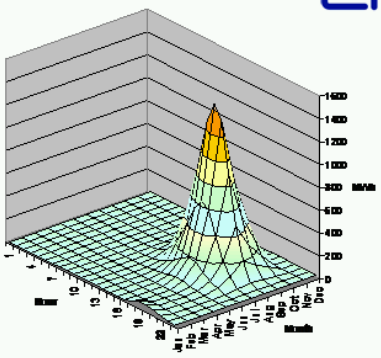

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Using OpenDSS for Simulation of Storage in AEP Virtual Power Plant Project

Roger Dugan
Sr. Technical Executive
rdugan@epri.com

Smart Grid DemonstrationAdvisory Meeting
Albuquerque, NM
Oct 13, 2009

Using OpenDSS for Simulation of Storage in AEP Virtual Power Plant Project

OpenDSS

- EPRI released its Distribution System Simulator (DSS) program as *open source* In Sept 2008
  - Source code is available to public
  - BSD License – basically no limitations
- Called "**OpenDSS**"
- Can be found at:
  - WWW.SOURCEFORGE.NET
    (Search for OpenDSS)

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2

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OpenDSS

History

- DSS development was started at Electrotek Concepts in 1997 to provide
  - a very flexible and expandable research platform
  - a foundation for special distribution analysis applications
    - In particular, DG analysis
- Fills many of the gaps left by more conventional distribution system analysis tools
- For developing new approaches to distribution system analysis
- Acquired by EPRI in 2004

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History

Time- and Location-Specific Benefits

- The DSS was designed from the beginning to capture both **Time- and Location-specific benefits** of
  - DG or other proposed capacity enhancements
- Most traditional distribution system analysis programs:
  - Capture only some location-specific benefits
  - Ignores time; Assumes resource is available
  - *This gets the wrong answer* for many DG and energy efficiency analyses
- Must do **time sequence analysis**
  - Over distribution planning area

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Time- and Location-Specific Benefits

Why Did We Make it Open Source?

- EPRI has made the DSS open source to:
  - Cooperate with other open source efforts in the USA in Smart Grid research
    - Gridlab-D at PNL, for example
  - To encourage new advancements in distribution system analysis
    - We've already seen proof of this
  - To provide Smart Grid researchers a tool for testing and developing distribution control algorithms

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Why Did We Make it Open Source?

Example DSS Applications (the more exotic ones)

- Neutral-to-earth (stray) voltage simulations.
- Loss evaluations due to unbalanced loading.
- Development of DG models for the IEEE Radial Test Feeders.
- High-frequency harmonic and interharmonic interference.
- Losses, impedance, and circulating currents in unusual transformer bank configurations.
- Transformer frequency response analysis.
- Distribution automation control algorithm assessment.
- Impact of tankless water heaters on flicker and distribution transformers.
- Wind farm collector simulation.
- Wind farm impact on local transmission.
- Wind generation and other DG impact on switched capacitors and voltage regulators.
- Open-conductor fault conditions with a variety of single-phase and three-phase transformer connections.

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Example DSS Applications (the more exotic ones)

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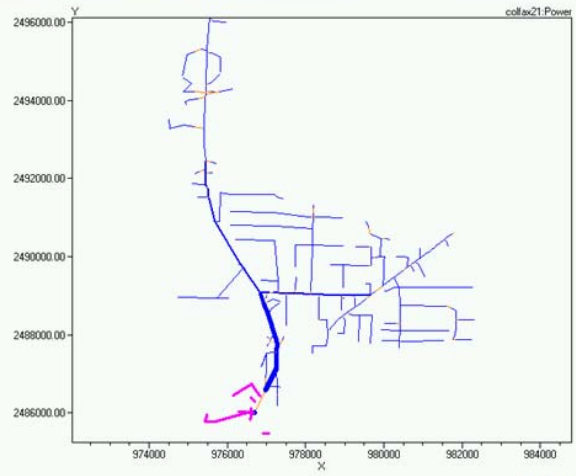
AEP Virtual Power Plant Demo

