

Demand Response (750 MW for 1 hr) and Energy Storage (750 MW for 4 hrs) in 3 Peak months can reduce CO<sub>2</sub> emissions

Resource	Replaces	Charged with	CO2 reduction (million lb. per yr)
DR	Average 2013 fleet generator	-	45
DR	Simple cycle CT	-	79
Storage	Simple cycle CT	Renewables	316
Storage	Simple cycle CT	Combined cycle	57

## Demand Response (750 MW for 1 hr) and Energy Storage (750 MW for 4 hrs) in 3 Peak months can reduce CO<sub>2</sub> emissions

1. DR replacing 2013 fleet generators at summer daily peaks would lead to 45 million lb. of CO<sub>2</sub> avoided
2. DR replacing simple cycle combustion turbines can reduce emissions by 79 million lbs. CO<sub>2</sub> per year
3. If storage were charged with zero-emission resources, it could reduce emissions by up 316 million lbs. CO<sub>2</sub> per year
4. However, gas fired combined cycle units would be used to charge storage most of the time
  - Emissions would be reduced by only 57 million lbs. CO<sub>2</sub> per year in this case
  - Losses in storage charge-discharge cycle tend to reduce emission benefits

# A range of assumptions about heat rates, emissions, and battery efficiencies could be used

	CAISO <sup>1</sup>	ARB <sup>2</sup>	ARB <sup>3</sup>	EPRI <sup>4</sup>	PG&E <sup>5</sup>	GE <sup>6</sup>	AIC <sup>7</sup>
Peaker (BTU/kwh)	10,000				7,815	7,813	10,000
CC (BTU/kwh)	7,000	7,000				6,342	6,500
Emissions (lb CO <sub>2</sub> /MMBTU)	117	116					
Battery efficiency (%)				85%			
Avoided CO <sub>2</sub> (MT/MWh)			0.3				

<sup>1</sup> CAISO PLEXOS model, high load scenario (Dec. 2012)

<sup>2</sup> California Air Resources Board, Technical Support Document: Initial Statement of Reasons for Proposed Rulemaking (Oct. 2007)

<sup>3</sup> California Air Resources Board, Climate Action Team, California EPA State Agency Greenhouse Gas Reduction Report Card, pg. 16, [MTCO<sub>2</sub> per MWh = 0.26 PG&E, 0.32 SCE, 0.35 SDG&E] (Jan. 2013)  
<http://climatechange.ca.gov/climate-action-team/reports/2013-CalEPA-Report-Card.pdf>

<sup>4</sup> EPRI, Benjamin Kaun, private communication, Li-ion round trip efficiency (Feb. 7, 2013)

<sup>5</sup> *Electric Power*, Top Plant: Panoche Energy Center, LMS100 heat rate at 60 F (Sept. 1, 2010)  
<http://www.powermag.com/top-plant-panoche-energy-center-firebaugh-california/>

<sup>6</sup> GE Corp., New High Efficiency Simple Cycle Gas Turbine – GE's LMS100, 53.8% efficiency in combined cycle configuration (2004)

<sup>7</sup> AIC Labs Emission Reduction Measure Form, submitted to ARB