

## DOCKETED

<b>Docket Number:</b>	15-IEPR-01
<b>Project Title:</b>	General/Scope
<b>TN #:</b>	210134
<b>Document Title:</b>	Gene Nelson, Ph.D. Comments: The Importance of Diablo Canyon - Technical Analysis
<b>Description:</b>	N/A
<b>Filer:</b>	System
<b>Organization:</b>	Gene Nelson, Ph.D.
<b>Submitter Role:</b>	Public
<b>Submission Date:</b>	2/3/2016 2:00:09 AM
<b>Docketed Date:</b>	2/3/2016

*Comment Received From: Gene Nelson, Ph.D.*

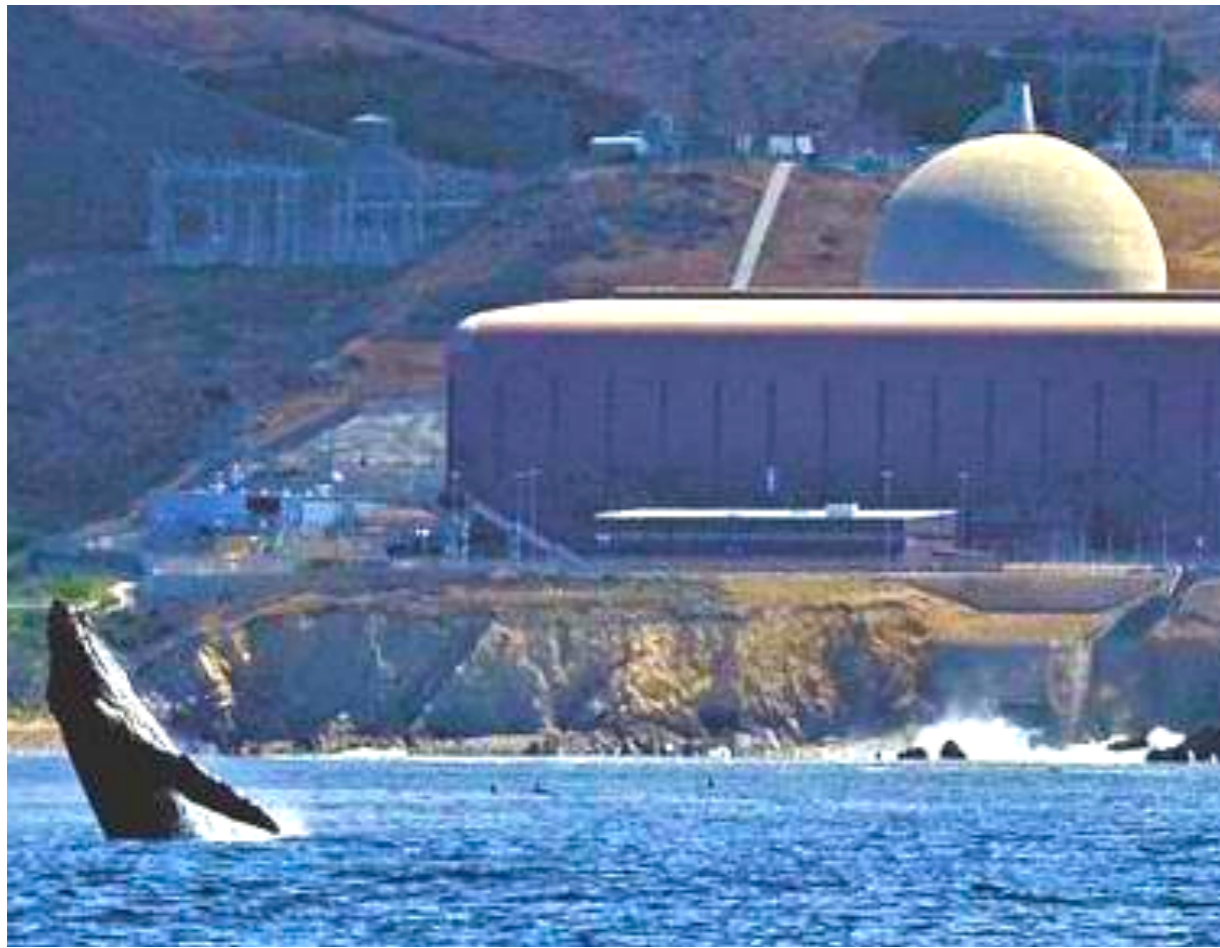
*Submitted On: 2/3/2016*

*Docket Number: 15-IEPR-01*

## **The Importance of Diablo Canyon - Technical Analysis**

This new analysis regarding the importance of Diablo Canyon Power Plant (DCPP) should be incorporated into the 2015 IEPR.

*Additional submitted attachment is included below.*



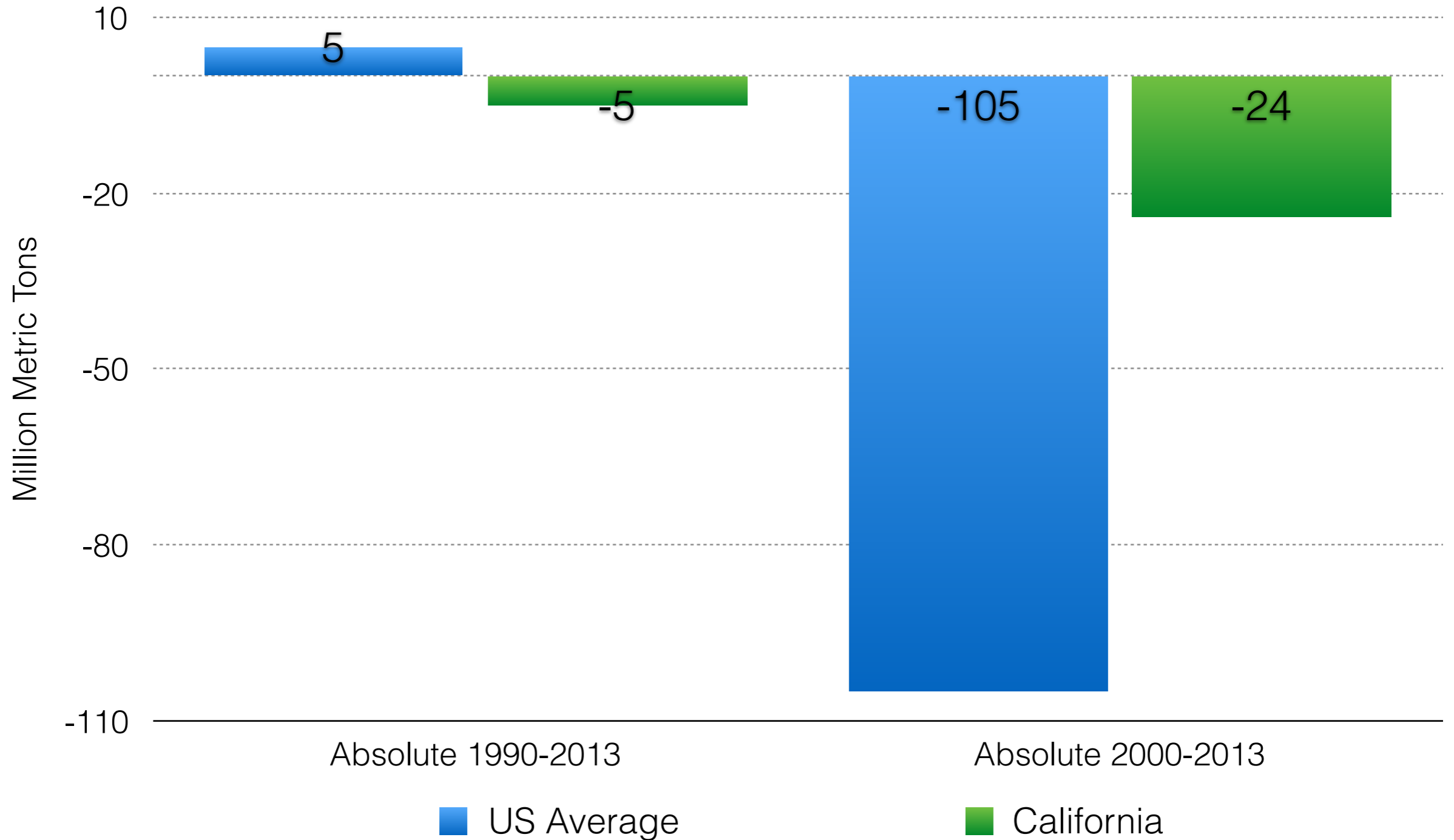
<http://www.savediablo canyon.org/s/Diablo-v12.pdf> Archived 02 03 16 by Gene A. Nelson, Ph.D.

# Energy & Environmental Implications of a Diablo Canyon Closure

Research & analysis by Michael Shellenberger  
([michaelshellenberger@gmail.com](mailto:michaelshellenberger@gmail.com)) for [SaveDiabloCanyon.org](http://SaveDiabloCanyon.org)  
January 29, 2016

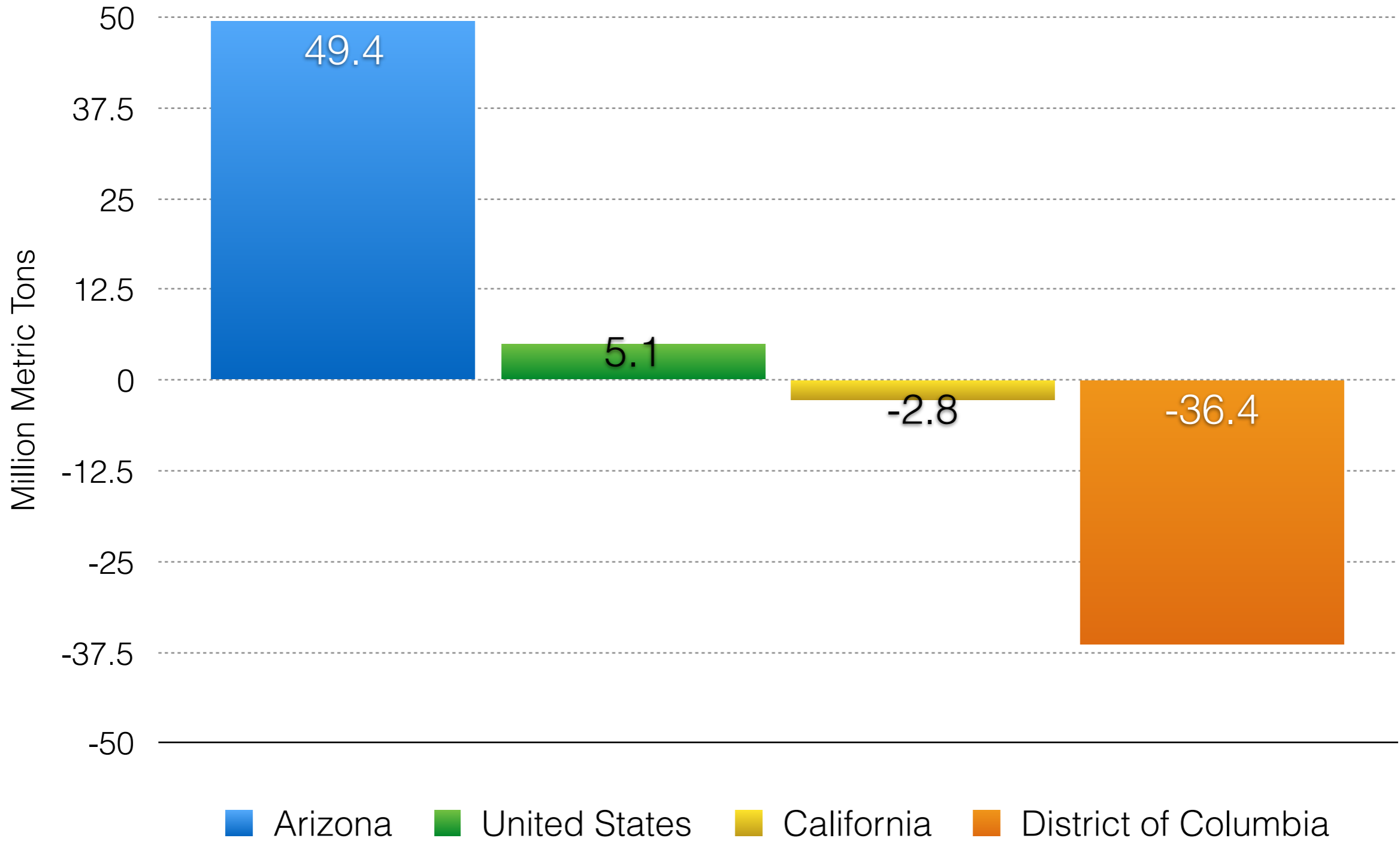
California Emissions Overview  
US Energy Information Administration data  
Includes emissions from in-state electricity  
only

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



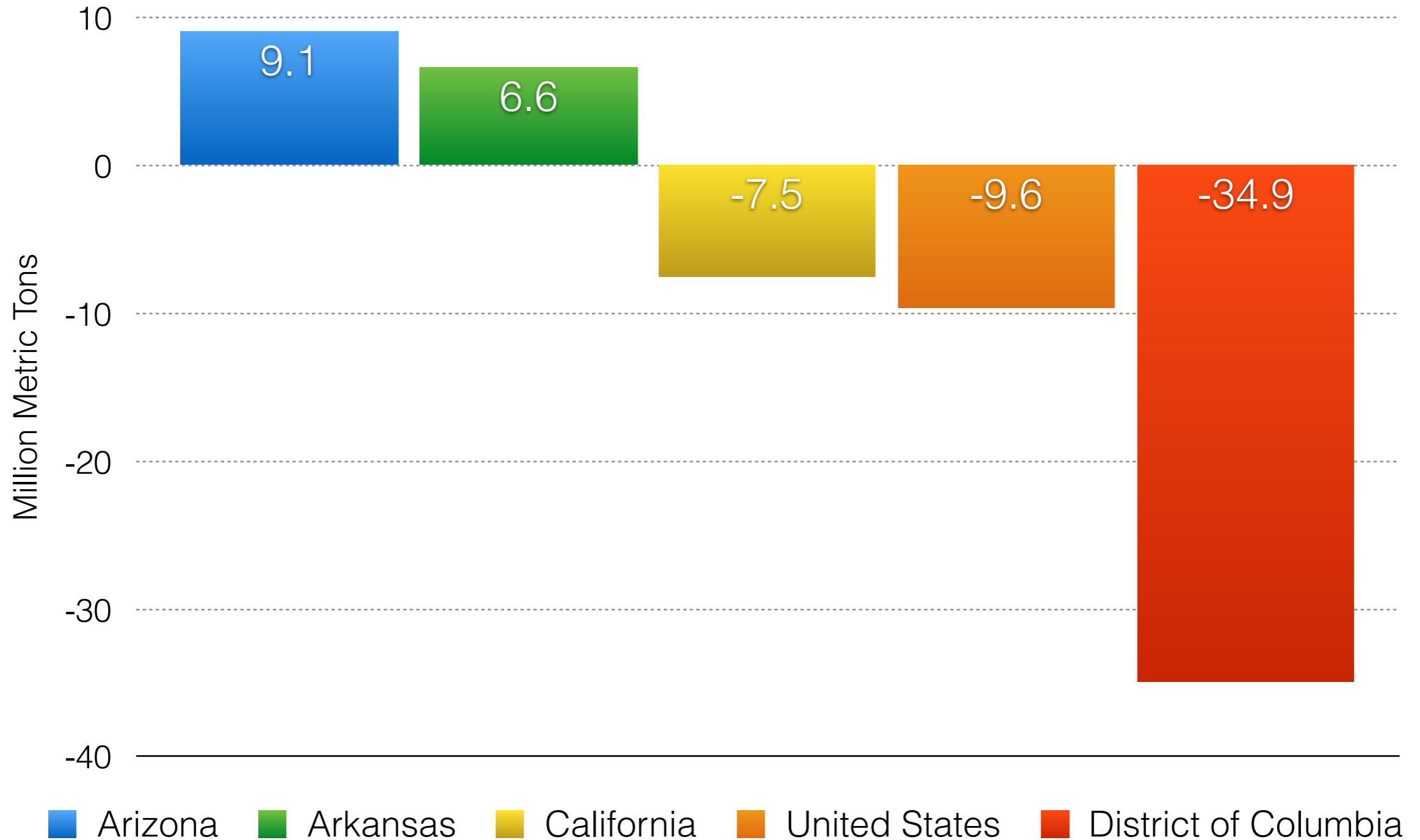
**Source:** US Energy Information Agency, "State Carbon Dioxide Emissions," October 2015

