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RESEARCH INSTITUTE



## Modeling the Value of Energy Storage



*EPR*I Renewable Council Meeting



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**April 5-6, 2011**

## Agenda

- EPR

2011 Analytic Tool

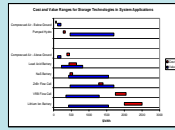
Open Distribution Simulator Software (OpenDSS)

Prism 2.0

- Q&A

# EPRI's Energy Storage Portfolio

## Technology Watch and Strategic Intelligence



Analytics Application Value & Business Case



Strategic Intelligence



Cost and Technology Capabilities



Industry White Papers

## Storage for Grid Support

Application Needs; Validated Capabilities



NaS Battery



Zn / Br Battery



Advanced Lead Acid Battery



Li-ion Battery



Micro-generation

## Bulk Storage for Renewable Generation



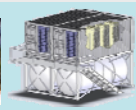
2nd Gen CAES



Regional Studies on Wind / Storage



Advanced - low fuel CAES



New Flow Batteries & Chemistries

Short-Term

Wind / Storage

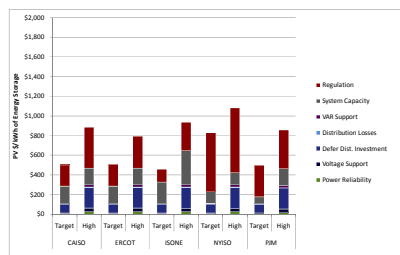
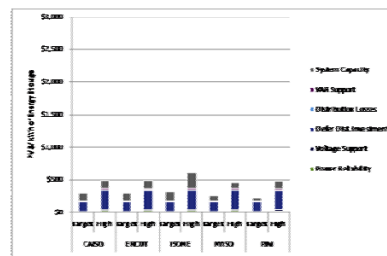
Long-Term

# Analytic Tool to Help Utilities Support Business Case for Energy Storage

Build from 2010 work to develop and deliver prototype analytic tool to estimate:

- Storage Application Value
- Total Resources Cost Recovery Test
- Benefit / Cost
- Utility / Societal perspectives
- Case Studies with selected utilities and EPRI Smart Grid Program
- 2012 Expand Applications and Release

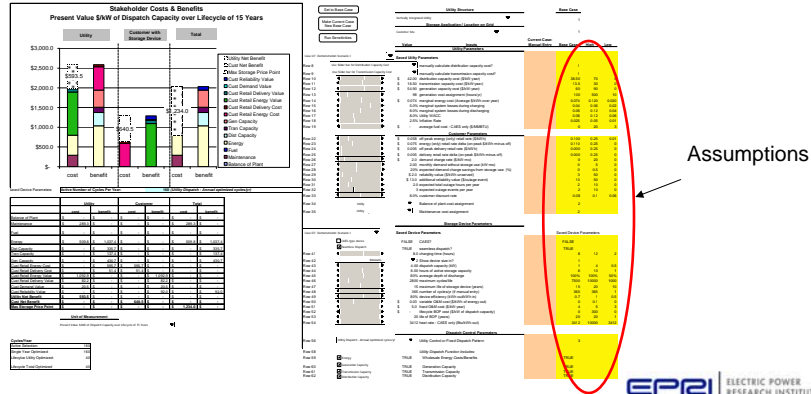
Prototype Deliverable in 2011



## 2011 Plans will Leverage from Earlier Work

### EPRI Energy Storage Valuation Tool V2.0 (2007)

- ESVT V2.0 (2007)
  - Estimated Locational Value of Storage – MS Excel Platform
  - Pre-loaded utility and storage assumptions with flexibility to change
  - Benefit analysis and dispatch model (inconsistent with 2010 approach)



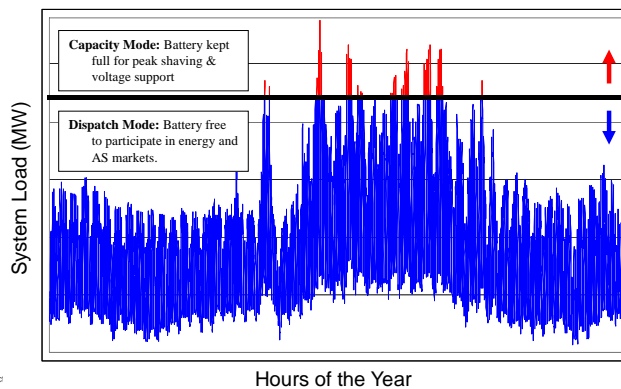
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5

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## 2011 Tool will include Improved Dispatch Model

- “Dual-Mode” Dispatch Model
  - Fulfill T&D objective of peak demand management while maximizing revenues
  - “Capacity Mode”: Keep battery full during 500 hours of highest demand
  - “Dispatch Mode”: Maximize revenues by providing Frequency Regulation

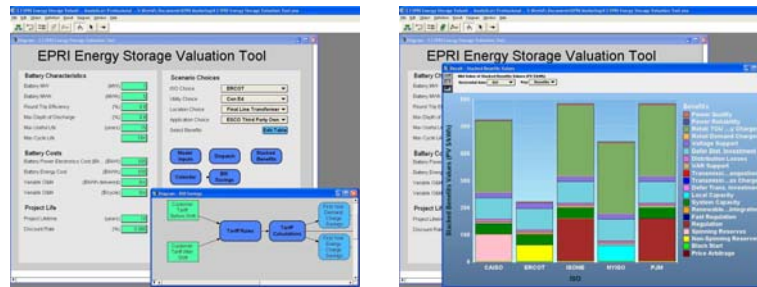


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## Analytics to Support Business Case Energy Storage Valuation Tool 2011 (V3.0)

