

# Energy Storage for Our Electricity Grid: Observations on Status, Barriers, and Innovation



Jason Makansi

President, Pearl Street Inc  
Principal, Pearl Street Liquidity Advisors

# Catalysts for Growth

- Investor and developer interest—quantum leap over past year. E.g., NREL Industry Growth Forum Applicants, investor conferences, new capitalized project development entities.
- Numerous inquiries from industry, academia, and the business and technical press
- Recognition of killer applications to drive future growth
  - Hybrids and electric vehicles storage needs
  - Political and public demand for renewable energy, 5-25% renewable energy mandates state to state

# Catalysts for Growth (cont)

- Example: Enhancing the value of wind— *fuel free electricity in the peak electricity markets*
  - Doubling the typical 35% capacity factor of wind turbine/generators
  - Expectations for between 30,000-50,000 MW of renewable energy to be installed, mostly wind, over next 25 years.
  - Back of the envelope calculation suggests an additional \$7-billion could be extracted from the wind energy market.

**What investment in storage might this additional value support?**

# Catalysts for Growth (cont)

- Huge increase in federal support for energy storage research-\$190-million (authorized, but not appropriated?)
- American Electric Power Corp Energy Storage Network technology (Na-S battery) demonstration and construction program
  - Single most important activity to emerge over the last few years
  - Mitigates a key barrier of a few years ago-lack of utility leadership
- Large-scale compressed air storage projects (at least 5) still percolating around the country
  - Utah, Iowa, Texas, Ohio, with (according to sources) the big OH project imminent
  - Renewed EPRI and industry interest

## Catalysts for Growth (cont)

- Example I: Replication of AEP's model across the country could create an estimated forward market of 20,000 MW of distributed, utility owned and operated, energy storage
- Example II: If large-scale CAES is built and dispersed across the country like pumped hydro storage is today, this could create another 20,000 MW of opportunity

# Barriers and Issues

- Value (revenue) Streams are spread across too many disparate players as a result of industry restructuring and deregulation programs.
- Single value point usually not enough to justify a project.
  - Transmission benefits-ISO or RTO
  - Avoiding plant cycling benefits-Genco/IPP
  - Security/reliability benefits-Govt, NERC?
  - Enhancing renewables-owner/operators

# Barriers and Issues (cont)

- Arbitrage-storing and moving low-cost power into higher price markets, reducing peak power prices.
- Security and assurance-voltage regulation, black start, frequency control, emergency power.
- Asset optimization—reducing the cycling and dispatch of large fossil units meant for baseload.
- Enhancing renewables –transforming “take it when you can get it” into scheduled power. A fuel-free electricity source in the peak markets! (Also, daily wind resource curves are often opposite the daily load demand curves)
- Transmission asset deferrals –postpone the need for new transmission assets depending on where storage assets are placed.
- Support distributed generation –Micro- mini-grids and on-site power systems must become at least as reliable as traditional grid-supplied electricity. Today’s digital society/economy demands power quality several orders of magnitude higher. Storage assets placed at distribution-voltage substations and integrated into advanced DG devices and uninterruptible power systems

**Multiple value buckets; how to apportion value and costs?**

# Barriers and Issues (cont)

- Lack of a “big dog” supplier with a long-term comprehensive view and strategy for the storage market
  - Where is this segment’s GE or Siemens?
  - Enthusiastic but fragmented technology companies with limited market-making skills
    - Example: Flow batteries. Company with some commercial success now on the ropes (which acquired another leading flow battery technology from a few years ago). **Technological Achilles Heels?**

# Barriers and Issues (cont)

- Resistance and lack of cooperation from the wind industry. Solar industry seems more approachable
- Impact of financial debacle. Will the nation's economy return to asset value and reduce the emphasis on transactional value?
- Communication – inability of this sector to conduct the necessary evangelism

# Innovation

- Technological
  - Focus on core Achilles Heel technical Issues – e.g., membrane life with flow batteries and fuel cells
  - System design and optimization – moving from device to a commercial system
  - Incubate and nurture more good ideas
  - Get upstart technologies over the “death valley.”
  - Combining storage devices to optimize the system
  - Leverage vehicle work into grid applications

# Innovation (cont)

- Example: Renewable Energy Development Inc
  - Recently raised \$5-million in venture capital
  - Develop, manufacture, and commercialize ultra-capacitor technologies for multiple markets
  - Increased power capacity and higher voltage applications compared to traditional UC products
  - High charge and discharge current
  - Lower cost, more efficient system solutions using UC, e.g. extends the life of a backup battery
  - Applications in UPS, wind turbine pitch control, Flexible AC transmission, hybrid vehicles, startup power, bridging power
  - Solved key materials issues to reduce cost and improve range of UC applications

# Innovation (cont)

- An incredible range of storage technologies seeking funding and commercialization
  - Buoyancy-based mechanical storage with potential killer app in offshore wind energy
  - Superconducting magnetic energy storage
  - Thermal energy storage to improve small-scale solar energy (residential and small commercial)

# Innovation-Policy and Political

- A new attitude towards infrastructure – The “infrastructure” backbone
- Reward competitive aspects of the industry for efficiency and optimization. The utility industry is still largely not incentivized to do faster, better, cheaper tomorrow than today
- Advocate for making energy storage the centerpiece of the government’s efforts to modernize and secure our electricity infrastructure. E.g., Strategic Electricity Reserve

