

Clean Power / Finance®

# Energy Storage and the Networked Grid

**James Tong**  
VP, Strategy

Confidential

# Benefits of Storage

## Historical Examples of Storage

Batteries

Hard Drives

Refrigeration

Currency

Writing



## Advantages

Consumption As Needed

Flexibility

Portability

Efficiency

Hedge Against Uncertainty

Enabler of New Innovations

**Limitations of the Grid: Must Always Balance Supply and Demand**

# Energy Storage Is More Than Batteries



## Chemical

- Batteries
- Fuel Cell
- “Liquid solar energy”



## Mechanical

- Hydroelectricity/Pumped Hydro-Power
- Compressed Air Energy Storage
- Flywheels



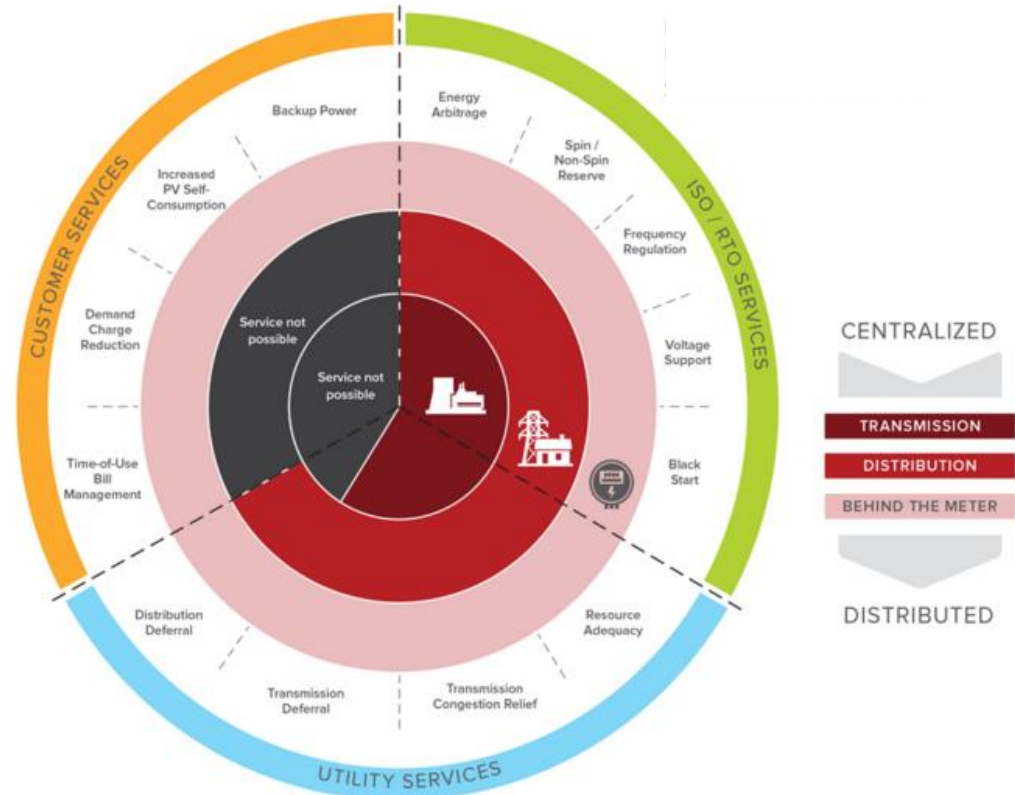
## Thermal

- Ice Storage Air Conditioning
- Latent Heat Thermal Energy Storage

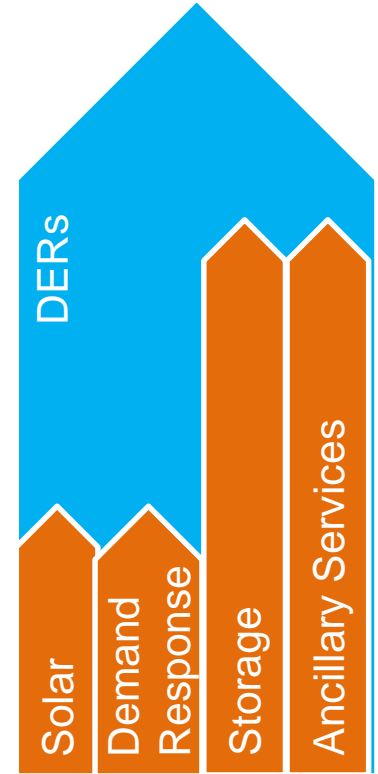
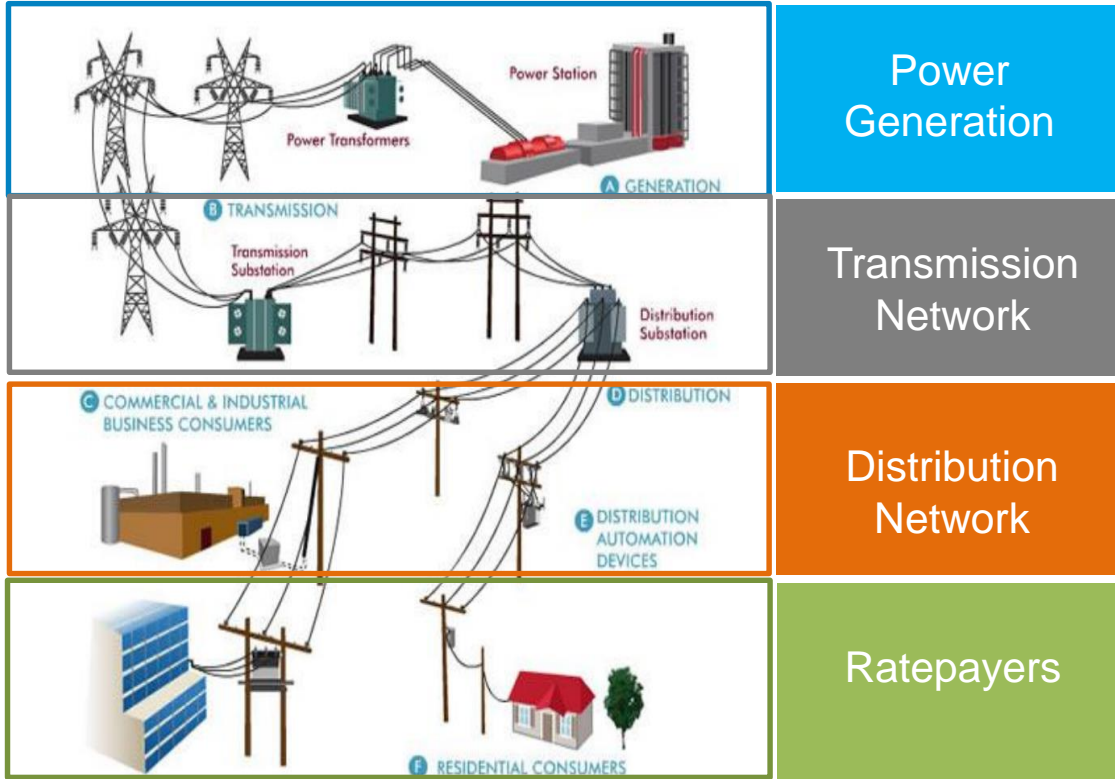
# The Appeal of Batteries

Batteries are costly but they...

- Can provide up to 13 services for the grid
- Can benefit the transmission and distribution grid and customers.
- Unlock opportunities to transform the power system.



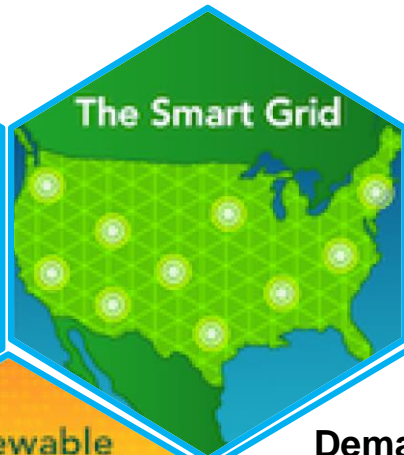
# 21<sup>st</sup> Century Grid: Consumers Becoming Suppliers