Colfax Circuit

AEP Virtual Power Plant Demo

Power Flow – No Storage



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8

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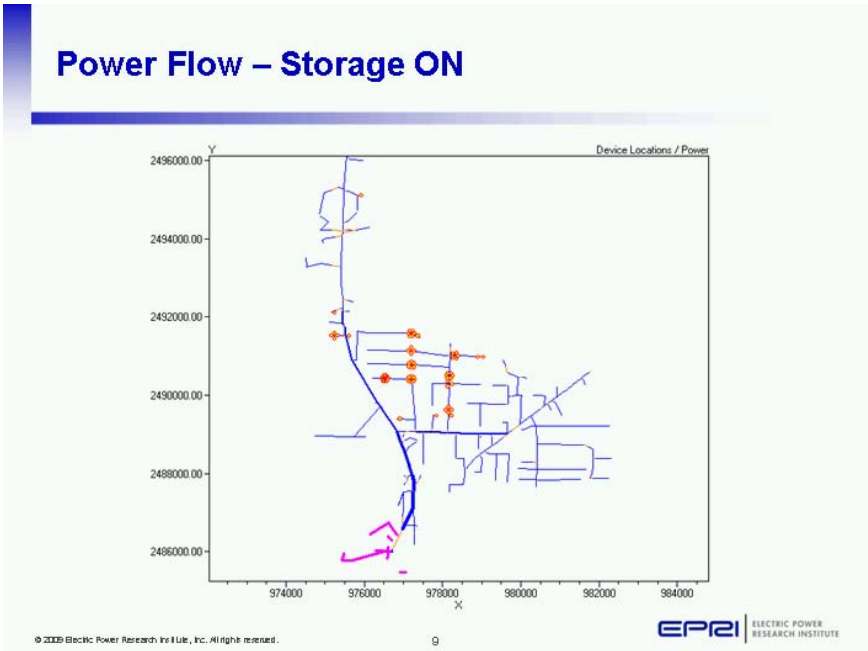
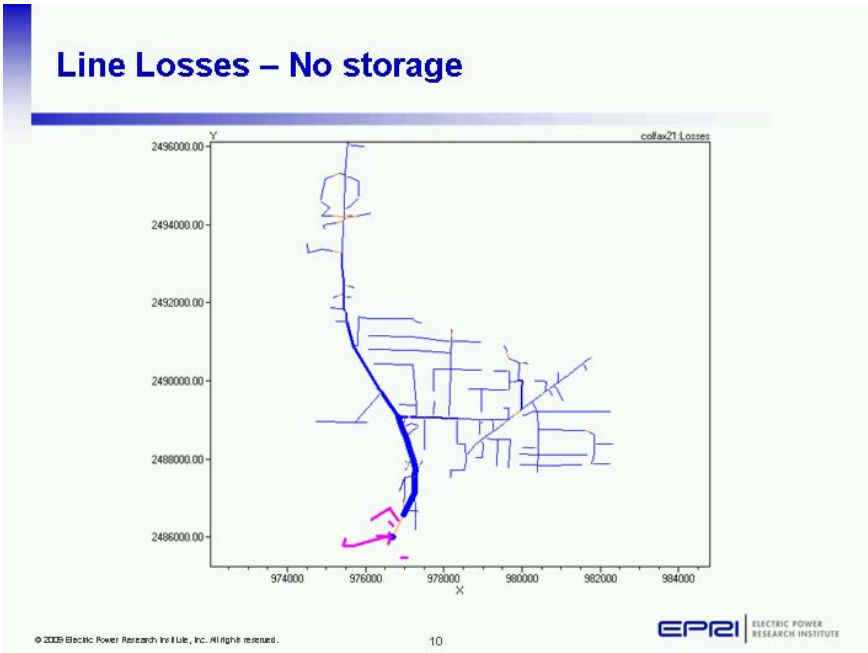
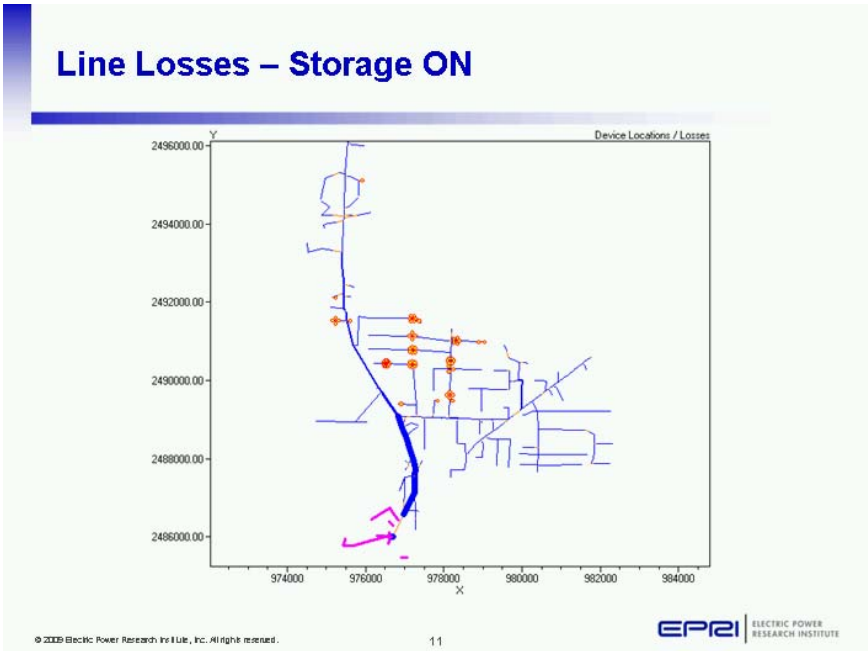
Power Flow – No Storage



