

RESOURCE RICH COLORADO



COLORADO'S NATIONAL AND GLOBAL
POSITION IN THE ENERGY ECONOMY



EIGHTH EDITION, DECEMBER 2016

RESOURCE RICH COLORADO

The integration of renewable energy and the state's rich energy resource base makes Colorado the Balanced Energy Capital of the the West.

Colorado's Energy Resource Mix



Large tracks of high-quality, low-sulfur coal



Abundant wind and solar clean energy



Significant oil and natural gas reserves



Major intellectual capital with 30 federal laboratories

Colorado's Balanced Energy Industry

FOSSIL FUELS

5.9%

EMPLOYMENT GROWTH (5 YEAR)

CLEANTECH

22.4%

\$106,996

2015 AVERAGE WAGE

\$79,100

#9

EMPLOYMENT CONCENTRATION (RANK FOR U.S.)

#4

DIRECT & INDIRECT WORKERS IN BOTH INDUSTRIES

274,760



ECONOMIC IMPACT



Colorado Energy by the Numbers



#1

Colorado is the No. 1 state for wind-energy manufacturing

Brain power



fuels innovation in Colorado's energy industry - we have the nation's 2nd-most highly educated workforce.

#10



Colorado is a top-10 state for alternative fuel vehicle adoption

#BalancedEnergy

 COLORADO ENERGY COALITION

www.metrodenver.org/CEC

Dedicated to supporting and promoting all energy sectors: fossil fuels, cleantech, efficiency, and conservation.



Resource Rich Colorado

Eighth Edition, December 2016

Acknowledgements

Resource Rich Colorado Committee Members

Brian Payer, Sphera, *Committee Co-Chair*

Michael Pomorski, Encana Corporation, *Committee Co-Chair*

Alisa Anderson, Pure Brand Communications

John Arigoni, Encana Corporation

Bob Burnham, Burnham Coal, LLC

Chris Hansen, Hansen Advisors, LLC

Dan Igoe, Pure Brand Communications

Jared Luner, Xcel Energy

Jim Marchiori, University of Colorado, Denver

Katherine Wang, Colorado Office of Economic Development & International Trade

Chris Worley, Colorado Energy Office

Metro Denver Economic Development Corporation Staff

Tom Clark

Scott Prestidge

Pam Reichert

Janet Fritz

Dani Barger

Special Thanks to David Hansen, Senior Economist, Development Research Partners



Resource Rich Colorado

Eighth Edition, December 2016

Methodology

The Colorado Energy Coalition (CEC), an industry affiliate of the Metro Denver Economic Development Corporation (Metro Denver EDC), published the first edition of *Resource Rich Colorado (RRC)* in 2009. This eighth edition further analyzes Colorado's competitive position in the global energy economy.

The eighth edition of *Resource Rich Colorado* includes data from a variety of public and private sources, such as the Energy Information Administration, International Energy Agency, Baker Hughes, SNL Energy, BP Statistical Review of World Energy, R.L. Polk & Company, National Renewable Energy Laboratory, and the U.S. Green Building Council. Another key resource is the Metro Denver EDC's annual *Energy Industry Cluster Study*, which will be released in January 2017. The cluster study provides Colorado-specific employment and industry growth statistics and is useful for illustrating statewide and regional economic trends. All of the data included in *Resource Rich Colorado* comes from the most recent and accurate public information available at the time of release.

Resource Rich Colorado uses data to evaluate Colorado's competitive position in the areas of oil, natural gas, coal, renewables, power generation, environment and sustainability, policies and programs, and employment and industry. States are evaluated in each category in order to determine their competitiveness and overall ranking. Graphs and charts are used to provide context. In most cases, the top-10 states are shown for each category. If Colorado does not appear in the top 10, it is placed in the graph to illustrate its position in relation to industry leaders. Five years of data are provided as often as possible in order to reveal industry trends.

Resource Rich Colorado also evaluates the United States' competitive position in the global energy economy. Countries are compared in terms of production, imports, exports, reserves, installed renewable generation capacity, emissions, and pricing. Graphs are used to demonstrate the size

and scale of the United States' role in various energy industry sectors. The top-10 international leaders of each category are typically presented. Five years of data are provided as often as possible in order to reveal industry trends.

Resource Rich Colorado ranks countries and states by metrics common to the energy industry, such as barrels, cubic feet, short tons, metric tons, megawatts, kilowatts, and other units of measurement. International metrics have been converted to more familiar U.S. measurements in most cases. A glossary of measurement conversions is provided below, as well as an explanation of chemicals that make up greenhouse gas emissions.