# Batteries are one of many distributed energy resources (DERs)



**Grid-scale Storage**



**The Smart Grid**



**Microgrids**



**The Smart Home**



**Retailer/Aggregator**



**Renewable Energy**



**Demand-side Management**



**Plug-In Electric Vehicles**



**Community Solar/Shared Models**



**New Distributed Generation Technologies**



**New Utility-scale Generation Technologies**



**Distribution Intelligence**



**Operation Centers**

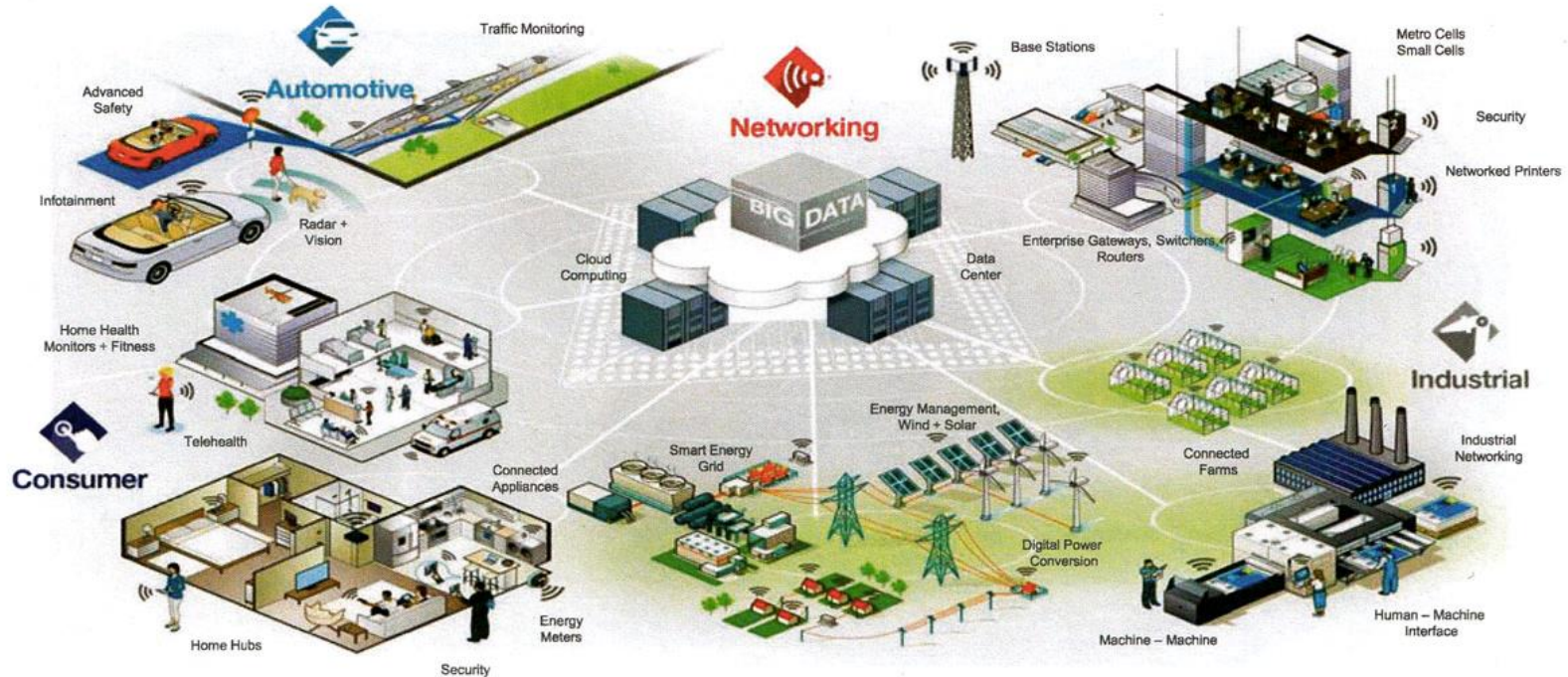


**Consumer Engagement**



**New T&D Technologies**

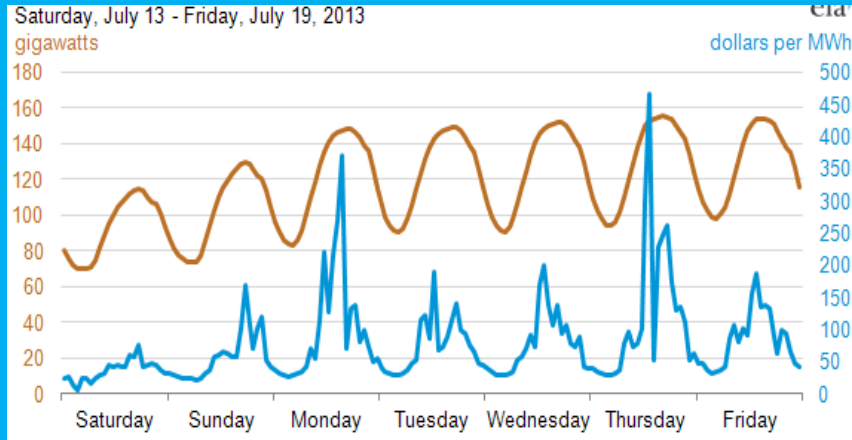
# From a One-Way Waterfall to a Multi-directional Network



