

37

35

33

31

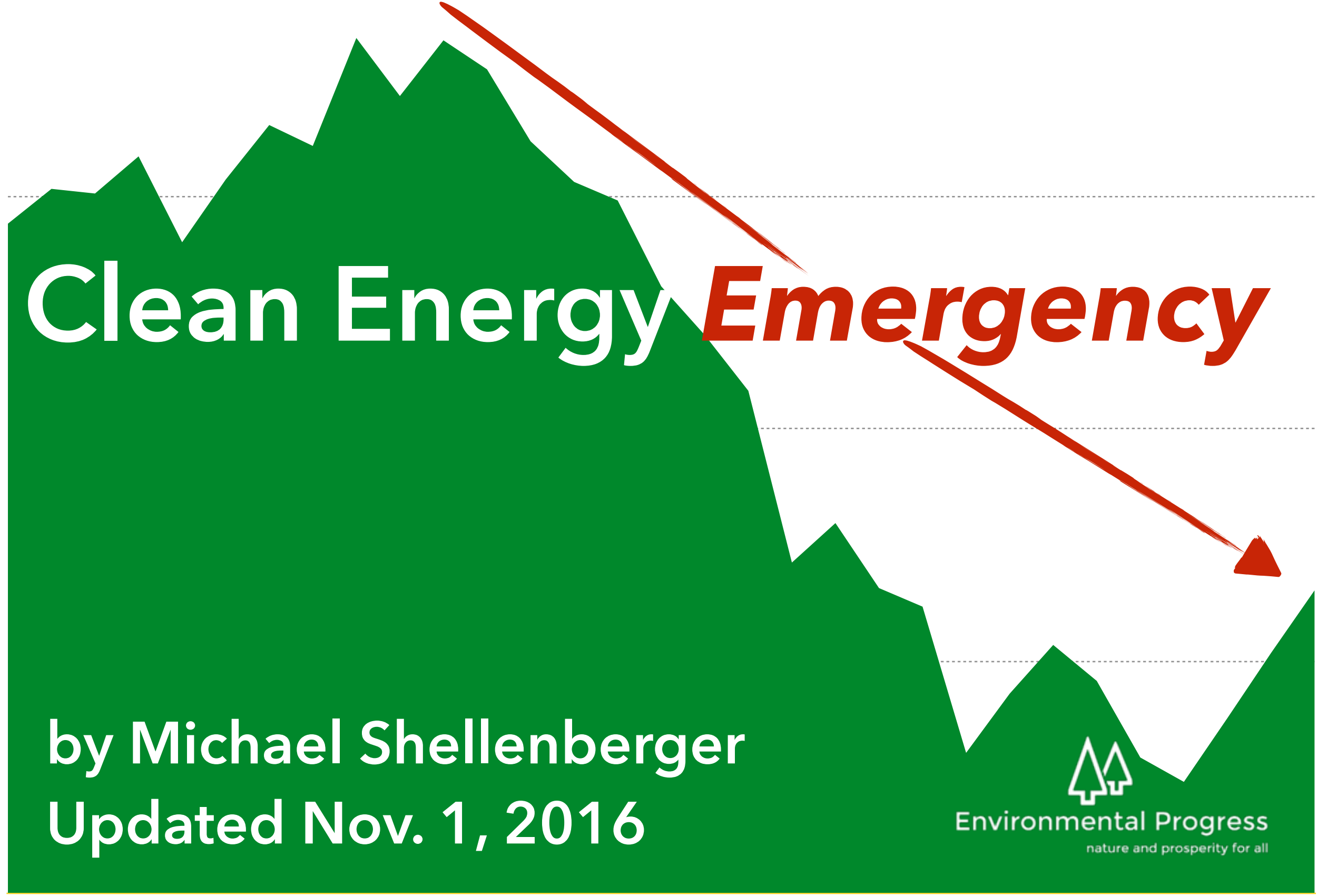
29

# Clean Energy *Emergency*

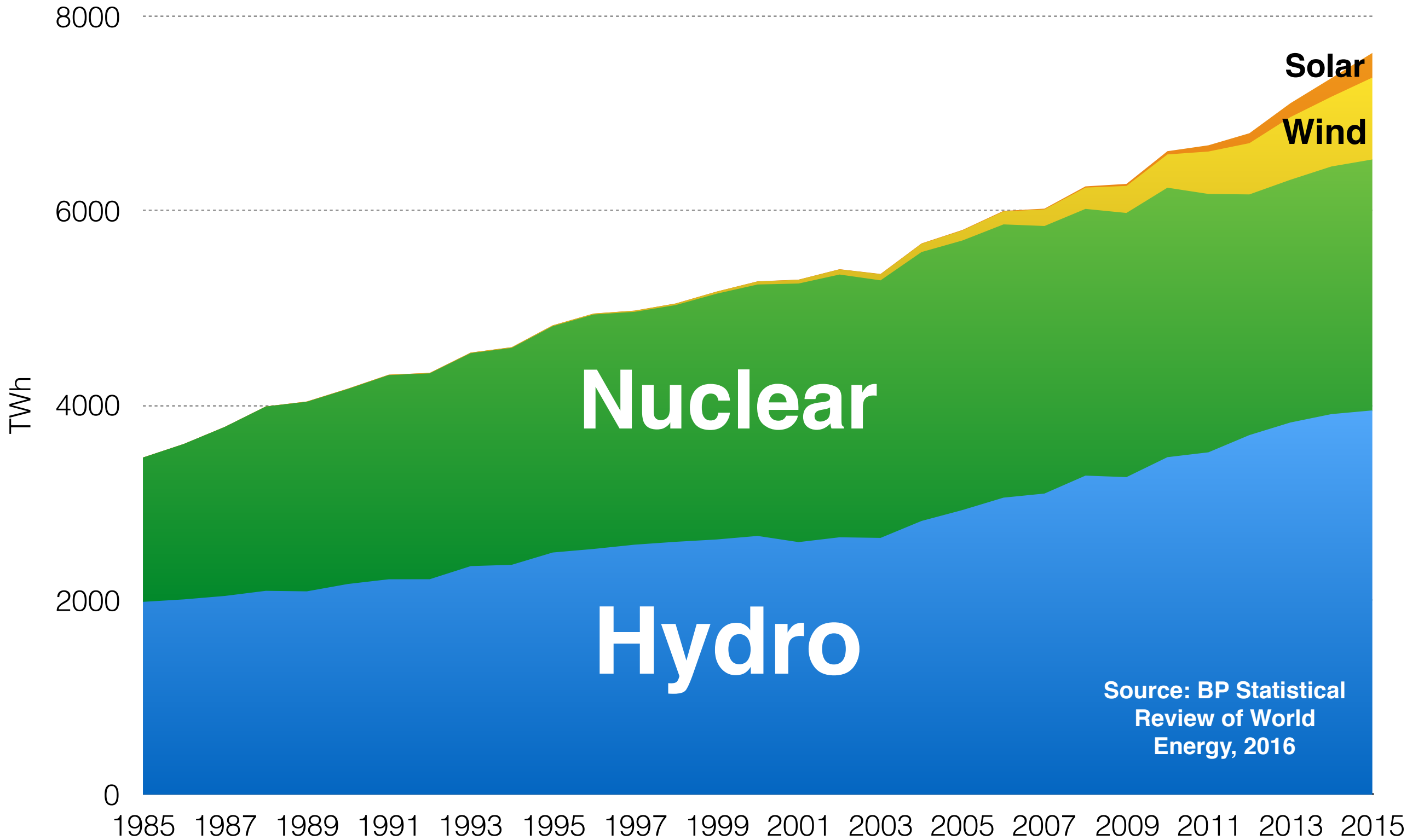
by Michael Shellenberger  
Updated Nov. 1, 2016



1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015

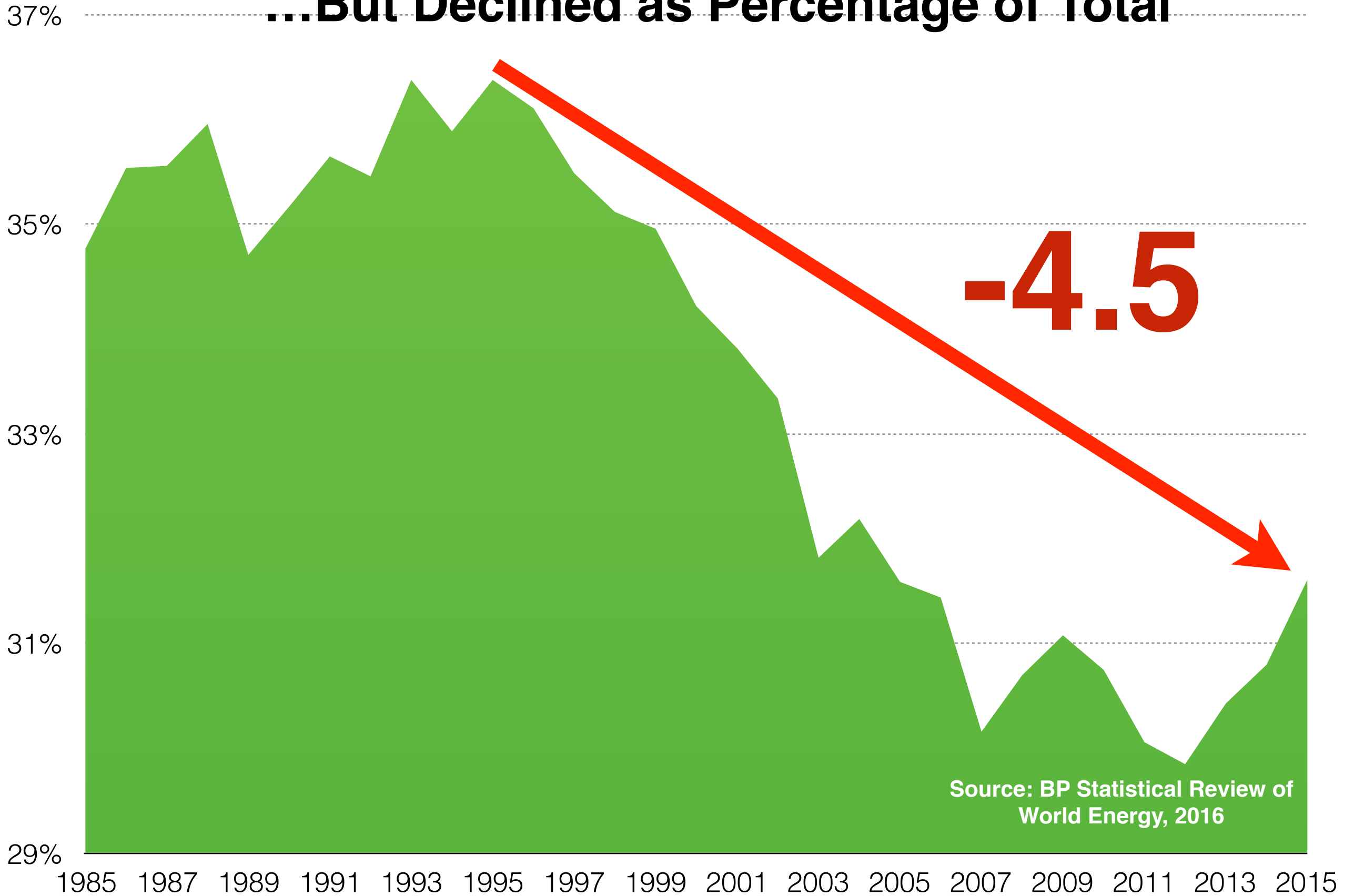


# Low-Carbon Power Has Grown in Absolute Terms...



Source: BP Statistical Review of World Energy, 2016

# ...But Declined as Percentage of Total



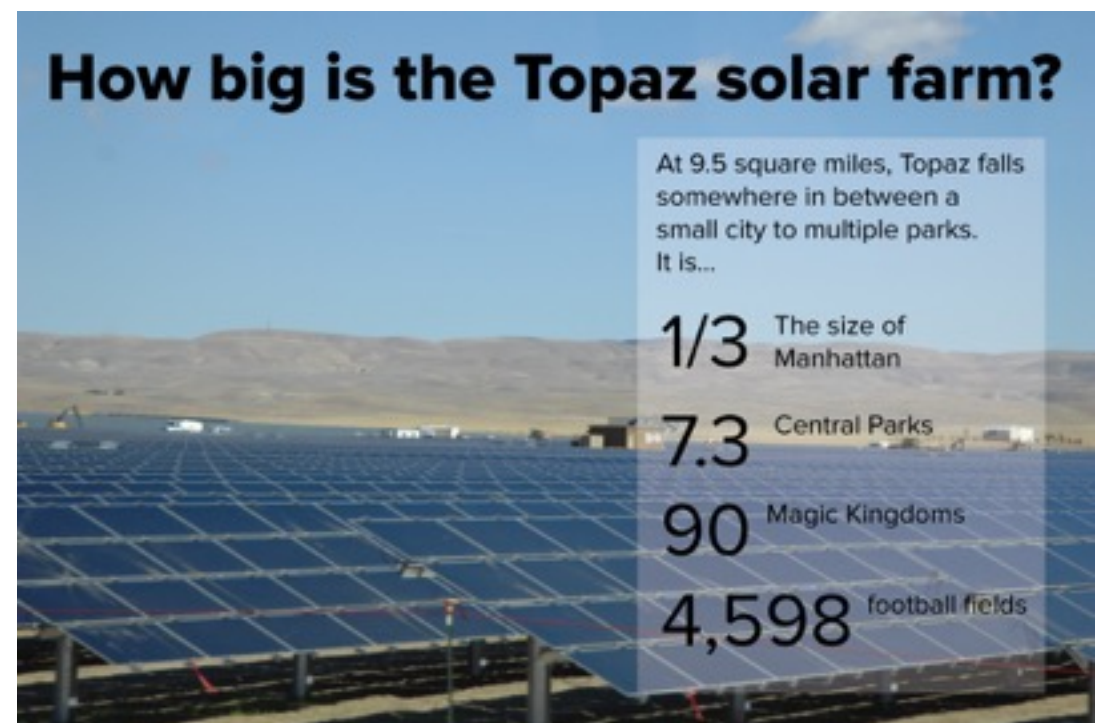
Source: BP Statistical Review of World Energy, 2016

**4.5 percentage points of global  
electricity =**

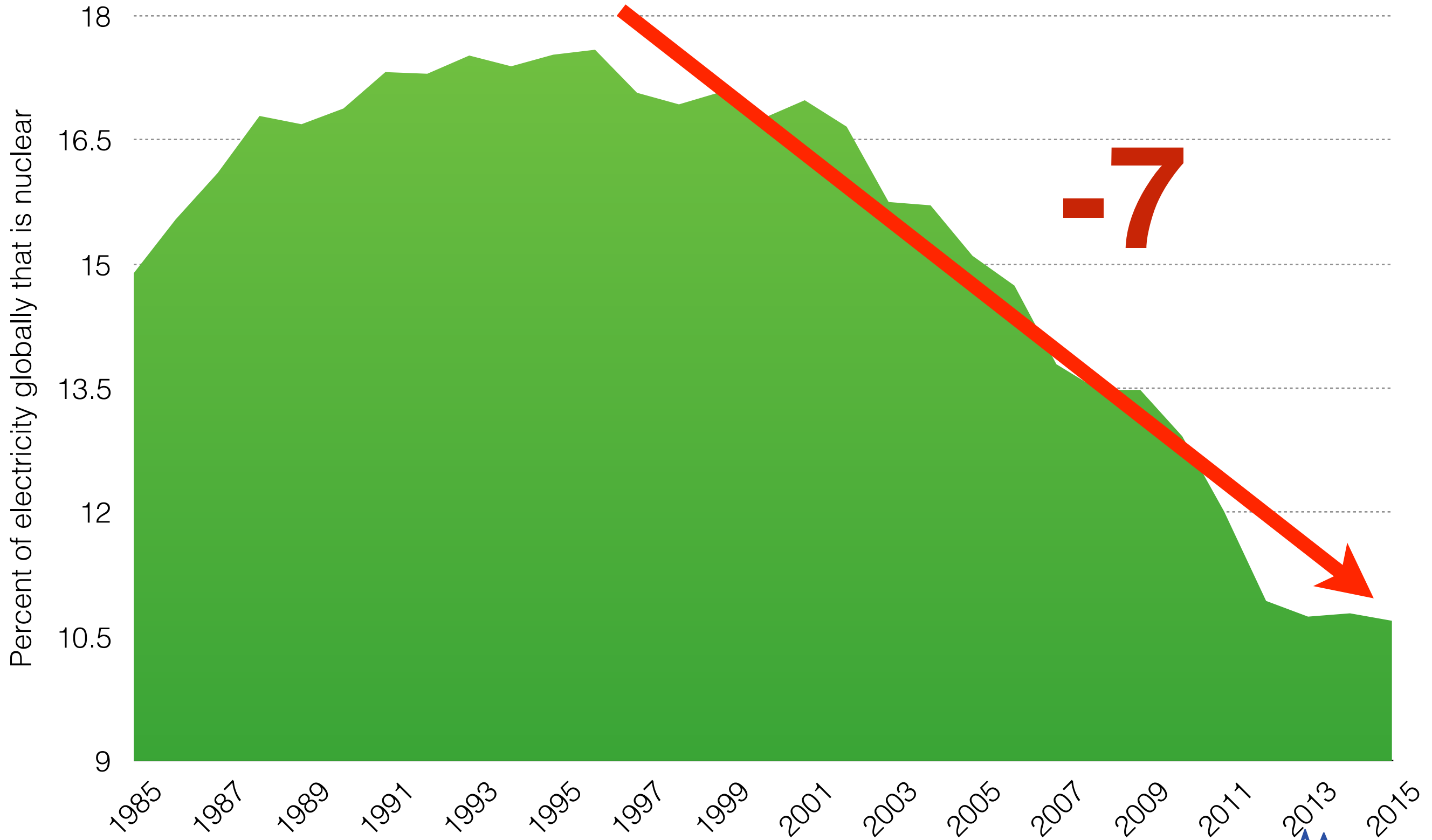
**60 nuclear plants the size  
of Diablo Canyon**

*or*

**900 of one of largest solar  
farms (Topaz, in California)**



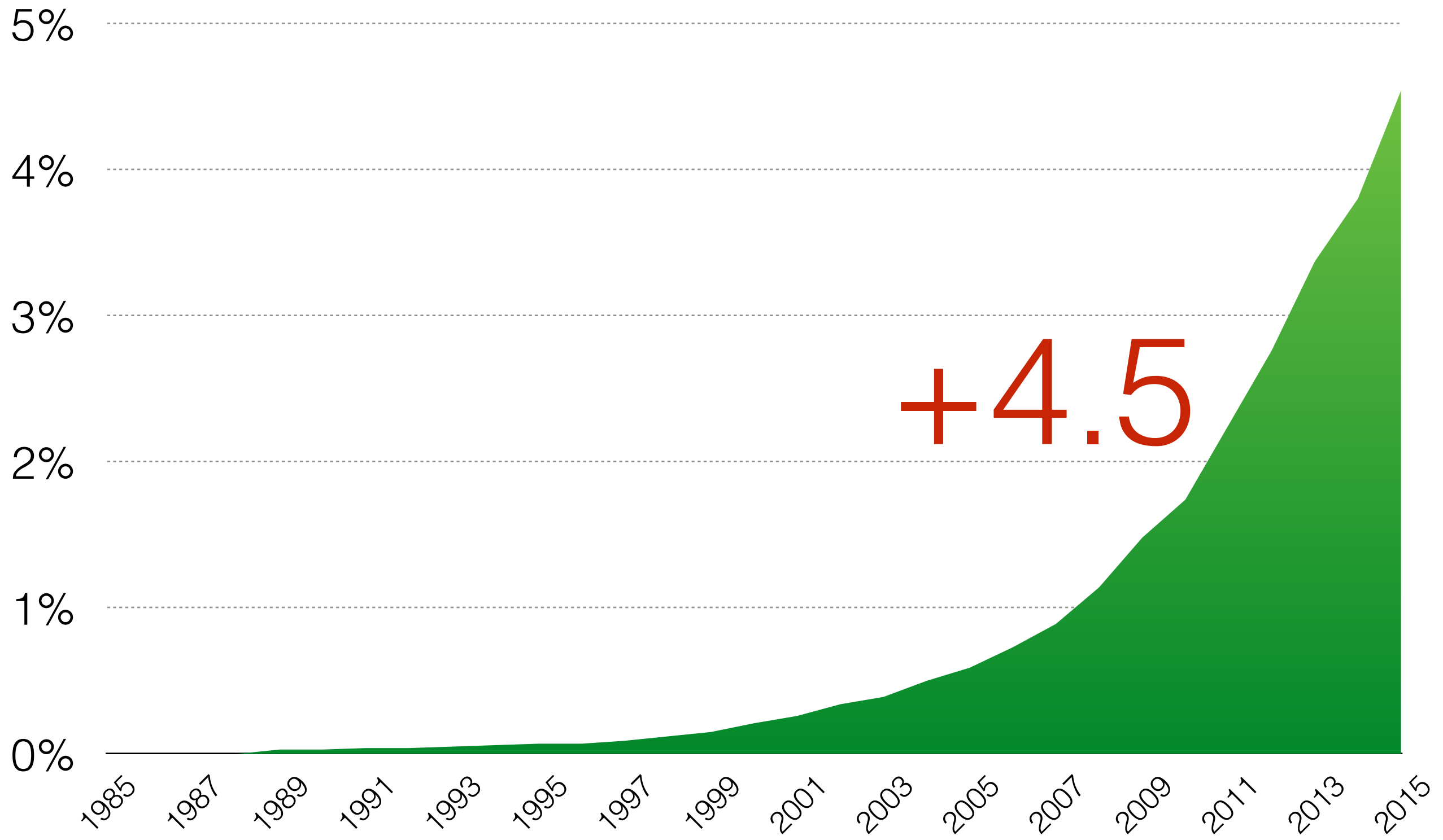
# Declining power from nuclear energy...



Source: BP Statistical Review of World Energy, 2015

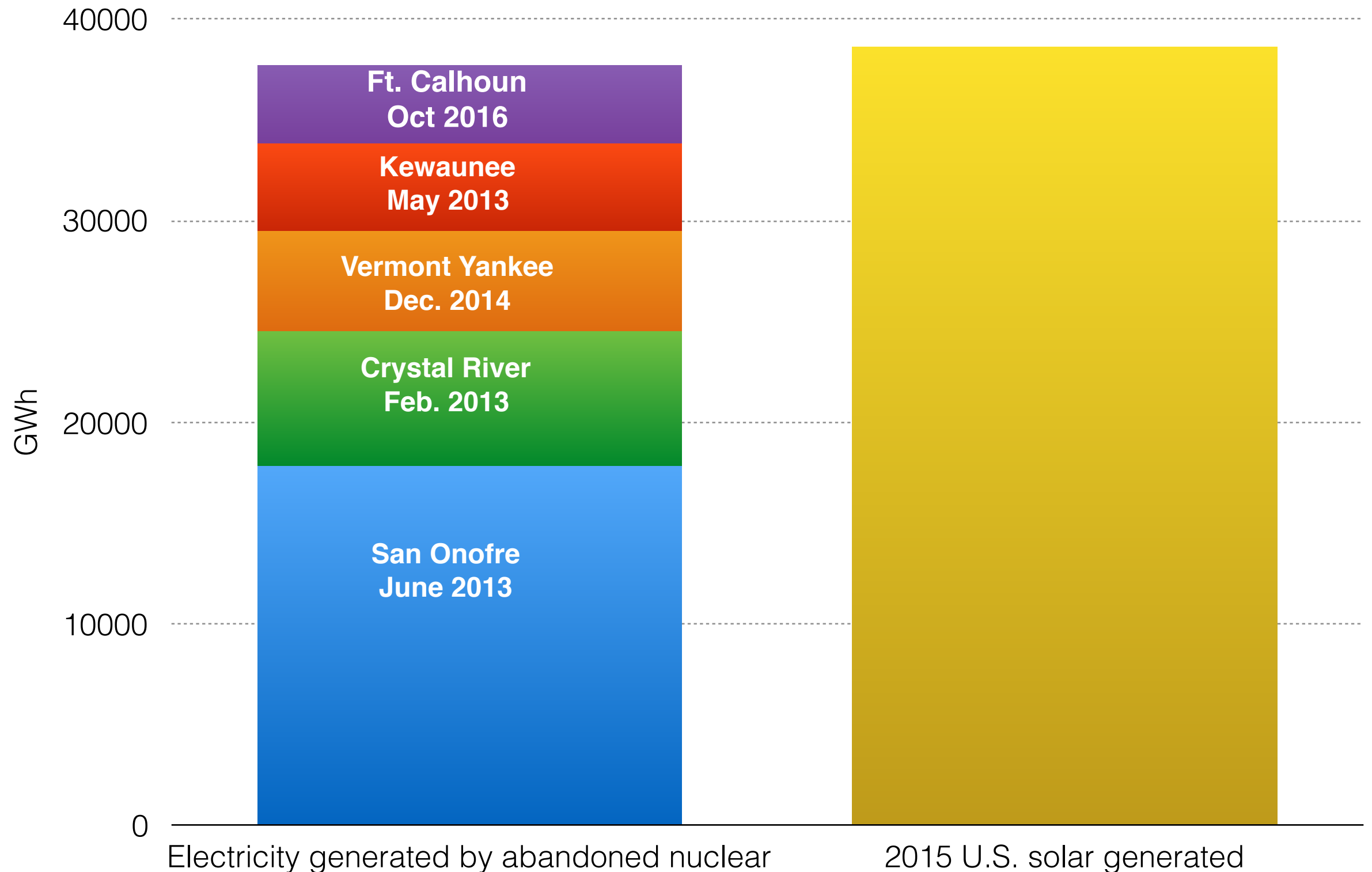


# ...was not made up by solar & wind



Over half of US nuclear fleet at risk of premature closure by 2030

# Five Abandoned Nuclear Plants Generated Almost Exact Same Amount of Power as All US Solar



Source: EIA. Assumes 90% capacity factor



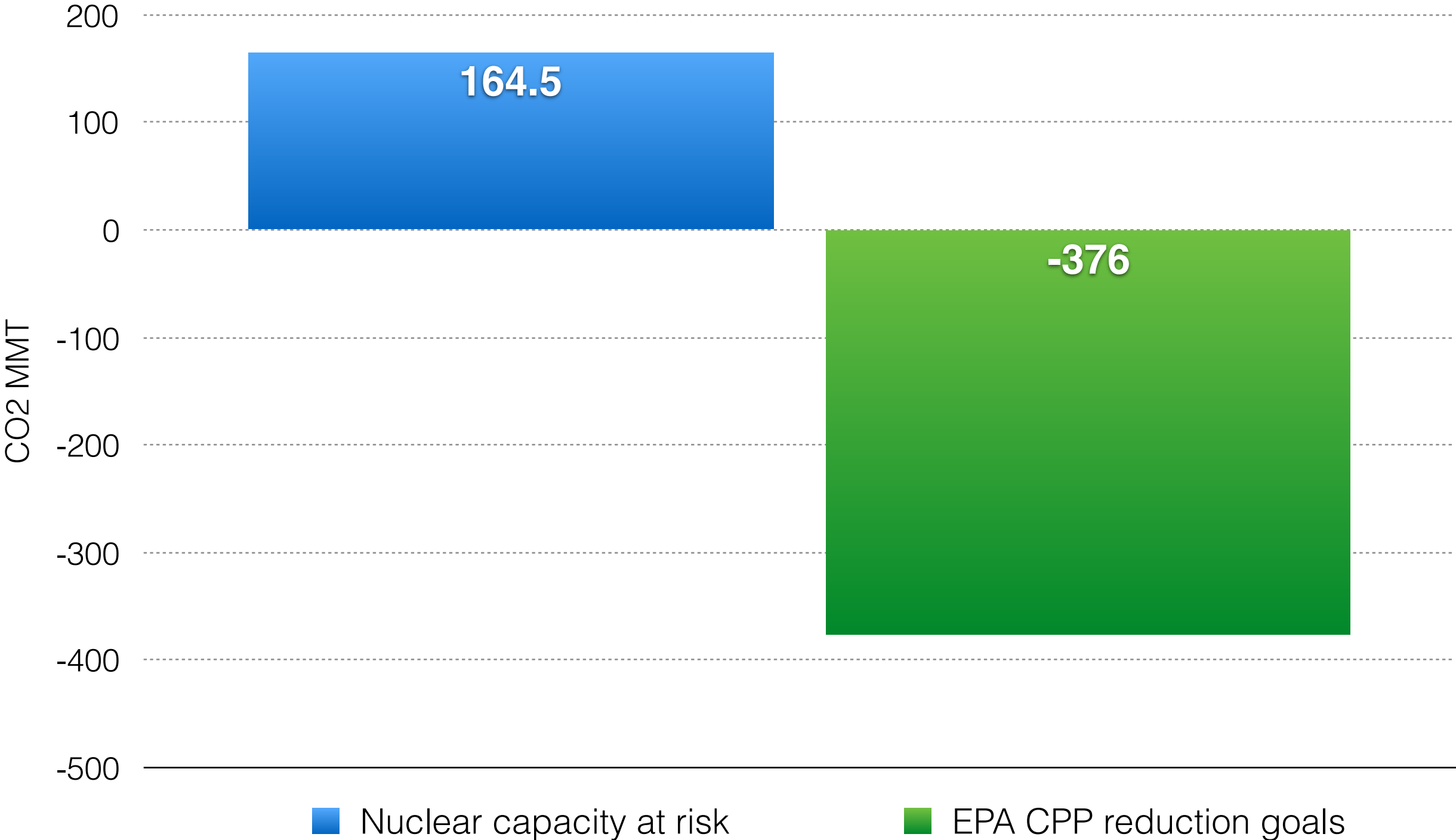
# Nuclear plants at risk of closure have \$142 billion carbon value