# 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

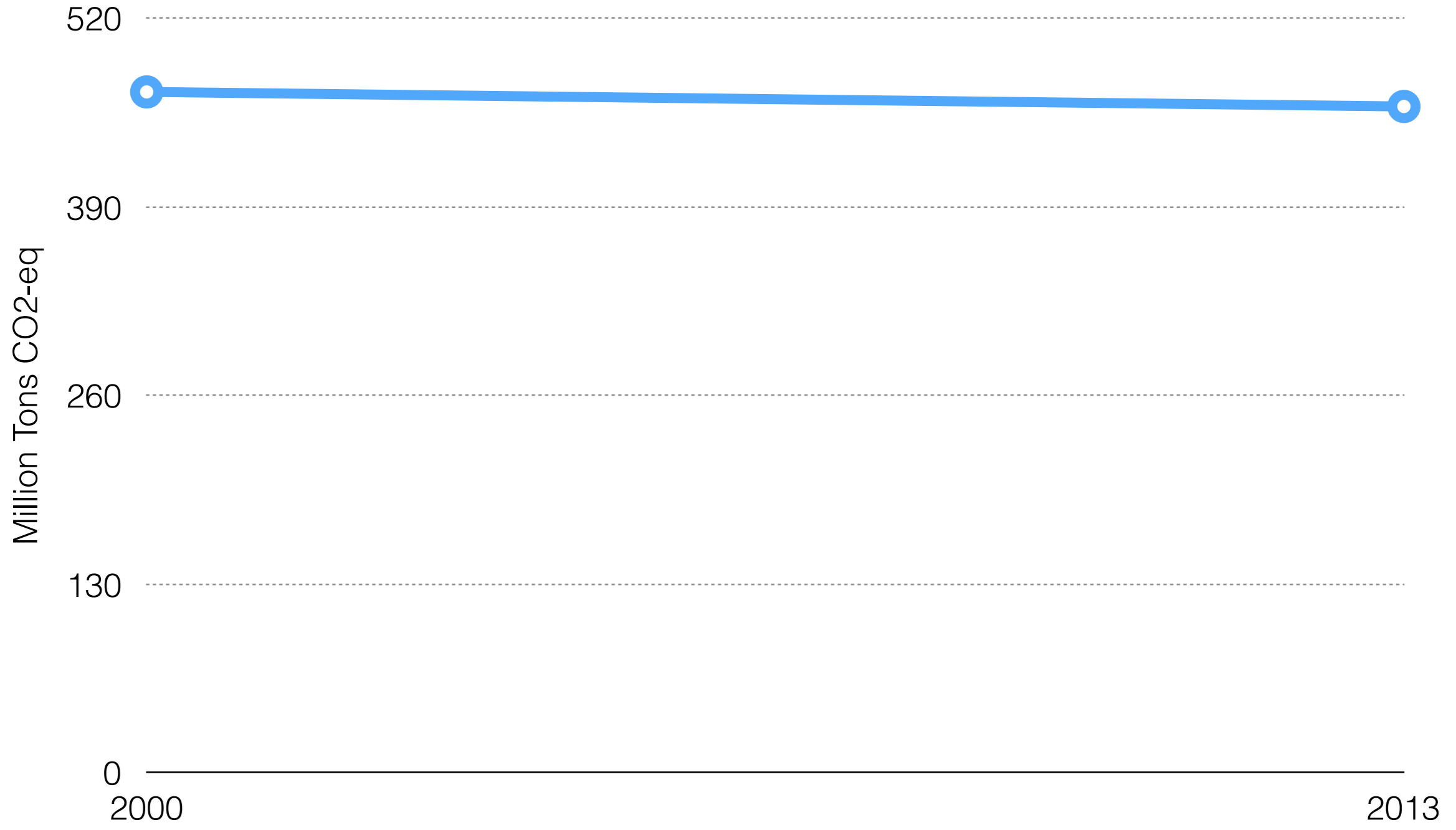
# California Emissions

## California Almanac (state) data

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

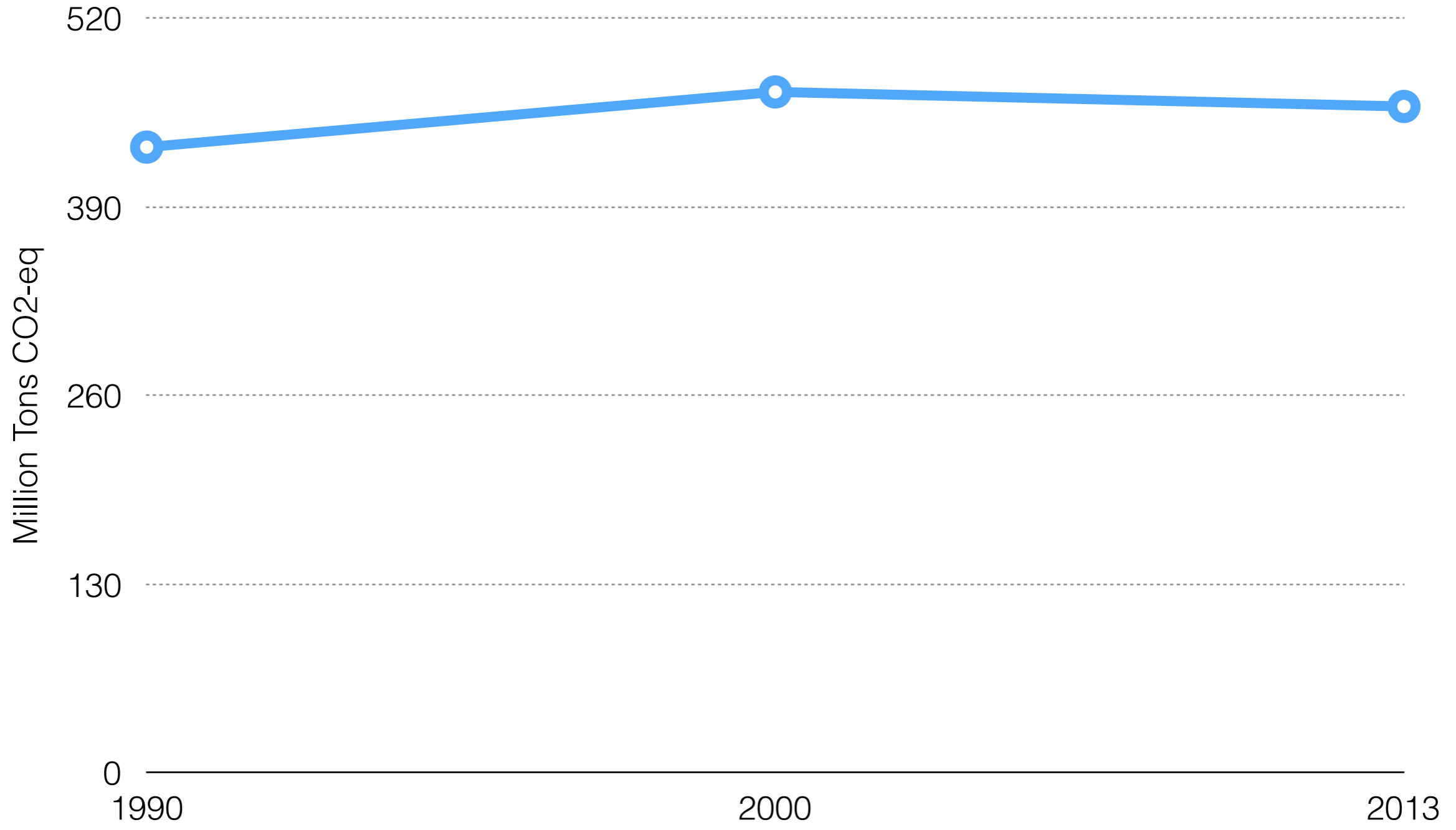


# California Emissions Fell 2% Between 2000-2013...



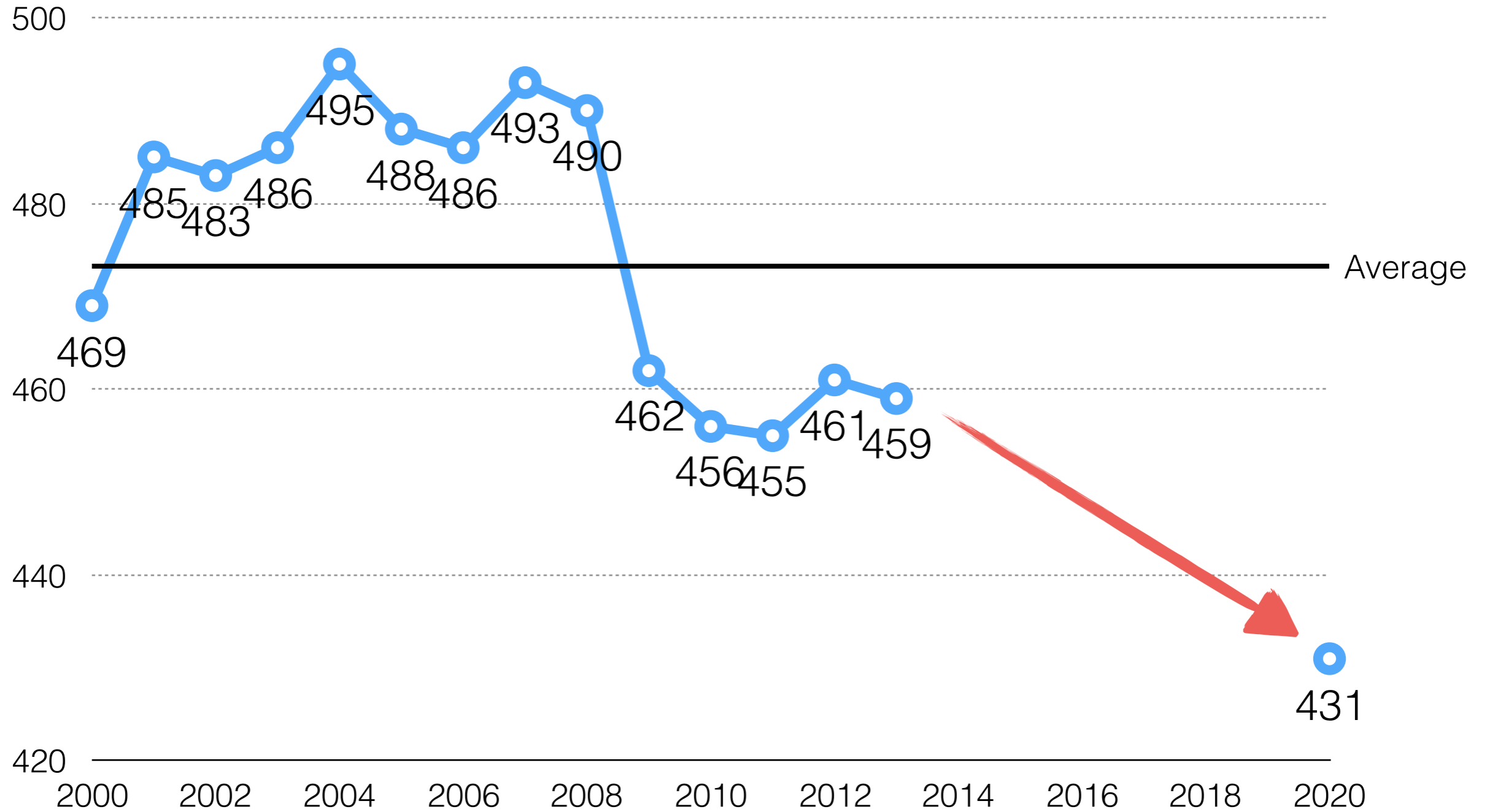
**Source:** "Greenhouse Gas Inventory," California Air Resources Board, 2015

# California Emissions Rose 8.8% between 1990-2013

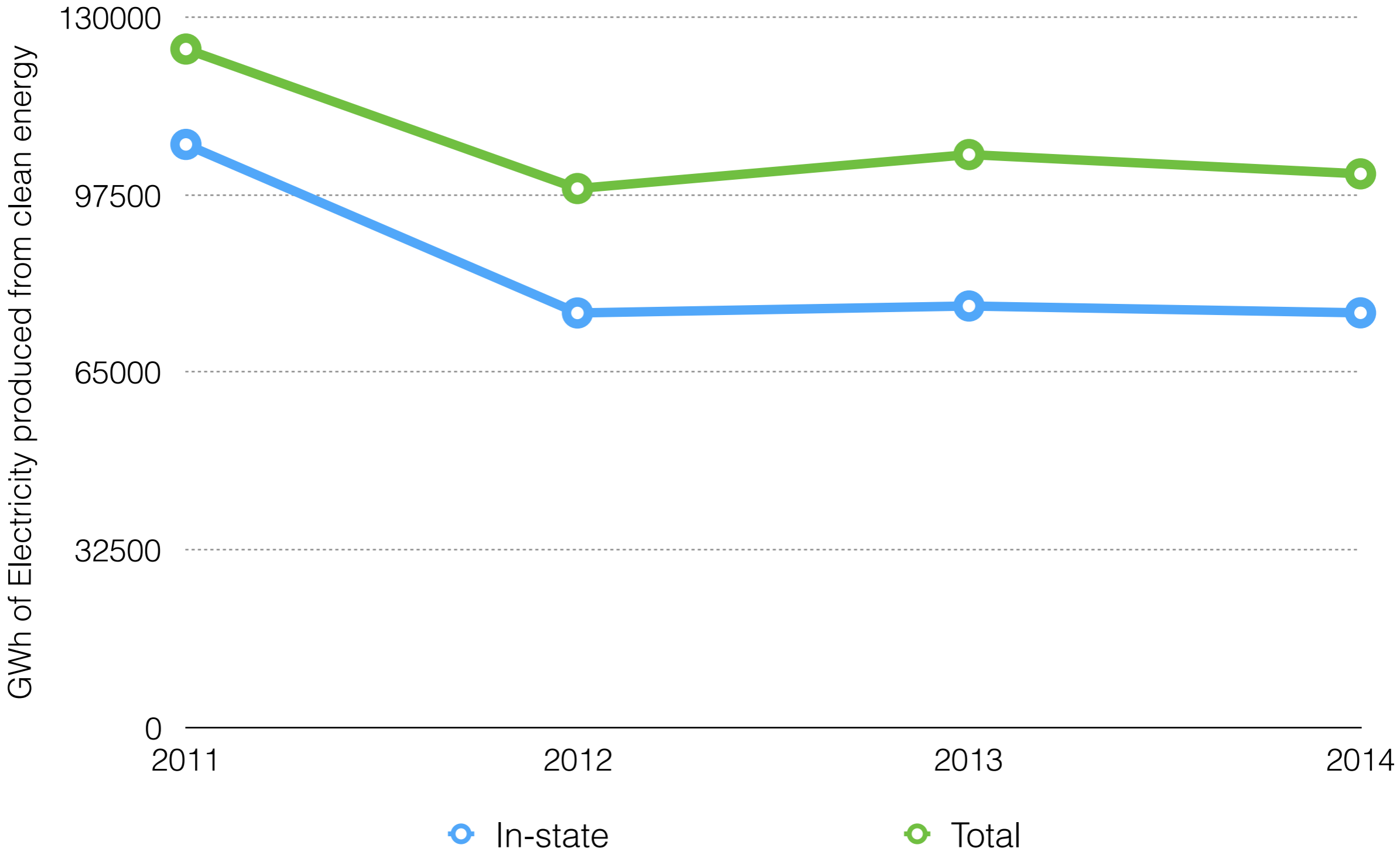


**Source:** "Greenhouse Gas Inventory," California Air Resources Board, 2015

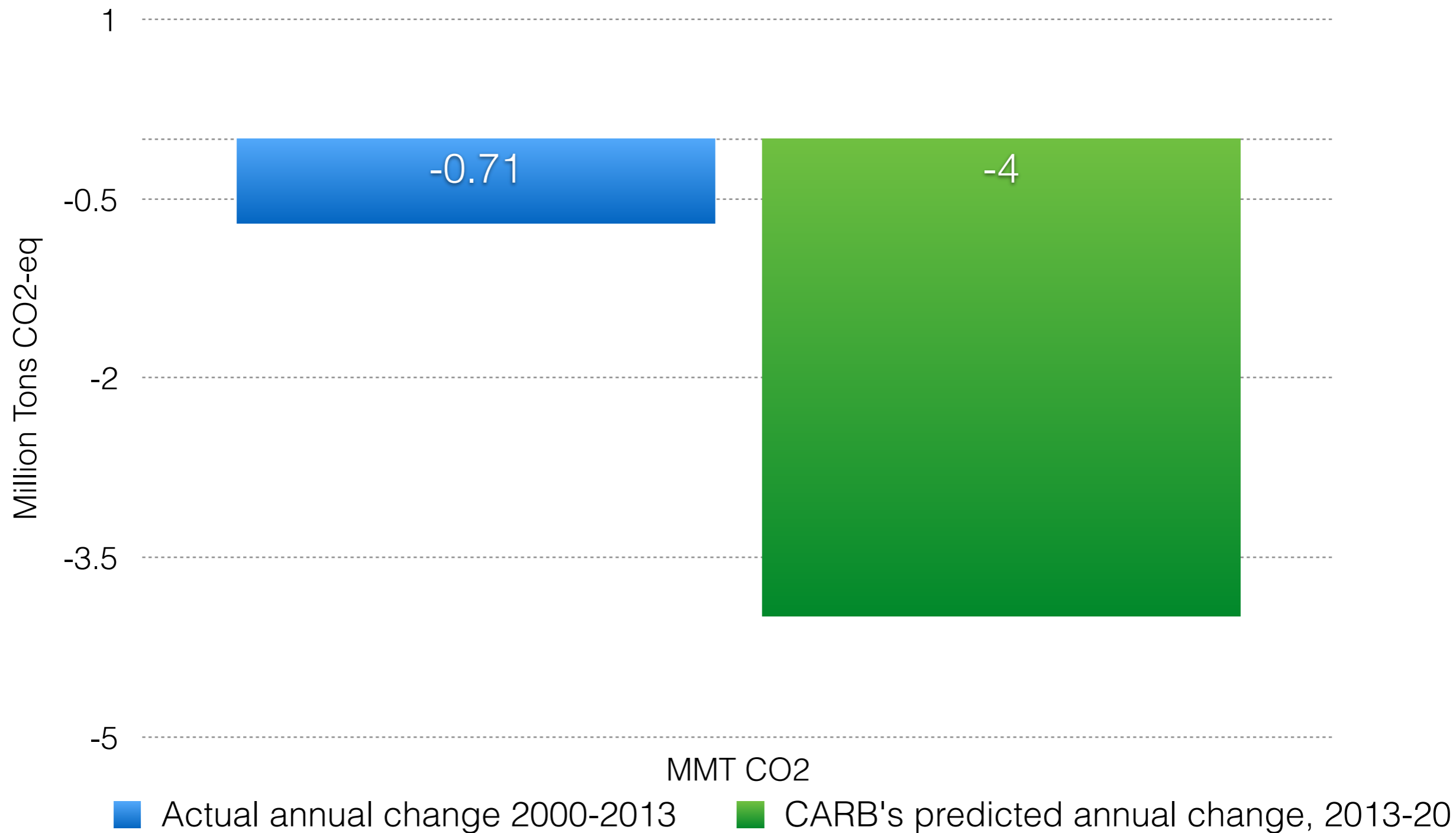
# California actual emissions & 2020 target



