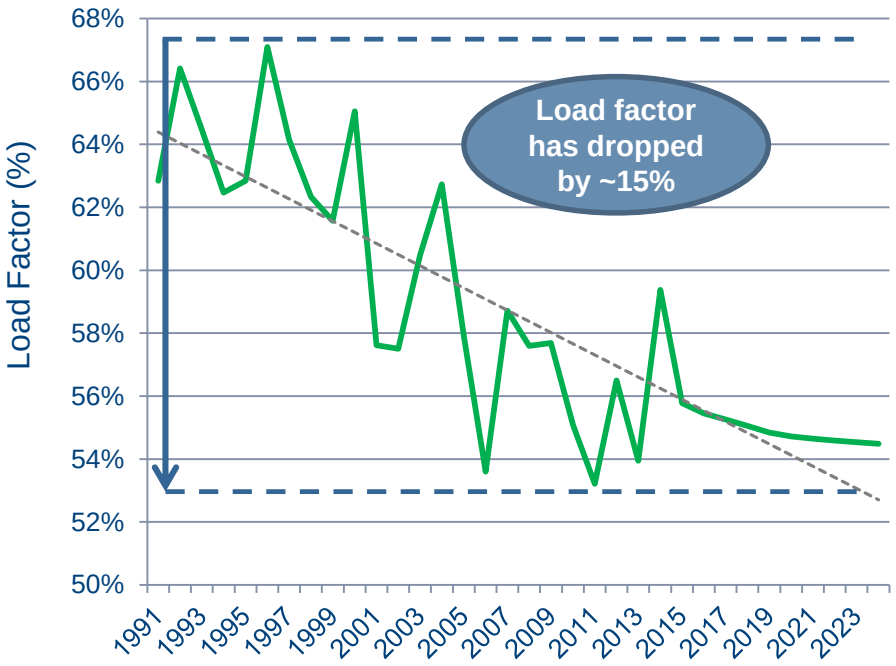




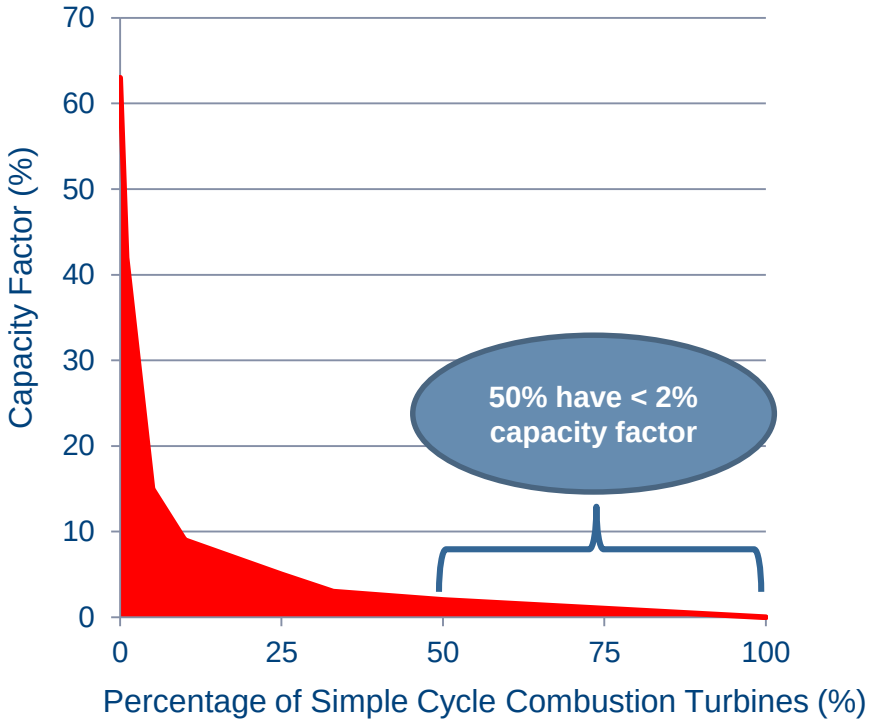
Grid: low asset utilization & most capital intensive

