Clean Power Finance

Energy Storage and the Networked Grid

James Tong
VP, Strategy

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”

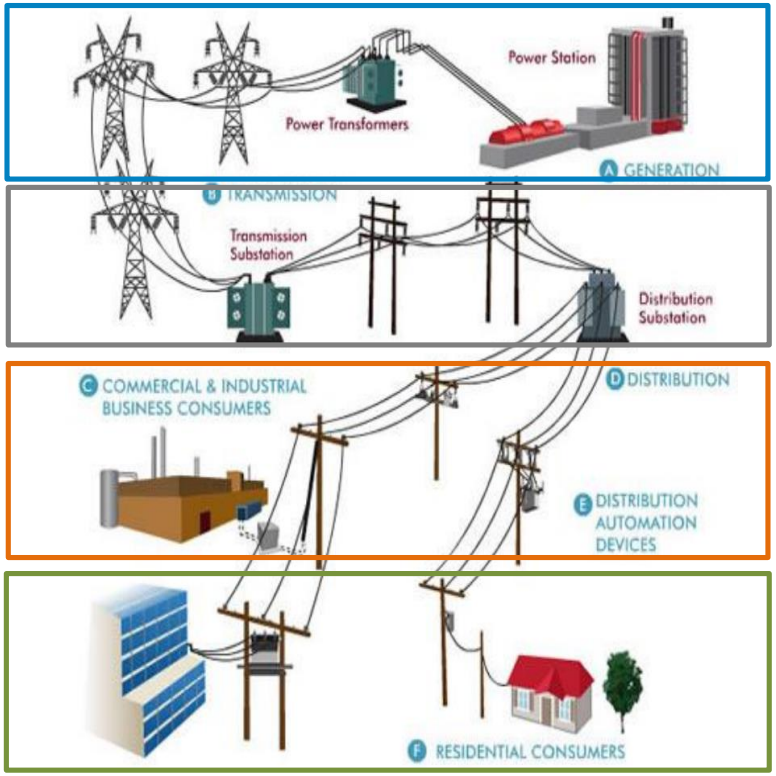
Mechanical

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

Thermal

- Ice Storage Air Conditioning
- Latent Heat Thermal Energy Storage

21st Century Grid: The Rise of Prosumers



Power Generation

Transmission Network

Distribution Network

Ratepayers

Wholesale

Retail

Market

RTO/ ISO

Reg. Utilities

Customers

DERs

Solar

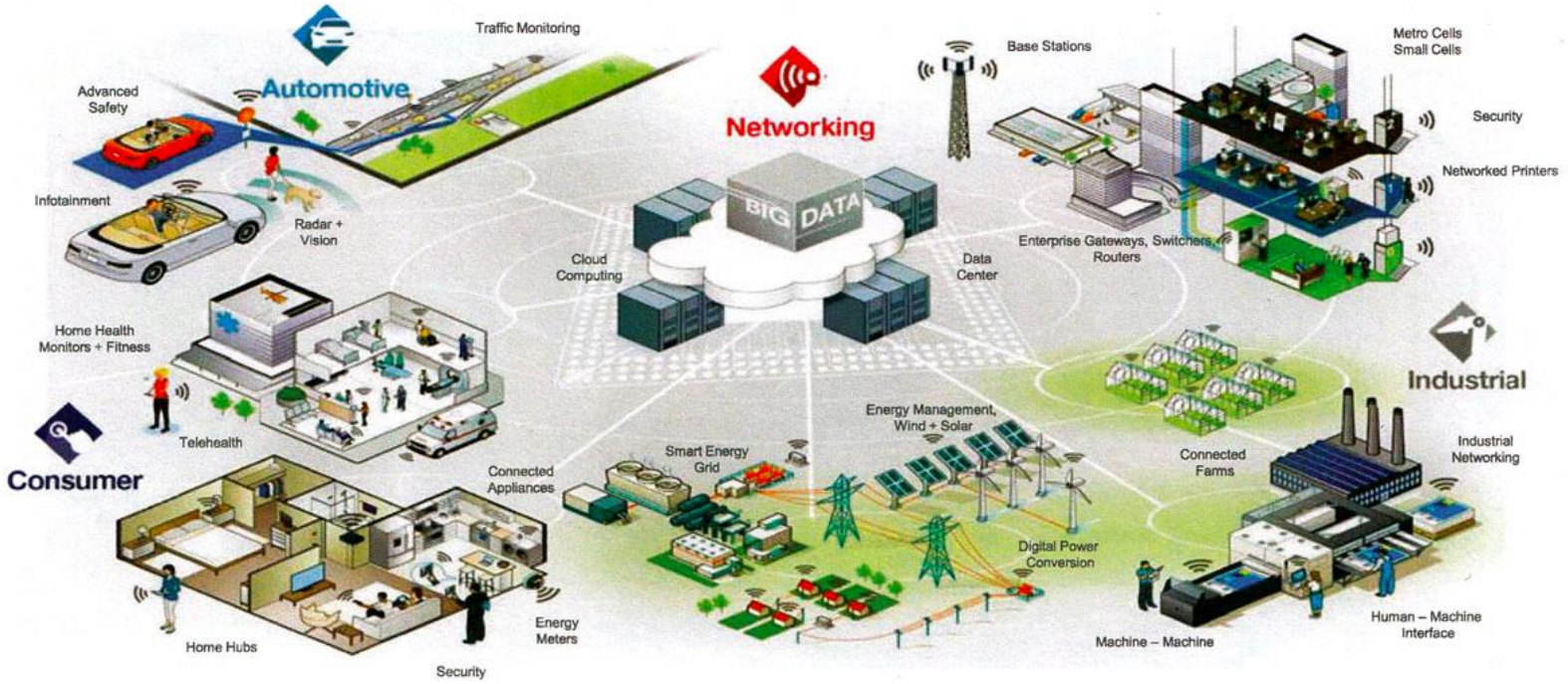
DR

Distributed storage

Ancillary Services

Storage is one of several emerging technologies

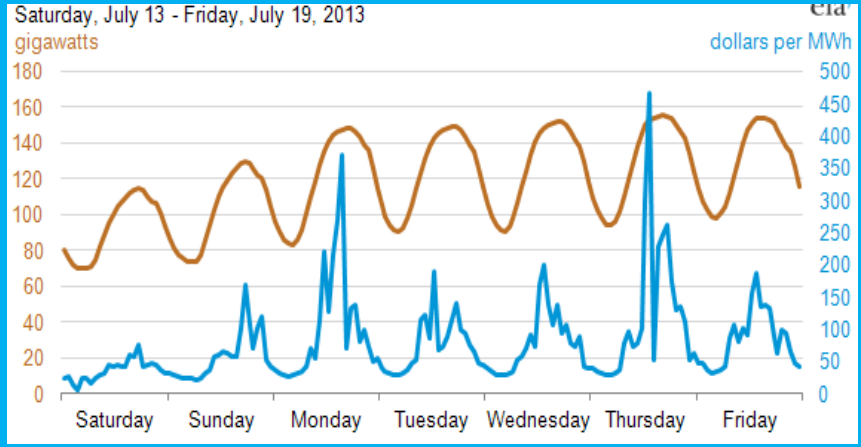
Grid Will Evolve from a Waterfall to a Network



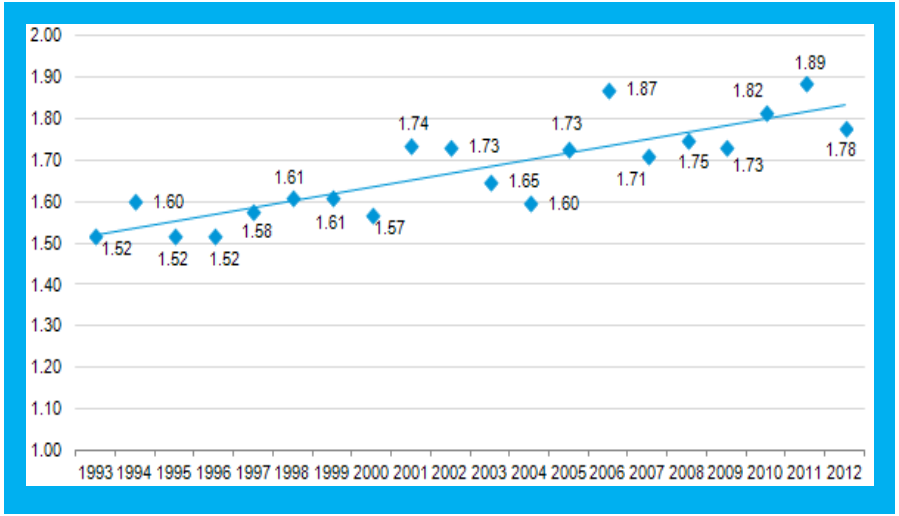
Cost-effective storage will empower consumers and protect against network irregularities and uncertainties (e.g., renewable energy or market manipulation)

Storage Can Increase Grid Efficiency →Reduce Fixed Costs

PJM Demand and Real Time Energy Prices