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

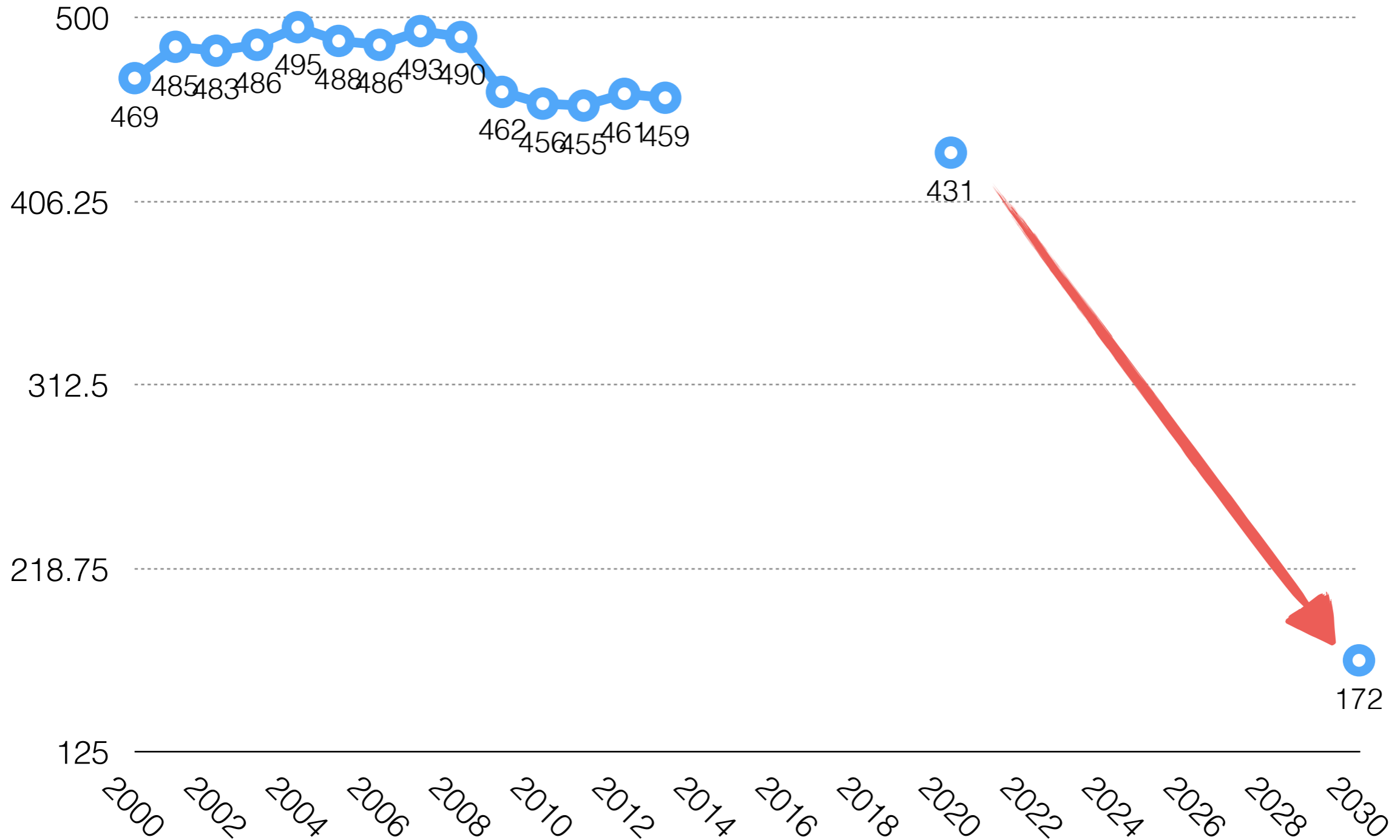


# CA Air Resources Board predicts emissions will fall 5x faster from 2014 - 20 than 2000-13



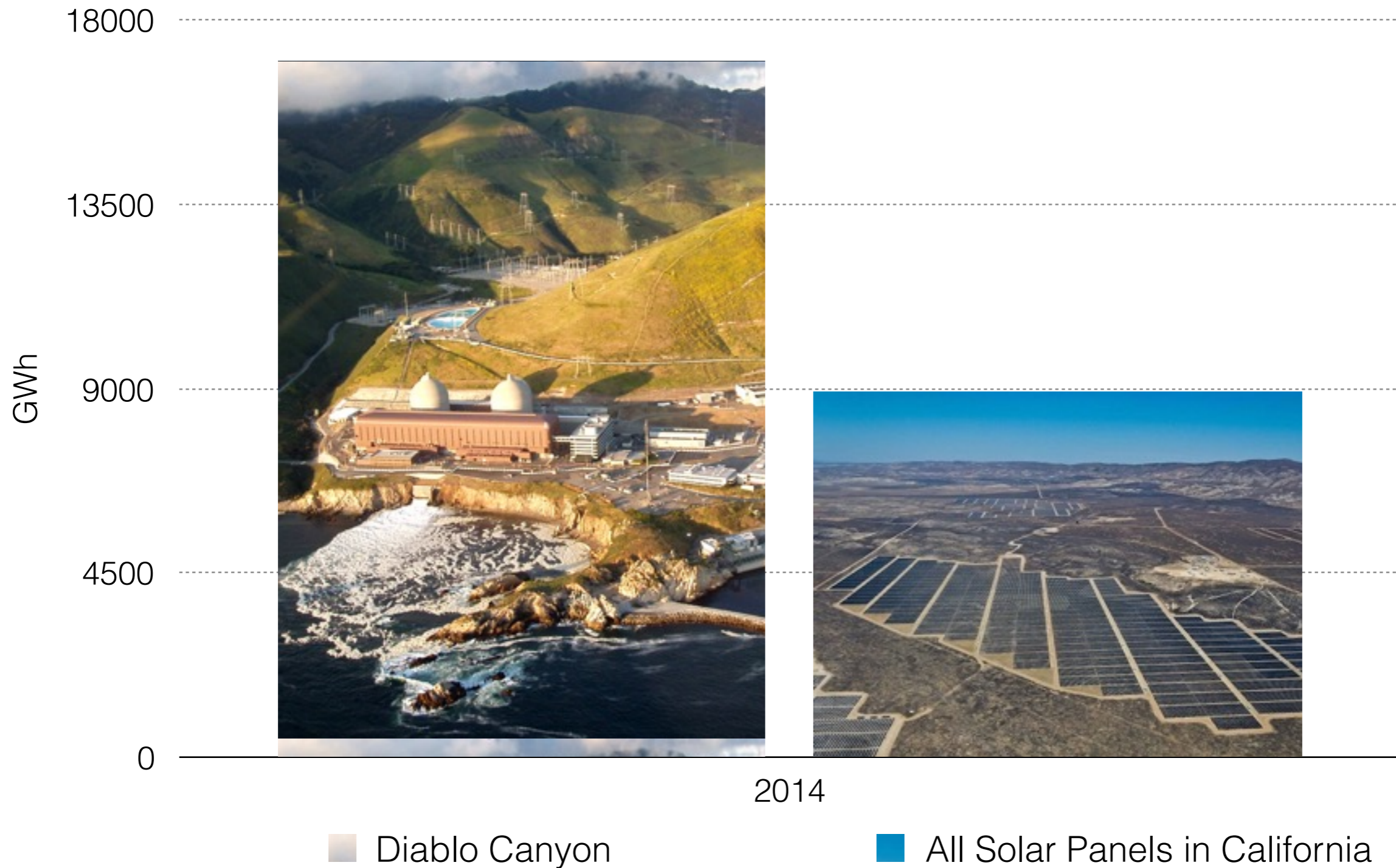
**Source:** "Greenhouse Gas Inventory," California Air Resources Board, 2015

# California actual emissions & 2030 target



# California Energy Overview

# Diablo produces 2x more electricity as all of California's solar panels



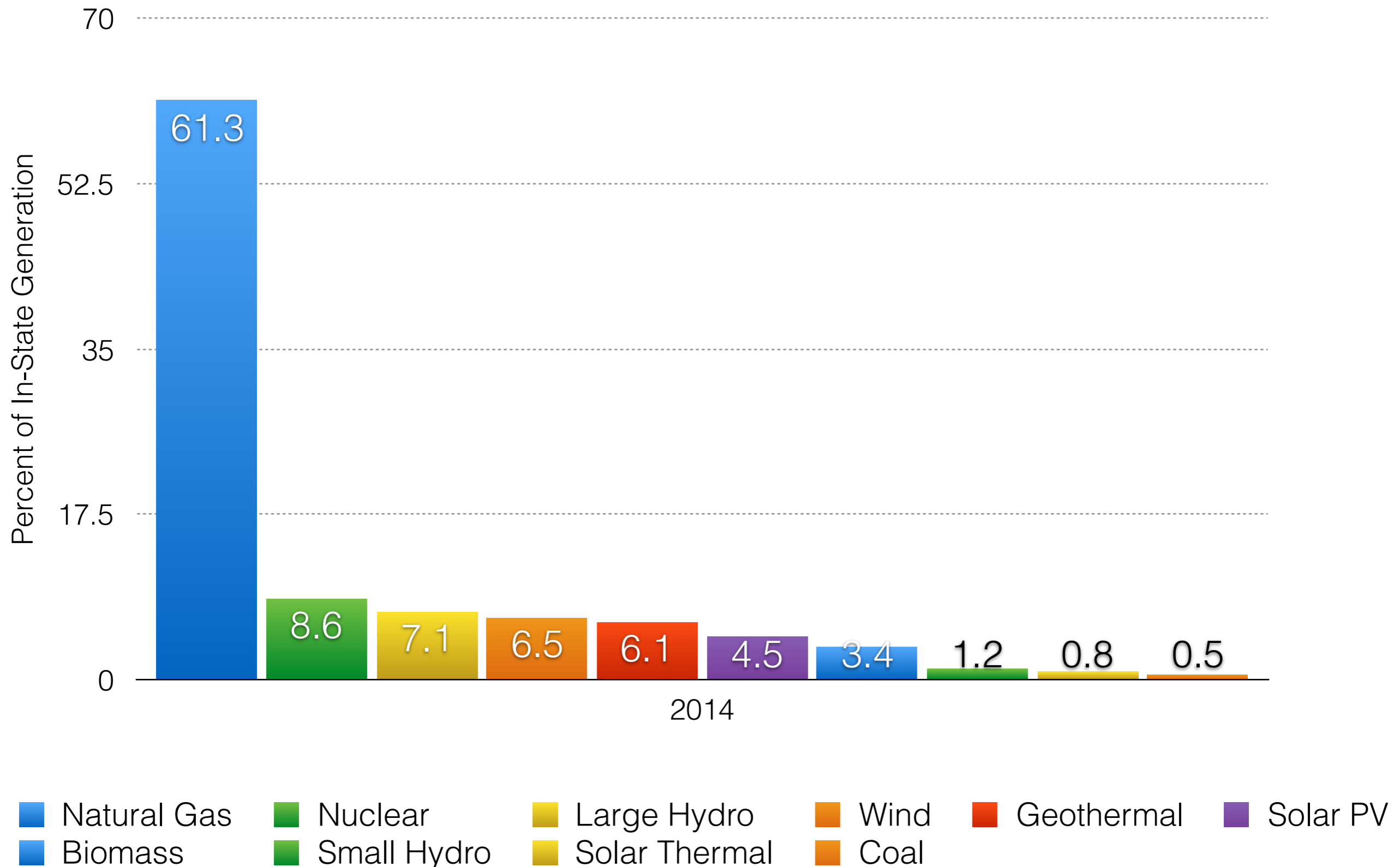
2014

■ Diablo Canyon

■ All Solar Panels in California



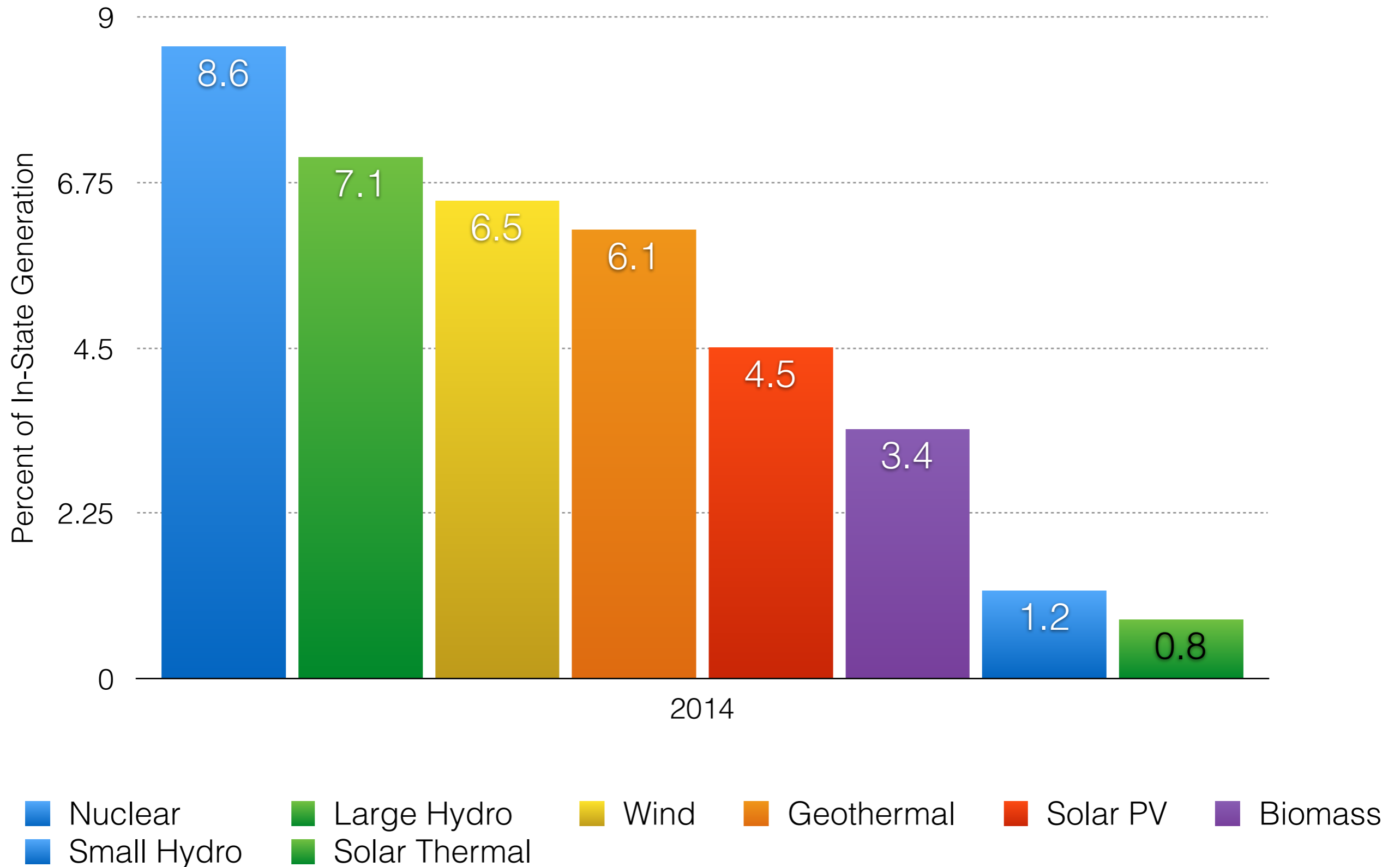
# California In-State Generation, by percent, 2014



California Almanac, "In-State Generation by Fuel Type"

[http://energyalmanac.ca.gov/electricity/electric\\_generation\\_capacity.html](http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html)