Glossary of Units and Measurements

- 1 Barrel of Oil = 42 U.S. Gallons or about 159 Liters
 - One barrel of oil produces approximately 19 gallons of gasoline. The remainder yields varying amounts of distillate, residual fuel oils, jet fuel, and other products.
- 1 Cubic Foot = 7.48 U.S. Gallons or 28.32 Liters
- 1 Short Ton = 2,000 Pounds
- 1 Long Ton = 2,240 Pounds
- 1 Metric Ton = 2,204.62 Pounds
- 1 Megawatt = 1,000 Kilowatts, or 1,000,000 Watts
 - 1 Megawatt represents enough electricity to power between 600 to 1,000 homes. Size of house and geographic location contribute to varying consumption levels.
- 1 Megawatt Hour (MWh) = 8,760 Megawatts of Electric Generation per Year
 - There are 8,760 hours in a year, so if a 1 megawatt power plant ran at full capacity for a year, it would generate 8,760 megawatt hours of electricity.
- 1 Gigawatt = 1,000 Megawatts, or 1 Billion Watts
- 1 Terawatt = 1,000 Gigawatts, or 1 Trillion Watts
- 1 British Thermal Unit (BTU or Btu) = 1,055 Joules
 - A Btu is a basic measure of thermal energy. One BTU is the amount of energy needed to heat one pound of water one degree Fahrenheit. If you placed 16 ounces of water at 59°F into a stovetop pan and turned on the gas burner, it would take one BTU to raise the temperature of the water to 60°F.

Greenhouse Gas (GHG) Emissions

- Carbon dioxide (CO₂) represents approximately 81 percent of annual GHG emissions. Common sources include fossil fuel combustion, solid waste, trees, wood products, and certain chemical reactions that may occur during industrial processes.
- Methane (CH₄) represents approximately 11 percent of annual GHG emissions. Common sources include the production and transport of fossil fuels, agriculture practices, livestock, and the decay of organic waste.
- Nitrous oxide (N₂O) represents approximately 3.5 percent of annual GHG emissions. Common sources include fossil fuel combustion, industrial activities, agriculture practices, livestock, vegetation, and the oceans. Natural sources create 62 percent of total N₂O emissions.
- High global warming potential (High-GWP) gases include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). High-GWP gases represent approximately 2.5 percent of annual GHG emissions. These gases have a variety of uses, including as refrigerants, insulators, solvents, and aerosols; as etching, cleaning, and firefighting agents; and as cover gases in various manufacturing processes.



Resource Rich Colorado

Eighth Edition, December 2016

Executive Summary

Resource Rich Colorado (RRC) analyzes Colorado's competitive position in the global energy economy. The eighth edition confirms that Colorado has one of the most diverse, balanced, and promising energy economies in the country.

Colorado is a strong performer in the production of oil, coal, natural gas, wind, and solar, and is spearheading the adoption of alternative fuel vehicles and improving the efficiency of our built environment. While many states are strong in either fossil fuels or cleantech, Colorado is a leader in both, reflecting the state's success with a balanced energy approach. This report provides an overview of the state's competitive position in all of these sectors, while also exploring electric power generation, energy policies and programs, and Colorado's energy employment and industry growth.

Colorado's energy resource mix consists of several important assets:

- The Niobrara Shale, a complex geological formation that stretches across several western states and contains large reserves of oil and natural gas.

- The Piceance basin, a tight-shale field with estimated reserves of 1.5 trillion barrels of oil, as well as significant natural gas reserves.
- Large tracts of super-compliant coal with low sulfur, mercury, and ash content.
- Excellent solar resources in south-central Colorado.
- Abundant wind resources along Colorado's eastern plains.
- High levels of intellectual capital, supported by leading federal laboratories and research universities.

According to the U.S. Department of Energy's (DOE) Energy Information Administration Colorado ranks sixth nationally in natural gas production, seventh in oil production, and 11th in coal production. In fact, 10 of the nation's 100 largest natural gas fields and three of the nation's 100 largest oil fields are in Colorado. Moreover, significant amounts of both coal and natural gas are exported to markets beyond the state's borders.

Colorado's cleantech sector also ranks highly. Colorado ranks 10th in installed wind capacity and seventh in wind generation as a percent of total state electric power generation. Colorado ranks ninth in installed solar capacity and 10th in solar generation as a percent of total state electric power generation. Colorado ranks third in cumulative square footage of LEED-certified space per capita, and it ranks 10th in the adoption of alternative fuel vehicles on a per capita basis.

