

# ENERGY STORAGE—A CHEAPER, FASTER, AND CLEANER ALTERNATIVE TO CONVENTIONAL FREQUENCY REGULATION

Janice Lin and Giovanni Damato

StrateGen Consulting, LLC, 2150 Allston Way, Suite 210, Berkeley, CA, USA

StrateGen Consulting completed the white paper *Energy Storage—A Cheaper, Faster, and Cleaner Alternative to Conventional Frequency Regulation* for the California Energy Storage Alliance (CESA) to conduct a side-by-side comparison of a natural-gas-fired combined cycle combustion turbine (CCGT) to a flywheel energy storage system for frequency regulation in California. The comparison includes performance, financial analysis, and emissions. Key findings from this analysis include the following:

- Energy storage can be 2.5 times more effective at performing frequency regulation than a conventional CCGT.
- Energy storage is a cleaner alternative to conventional plants with respect to air quality impacts.
- Energy storage is a more cost-effective alternative to conventional power plants performing frequency regulation.

The presentation of these findings will include a thorough review of the ways in which conventional ancillary services are supplied, the utilization of energy storage for the operational use of frequency regulation, as well as a detailed financial comparison of the gas-fired combustion turbine to a flywheel from the perspective of a merchant plant owner. In addition to the financial analysis, the presentation will illustrate the air quality benefits associated with substituting conventional frequency regulation with energy storage. It will also explore why and how energy storage performs regulation 2.5 times better than conventional plants. Finally, the presentation will lay out the key market and regulatory challenges involved with utilizing energy storage to provide frequency regulation and recommend a clear pathway to overcome these hurdles.

Figure 1 gives a general overview of the comparison’s assumptions and results. Figure 2 illustrates the effects of a flywheel’s performance factor on Internal Rate of Return (IRR) and emissions.

The full white paper and the associated model can be downloaded from CESA’s website: <http://www.storagealliance.org/work-whitepapers.html>.

Project Specifications	Flywheel	CCGT Baseload
Plant Ownership Model	Merchant	Merchant
Project Tenor (yr)	20	20
System Capacity Dedicated to Regulation (MW)	20	20
Plant Heat Rate (Btu/kWh)	N/A	7,050.0
Heat Rate Degradation	N/A	0.0
Capacity Degradation	0.00%	0.24%
Plant Parasitic Losses	2.00%	2.90%
Efficiency	87.00%	N/A
Efficiency Degradation	0.00%	N/A
Installed Cost (\$/MW)	1,900,000	1,021,000
<b>Operation &amp; Maintenance</b>		
Fuel Cost - Conventional (\$/MMBtu)	N/A	4.31
Fuel Cost - Storage (\$/MWh)	50.00	N/A
Fuel Cost Escalation Rate	1.53%	1.53%
Carbon Price (\$/ton)	0.00	0.00
Carbon Price Escalation Rate	0.00%	0.00%
<b>Revenue Assumptions</b>		
Average Regulation Clearing Price (\$/MWh)	33.41	33.41
Regulation Clearing Price Escalation Rate	3.5%	3.5%
Comparative Performance Factor	2.5	1.0
<b>Base Case Results</b>		
IRR	25.7%	7.0%
Payback Period (yr)	3.9	13.6
Lifetime Carbon Emissions (tons)	69,975	986,595

Fig. 1. Case study assumptions and results.

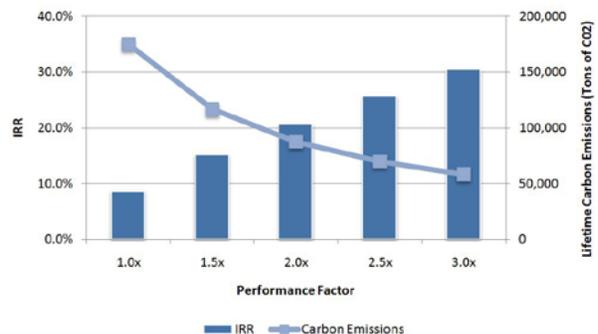


Fig. 2. Flywheel performance factor effects on IRR and emissions.

## BIOGRAPHICAL NOTE



**Conference presenter:** Giovanni Damato has led StrateGen’s Value Proposition Practice in distributed energy storage since 2005. Storage technology providers, global solar integrators, leading real estate developers, and public utility commissions have sought out his expertise to make critical strategic decisions about distributed storage markets, including the integration of storage with renewable energy resources. He is currently advising suppliers and developers as well as clean energy end users to develop the value proposition and strategic implications of photovoltaic, solar thermal, and advanced energy storage systems for a wide range of key stakeholders.

Mr. Damato brings practical and analytical skills to StrateGen from the construction industry. Before joining StrateGen, he founded a custom homebuilding business and is a licensed General Contractor in the State of California. Incorporating green building into his homebuilding business ultimately led Mr. Damato to the clean energy space and StrateGen. He has also worked for Granite Construction, a leading U.S. heavy civil transportation contractor, as a Field Engineer on the Las Vegas Monorail Project, where he was responsible for day-to-day construction activities and jobsite/public safety.

Mr. Damato holds an MBA from the Stanford Graduate School of Business and a B.S. in Civil Engineering from California Polytechnic State University, San Luis Obispo. He enjoys adventure traveling—including Mount Everest, Aconcagua, and Kilimanjaro.