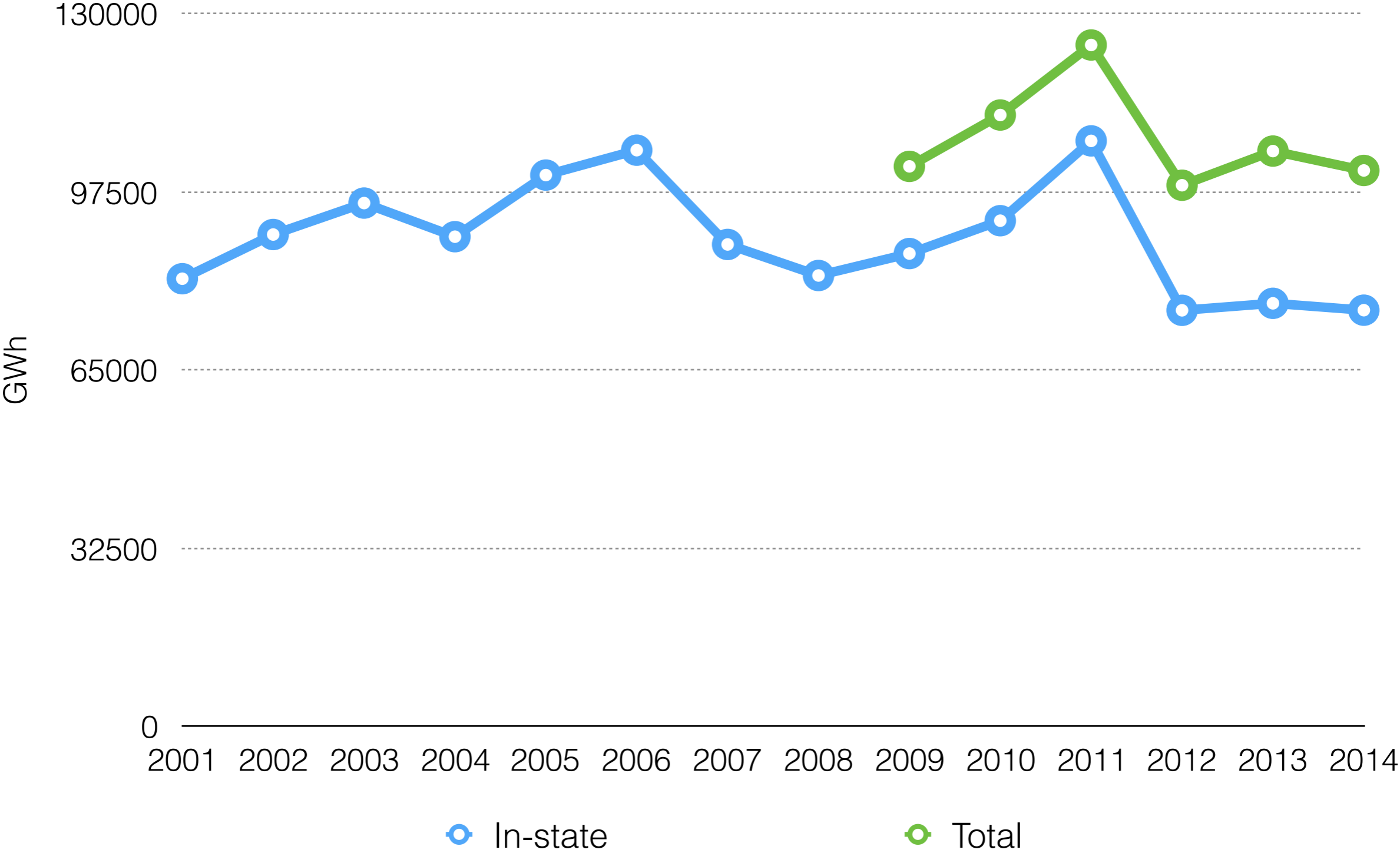
# California Clean Electricity, by percent, 2014



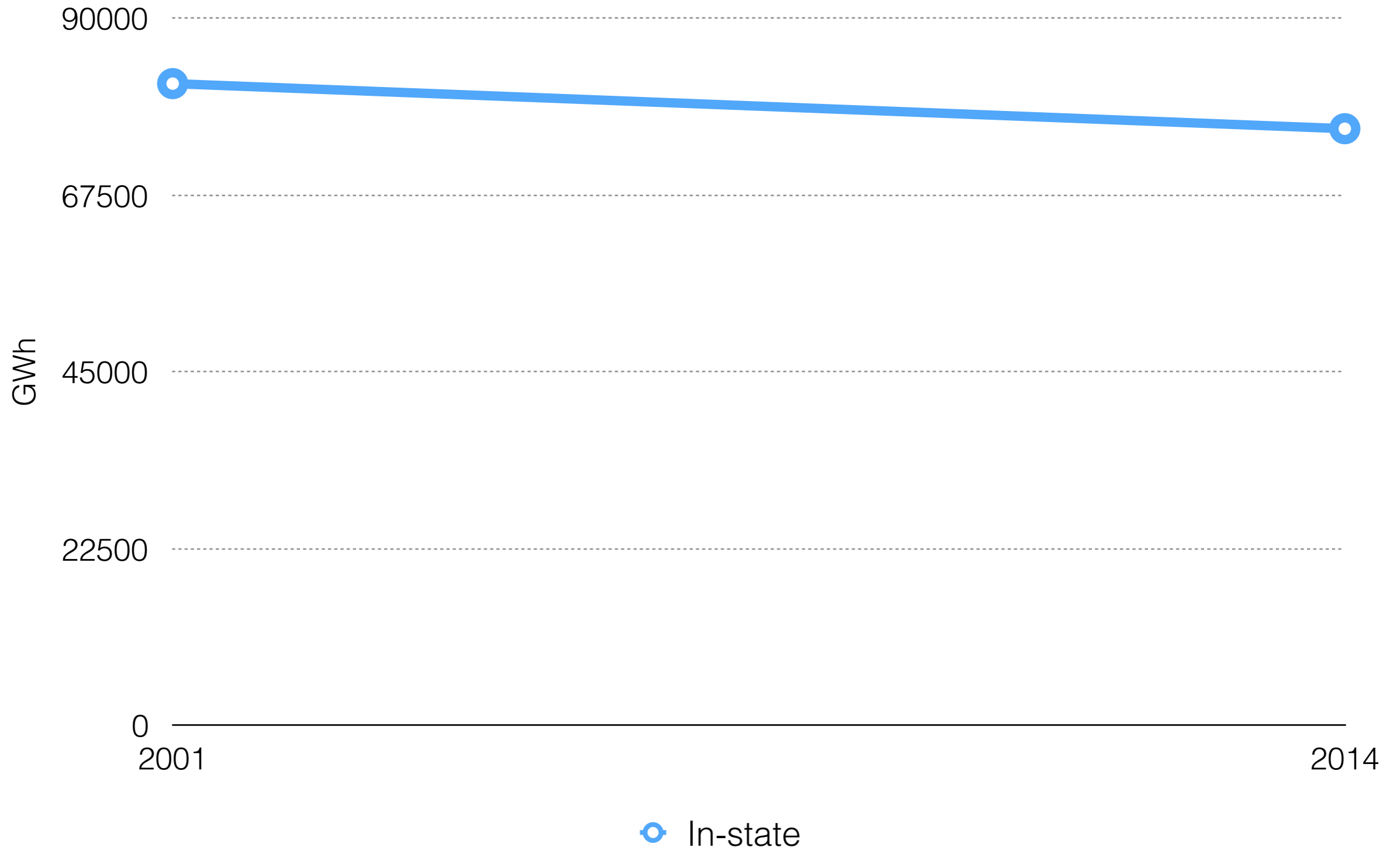
California Almanac, "In-State Generation by Fuel Type"

[http://energyalmanac.ca.gov/electricity/electric\\_generation\\_capacity.html](http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html)

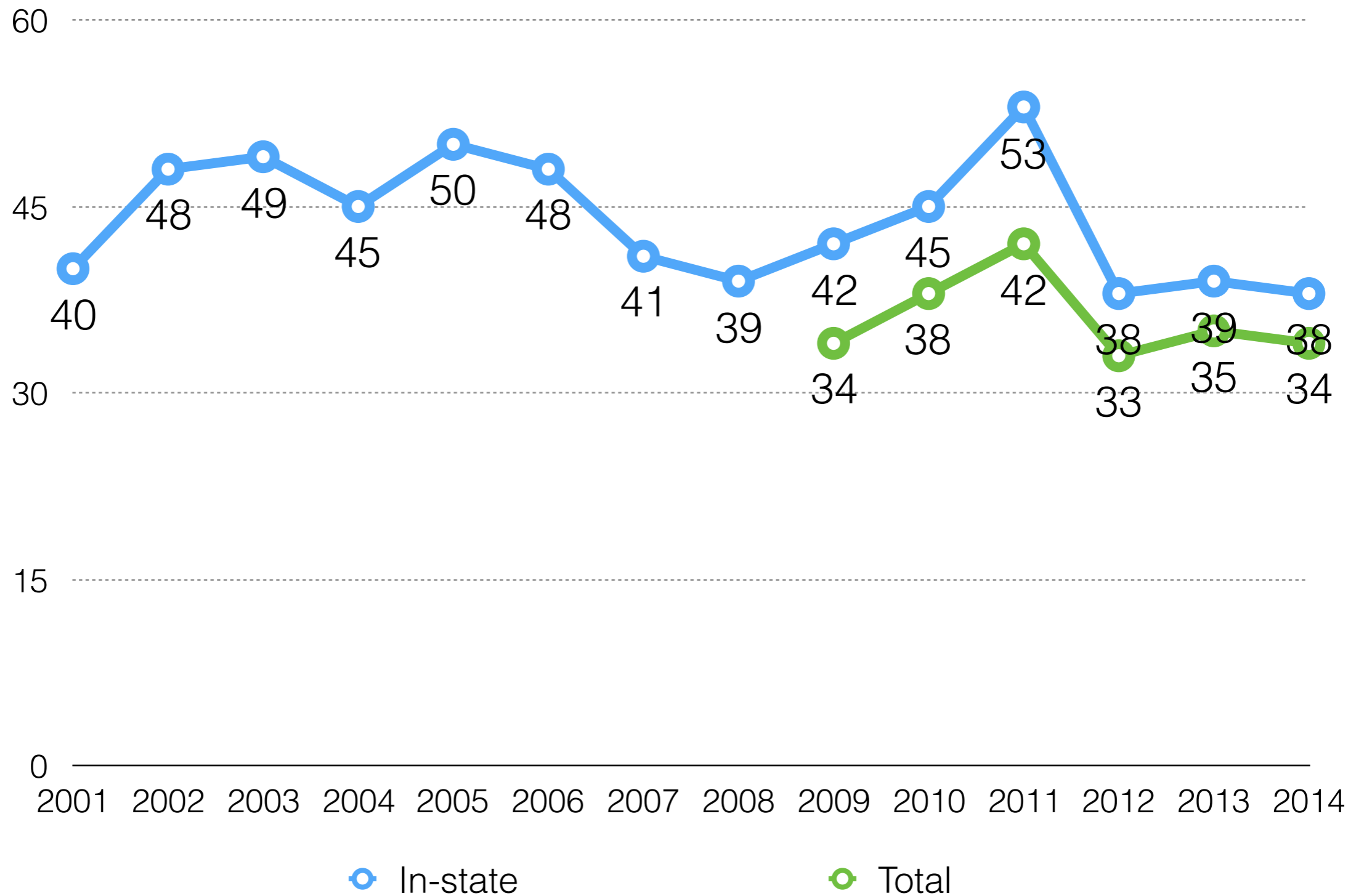
# California clean electricity (in-state & total)



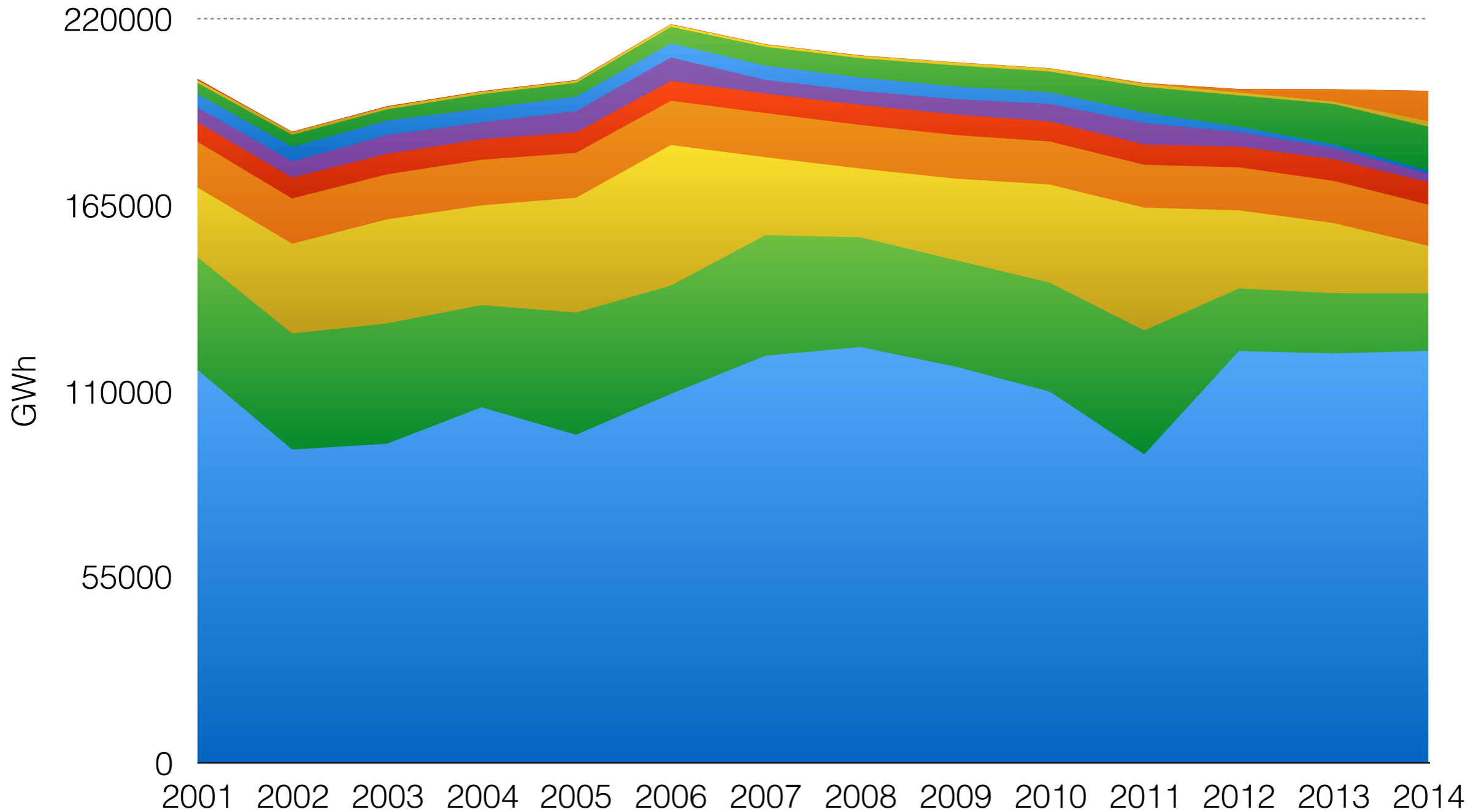
# California clean electricity in-state



# California clean electricity as percent of total

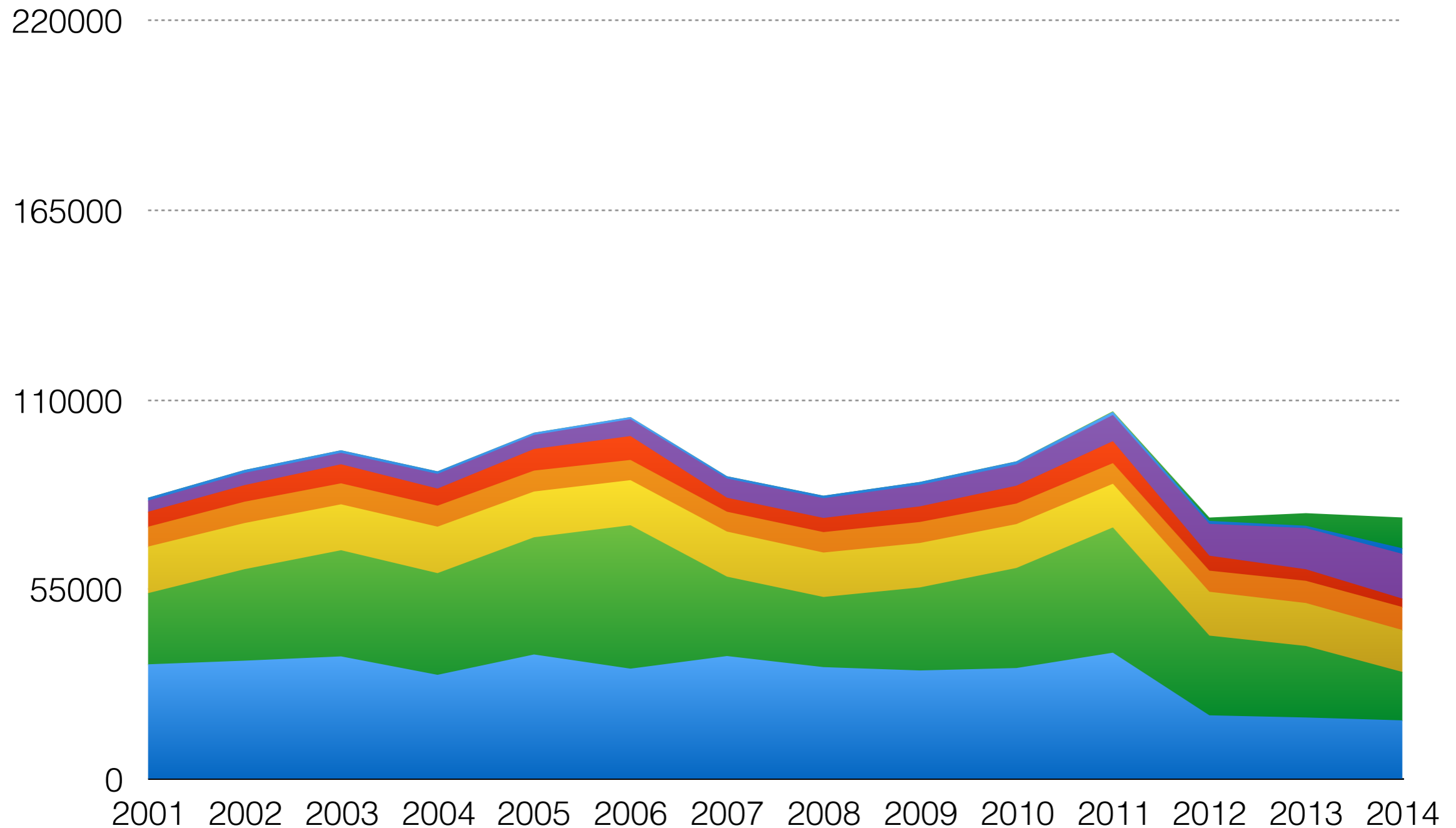


# California In-State Electricity, 2001 - 2014



- Natural Gas
- Nuclear
- Large Hydro
- Geothermal
- Biomass
- Small Hydro
- Coal
- Wind
- Solar Thermal
- Solar PV
- Other