- **Goal: Develop Prototype Tool in 2011 and Conduct Case Studies**
  - User-friendly, robust platform for future enhancements
  - Enable deep understanding of energy storage value analysis & assumptions
  - Ability to tailor site-specific analysis on any utility system
  - Cost / benefit analysis
  - Transparent assumptions and analysis for future public stakeholder use



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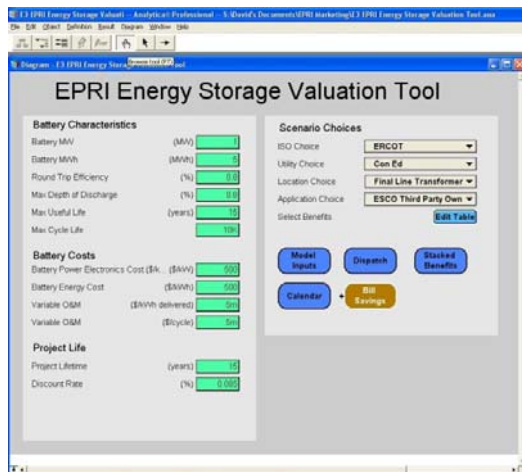
7

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## Energy Storage Valuation Tool 2011 (V3.0)

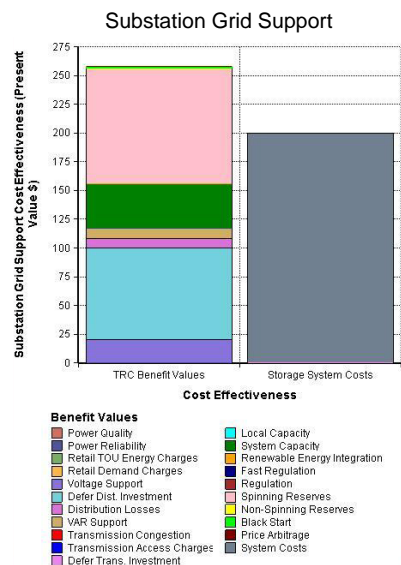
Based on Analytica software platform

### Screenshots of Analytica Tool



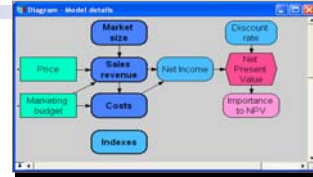
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8



## Features of Energy Storage Evaluation Tool

- **Transparency:** Visual influence diagrams make models easier to create, communicate, and maintain.
- **Flexibility:** Intelligent Arrays™ make it easier to start simple, and extend to multi-dimensional models (data cubes)
- **Risk analysis:** Integrated Monte Carlo simulation enables fast evaluation of risk and uncertainty
- **Scalability:** Hierarchical modules, Intelligent Arrays, and compact code let you easily manage and run models much larger than is practical with spreadsheets.



Model	Mid Value of Sales revenue	Relative Prices	Time	Totals		
0.5	0	2000	2001	2002	2003	2004
0.6	0	71.72M	143.4M	215.2M	215.2M	215.2M
0.65	0	66.61M	133.2M	199.6M	199.6M	199.6M
0.7	0	58.91M	117.8M	176.7M	176.7M	176.7M
0.75	0	51.72M	103.4M	155.2M	155.2M	155.2M
0.8	0	45.66M	91.31M	137M	137M	137M



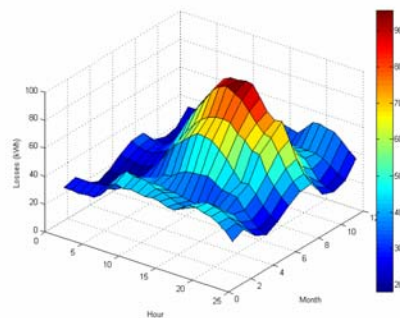
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9

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## Modeling Distribution Feeders for Storage Apps Advanced Simulation Platform – OpenDSS

- Open source of EPRI's Distribution System Simulator
  - developed in 1997
  - open sourced Nov 2008
- OpenDSS designed from the beginning to capture
  - Time-specific benefits **and**
  - Location-specific benefits
- Differentiating features
  - full multiphase model
  - numerous solution modes
  - “dynamic” power flow
  - system controls
  - flexible load models
- Needed for analysis of
  - DG/renewables
  - energy efficiency
  - PHEV/EV
  - non-typical loadshapes



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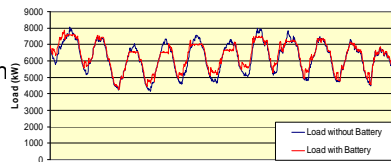
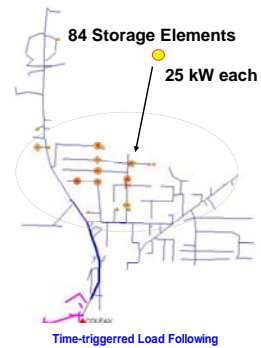
10

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## Use of OpenDSS to Assess the Operational Value of Energy Storage to Smart Grid

### Approach

- Use OpenDSS to model grid support applications
  - DESS system testing/evaluation to refine storage controllers & modes
  - Develop adoptive dispatch mechanisms of managing storage
- Conduct case studies and evaluation of distribution system integrated w/PV and storage (residential and commercial systems)
  - AEP-CES (part of Smart Grid demo activity)
  - Progress Energy (PV & Storage)
  - SDG&E (PV & Storage)
- Quantify operational value of storage and DG in smart grid
  - Location Value
  - How Much Storage?
  - Impacts



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11

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## Questions & Discussion



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12

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