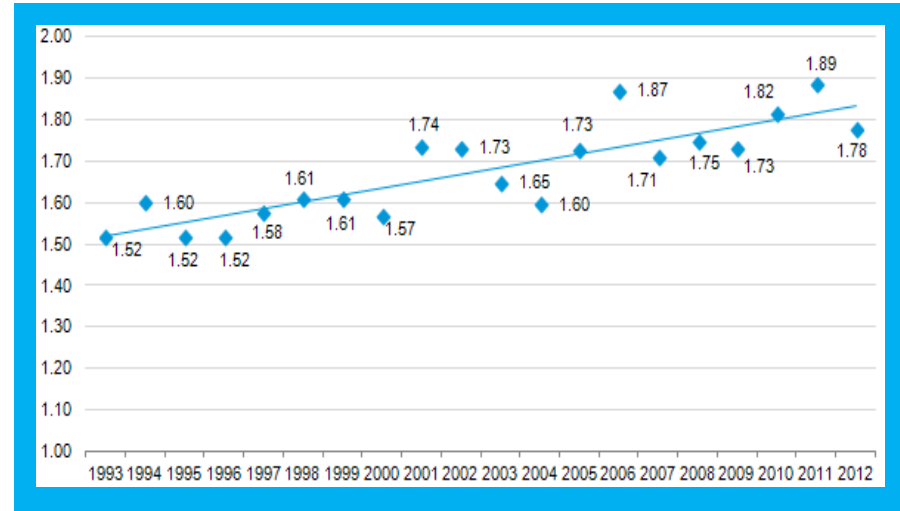
With cost-effective storage, grid will look like the internet: more dynamic, reliable, efficient, and resistant to disruptions.

# Storage Can Increase Grid Efficiency and Reduce Waste

## PJM Demand and Real Time Energy Prices



## New England ISO Peak-to-Average Demand Ratio

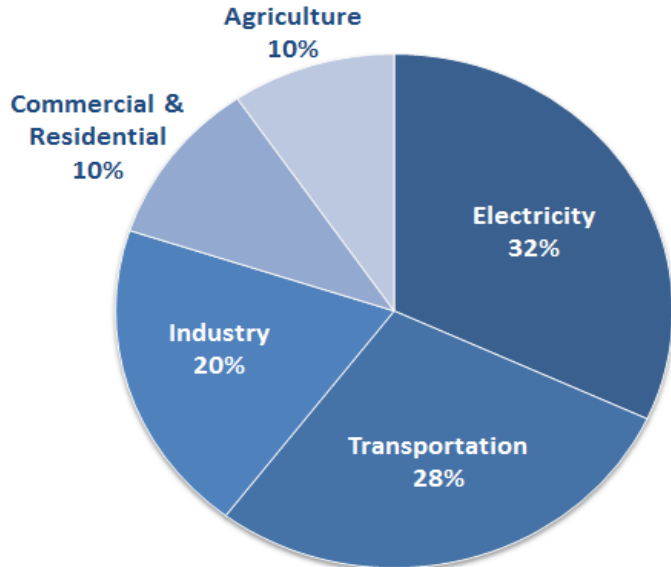


- Peak demand drives much of costs of grid
- Storage can better align supply and demand and flatten costly peaks and need for excessive capacity



# Cost-Effective Will Help Address Climate Change

## Carbon Emissions by Sector



Source: EPA

1. Electrification of Transportation
  - Need for cost-effective batteries
2. Cleaner Sources of Electricity
  - Facilitate wider use of renewables

Storage can facilitate reduction of other pollutants (e.g., CO, NO<sub>x</sub> & SO<sub>2</sub>)

# Getting Policies Right

- More R&D for storage to lower cost
- More refined mechanisms to appropriately price storage and DER
- A more holistic resource planning incorporating both supply-side and demand-side resources
- More efficient pricing signals to encourage investments by third parties and customers to use DERs to contribute to the grid.
  - Balance between regulatory controls vs. market mechanisms.
  - Ensure neutrality/agnosticism with the grid operator.

**Regulation must learn to optimize *distributed, demand-side* resources.**