# California Clean Electricity In-State Generation, 2001 - 2014

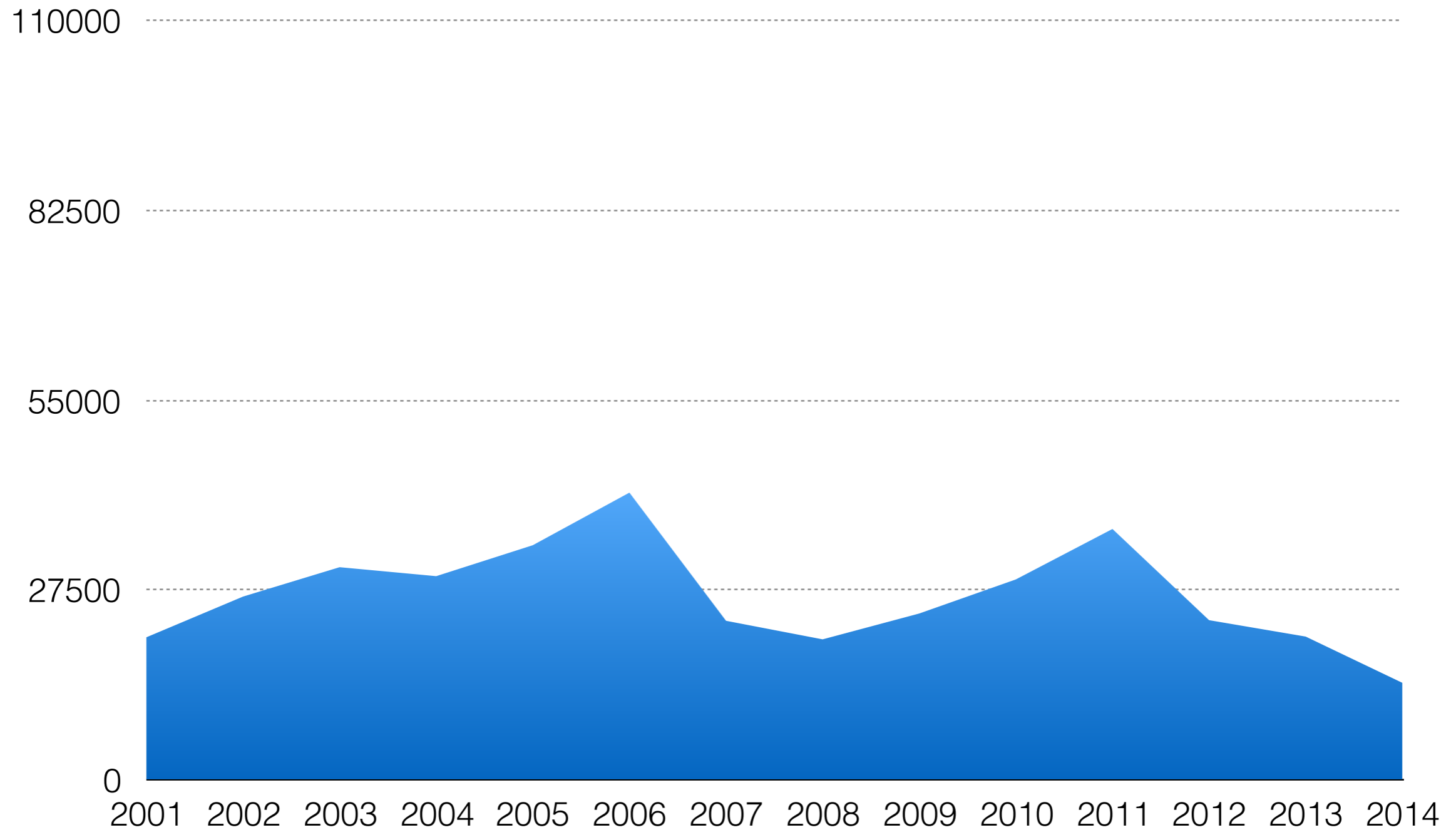


■ Nuclear      ■ Large Hydro      ■ Geothermal      ■ Biomass      ■ Small Hydro      ■ Wind  
■ Solar Thermal      ■ Solar PV

California Almanac, "In-State Generation by Fuel Type"

[http://energyalmanac.ca.gov/electricity/electric\\_generation\\_capacity.html](http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html)

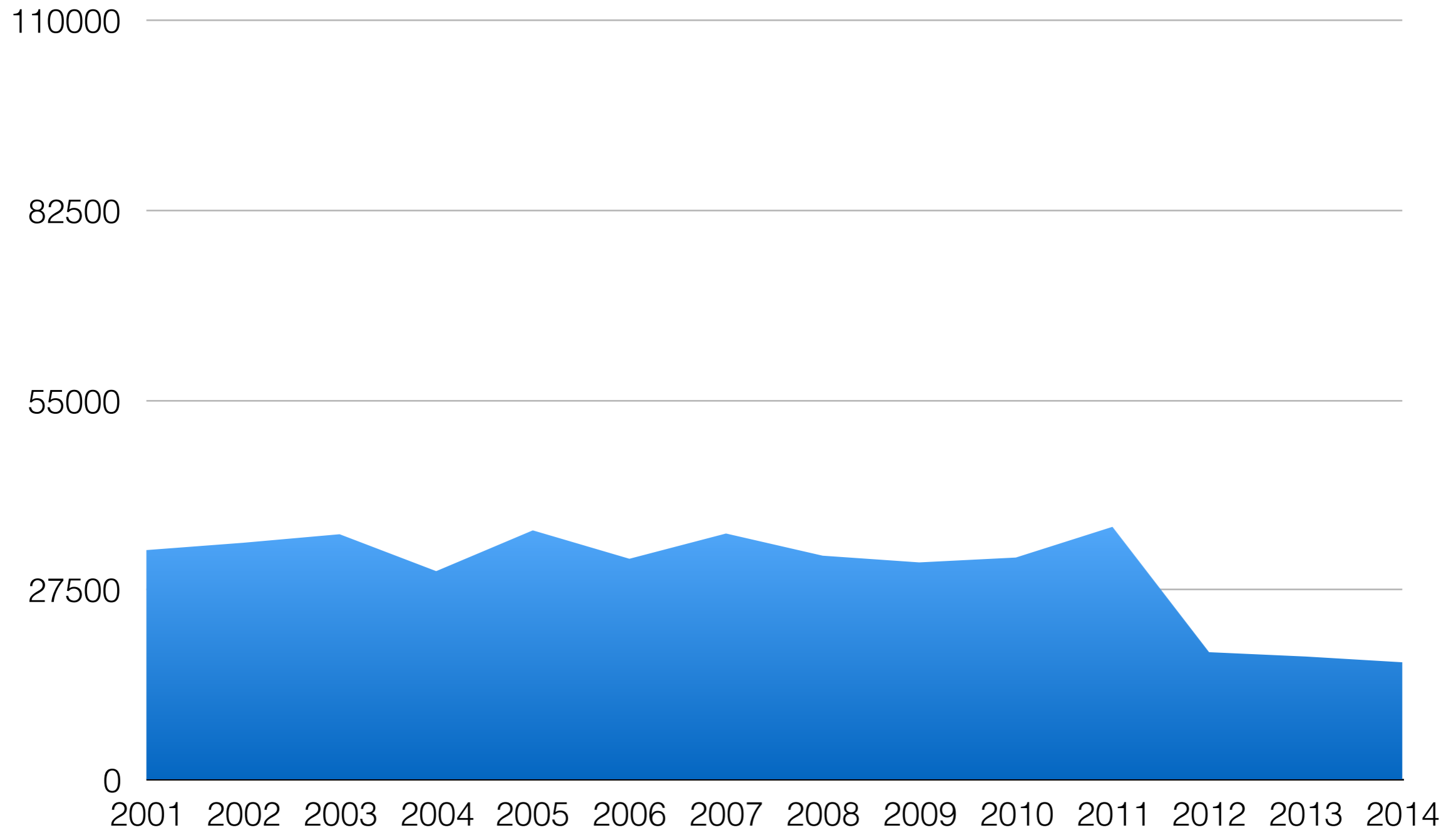
# California In-State Hydro, 2001 - 2014