Assumes U.S. government cost of carbon of \$36/ton, 60-year lifetimes

**Source:** EPA, EIA

# Premature closures would set back the EPA clean power plan goals by 44%

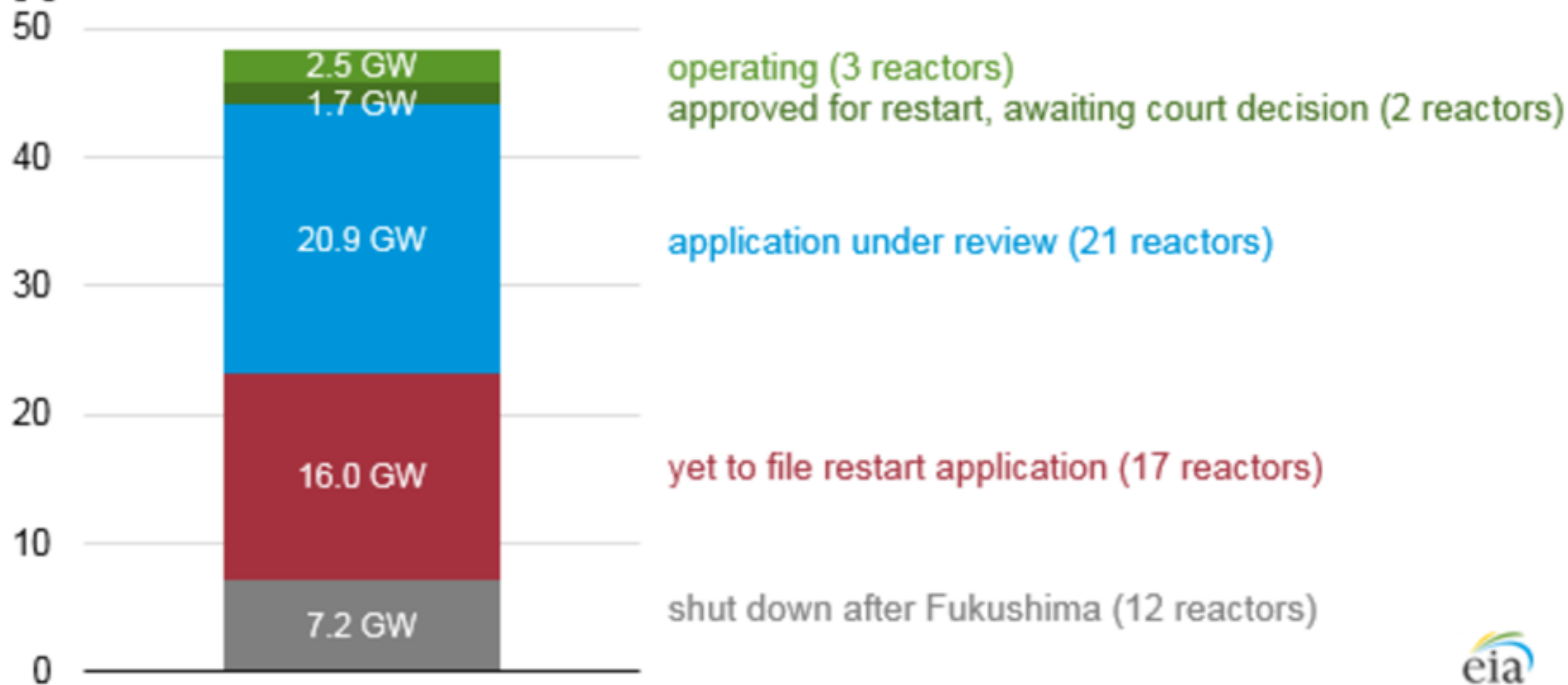


Calculation: Assumes replacement with natural gas

# Five and a half years after Fukushima, 3 of Japan's 54 nuclear reactors are operating

Current status of nuclear capacity in Japan (as of August 2016)

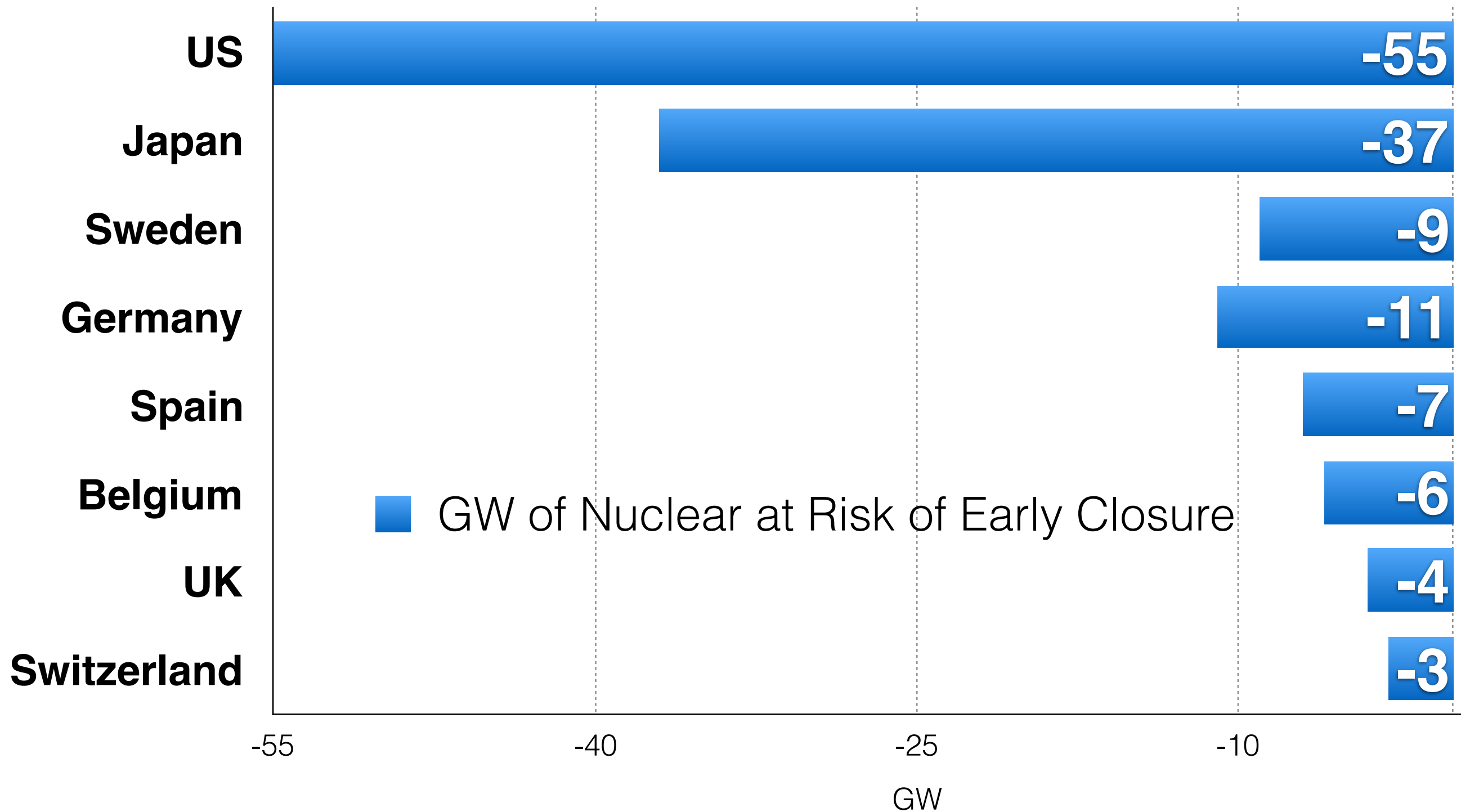
gigawatts



Source: U.S. Energy Information Administration, based on Institute of Energy Economics, Japan, and IAEA Power Reactor Information System

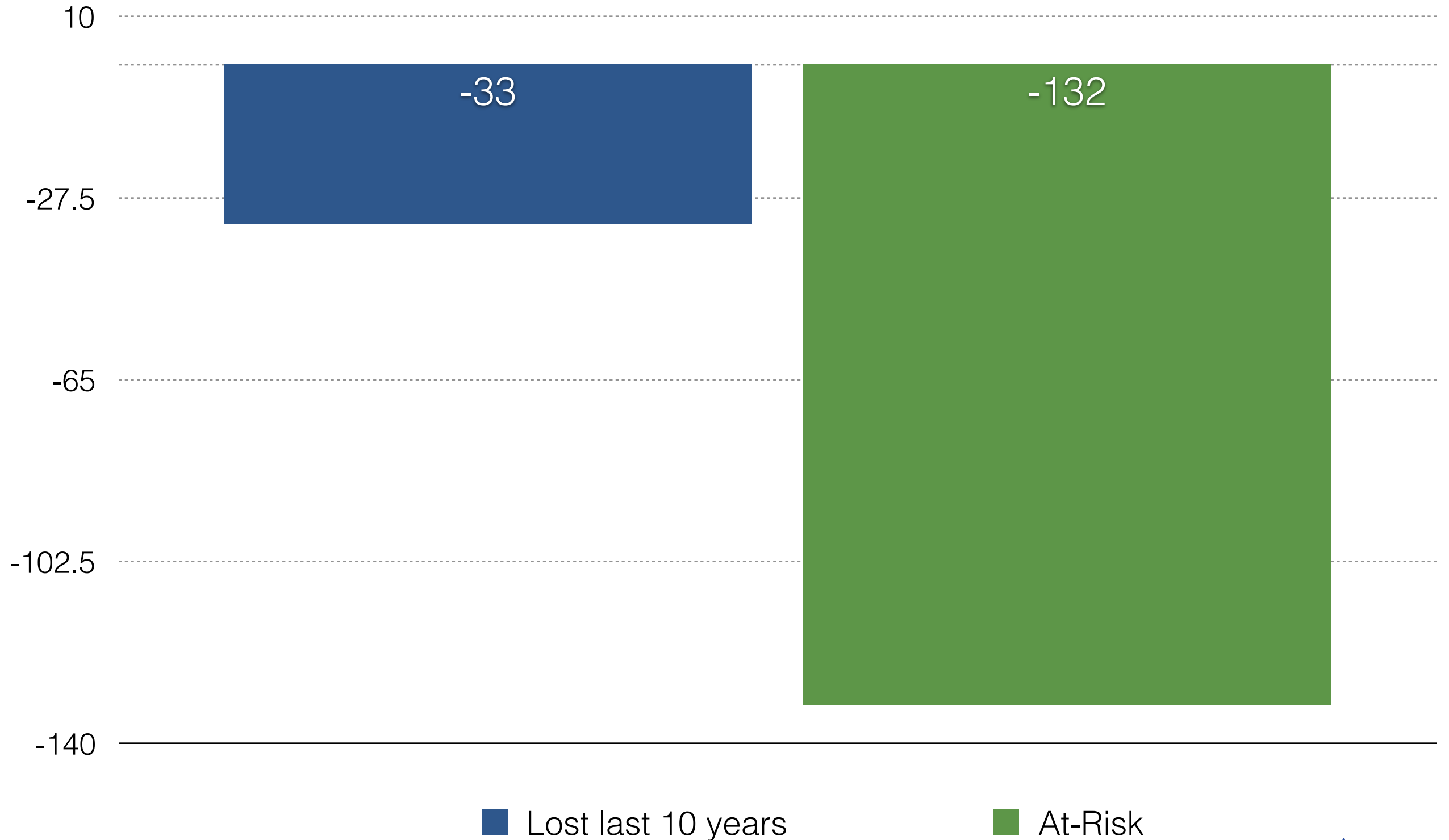


# Globally, 132 GW of Nuclear Could Be Lost by 2030

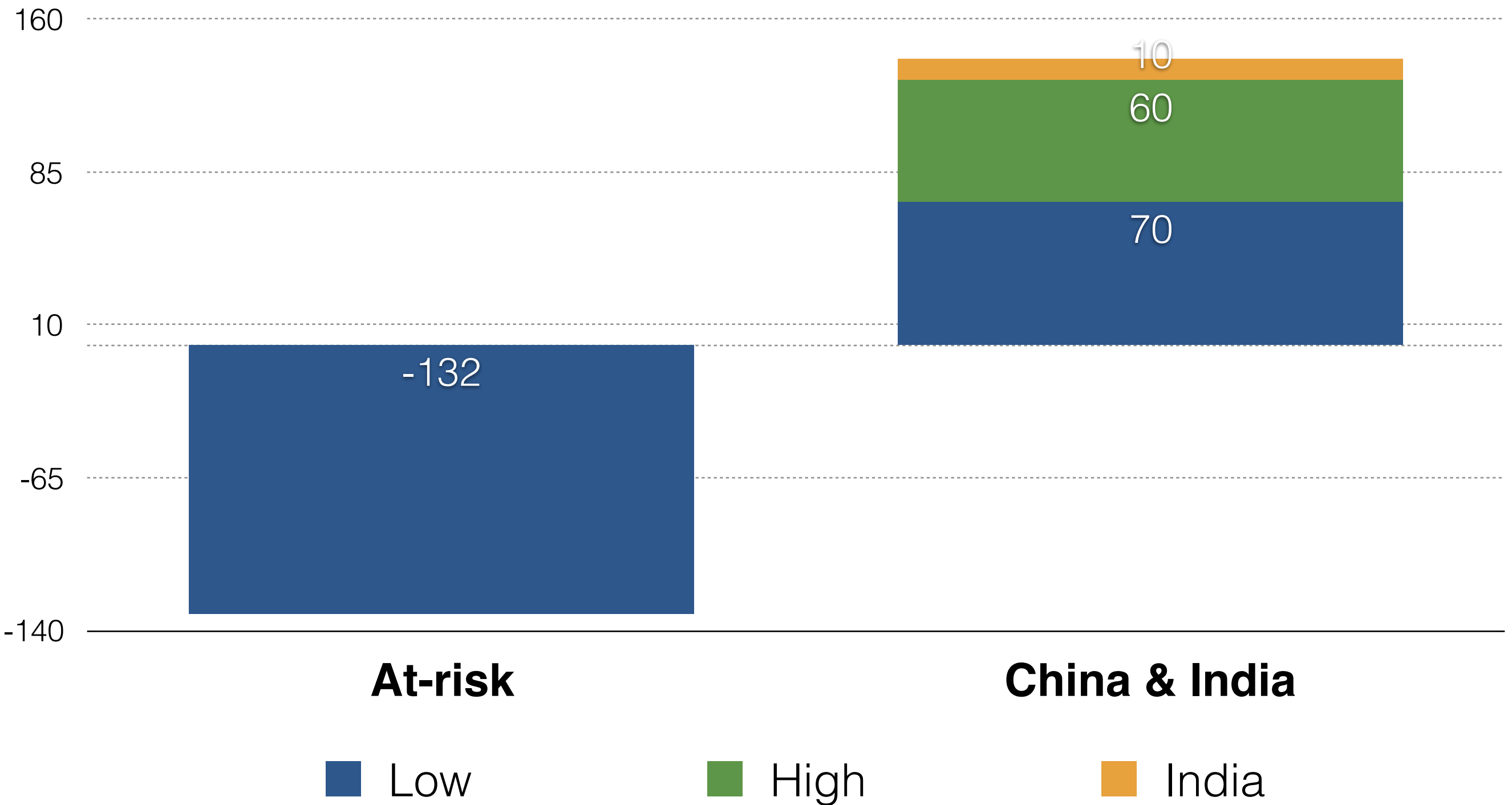


**Sources:** Environmental Progress estimates based on WNA, EIA, BNEF, interviews and analysis, 2016.

# World at risk of losing four times more nuclear over next 13 years than we lost over last 10



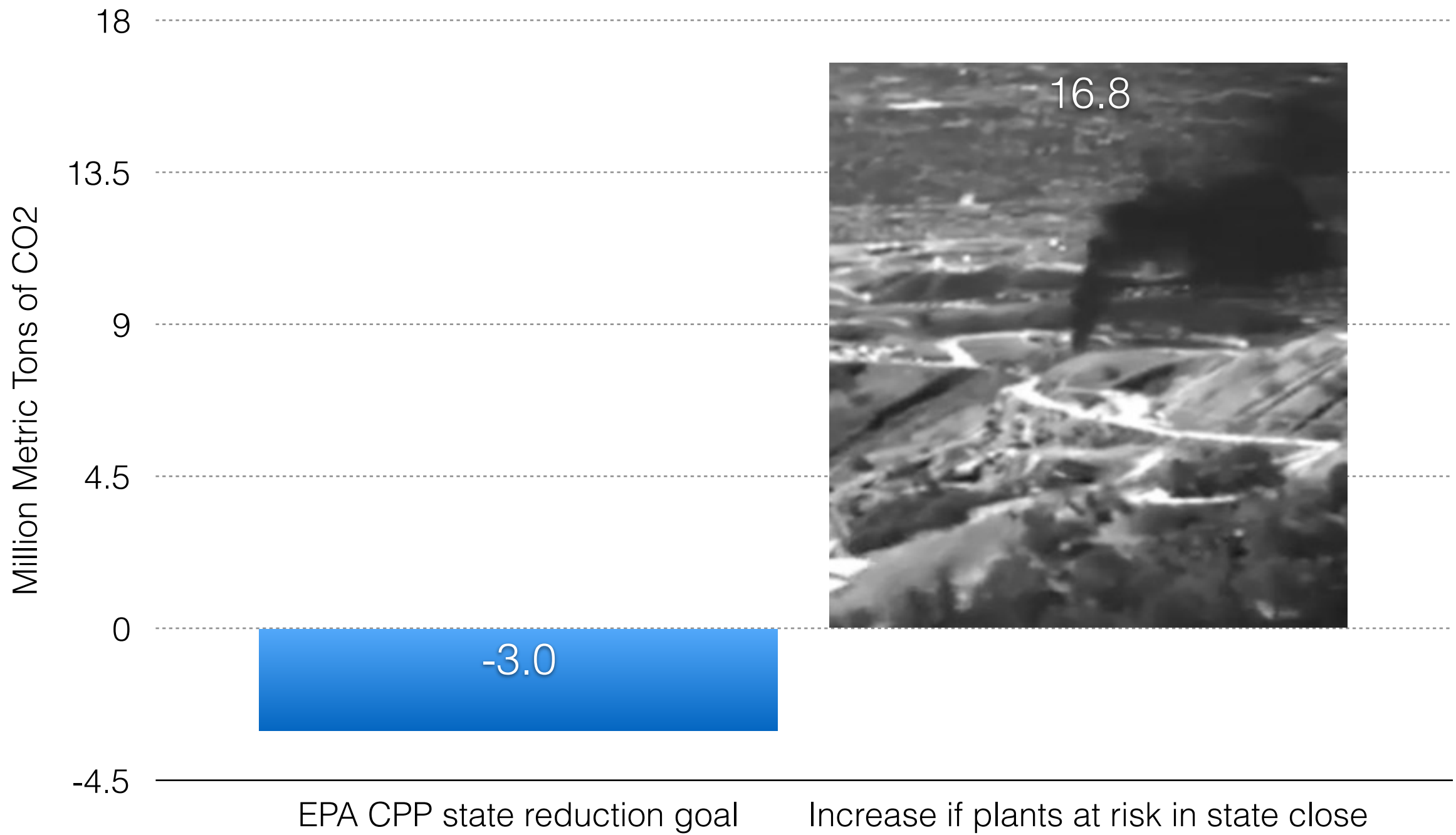
# China & India Not Building Enough Nuclear to Make up the Difference



Sources: Interviews with Chinese officials (and consonant with WNA) 2016; Indian government planning documents & interviews with Indian officials

# Closer Look at U.S.

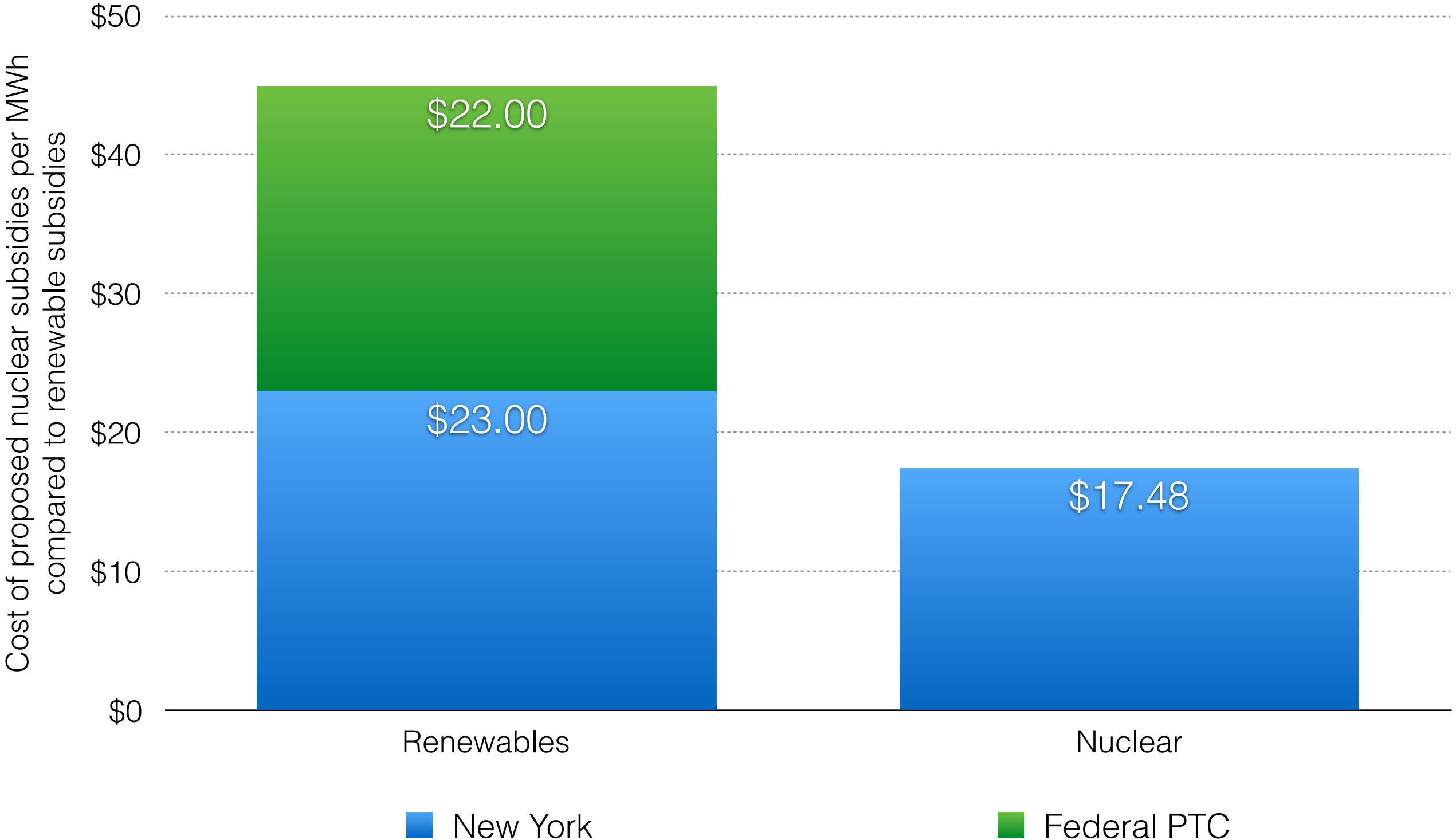
# Loss of Nuclear Plants Would Create 5 Times More Emissions than New York State Must Reduce Under EPA Clean Power Plan



