DOCKETED

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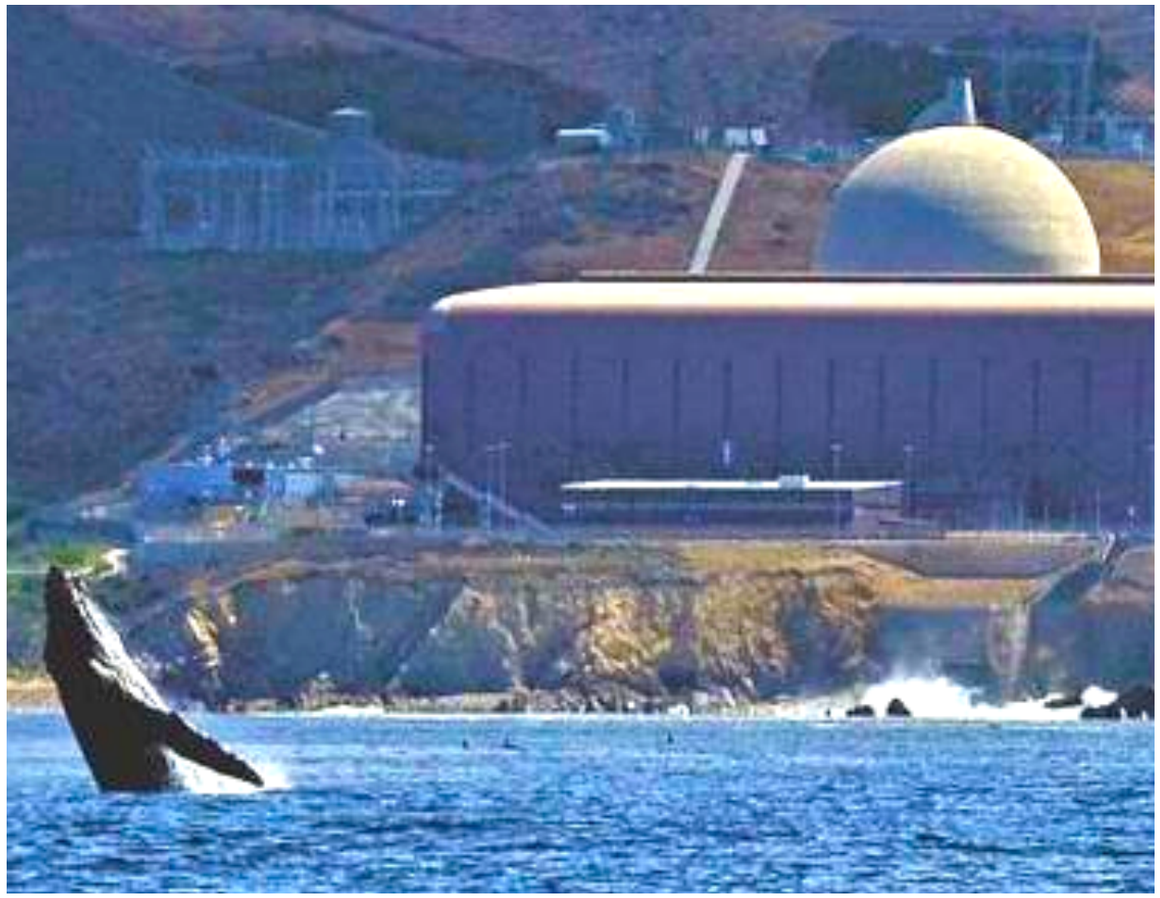


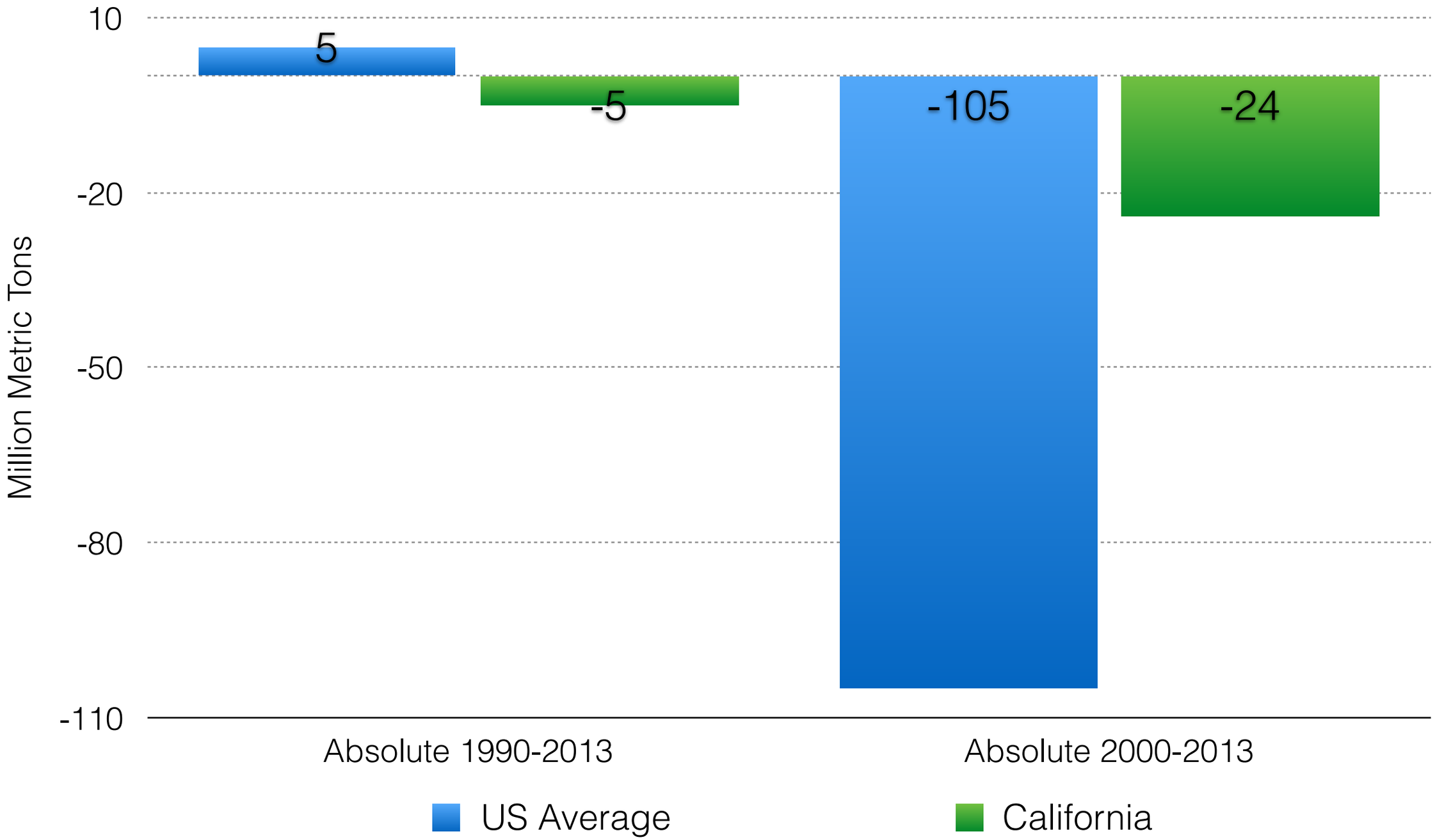
Energy & Environmental Implications of a Diablo Canyon Closure

Research & analysis by Michael Shellenberger
(michaelshellenberger@gmail.com) for SaveDiabloCanyon.org
January 29, 2016

California Emissions Overview
US Energy Information Administration data

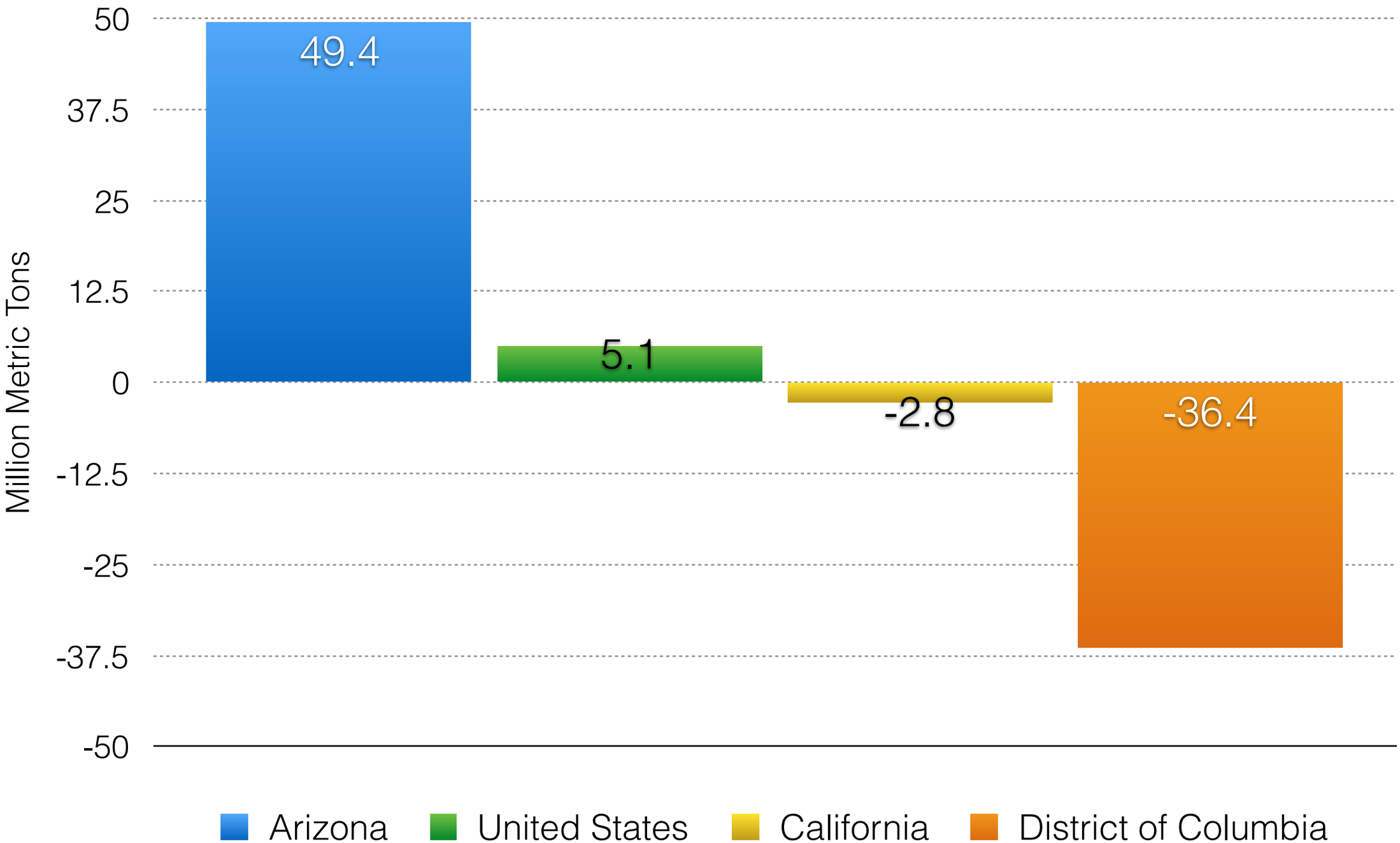
Includes emissions from in-state electricity only

Absolute Change in California vs average US state CO2 emissions,1990 - 2013 vs. 2000 - 2013 (in-state only)



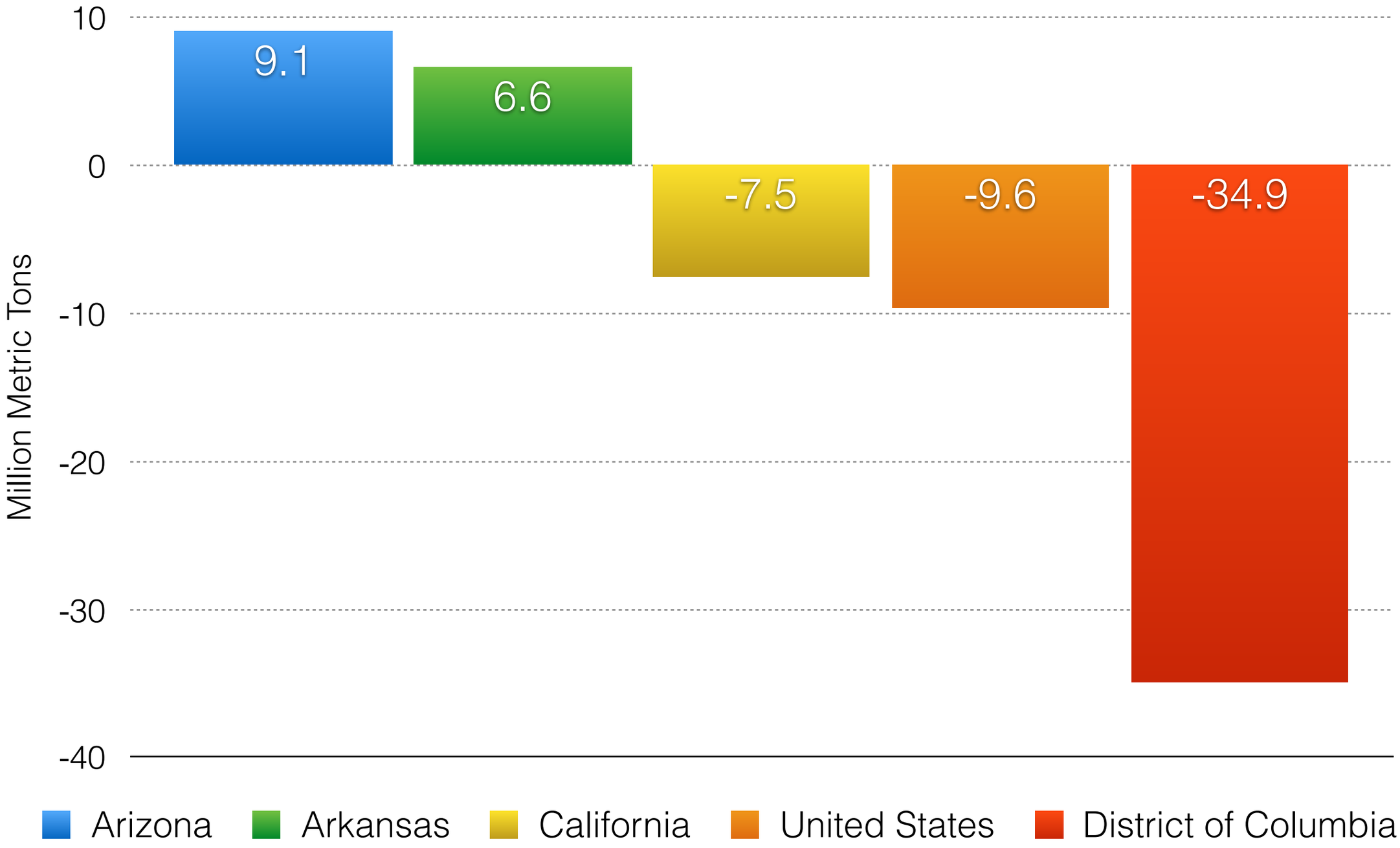
Source: US Energy Information Agency, "State Carbon Dioxide Emissions," October 2015

Percent Change in CO2 emissions 1990-2013 (in-state only)



Source: US Energy Information Agency, "State Carbon Dioxide Emissions," October 2015

Percent Change in CO2 emissions 2000-2013
(In-state only)

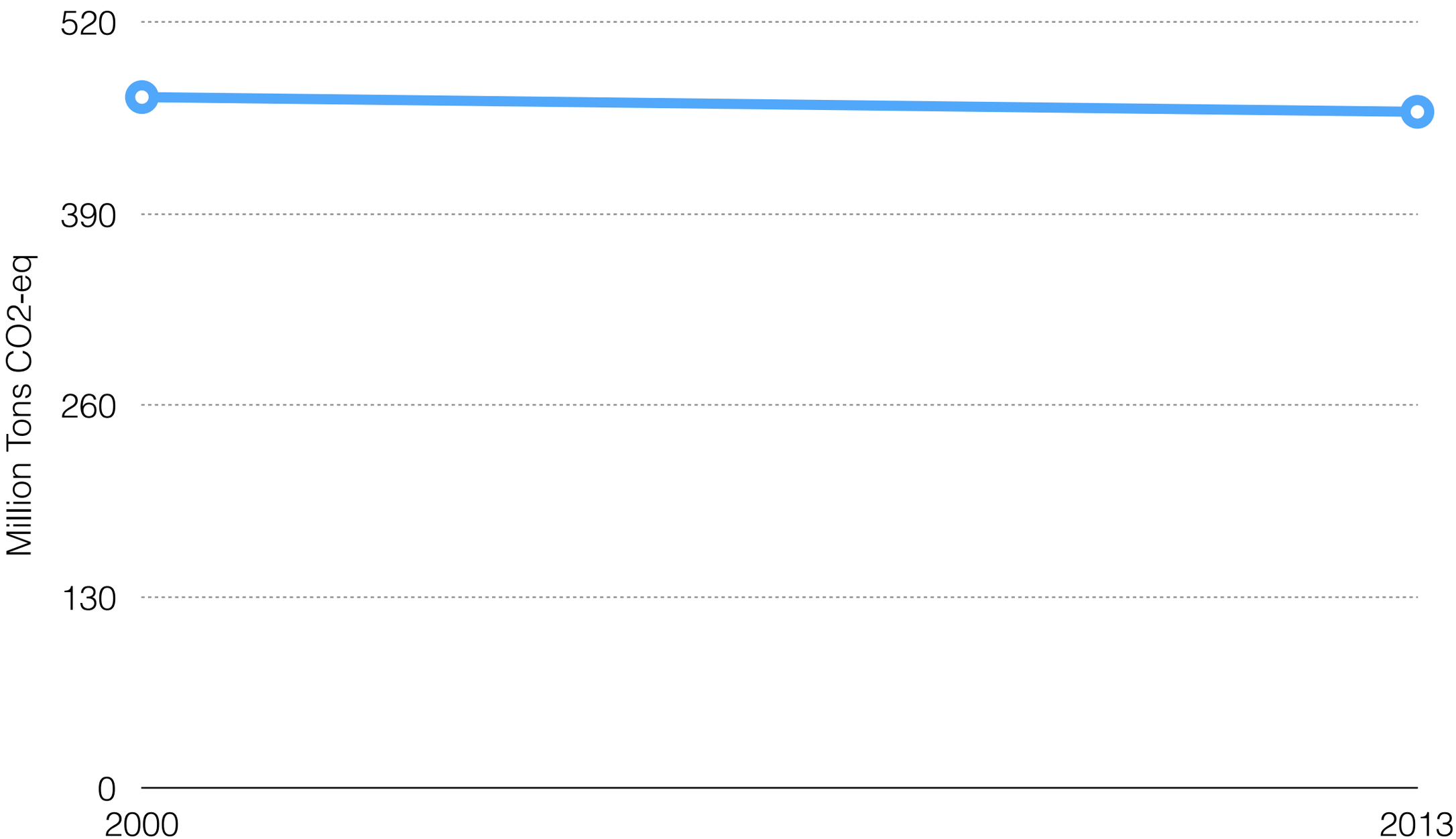


Source: US Energy Information Agency, “State Carbon Dioxide Emissions,” October 2015