Electricity is the most capital intensive industry – in the US, $3 of assets required for $1 of annual revenues

New England Load Factor, Summer Peak, 1991-2024



US Peaking Power Plant Utilization



Sources: EPA, ISO-NE

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Storage addresses challenges across the grid

Generation

- Underutilized assets
- Carbon emitting resources
- Intermittent renewables
- Volatile fossil fuel costs

Transmission & Distribution

- Congestion management
- Capital intensive infrastructure upgrades
- VAR/Voltage management

End Users

- Rising energy costs
- Rising peak demand charges
- Sensitive equipment
- Outage management

Market Operations

- Perfectly balance real time supply and demand
- Manage frequency regulation
- Maintain adequate reserve capacity

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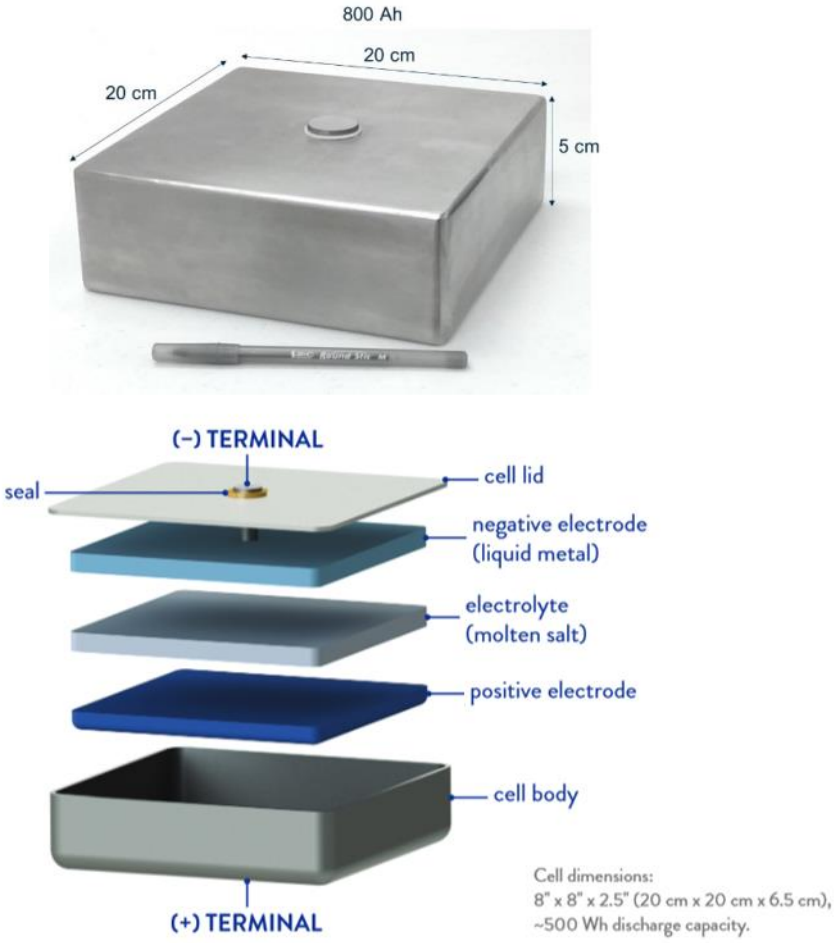
Ambri's Liquid Metal Battery cell technology is an innovative approach to grid-scale storage