Source: EPA, EIA



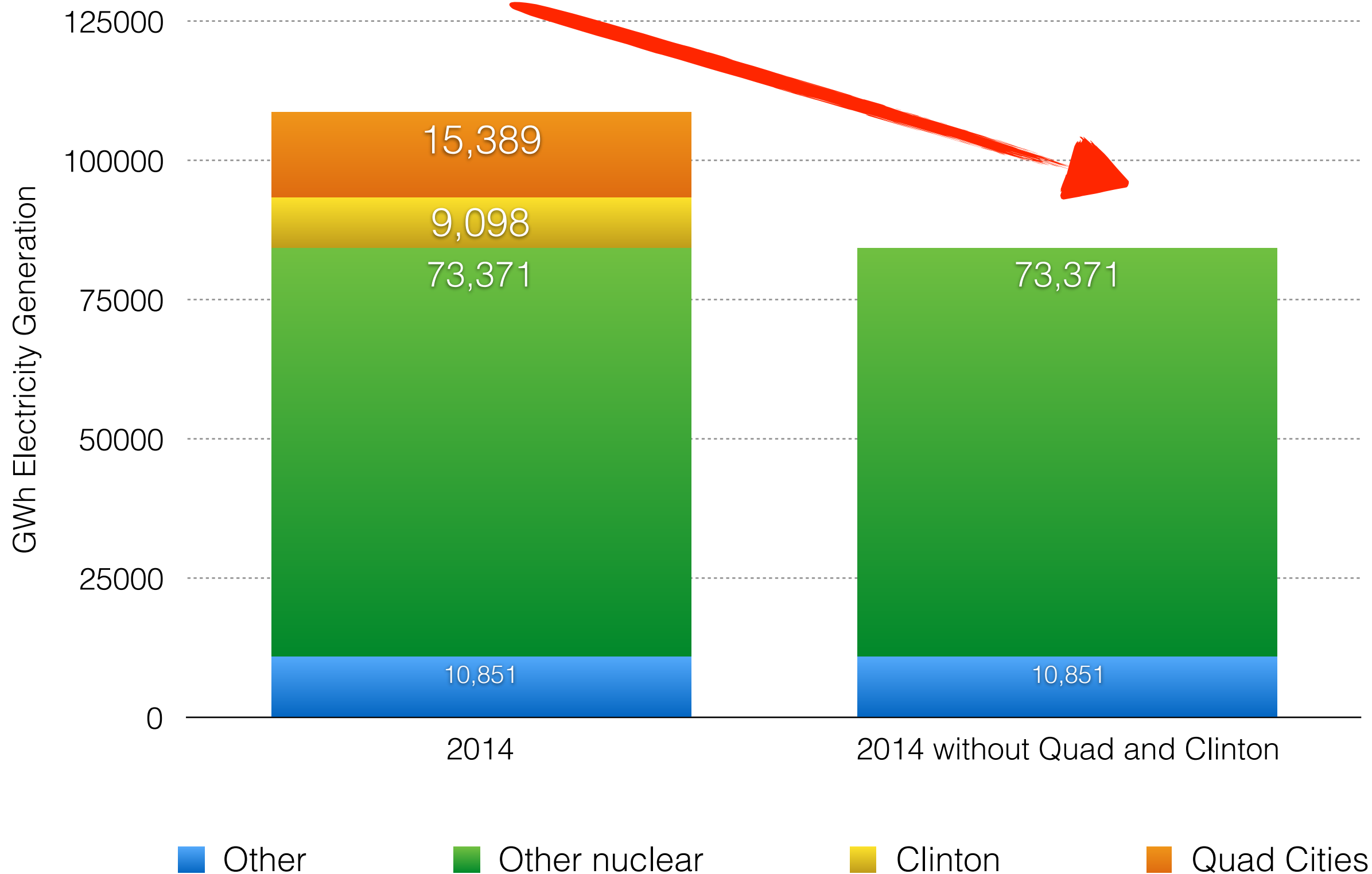
# Renewables Subsidies 2x More Expensive than Proposed New York Nuclear Subsidies



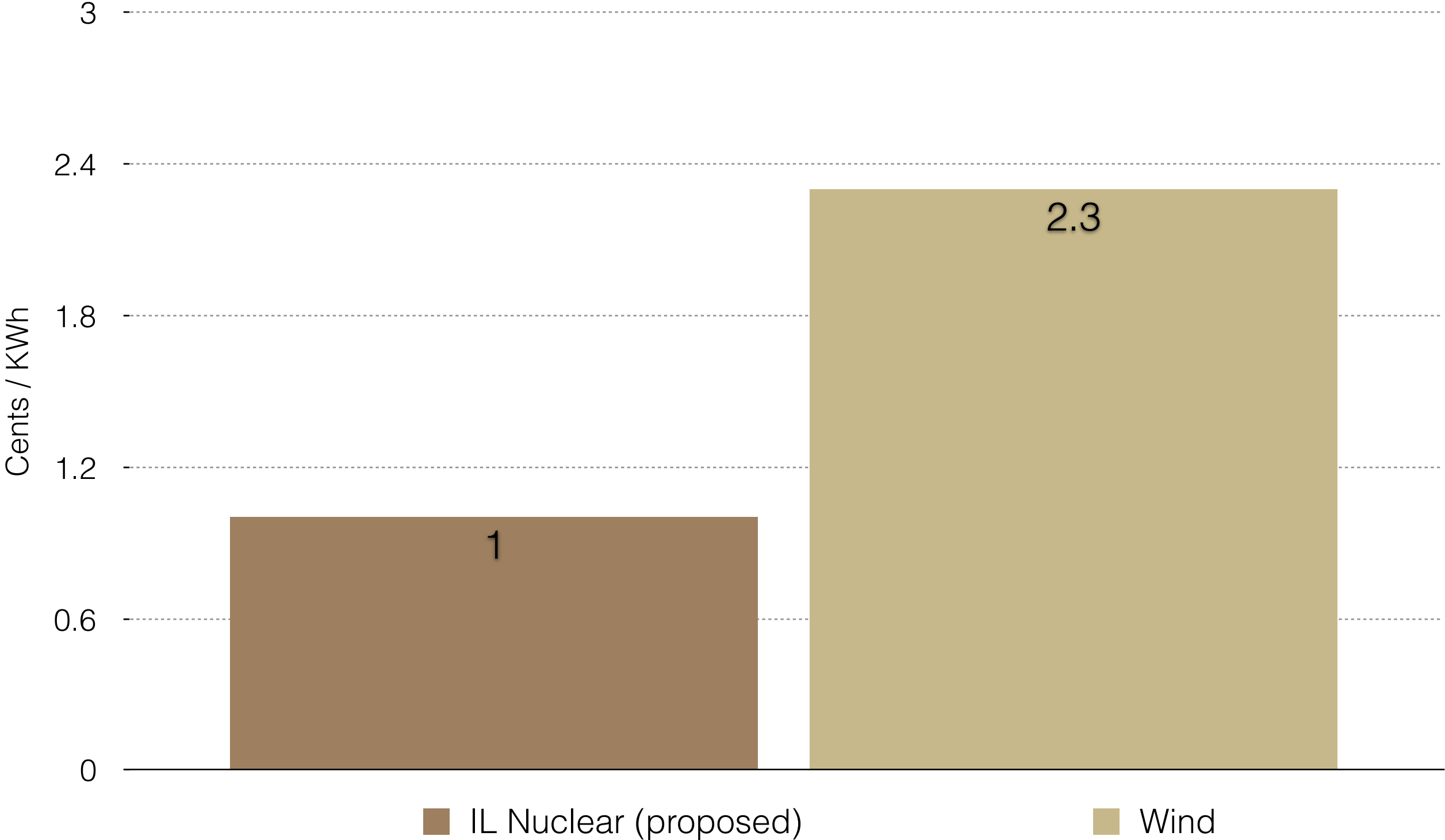
**Source:** NYSERDA, PSC

New York victory buys us time but  
gives no incentive to replace  
much less add to new nuclear.

# If Quad Cities and Clinton close, 23% of Illinois's clean electricity would be lost

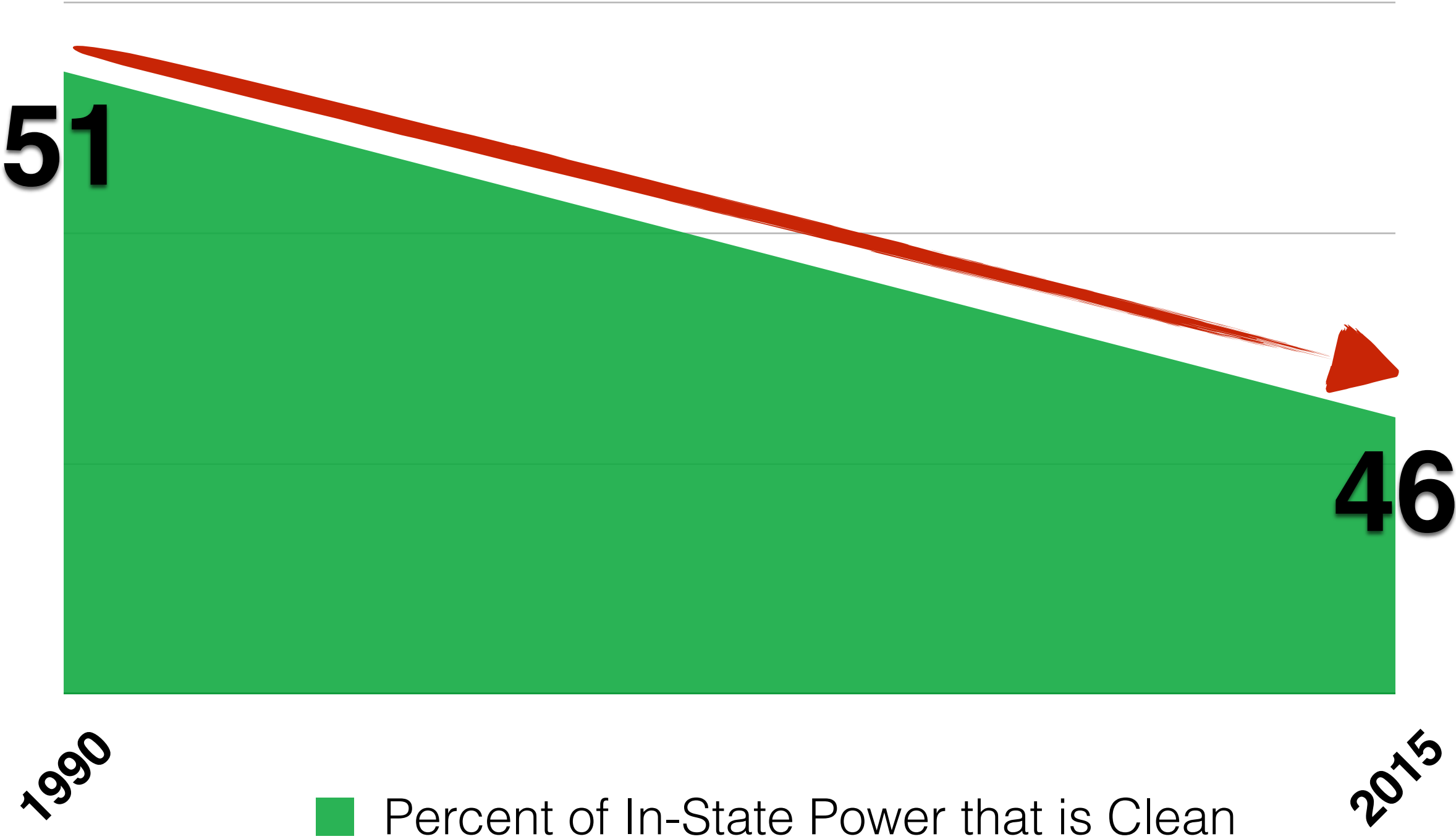


# Proposed Illinois Nuclear Subsidy Would Cost Less than Half of Wind Subsidy



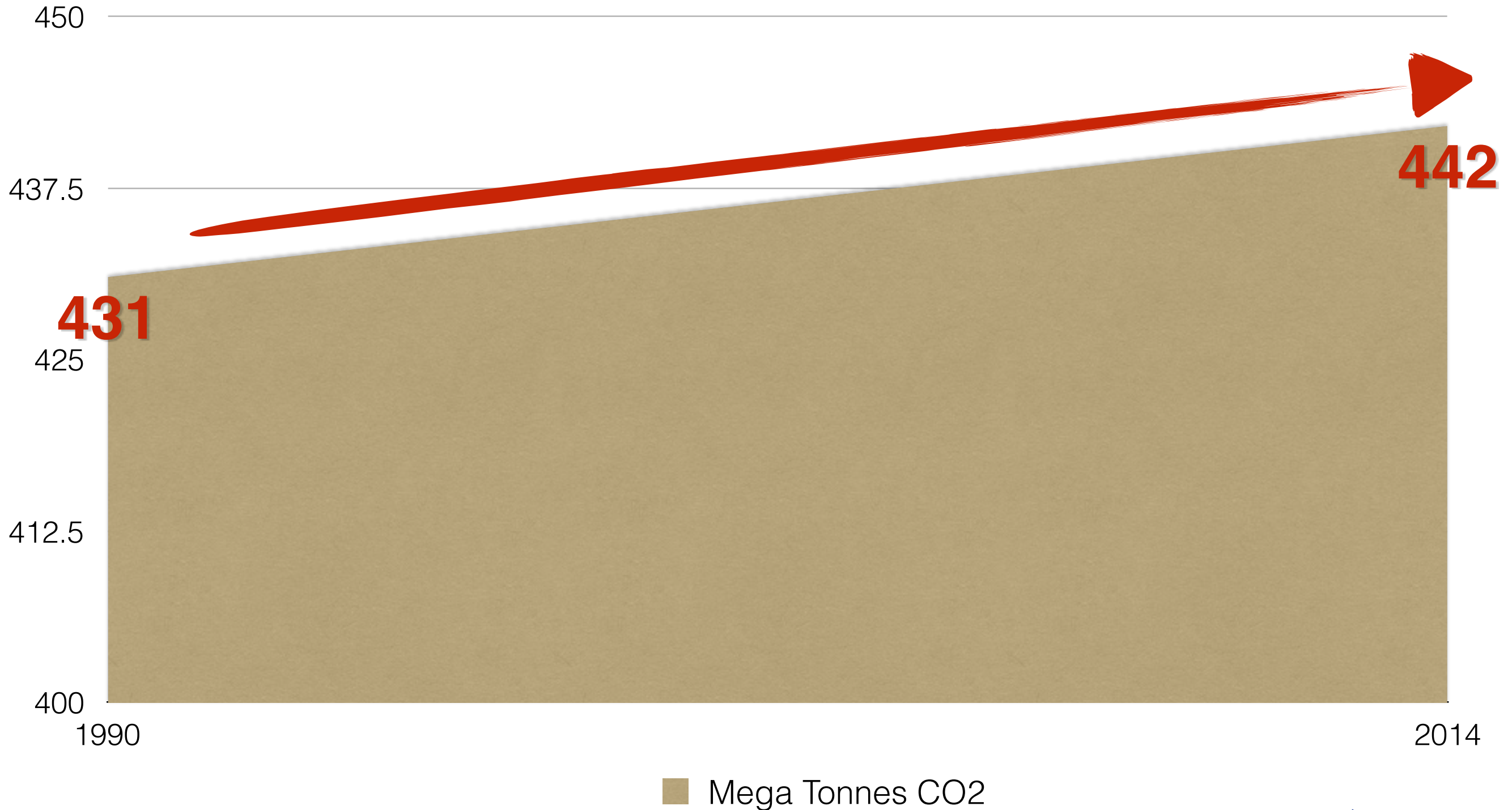
Source: Calculations based on \$250 million/year subsidy (high end estimate) from Steve Daniels, Crane's, May 19, 2016. DOE Wind PTC.

# Clean California Power Declined



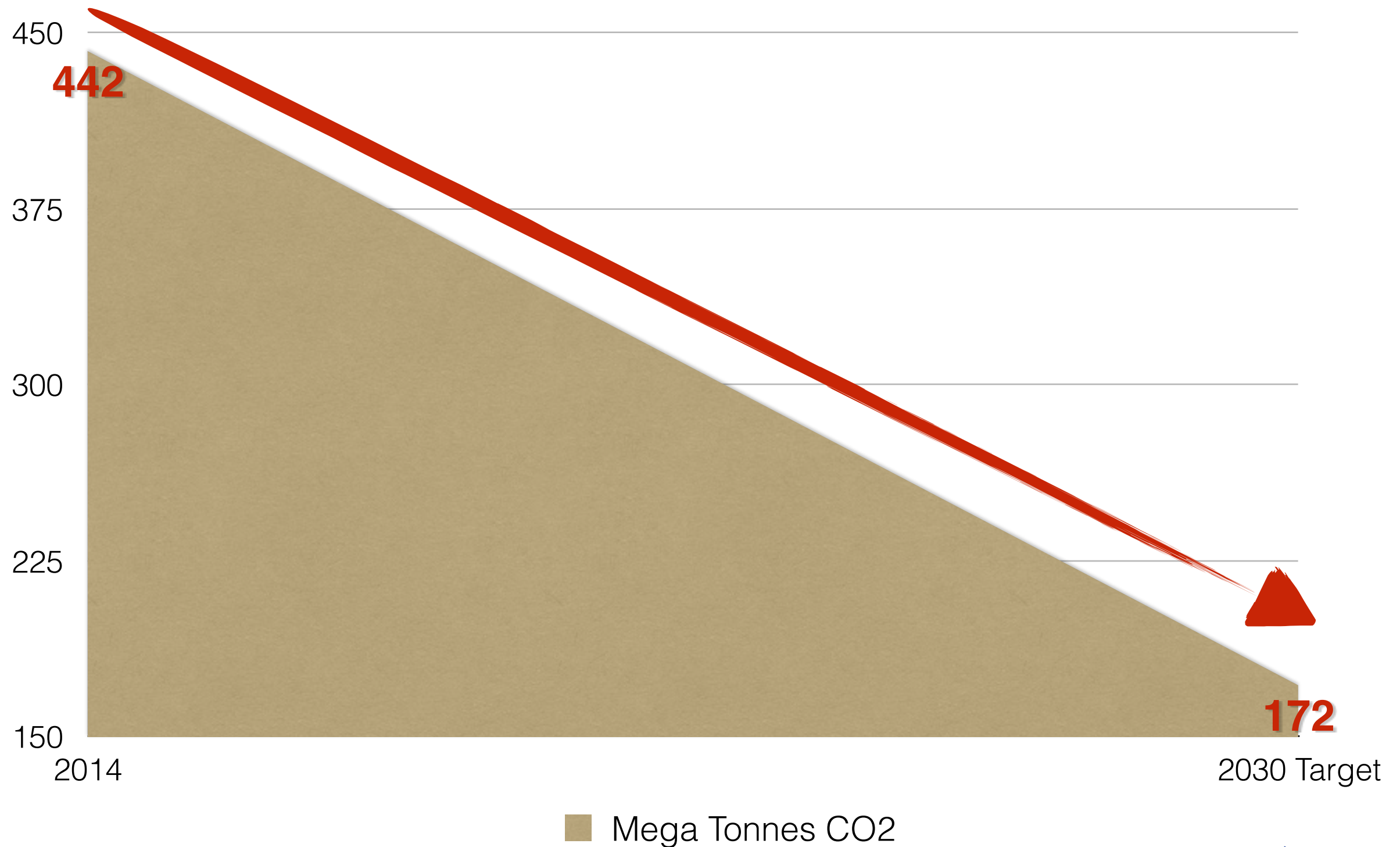
**Source:** California Almanac, "In-state System Power," 2016; **Rooftop Solar Added;**  
[https://docs.google.com/spreadsheets/d/1uXuqaE-BBvdNLnmuUic5mmhCkqOoU0VTunn3meS\\_dAU/edit?usp=sharing](https://docs.google.com/spreadsheets/d/1uXuqaE-BBvdNLnmuUic5mmhCkqOoU0VTunn3meS_dAU/edit?usp=sharing)

# California Emissions Rose Since 1990



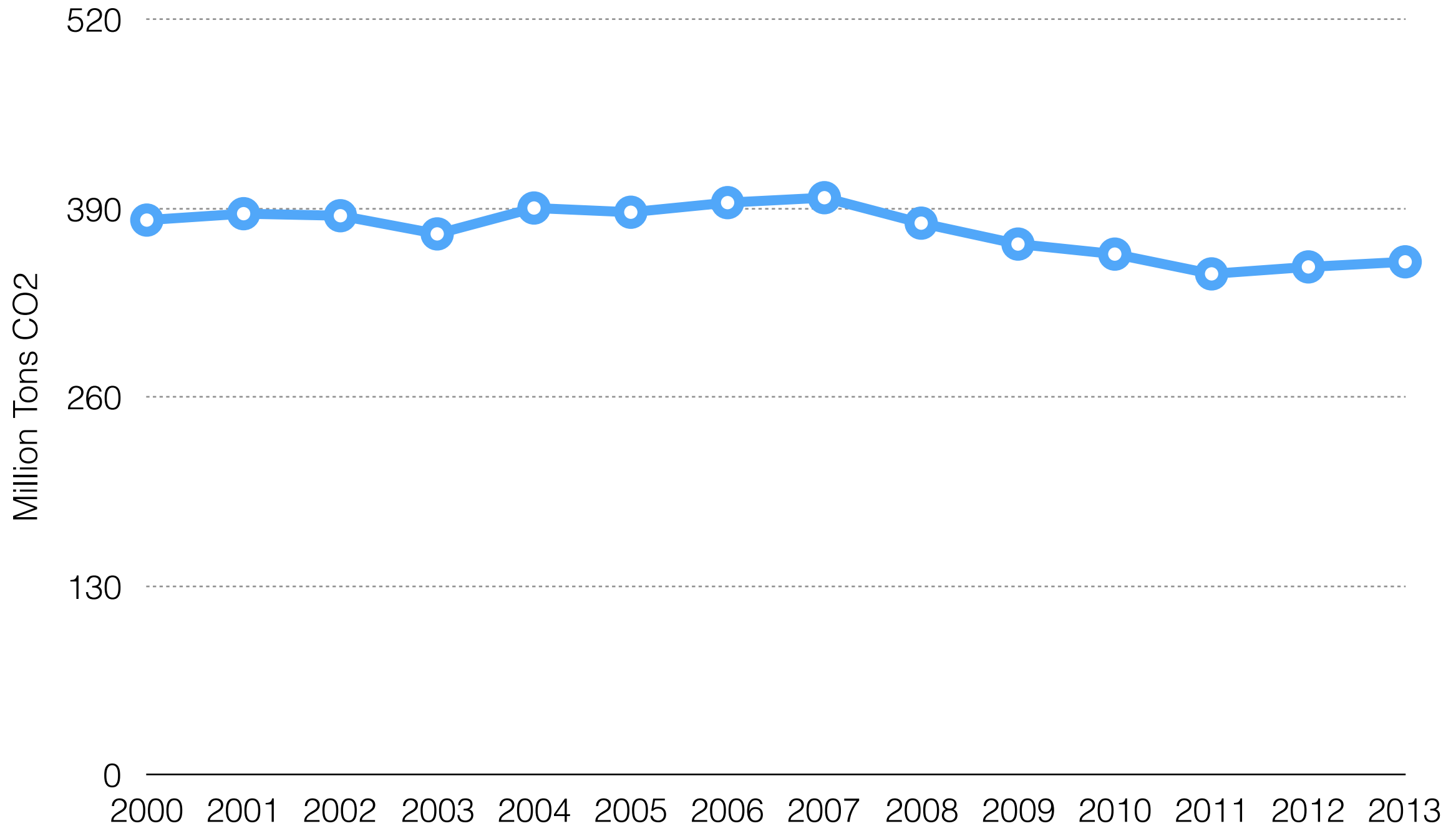
**Source:** California Air Resources Board (CARB), "2016 Edition California Greenhouse Gas for 2000-2014 — by Sector and Activity," 2016

# California Emissions Actual & Target



**Source:** California Air Resources Board (CARB), "2016 Edition California Greenhouse Gas for 2000-2014 — by Sector and Activity," 2016

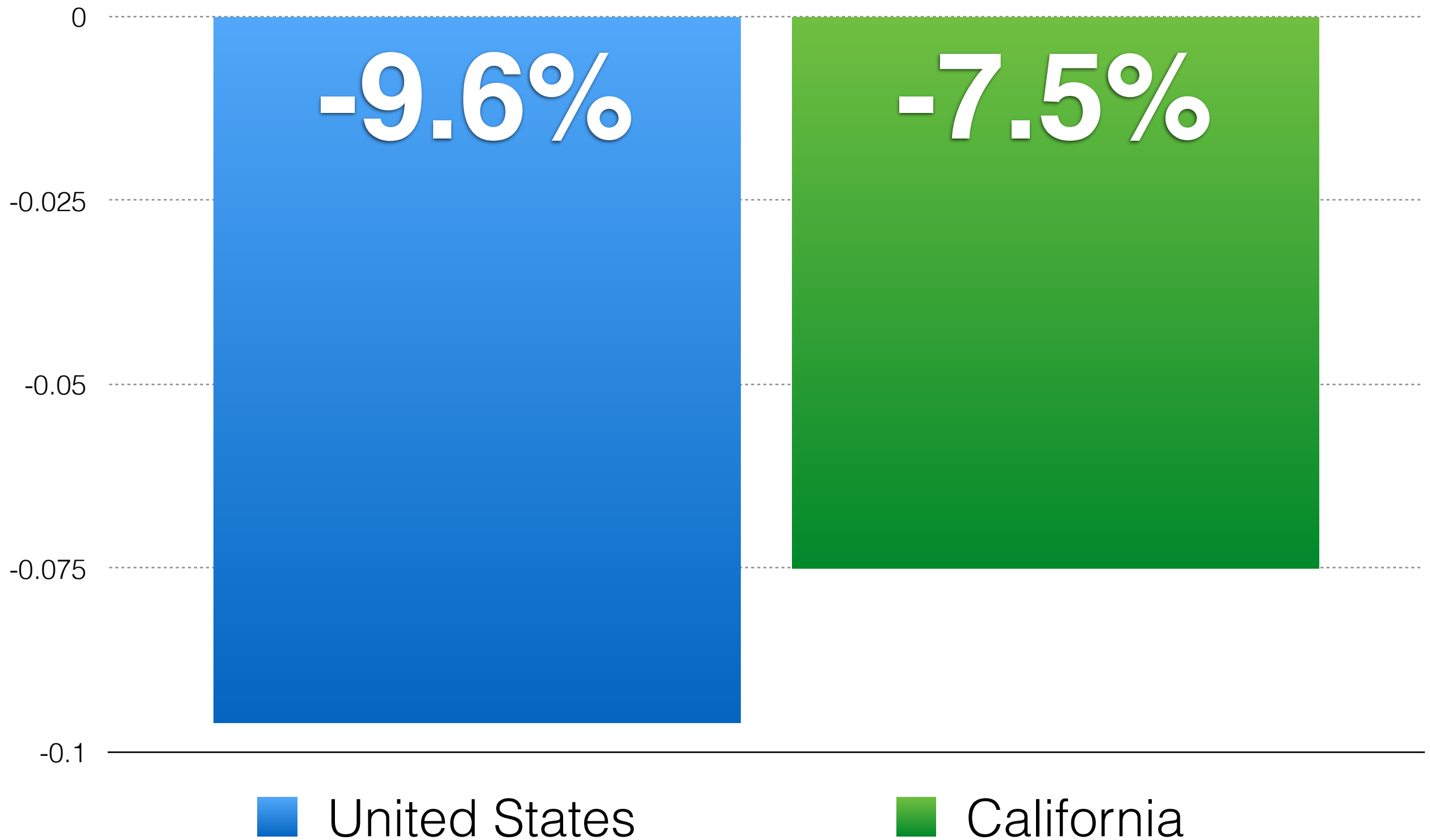
# California Emissions did decline since 2000...