California Emissions
California Almanac (state) data

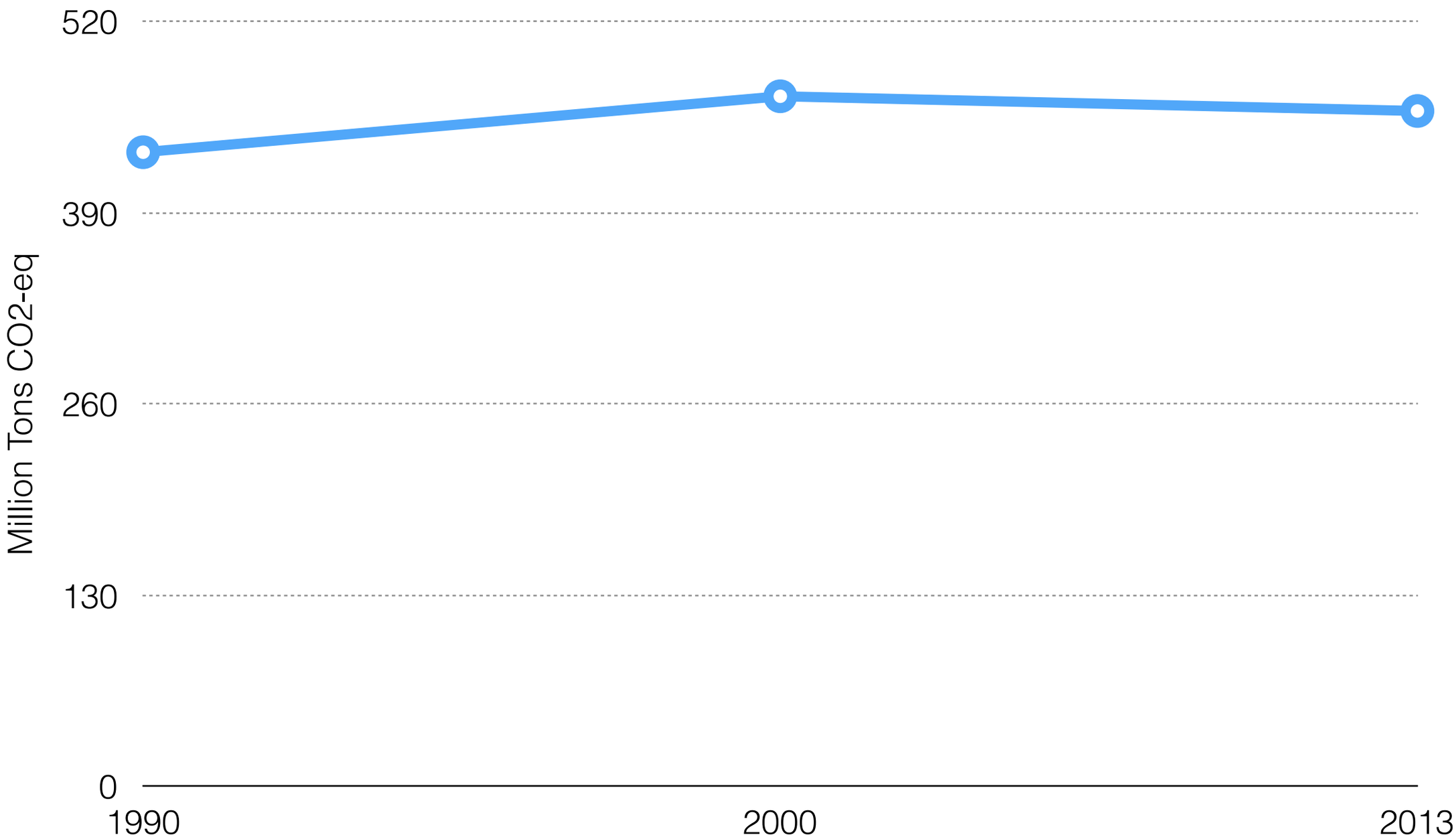
Includes emissions from both in-state electricity and out-of-state electricity

California Emissions Fell 2% Between 2000-2013…



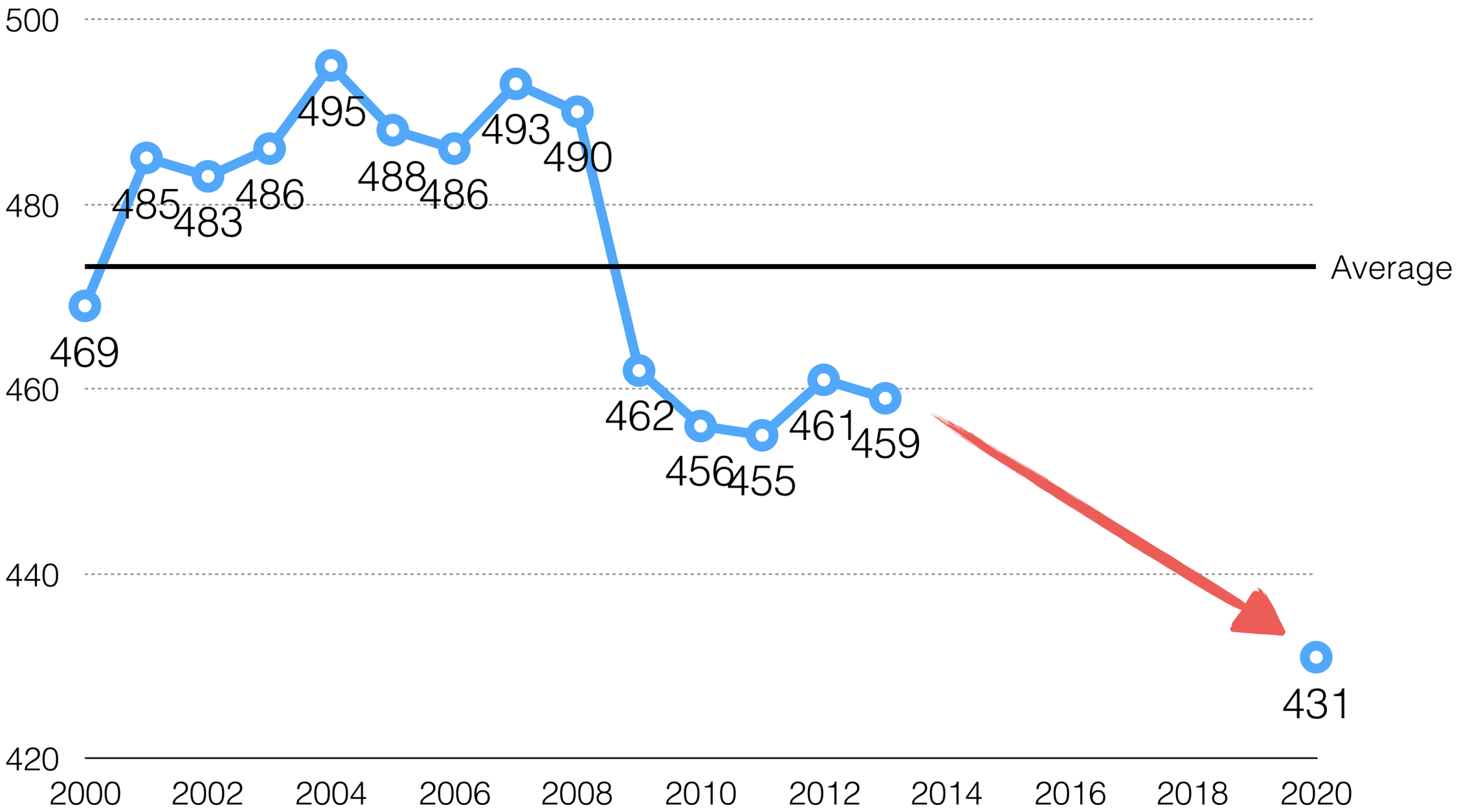
Source: “Greenhouse Gas Inventory,” California Air Resources Board, 2015

California Emissions Rose 8.8% between 1990-2013

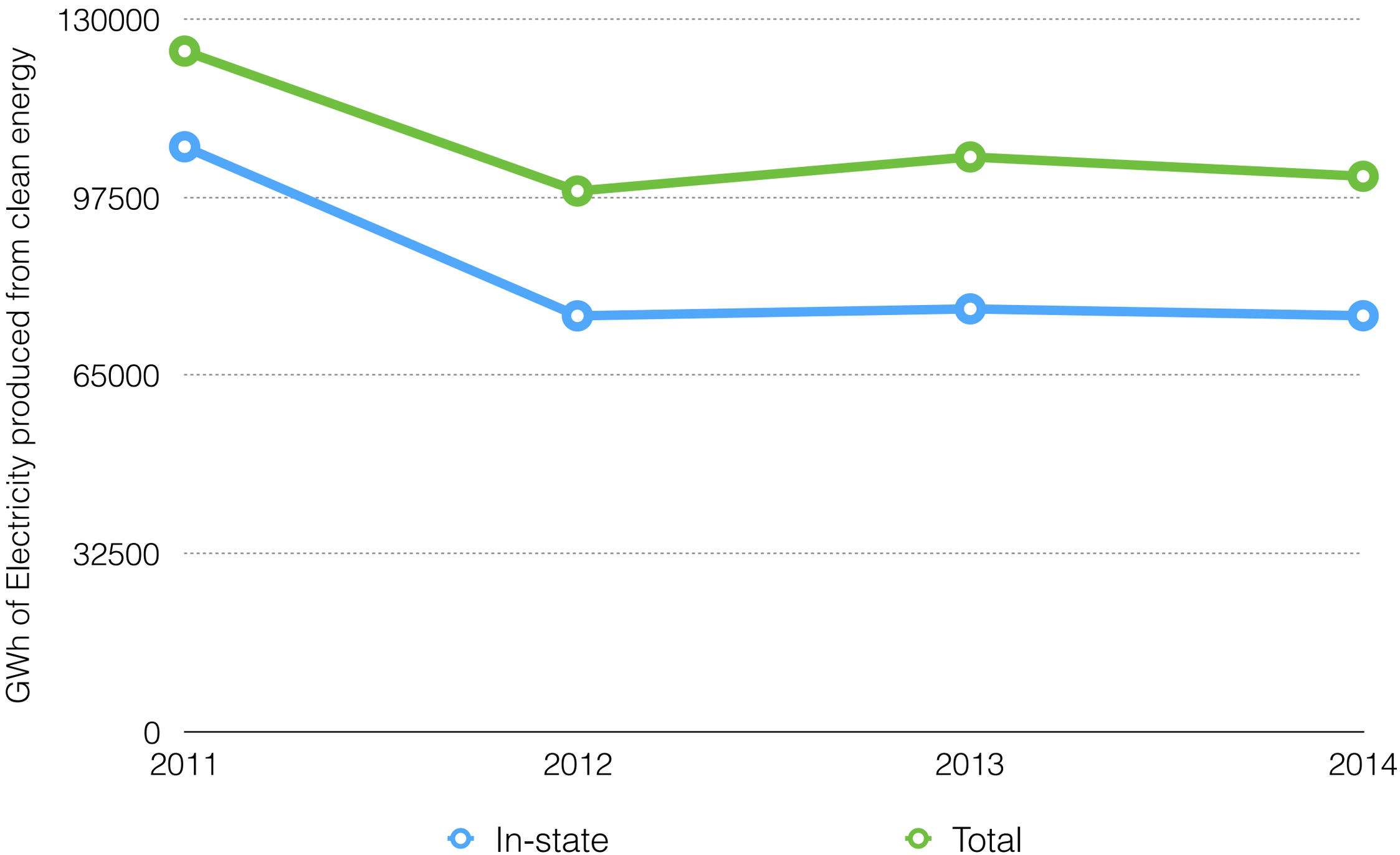


Source: “Greenhouse Gas Inventory,” California Air Resources Board, 2015

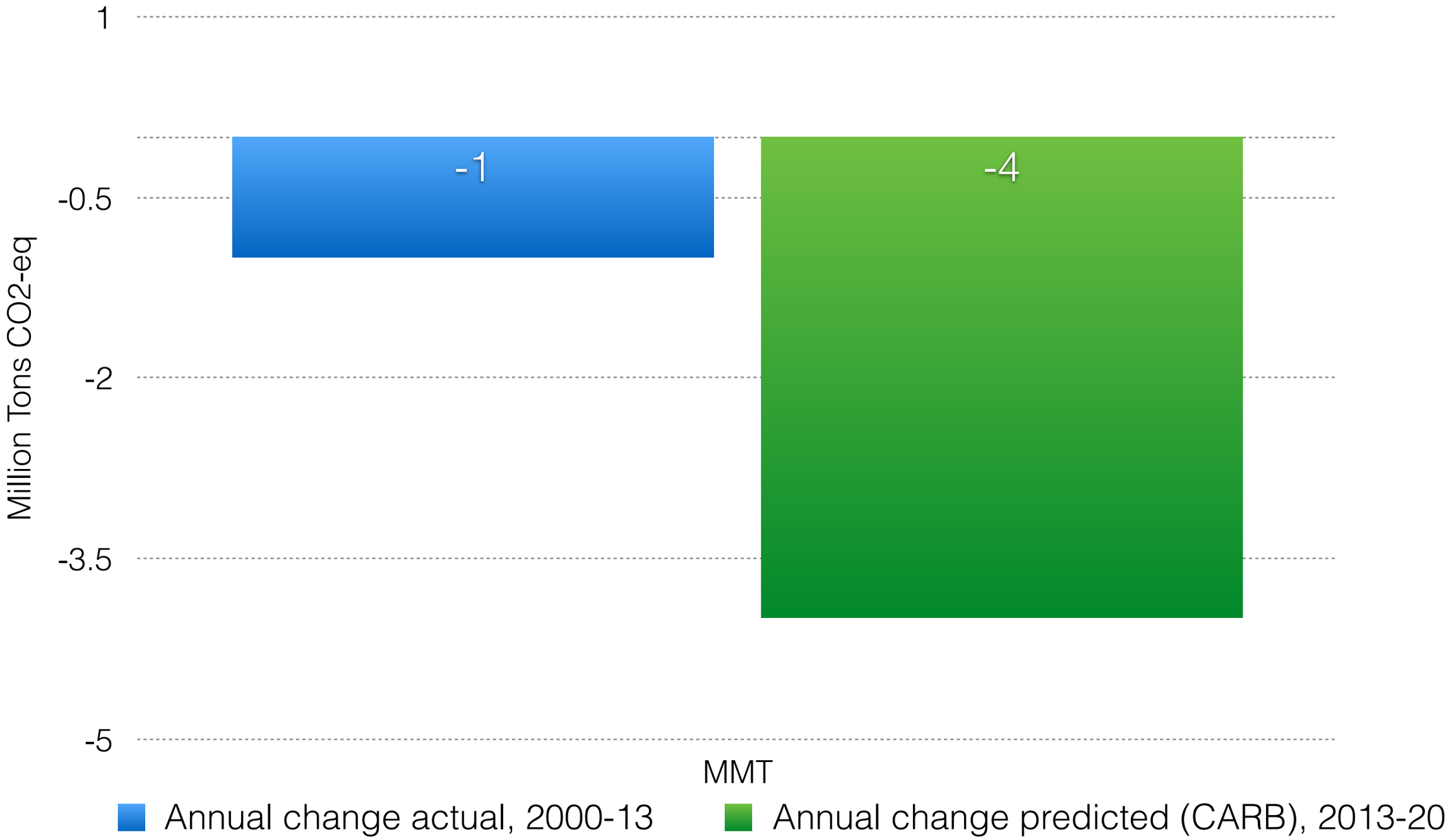
California actual emissions & 2020 target



CO2 data from 2014 isn't yet available but emissions were likely flat or higher in 2014 given energy trends

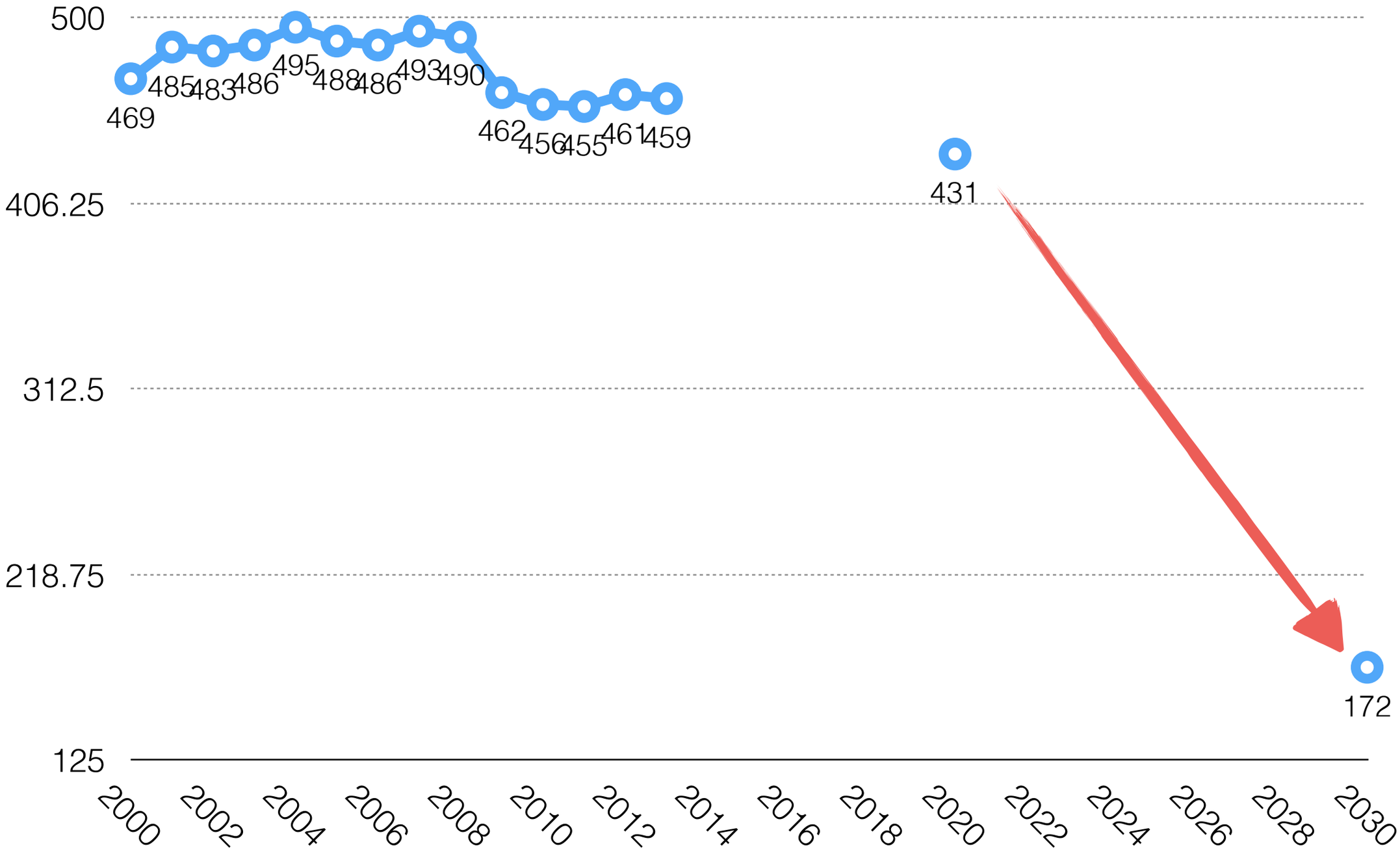


CA Air Resources Board predicts emissions will fall 4x faster from 2016 - 20 than 2000-13



