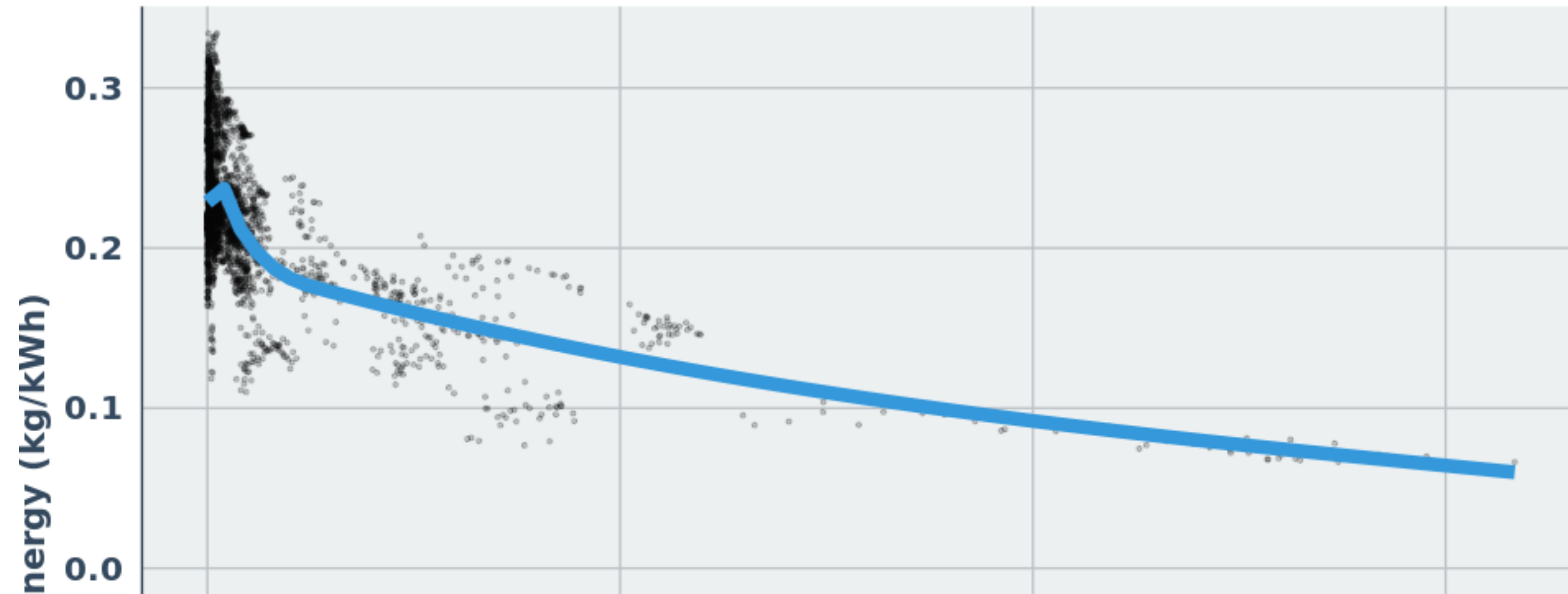
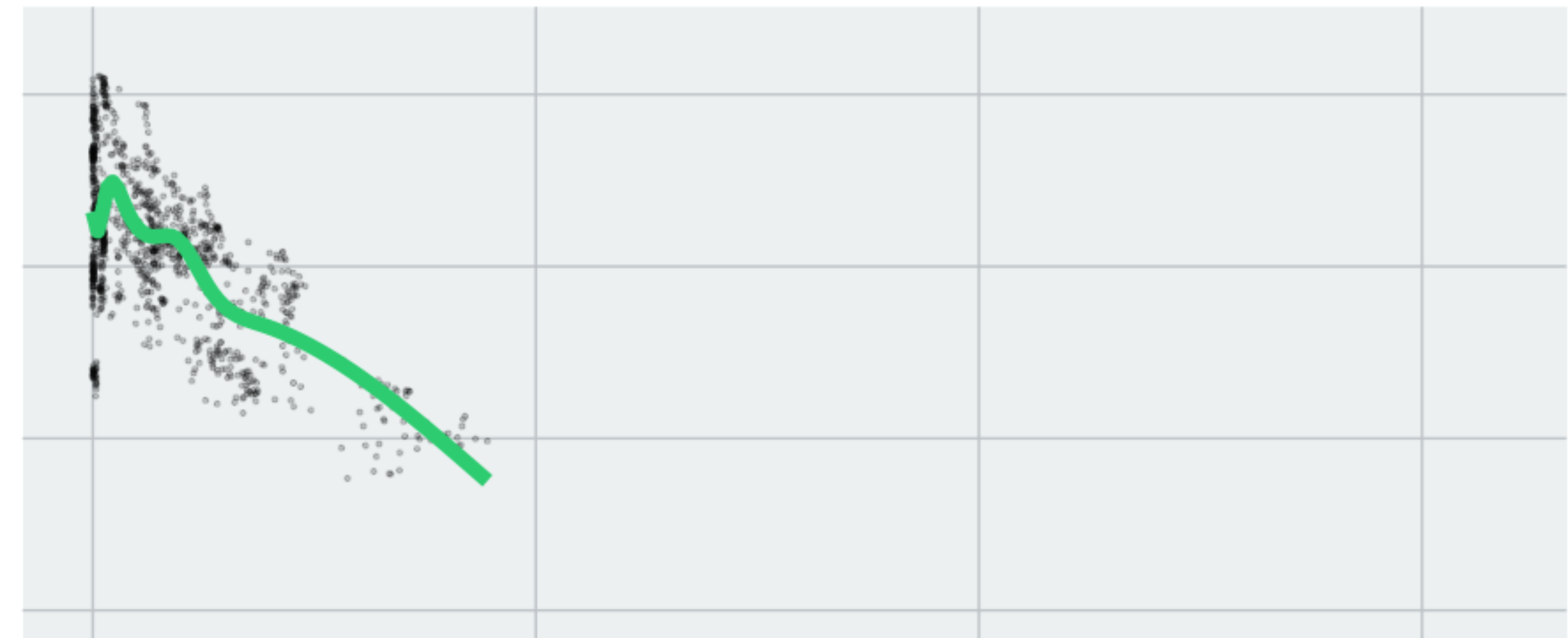


Correlation between Low-Carbon Electricity Generation and Carbon Intensity of Energy