**Source:** EIA, State Energy Emissions Data, 2016

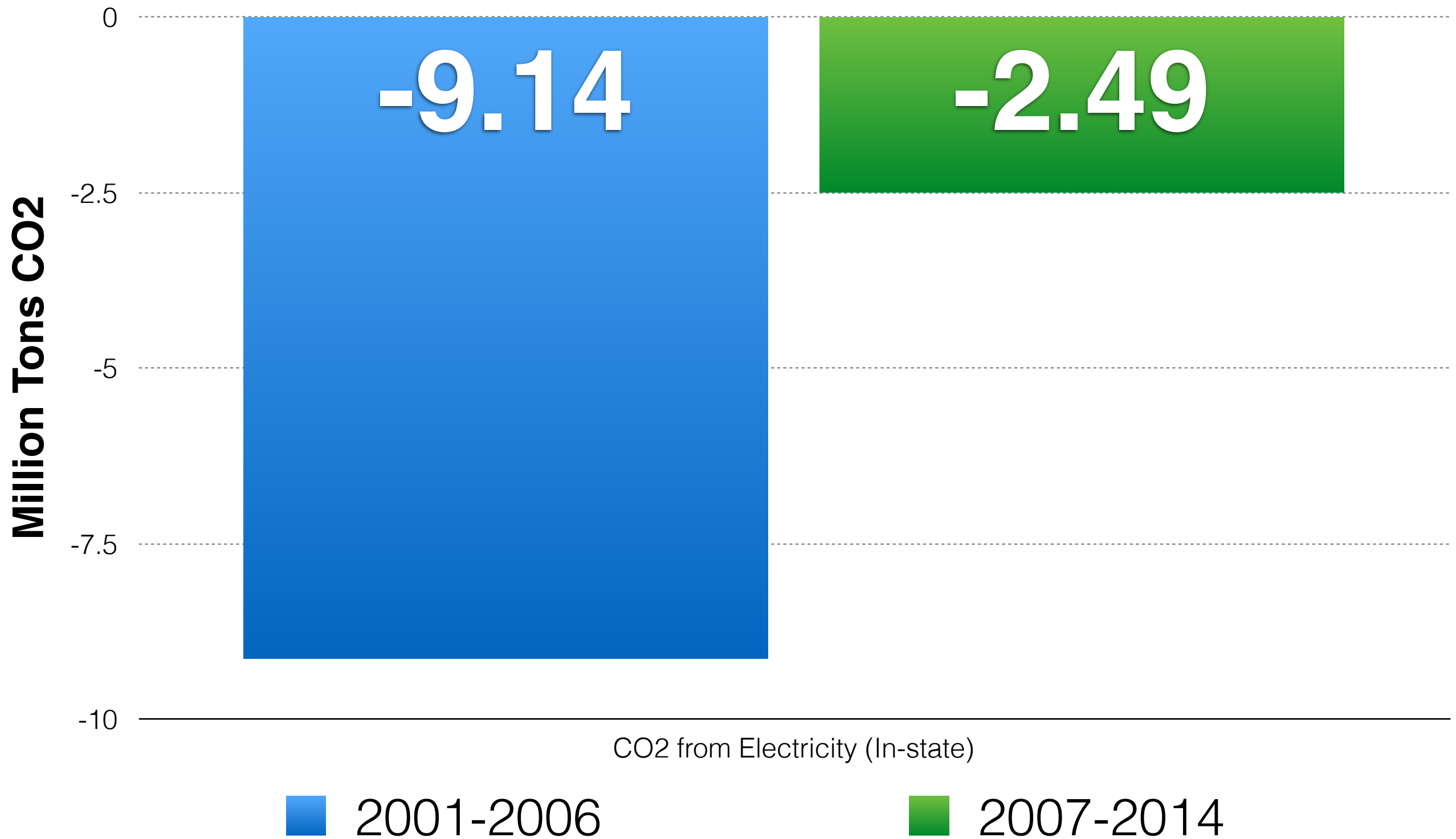


# ...but less than national average



**Source:** EIA, State Energy Emissions Data, 2016

# ...and less after passage of climate legislation than before

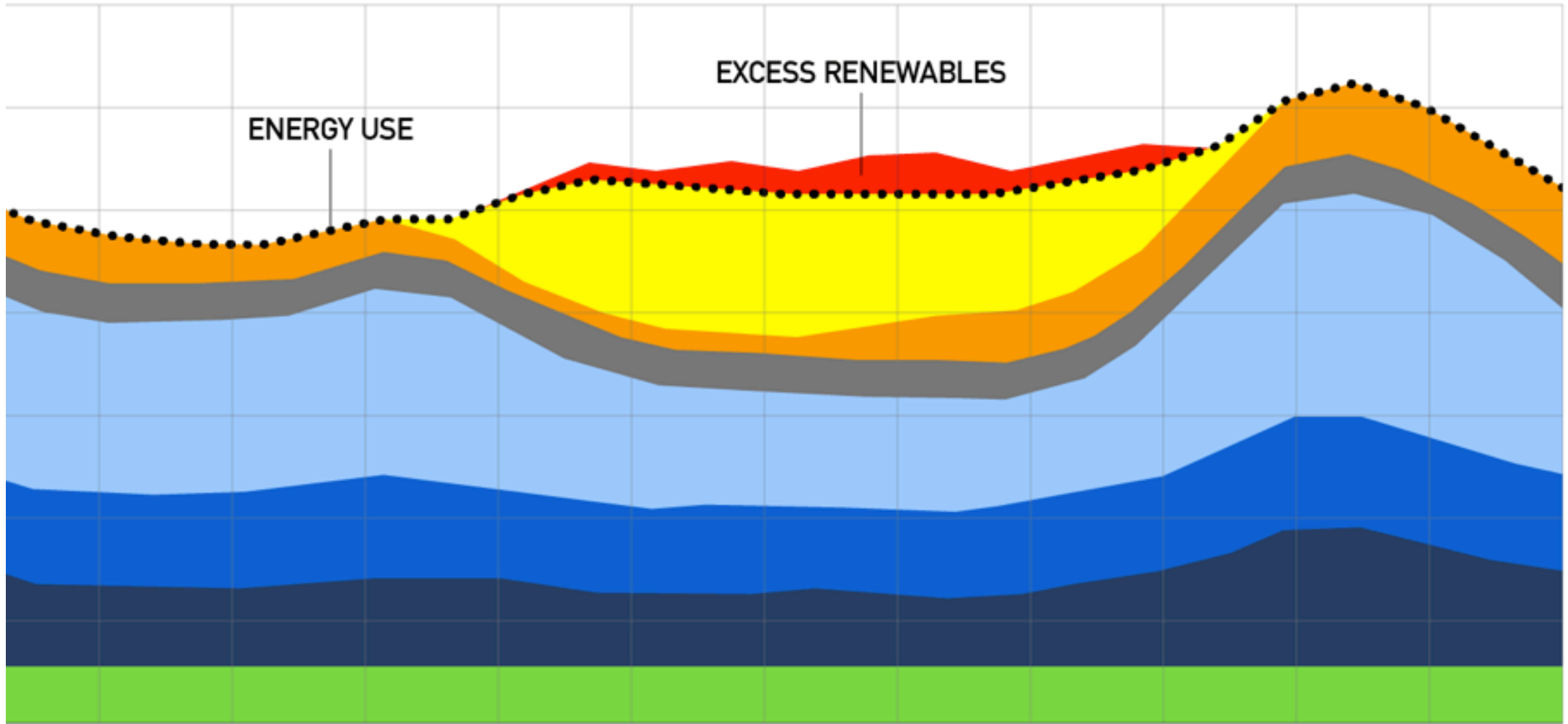


**Source:** CARB, 2016 Edition California Greenhouse Gas Inventory for 2000-2014 — by Sector and Activity, 2016

**Because solar and wind produce power just 10 - 30% of the time they *almost always* require fossil fuel back-up**



Methane gas leaking from Aliso Canyon, California, where it was stored to provide rapid back-up power to solar & wind. Source: Environmental Defense Fund

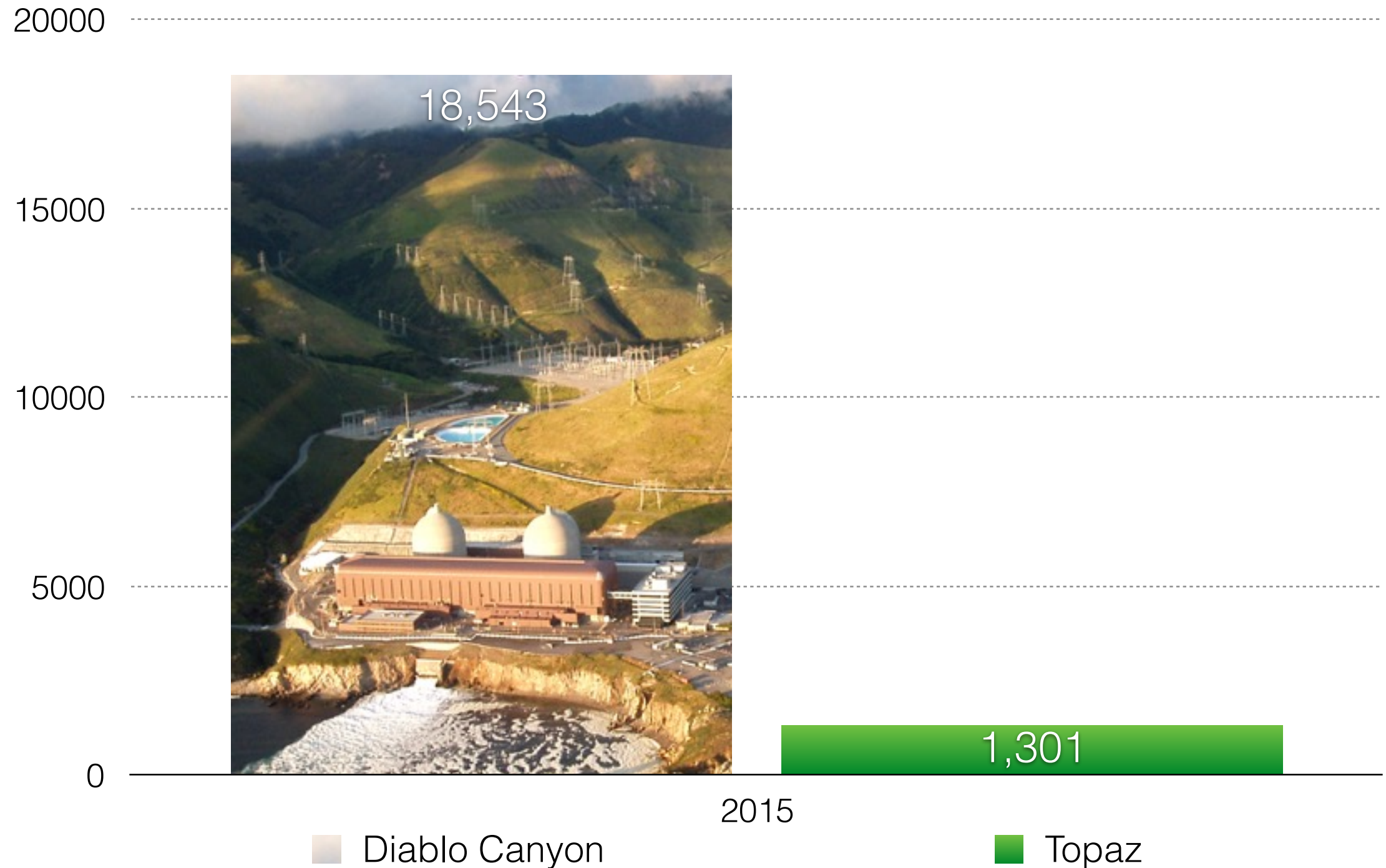


2AM 4AM 6AM 8AM 10AM 12PM 2PM 4PM 6PM 8PM 10PM

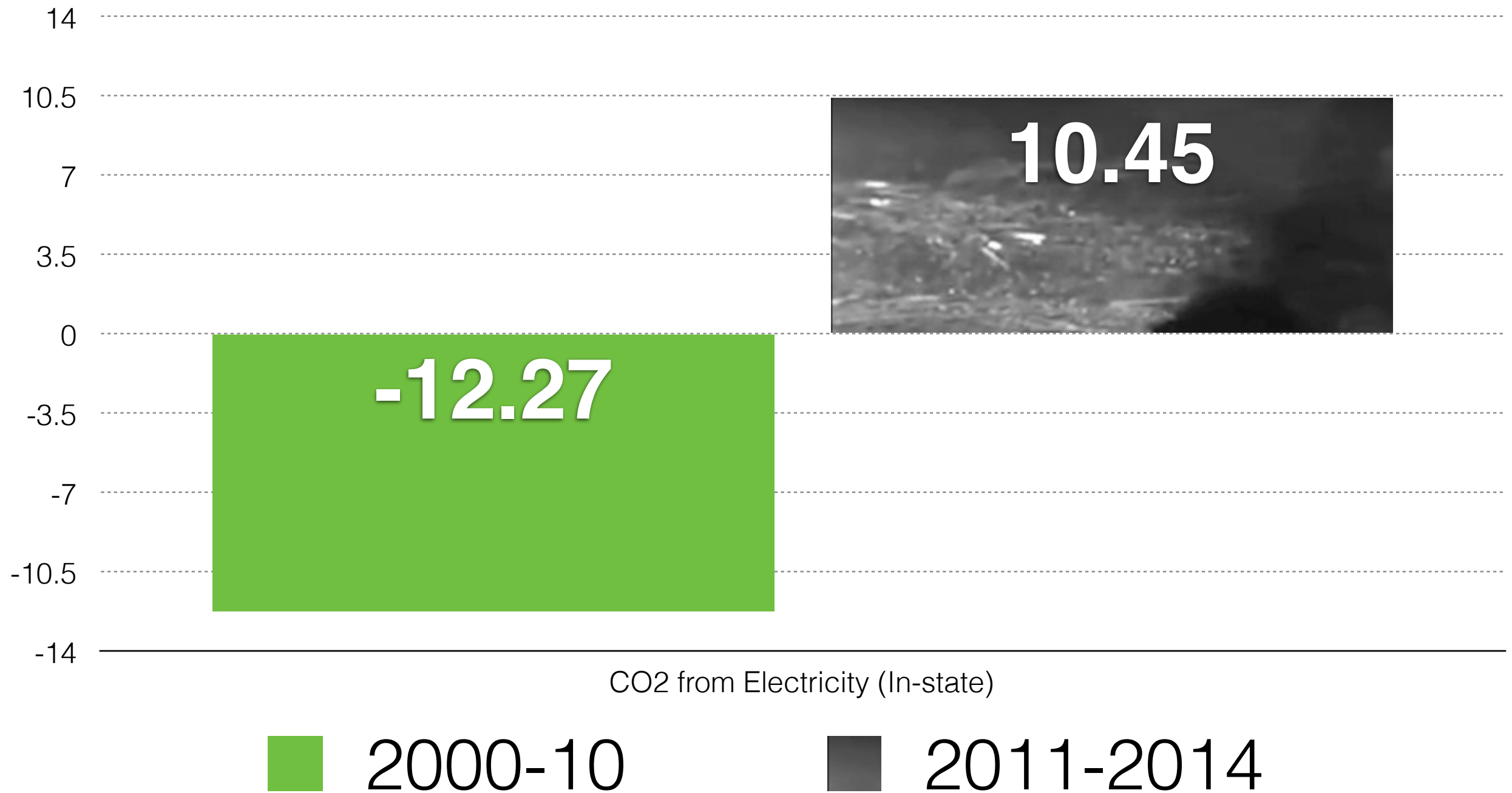
- NATURAL GAS
- IMPORTS
- WIND
- SOLAR
- NUCLEAR
- HYDRO
- BIOMASS/GAS  
GEOTHERMAL
- EXCESS  
RENEWABLES