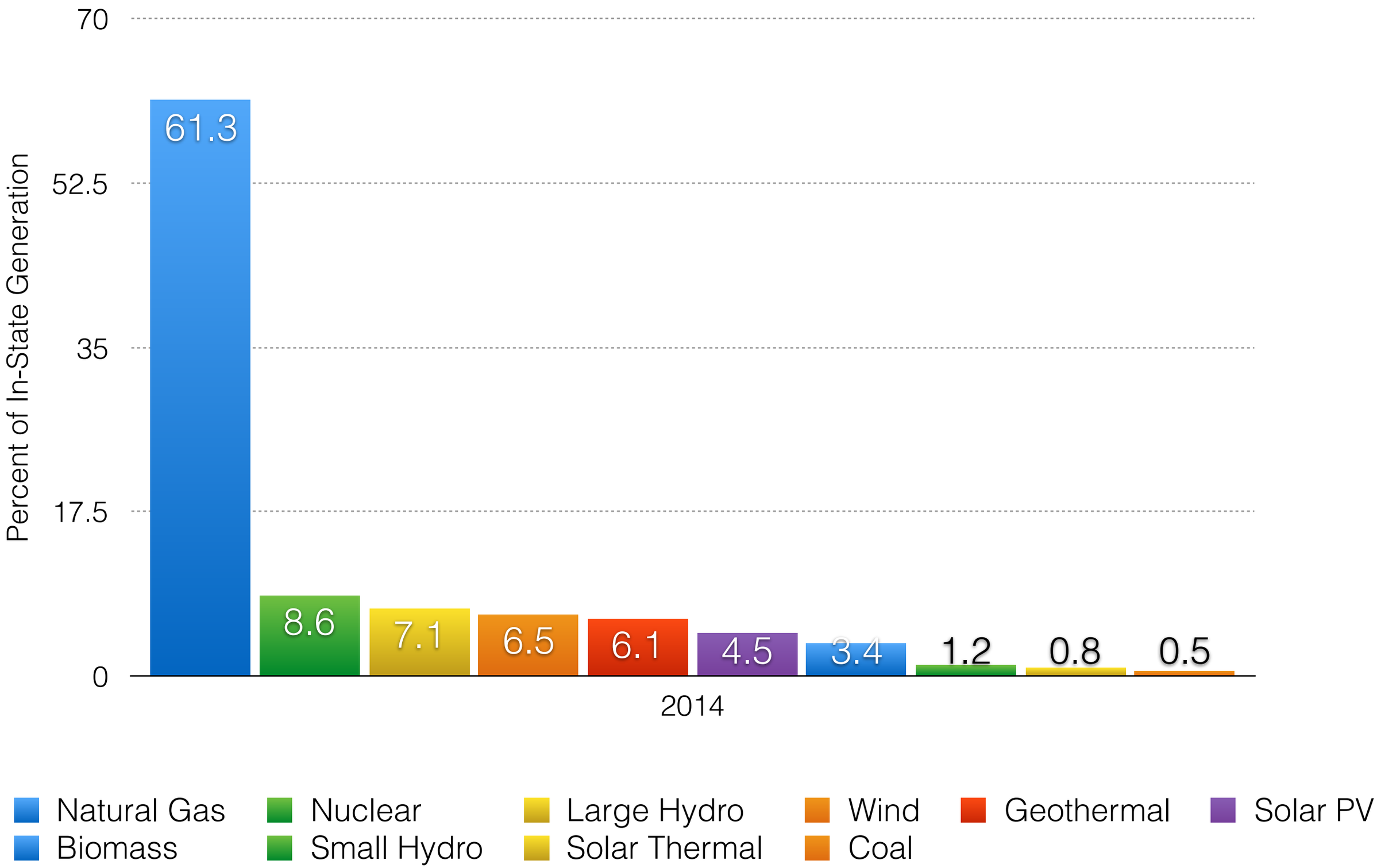
Source: “Greenhouse Gas Inventory,” California Air Resources Board, 2015

California actual emissions & 2030 target



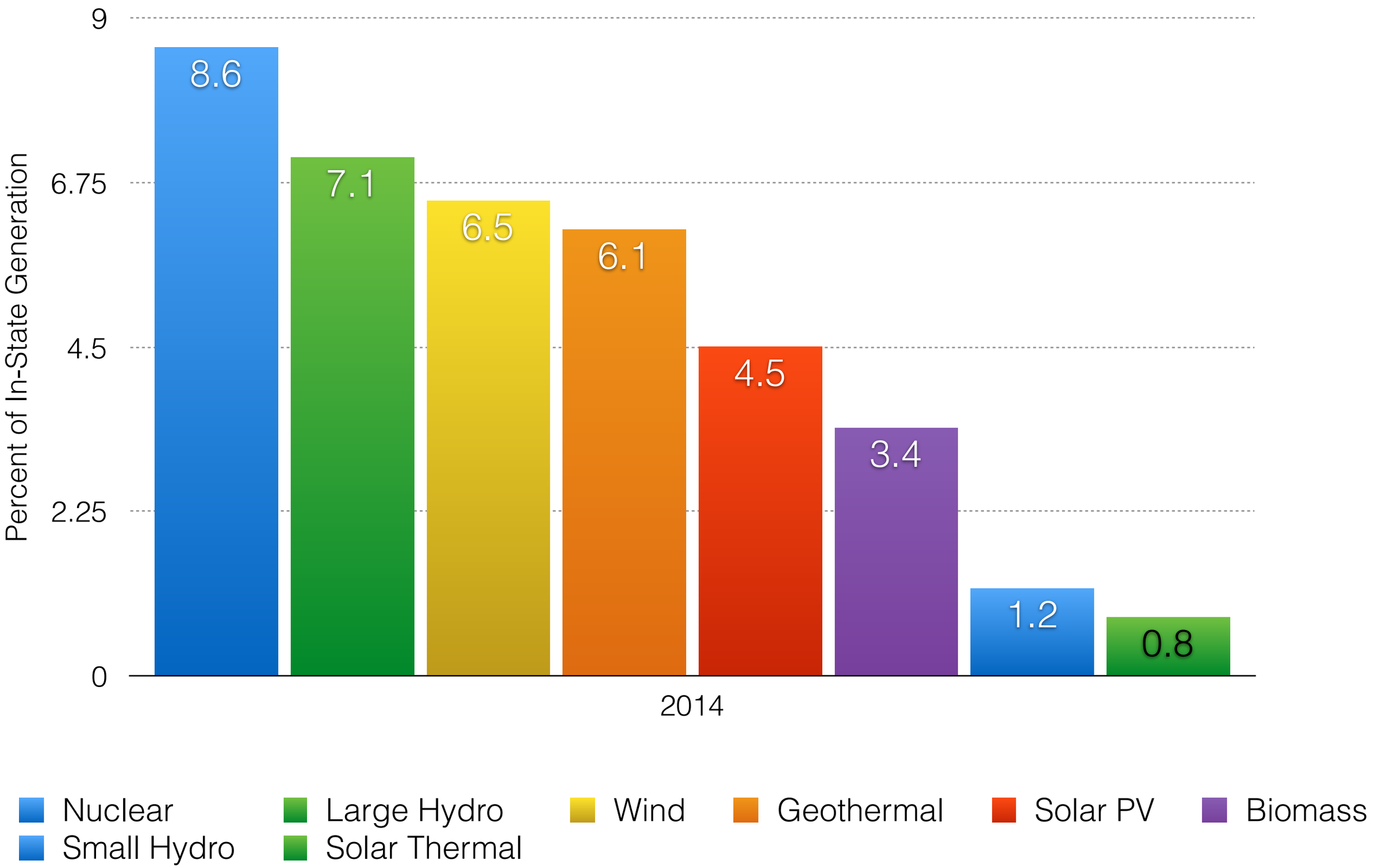
California Energy Overview

California In-State Generation, by percent, 2014



California Almanac, “In-State Generation by Fuel Type”
http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html

California Clean Electricity, by percent, 2014



California Almanac, “In-State Generation by Fuel Type”
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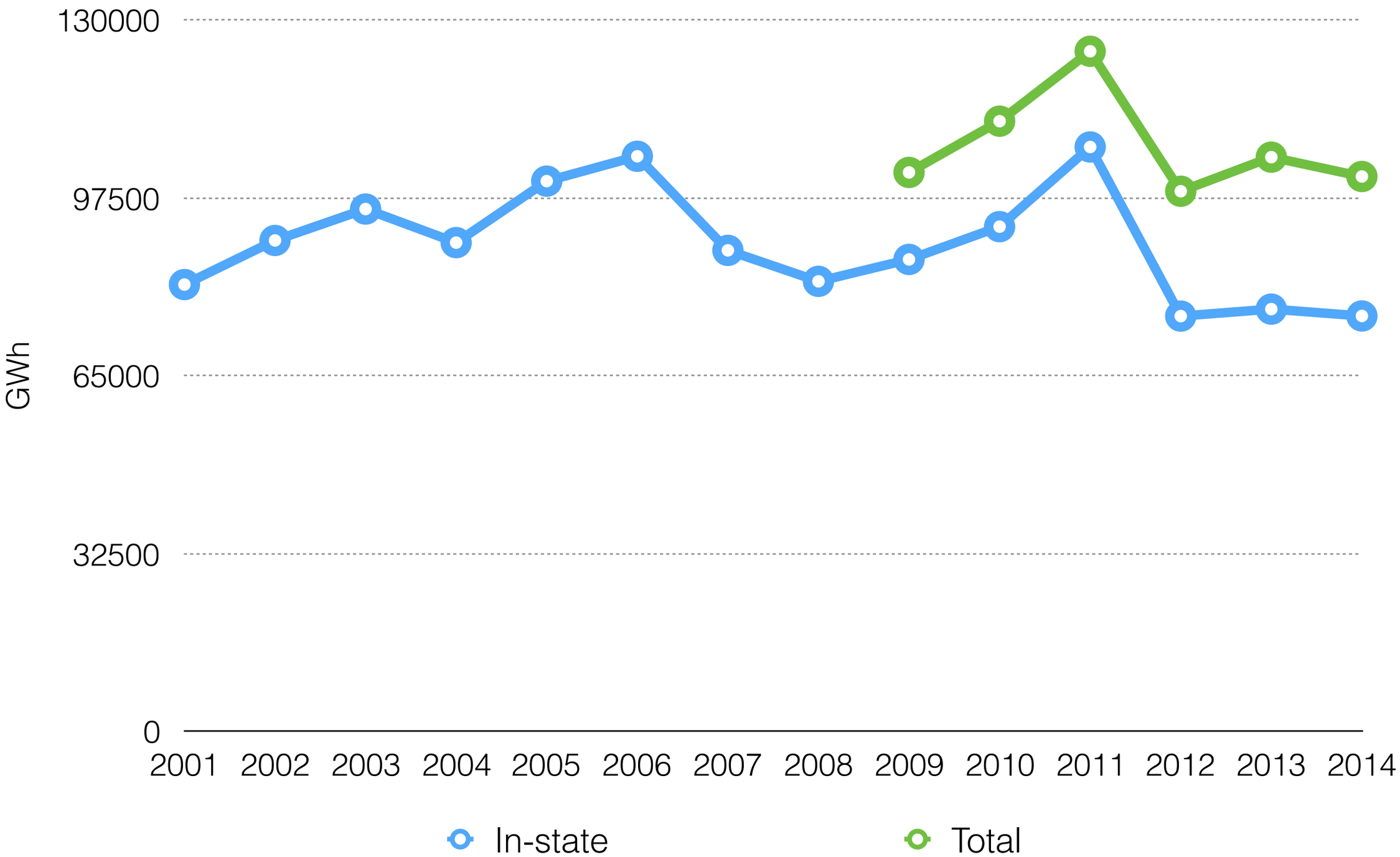
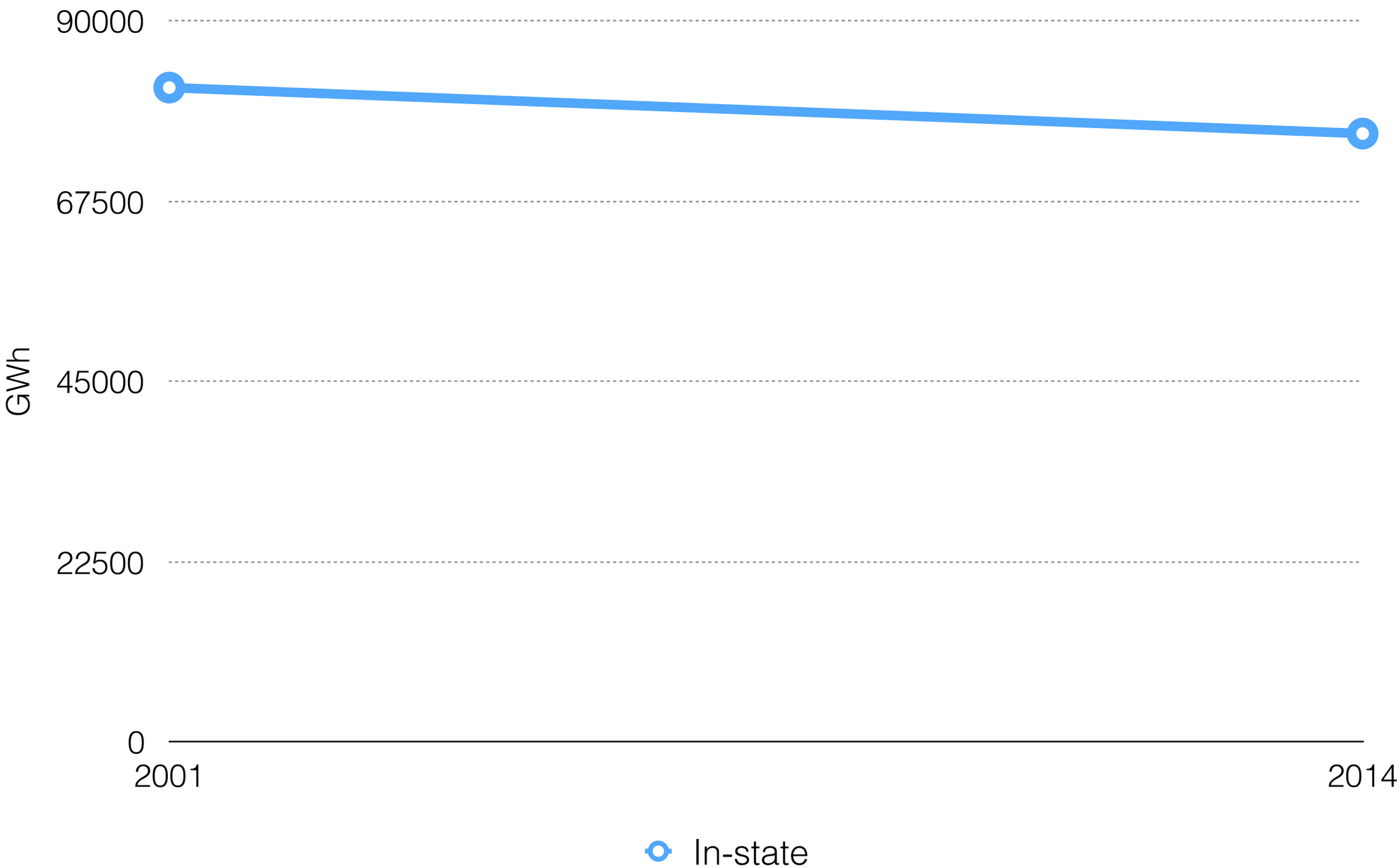
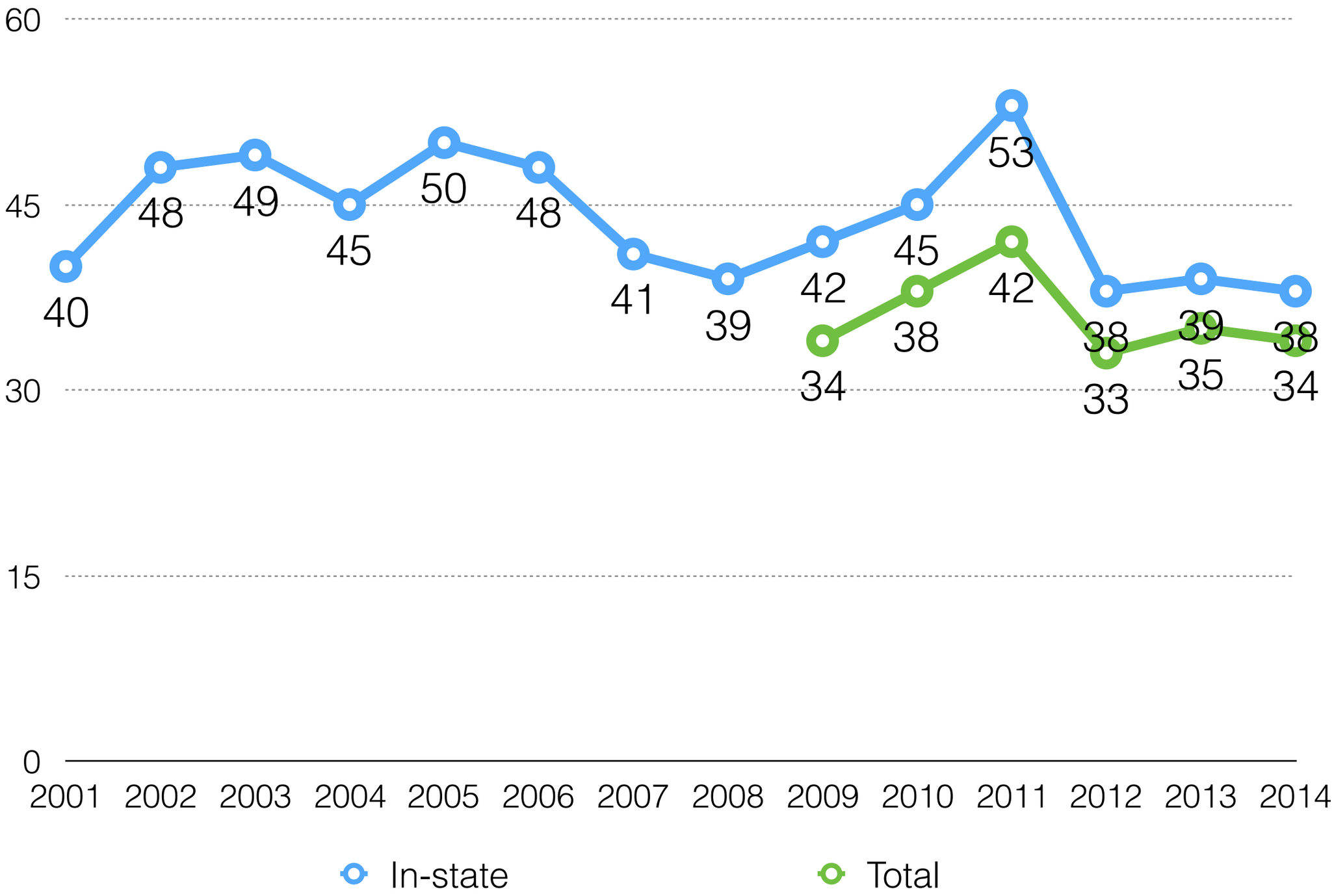
California clean electricity (in-state & total)