■ Large Hydro

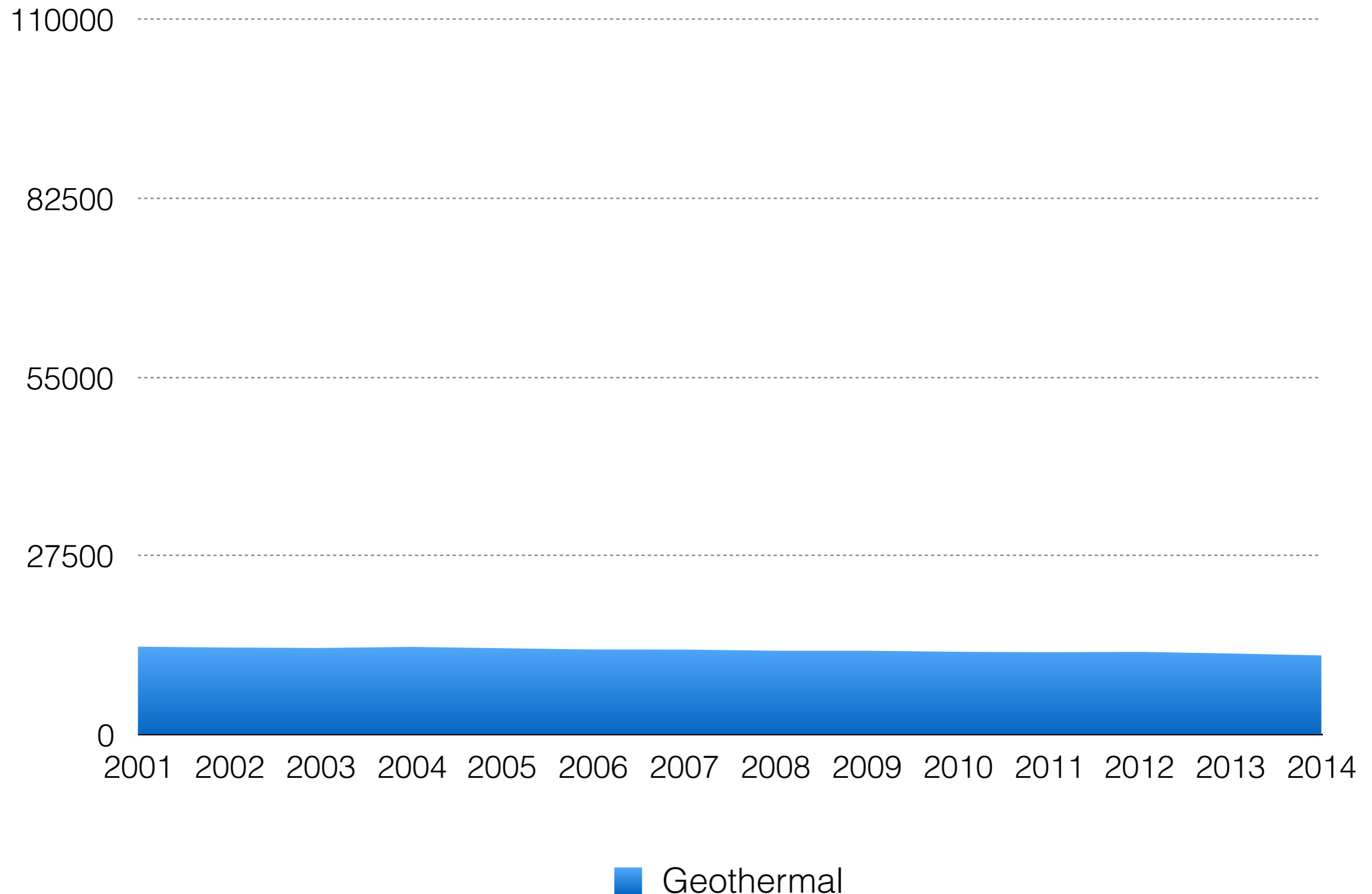


# California In-State Nuclear, 2001 - 2014

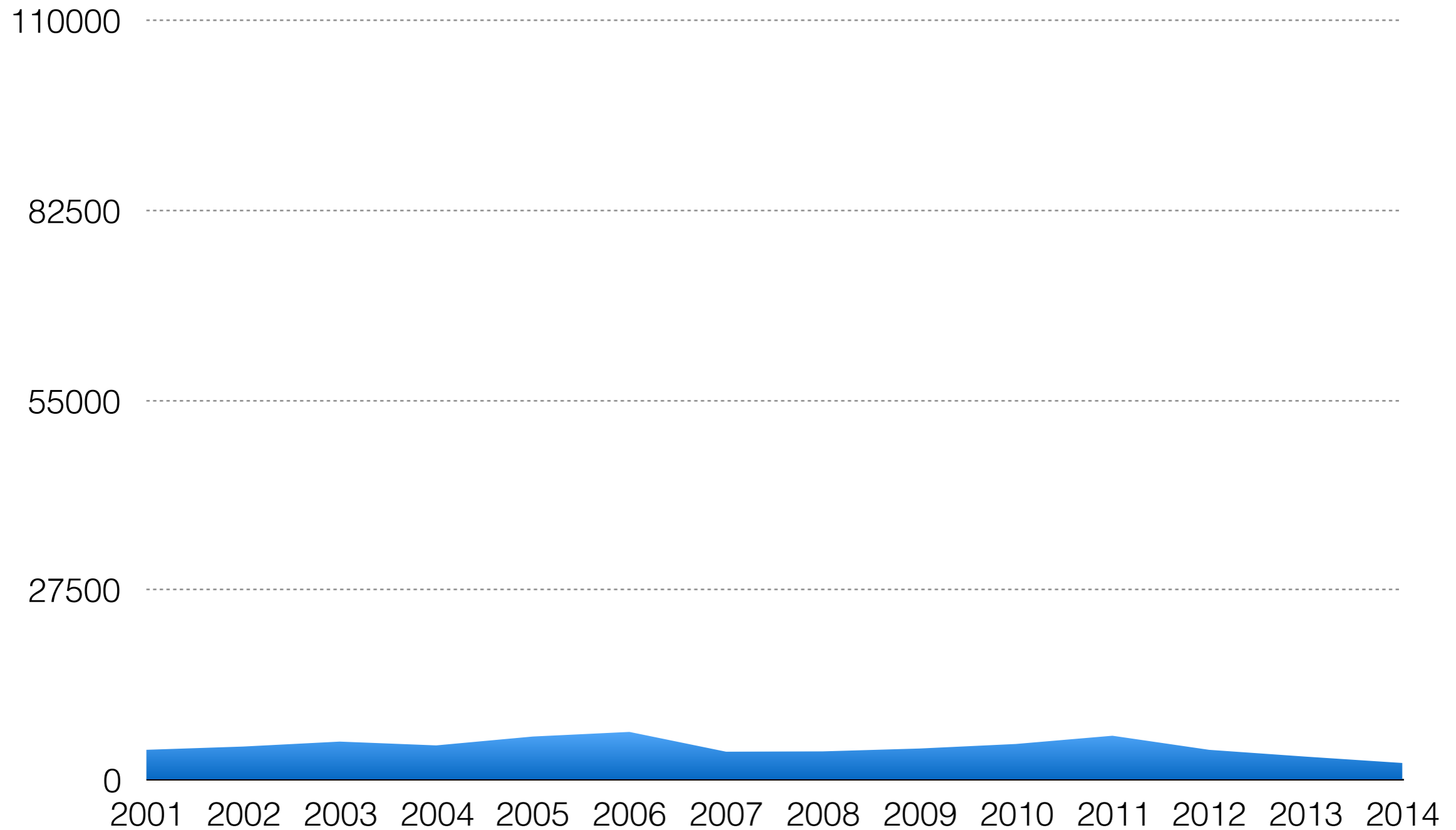


■ Nuclear

# California In-State Geothermal, 2001 - 2014

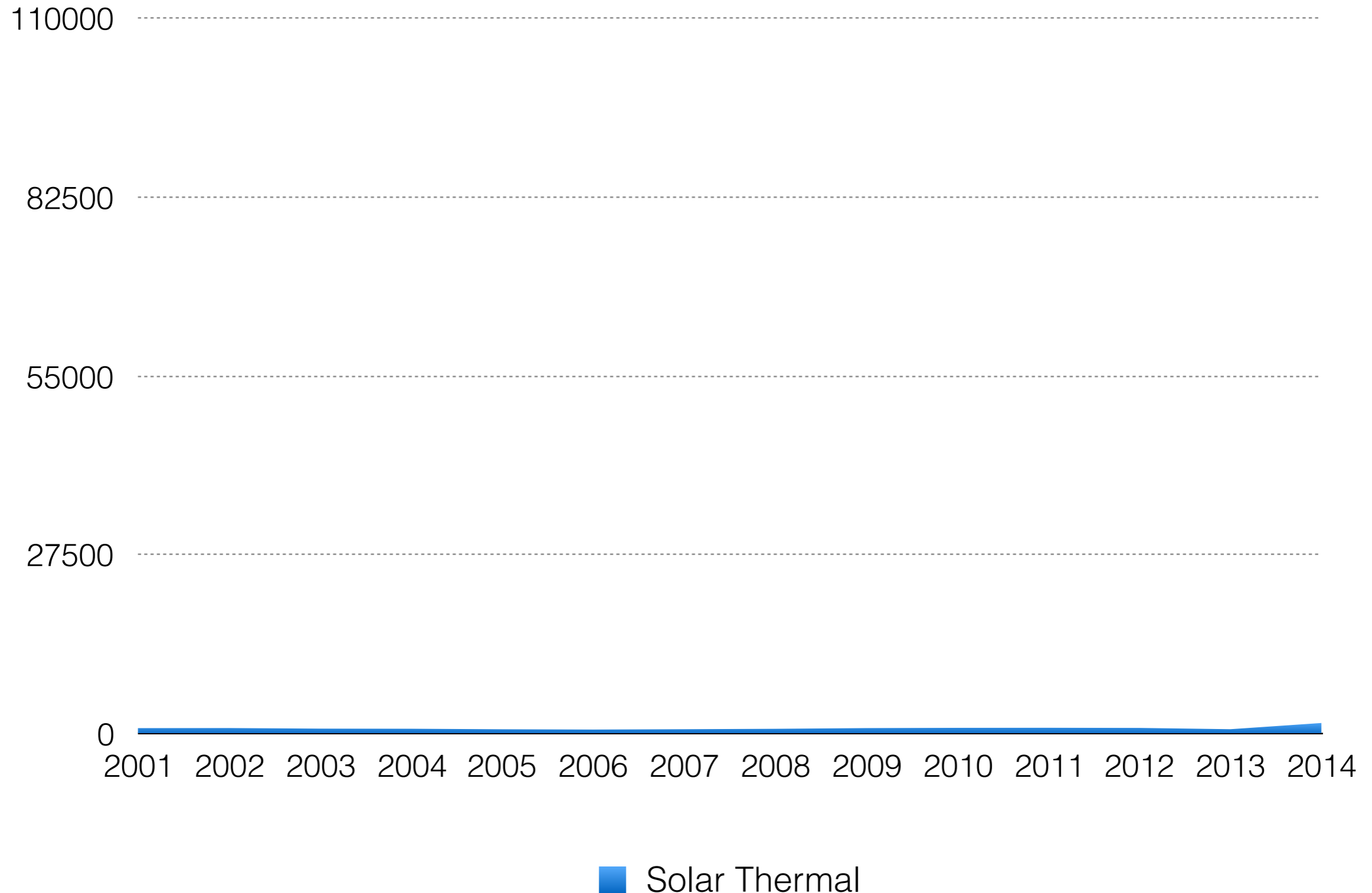


# California In-State Small Hydro, 2001 - 2014



■ Small Hydro

# California In-State Solar Thermal, 2001 - 2014



# California In-State Solar PV, 2001 - 2014



■ Solar PV

# Environmental Consequences of Diablo Closure

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

2500000

1250000

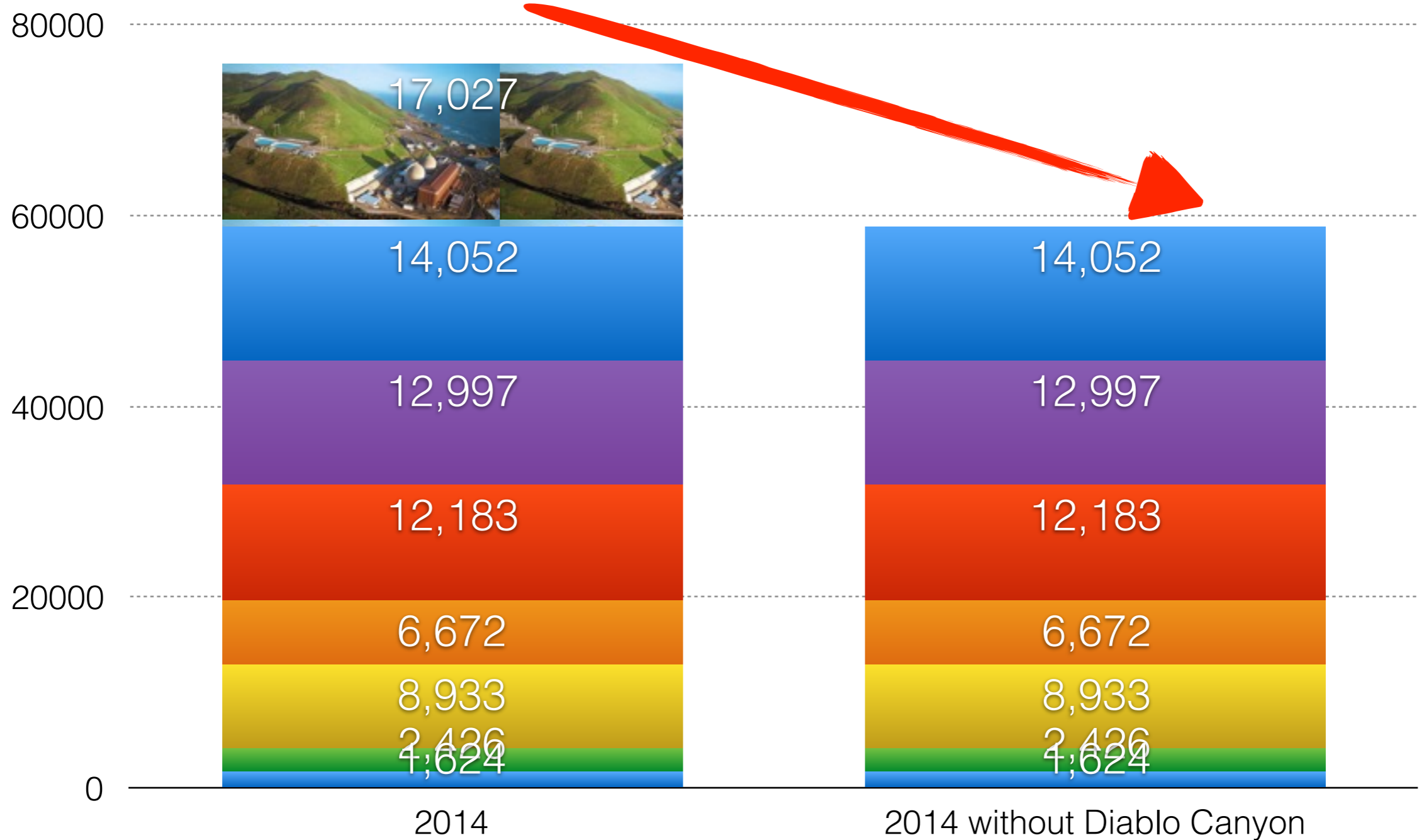
0



Number

**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



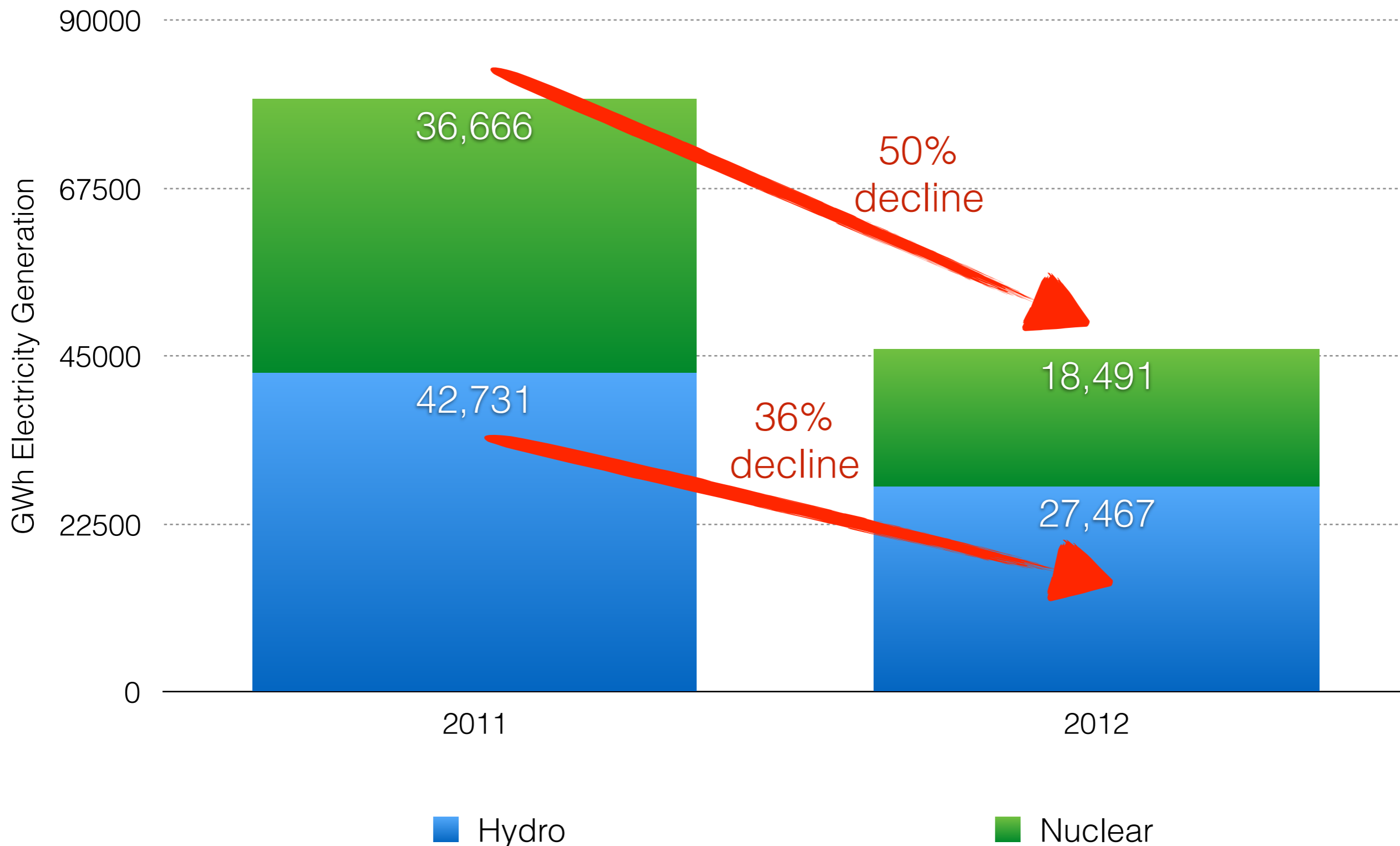
- Solar Thermal
- Large Hydro
- Small Hydro
- Nuclear
- Solar PV
- Biomass
- Geothermal
- Wind

California Almanac, "In-State Generation by Fuel Type"

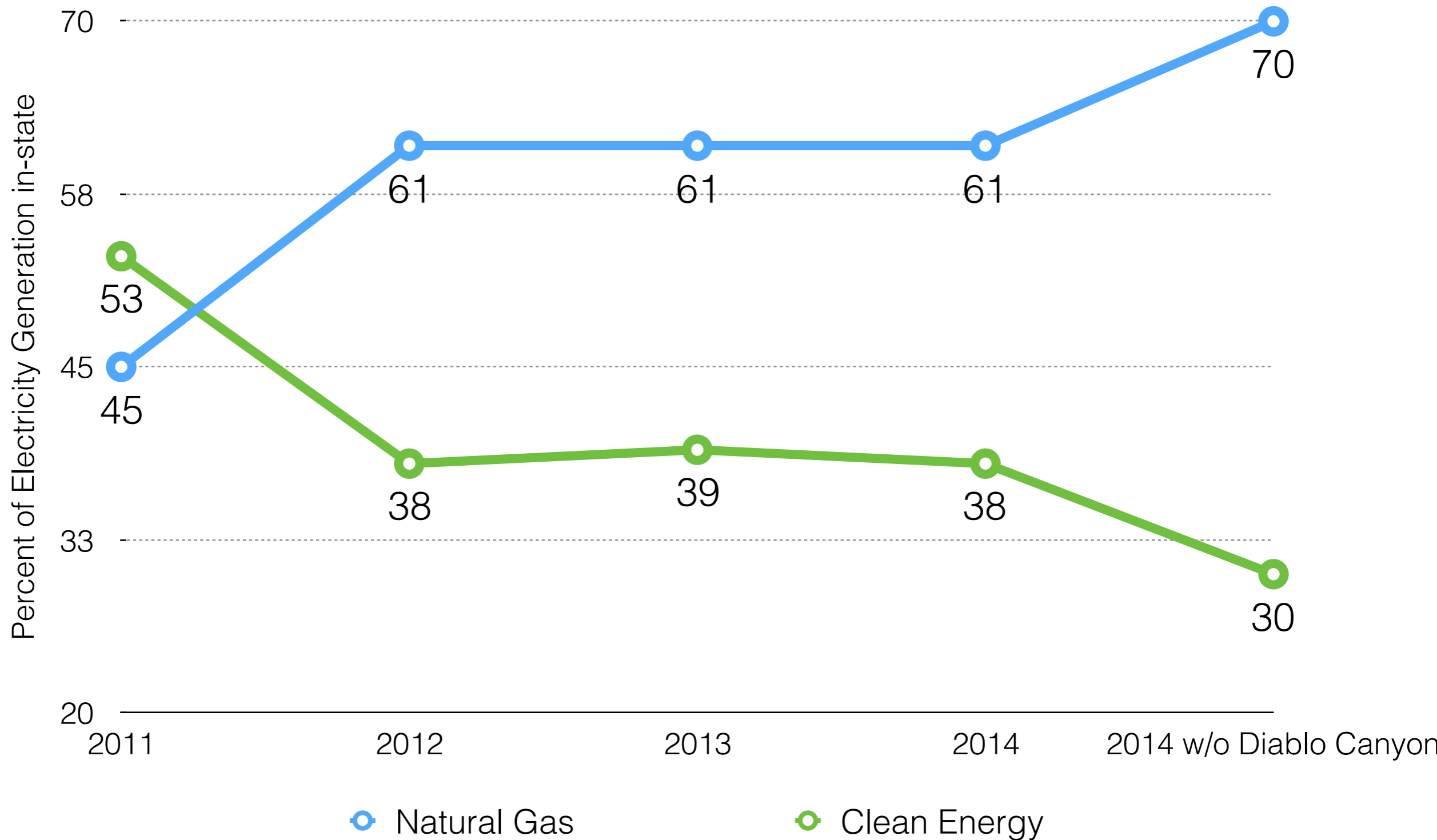
[http://energyalmanac.ca.gov/electricity/electric\\_generation\\_capacity.html](http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html)



