

Cost-Benefit Analysis of On-Site Energy Storage in MN

Solar Powering Minnesota
March 7, 2014



Lise Trudeau
Senior Engineering Specialist
Minnesota Department of Commerce
Division of Energy Resources

Energy Storage Study

Submitted Jan 1, 2014:

- Completed by Strategen Consulting and the Electric Power Research Institute for the Department of Commerce.
- Investigates the potential costs and benefits of installing utility-managed, grid-connected energy storage devices in residential and commercial buildings in Minnesota



MN Energy Storage Study

Scope

Scope of Work (Laws 2013 Ch. 85, Art. 12, Sec. 5):

- **Cost-Benefit Analysis:** estimate the potential value of on-site energy storage devices as a load-management tool to reduce costs for individual customers and for the utility, including but not limited to reductions in energy, particularly peaking, costs, and capacity costs;
- **PV Interaction:** examine the interaction of energy storage devices with on-site solar photovoltaic devices; and
- **Analyze Barriers:** analyze existing barriers to the installation of on-site energy storage devices by utilities, and examine strategies and identify potential economic incentives to overcome those barriers.

Strategen Team



Chris Edgette, Senior Director

- » Extensive product development, engineering and field installation experience
- » Founded and managed the Commercial Projects Division for SolarCity. Previously served as SolarCity's Director of Field Engineering
- » Led Construction Management for PowerLight, directed worldwide installations and brought to market a successful rooftop solar system



Giovanni Damato, Senior Manager

- » Focused on developing the value proposition and strategic implications of Solar PV, Solar Thermal, and Advanced Energy Storage for a wide range of key stakeholders
- » Prior to Strategen, was Field Engineer for Granite Construction on Las Vegas Monorail project. Also founded home construction business and certified CA Class B General Contractor
- » MBA from Stanford GSB, BS in Civil Engineering from Cal Poly, San Luis Obispo



Amanda Coggins, Associate

- » Experienced in renewable energy technologies and policies, environmental sustainability, and energy efficiency
- » Prior to Strategen worked for a variety of engineering companies in Washington, D.C. supporting private sector and federal government clients, including the DOE and DOD
- » B.S. in Mechanical Engineering from Virginia Tech; M.S. in Environmental Systems - Energy, Technology, and Policy from Humboldt State University; Certified LEED® Accredited Professional



Janice Lin, Founder and Managing Partner

- » Founded Strategen in 2005. Also co-founded the California Energy Storage Alliance in 2009
- » More than a decade of clean energy strategy and market development experience
- » Prior to Strategen, VP of Product Strategy and VP of Business Development at PowerLight. Former strategy consultant with Booz Allen and Hamilton
- » MBA from Stanford GSB, BS from Wharton at the University of Pennsylvania



Alex Ghenis, Senior Analyst

- » Focused on policy development for energy storage grid applications, public education through assorted media, and business positioning strategies
- » Prior to Strategen, worked on internal sustainability strategies for US EPA Region 9. Also has extensive disability rights and media experience, and is a regular contributor to *Life in Action* magazine.
- » MPP from the Goldman School of Public Policy at UC Berkeley, BA in Geography from UC Berkeley

EPRI Team



Ben Kaun, EPRI Project Lead

Sr. Project Engineer, Energy Storage

- Energy Storage Program Analysis Lead
- 7 years energy storage experience; R&D, testing, and analysis
- M.S. Stanford in Management Science & Engineering
- B.S. Univ of Illinois in Systems Engineering



Stella Chen

Project Engineer, Energy Storage

- 2 years grid energy storage experience with EPRI
- EPRI Energy Storage Valuation Tool modeling expert
- B.S. Pomona College in Economics and Mathematics



Ram Narayanamurthy

Sr. Project Manager, Energy Efficiency

- Over 10 years efficiency experience, building modeling, thermal storage
- Developed Ice Energy Ice Bear thermal energy storage product
- M.S. Penn State MechE, B.S. Indian Institute of Technology MechE

Energy Storage Technologies

Electrochemical Storage



(Batteries)

Mechanical Storage



(Flywheel)

Bulk Mechanical Storage



(Compressed Air)

Thermal Storage



(Ice)



(Molten Salt)

Bulk Gravitational Storage



(Pumped Hydro)



(Gravel)

Energy Storage Technologies: Study Scope

Electrochemical Storage



(Batteries)

Mechanical Storage



(Flywheel)

Bulk Mechanical Storage



(Compressed Air)

Thermal Storage



(Ice)



(Molten Salt)