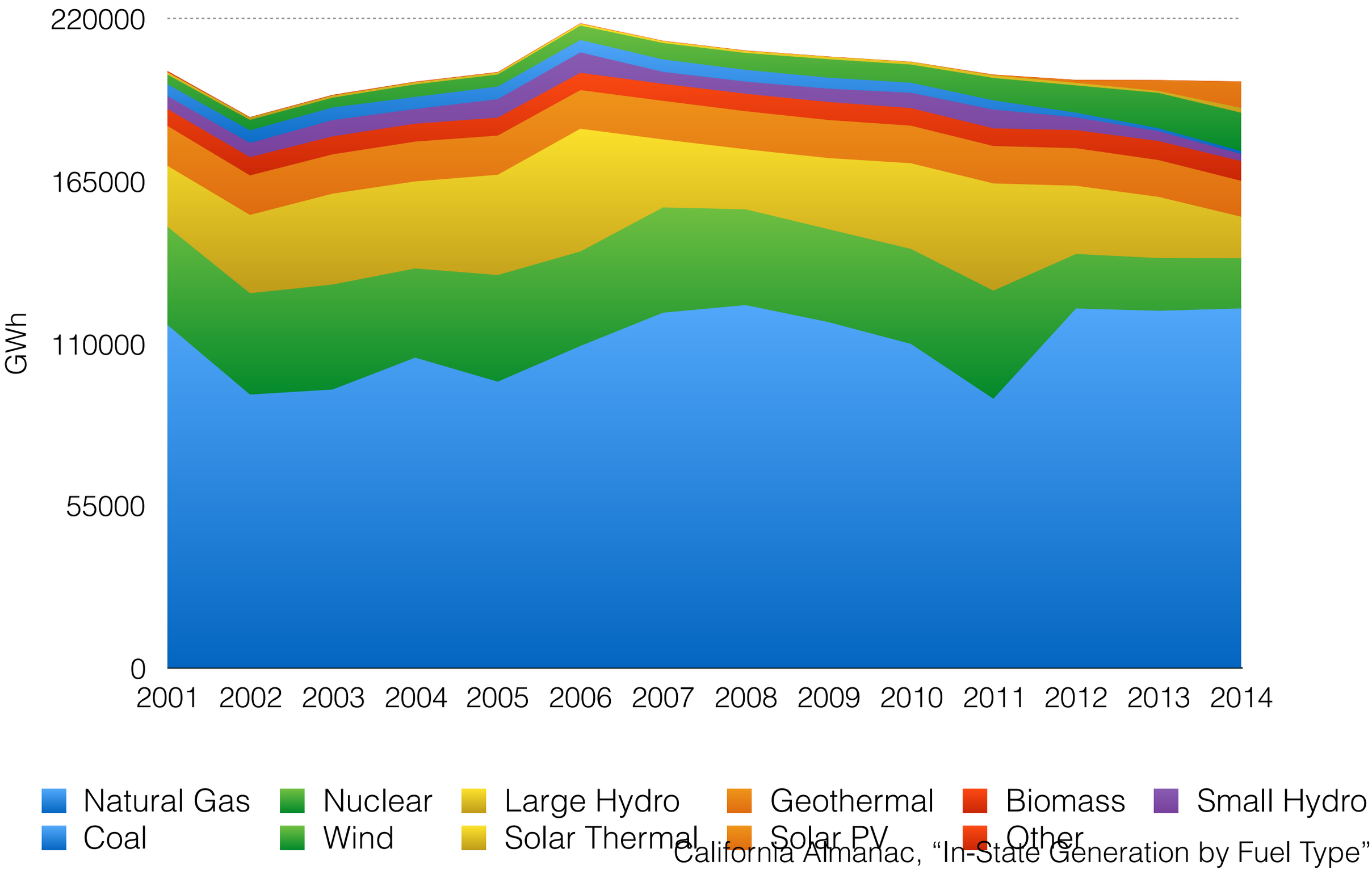
California clean electricity in-state



California clean electricity as percent of total



California In-State Electricity, 2001 - 2014



California Almanac, “In-State Generation by Fuel Type”
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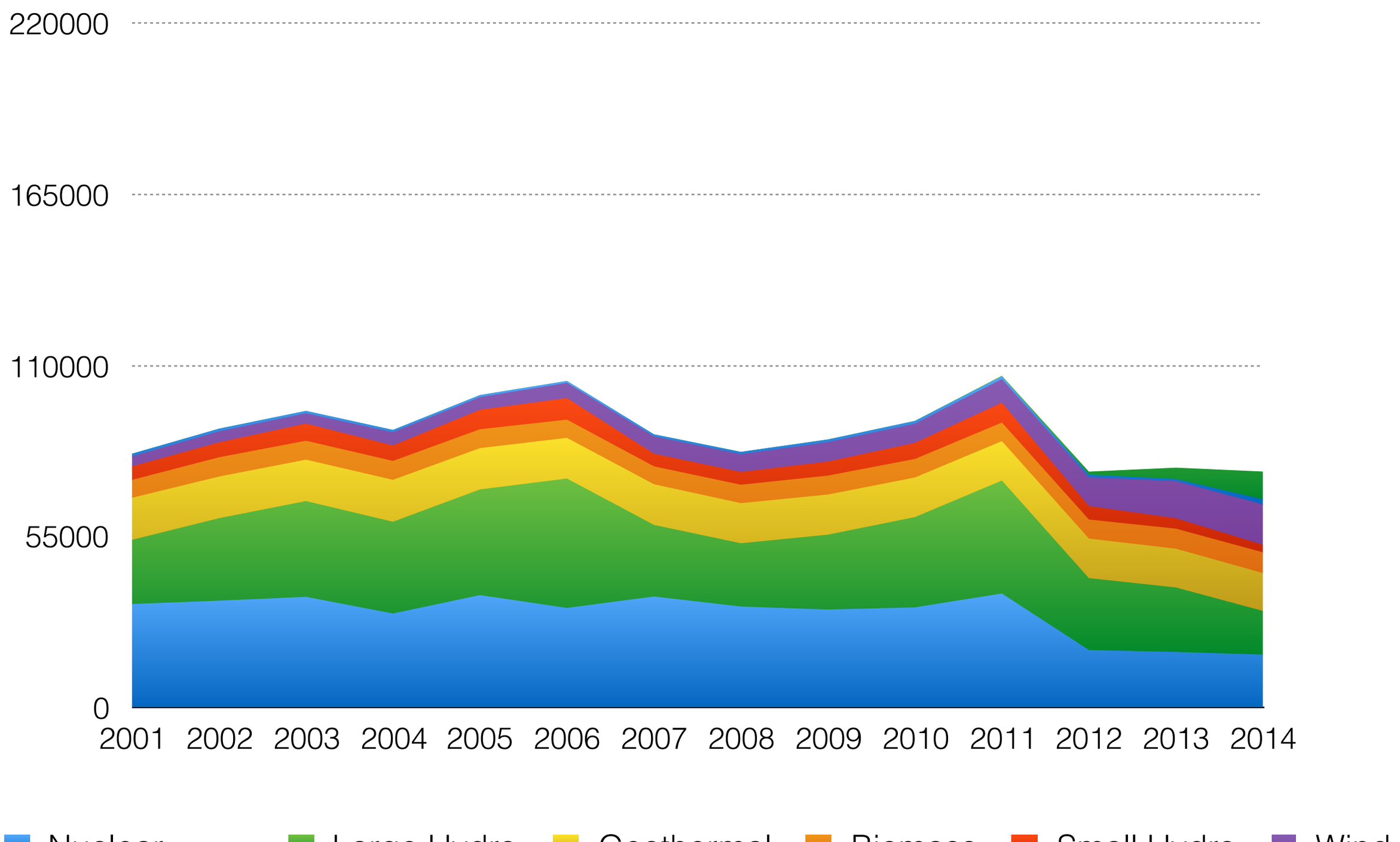
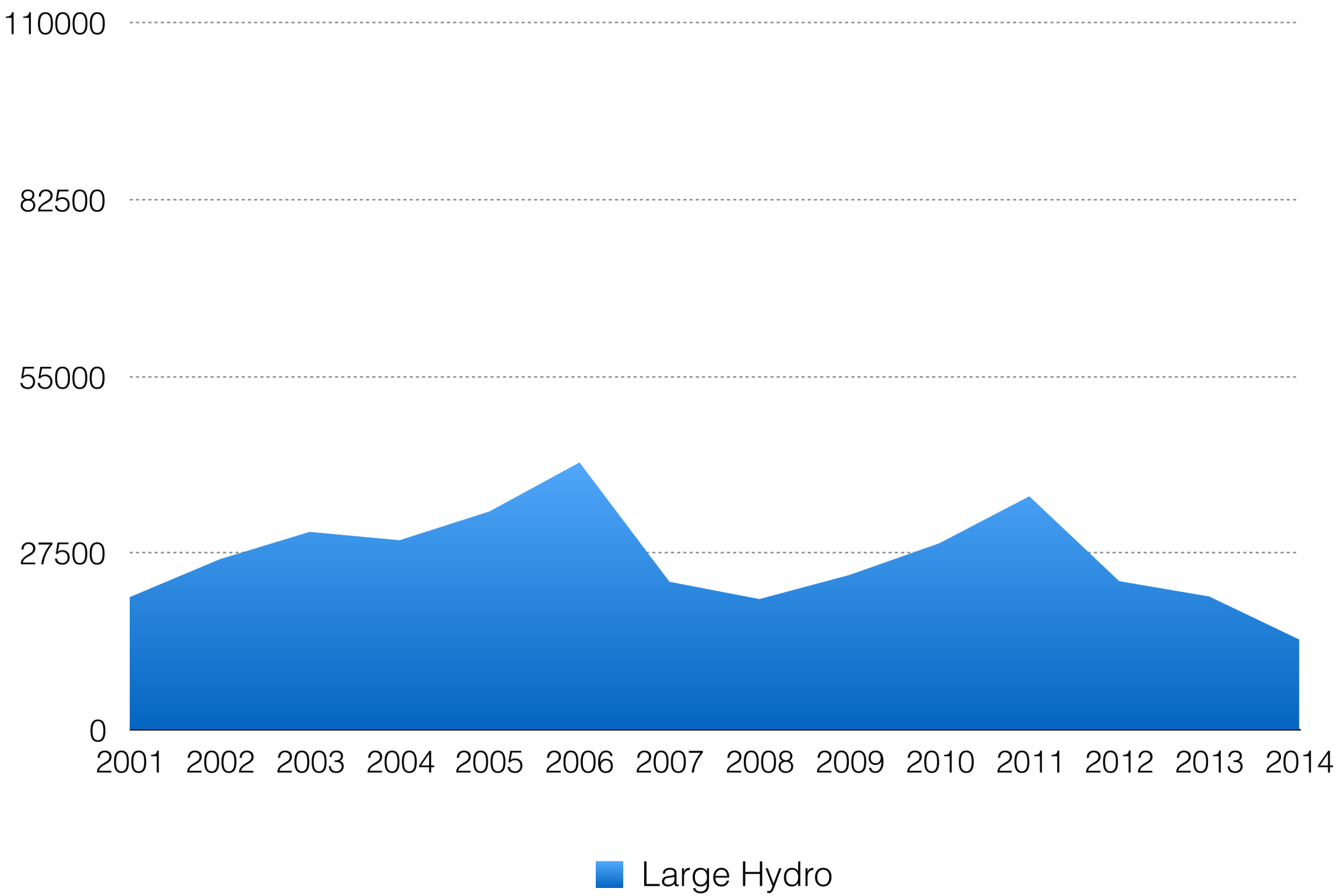
California Clean Electricity In-State Generation, 2001 - 2014



California Almanac, “In-State Generation by Fuel Type”
http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html

California In-State Hydro, 2001 - 2014



California Almanac, “In-State Generation by Fuel Type”
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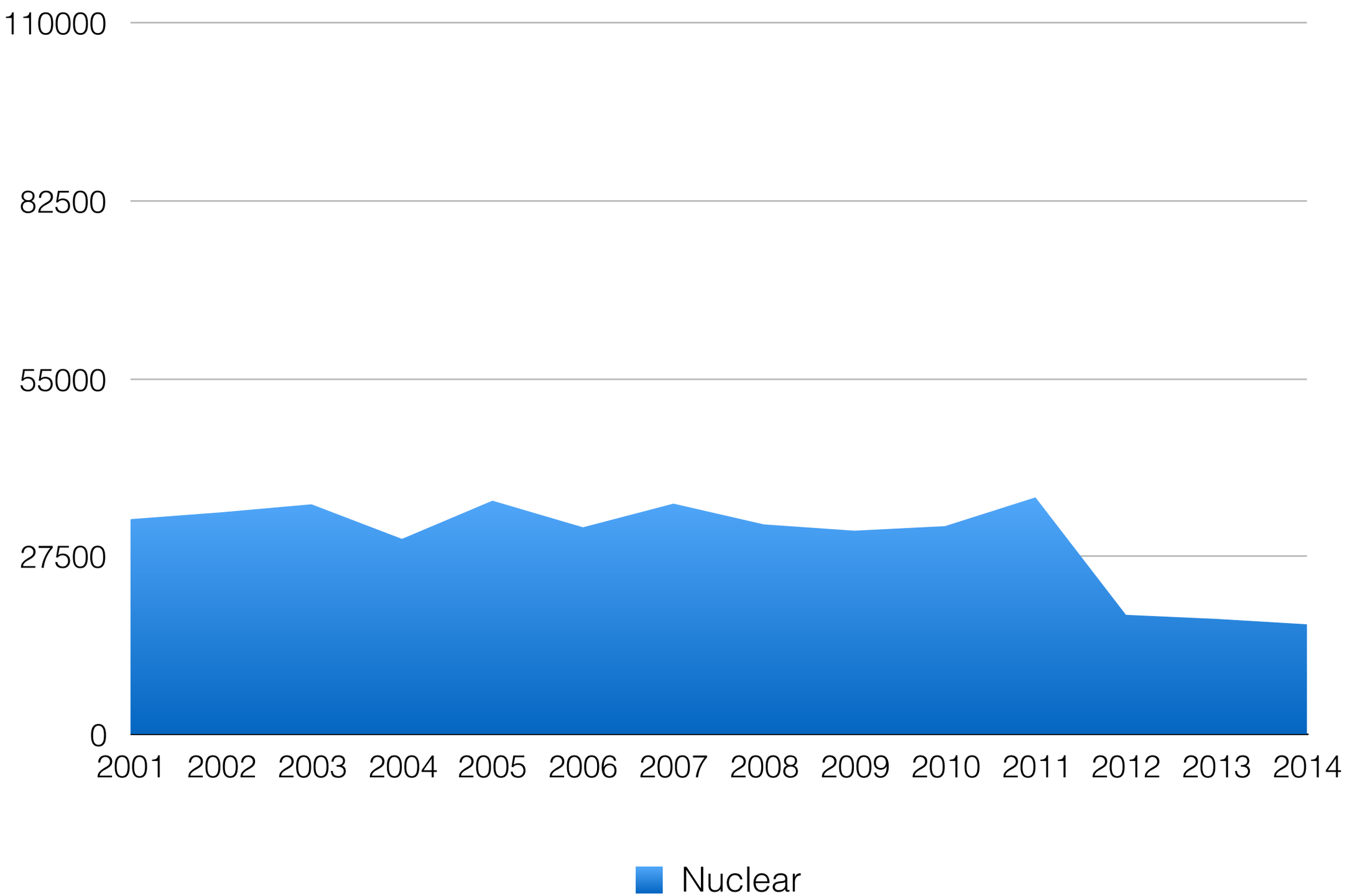
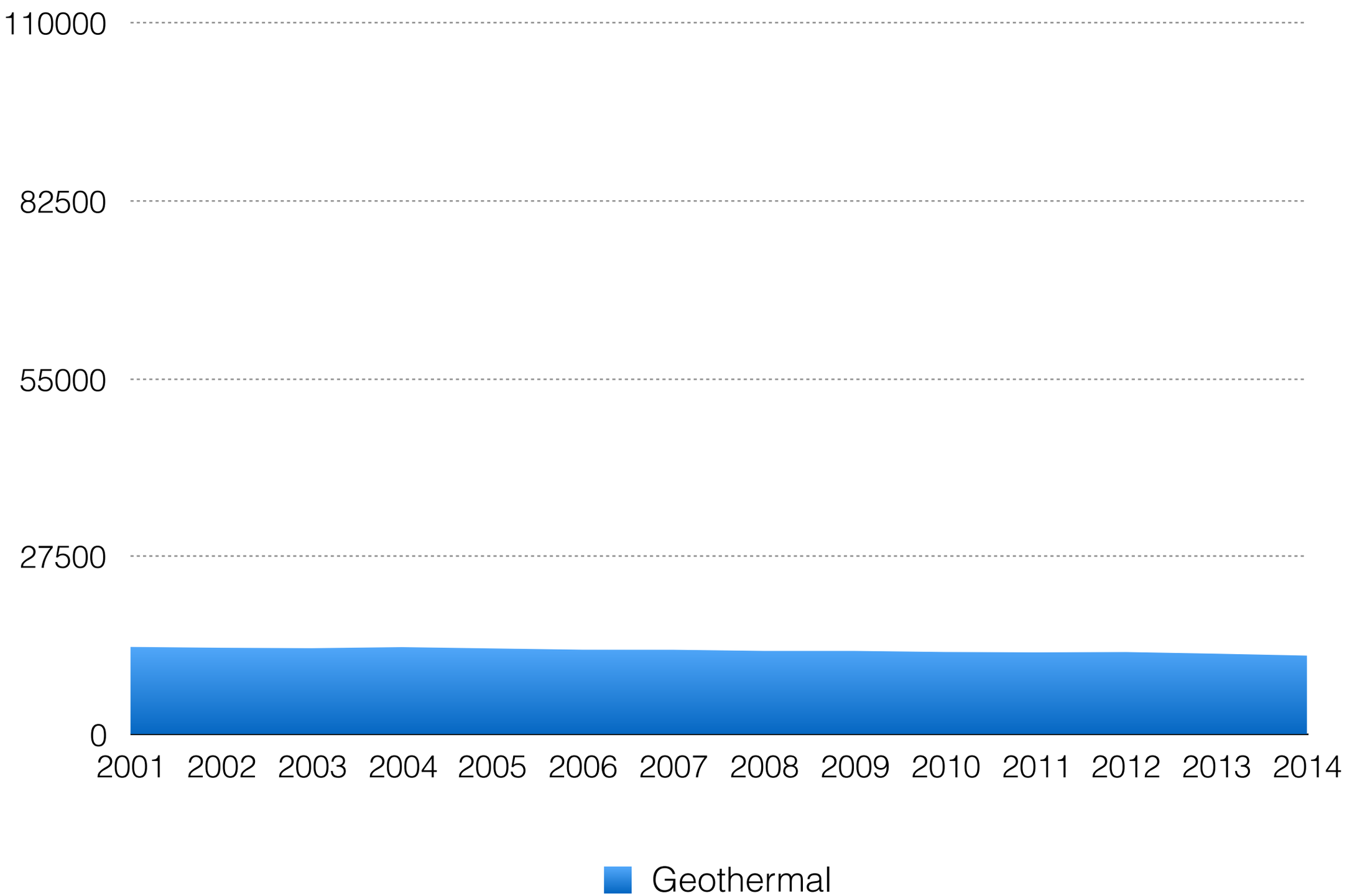
California In-State Nuclear, 2001 - 2014