Colorado is also fortunate to have a tremendous amount of intellectual capital—boasting 30 federally funded scientific research laboratories—such as the National Oceanic and Atmospheric Administration (NOAA), the National Institute of Standards and Technology (NIST), and the National Renewable Energy Laboratory (NREL). NREL is the only DOE laboratory dedicated to the research, development, commercialization, and deployment of renewable energy and energy efficiency technologies. NREL's assets are further heightened through its research partnerships with the Colorado School of Mines, the University of Colorado Boulder, and Colorado State University, as well as through a network of collaborations with the private sector.

While Colorado's energy industry can boast of broad success, companies are facing market, regulatory, and political uncertainty. Oil and gas prices remain uncharacteristically low. Multiple coal plant and mine closures are pending and will provide unique challenges for several Colorado communities. In addition, there are countless questions surrounding the future of the Clean Power Plan, the Paris Climate Agreement, the Renewable Fuel Standard (RFS), OPEC oil production levels, global growth and economic stagnation, infrastructure funding, strengthened ozone regulations, and continued local control debates over oil and gas development. While this uncertainty should not be taken lightly, Colorado's diverse energy industry has proven its versatility and leadership, and should be expected to persevere.

In support of that assertion, Colorado maintains several competitive advantages that are worthy of note. The state's low income tax, moderate business costs, and diverse resource base, which continue to attract and retain businesses in the energy and natural resource sector.

According to the results listed in the 12th edition of the report *Toward a More Competitive Colorado*, Colorado may also claim the following distinctions:

- Second-most highly educated state in the nation
- Fifth-highest employment growth rate
- Second-fastest growing population
- Second in State Science and Technology Index
- Fourth in initial public offerings
- Seventh in number of new companies per 1,000 employees
- Third in Small Business Innovation Research Grants

In order to understand how Colorado's energy economy fits within the broader global marketplace, *Resource Rich Colorado* also analyzes national and international dynamics. For example, the United States remains a top global producer and consumer of natural resources. The U.S. ranks first in oil production, first in natural gas production, and second in coal production. On the cleantech front, the U.S. ranks second in cumulative installed renewable energy capacity with over 100 gigawatts of electric power generation.

Resource Rich Colorado also draws from the Metro Denver EDC's annual *Energy Industry Cluster Study*. This study provides employment and company data regarding Colorado's energy industry cluster. In 2016, Colorado ranks ninth nationally in fossil fuel employment concentration with 44,370 direct jobs. Colorado also ranks fourth in cleantech employment concentration with 26,270 direct jobs. Combined, energy employment figures represent a \$14.9 billion economic impact. These numbers underscore the achievements of Colorado's diverse energy industry cluster.

The eighth edition of *Resource Rich Colorado* solidifies Colorado as a balanced energy industry leader. And while there are regulatory, political, and market-based challenges to contend with, Colorado's energy industry is poised to continue its pattern of resilience, innovation, and growth.

Resource Rich Colorado

Eighth Edition, December 2016

List of Figures

<i>Figures</i>	Oil
	Introduction to Oil
1	Annual Average Crude Oil Prices
2	Crude Oil Production by State
3	Crude Oil Reserves & Utilization Rate
4	Annual Average Rotary Rig Count
5	U.S. Shale Oil Drilling Efficiency by Major Resource Play
6	U.S. Shale Oil Production by Major Resource Play
7	U.S. Crude Oil Production & Consumption
8	Map of Crude Oil & Refined Products Infrastructure
9	Global Oil Production Leaders
10	Global Net Importers of Oil
11	Map of Major Oil and Products Trade Movements
	Natural Gas
	Introduction to Natural Gas
12	Average Annual Natural Gas Prices
13	Natural Gas Production by State
14	Natural Gas Reserves & Utilization Rate
15	Lower 48 States Shale Plays
16	U.S. Shale Gas Production by Major Resource Play
17	U.S. Shale Gas Drilling Efficiency by Major Resource Play
18	U.S. Natural Gas Production & Consumption
19	Map of Natural Gas Pipeline Infrastructure
20	Global Natural Gas Production Leaders
21	Global Net Importers of Natural Gas
22	Map of Major Natural Gas Trade Movements
	Coal
	Introduction to Coal
23	Average Annual Coal Prices
24	U.S. Coal Production by State
25	U.S. Coal Reserves & Utilization Rate
26	U.S. Coal Capacity Installations and Retirements
27	Global Coal Production Leaders
28	Global Proved Coal Reserves
29	Global Net Exporters of Coal
30	Global Net Importers of Coal
	Cleantech
	Introduction to Cleantech
31	Price of Wind
32	Total Installed Wind Capacity
33	Wind Net Generation as a Percent of Total
34	Price of Solar
35	Total Installed Solar Capacity
36	Solar Net Generation as a Percent of Total
37	Total Installed Hydropower Capacity