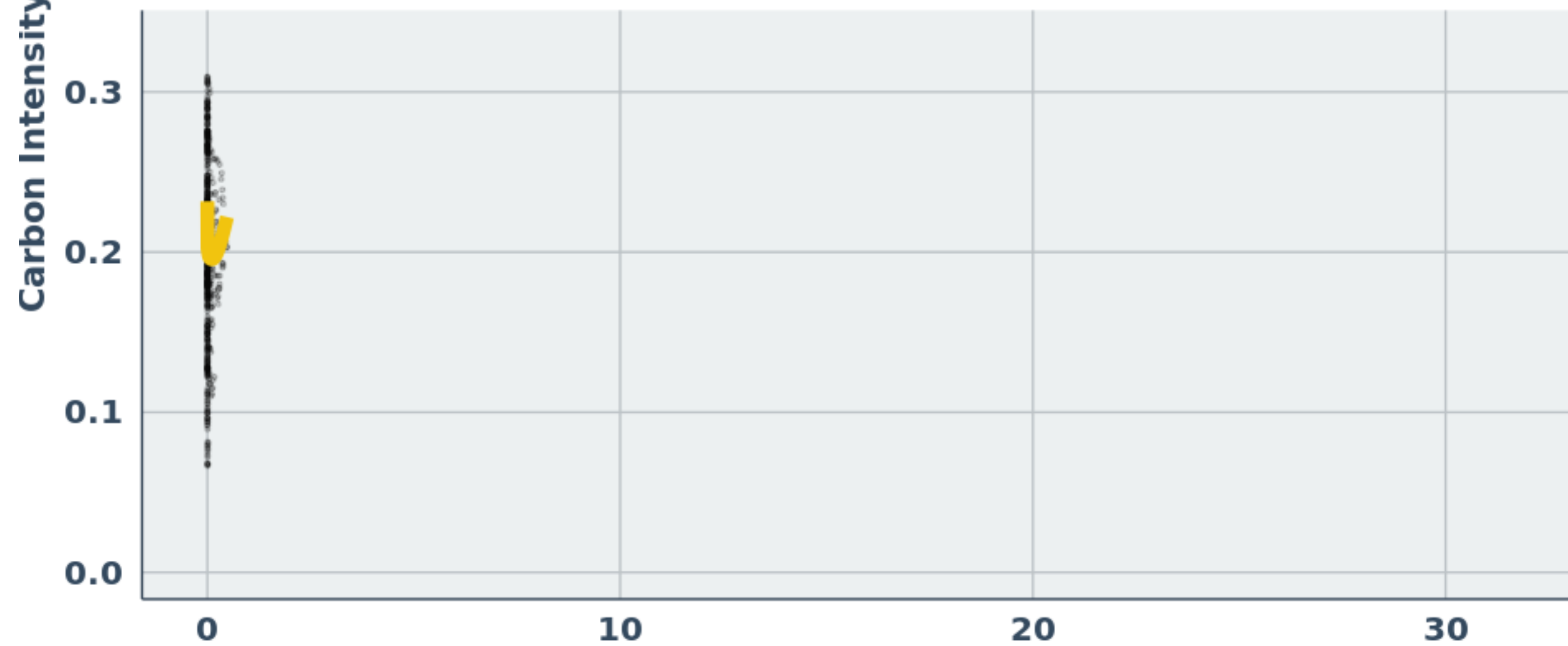
Hydro



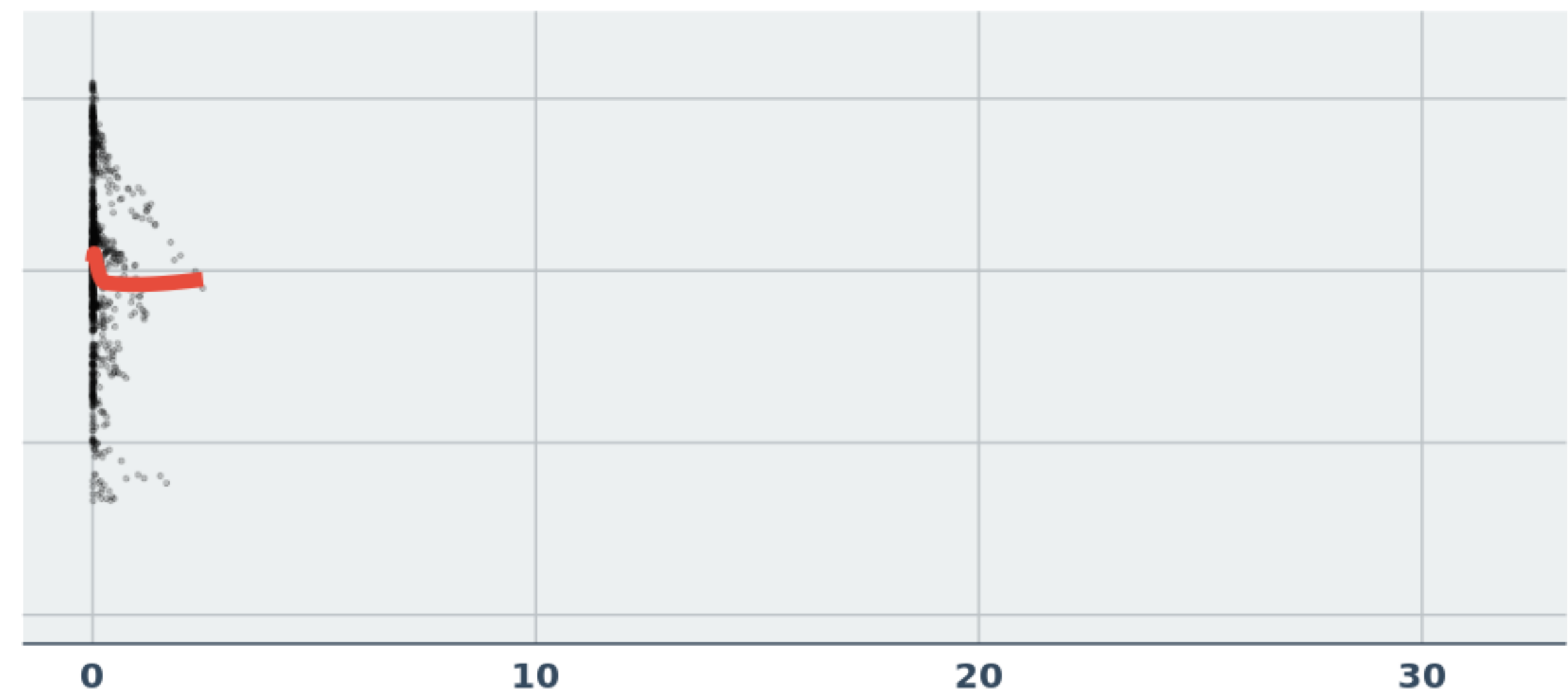
Nuclear



Solar



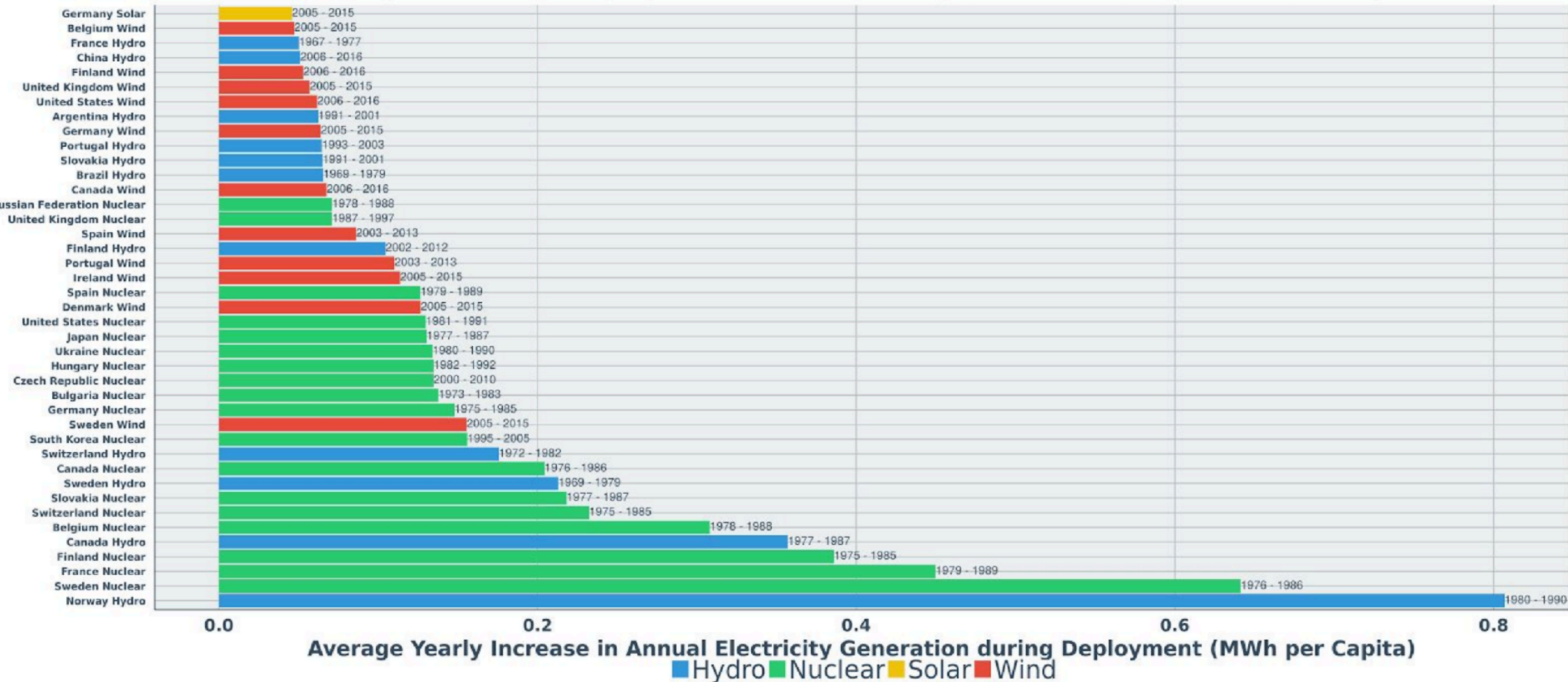
Wind



Annual Electricity Generation from Solar, Wind, Nuclear, or Hydro (MWh per Capita)