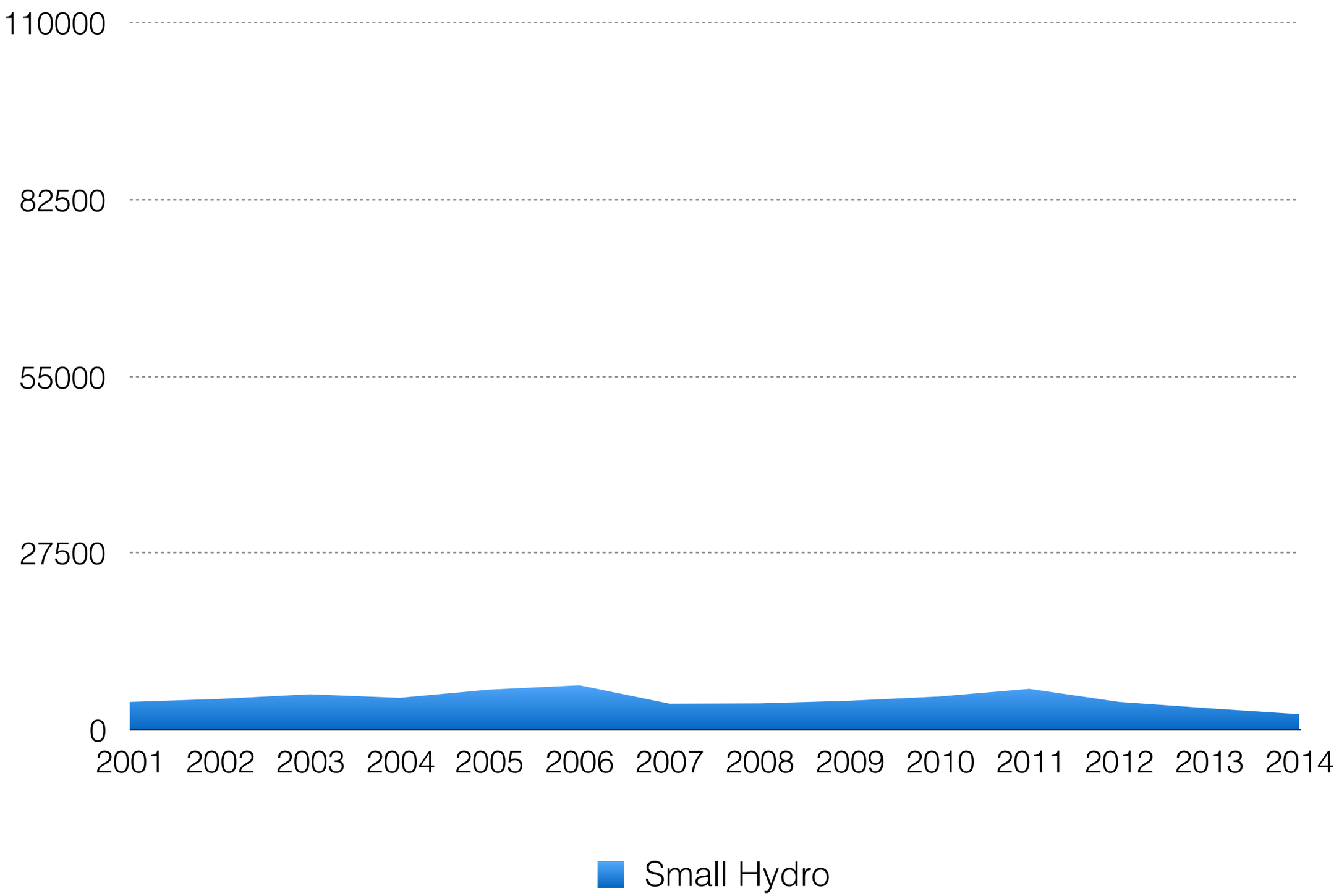
California Almanac, “In-State Generation by Fuel Type”
http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html

California In-State Geothermal, 2001 - 2014



California Almanac, “In-State Generation by Fuel Type”
http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html

California In-State Small Hydro, 2001 - 2014



California Almanac, “In-State Generation by Fuel Type”
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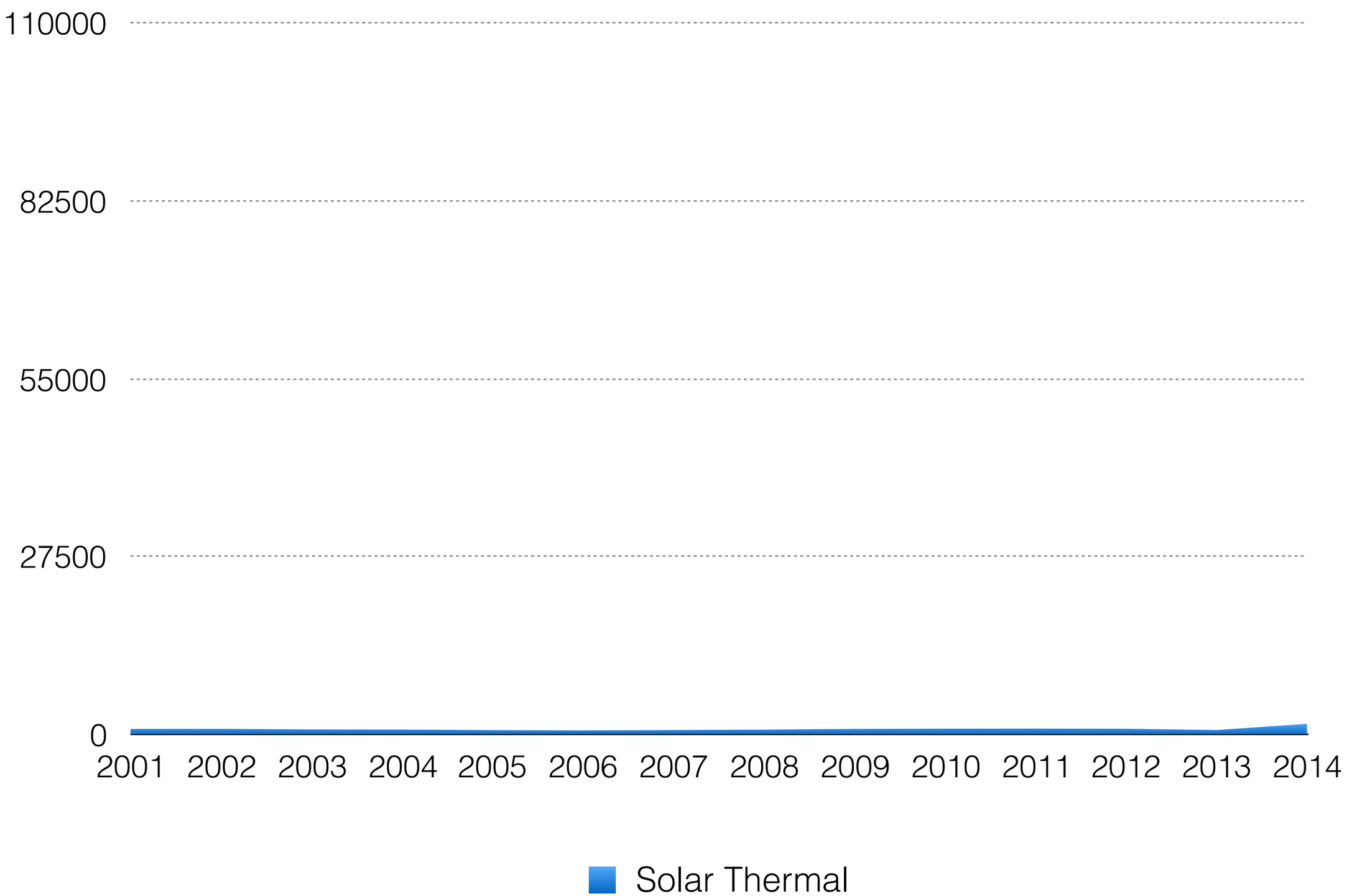
California In-State Solar Thermal, 2001 - 2014



California Almanac, “In-State Generation by Fuel Type”
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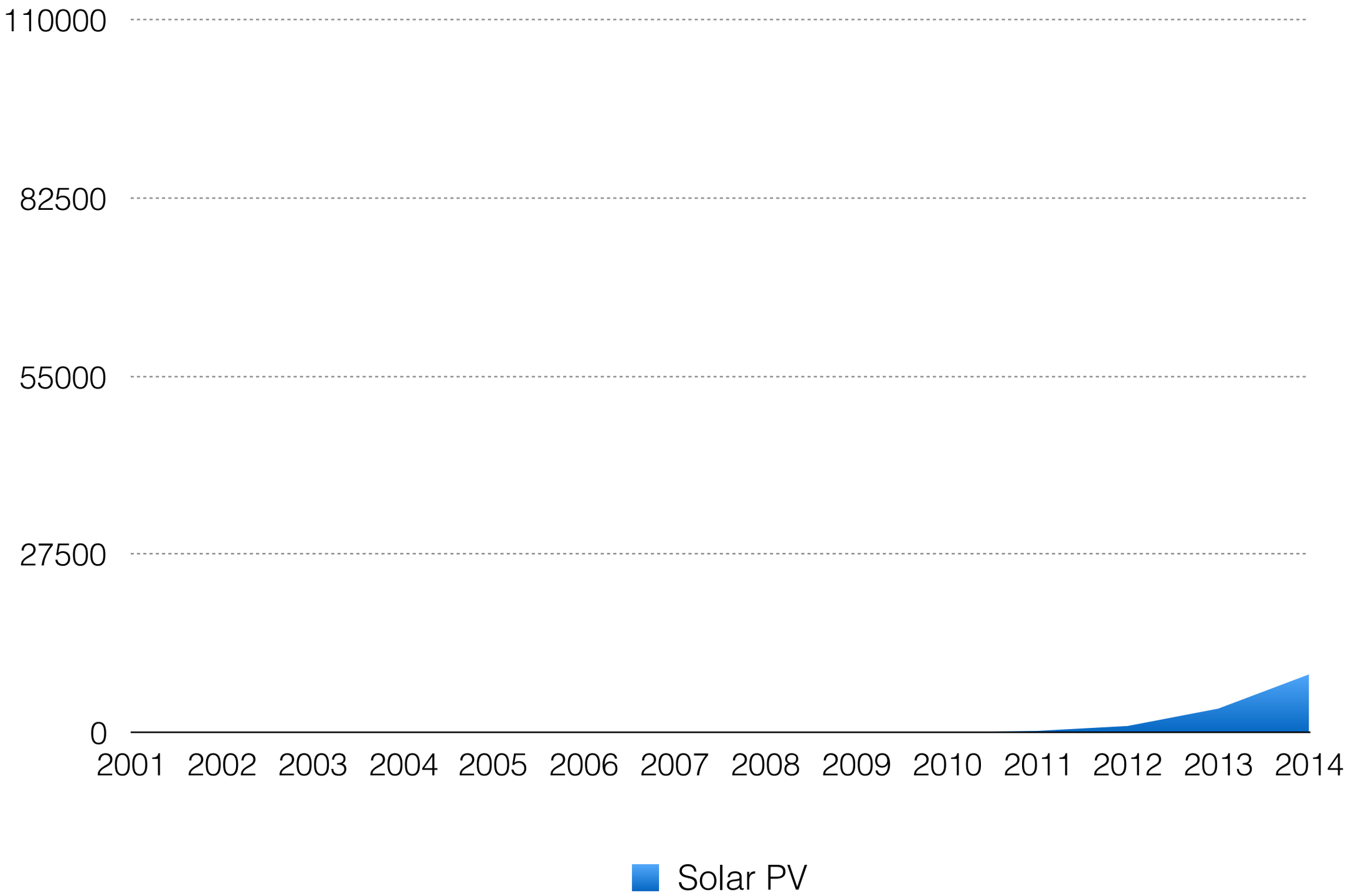
California In-State Solar PV, 2001 - 2014