Elegant & simple cell design



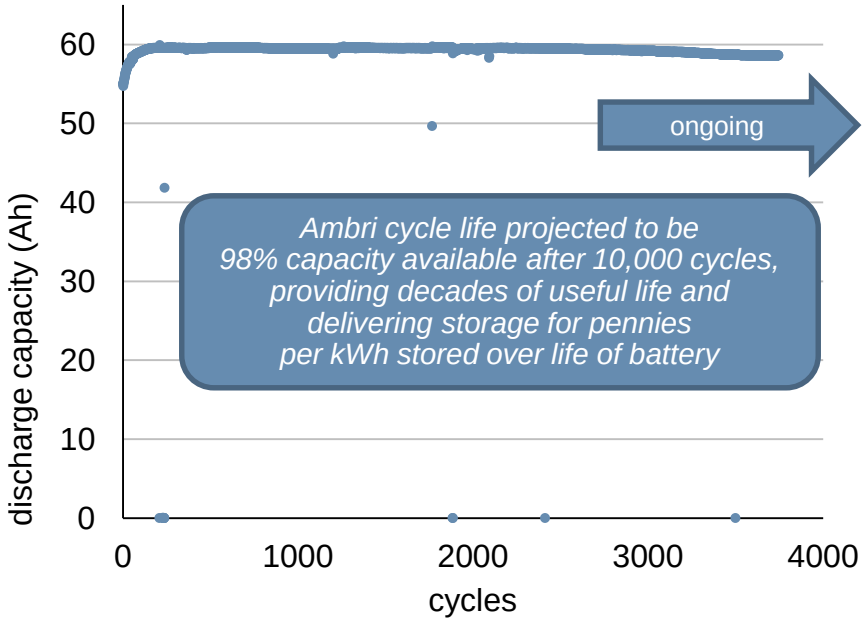
Attractive Features:

- ✓ **Low cost product –** upfront capital cost and per cycle cost of storage
- ✓ **No degradation in capacity** – initial capacity maintained after thousands of cycles
- ✓ **Low-cost and scalable manufacturing** – the cost of an Ambri factory is 8-10 times less than lithium-ion manufacturing
- ✓ **Durable to external climates** – able to operate in hot and cold climates without ill effect
- ✓ **Safe** – robust design offers inherent safety features

Ambri performance is unique: negligible fade

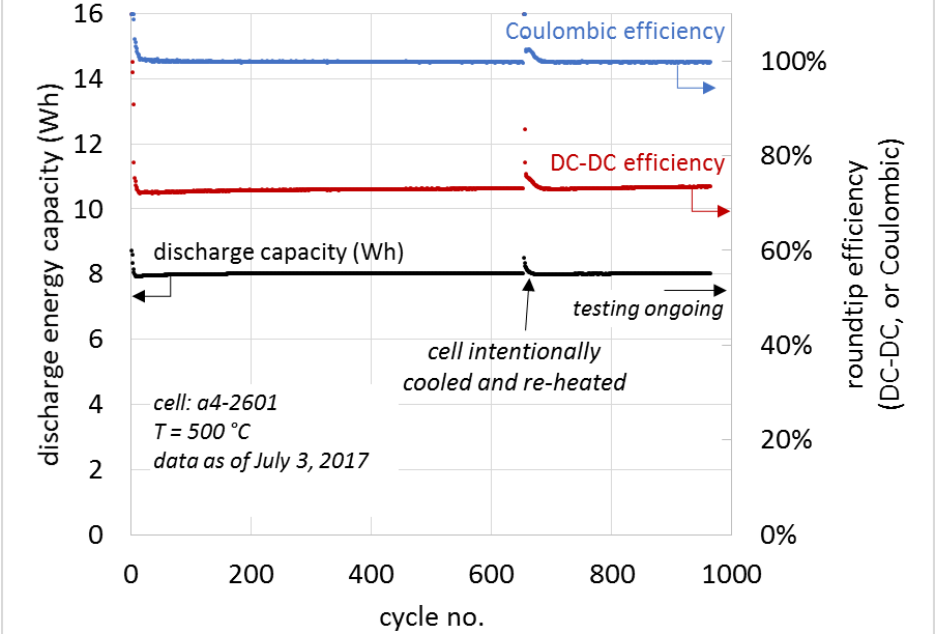
- < 0.0002%/cycle capacity fade on full depth of discharge cycling; thousands of cells tested
- Over 4,000 cells built and operated; consistently demonstrate negligible fade