38	Hydro Net Generation as a Percent of Total
39	Total Installed Biomass Capacity
40	Total Installed Geothermal Capacity
41	Total Energy Storage Capacity
42	Global Cumulative Installed Renewable Energy Capacity
43	State Energy Efficiency Scorecard
44	Cumulative LEED-Certified Space per Capita
45	Net Electricity Savings from State Energy Efficiency Programs
46	Alternative Fuel Vehicles per Capita
47	Alternative Fuel Vehicle Stations per Registered Alternative Fuel Vehicle
48	Metro Mobility
49	Cleantech Venture Capital Investments
Power	
Introduction to Power	
50	Map of Major Electric Transmission Lines
51	U.S. Net Generation by Market Share
52	U.S. Net Generation by Resource
53	Average U.S. Capacity Factor by Resource
54	U.S. Nameplate Capacity and Net Generation
55	Colorado Nameplate Capacity and Net Generation
56	Levelized Costs for Electric Generation Plants
57	Average Residential Summer Retail Electric Price
58	Average Commercial Summer Retail Electric Price
59	Average Industrial Summer Retail Electric Price
60	U.S. per Capita Energy Consumption
Emissions	
Introduction to Emissions	
61	Global CO ₂ Emissions per Capita
62	Global CO ₂ Emissions by Country
63	State CO ₂ Emissions per Capita
64	State CO ₂ Emissions from Fossil Fuel Combustion per \$1 M State GDP
Policies & Programs	
Introduction to Energy Policies & Programs	
65	Renewable Energy Policies
66	Net Metering Policies
67	State Gasoline Tax
68	Global Retail Prices of Premium Unleaded
69	Acres Leased for Drilling on Federal Lands
70	Colorado Water Utilization by Sector
Employment & Industry	
Introduction to Employment & Industry	
71	Fossil Fuels - Number of Employees
72	Colorado Fossil Fuels Employment by Industry Sector
73	Fossil Fuels Employment Concentration
74	Cleantech - Number of Employees
75	Colorado Cleantech Employment by Industry Sector
76	Cleantech Employment Concentration
77	Average Annual Salary
78	Economic Impact
79	Colorado GDP by Sector

Oil



Oil

Cost-effective technology advancements opened vast, new resources over the past decade and led to a surge in domestic oil production. In fact, according to the International Energy Agency (IEA), the United States produced 7.2 million barrels of oil per day in 2010, but by the end of 2015, the U.S. leapfrogged Russia and Saudi Arabia to become the world's top oil producer at 12.3 million barrels per day.

Historically, according to the U.S. Energy Information Administration (EIA), U.S. crude oil production peaked in 1970 with an annual average of 9.64 million barrels a day. U.S. production then experienced a slow decline until 2008, bottoming out at 5 million barrels a day. It was at that point that U.S. crude began its steep surge in domestic production.

However, weak demand and global over-supply in 2015 and 2016 led to a steep price decline. U.S. crude oil prices were \$106 per barrel in June 2014, but plummeted nearly 60 percent to \$45 per barrel by January 2015. Prices eventually bottomed-out below \$30 per barrel in early 2016. Since then, oil prices hovered between \$40-\$50 most of the year. At the time of this publication (December 2016), the EIA forecasts crude oil prices will average \$50 per barrel in 2017, marking the likelihood of a long, slow price recovery.