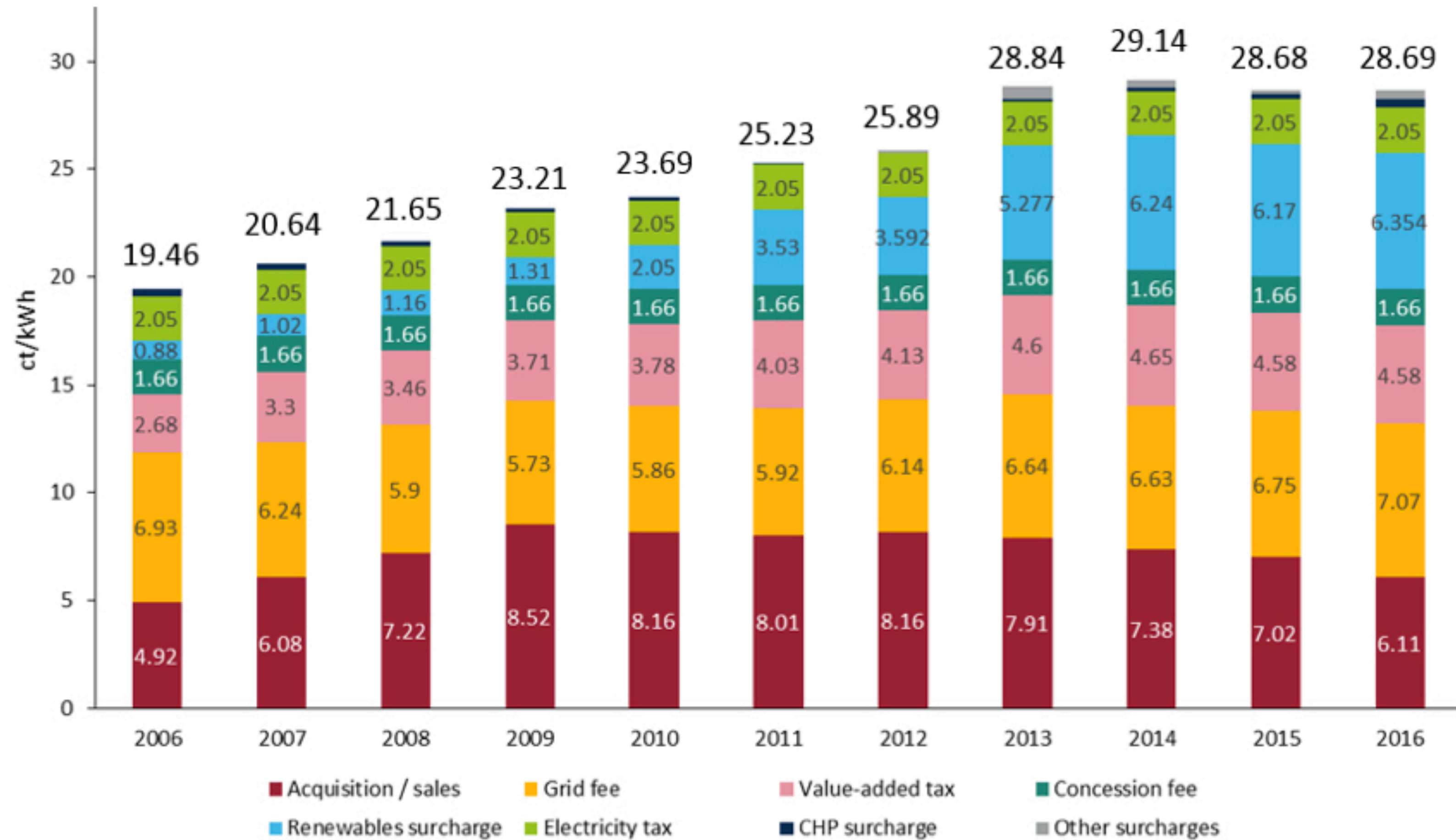
Hydro Nuclear Solar Wind

Largest 10-Year Deployments of Nuclear, Hydro, Wind and Solar Electricity

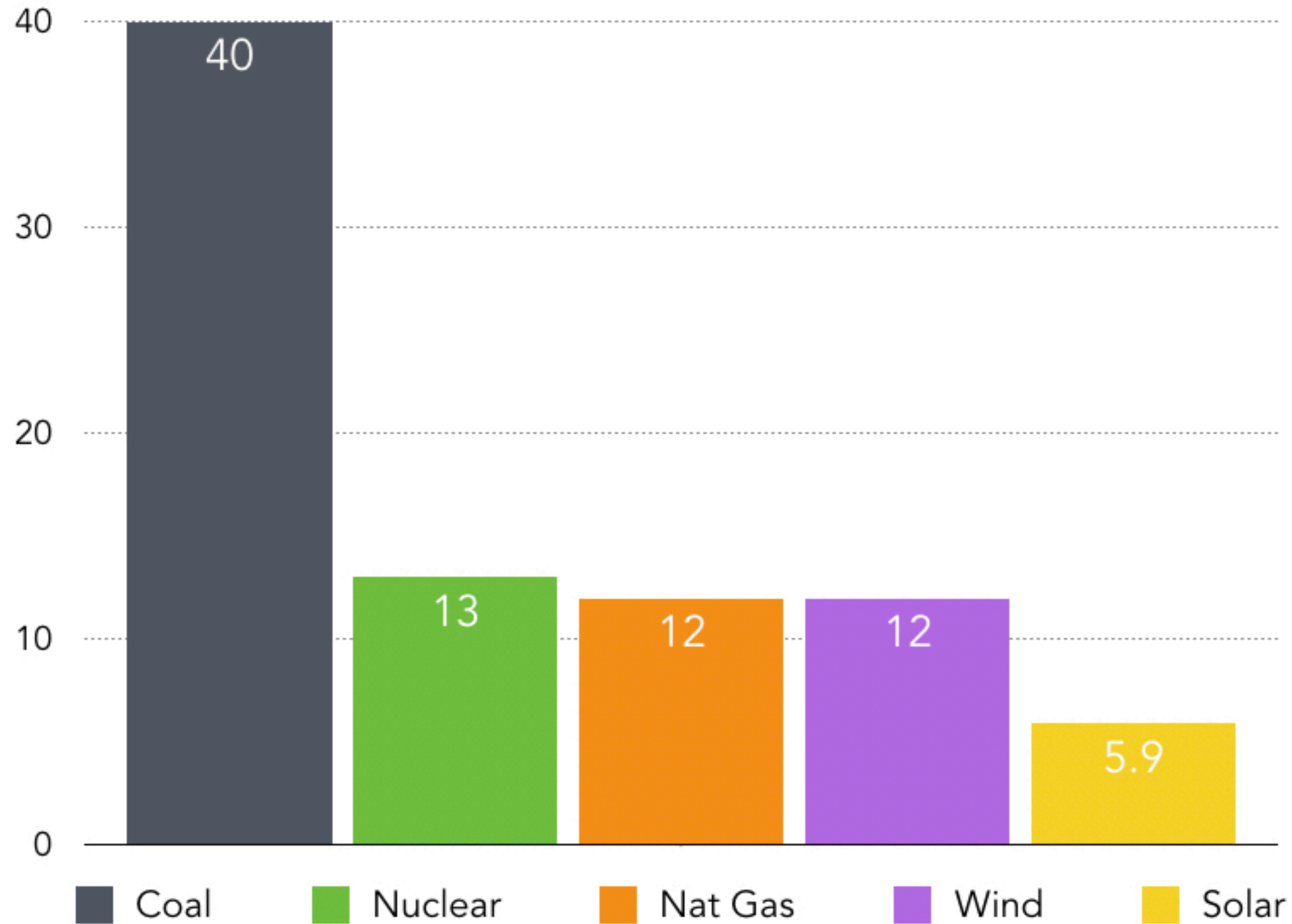


Germany has invested \$222
billion in renewables since
2000