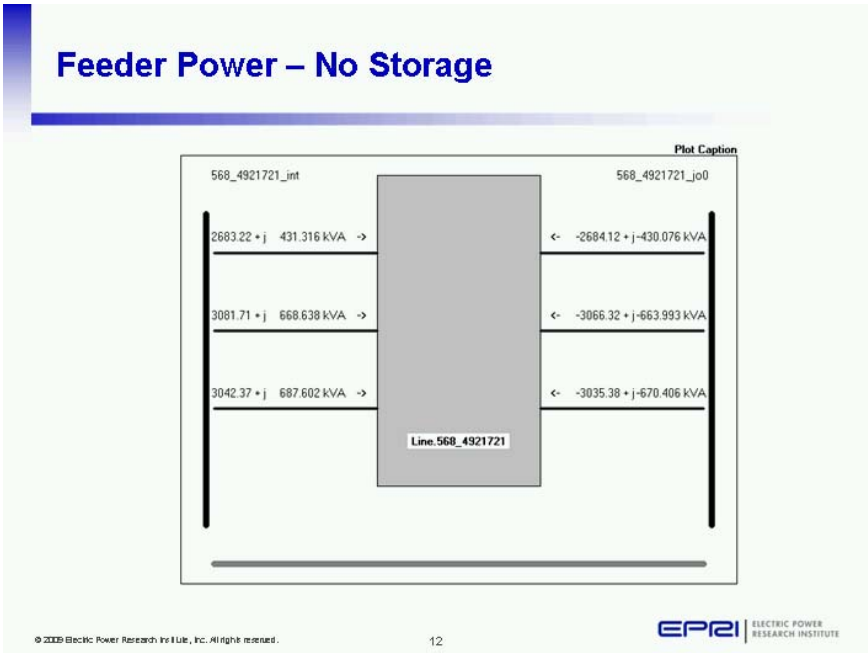
Power Flow – Storage ON



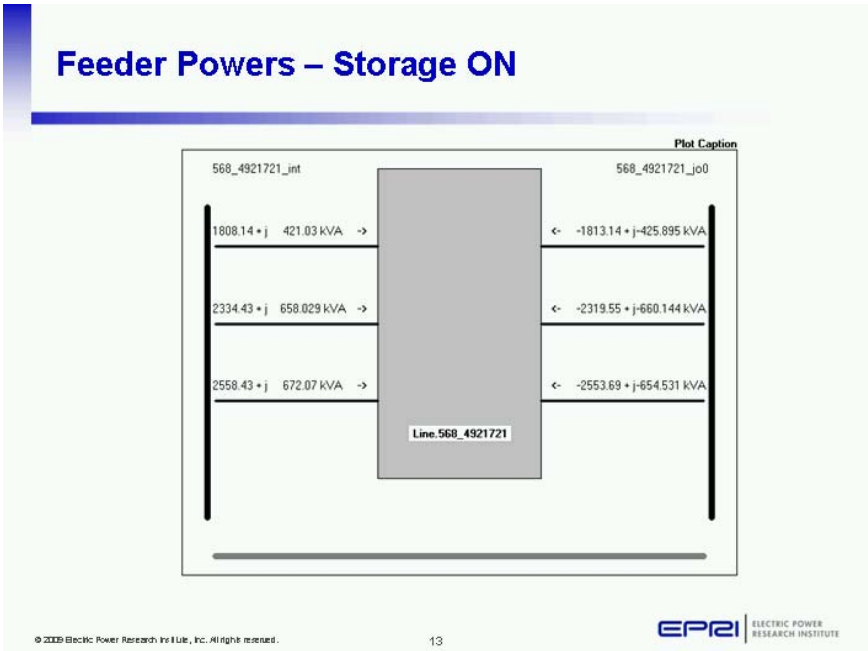
Line Losses – No storage



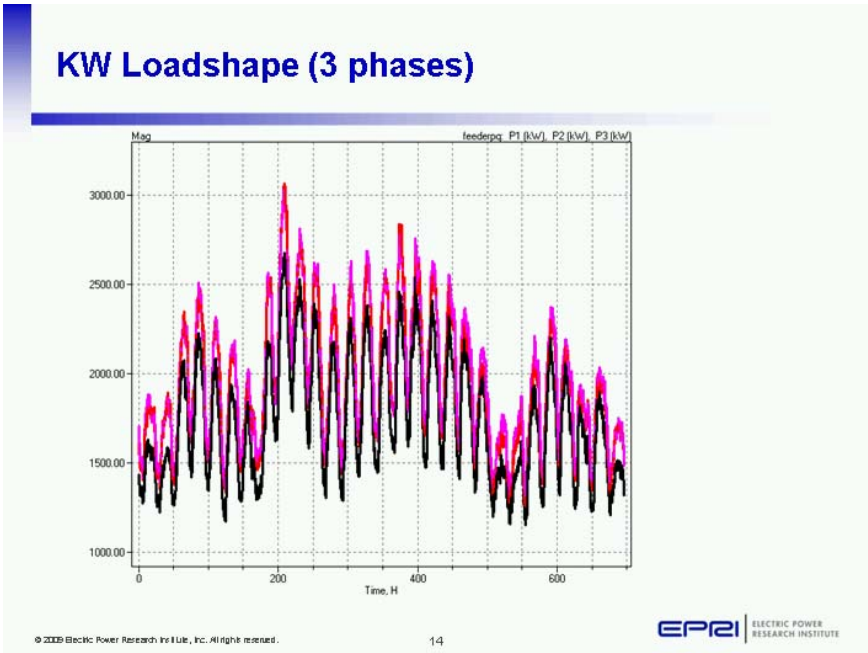