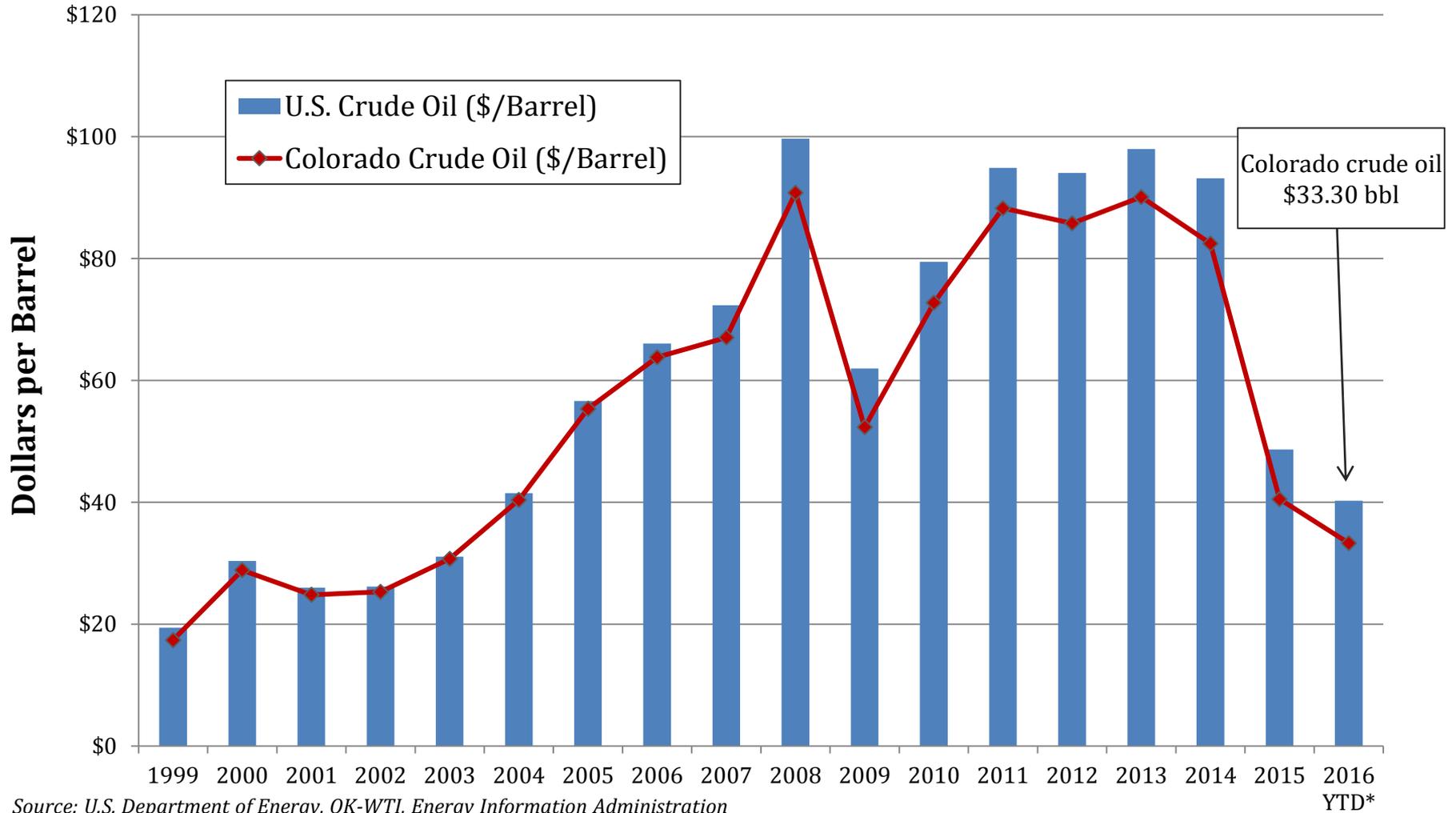
Colorado oil production parallels national trends. According to the Colorado Oil and Gas Conservation Commission, in 2008, the state produced nearly 30 million barrels of oil. By 2012, that jumped to 49 million barrels. In 2013, Colorado broke a nearly 60-year record, producing 65 million barrels of oil. Remarkably, Colorado continued that upward trajectory producing 95 million barrels in 2014 and 126 million barrels in 2015. For the first time in a number of years, Colorado production numbers are declining, due to low prices. While 2016 production totals will fall below the high-water mark set in 2015, production will remain above 2014 totals, demonstrating the resiliency and adaptability of Colorado's oil and gas industry.

Oil production remains a major portion of Colorado's fossil-fuel sector. According to the 2016 Metro Denver EDC annual *Energy Industry Cluster Study*, Colorado ranked ninth nationally in fossil fuel employment concentration. This includes 44,370 direct fossil fuels workers supporting an additional 118,020 indirect workers, with an economic impact of \$10.3 billion. In 2015, the average annual salary for a fossil fuels worker was \$106,996 in Colorado, compared with the national average of \$101,672. Current market conditions may be challenging, but it is clear that the oil industry will continue to be an important part of Colorado's energy economy.