KQED

# Diablo Canyon produced 14 times more electricity than Topaz, one of world's largest solar farms

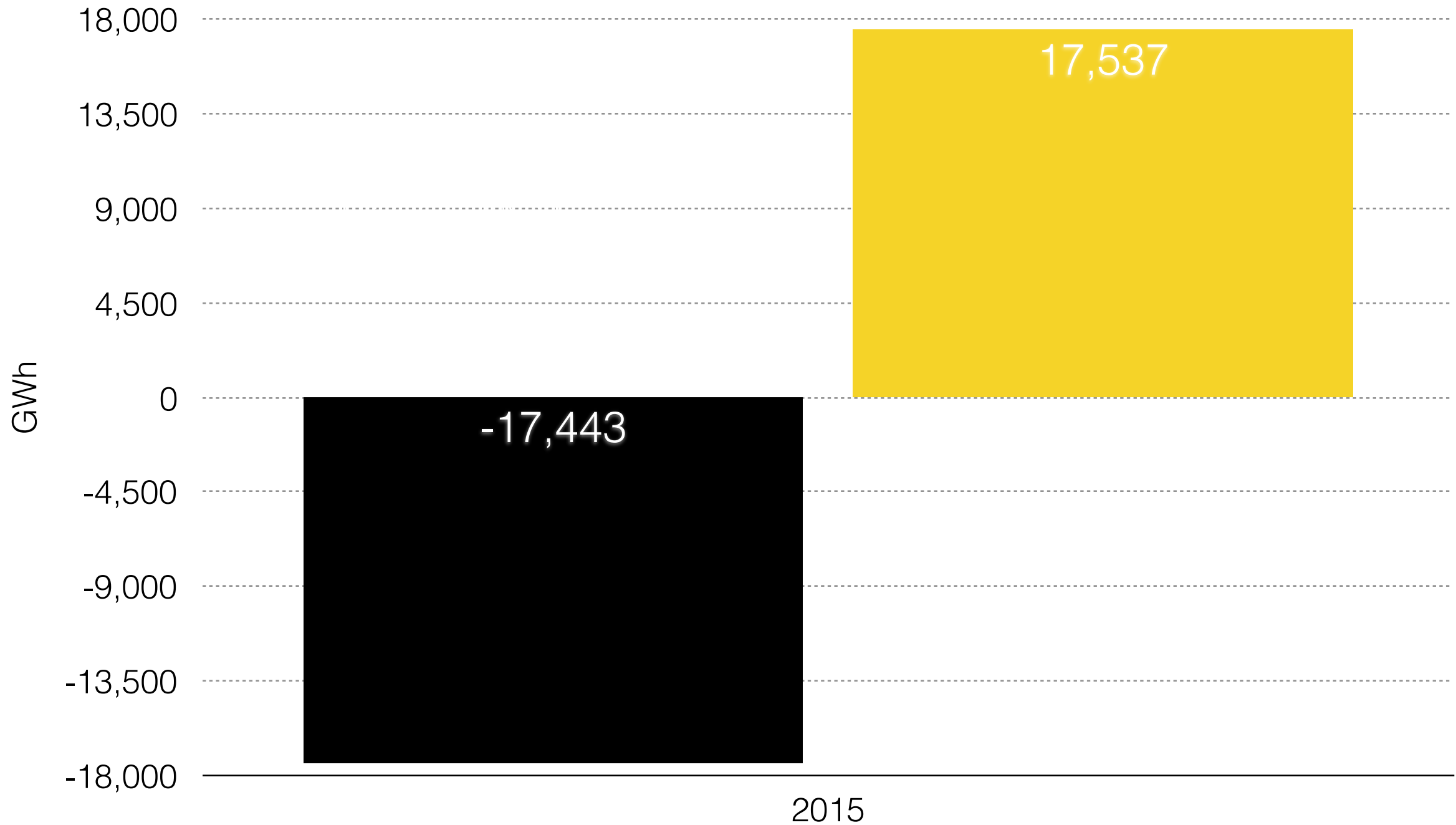


# California Power Emissions Rose Dramatically After Closure of San Onofre Nuclear Plant

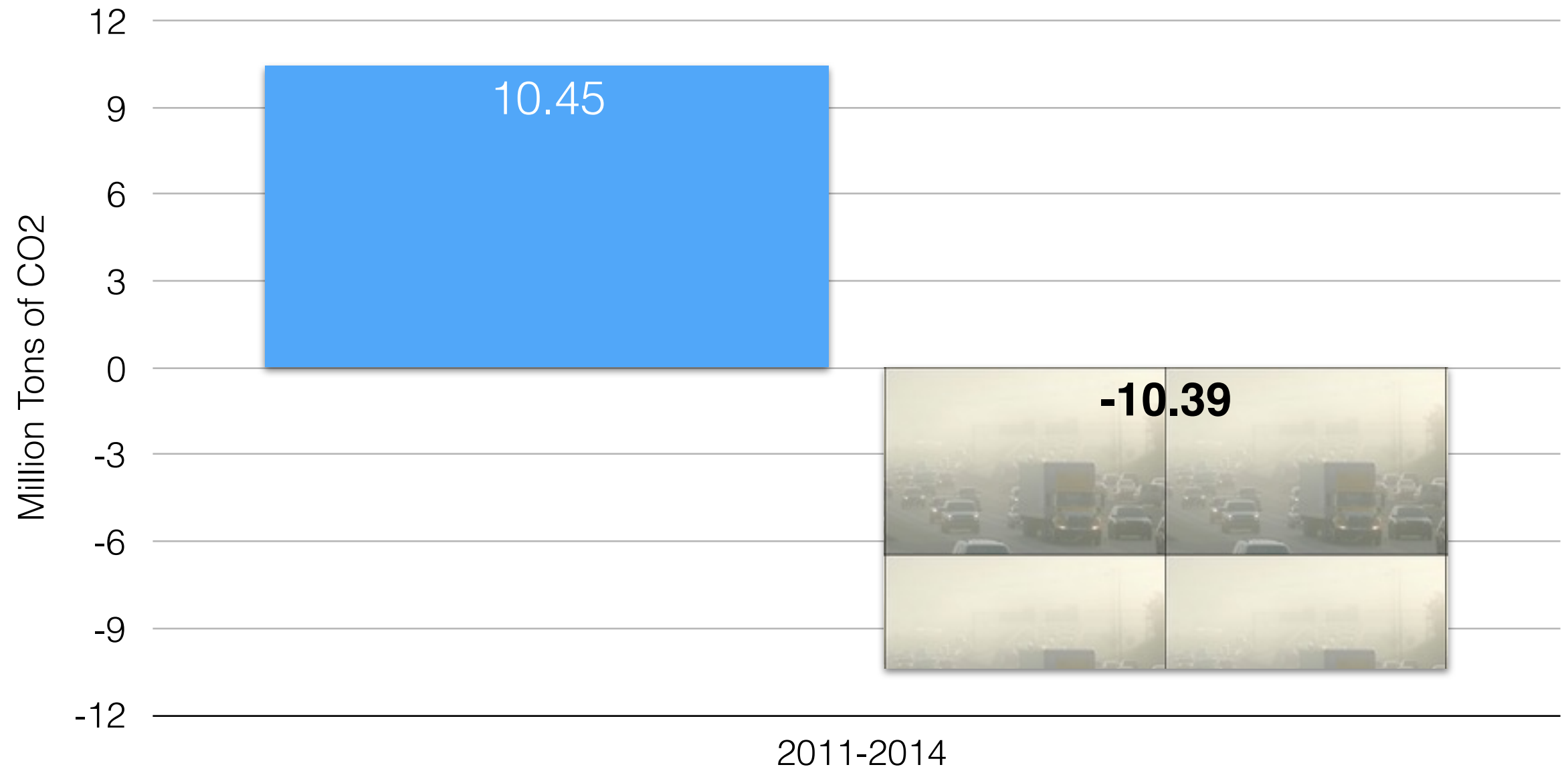


**Source:** CARB, 2016 Edition California Greenhouse Gas Inventory for 2000-2014 — by Sector and Activity, 2016

# Loss of San Onofre Cancelled Out Solar Gains



# Decline in Emissions from Out-of-State Power Canceled Out by Rise of In-State Power Emissions



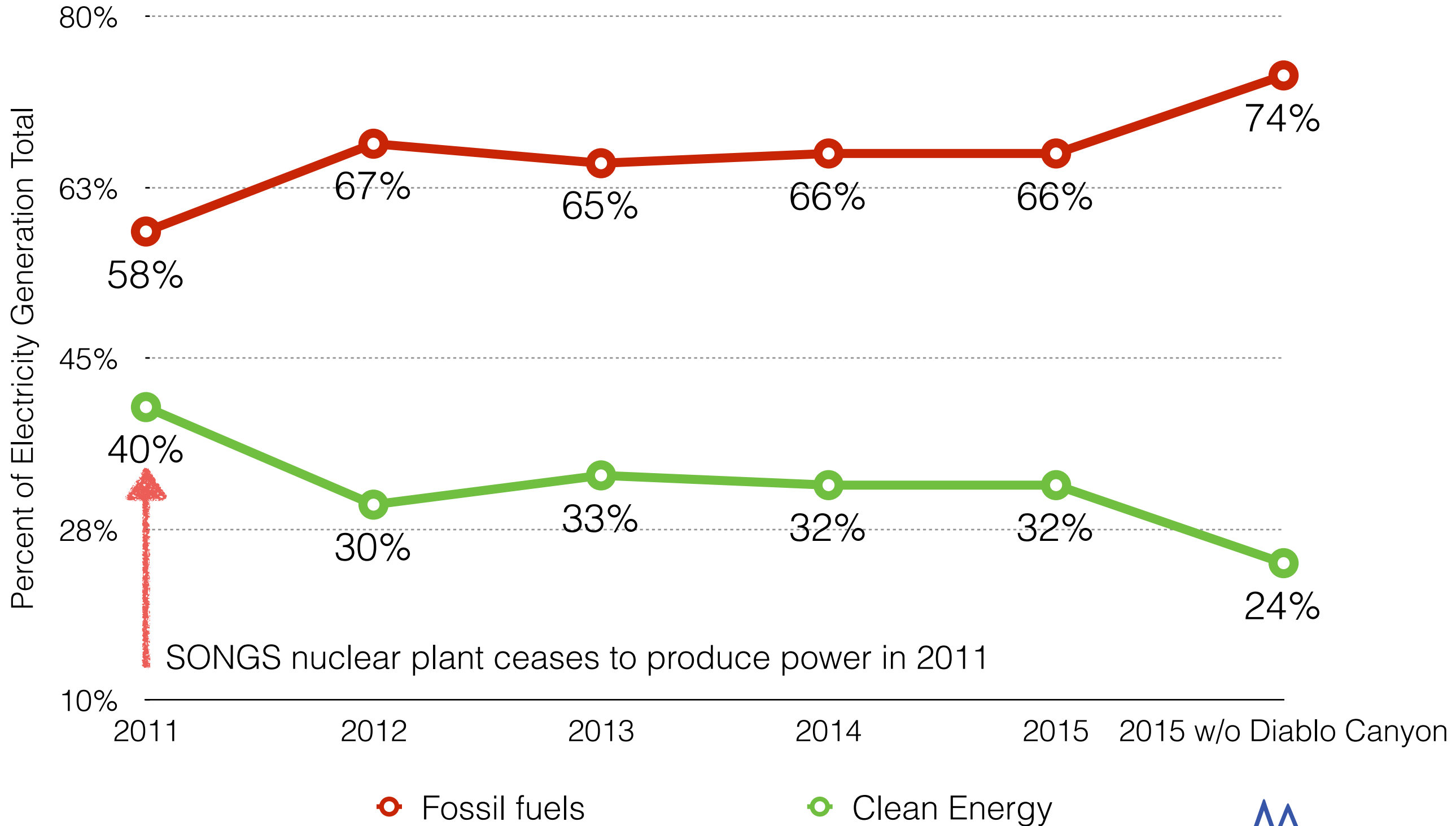
■ Change in CO2 from In-State Power

■ Change in CO2 from Power Imports

**Source:** CARB, 2016 Edition California Greenhouse Gas Inventory for 2000-2014 — by Sector and Activity, 2016



# Total Nat Gas Rises with Nuclear Closures



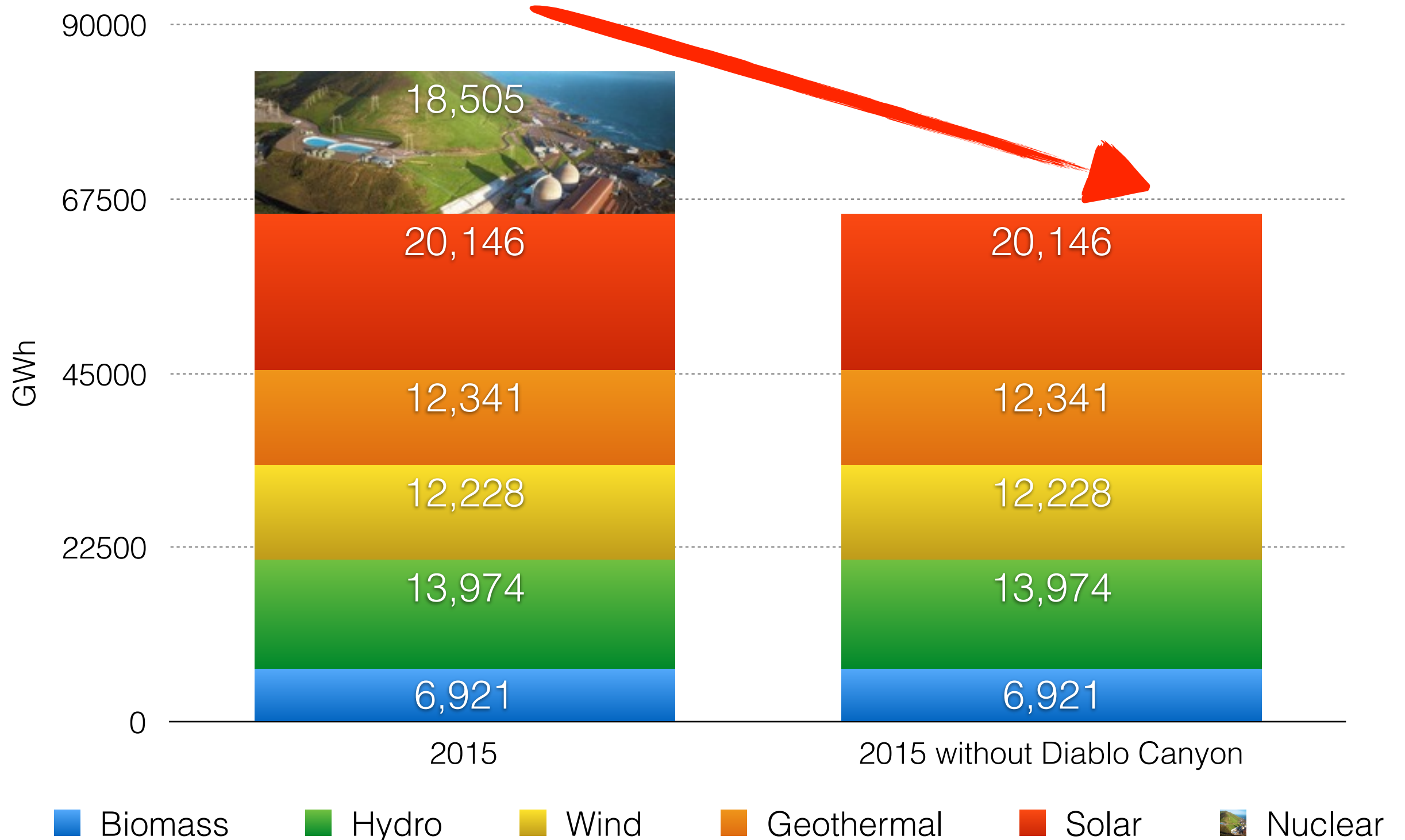
SONGS nuclear plant ceases to produce power in 2011

○ Fossil fuels

○ Clean Energy

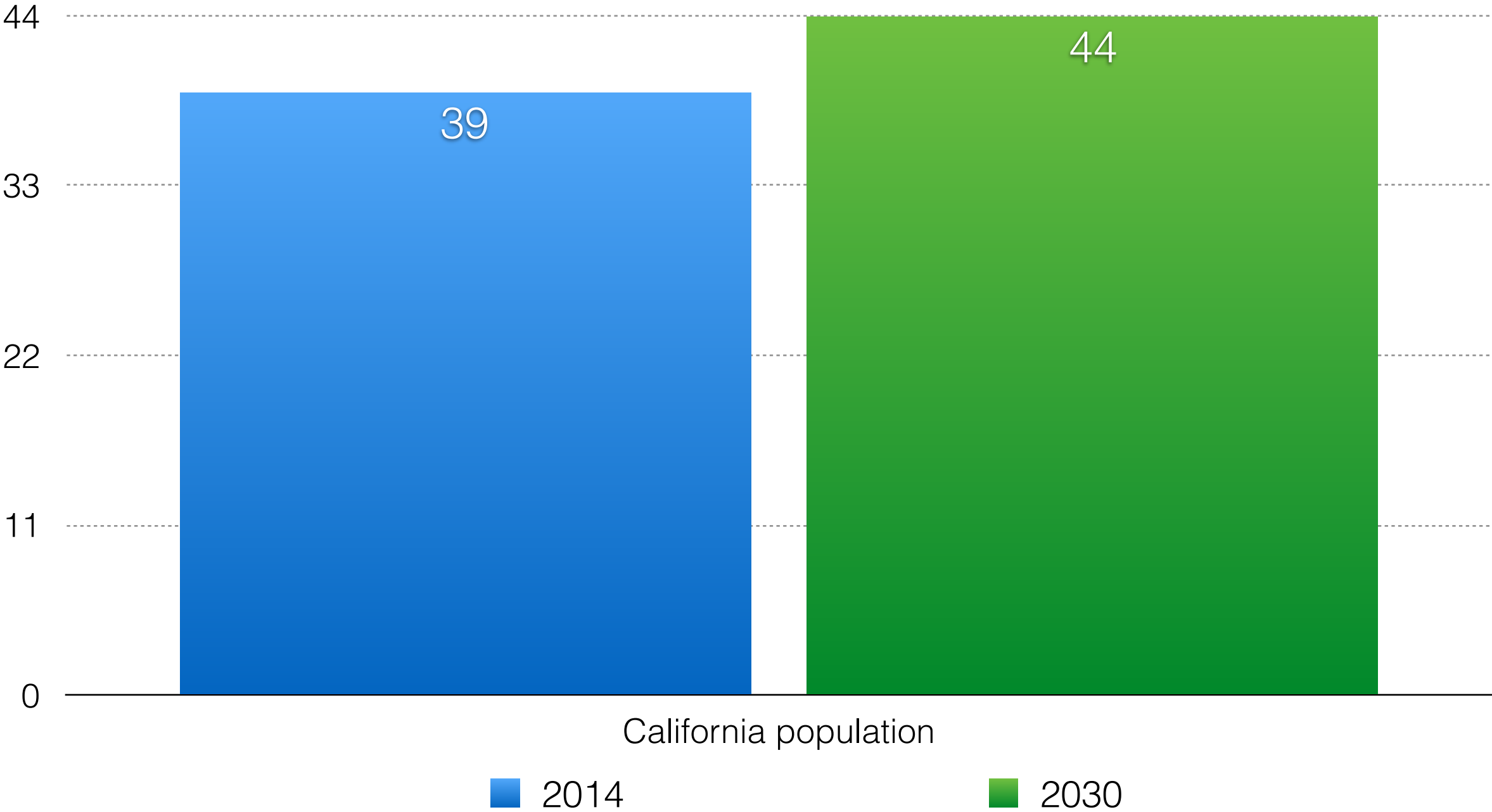
If Diablo Canyon is closed early, it could result in over 5,000 premature deaths from air pollution.

# If Diablo closes, 21% of California's clean electricity would be lost



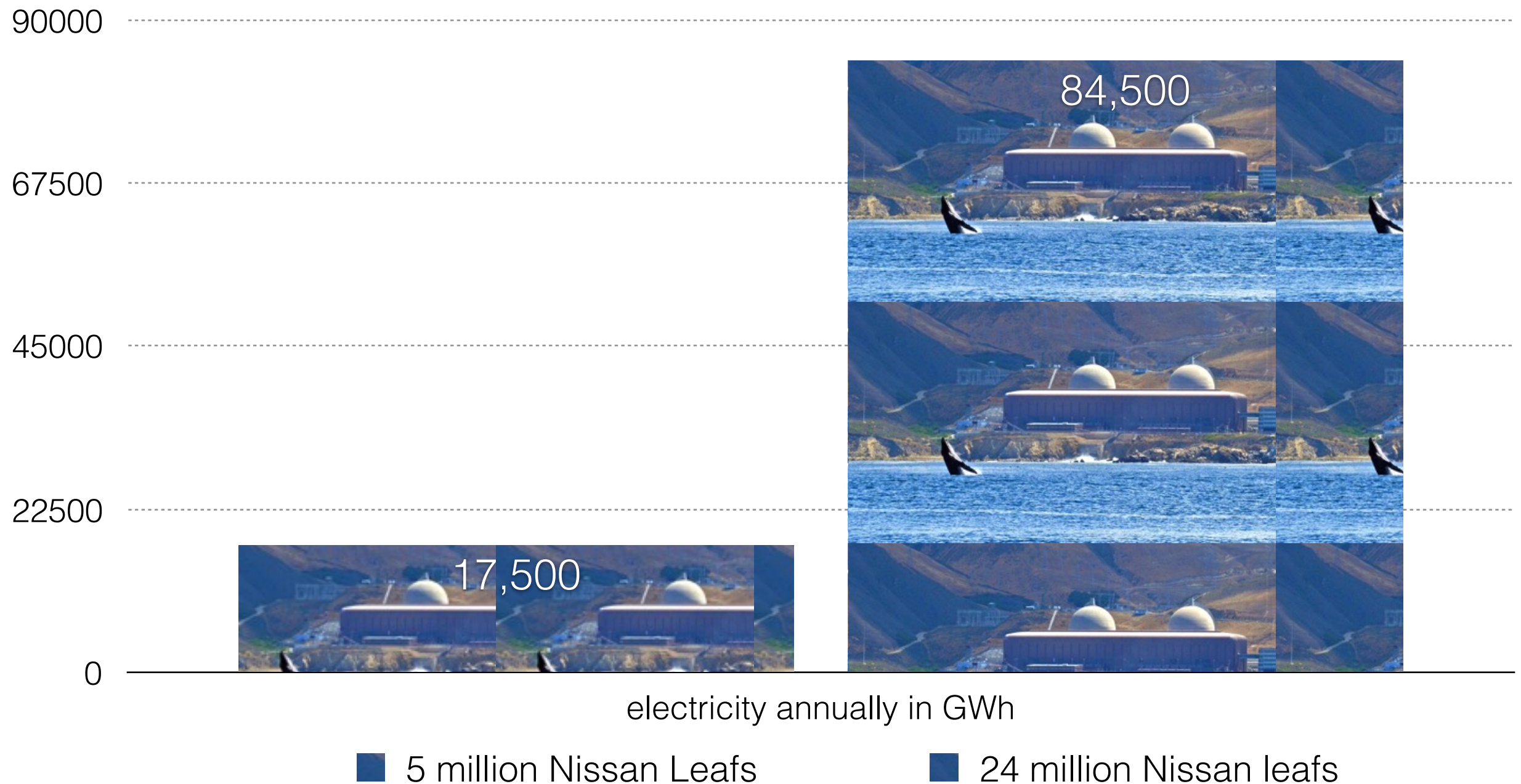
Includes distributed solar

# California Population Expected to Rise 13% by 2030



**Source:** California Department of Finance, "Projections: Population" 2016, <http://www.dof.ca.gov/Forecasting/Demographics/projections/>

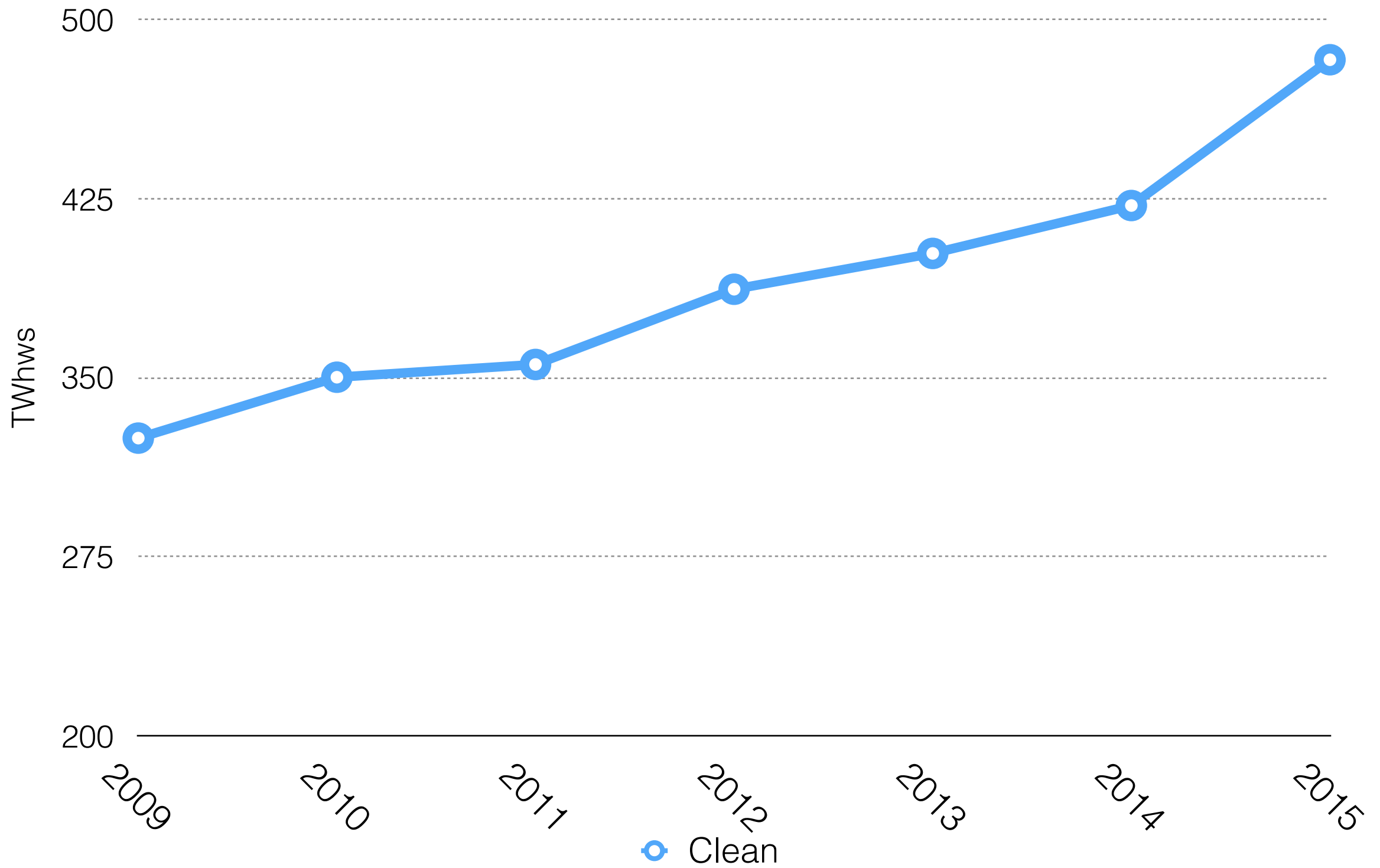
# Electric vehicles will require 1 - 5x clean power currently provided by Diablo Canyon



**Sources and Calculation:** Nissan Leaf needs 30 kWh of electricity to travel 100 miles, or .3 kWh per miles. Department of Energy, 2016. <http://www.fueleconomy.gov/feg/Find.do?action=sbs&id=37066>. 5,000,000 Nissan Leafs at 0.3kWh per mile, multiplied by 12,000 miles (California average)

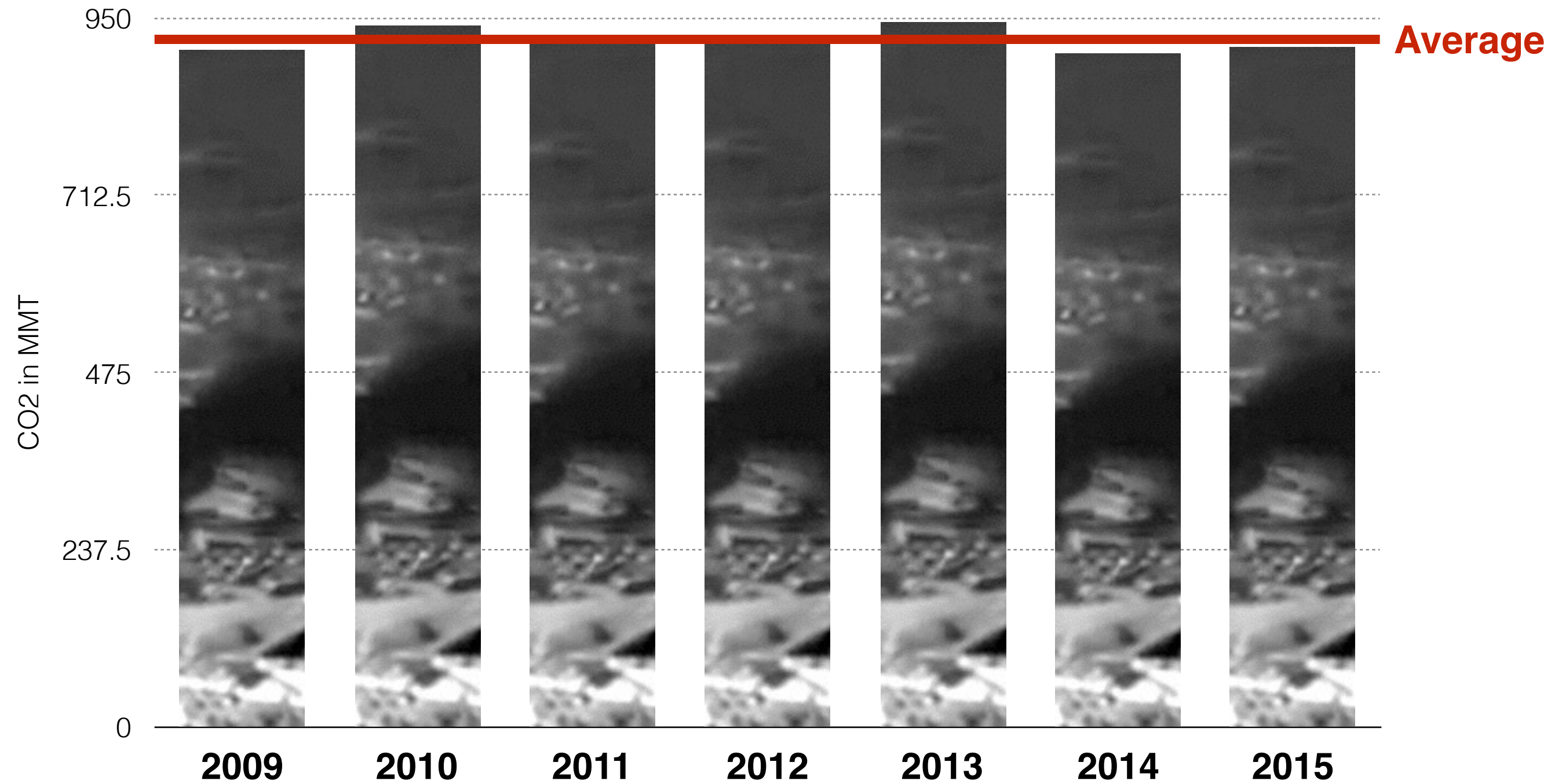
Germany

# German electricity from clean energy *is* rising....



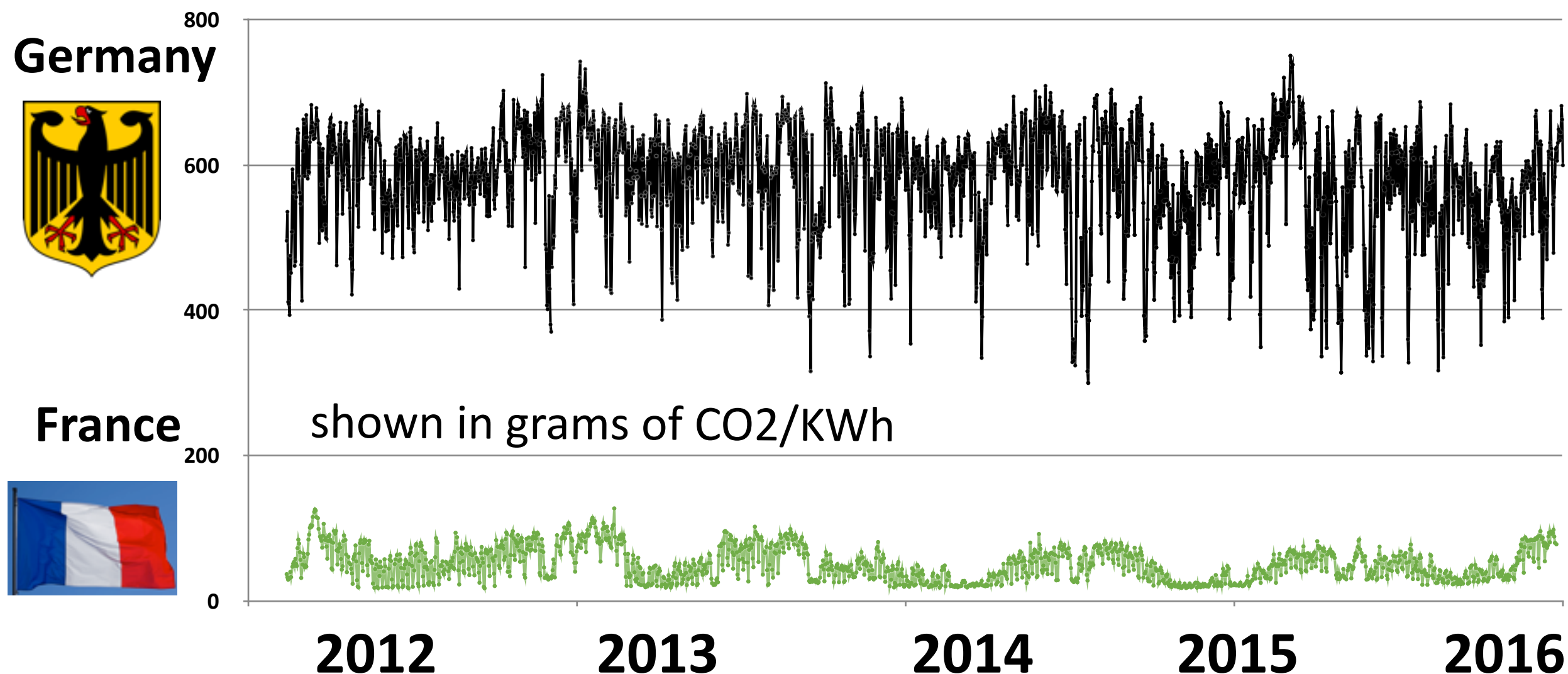
**Source:** BP Global Outlook 2016

# ...but Germany's emissions *aren't* declining.





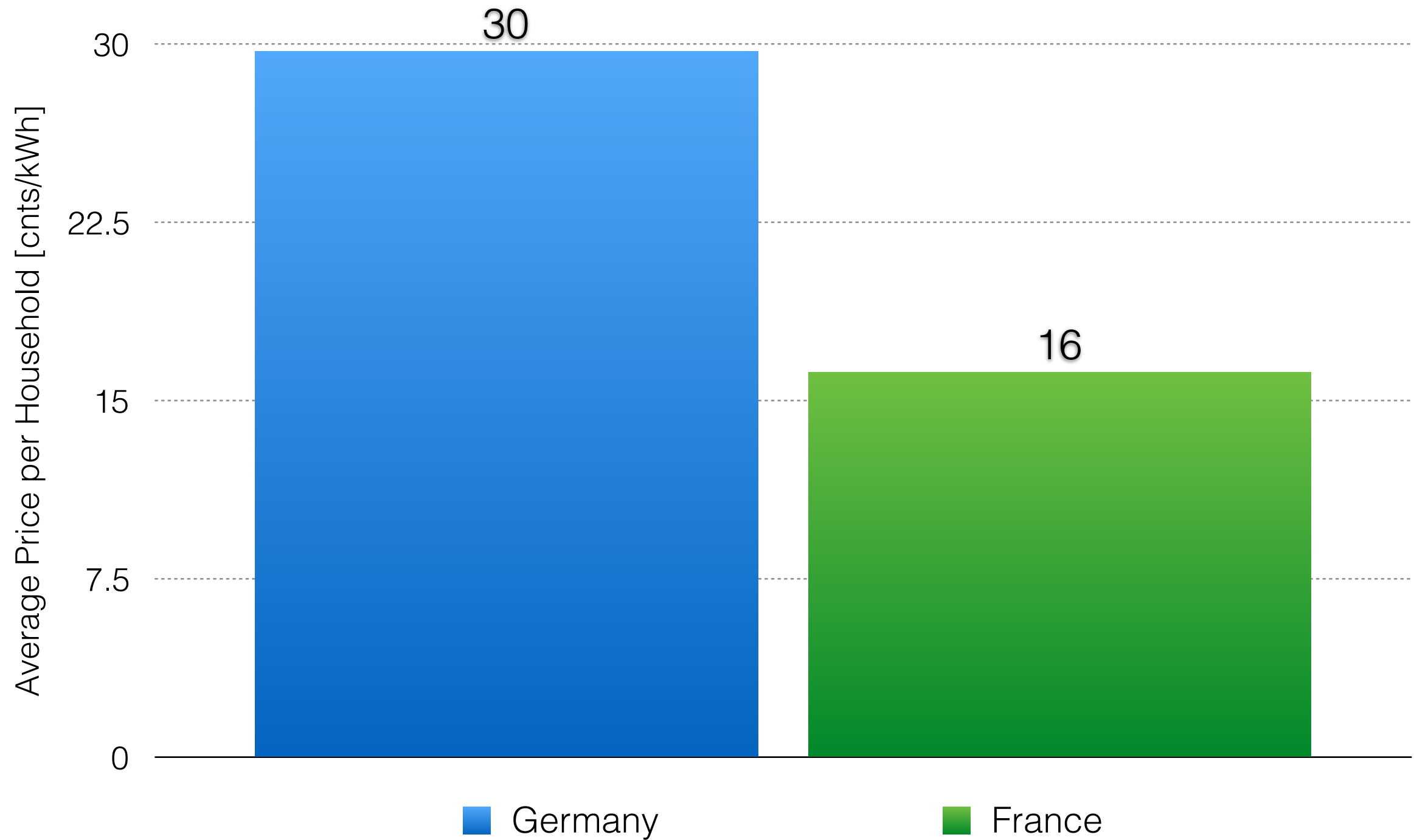
# Electricity in Germany Remains 6x More Carbon-Intensive than in France



**Sources:** Daily German electricity production data from Fraunhofer ISE. Hourly French electricity production from RTE-France.