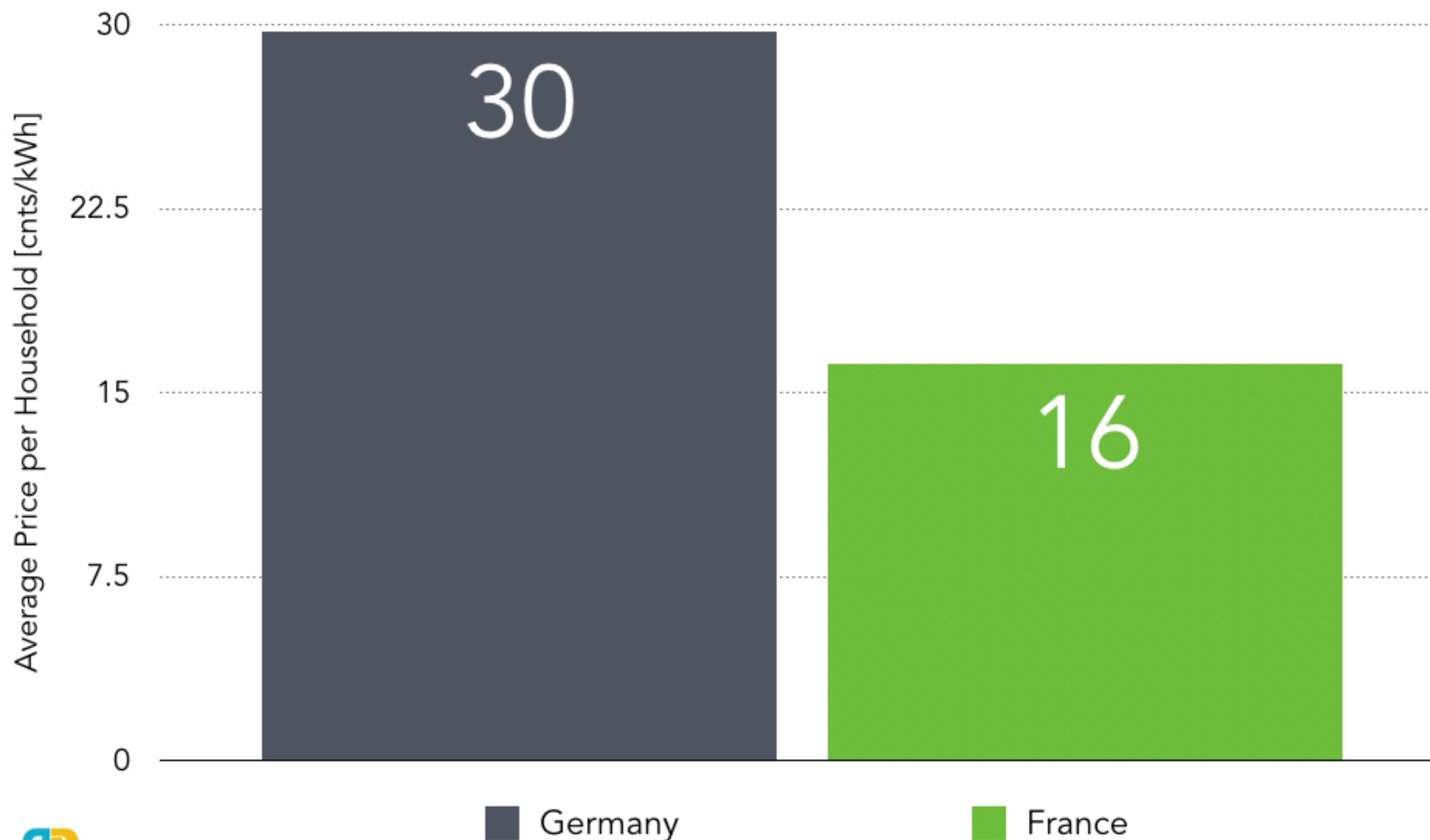
German electricity prices rose 47 percent from 2006 to 2016.



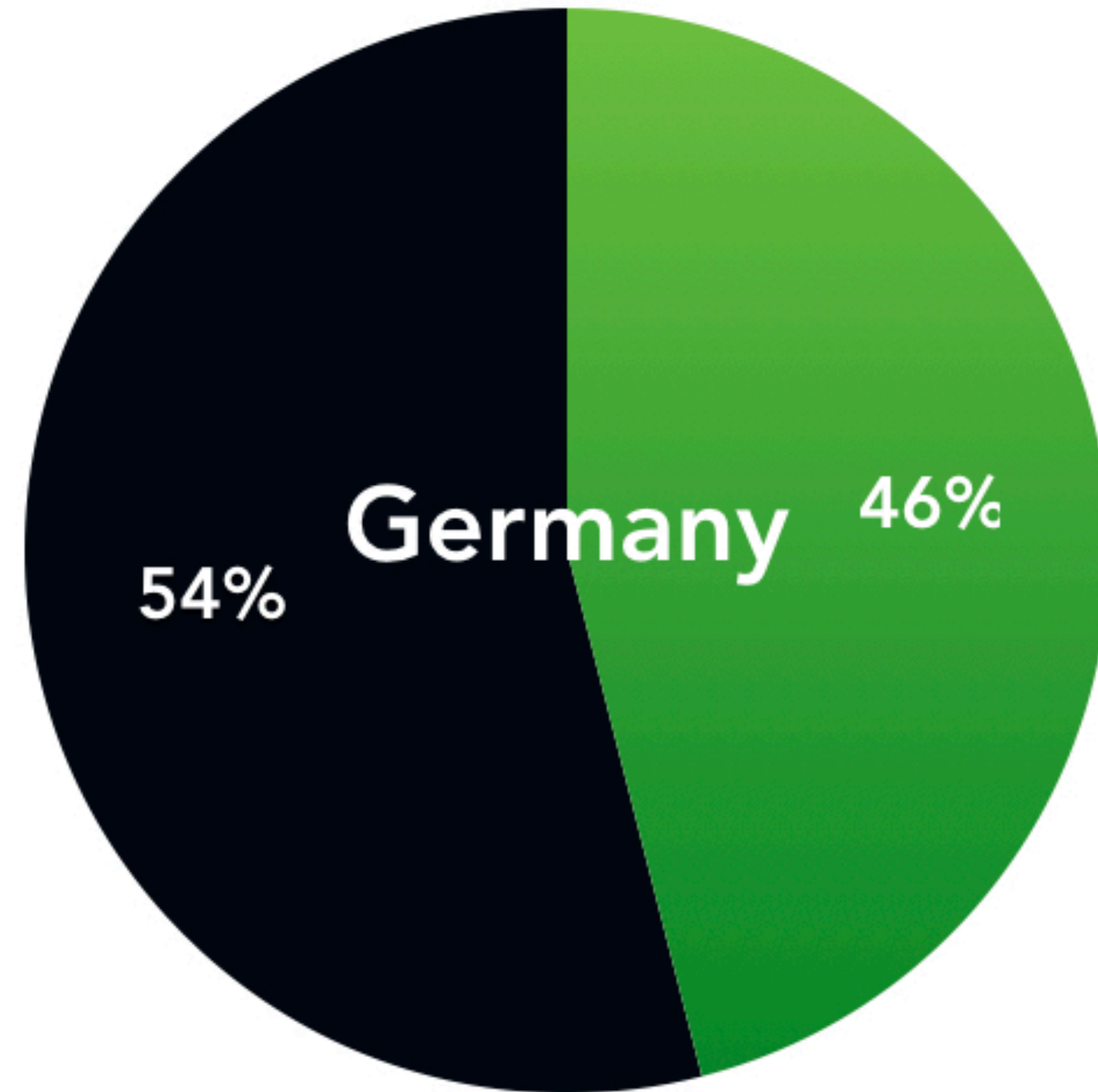
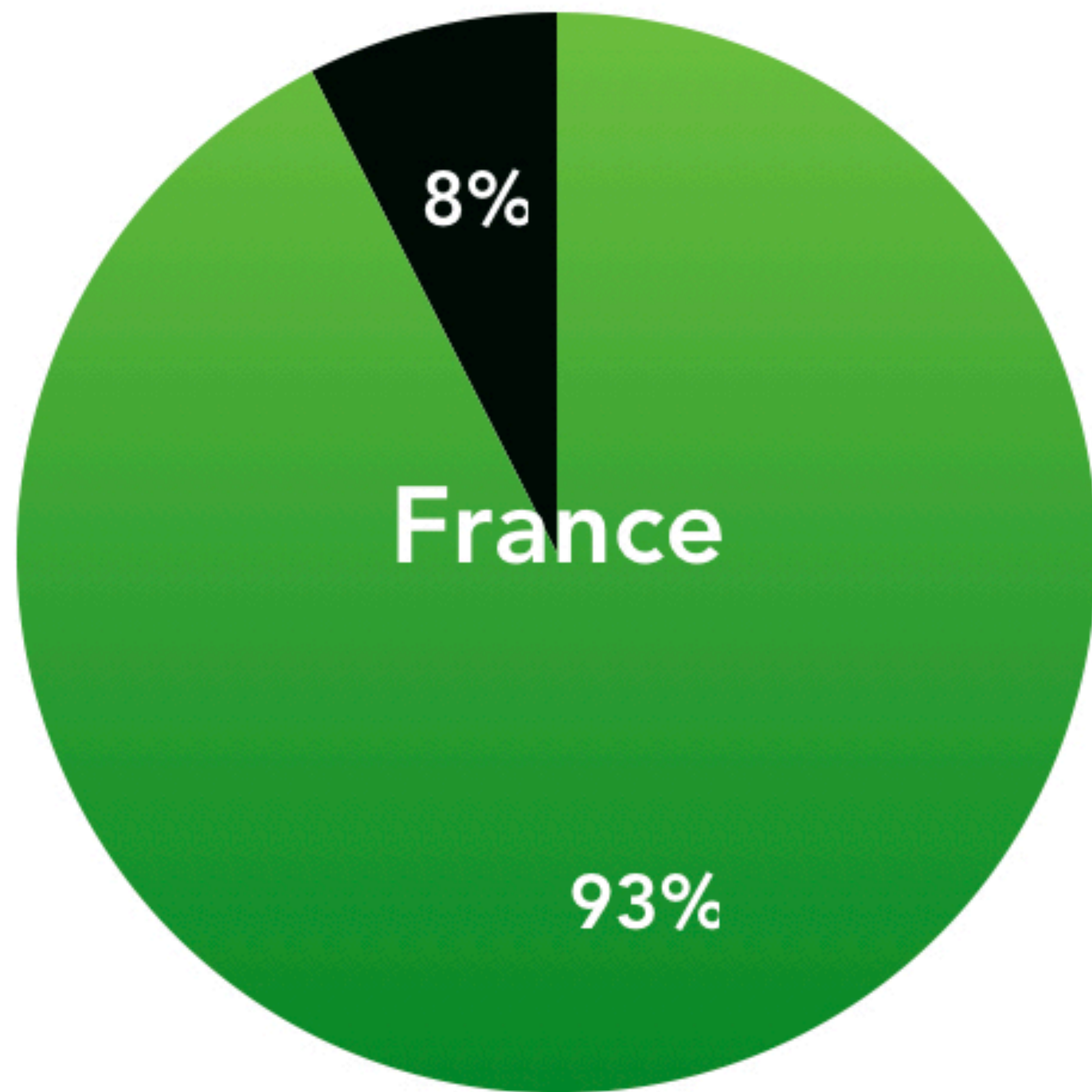
Percent of German electricity in 2016 from coal, nuclear, natural gas, wind and solar