# San Onfore closure reduced clean electricity by 50%, drought reduced it by 36%, 2011-2012

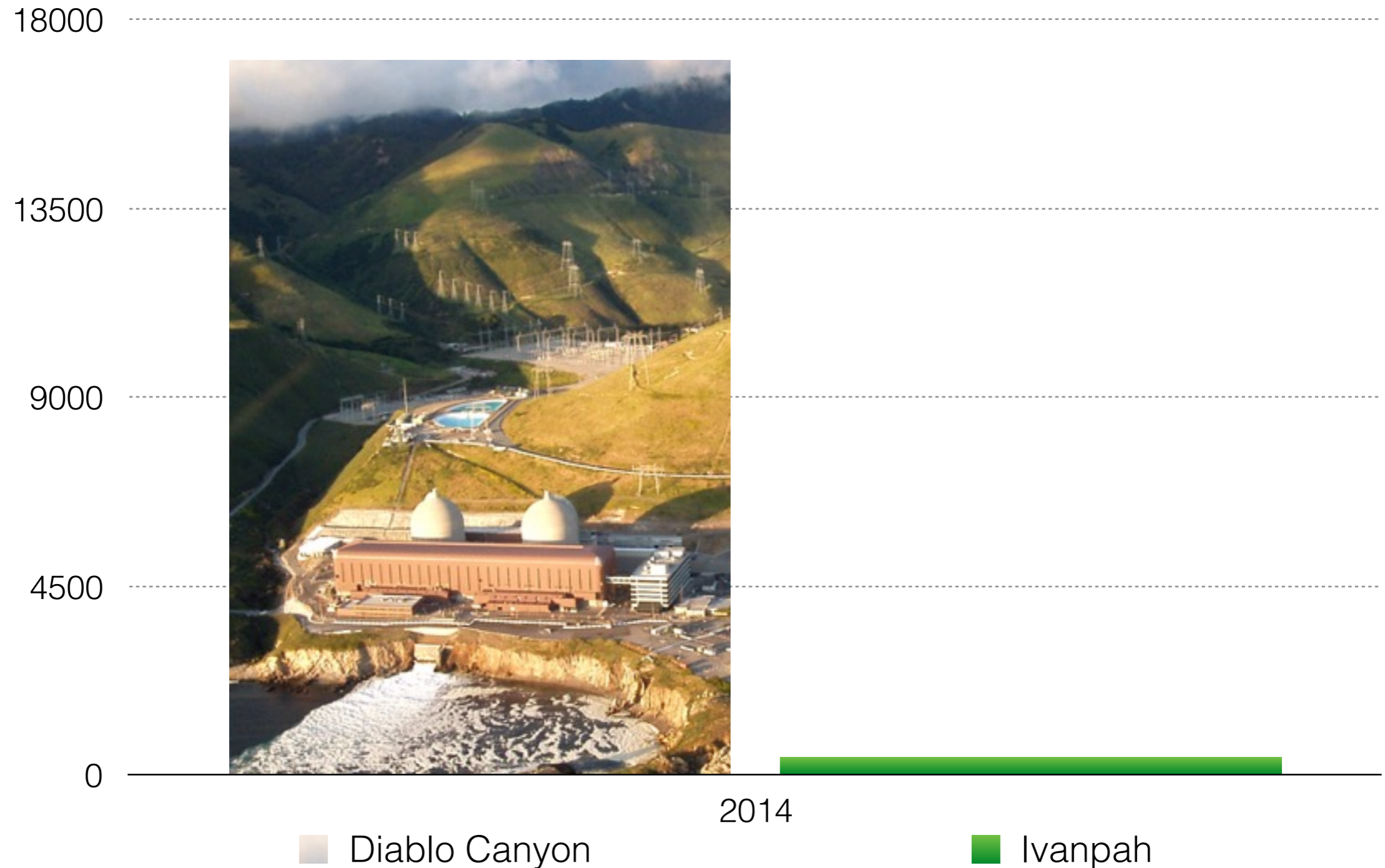


# Replacing Diablo Closure with natural gas would cut clean electricity to 30% & increase natural gas to 70%



**Source:** California Almanac, "In-State Generation by Fuel Type"  
[http://energyalmanac.ca.gov/electricity/electric\\_generation\\_capacity.html](http://energyalmanac.ca.gov/electricity/electric_generation_capacity.html)

# Diablo Canyon produced 41 times more electricity than Ivanpah, California's largest solar plant



Diablo Canyon produced 24% percent more electricity than all of California's wind, and 33% more than all of its solar



■ Diablo Canyon

■ Wind

■ Solar

California Almanac, "In-State Generation by Fuel Type"

[http://energyalmanac.ca.gov/electricity/electric\\_generation\\_capacity.html](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

2500000

1250000

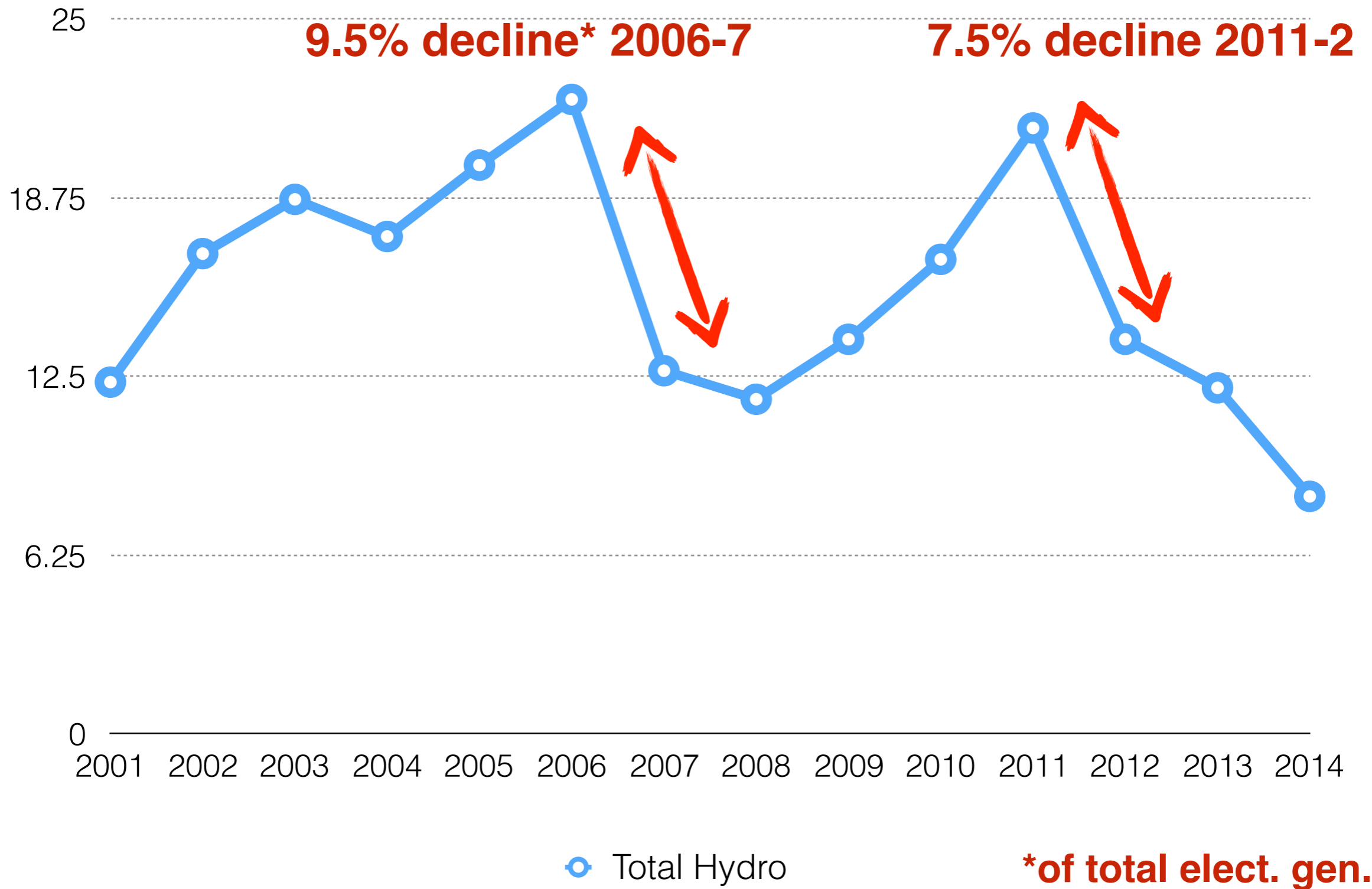
0



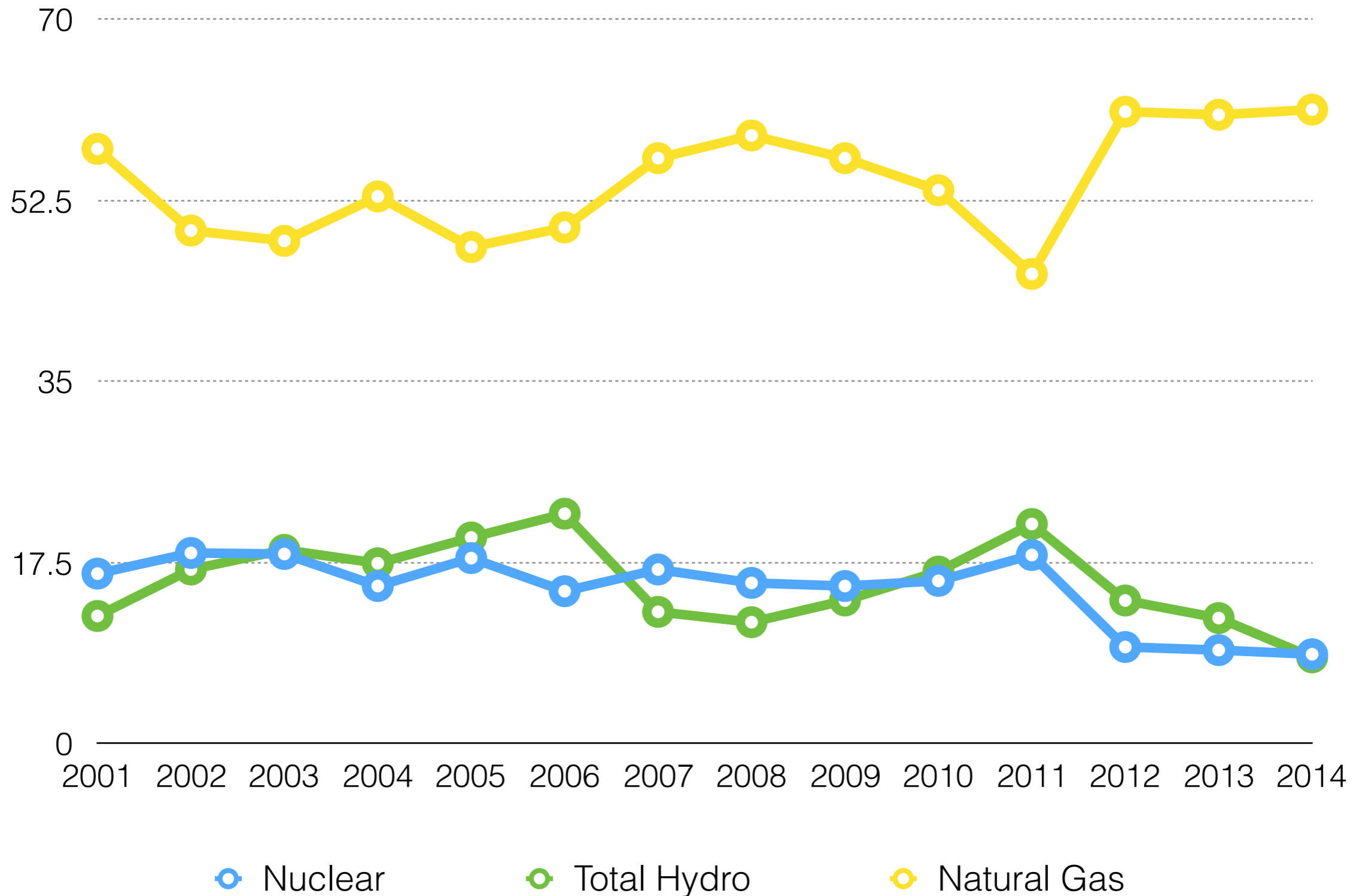
Number

**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 CO<sub>2</sub> per KWh, or 9,975,282 metric tons of CO<sub>2</sub>. Average US vehicle emits 4.7 metric tons of CO<sub>2</sub> per year.  $9,975,282 \div 4.7 = 2,100,059$  cars

# Hydro-electricity fluctuates significantly



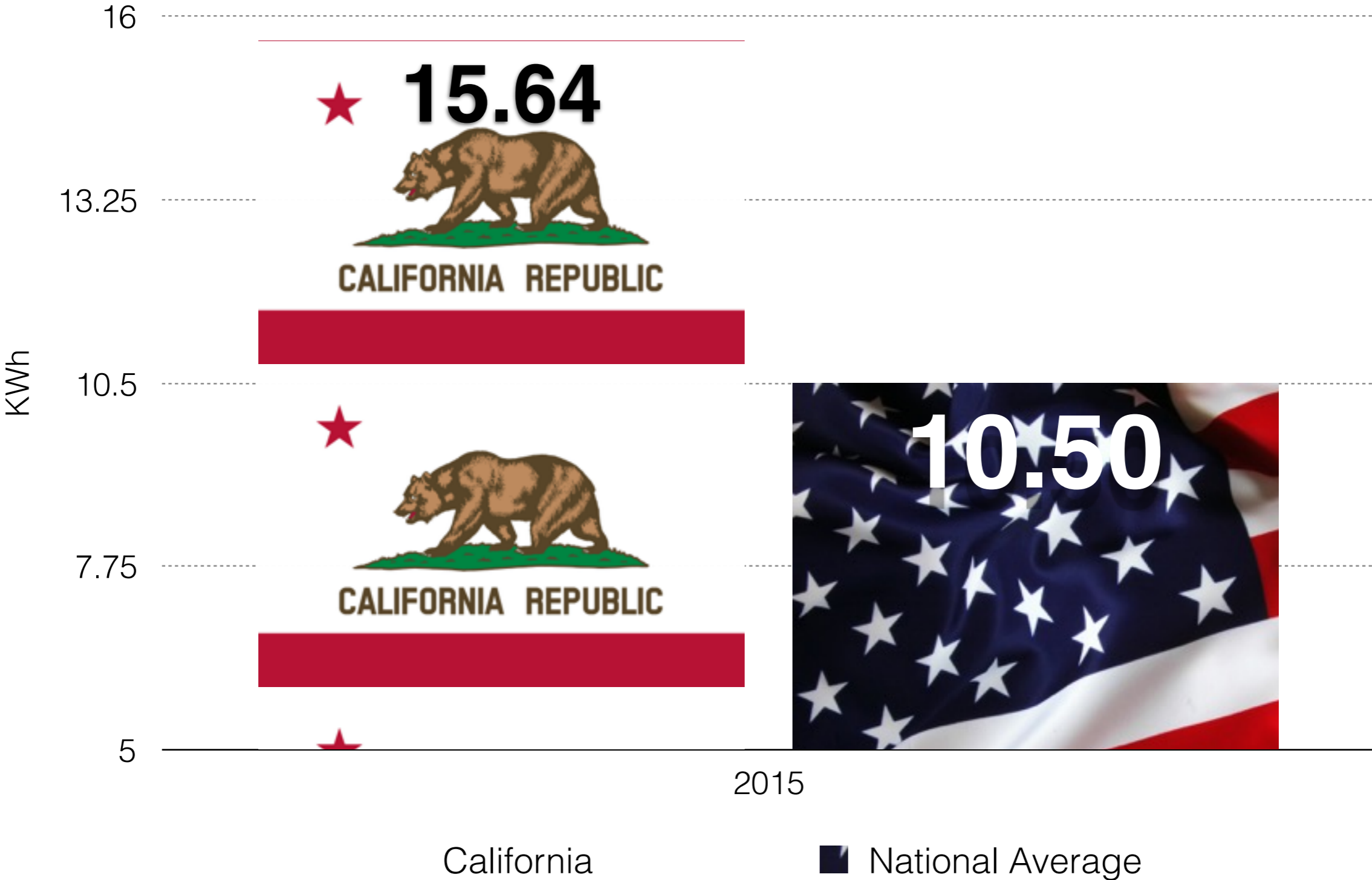
# Natural Gas Substitutes for Hydro & Nuclear