Early LMB chemistry
(test started >4 years ago, still running)



Ambri's present LMB chemistry (lower cost)

No observable capacity fade after ~1000 cycles. Cells run at high rate (i.e. 40 min charge, 40 min discharge), achieving ~72% DC-eff. Lower rate cycling cells achieving 80-85% DC-eff



Ambri storage enables renewables

A new energy future

- 50+% powered by renewable resources
- Fully-delivered generation cost at $0.07/kWh ($0.03/kWh for solar; $0.04/kWh for storage)

…***made possible through Ambri energy storage***

Features

- ✓ **Safe**
- ✓ **Scalable to hundreds of MWhs**
- ✓ **Flexible operations**
- ✓ **Modular design**
- ✓ **Space-efficient**
- ✓ **Suitable in all climates**
- ✓ **Long lifespan**
- ✓ **Stable performance**

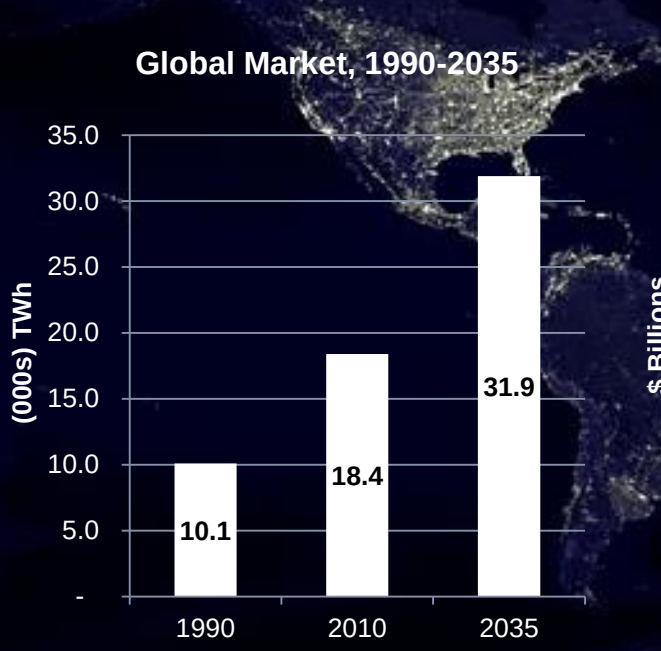
Power	~350 kW
Energy	1,000 kWh
Voltage	> 700 VDC
External temperature range	-50°C to 100°C (well suited for all climates)
DC Efficiency	85 to 90%
Operating temperature	475°C (no heating needed)
Response time	Responds in milliseconds
Dimensions	10'x8'x8'
Design life	20 years
Weight	18 tons

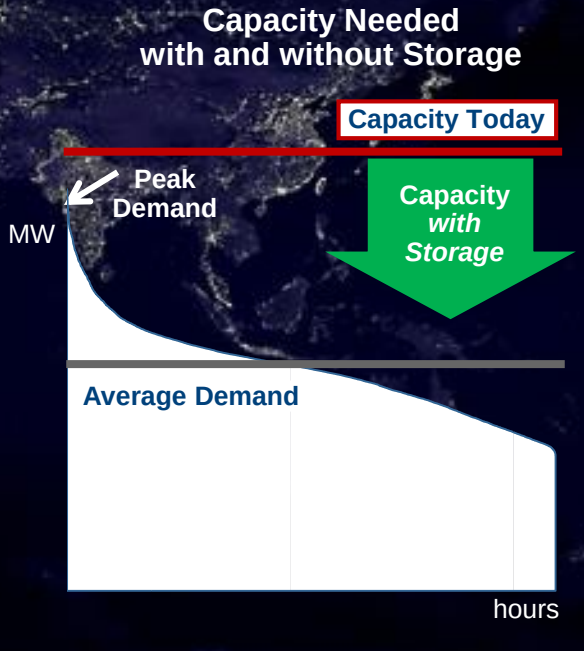
Ambri on path to transform global power markets

Electricity demand worldwide is increasing as populations and economies grow.