German electricity is 2x more expensive than French electricity.



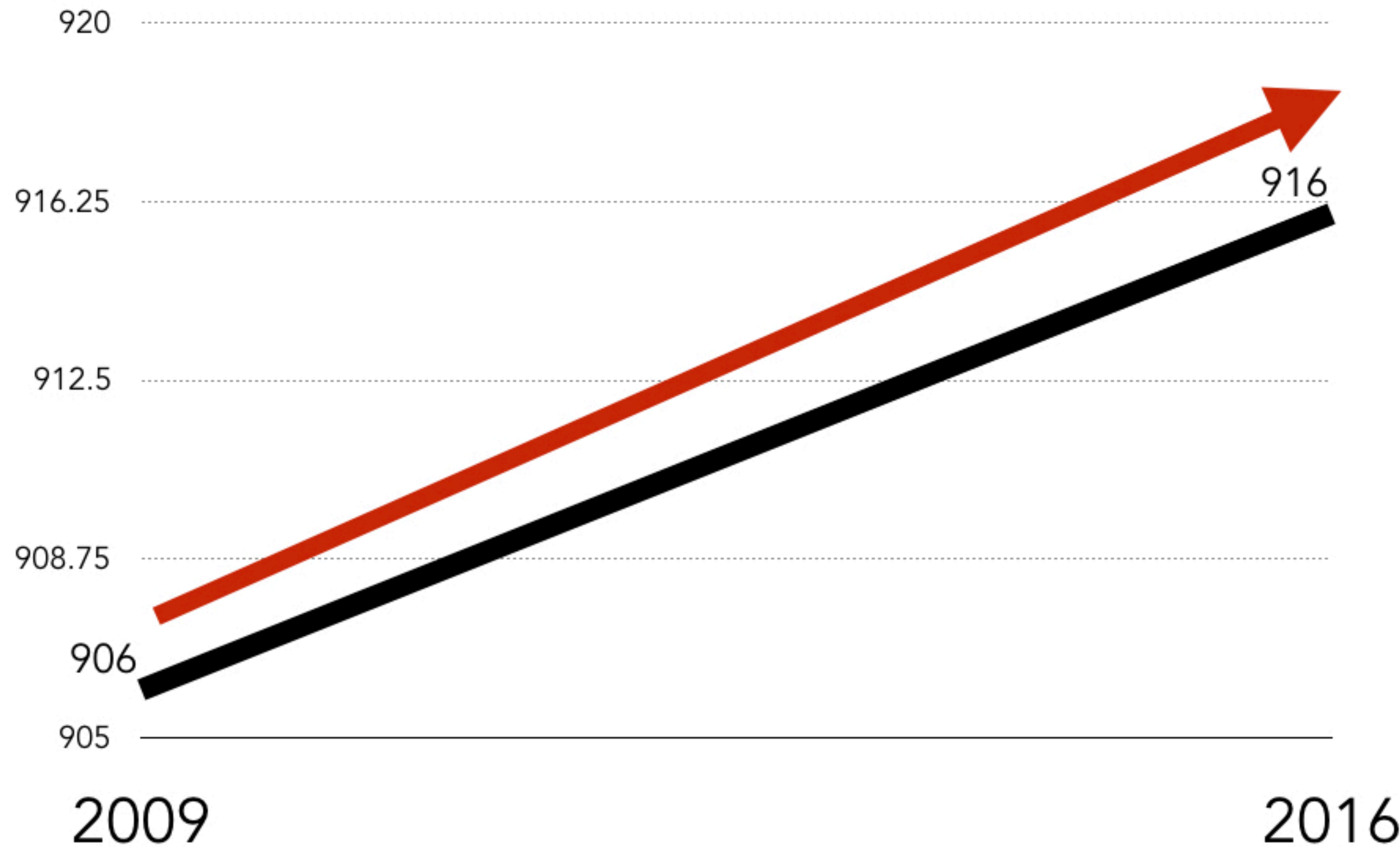
France generates 2x more electricity from clean energy sources than Germany.