# Economic Consequences

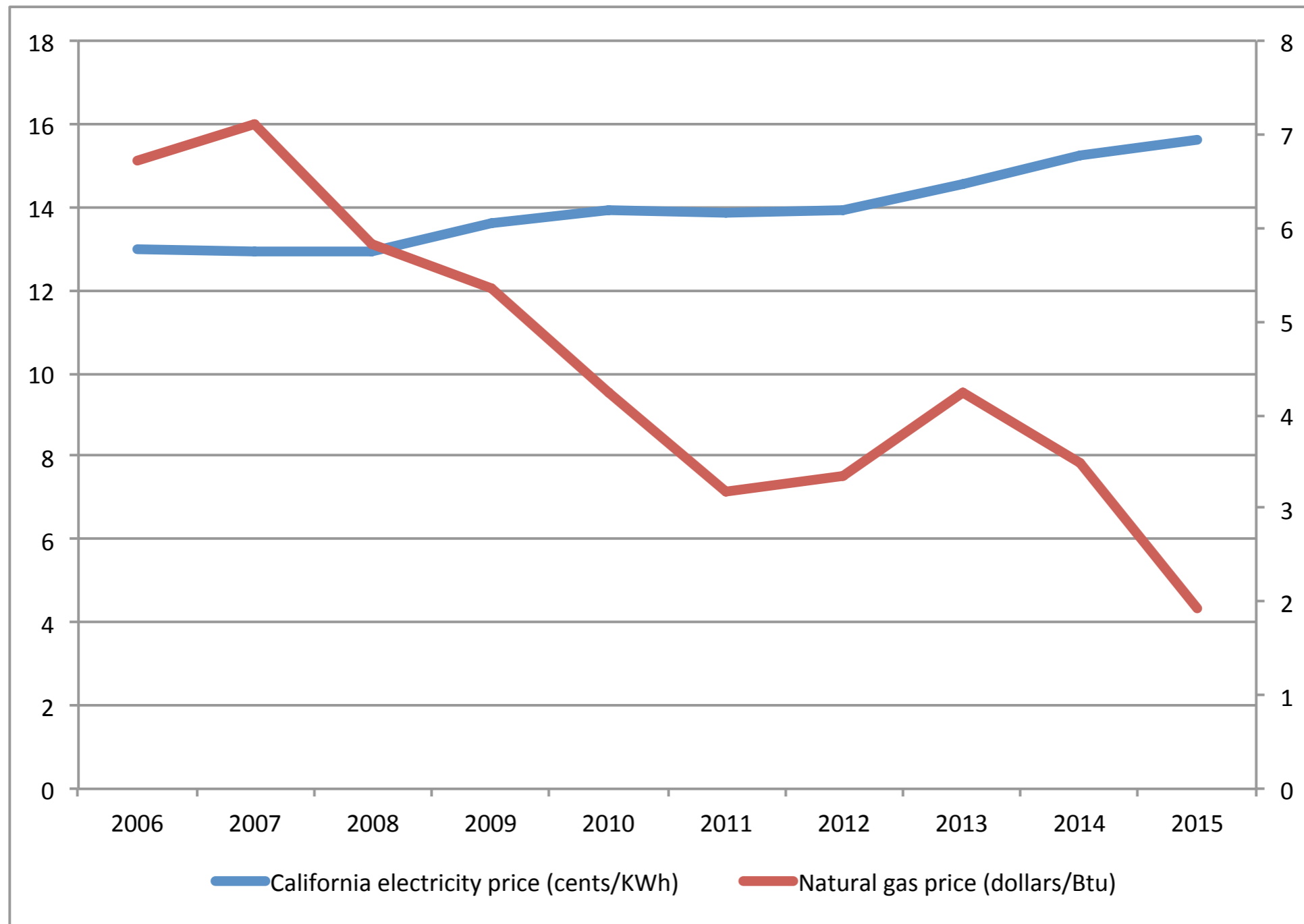


# California has 6th most expensive retail (all sectors) electricity in continental United States



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

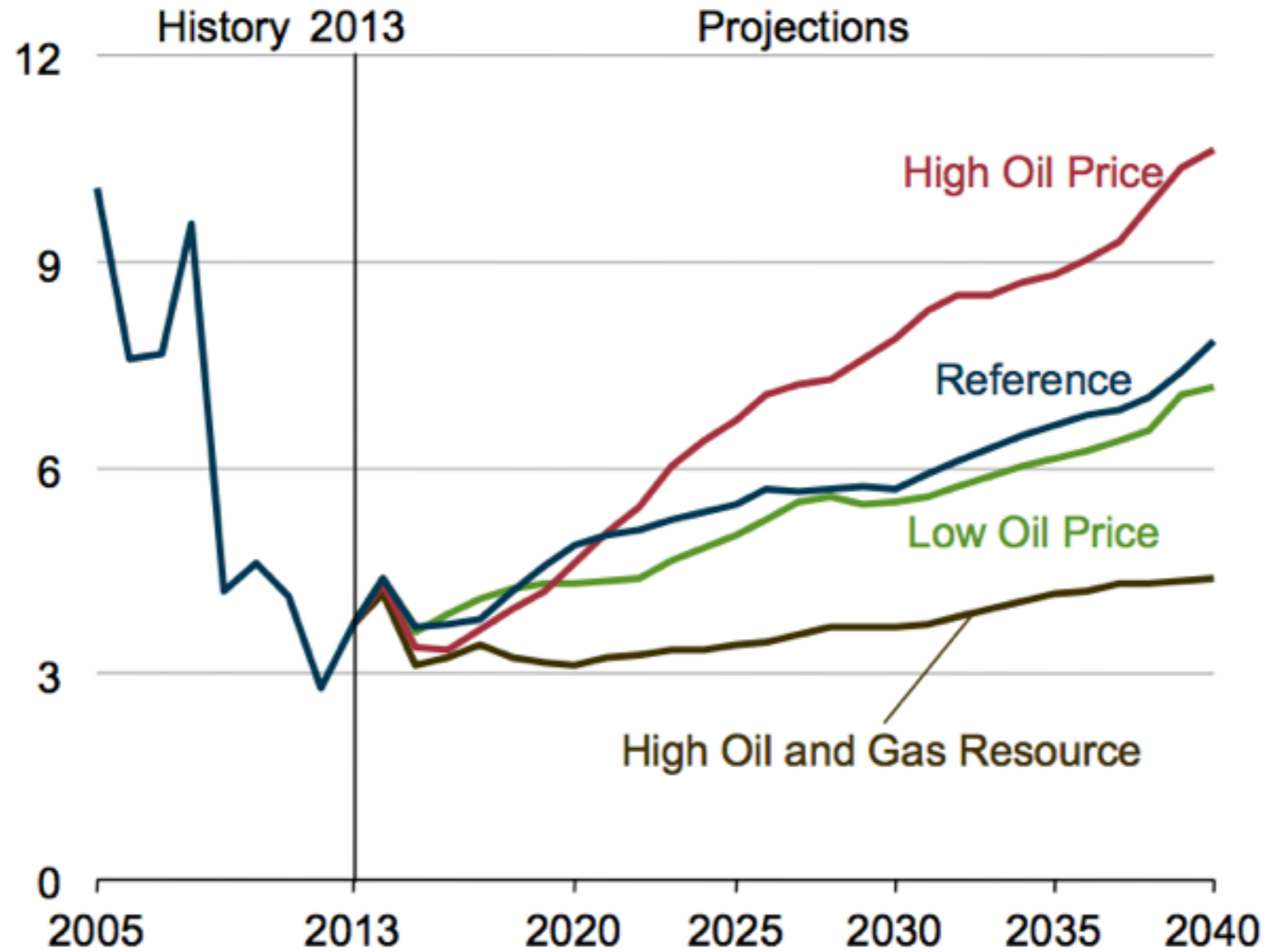
# Cheap natural gas has masked significant electricity cost increases from deploying (non-large hydro) renewables



**Source:** US Energy Information Administration,

# Natural Gas Prices Predicted to Double by 2025

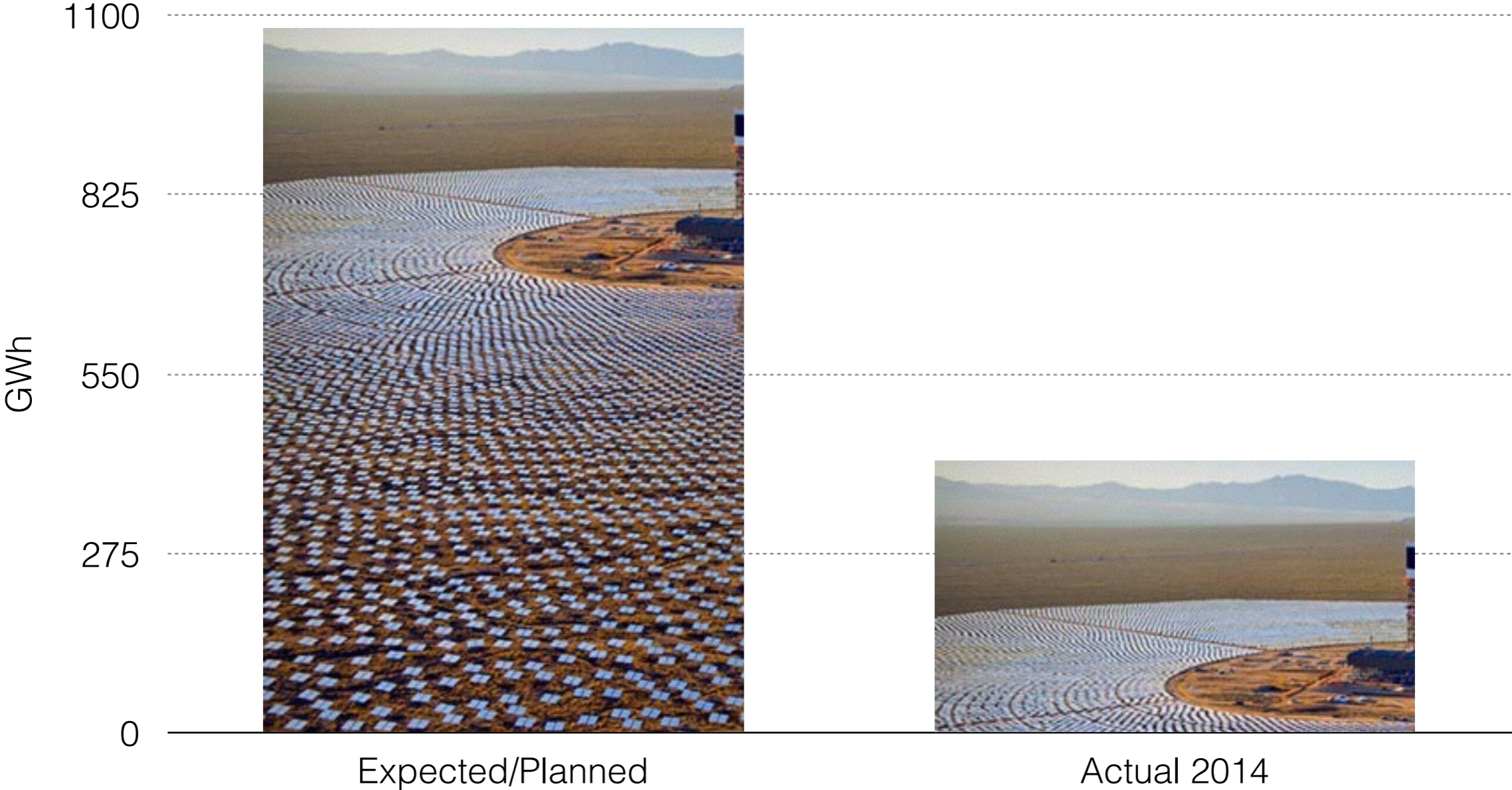
**Figure ES2. Average Henry Hub spot prices for natural gas in four cases, 2005-40 (2013 dollars per million Btu)**



on | Annual Energy Outlook 2015

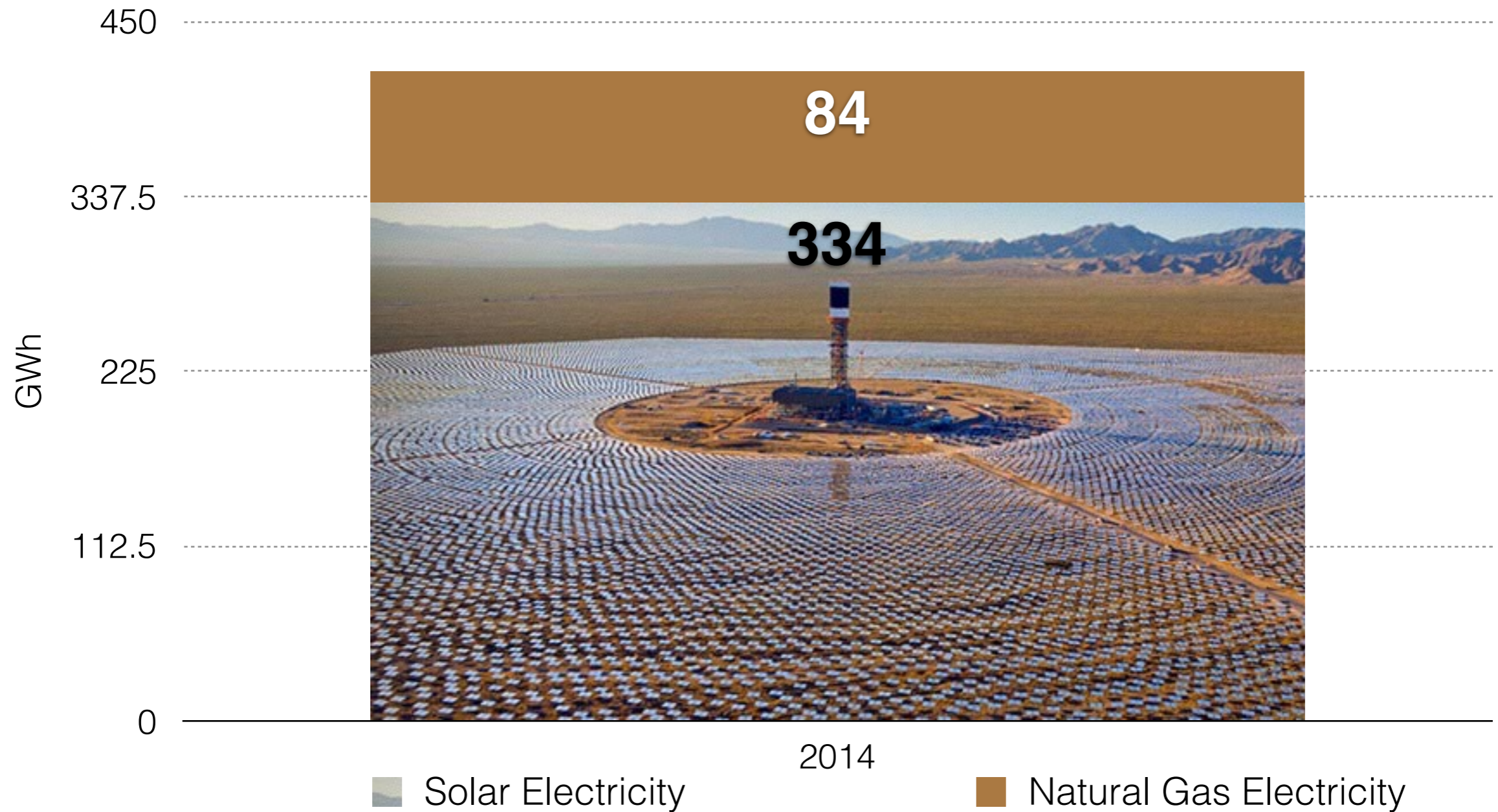
**Source:** US Energy Information Administration,

# Ivanpah produced 60% less electricity than was expected and planned



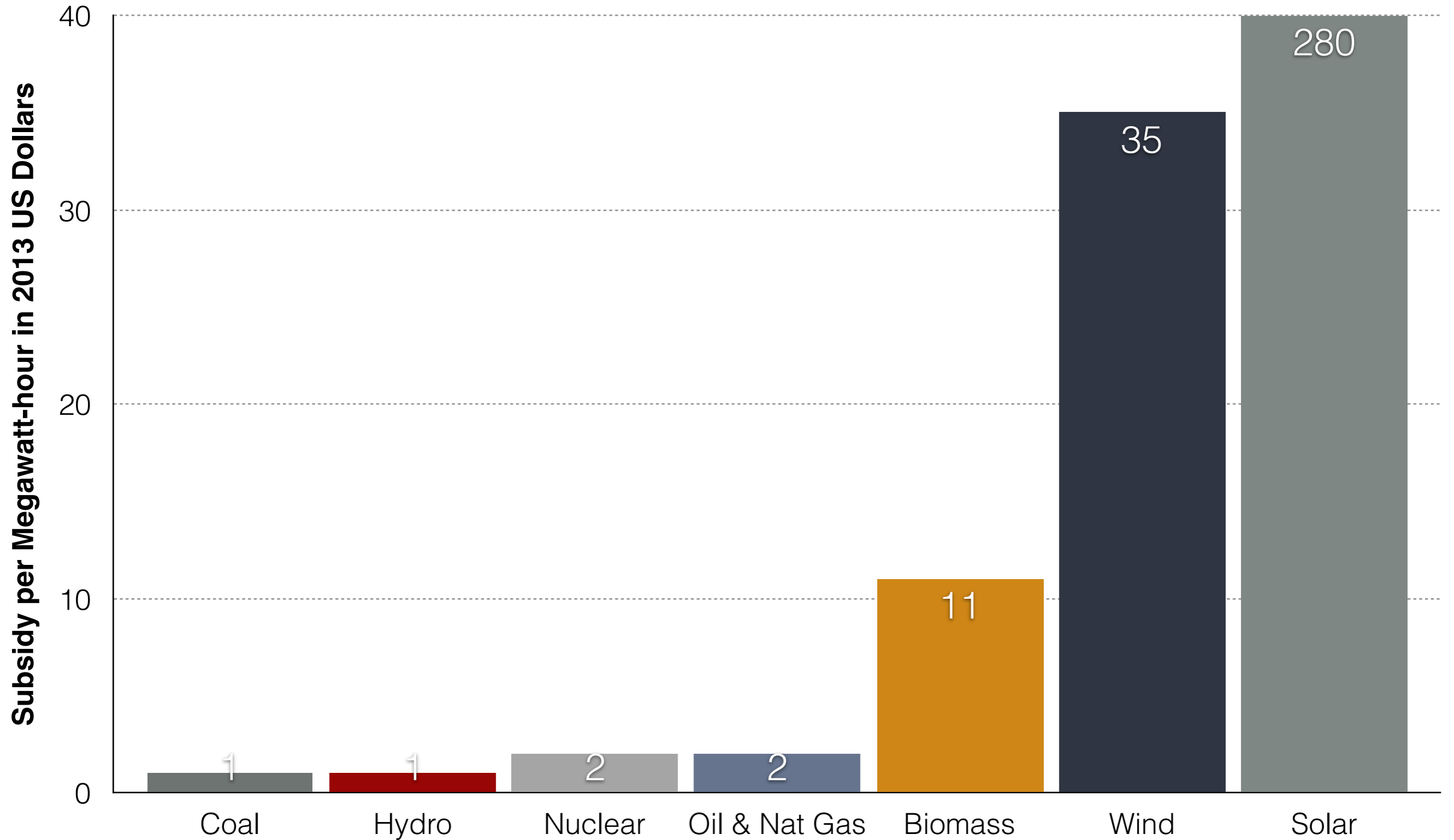
**Sources:** Expected: NREL, "Concentrating Solar Power Projects," [http://www.nrel.gov/csp/solarpaces/project\\_detail.cfm/projectID=62](http://www.nrel.gov/csp/solarpaces/project_detail.cfm/projectID=62)  
Actual: California Almanac, "Annual Generation Plant," [http://energyalmanac.ca.gov/electricity/web\\_qfer/Annual\\_Generation-Plant\\_Unit.php](http://energyalmanac.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](http://energyalmanac.ca.gov/electricity/web_qfer/Annual_Generation-Plant_Unit.php)

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



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