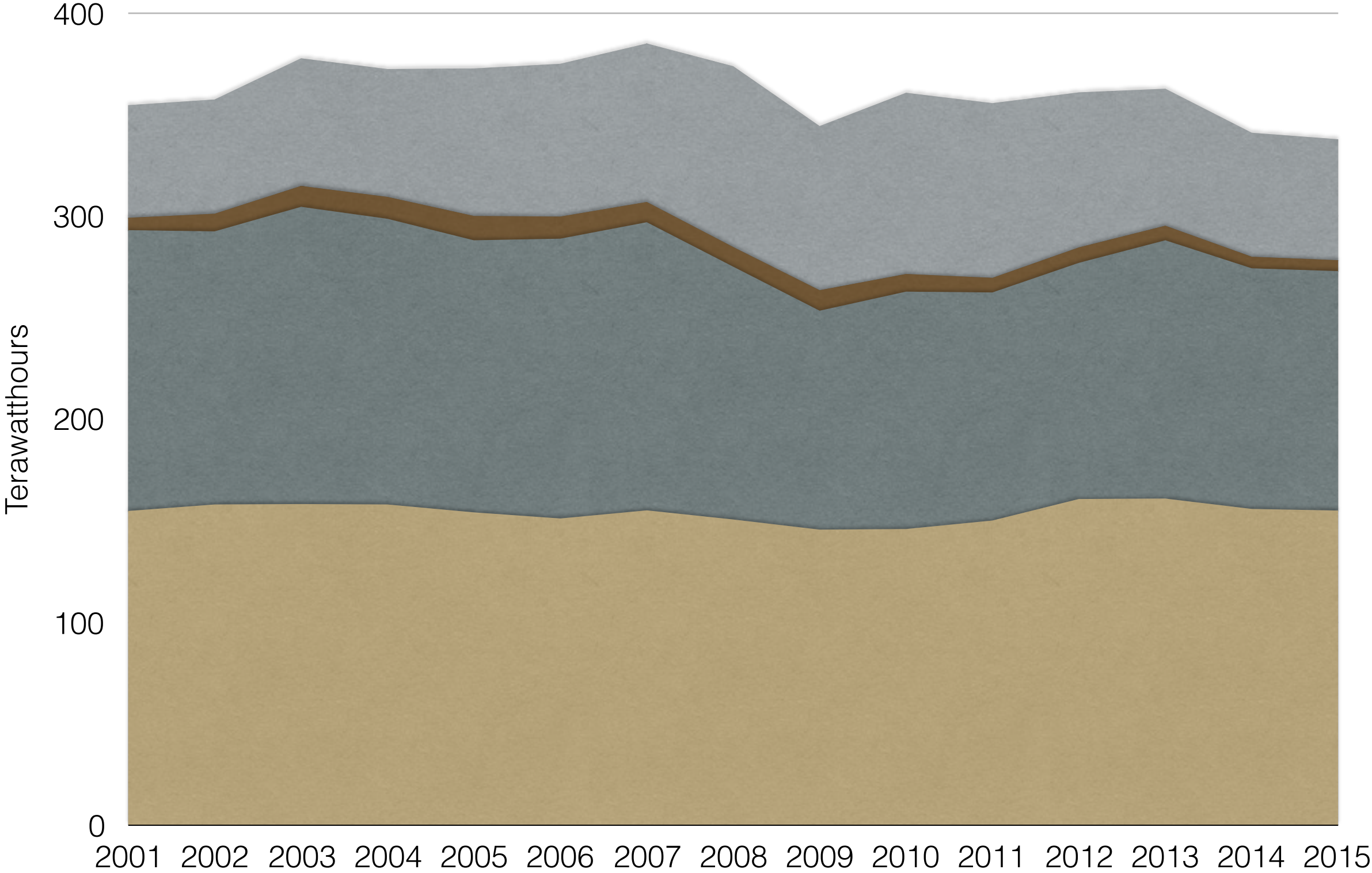
**Methods:** Calculation of German Specific Carbon Intensity uses values of 1100g, 950g, 350g, and 983g of CO<sub>2</sub> per kWh for lignite coal, hard coal, natural gas, and biomass (respectively). Calculation of French Specific Carbon Intensity calculated by RTE-France.

# German Electricity is 2x Expensive as French Electricity

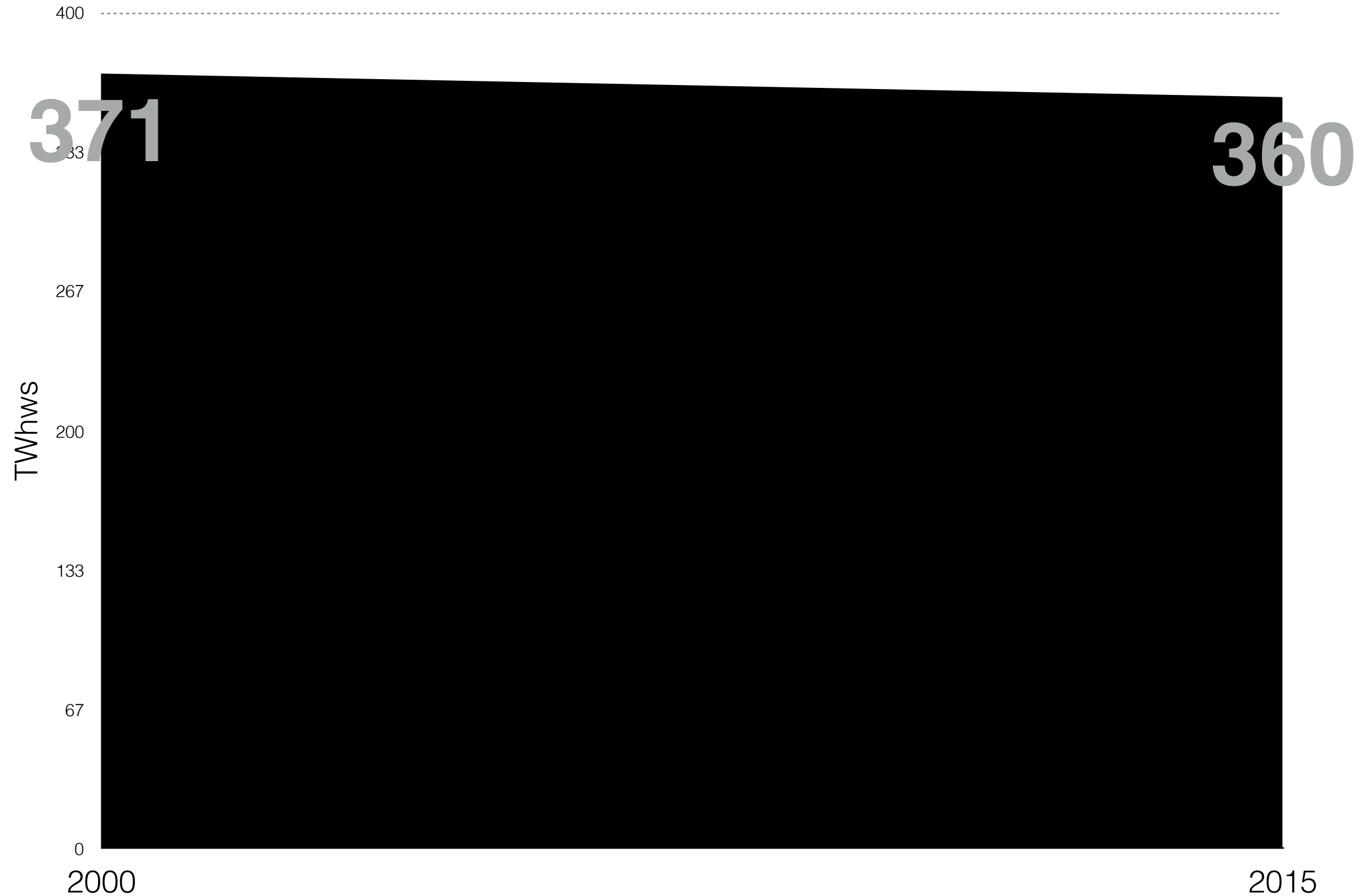


**Source:** Eurostat, 2015

# Germany Relies on Dirtiest Fossil Fuel



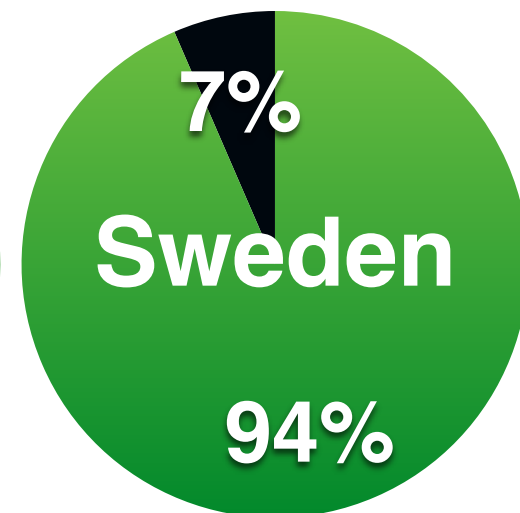
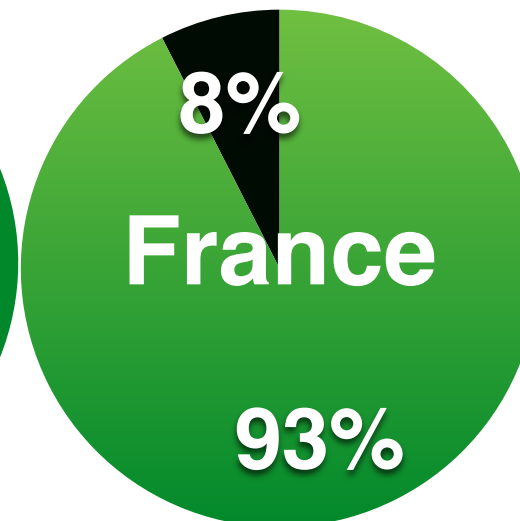
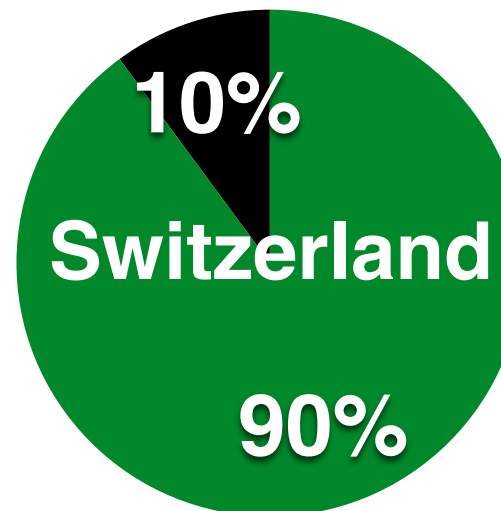
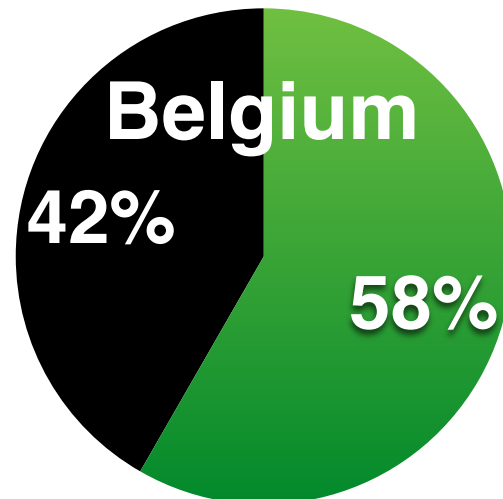
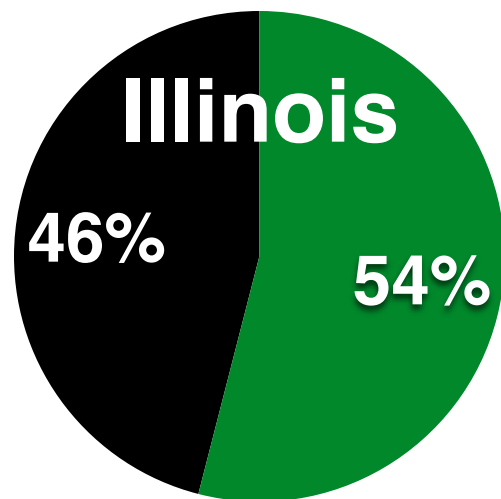
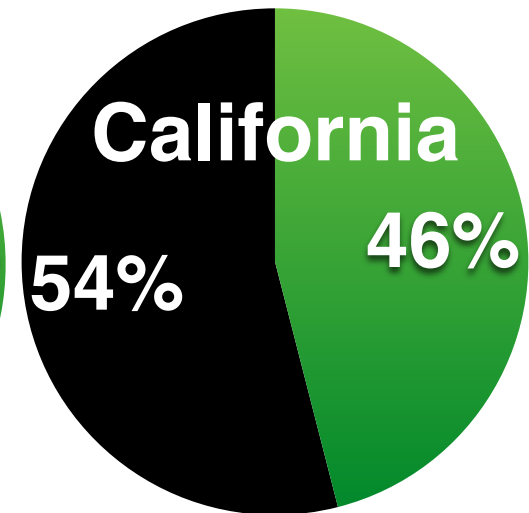
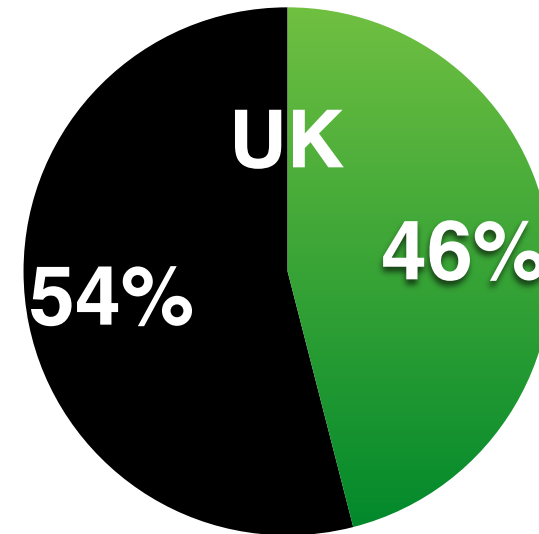
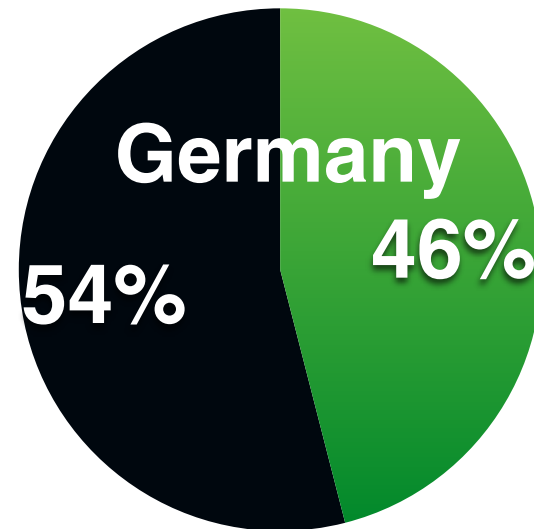
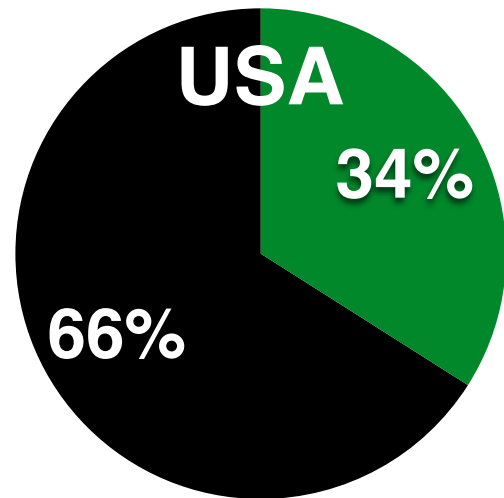
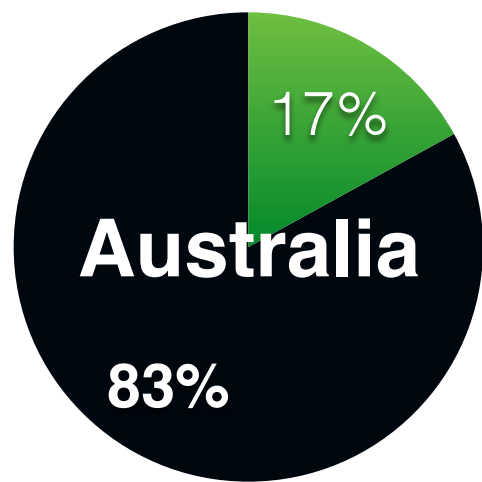
# Fossil electricity consumption declined 3% since 2000



Source: BP Global Outlook 2016

■ Fossil

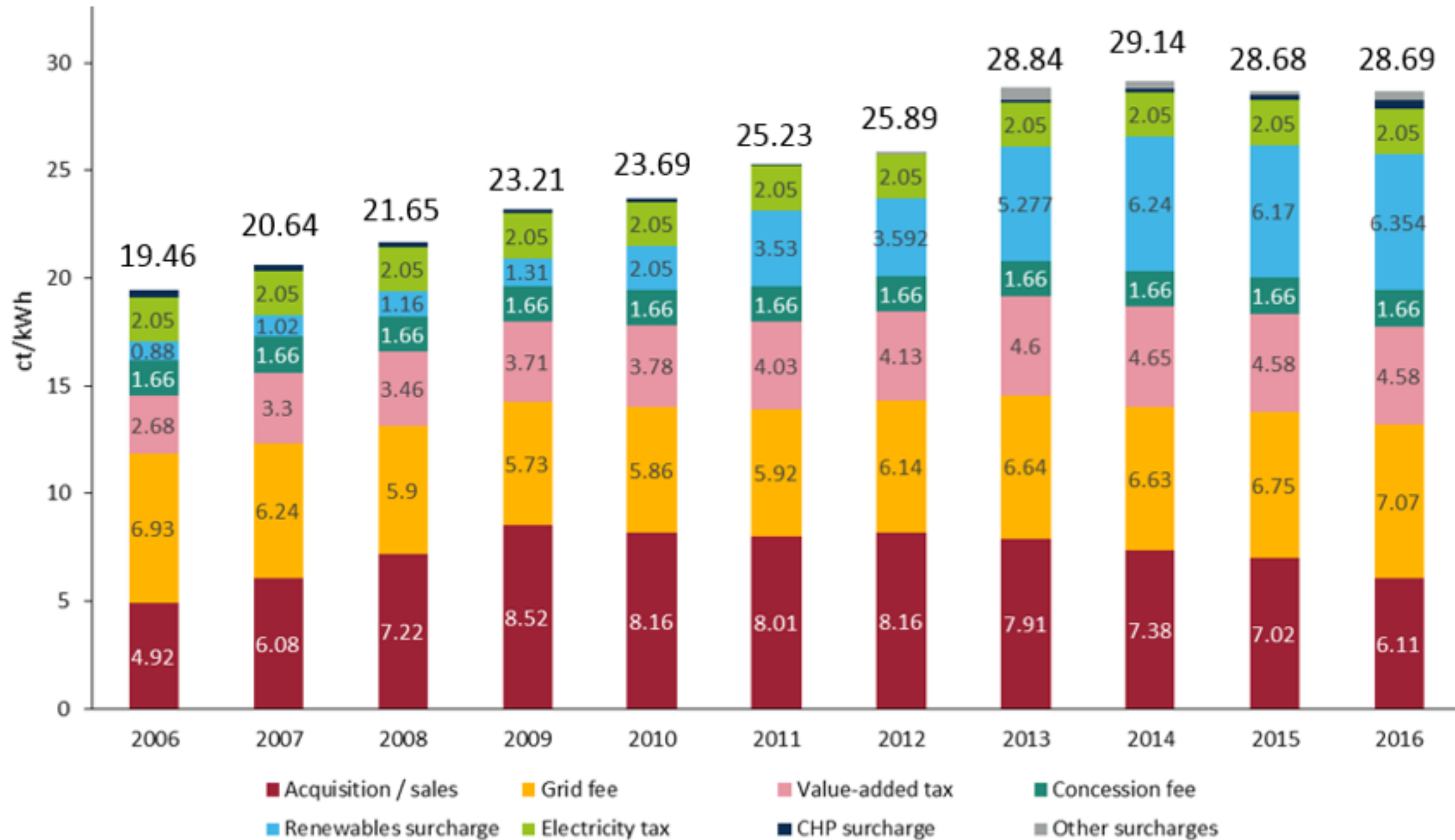
# Carbon-Intensity of Electricity Supply



● Clean ● Dirty

Source: BP Global Outlook 2016

# German Electricity Costs Rose 47 Percent, 2006 - 2016



Composition of average power price in ct/kWh for an average household (3,500 kWh per year). Data: BDEW, 2016.

# The Storage Fantasy

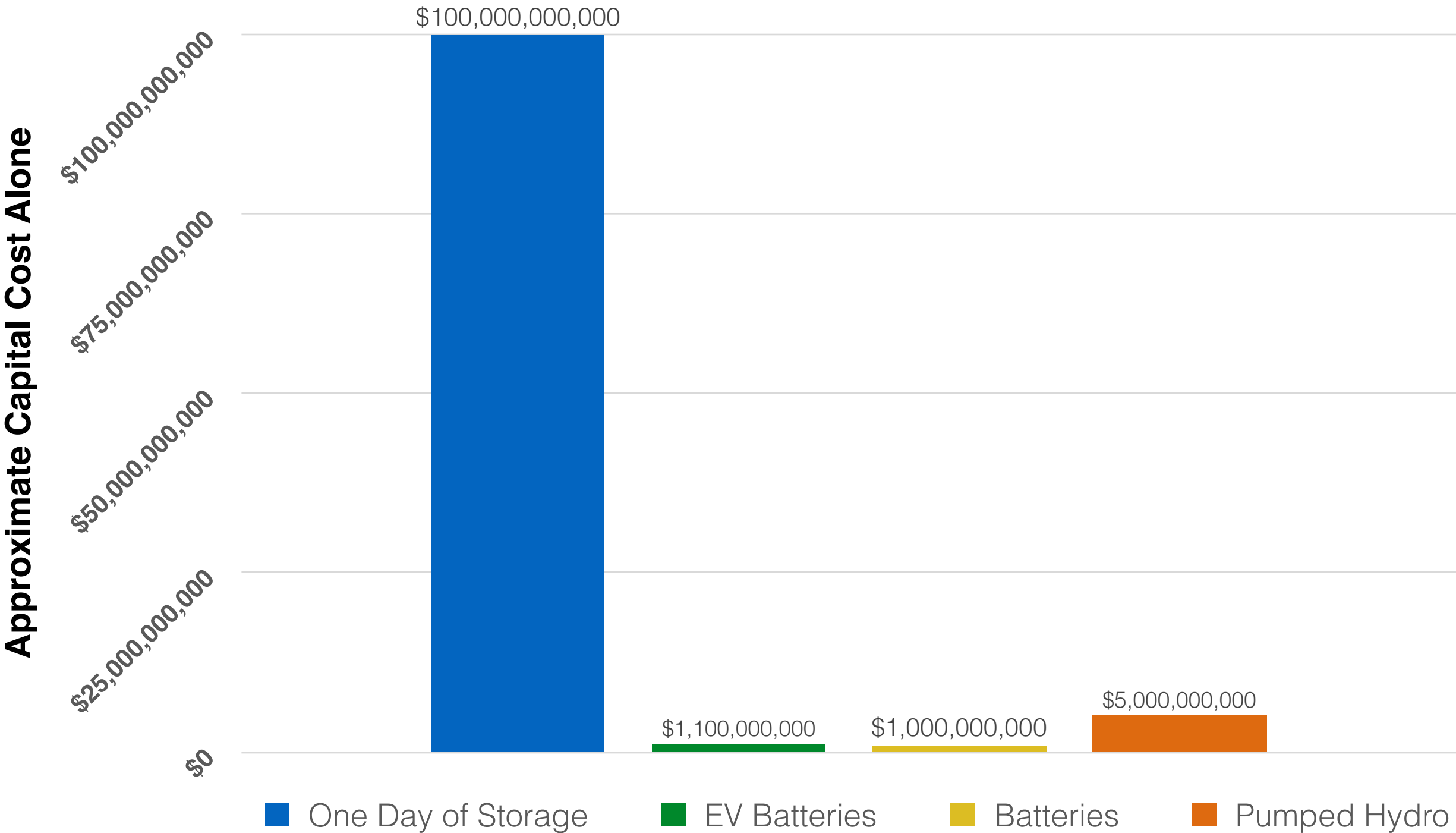


California has 23 minutes of electricity storage — if you used every car and truck in the state along with existing storage.

