

Value of Storage for Restructured Utilities

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Agenda

- Background (Phase I)
- Current Scope (Phase II)
 - Themes
 - Emphases
 - Approach
 - Results Description
 - Timeframe
- Next Step (Phase III)

Background - Phase I

Characterize Innovative Storage Market Opportunities

- Scope/Goal
 - Develop a high-level inventory of innovative energy storage “market opportunities”
- Result
 - Crystallized specification/characterization of market opportunities for further consideration

Current Scope - Phase II

Quantify “Most Promising” Storage Market Opportunity

- Scope/Goal
 - Detailed evaluation of all market opportunities, 12 “versions” were evaluated
 - Identify and characterize the “most promising” market opportunity, for further study
- Result
 - Quantitative ranking of most promising innovative market applications

Storage Market Opportunities

- ✓ Power Price Volatility**
- ✓ Customer Siting for Transmission and/or Distribution System Benefits**
- ✓ Enhanced Environmental Externalities
- ✓ Storage System Packaging Breakthroughs
- ✓ Combined Heat and Power Output Smoothing

**Several “versions” evaluated

Market Success Metrics

10 year Power/Output Capacity Potential	<i>GW</i>
10 Year Energy Storage Potential	<i>GWh</i>
Storage Value Metric	<i>\$/kWh</i> <i>(of storage)</i>
10 Year Economic Benefits Potential	<i>\$</i>
Environmental Benefits	<i>score</i>
Technology Innovation Opportunity	<i>score</i>
Scenario Likelihood	<i>score</i>

Market Success Metric #1

10 year Power/Output Capacity Potential

- GigaWatts
- technical potential (power rating/output)
*embedded load (800 GW) plus load growth (240 GW)
from 2001 - 2010*
- load in-play
*portion of existing load and/or load growth that might be
served cost-effectively with energy storage
(application-specific)*

Market Success Metric #2

10 Year Energy Storage Potential

- GigaWatt-hours (“reservoir” capacity)

- technical potential

storage market opportunity-specific hours-of-storage capacity required (e.g., 4 - 6) multiplied by technical potential for Power/Output Capacity

- storage market potential

storage market opportunity-specific hours-of-storage required multiplied by load in play

Market Success Metric #3

Storage Value

- \$/kWh value of storage (“reservoir” capacity)
- economic benefit accruing for each kWh of storage required (higher values are superior)
- strong indication of the price for energy storage systems necessary for financial competitiveness, for a given opportunity

Storage Value Details

Function of

- ✓ energy storage roundtrip efficiency
- ✓ time-specific electric energy cost (¢/kWh)
 - utility unit cost
 - customer unit price
- ✓ value of T&D capacity
 - utility avoided cost
 - customer demand charges
- ✓ value of superior reliability and power quality
- ✓ value of "green" power production

Example: Success Metrics for “Best” Opportunity

“High T&D Value & High Power Price Volatility”

- five hours of storage capacity is required
1. Power/Output Capacity Potential Over 10 Years
= 10% of load growth of 240 GW = 24 GW
 2. Storage Capacity Potential for 10 Years =
= five hours * 24 GW = 120 GWh
 3. Storage value = \$218/kWh

Storage Value Calculation for “Best” Opportunity

- net electric energy cost (@ 65% efficiency)
 - 25¢/kWh during “top” 200 load hours
 - 3¢/kWh/.65 = 4.6¢/kWh net for charging
 - (25¢/kWh - 4.6¢/kWh) * 200 hours = \$40.8/kW-yr
- value of T&D capacity: \$90/kW-yr

Storage Value Calculation for “Best” Opportunity

- annual benefit
= $\$90 + \$40.8 = \$131/\text{kW-yr}$
- “equivalent capacity value” (fixed charge rate = .12)
= $\$131/\text{kW-yr} \div .12 = \$1,090/\text{kW}$
- storage value
= $\$1,090/\text{kW} \div 5 \text{ hours} = \$218/\text{kWh}$

Market Success Metric #4

10 Year Economic Benefits Potential

120 GWh * \$218/kWh = \$26 Billion

Market Success Metrics 5 - 7

- all specified as a “score” of 0 to 1
 - ✓ Environmental Benefits
 - ✓ Technology Innovation Opportunity
 - ✓ Scenario Likelihood