Annual Average Crude Oil Prices, 1999-2016

Prices for Colorado-produced oil trend below the national average to account for fuel transportation costs to markets outside the state



Source: U.S. Department of Energy, OK-WTI, Energy Information Administration

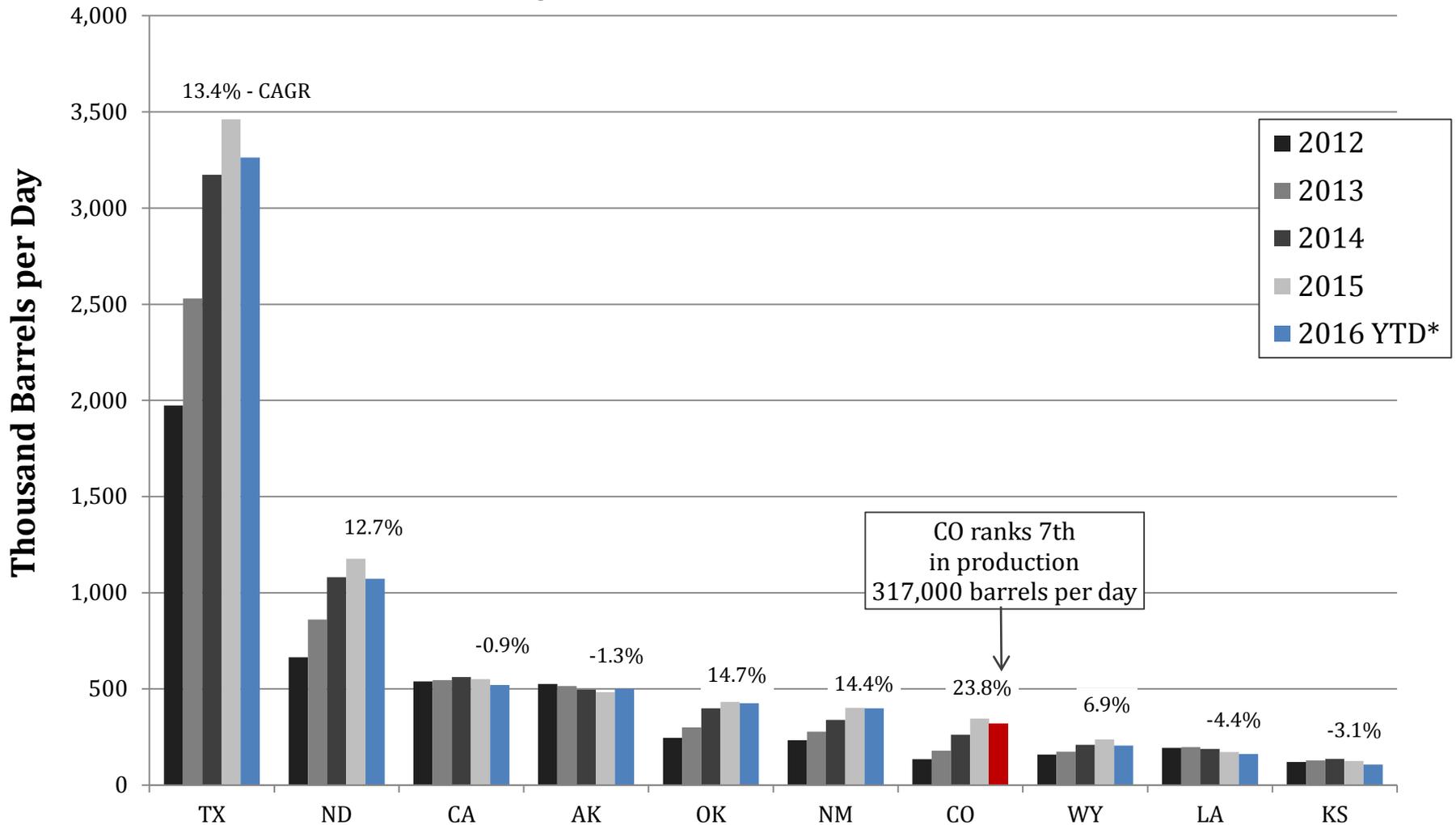
Note: Crude oil includes lease condensate recovered as liquid from natural gas wells. Colorado price represents the first-purchase price.