Massive infrastructure investment is needed -- $17 trillion; storage can significantly reduce needed infrastructure.

Storage will change how electric systems are engineered – building to average demand rather than peak.





Source: IEA, World Energy Outlook 2012

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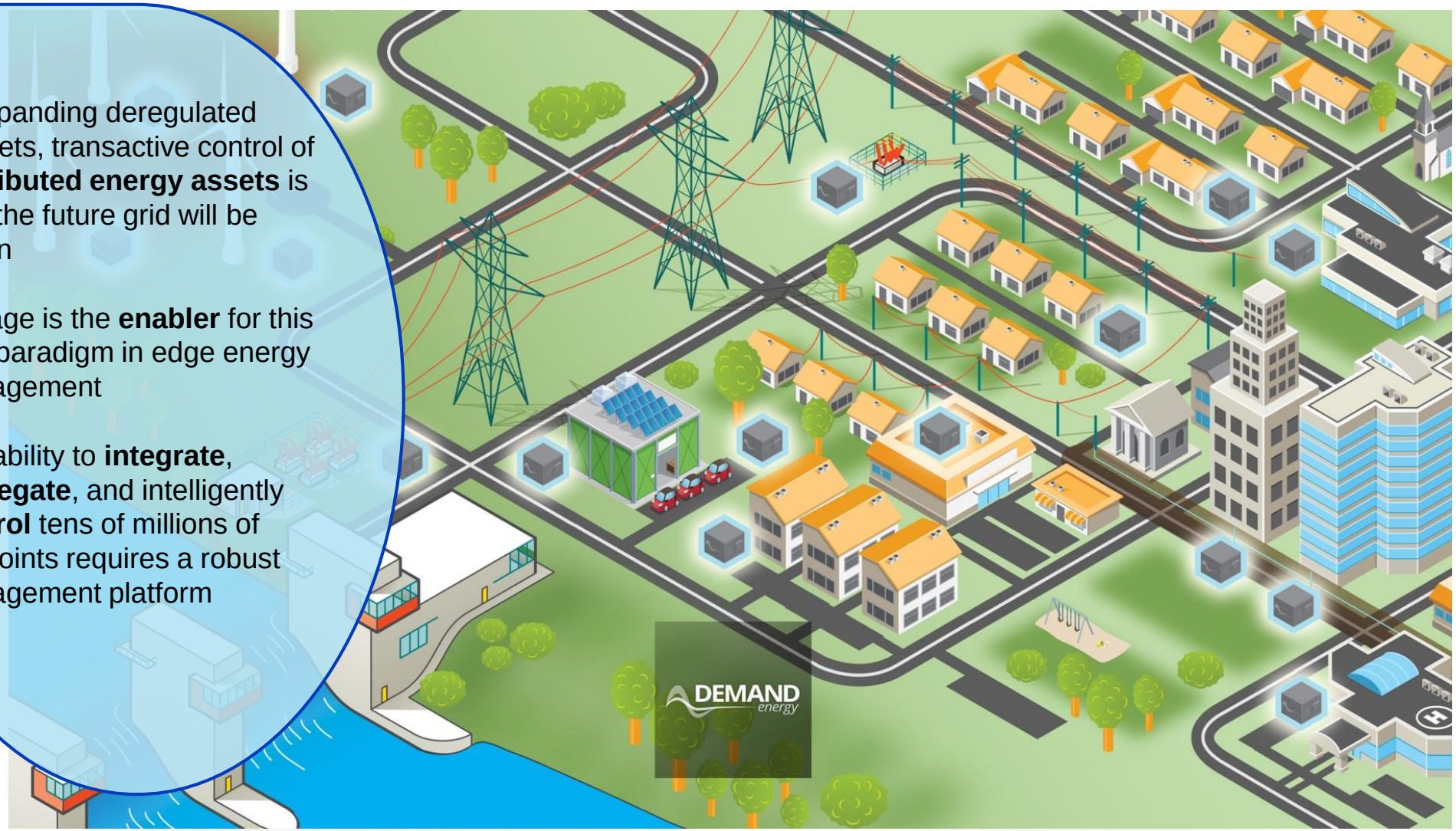
Demand Energy Networks