Bulk Gravitational Storage



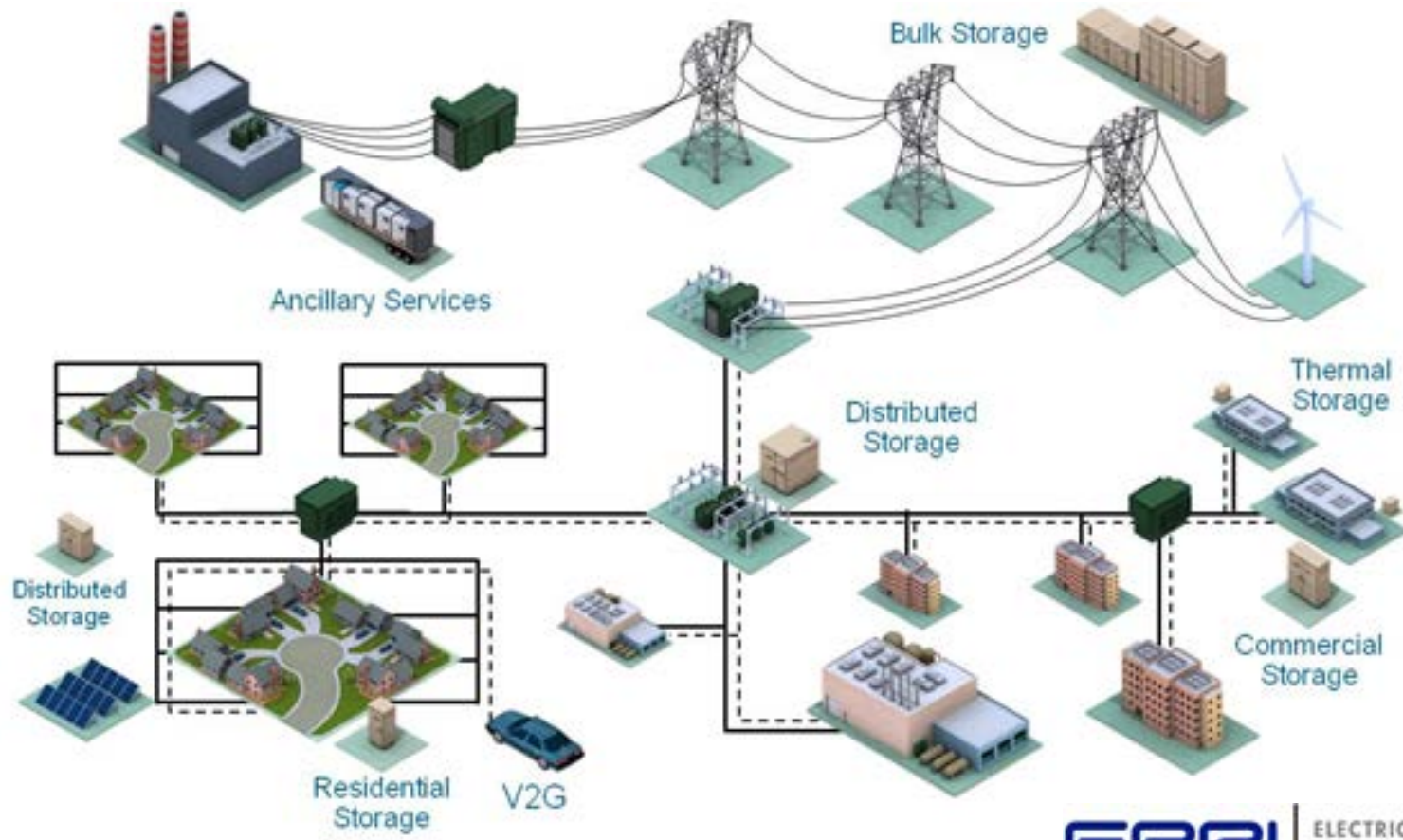
(Pumped Hydro)



(Gravel)