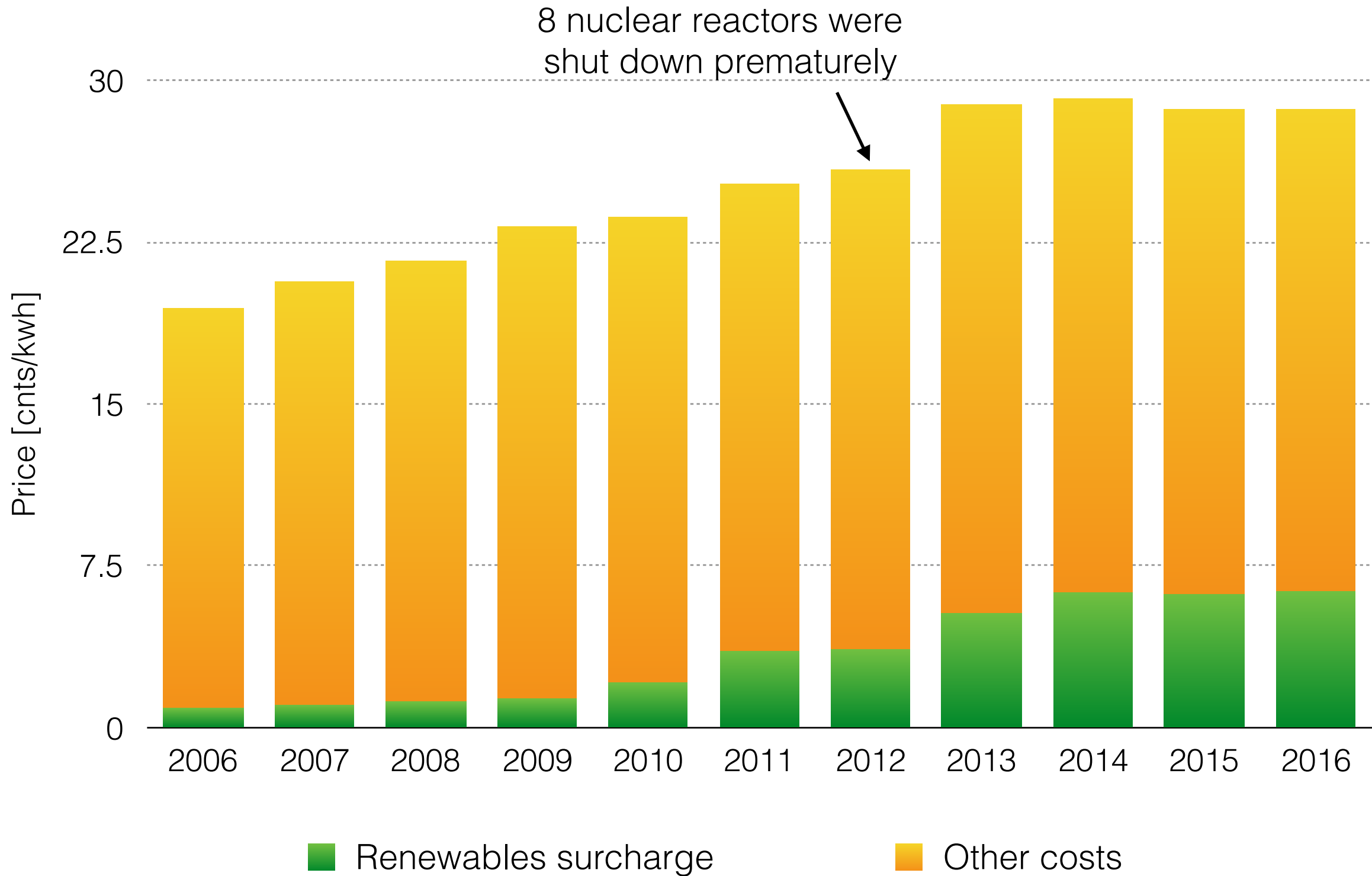




# One day of back-up power as batteries and pumped storage would cost \$100 billion



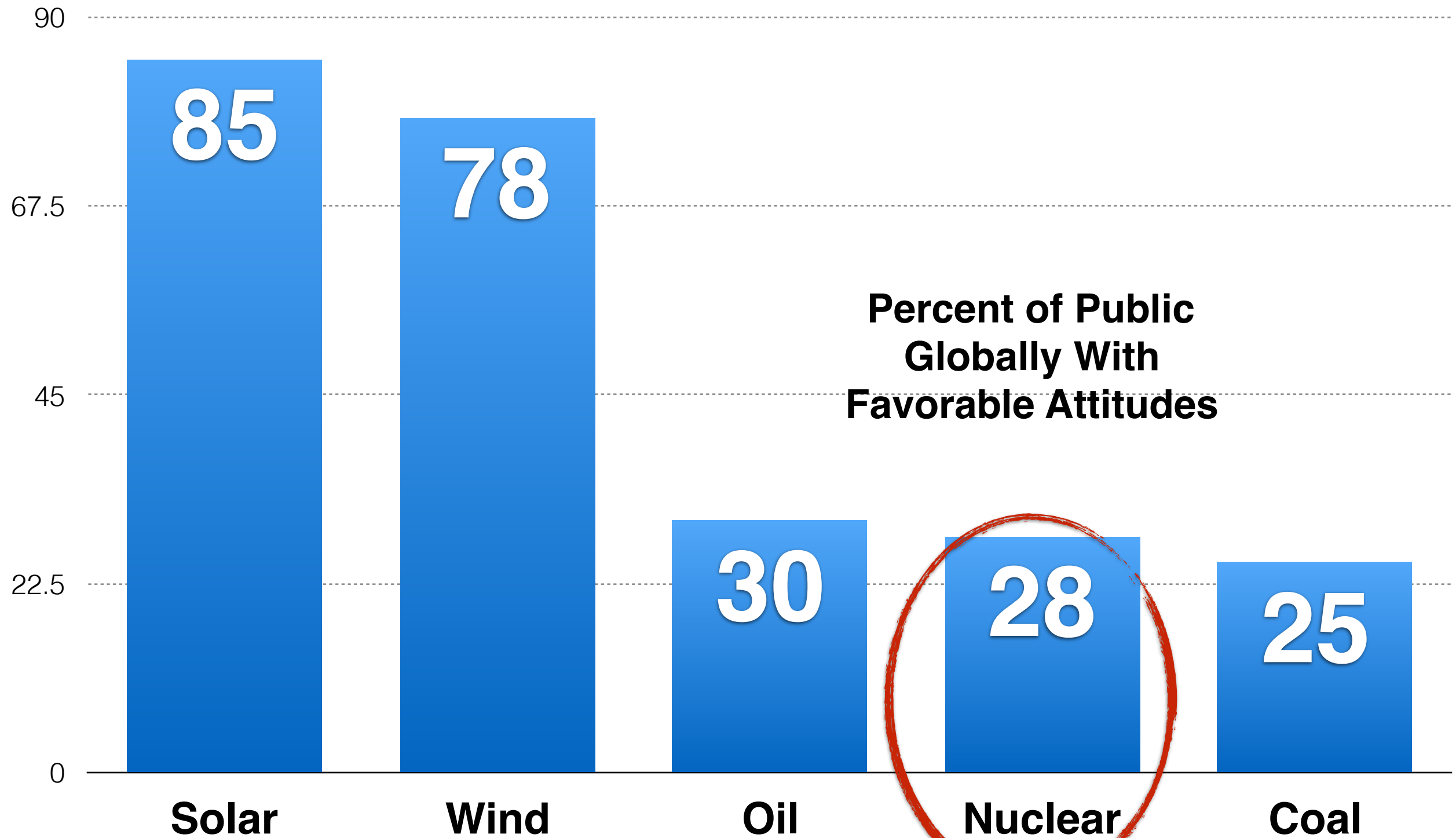
# Electricity Costs Rose with Less Nuclear & More Renewables



Composition of average power price in ct/kWh for an average household (3,500 kWh per year). Data: BDEW, 2016.

Why is this happening?

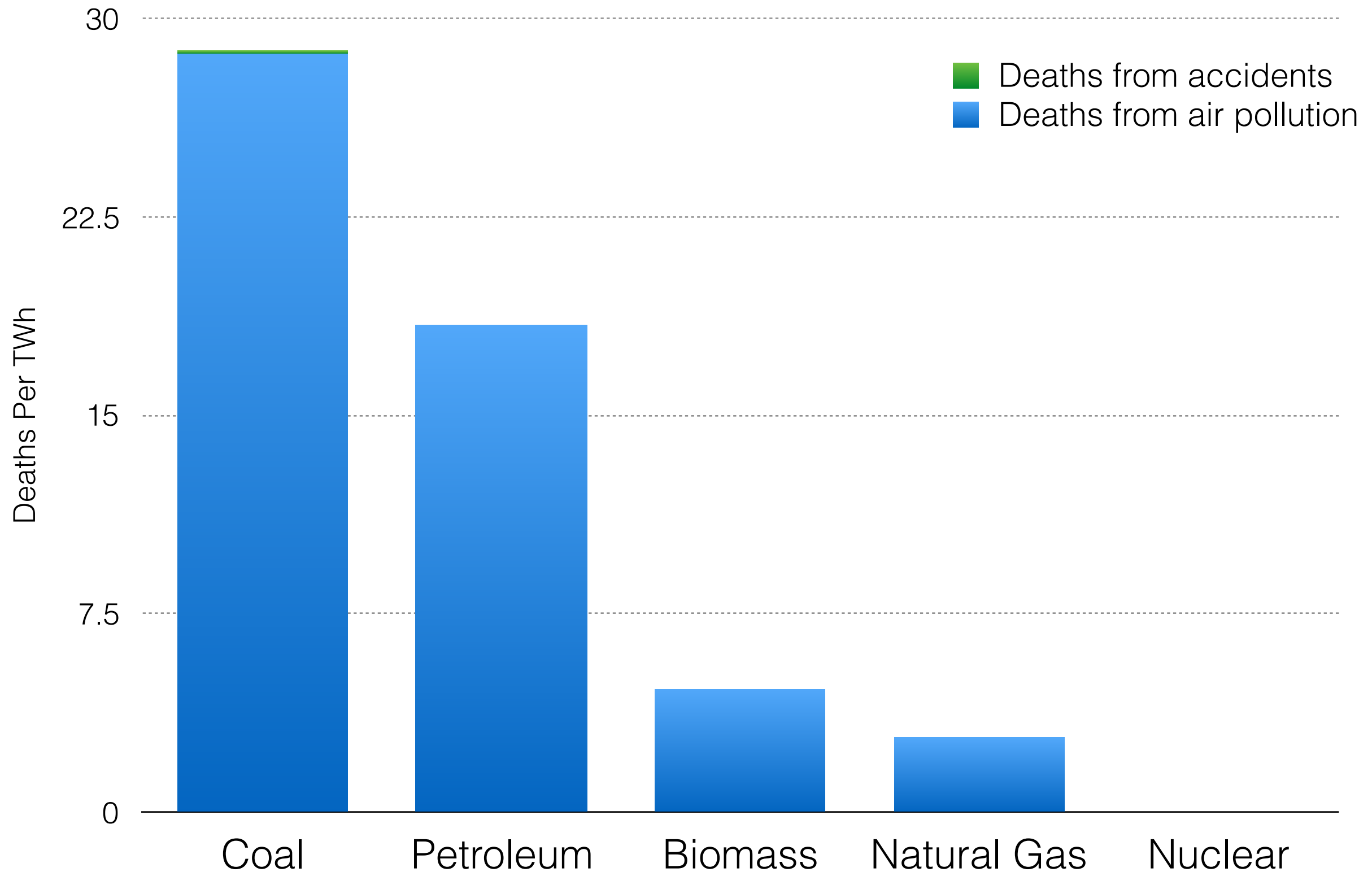
# Public fears nuclear...



**Percent of Public Globally With Favorable Attitudes**

Source: Ipsos, December 2014

...even though it is the safest way to make reliable power



Health effects of electricity generation in Europe by primary energy source

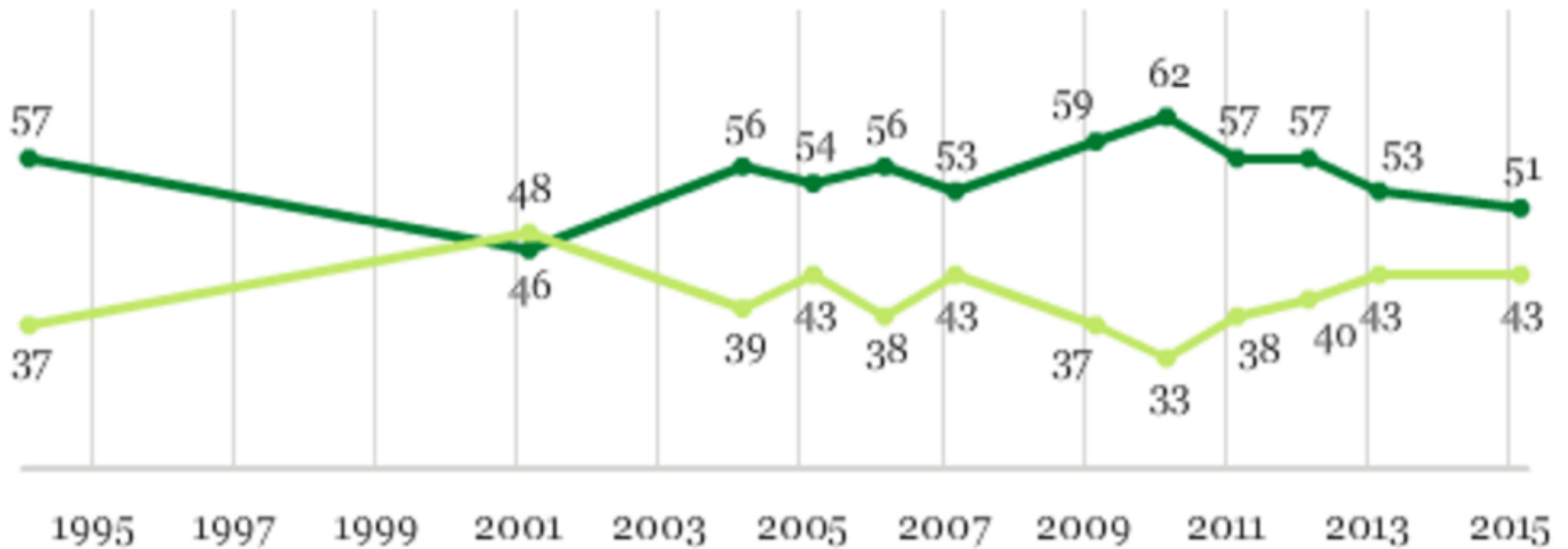
Source: Markandya, A. & Wilkinson, Electricity generation and health. Lancet 2007; 370:970-90

# Nuclear support declined from 62% to 51% last five years

## *Slight Majority in U.S. Favors Nuclear Energy*

Overall, do you strongly favor, somewhat favor, somewhat oppose, or strongly oppose the use of nuclear energy as one of the ways to provide electricity for the U.S.?

■ Total % favor    ■ Total % oppose

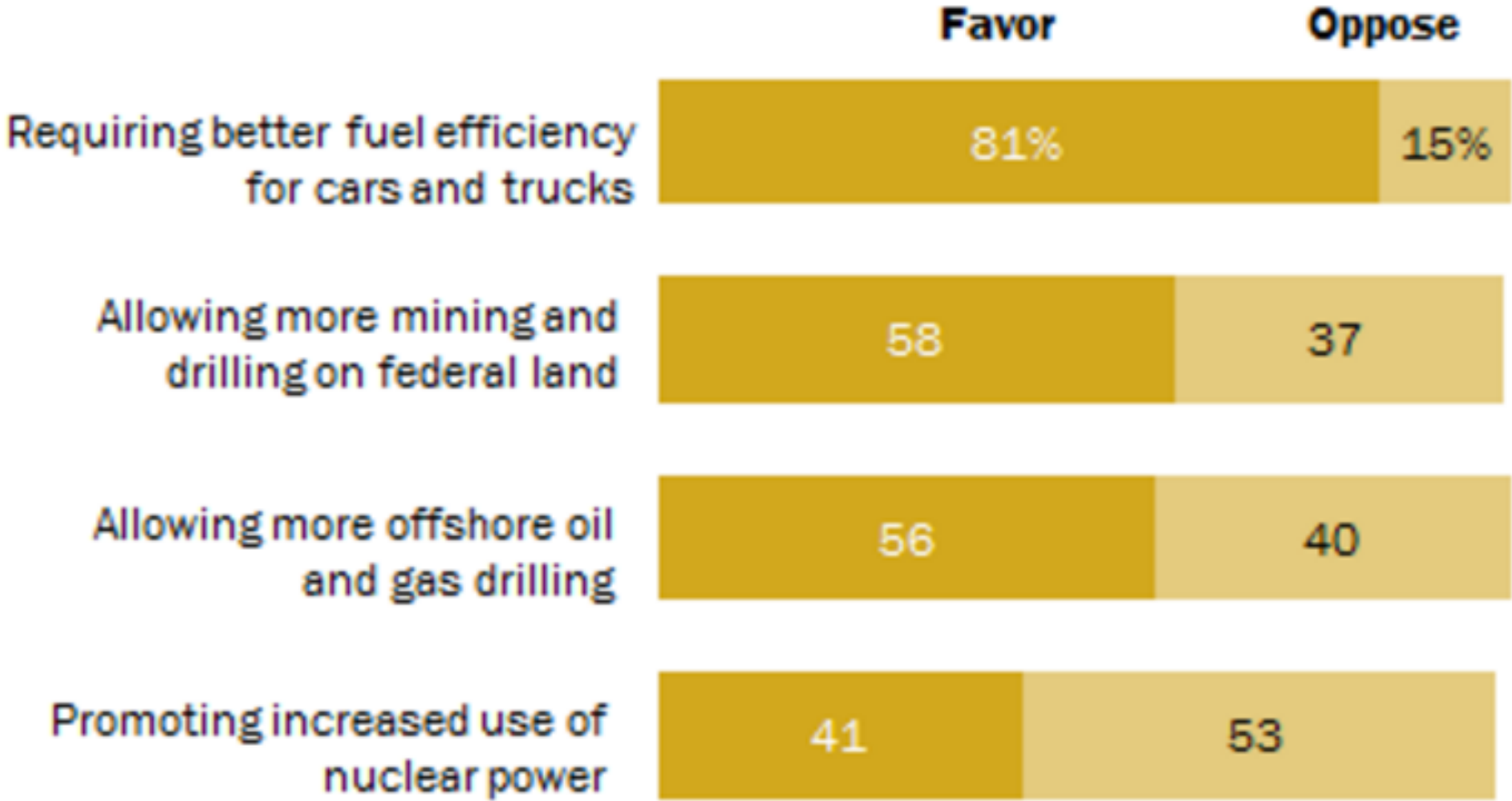


Note: 2012, and 2001-2009 measures were asked of a half sample

# Gallup: 53% Oppose “increased use” nuclear power

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## Views of Policies for Addressing U.S. Energy Supply

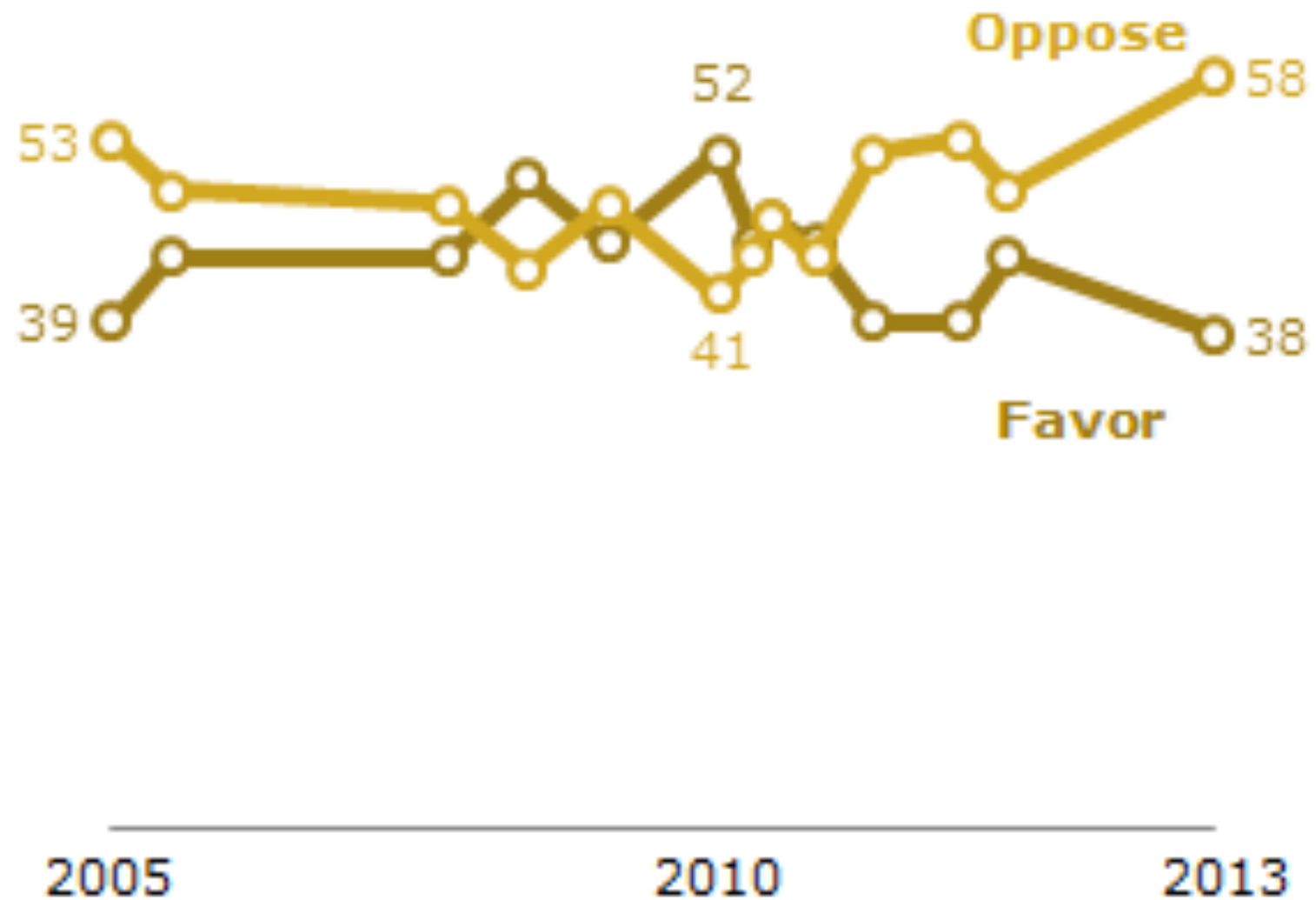


Survey conducted Dec. 3-7, 2014. Don't know responses not shown.

**PEW RESEARCH CENTER**

# Pew: 58% oppose expanding nuclear power

## Promoting the Increased Use of Nuclear Power

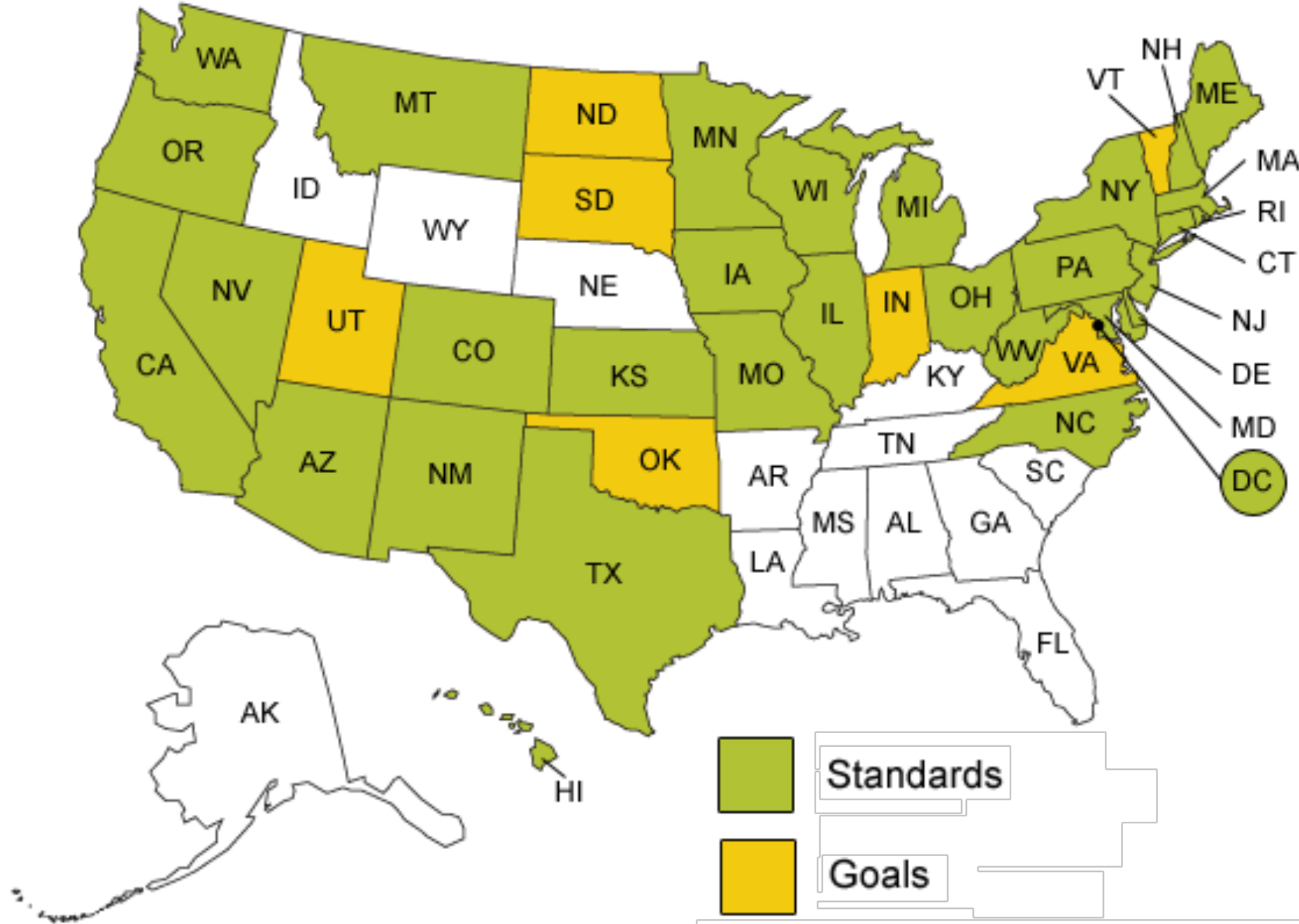


PEW RESEARCH CENTER Sept. 4-8, 2013. Don't know responses not shown.