Intelligent Distributed Energy Storage

DEMAND energy
An Enel Green Power Company

- In expanding deregulated markets, transactive control of **distributed energy assets** is how the future grid will be driven
- Storage is the **enabler** for this new paradigm in edge energy management
- The ability to **integrate**, **aggregate**, and intelligently **control** tens of millions of endpoints requires a robust management platform



Benefits of Distributed Storage

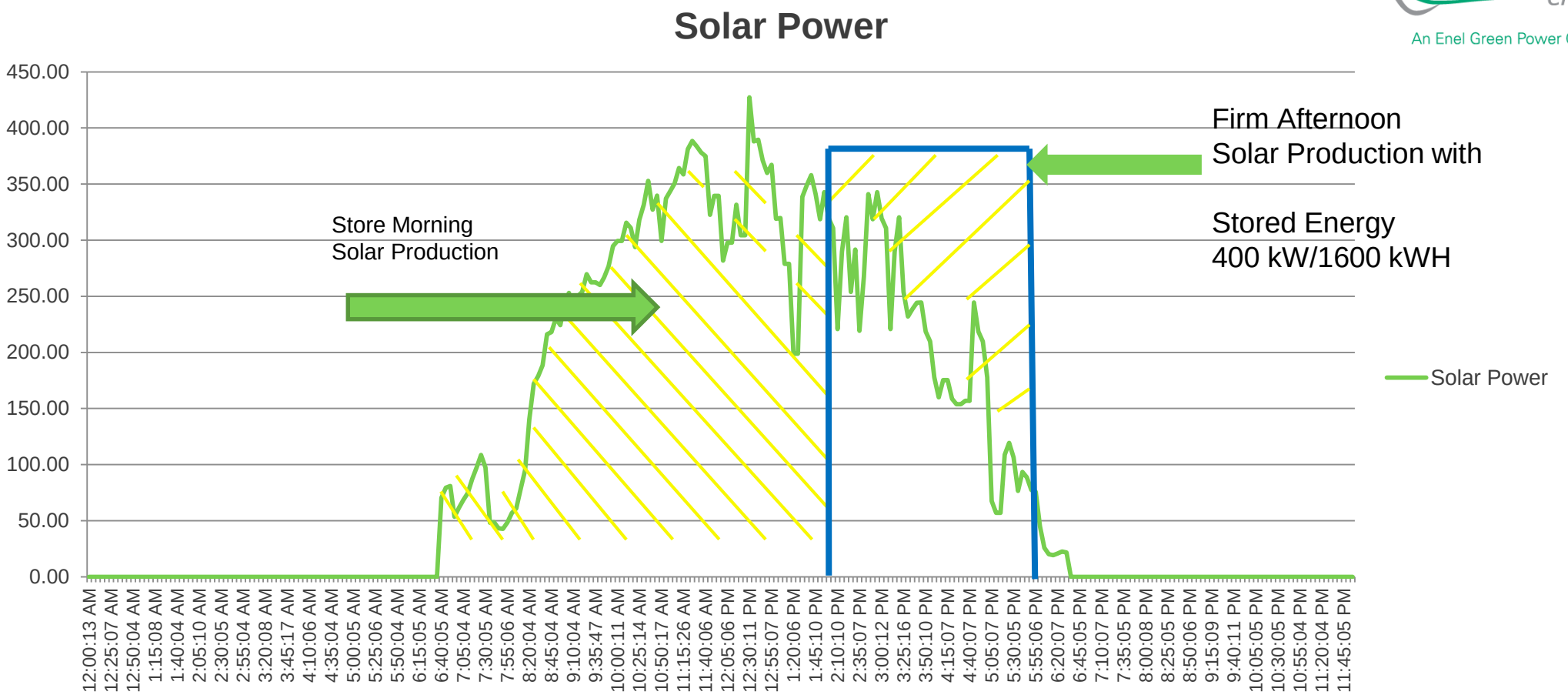
UTILITIES

- Conversion of variable generation in to base load generation
- Better utilization of Transmission & Distribution resource
- Integration of Renewable Generation
- Better solution to Demand Response
- System balancing-Load, Frequency- Voltage
- Lessen the impact of EV Charging integration