California Almanac, “In-State Generation by Fuel Type”
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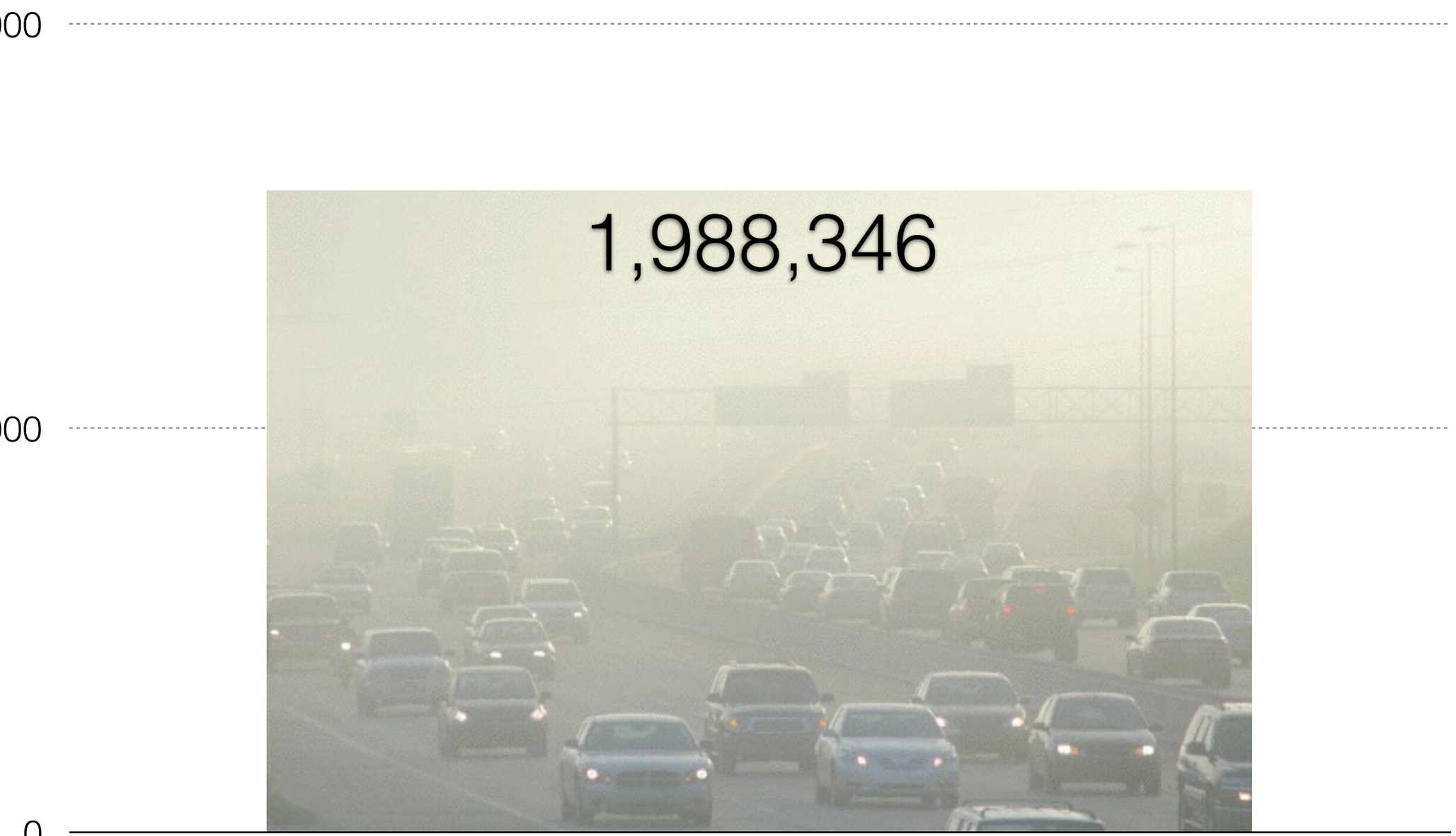
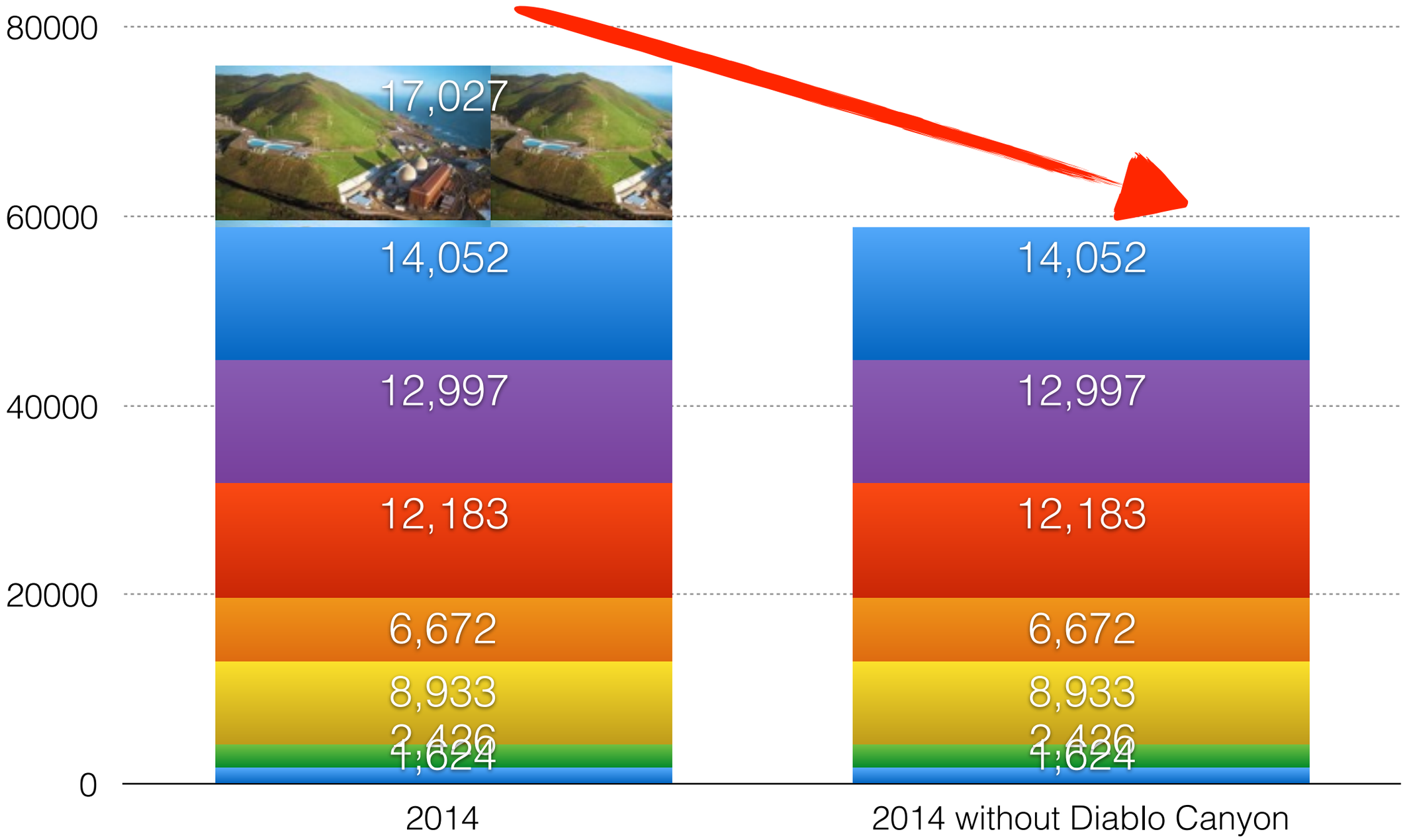
Environmental Consequences of Diablo Closure

Replacing Diablo with Natural Gas Would Be Equivalent of Adding ~2 Million Cars to the Road



Source: EIA carbon emissions from natural gas; California (State Government Energy) Almanac, 2016

If Diablo closes, 22% of California's clean electricity would be lost



California Almanac, "In-State Generation by Fuel Type"
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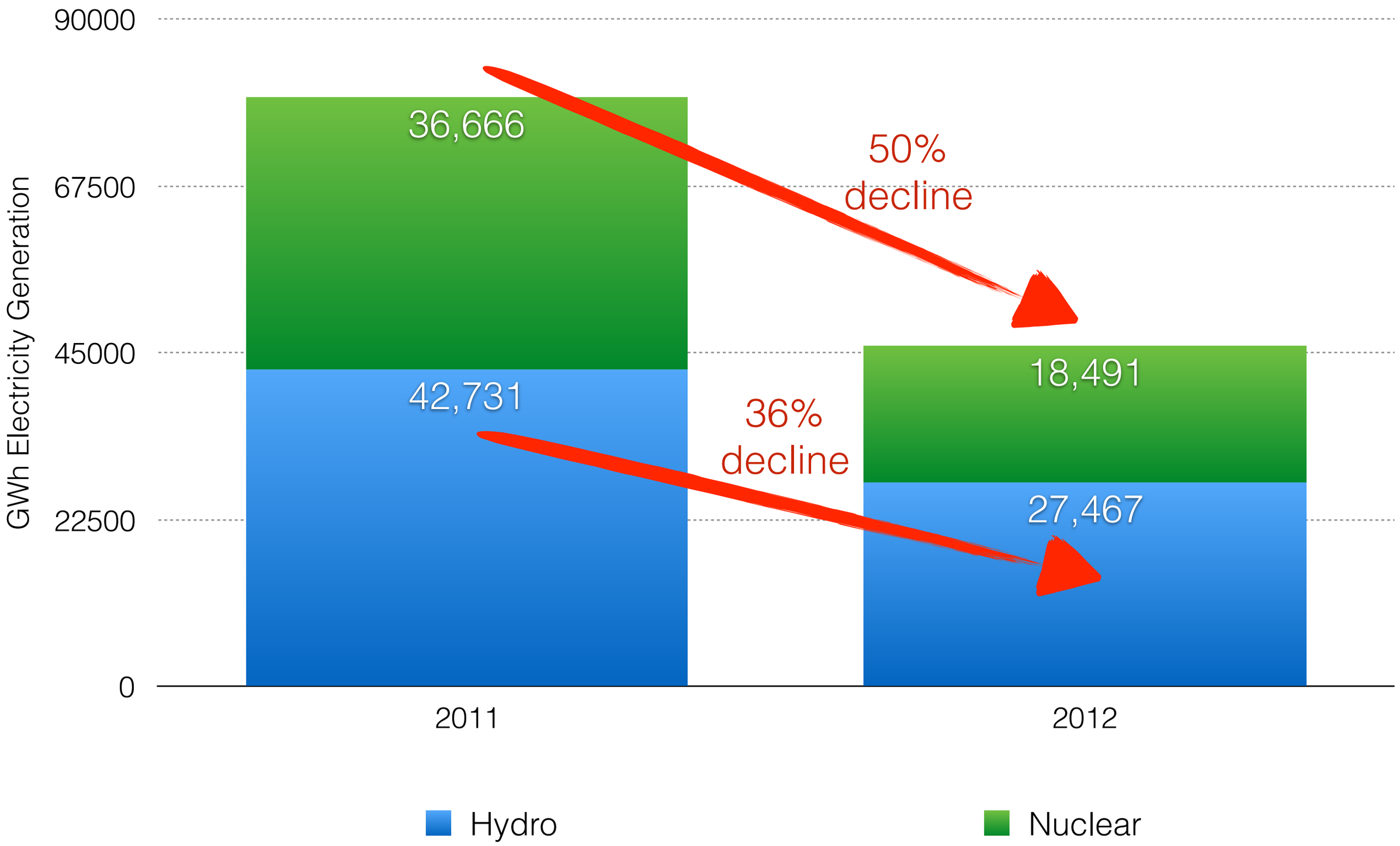
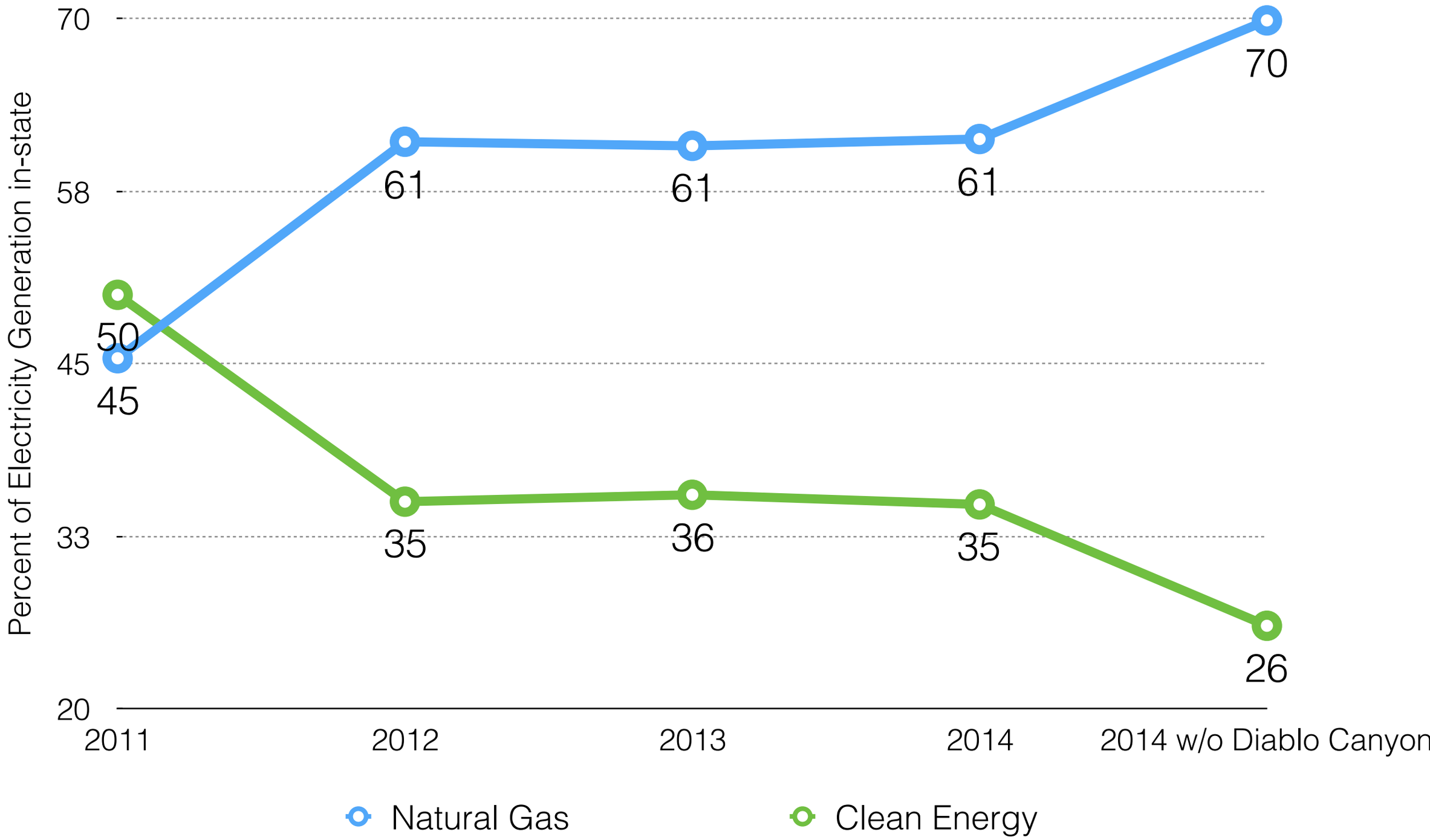
San Onfore closure reduced clean electricity by 50%, drought reduced it by 36%, 2011-2012



California Almanac, “In-State Generation by Fuel Type”
http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html

Replacing Diablo Closure with natural gas would cut clean electricity to 26% & increase natural gas to 70%

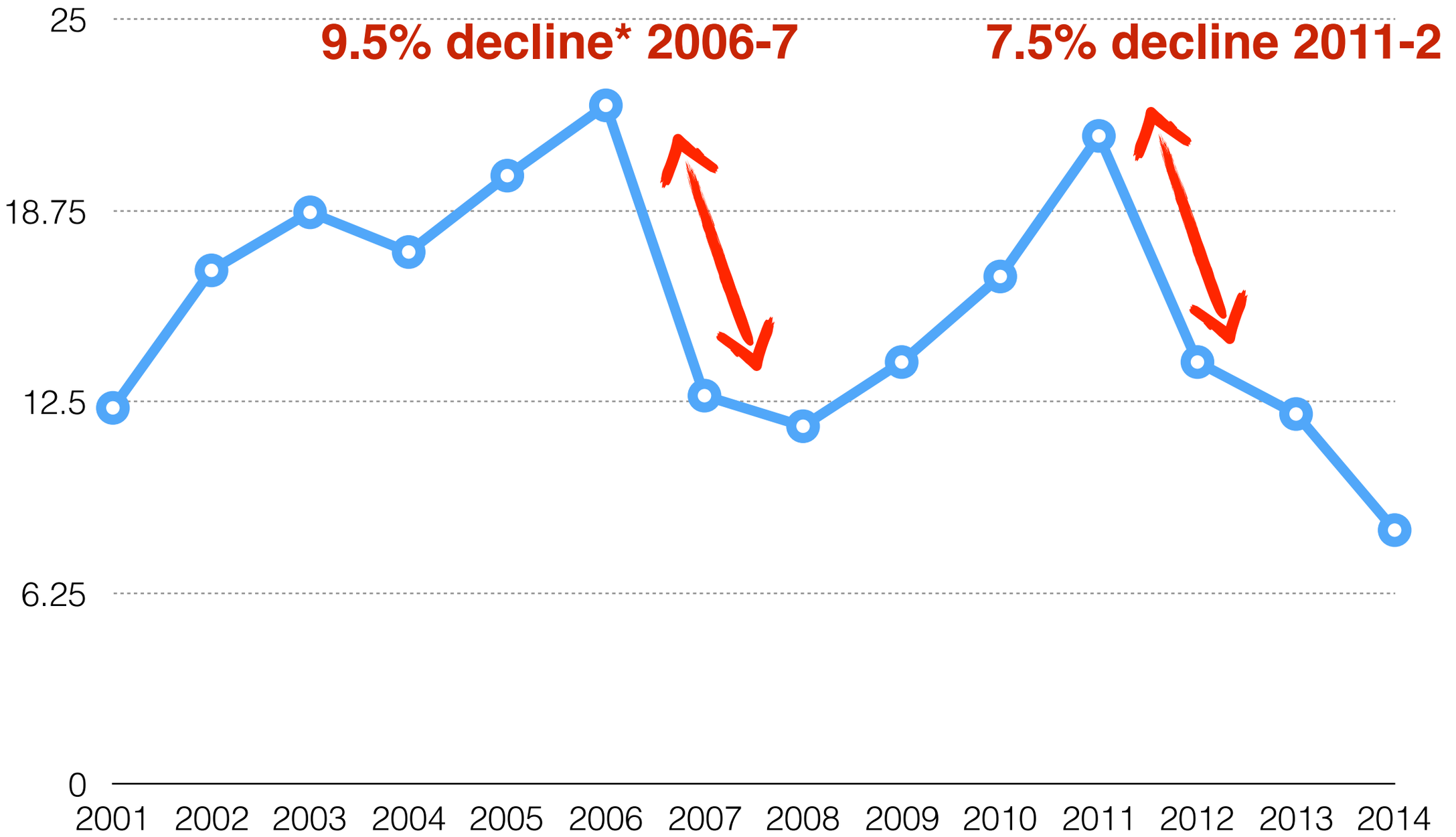


Source: California Almanac, “In-State Generation by Fuel Type”
http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html

Carbon equivalent of 2.1 million cars added to road after San Onofre nuclear plant was replaced by natural gas

Source: California Almanac. In 2011, San Onofre Generating Station 18,175,000,000 KWh of power. It was replaced by natural gas, which according to US EIA generates 1.2 pounds of CO2 per KWh, or 9,975,282 metric tons of CO2. Average US vehicle emits 4.7 metric tons of CO2 per year. 9,975,282 divided by 4.7 = 2,100,059 cars

Hydro-electricity fluctuates significantly



California Almanac, “In-State Generation by Fuel Type”
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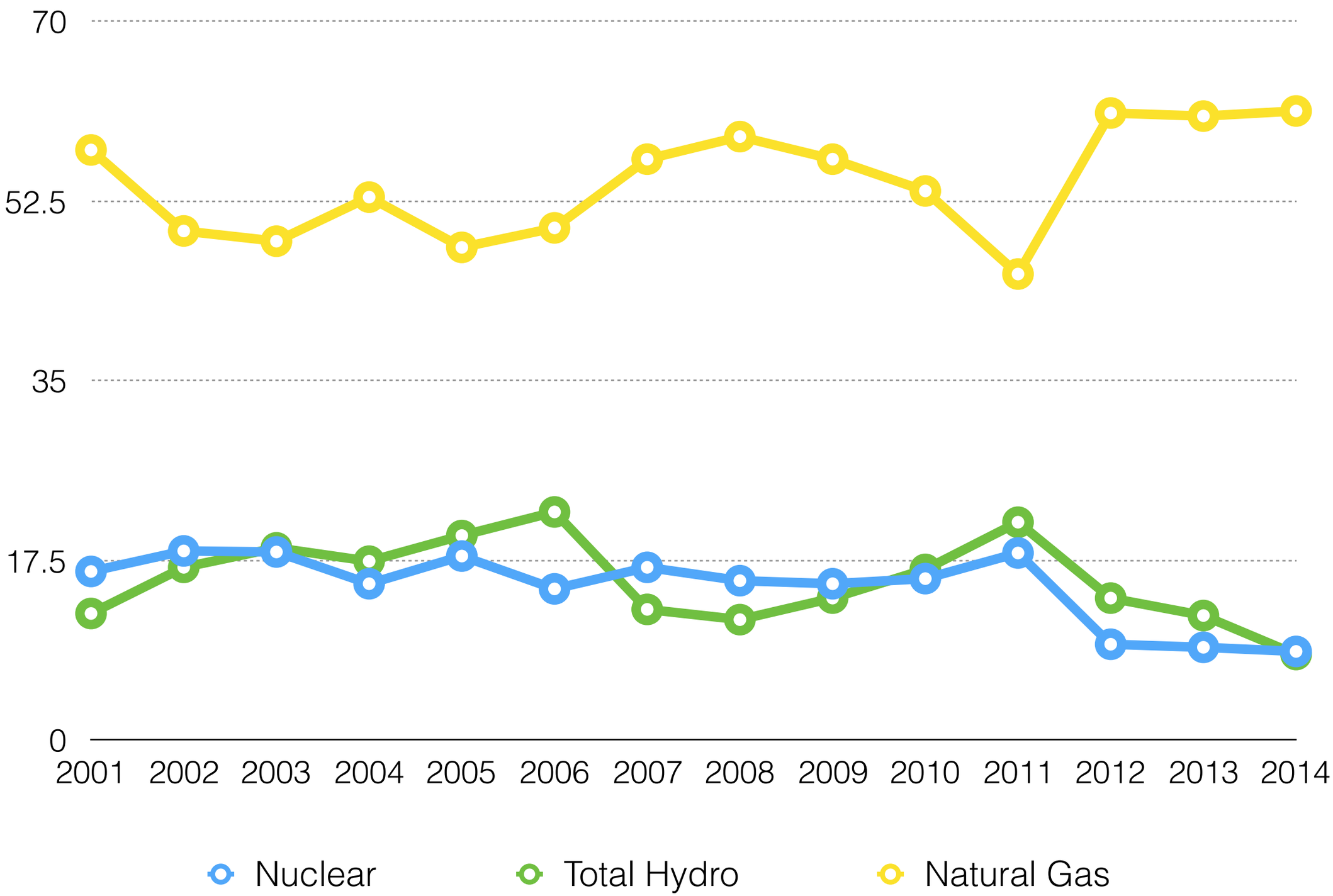
Natural Gas Substitutes for Hydro & Nuclear