Line Losses – Storage ON



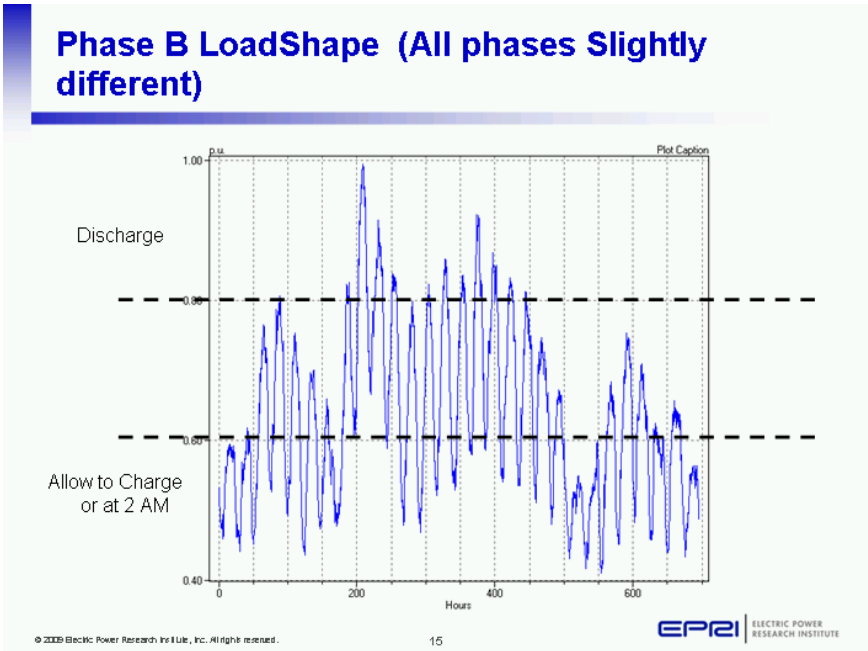
Feeder Power – No Storage



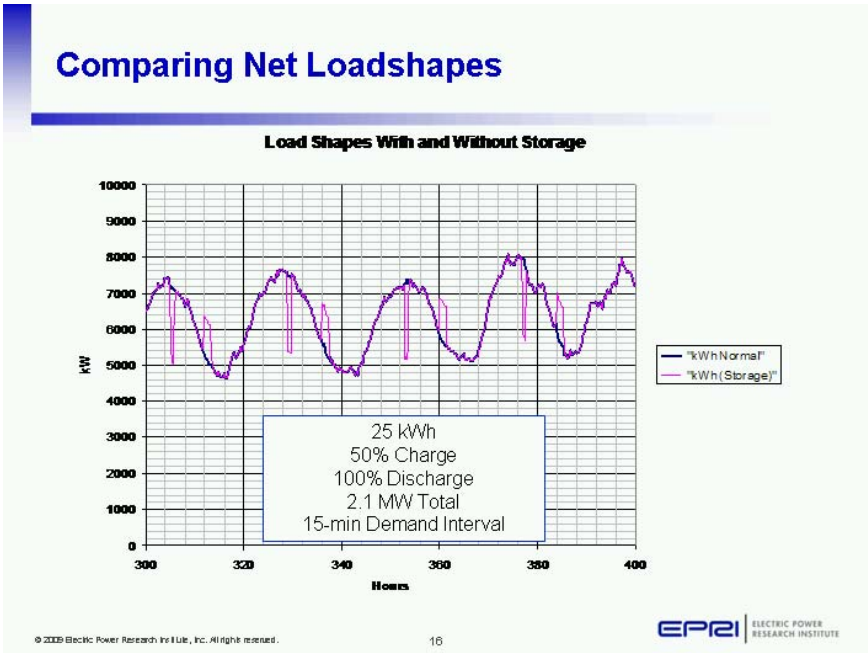
Feeder Powers – Storage ON