CUSTOMER SIDE

- Take Advantage of Market Price Incentives- TOU & Demand
- Demand Response w/o load reduction
- Overall Load management
- Renewable Integrations- Net Zero
- Disaster Response Services
- Minimize EV Demand Charges

Solar Peaker Plant



- Solar Production- Time shifted to period of highest benefit
- All intermittent performance removed
- Increased Value should receive a higher FIT price/kWh

NY REV Initiative

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REV 2030 Goals

40% reduction in greenhouse gas emissions from 1990 levels

A mandate for 50% of New York's electricity to be generated from renewable sources

23% reduction in energy consumption of buildings from 2012 levels

Develops a Transactive Energy Market – Moves Con Ed to the Role of DSO

Est. 500MW over next 5 years

Non Wire Alternatives- Con Ed BQDM

DEMAND energy
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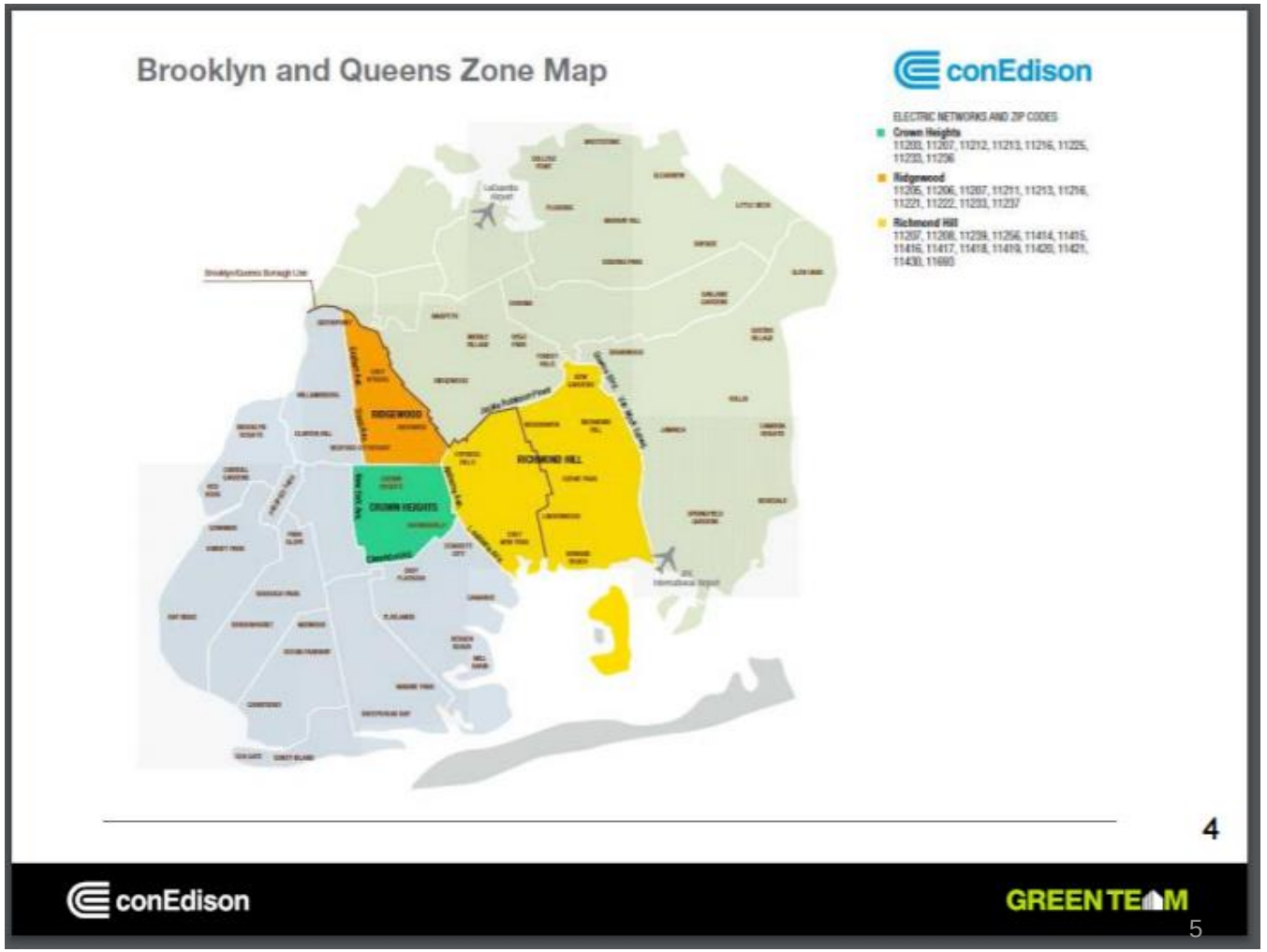
- Substation Upgrade Deferment= $ 1.2 B
- PSC Approved $200M Non-Wires Alternative (NWA)
- Program cost allowed in Rate Base
- Reverse Auction- Drove Market Based Response > $1992/kW-2 year program
- Drives Better system utilization
- Framework for future market based (NWA)