California Almanac, “In-State Generation by Fuel Type”
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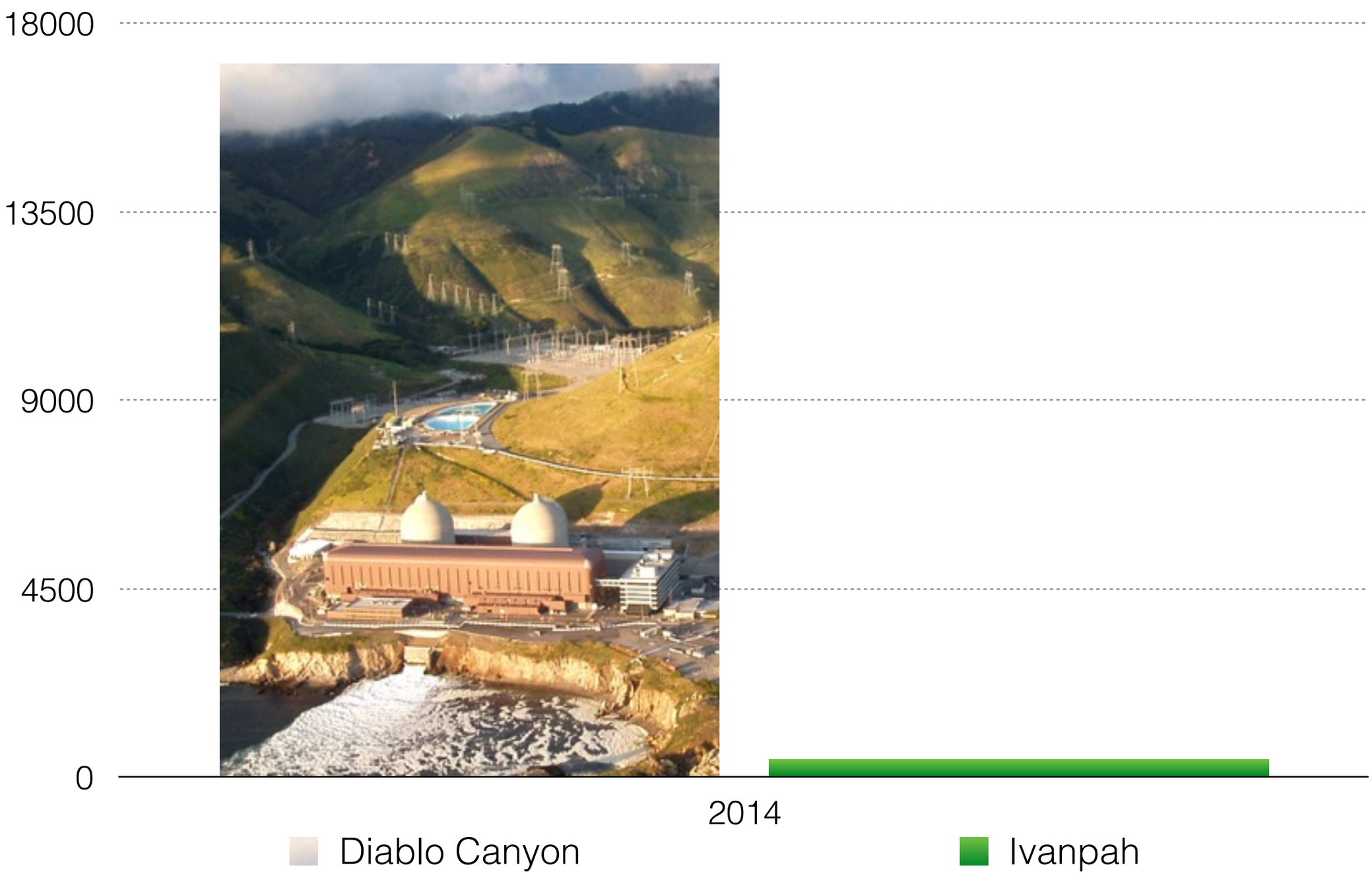
Diablo Canyon produced 41 times more electricity than Ivanpah, California's largest solar plant



California Almanac, "In-State Generation by Fuel Type"
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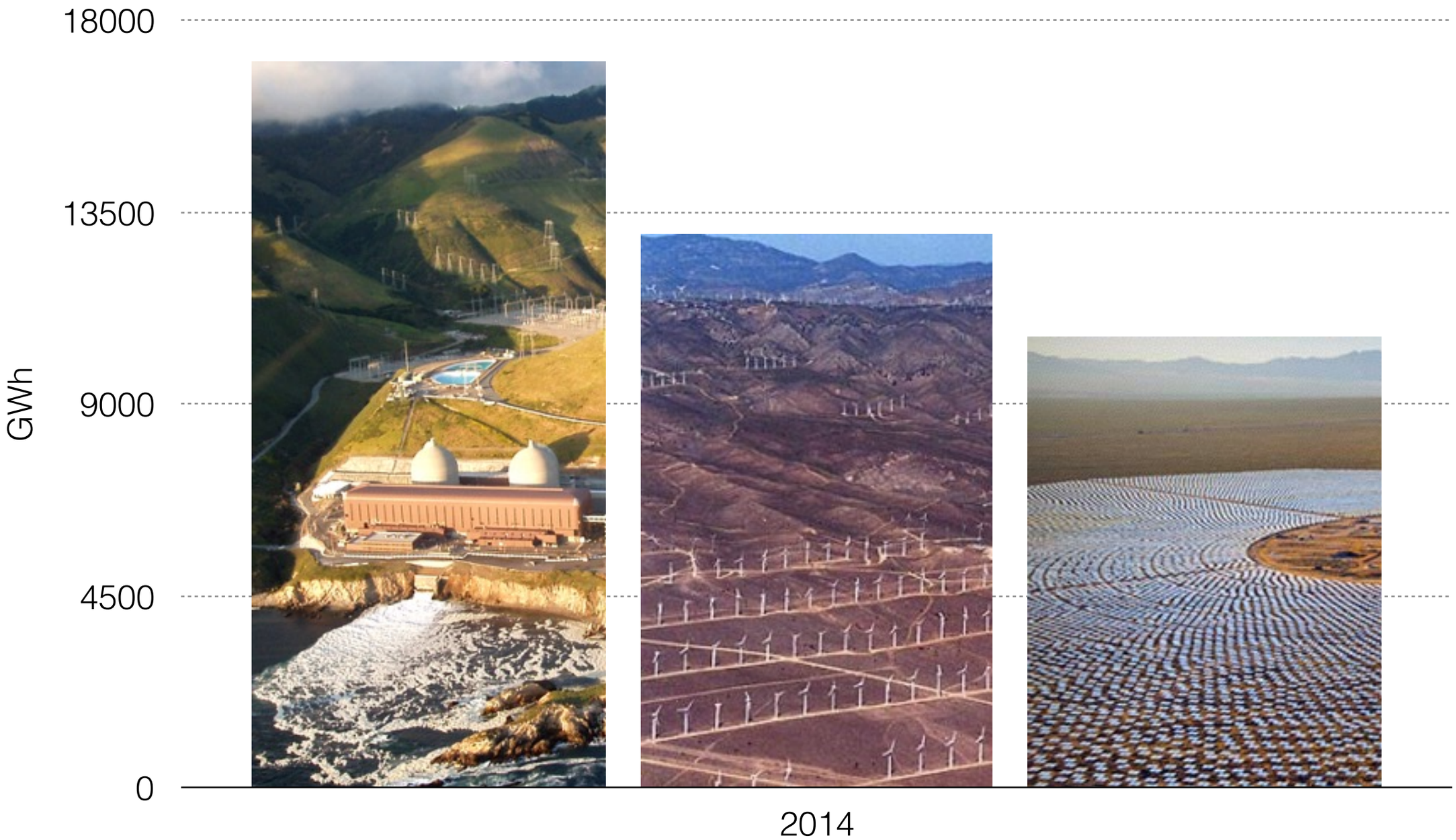
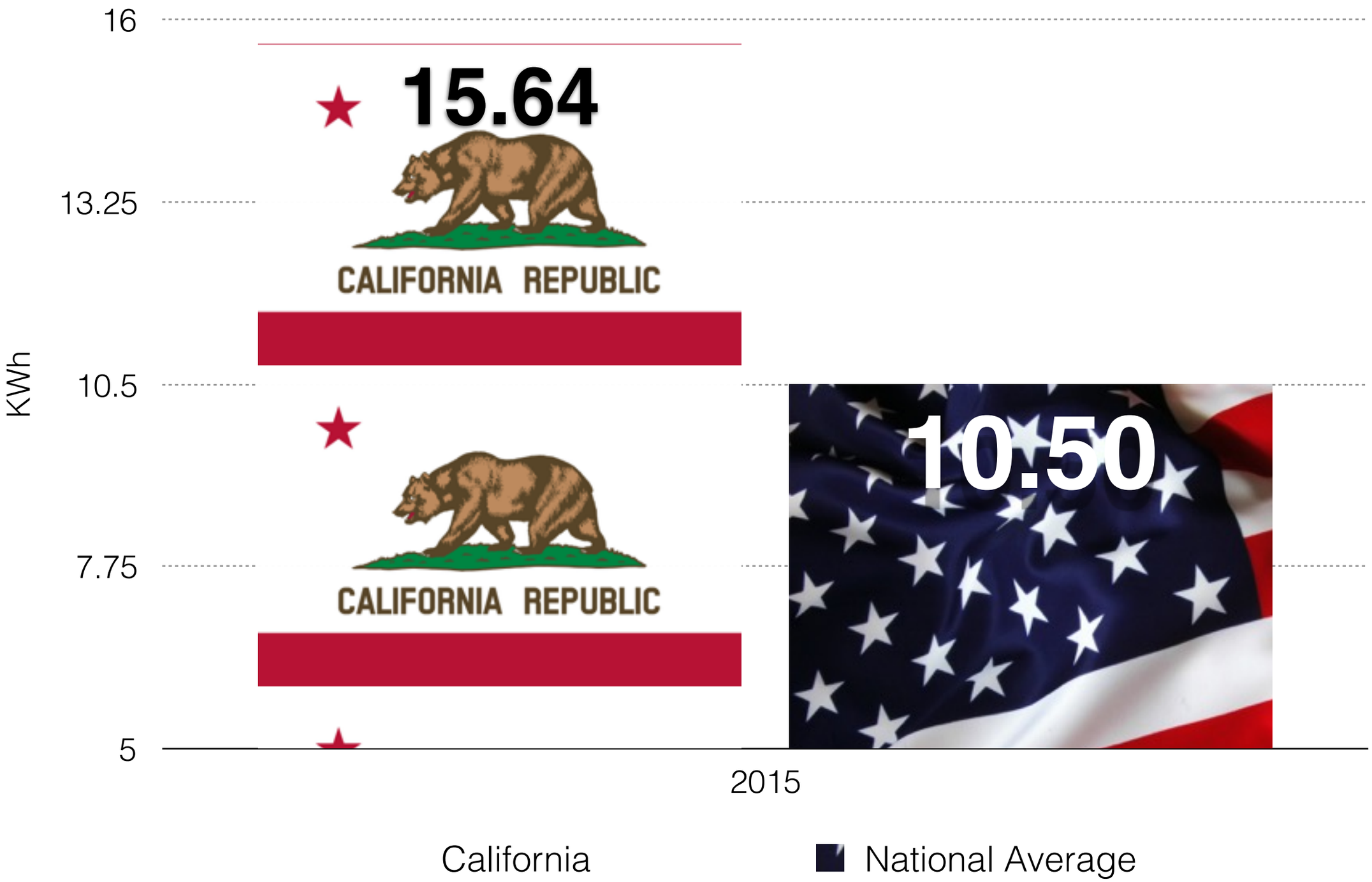
Diablo Canyon produced 24% percent more electricity than all of California's wind, and 33% more than all of its solar



California Almanac, "In-State Generation by Fuel Type"
http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html

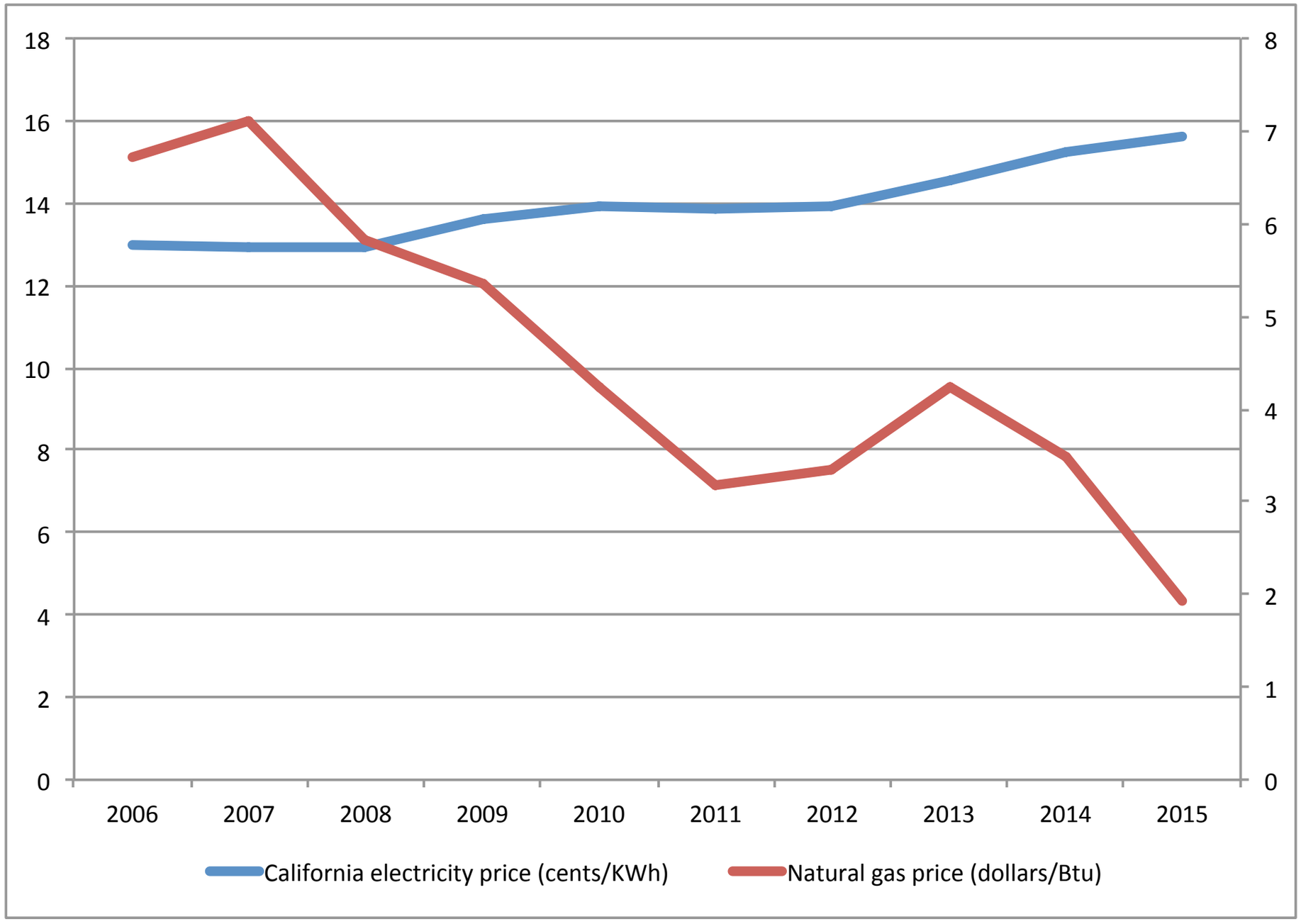
Economic Consequences

California has 6th most expensive retail (all sectors) electricity in continental United States