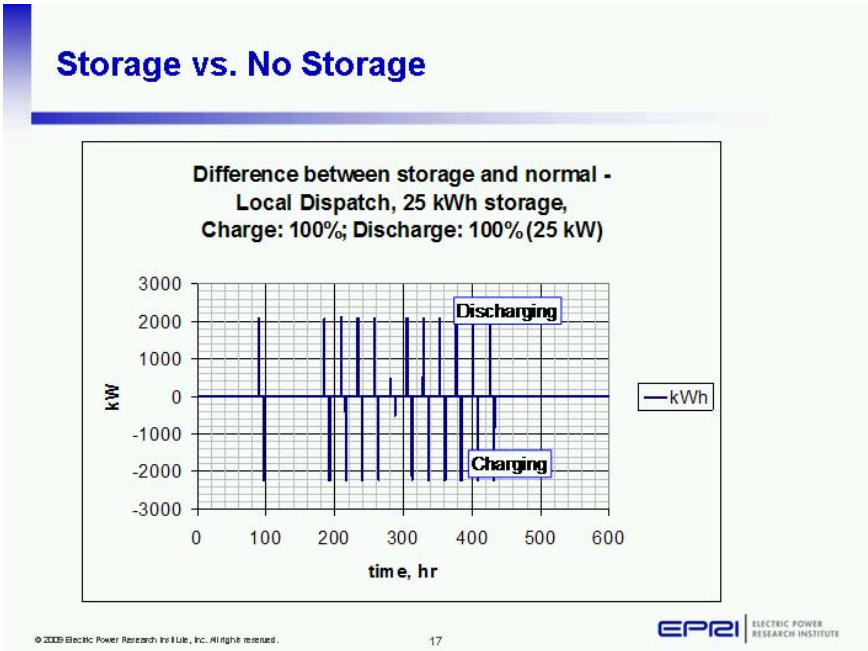
KW Loadshape (3 phases)



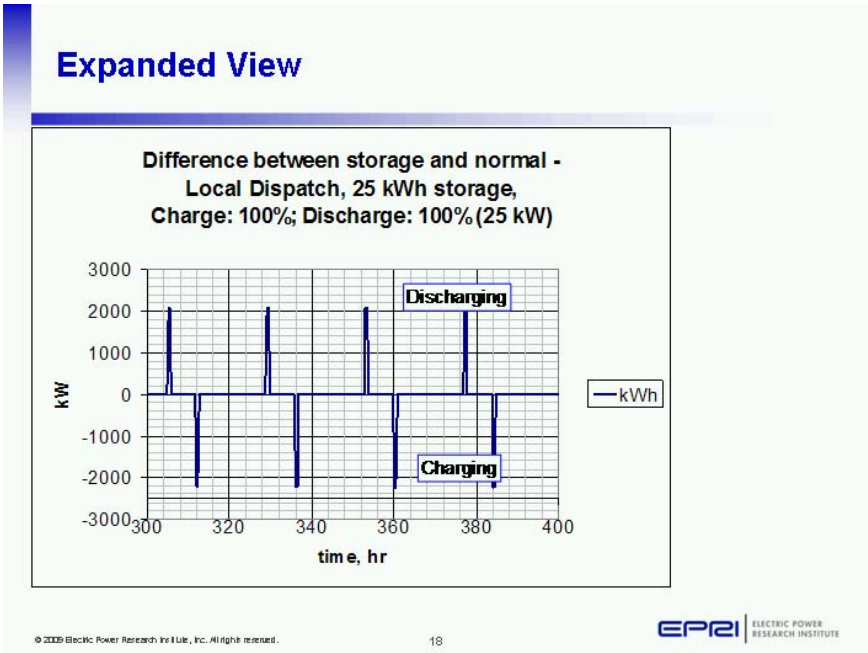
Phase B LoadShape (All phases Slightly different)