*2016 year-to-date data represents US average daily spot price from January to July and Colorado monthly average price over the same time.

Fig. 1

Crude Oil Production by State, 2012-2016

U.S. 2012 to 2016 compound annual growth rate (CAGR) was 8.6% compared with 23.8% in Colorado



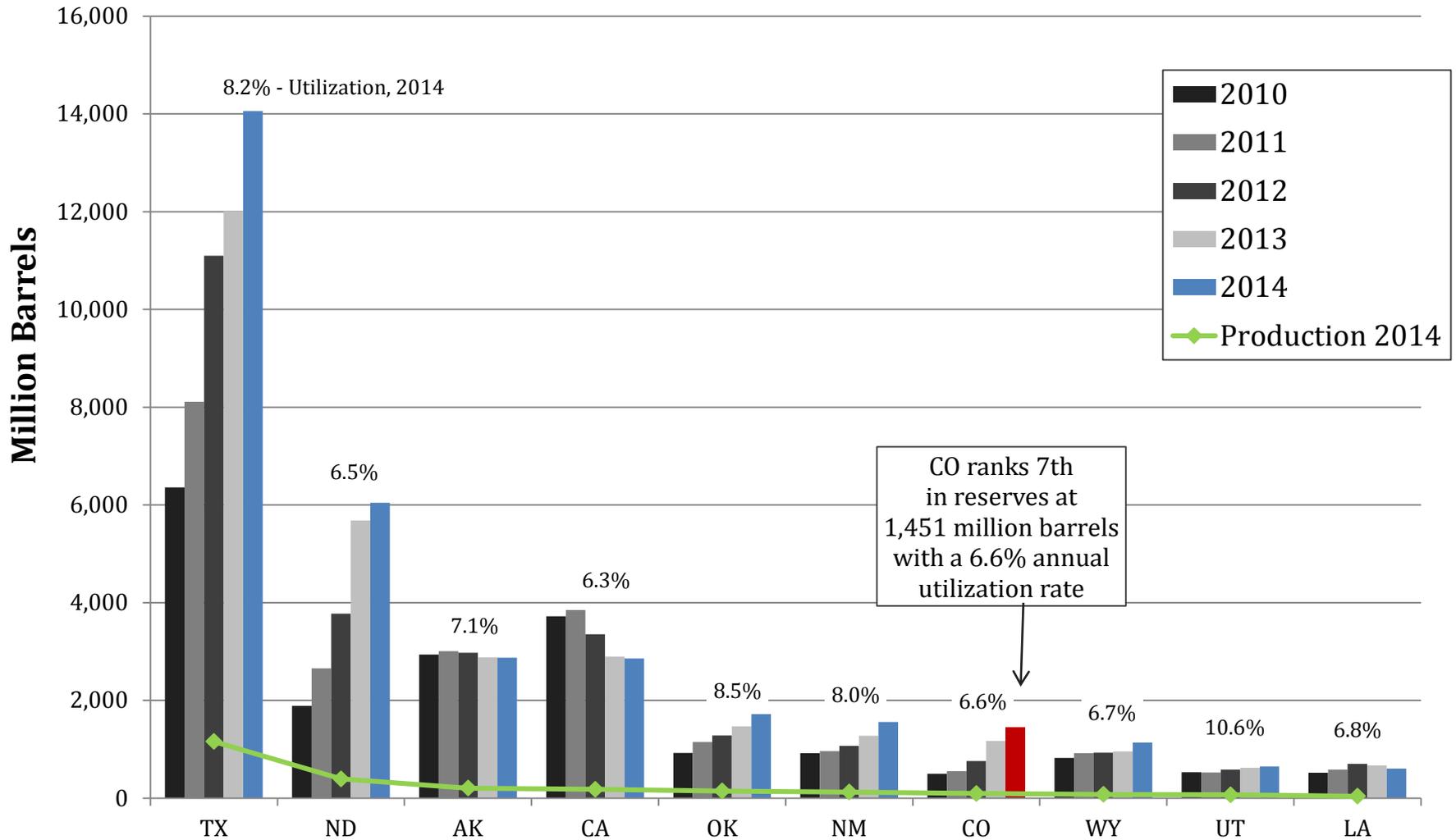
Source: U.S. Department of Energy, Energy Information Administration

Note: Crude oil includes lease condensate recovered as liquid from natural gas wells; the compound annual growth rate (CAGR) reflects the 2012 to 2016 period; *2016 year-to-date represents January to June.