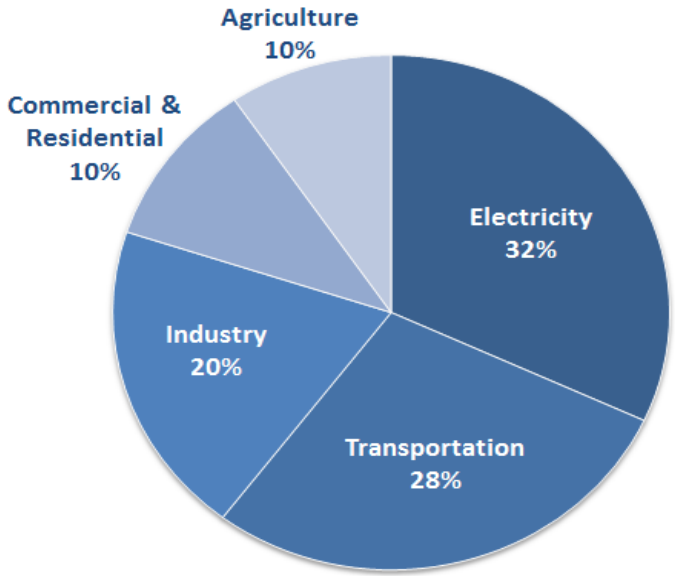
New England ISO Peak-to-Average Demand Ratio



- Peak demand drives much of costs of grid
- Dynamic pricing and storage can flatten costly demand peaks
- Electric industry will behave more like efficient markets

Storage Can Help Reduce GHG Emissions

Carbon Emissions by Sector



Source: EPA

1. Electrification of Transportation
   - Need for cost-effective batteries

2. Cleaner Sources of Electricity
   - Facilitate wide use of renewables

Storage can facilitate reduction of other pollutants (e.g., CO, NO_x & SO_2)

Getting Policies Right

- Need for more R&D for storage to lower cost
- Holistic resource planning
  - More symmetry between demand-side and supply-side resources
- Market mechanisms to increase the value of storage and DER
  - More dynamic electric rates
- Transparent and universal principles to fairly evaluate all resources
  - Incorporate all costs for cleaner vs. traditional fuels
  - Neutral grid operator
  - Focus on what vs. who

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