# A New Order for Electricity Infrastructure & Markets

## Wholesale market

- Fully deregulated
- Significant hedging/trading
- **Energy storage for arbitrage**
- Flexible/truly dispatchable power stations (coal, gas)
- New private DC lines
- Conversion to some private AC Transmission
- **FLEXIBILITY, COMMODITY MARKET MENTALITY. ARBITRAGE-DRIVEN**

## Retail market

- Mostly deregulated
- Distributed power, micro-, mini-grids
- **Distributed energy storage devices**
- Natural-gas driven
- **CUSTOMER-DRIVEN SERVICES**
- Demand-side conservation
- Little trading and hedging (except big-load customers)
- Power quality management

## The Electricity Infrastructure BACKBONE

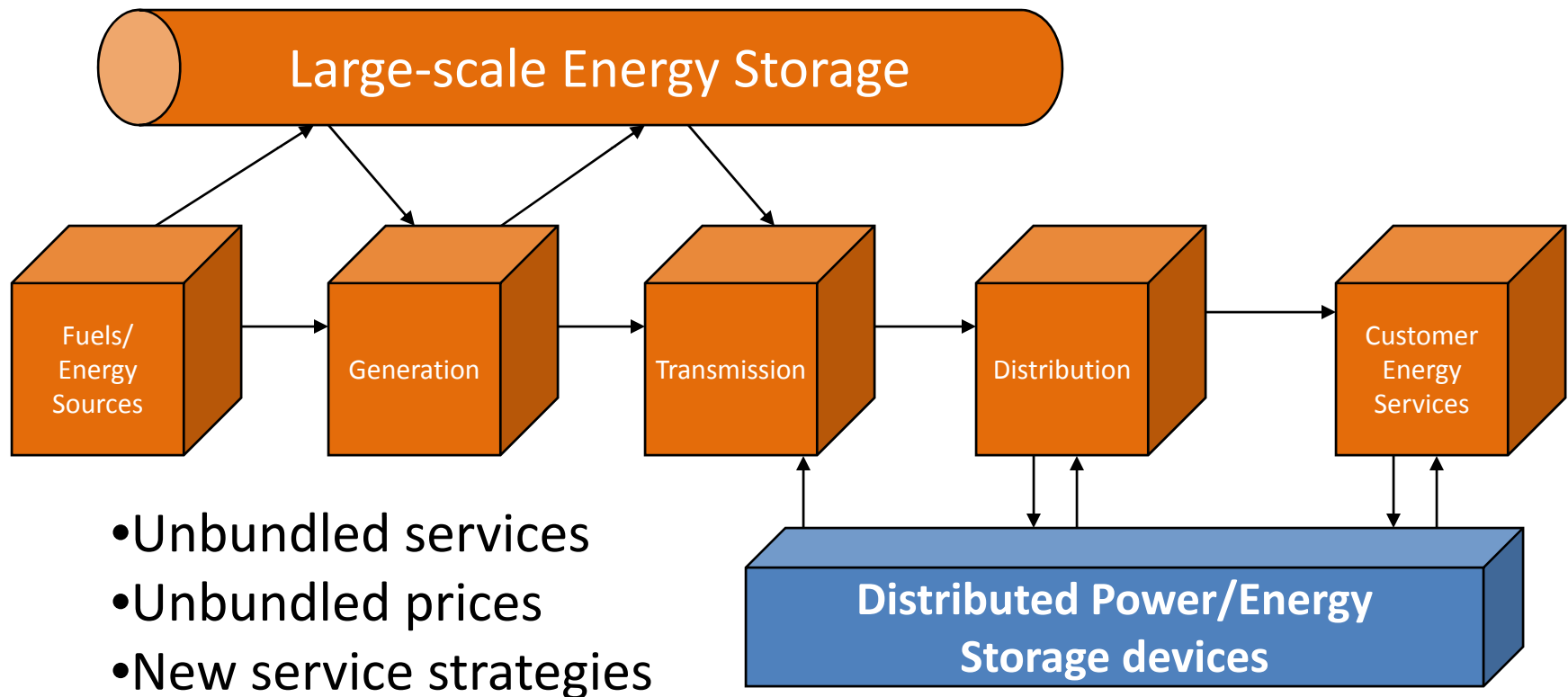
- Mostly regulated or large government role
- **Energy storage for ancillary services/security/assurance**
- Low cost but inflexible baseload stations (coal, nuclear)

- Fee-for-service
- **RELIABILITY AND SECURITY DRIVEN**
- Incremental rates of return over costs

# Innovation - Communication

- A serious, sustained, and well-funded effort in Washington and key states to capitalize on recent gains
- A sense of urgency – fear sells
- Healthy competition. Whole programs go under if one technology company falters
- War room mentality
  - Punching back when wind people say storage isn't necessary
- Evangelism
  - Leadership, anchor tenants, supply chain entrants
  - Talking points. What is your elevator pitch? What is the collective elevator pitch?

# Six Dimensions of the “New” Electricity Value Chain



# Benefits of Energy Storage Along the Electricity Value Chain

## Industry Challenges

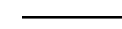
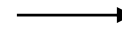
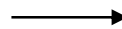
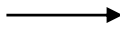
Volatility

Low Utilization

Congestion

Security

“Dirty Power”



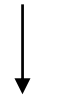
**Fuel**



**Generation**



**Transmission**



**Distribution**



**Services**



**ENERGY STORAGE**

Hedge Risk


Baseload Arbitrage

Higher Utilization

Stability

Power Quality

**Market Benefits**



Let's Work Together  
to Make  
Energy Storage  
*The Sixth Dimension of  
Electricity Supply and Delivery*