Storage Market Opportunities Scoring

A. Utility: Power Cost "Super Volatility"

- 60¢/kWh energy for 100 hours per year
- 15¢/kWh energy for 100 hours per year

B. Customer: Electricity Bill Minimization

- 10¢/kWh retail energy price
- \$60/kW-yr demand charge
- 650 hours per year

Storage Market Opportunities

Scoring

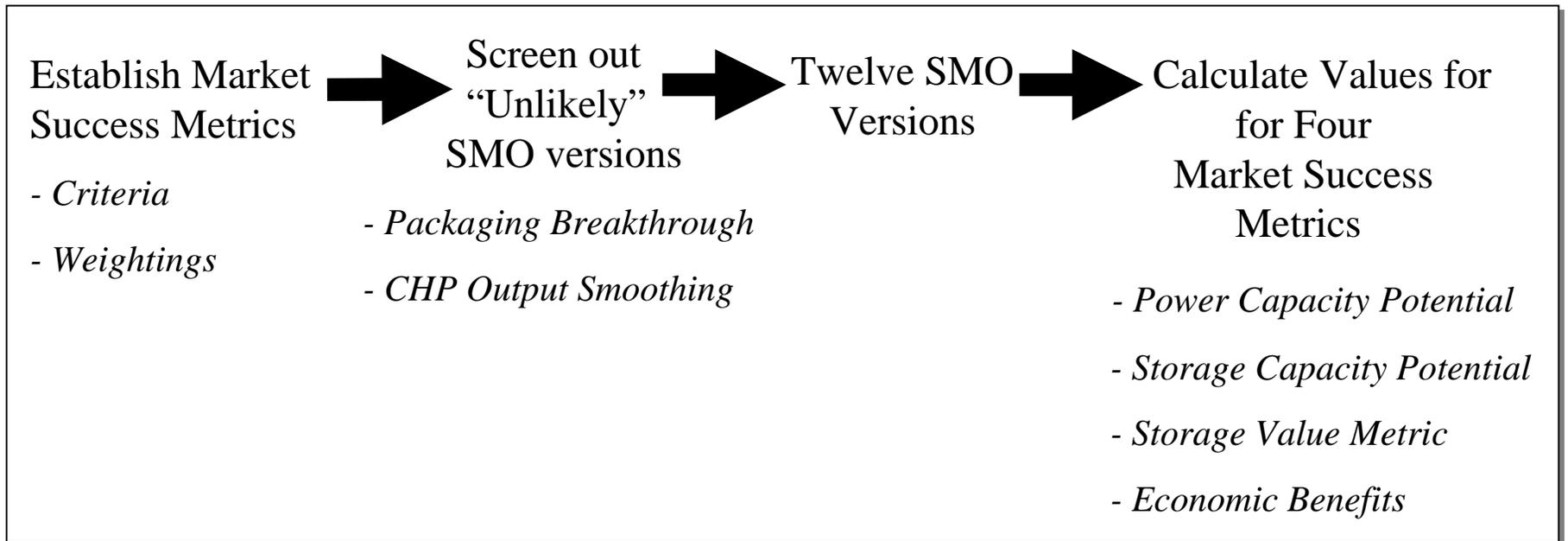
C. High T&D Benefits & Modest Power Cost Volatility

- \$90/kW-yr T&D “avoided cost”
- 10¢/kWh on-peak wholesale energy price
- 200 hours per year

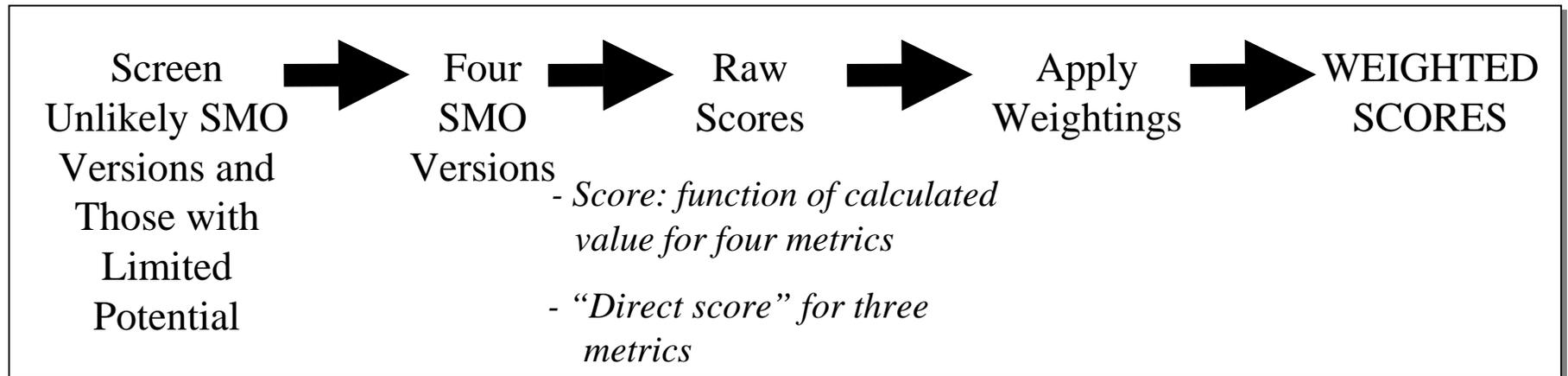
D. High T&D Benefits & High Power Cost Volatility

- \$90/kW-yr T&D “avoided cost”
- 25¢/kWh on-peak wholesale energy price
- 200 hours per year