Source: US EIA, All in Year-to-date, Electric Power Monthly, 2011-2015

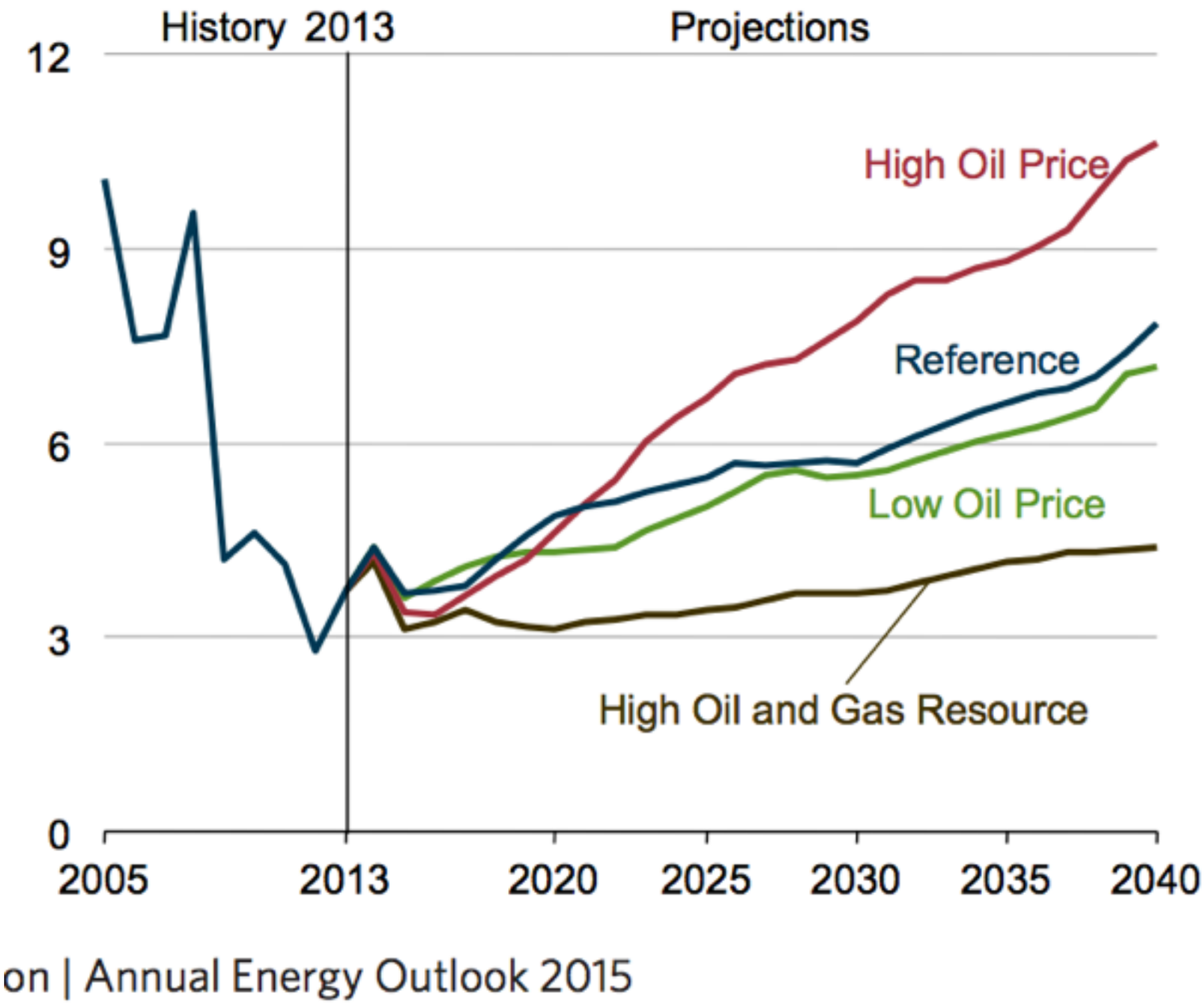
Cheap natural gas has masked significant electricity cost increases from deploying (non-large hydro) renewables



Source: US Energy Information Administration,

Natural Gas Prices Predicted to Double by 2025

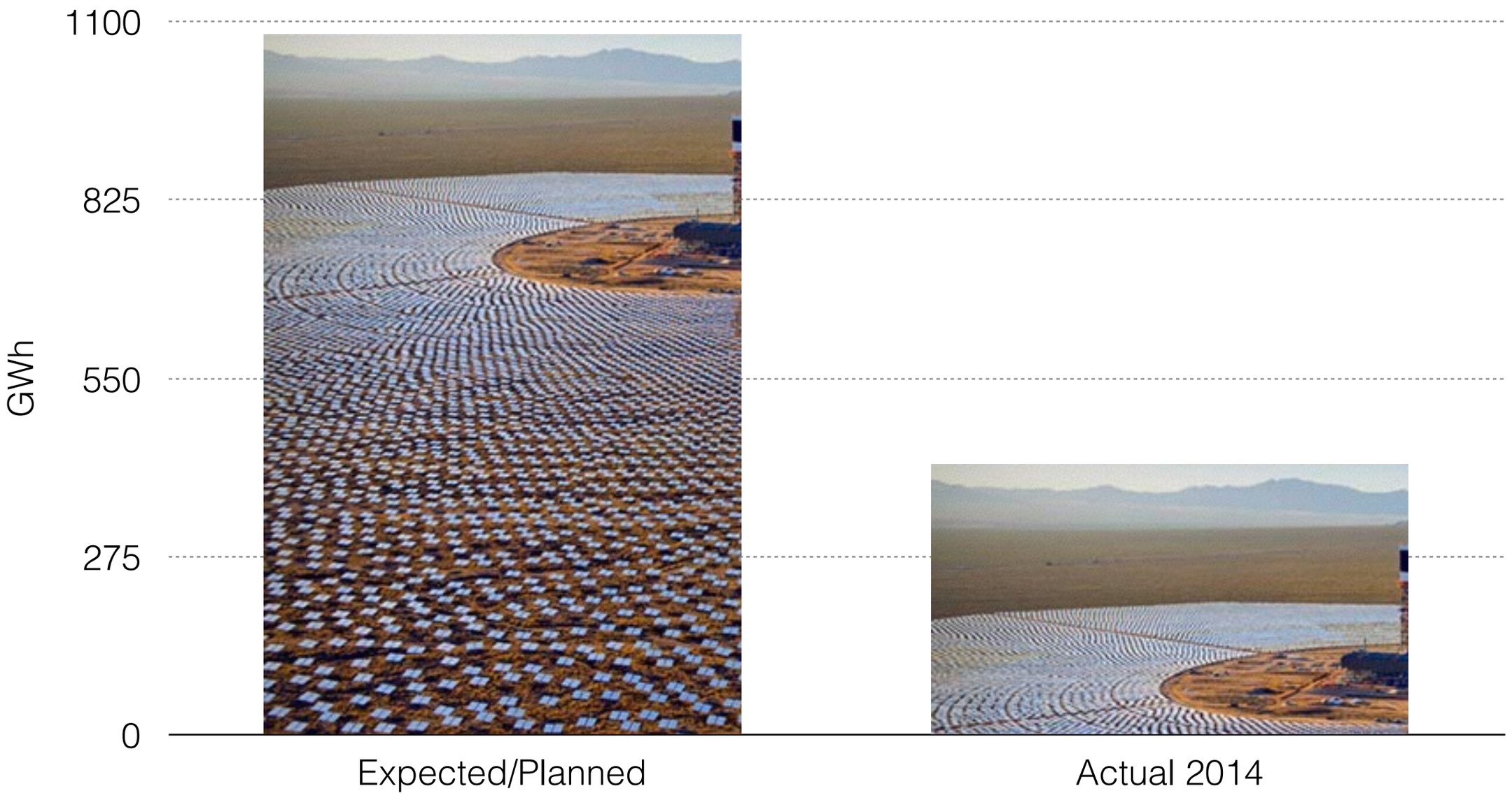
Figure ES2. Average Henry Hub spot prices for natural gas in four cases, 2005-40 (2013 dollars per million Btu)



on | Annual Energy Outlook 2015

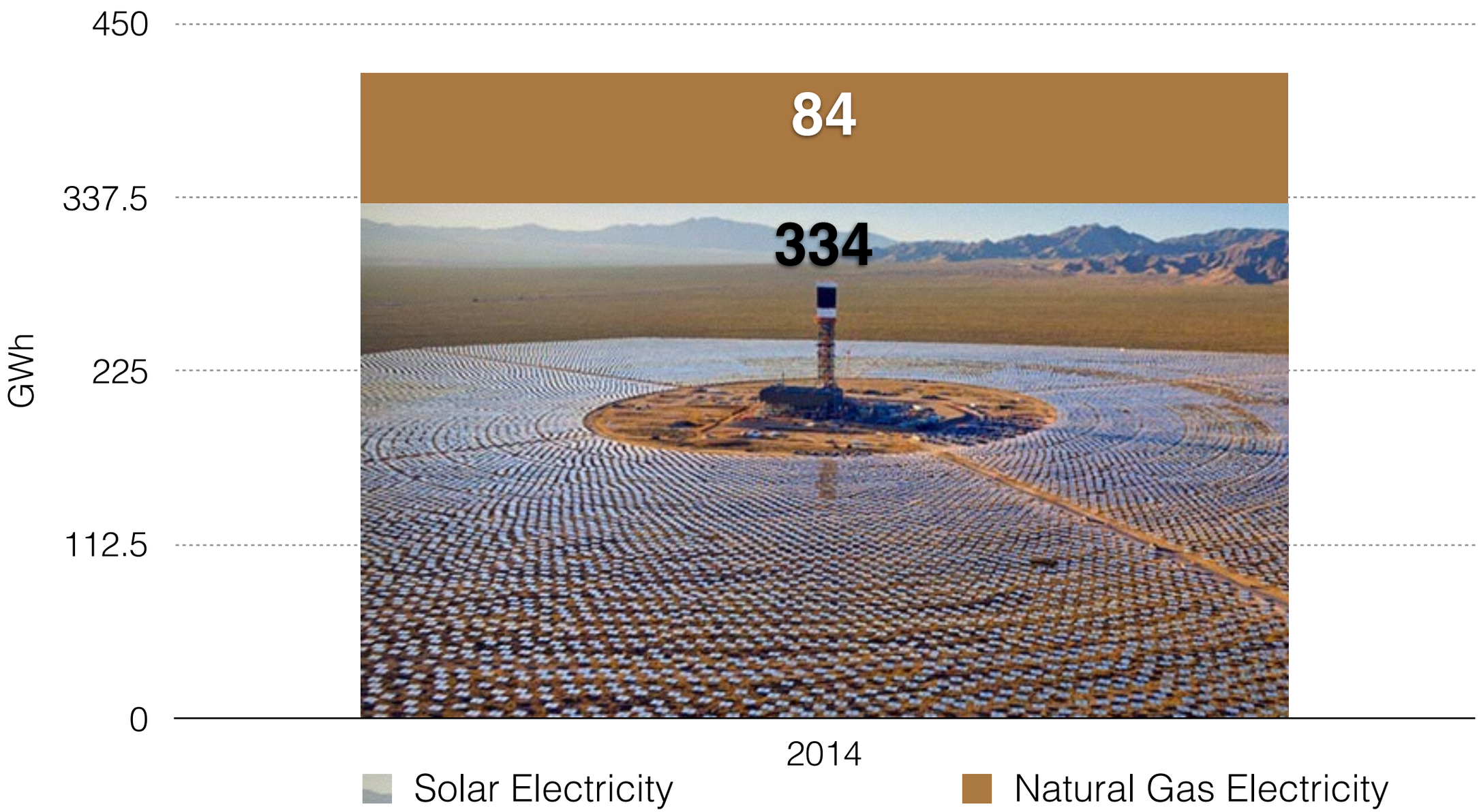
Source: US Energy Information Administration,

Ivanpah produced 60% less electricity than was expected and planned



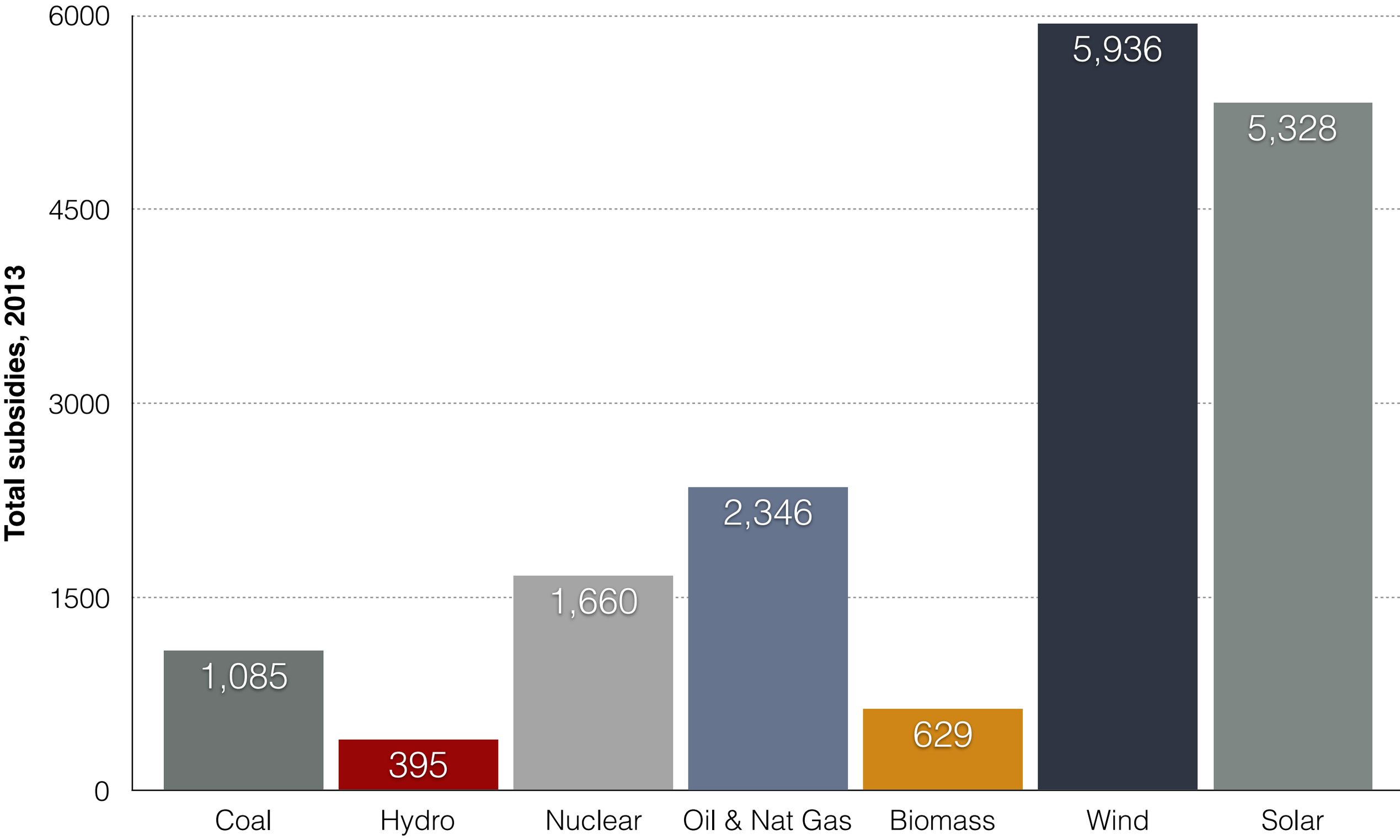
Sources: Expected: NREL, “Concentrating Solar Power Projects,” http://www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=62
Actual: California Almanac, “Annual Generation Plant,” http://energyalmanac.ca.gov/electricity/web_qfer/Annual_Generation-Plant_Unit.php

20% of Ivanpah's power was produced with natural gas — 4x more than State allows for projects to count as renewable



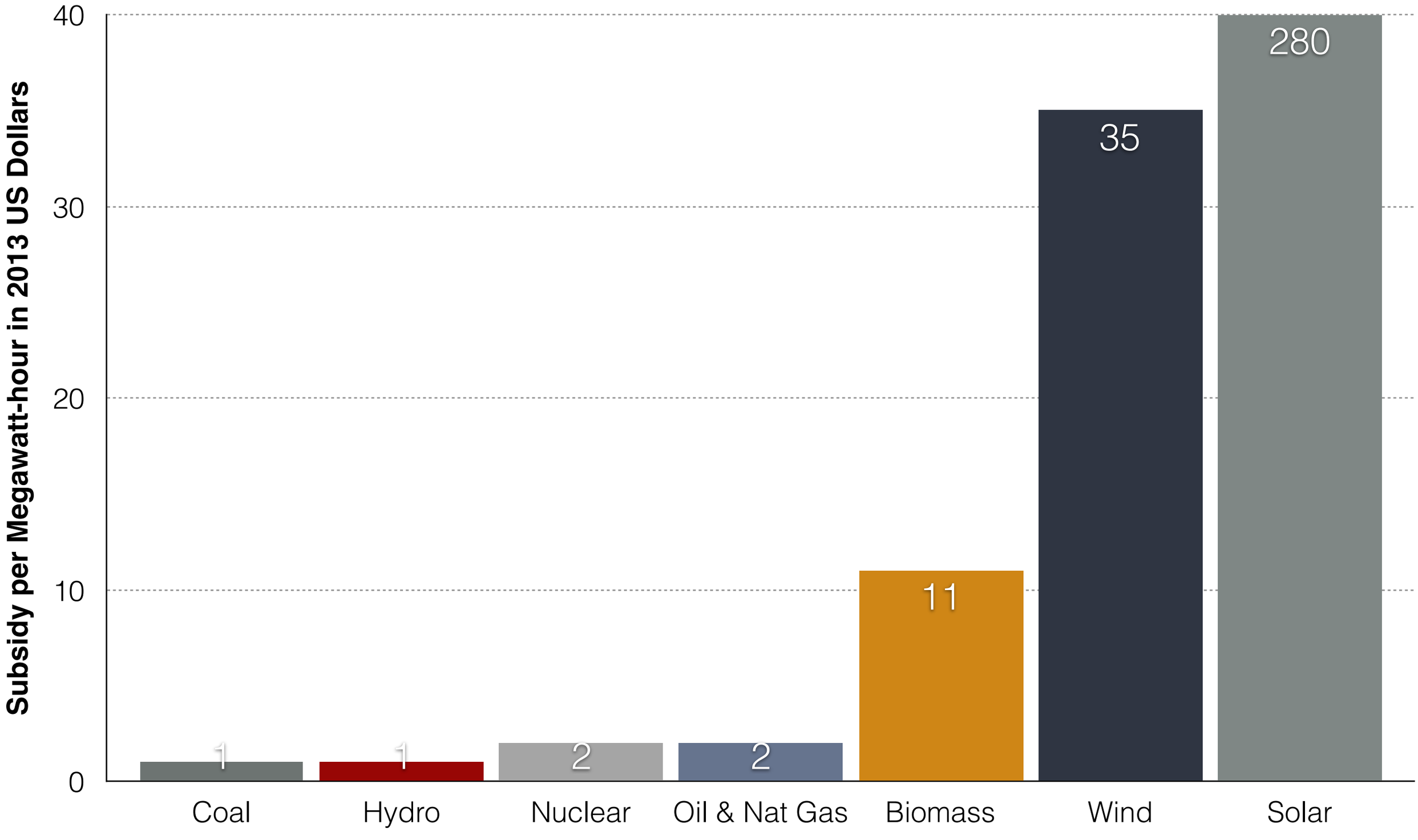
Sources: California Almanac, "Annual Generation Plant," http://energyalmanac.ca.gov/electricity/web_qfer/Annual_Generation-Plant_Unit.php

US subsidizes renewables the most in absolute terms…



Source: US EIA Data http://www.eia.gov/analysis/requests/subsidy/

US Subsidizes Solar & Wind 140x & 17x more than Nuclear



Source: US EIA Data http://www.eia.gov/analysis/requests/subsidy/