● Clean

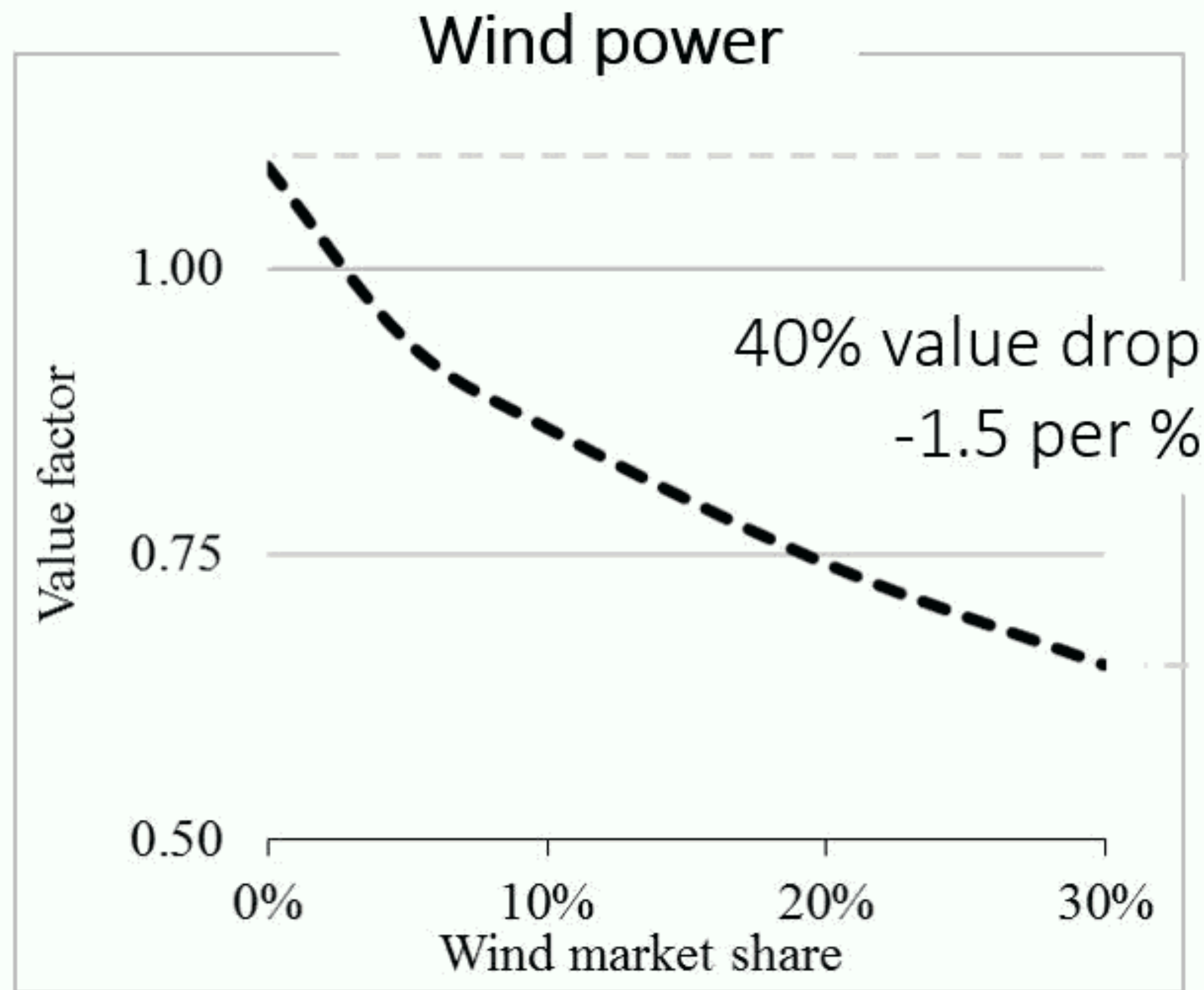
● Dirty

German emissions have been rising since 2009

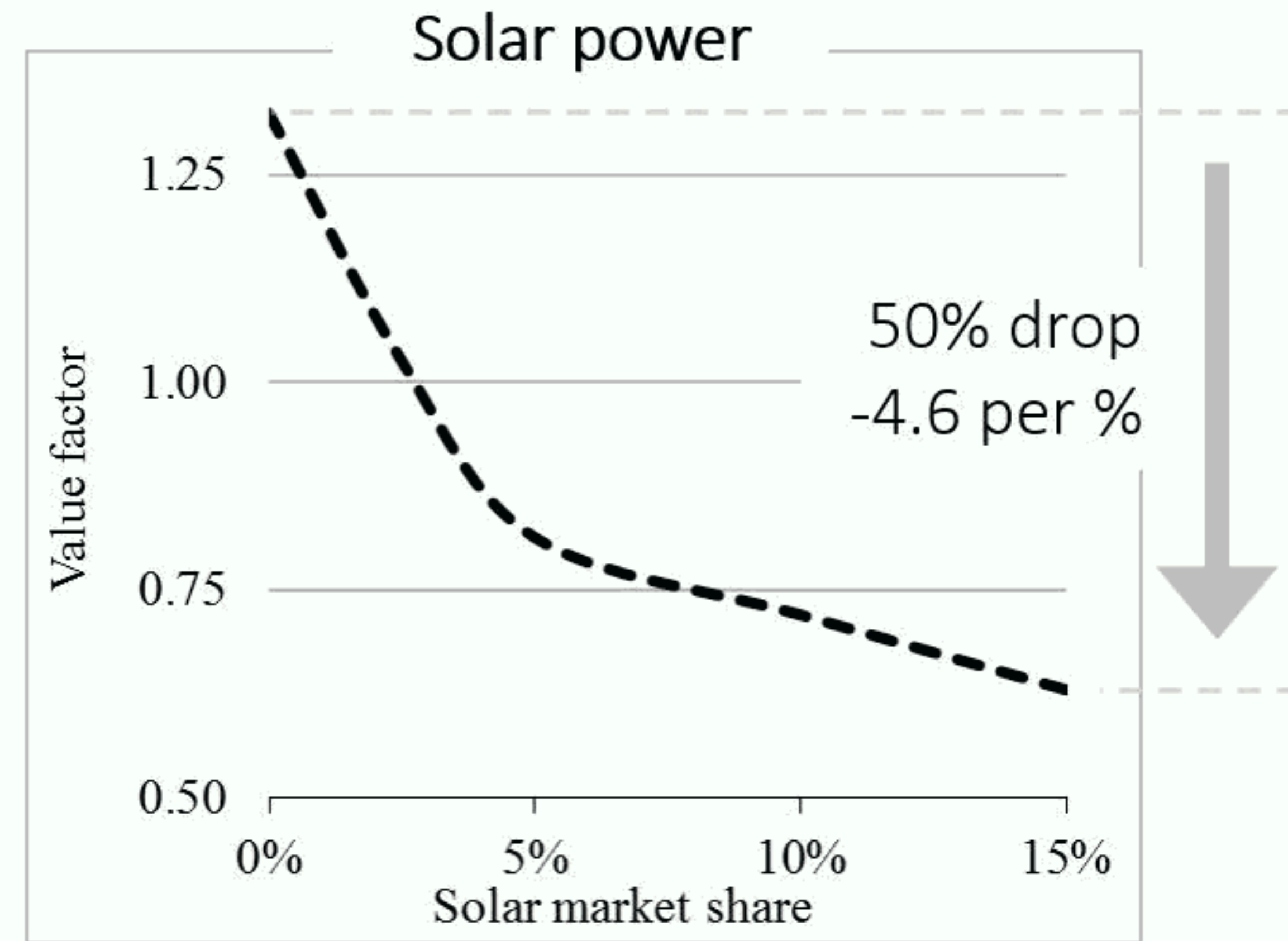


Germany installed 4% *more* solar panels in 2016 – but generated 3% *less* electricity from solar.

Germany installed 11% *more* wind turbines in 2016 – but generated 2% *less* electricity from wind.



Source: updated from Hirth (2013): Market value



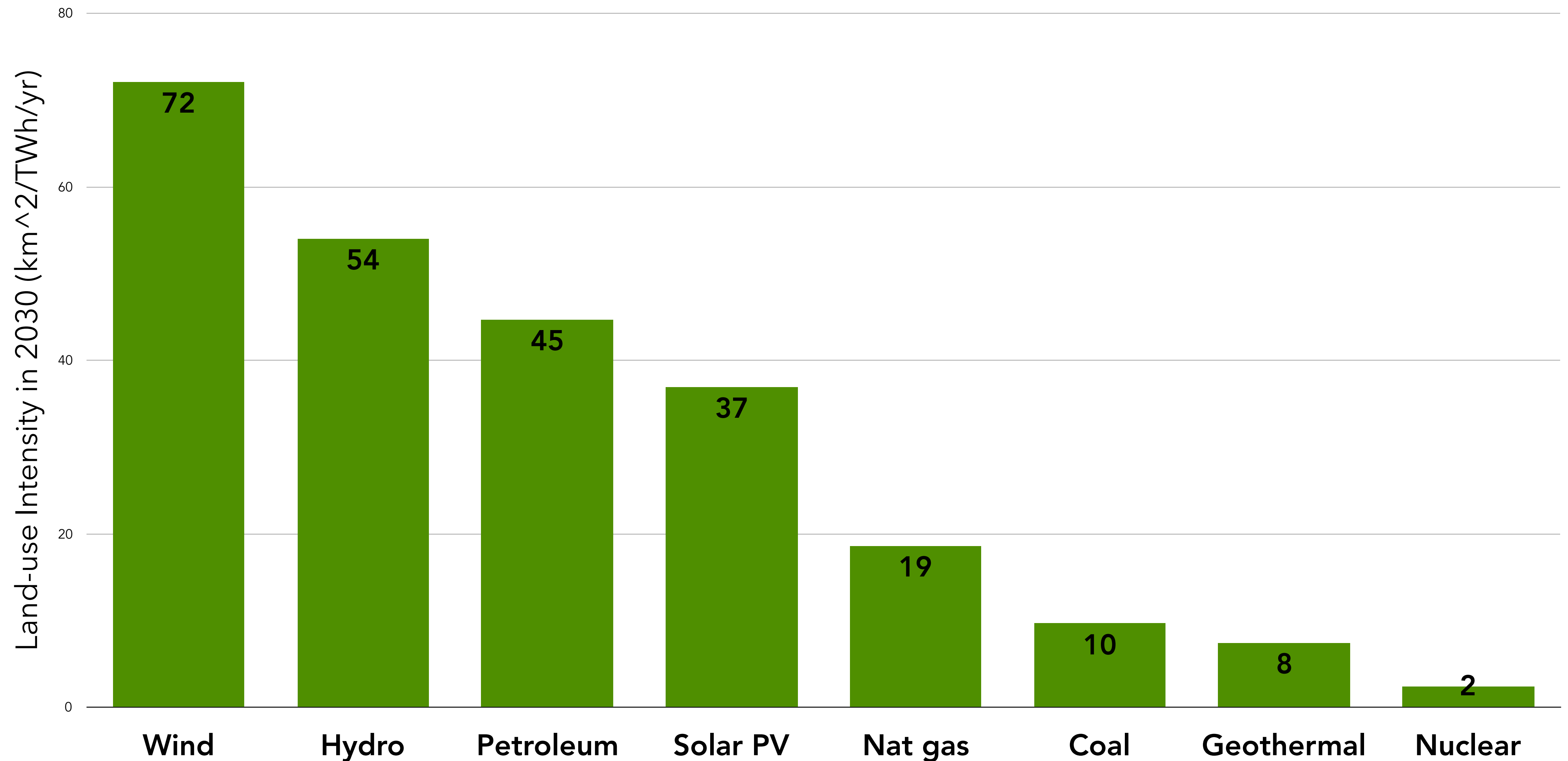
Source: updated from Hirth (2015): Market value of solar