Scoring Process Preliminaries



Scoring Process



Scoring Results Overview

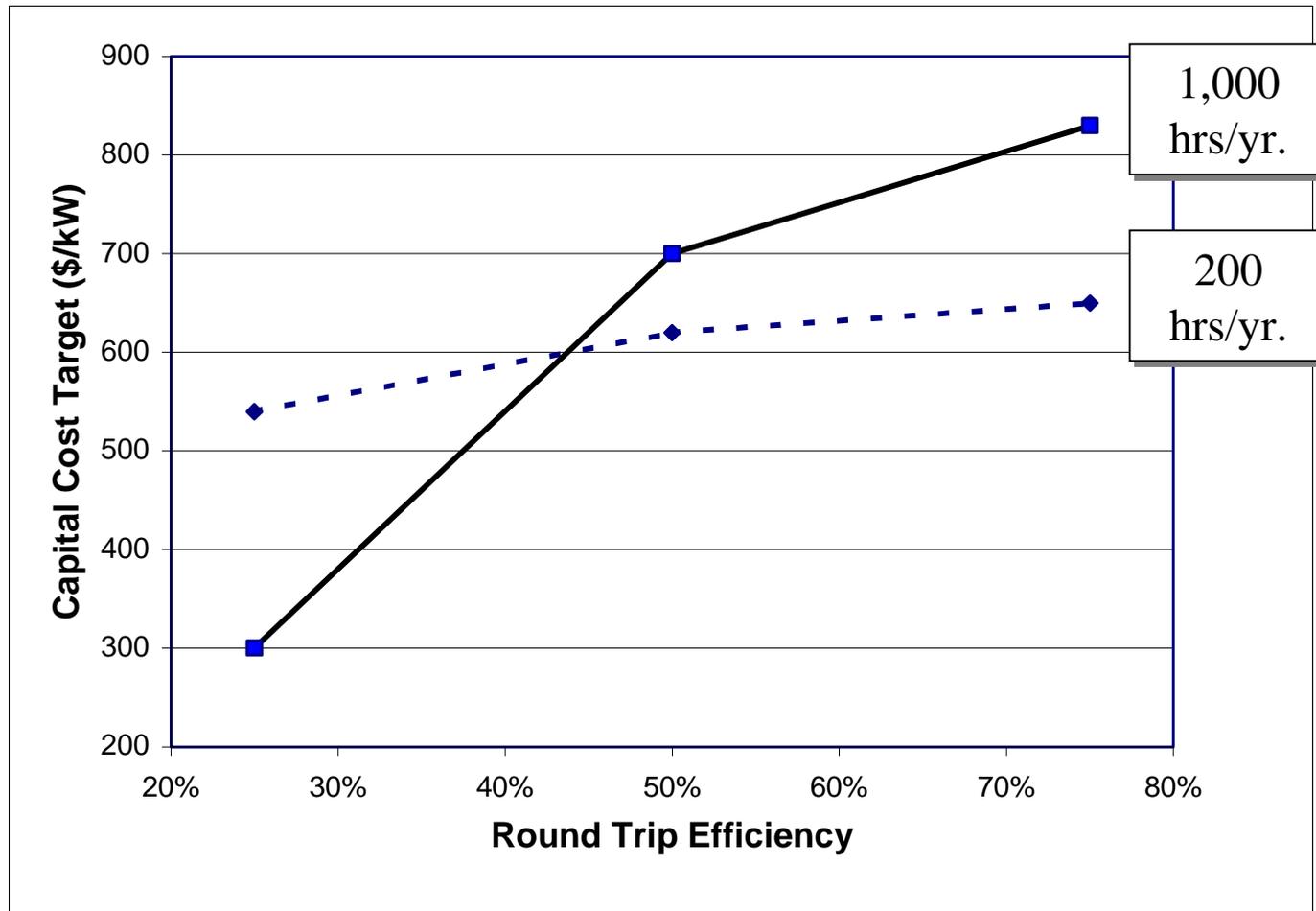
- A. Power Cost "Super Volatility" 49
- B. Customer Electricity Bill Minimization.. 59
- C. High T&D Benefits
& Modest Power Cost Volatility..... 49
- D. High T&D Benefits
& High Power Cost Volatility..... 60

“Most Promising” Opportunity (D.)

High T&D Benefits Plus
High Power Cost Volatility

- T&D Benefits \$90/kW-year
 - Power Cost 25¢/kWh
 - 200 hours per year discharge
- } \$1,090/kW, or
\$131/kW-yr
- 24 GW of load in-play
 - Five hours of storage required
- => 24 GW * 5 hours = 120 GWh
- } \$26.2 Billion
\$218/kWh

Energy Storage Value, an Illustration



Next Step

- Develop Market Plan for exploiting the opportunity: energy storage for
 - ✓ High T&D “Capacity” Benefits
 - Plus
 - ✓ High Power Cost Volatility (buy low-sell high)

Develop Market Plan

- Market Evaluation Research
 - benefits and costs
 - including detailed evaluation of relationship between storage value and storage efficiency
 - technical potential
 - synergies with existing energy storage markets
 - stakeholder interviews (e.g technology developers and utilities)
- Plan
 - explore federal roles