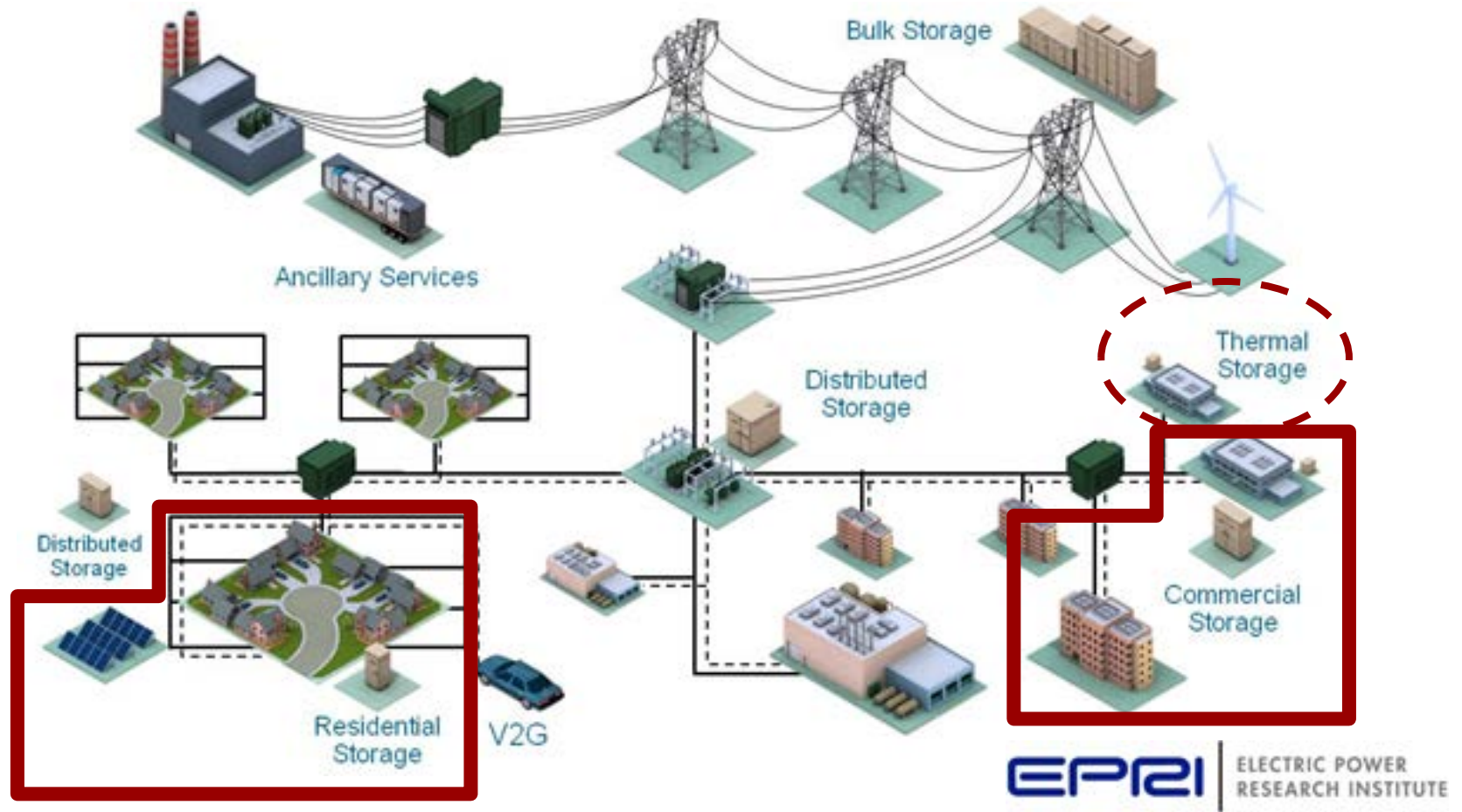
Energy Storage Roles on the Grid

Energy storage is broad category including diverse technologies and benefits to the electric grid.



Energy Storage Roles on the Grid: Study Scope

Energy storage is broad category including diverse technologies and benefits to the electric grid.



Identified Energy Storage Grid Services

Bulk Energy Services		Transmission Infrastructure Services
Electric Energy Time-Shift (Arbitrage)		Transmission Upgrade Deferral
Electric Supply Capacity		Transmission Congestion Relief
Ancillary Services		Distribution Infrastructure Services
Regulation		Distribution Upgrade Deferral
Spinning, Non-Spinning and Supplemental Reserves		<i>Voltage Support</i>
Voltage Support		Customer Energy Management Services
Black Start		Power Quality
Other Related Uses		Power Reliability
		Retail Electric Energy Time-Shift
		Demand Charge Management

Source:DOE/EPRI Electricity Storage Handbook in Collaboration with NRECA. 2013.

Today's Presenters



Giovanni Damato, Senior Manager

- » Focused on developing the value proposition and strategic implications of Solar PV, Solar Thermal, and Advanced Energy Storage for a wide range of key stakeholders
- » Prior to Strategen, was Field Engineer for Granite Construction on Las Vegas Monorail project. Also founded home construction business and certified CA Class B General Contractor
- » MBA from Stanford GSB, BS in Civil Engineering from Cal Poly, San Luis Obispo



Ben Kaun, EPRI Project Lead

Sr. Project Engineer, Energy Storage

- Energy Storage Program Analysis Lead
- 7 years energy storage experience; R&D, testing, and analysis
- M.S. Stanford in Management Science & Engineering
- B.S. Univ of Illinois in Systems Engineering