17 Electric Utility-Related Electricity Storage Benefits, Featuring T&D Deferral

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by

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Agenda

Menu of possible benefits
- 17 Direct Benefits
- 5 Incidental Benefits

• Featured Benefit: T&D Deferral

• Conclusions
  - Aggregate Benefits: Value Propositions
Background

• 2003 - 2004 California Energy Commission (CEC) Storage Demonstration Program
  – proposals addressed “value propositions” ($)
    • rather than technology or applications
    • value proposition = benefit(s) – cost
  – produced “Benefits Handbook” used by proposers to develop value propositions

• Developed “National” Benefits Guide
  Published by DOE/SNL in 2004
  California-centric
The Benefits Guide

• **Update for 2008** is pending

• Describe and Estimate
  
  ✓ 17 Benefits’ Magnitude ($)
    ₀ Primarily in terms of avoided cost
  
  ✓ Maximum Market Potential (MW)
    ₀ *generic* values established using subjective but transparent assumptions

✓ Somewhat High Level

✓ Technology Agnostic

✓ Value Proposition Examples
Benefit Categories

• Electric Supply
• Grid Operation (a.k.a. Ancillary Services)
• Grid System
• End-User/Utility Customer
• Renewables Integration
• Incidental

Some overlaps among benefits.
Electric Supply

• Electric Energy Time-shift ($/MWh)
  – Buy Low (off peak) and Sell High (on peak)

  Arbitrage = \textit{Simultaneous} purchase (@ “bid” price) and sale (@ “offer” price) to derive profit from a difference in prices.

• Electric Supply Capacity ($/MW)
  – offset need for generation \textit{equipment}
  – avoided generation resource on the margin
Grid Operation
(a.k.a Ancillary Services)

- Load Following
  - up or down when charging or discharging

- Area Regulation
  - “rapid” up and down => 2x benefit

- Electric Supply Reserve Capacity
  - storage is excellent reserve capacity

- Transmission Support
  - damping & stability, per EPRI

- Local Voltage Support
Grid System

• Transmission Congestion Relief
• Transmission and Distribution (T&D) Upgrade Deferral
  – may have especially high value
    ➕ very location-specific
  – compatible with several other benefits
• Substation Onsite Power
  – backup
End-User/Utility Customer

• Time-of-Use Energy Cost Management
  – “energy time shift” by energy user
    ▶ requires tariff with time-of-use energy pricing

• Demand Charge Management
  – reduce peak demand
    ▶ requires tariff with demand charges
    ▶ probably reduces energy cost too

• Improve Electric Service Reliability

• Improve Electric Service Power Quality
Renewables Integration

• Renewables Energy (RE) Time-Shift
  – wind and baseload RE generation

• Renewables Capacity Firming (during peak)
  – wind and solar generation
  – addresses mostly diurnal variation

• Wind Generation Grid Integration
  ✓ power quality
  ✓ ramping & load following (output “volatility”)
  ✓ minimum load violations
  ✓ unexpected wind generation shortfall
Incidental Benefits

• Avoided T&D “I$^2$R” Energy Losses
  – on peak minus off peak

• Avoided Transmission Access Charges

• Increased Asset Utilization
  – generation & transmission, possibly distribution

• Reduce T&D Investment Risk
  – DOE/Sandia report by DUA is pending

• Generation Dynamic Operating Benefits (EPRI)
  Reduced: 1) ramping, 2) part load operation, 3) wear and tear, 4) fuel use (per kWh), and 5) air emissions.
Benefits Market Potential

Preliminary Results
Do not Cite.

- Benefit
- Maximum Market Potential

Max. Market Potential (MW, 10 Years)

Benefits (%/kW, 10 Years)

- Max. Market Potential (MW, 10 Years)
- Benefit ($/kW, 10 Years)

- Outage
- Capacity
- Load Following
- Area Regulation
- Reserve Capacity
- Transmission Support
- Voltage Support
- Transmission Congestion
- T&D Deferral 50th Percentile
- T&D Deferral 90th Percentile
- Substation Onsite
- T.O.U. Energy
- Demand Charge
- Reliability
- Power Quality
- RE Time-shift
- RE Firming
- Wind, Gen. Integration, Short
- Wind, Gen. Integration, Long

- DOE Peer Review 2008
T&D Deferral Background

• Significant Benefit ($) Possible
• Limited Storage Cycling…for High Benefit
• Distributed Deployment
  ✓ richer value propositions possible
  ✓ if transportable: multiple deployments
• Pending DOE/Sandia Report
  ✓ survey of existing research
  ✓ important context such as indicators
  ✓ generalized benefit estimation framework
T&D Upgrade Deferral Benefit: Generalized Estimation Framework

Storage Power*

- 1.0%
- 2.0%
- 3.0%
- 4.0%
- 6.0%
- 8.0%

Fixed Charge Rate = 0.11
T&D Upgrade Factor = 0.33

Storage power relative to EXISTING T&D Capacity.
Range of Distribution Upgrade Costs

Sources: PG&E and EPRI

* T&D Upgrade Factor = 0.33
Value Proposition Examples

• Transportable storage for T&D deferral and PQ/Reliability at two or more locations
• PV + storage: capacity firming, energy time-shift, reliability, T&D deferral, congestion relief
• Small A/C: “load from hell,” energy time-shift, small motors’ effect on Voltage
• Central wind => distributed storage
Conclusions

• Emphasize *Value Propositions*
  ✓ less emphasis on applications & technology
  ✓ need artful aggregation of benefits (≥ cost)
  ❆ many storage opportunities require two or more benefits (combined) to exceed cost

• Increasingly Rich Possibilities for Attractive Value Propositions
  – menu of benefit categories
  – increasing value for those benefits
  – distributed resources (storage, generation, DR)
Conclusions

• T&D Deferral
  ⚫ potentially high value element of attractive value propositions for a growing number of locations

• Before purchase of storage many prospective users need:
  ✓ improved familiarity with the storage option
  ✓ more evidence about benefits
  ✓ better risk and reward sharing and means to internalize some benefits (efficient pricing)
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