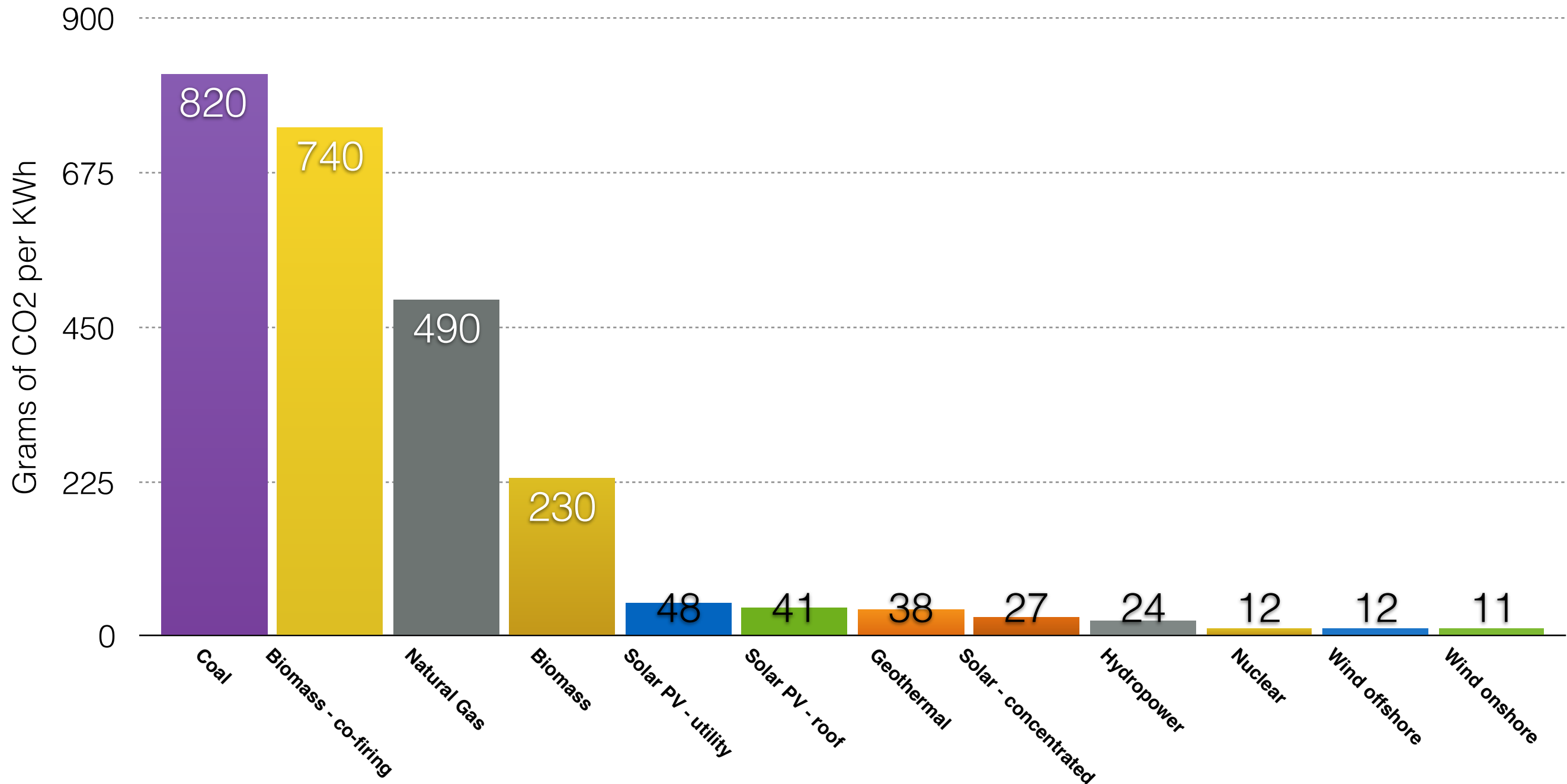


# State clean energy standards exclude nuclear...

States with Renewable Portfolio Standards (mandatory) or Goals (voluntary),  
January 2012

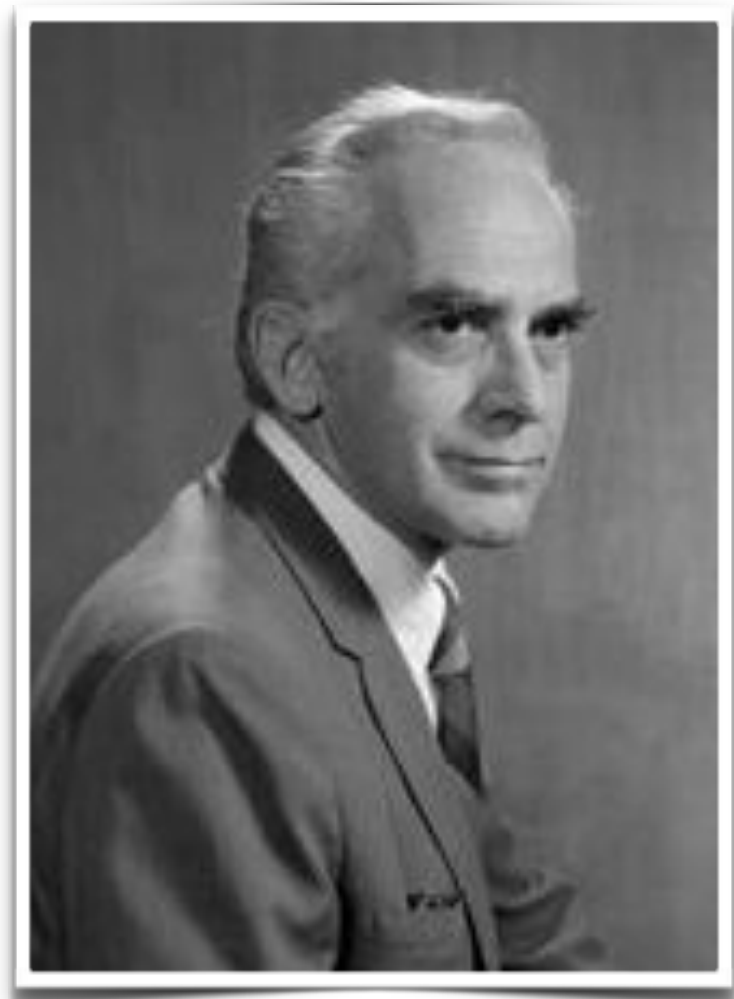


...even though is lower-carbon than solar



**Source: IPCC 2014, Annex III Table A III.2**

Schlömer S., T. Bruckner, L. Fulton, E. Hertwich, A. McKinnon, D. Perczyk, J. Roy, R. Schaeffer, R. Sims, P. Smith, and R. Wiser, 2014: Annex III: Technology-specific cost and performance parameters. In: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.



“Nuclear power is one of the chief long-term hopes for conservation.”

– David Siri, Sierra Club Director, 1966



“If a doubling of the state’s population in the next 20 years is encouraged by providing the power resources for this growth, [California’s] scenic character will be destroyed.”

– David Brower, Sierra Club Director, 1966



“It’d be little short  
of disastrous for us  
to discover a source  
of clean, cheap,  
abundant energy  
because of what we  
would do with it.”

— Amory Lovins

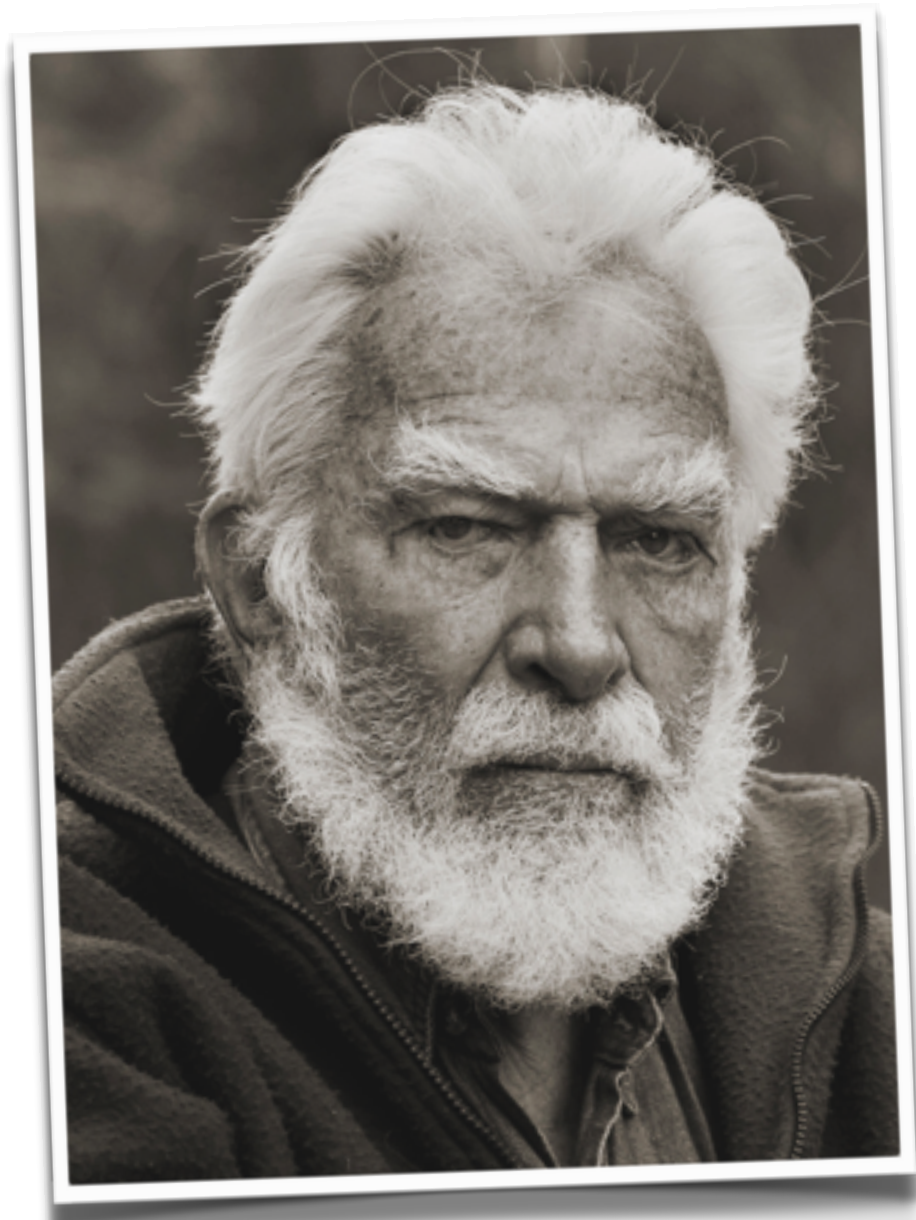
In 1966, 1967 and  
again in 1969 the  
Sierra Club's Board  
of Directors, and its  
members, voted in  
*favor* of building  
Diablo Canyon.



“Our campaign stressing the hazards of nuclear power will supply a rationale for increasing regulation.. and add to the cost of the industry..”

– Sierra Club Executive Director, Michael McCloskey, 1974





“I really didn’t care  
[about possible  
nuclear accidents]  
because there are too  
many people anyway.. I  
think that playing  
dirty if you have a  
noble end is fine.”

– Martin Litton,  
Sierra Club Board  
Member





“If you’re trying to get people aroused about what is going on.. you use the most emotional issue you can find.”

– Doris Sloan, anti-nuclear activist

**Source:** Thomas Wellock, *Critical Masses: Opposition to Nuclear Power in California, 1958-1988*, 1998, University of Wisconsin Press

# North China Syndrome





# NO NUKES



DVD

ogress  
perity for all







Diablo Canyon No Nukes concert, June 1979

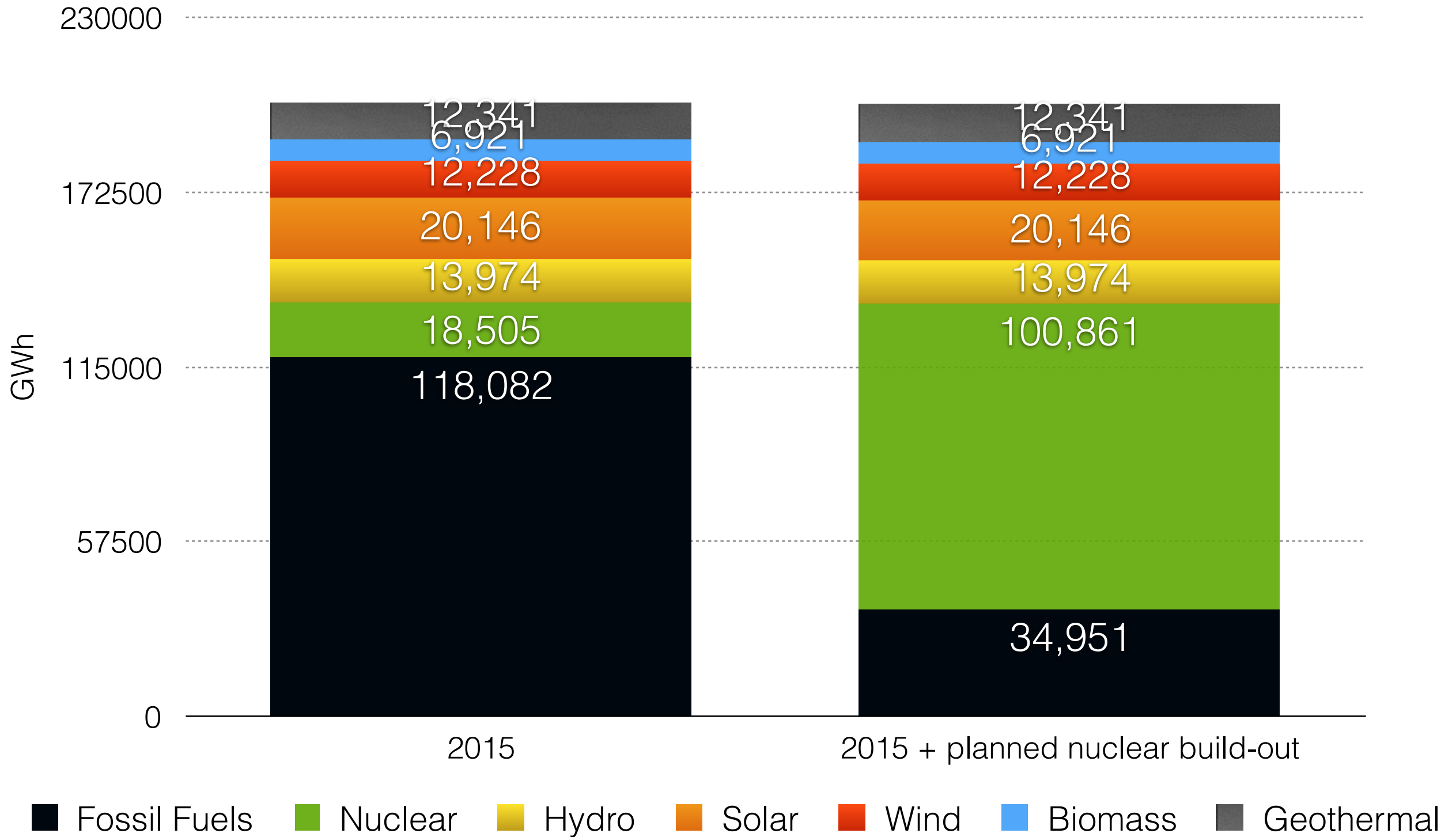




“The governor [Jerry Brown] said, ‘I want the Department of Water Resources to build a coal plant.’ So we embarked on the planning of a coal plant... a dreadful prospect.”

– Ron Robie, California  
Department of Water  
Resources

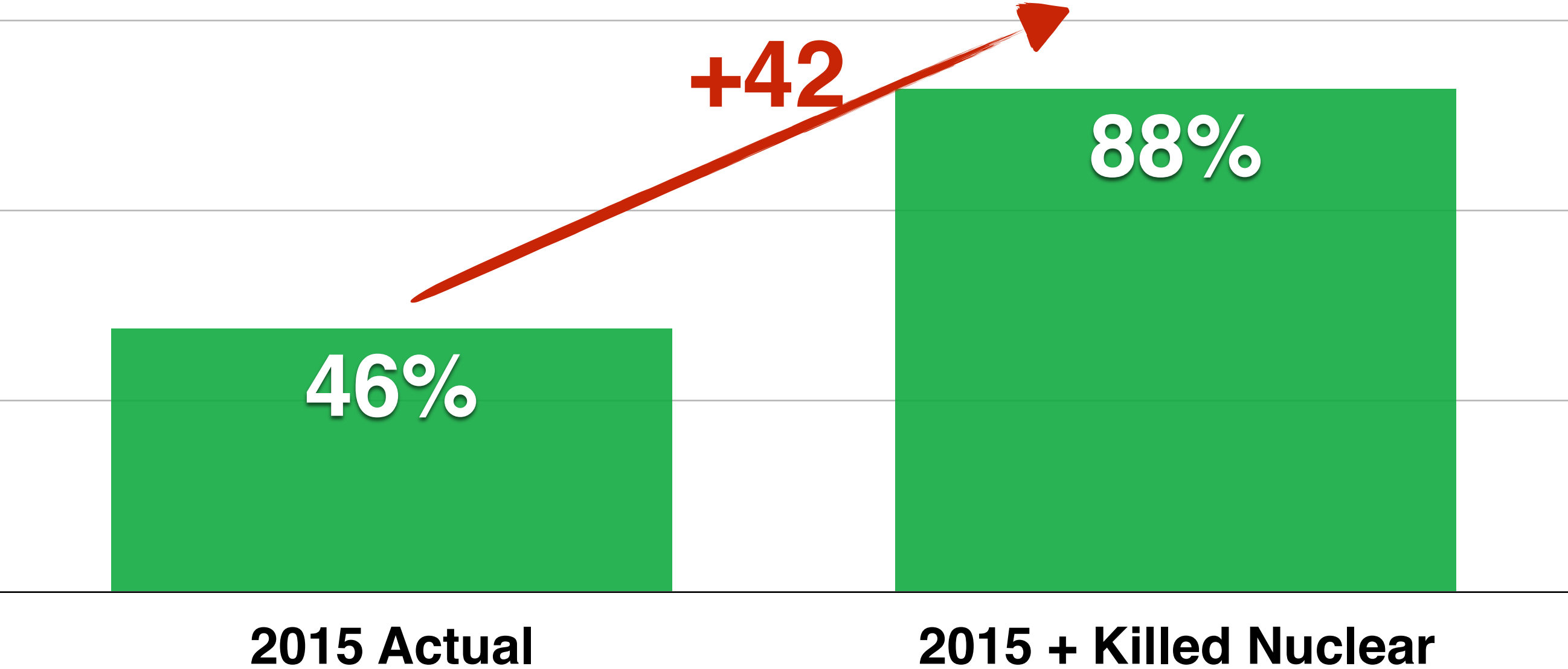
# Nuclear Abandonments Locked in Fossil



Includes distributed solar

**Source:** US Energy Information Administration

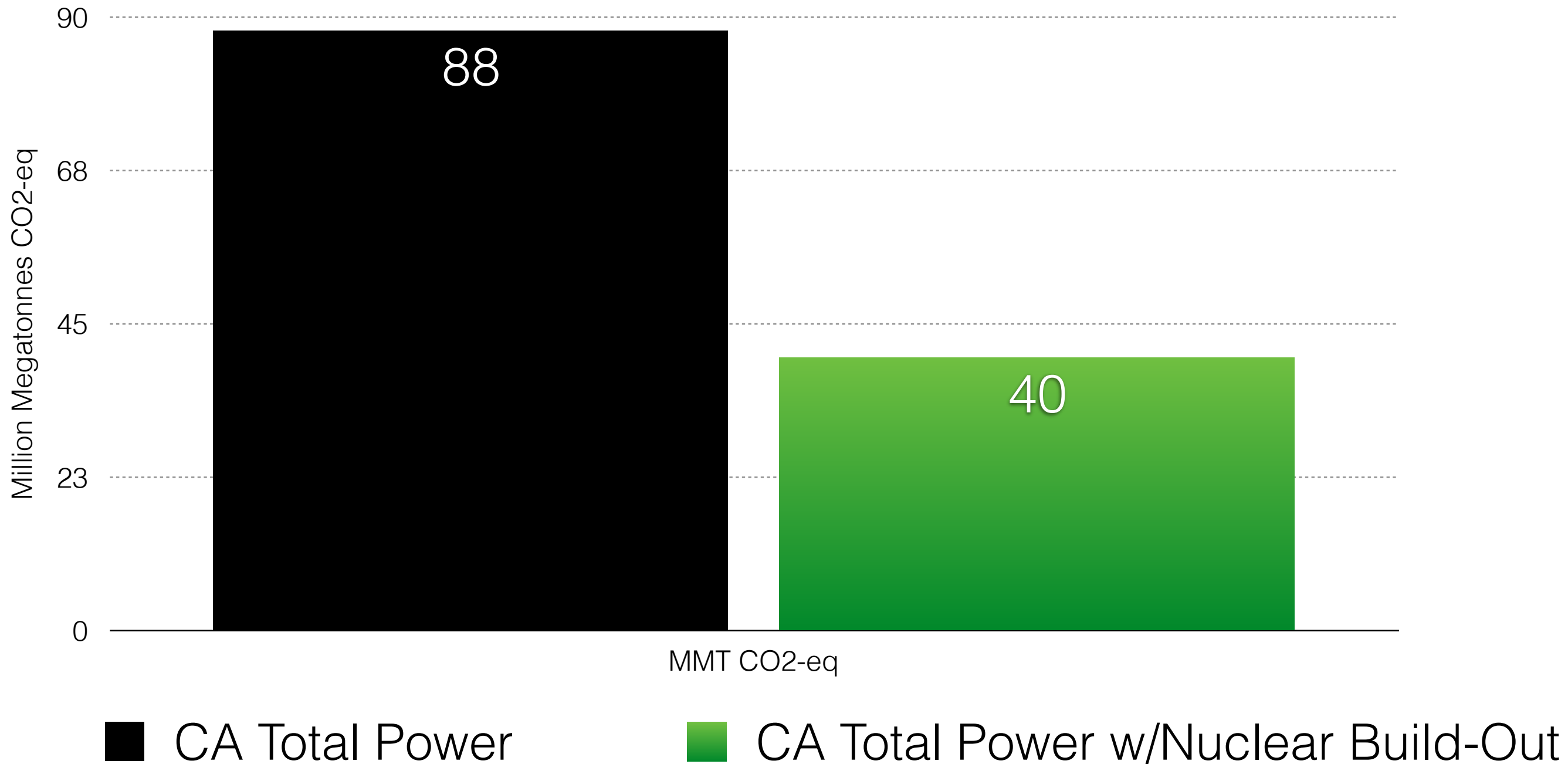
# California Clean Power 42% Less Without California Nuclear



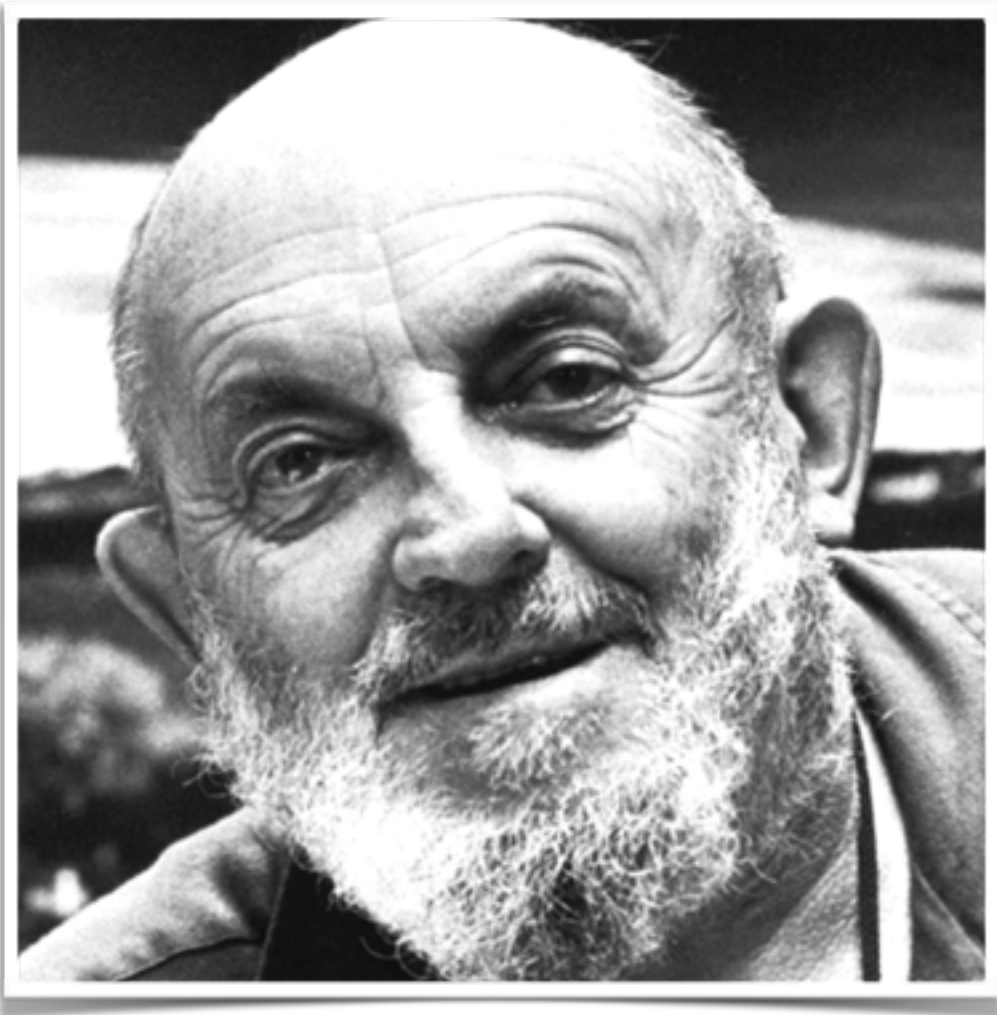
Source: California Almanac, "In-State Power," 2016; Rooftop Solar Added;  
[https://docs.google.com/spreadsheets/d/1uXuqaE-BBvdNLnmuUic5mmhCkqOoU0VTunn3meS\\_dAU/edit?usp=sharing](https://docs.google.com/spreadsheets/d/1uXuqaE-BBvdNLnmuUic5mmhCkqOoU0VTunn3meS_dAU/edit?usp=sharing)



# California Emissions Are 2x Higher Without Nuclear



Source: California Almanac, "In-State Generation by Fuel Type", 2016



“Nuclear energy is the only practical alternative that we have to destroying the environment with oil and coal.”

– Ansel Adams, 1983