Marcus Garvey Village - Redevelopment

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2013

The New York Times

N.Y. / Region

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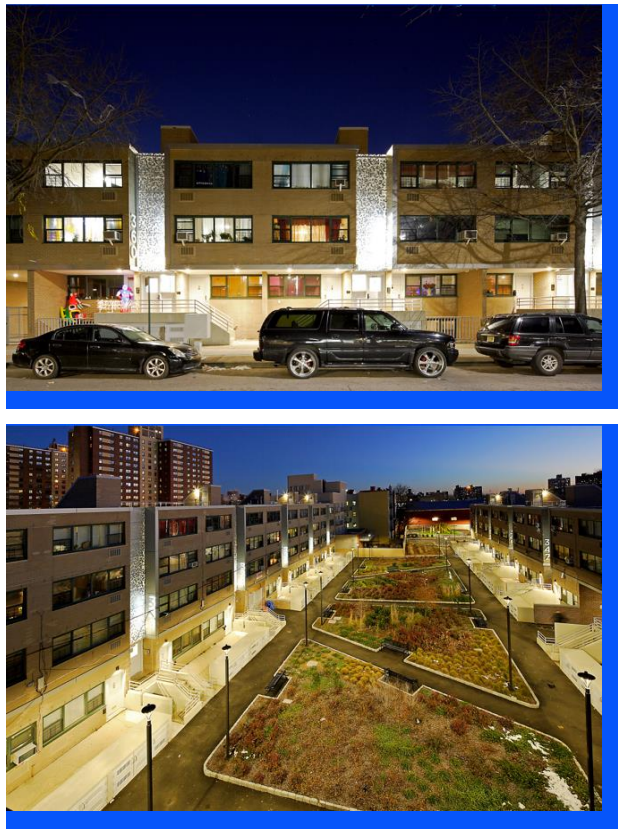
BIG CITY

A Housing Solution Gone Awry

Todd Heisler/The New York Times

2017



Doing The Right Thing Is Always The Right Thing To Do

Micro-Grid Solution

DEMAND energy
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DENS™

- 300 kW/ 1.2 MW Battery Storage System

BRIGHT POWER

- 400kW Distributed PV Power

Bloomenergy®

- 400 kW Energy Server Fuel Cell

A Blend Of DER Resources - Enhances Success

DEMAND energy
An Enel Green Power Company

Resiliency

Backup Power

- Provides Backup Power for Management and Security Office
- Community Room power for extended Outages

8

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