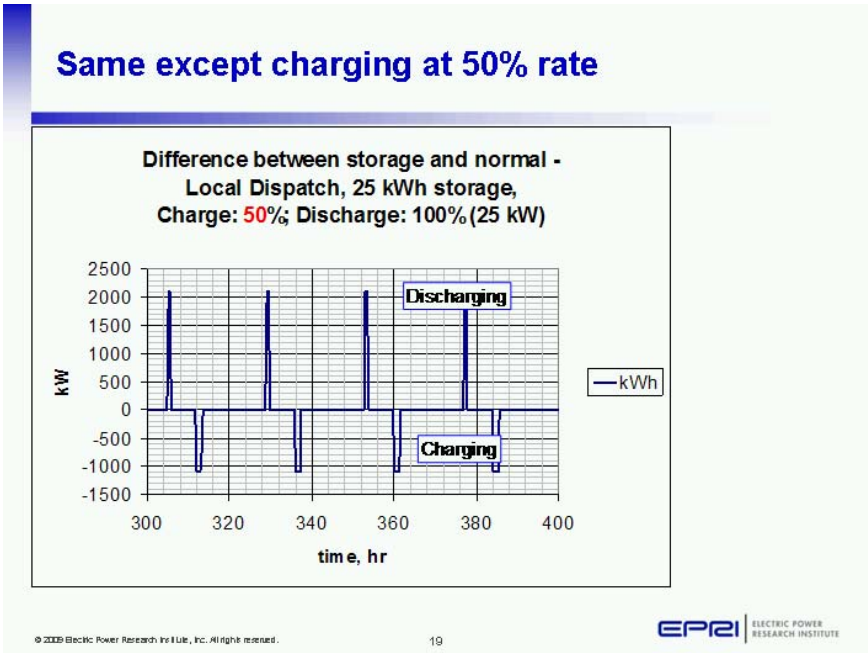
Comparing Net Loadshapes



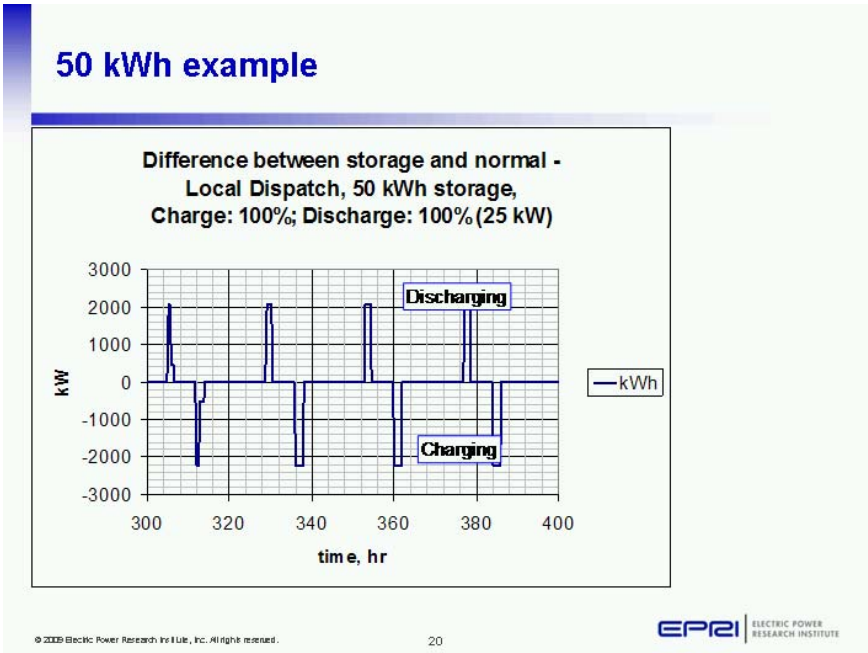
Storage vs. No Storage



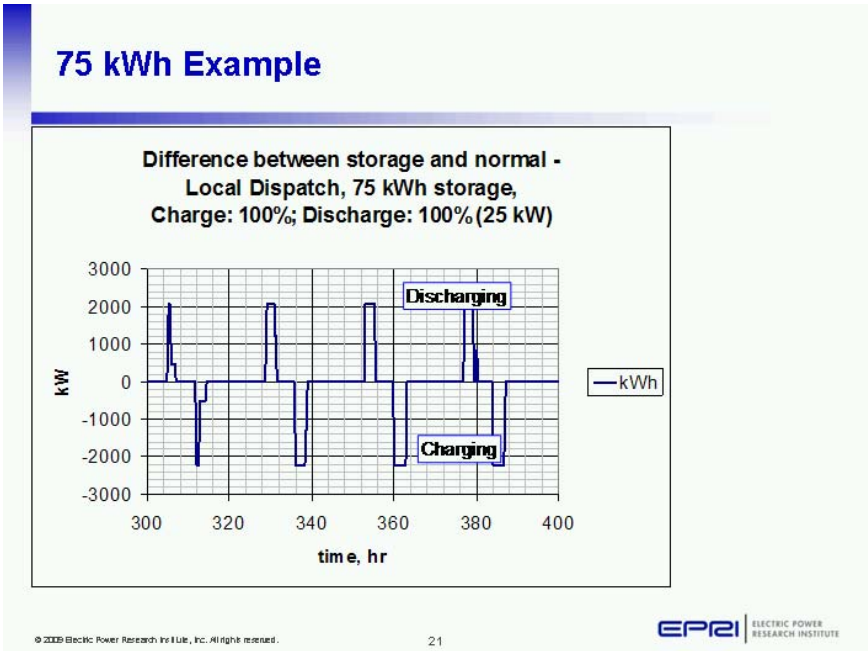
Expanded View



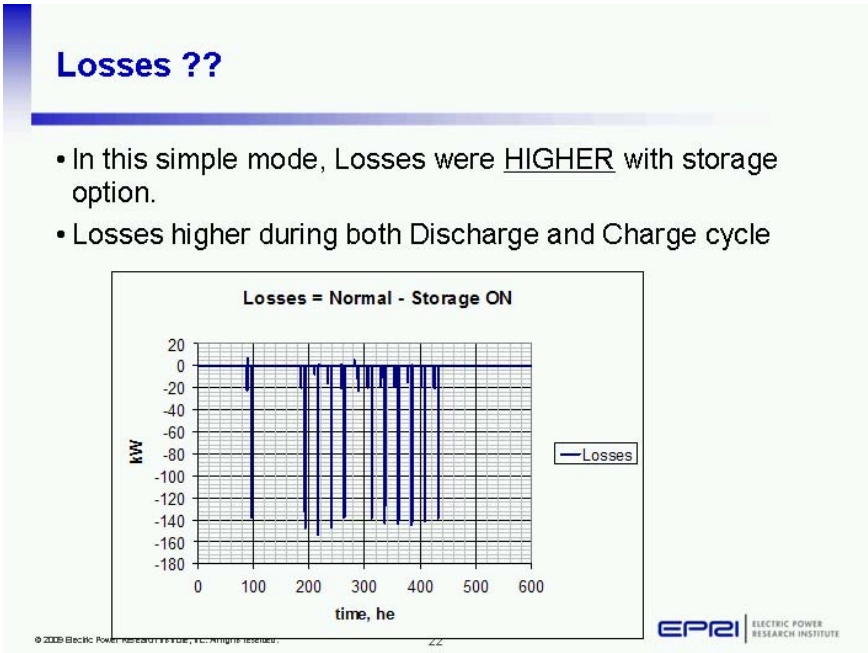
Same except charging at 50% rate



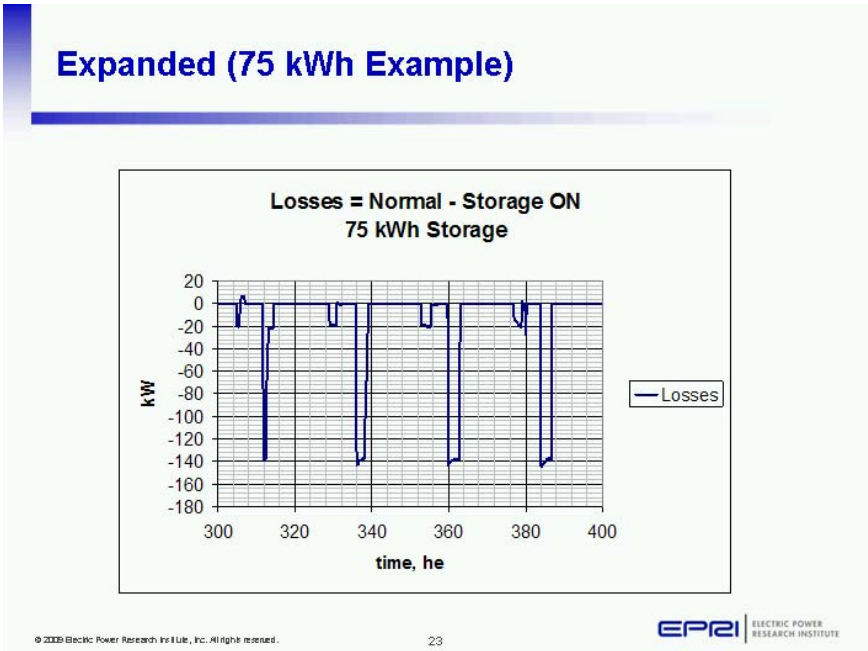
50 kWh example



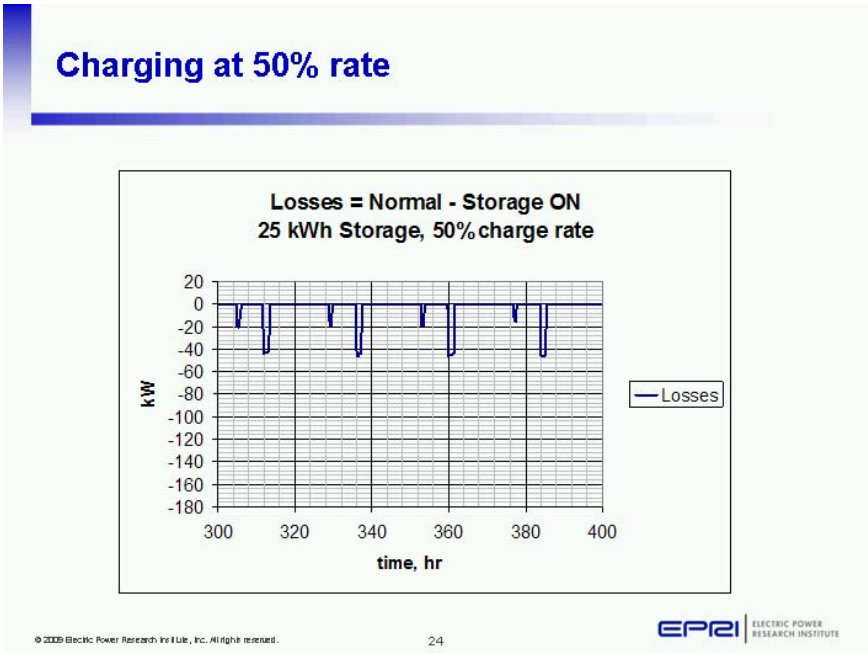
75 kWh Example



Losses ??



Expanded (75 kWh Example)



Charging at 50% rate

OpenDSS Application Workshop - Nov 2-3

OpenDSS Introduction and Basics
Setting up the model
Modeling control systems
Example Applications - Case Studies

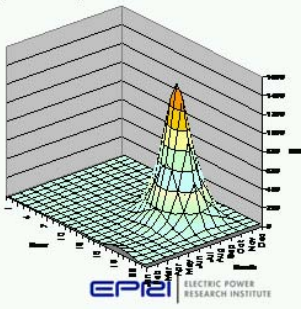
- Distribution Loss Studies - Green Circuits, Program 172B
- Modeling distribution automation and distribution controls - Program 124C
- Integration of Plug-In Hybrid Electric Vehicles
- Distributed Energy Resources Integration with the Smart Grid - Smart Grid Demonstration Initiative
- Evaluation of PV and other renewables integration with the distribution system - Program 174
- Energy storage integration - e.g. community energy storage
- Using OpenDSS for Harmonic Analysis
- CIM Interface for OpenDSS

Ongoing development plans

- Coordination with other development efforts

Bring your own Windows laptops for hands-on experience
Webcast of workshop for those that cannot attend (attendance limited to 25)

Nov 2-3, Knoxville, TN
Half day Monday
Full day Tuesday



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25

OpenDSS Application Workshop - Nov 2-3

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Questions?

Questions?