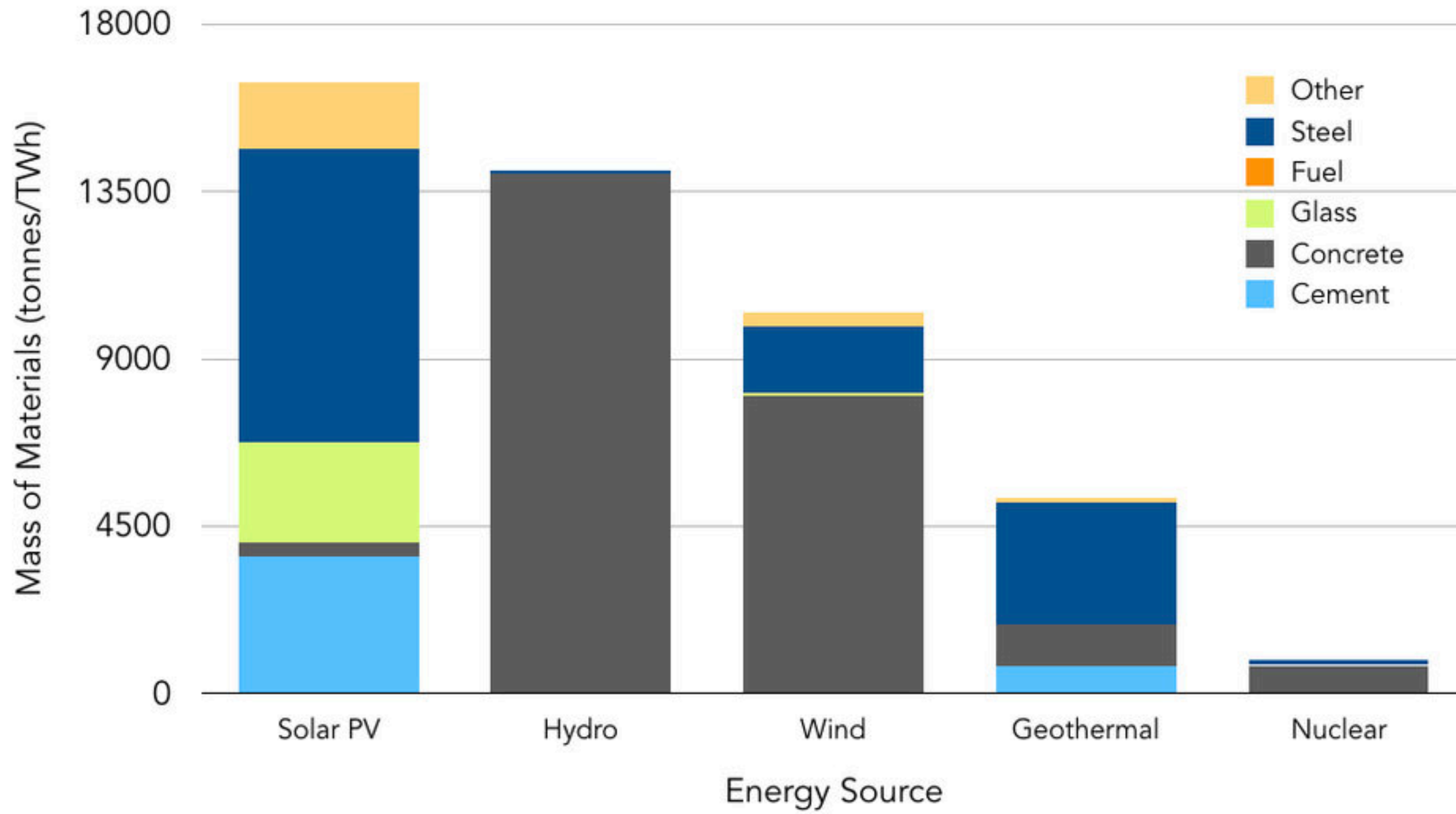
Source: Leon Hirth, "Market Value of Variable Renewables," EUI Working Paper, 2013, http://cadmus.eui.eu/bitstream/handle/1814/27135/RSCAS_2013_36.pdf?sequence

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

Renewables require 17 - 35 times more land than nuclear

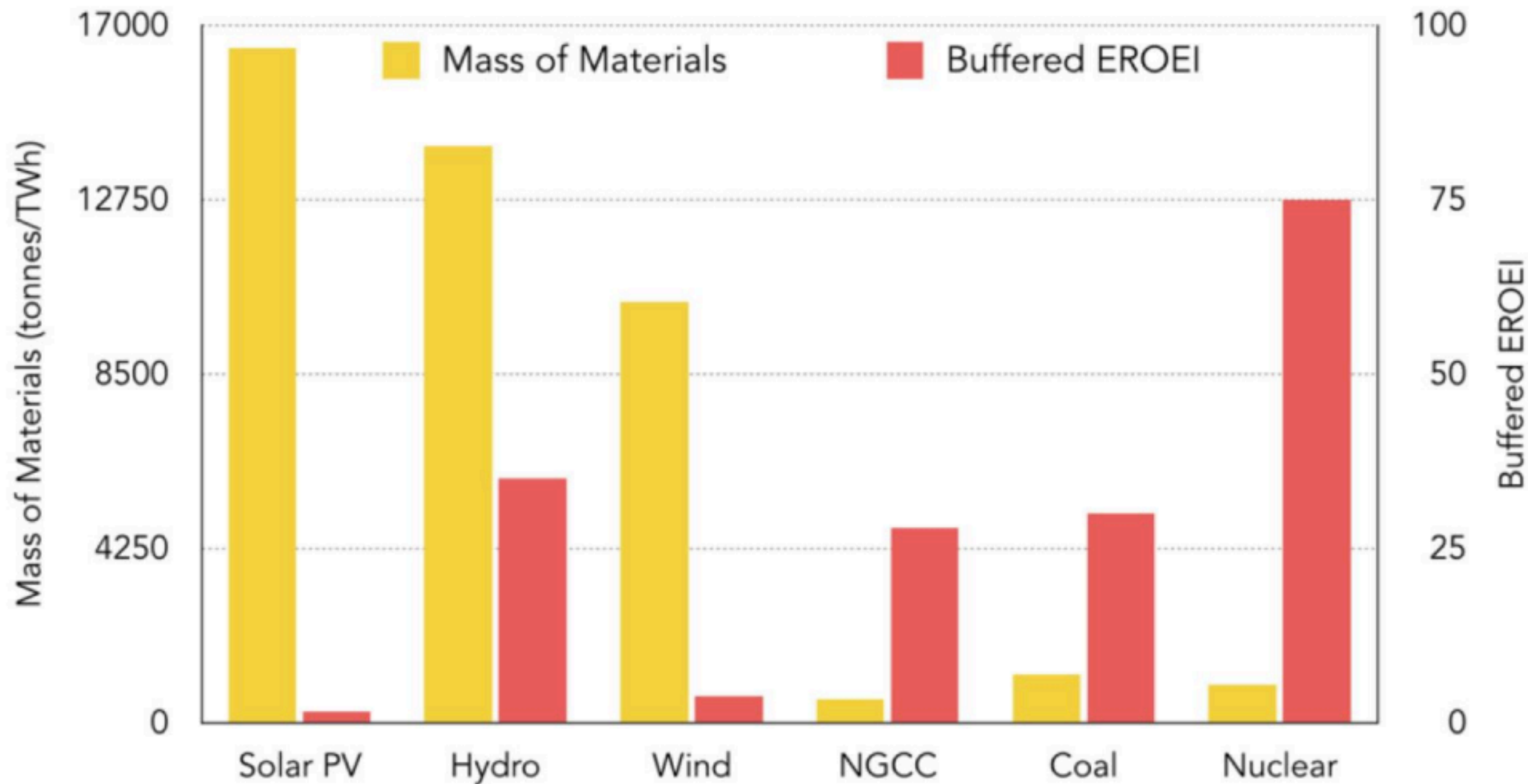


Materials throughput by type of energy source



Sources: DOE Quadrennial Technology Review, Table 10.
Murray, R.L. and Holbert, K.E. 2015. Nuclear energy: an introduction to the concepts, systems, and applications of nuclear processes (7th ed.). Elsevier.

Materials throughput and EROEI by type of energy source

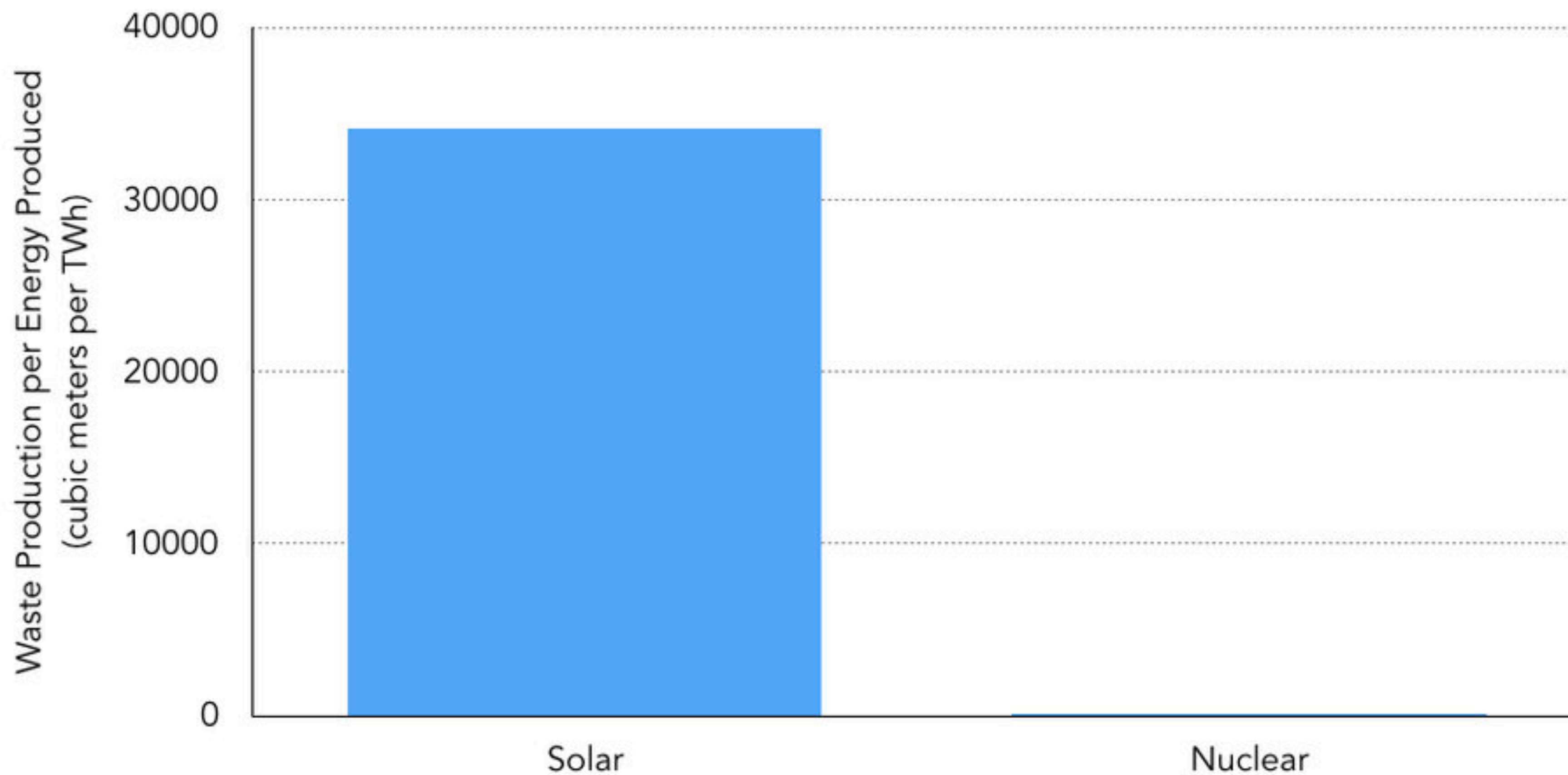


Sources: DOE Quadrennial Technology Review, Table 10.

Murray, R.L. and Holbert, K.E. 2015. Nuclear energy: an introduction to the concepts, systems, and applications of nuclear processes (7th ed.). Elsevier.

Weißbach, D., Rupprecht, G., Huke, A., Czerskia, K., Gottlieb, S., & Hussein, A. Energy intensities, EROIs, and energy payback times of electricity generating power plants.

Solar panels produce ~300x more waste than nuclear reactors when providing the same amount of energy.



Sources and Notes:

US GAO, http://www.gao.gov/key_issues/disposal_of_highlevel_nuclear_waste/issue_summary

World Nuclear Association, <http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-waste-management.aspx>

<http://www.world-nuclear.org/information-library/facts-and-figures/world-nuclear-power-reactors-archive/reactor-archive-december-2015.aspx>

IAEA, <https://www.iaea.org/PRIS/home.aspx>

BP, <http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html>

Solar panels specifications vary. Panel specifications were standardized according to TrinaSolar's Duomax Dual Glass 60-Cell Module:

http://static.trinasolar.com/sites/default/files/PS-M-0474%20A%20Datasheet_Duomax_PEG5.XX_US_Feb_2017_A.pdf

Is there an alternative to nuclear for cheap, clean energy?

- Carbon capture and storage *must* be more expensive than coal or natural gas alone
- Intercontinental super-grid would be expensive
undermine energy security
- Geo-engineering doesn't solve problems but creates new ones



Chernobyl



- 28 deaths from acute radiation syndrome
- 15 deaths from thyroid cancer in 25 years
- 1% death rate overall predicted for thyroid cancer.
- 16,000 excess thyroid cancers in total predicted, thus 160 deaths predicted
- No effect on fertility, malformations or infant mortality
- No conclusion on adverse pregnancy outcomes or still births
- Heritable effects not seen and very unlikely at these doses
- No proven increase in any other cancer (including liquidator cohorts)

Source: www.unscear.org/docs/reports/2008/11-80076_Report_2008_Annex_D.pdf

Fukushima

- No radiation deaths
- Over 1,500 deaths from radiophonic panic, evacuation & stress
- Over 15,000 killed by in tsunami
- Unlikely to be any increase in thyroid cancer
- No impact on adverse pregnancy



Living in big city increases risk of death more than putting out Chernobyl fire

Megacity versus small town living	2.8%
Passive smoking	1.7%
Exposure of 250mSv (Chernobyl Liquidator)	1.0%
Exposure of 100mSv (Chernobyl Liquidator)	0.4%



Source: Smith J BMC Public Health 2007 7:49



WHO

7 million die
annually from air
pollution

Nuclear is already the safest way to make reliable electricity.