Fig. 2

Crude Oil Reserves & Utilization Rate, 2010-2014

Technology improvements contribute to growing reserves



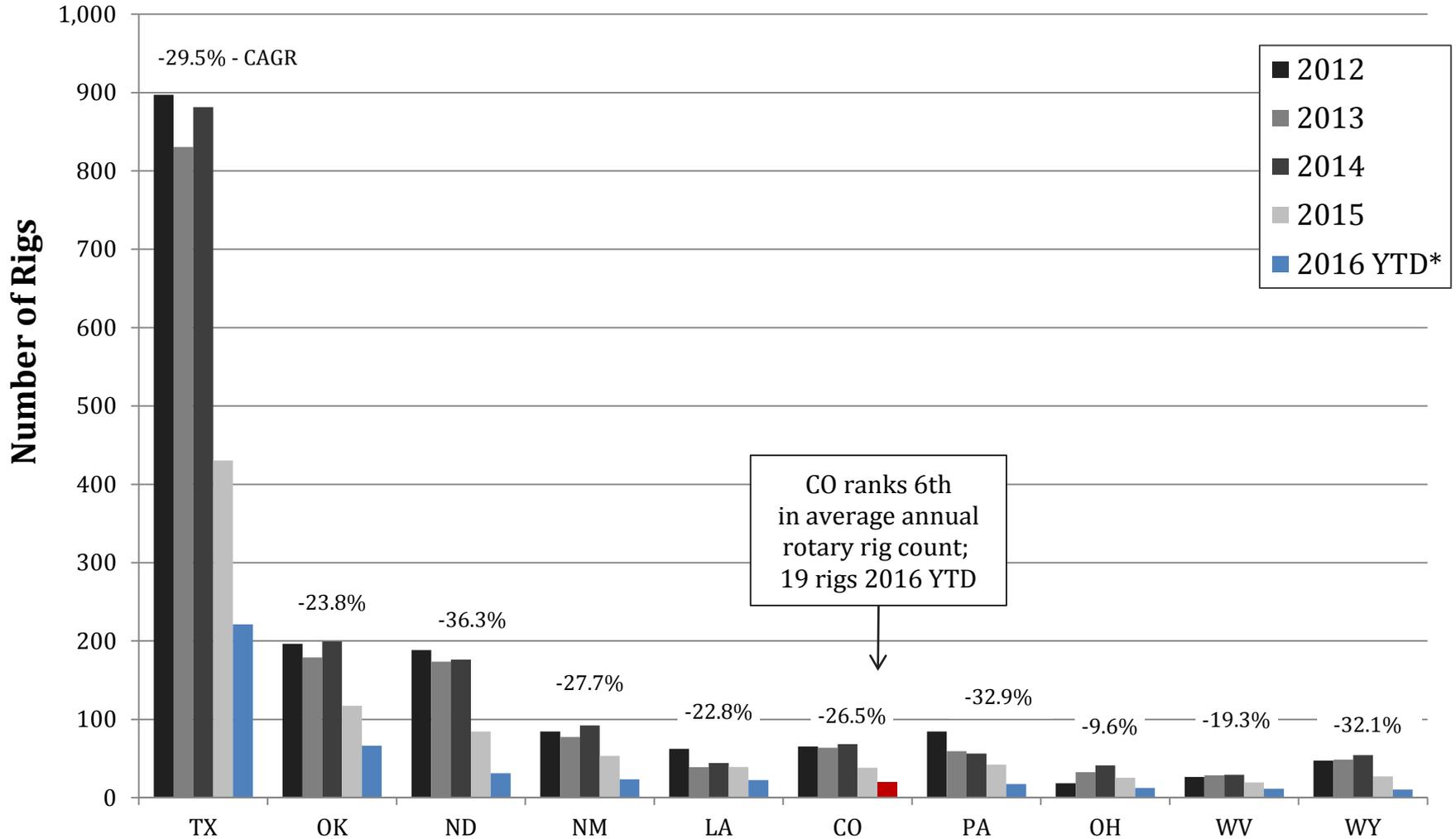
Source: U.S. Department of Energy, Energy Information Administration

Note: Utilization rate is the amount of reserves developed/produced annually; crude oil reserves include lease condensate

Fig. 3

Annual Average Rotary Rig Count, 2012-2016

DJ-Niobrara formation driving Colorado rotary rig count activity; 1,456 new wells were drilled in 2015; as of August 2016 there were 53,724 active wells in Colorado



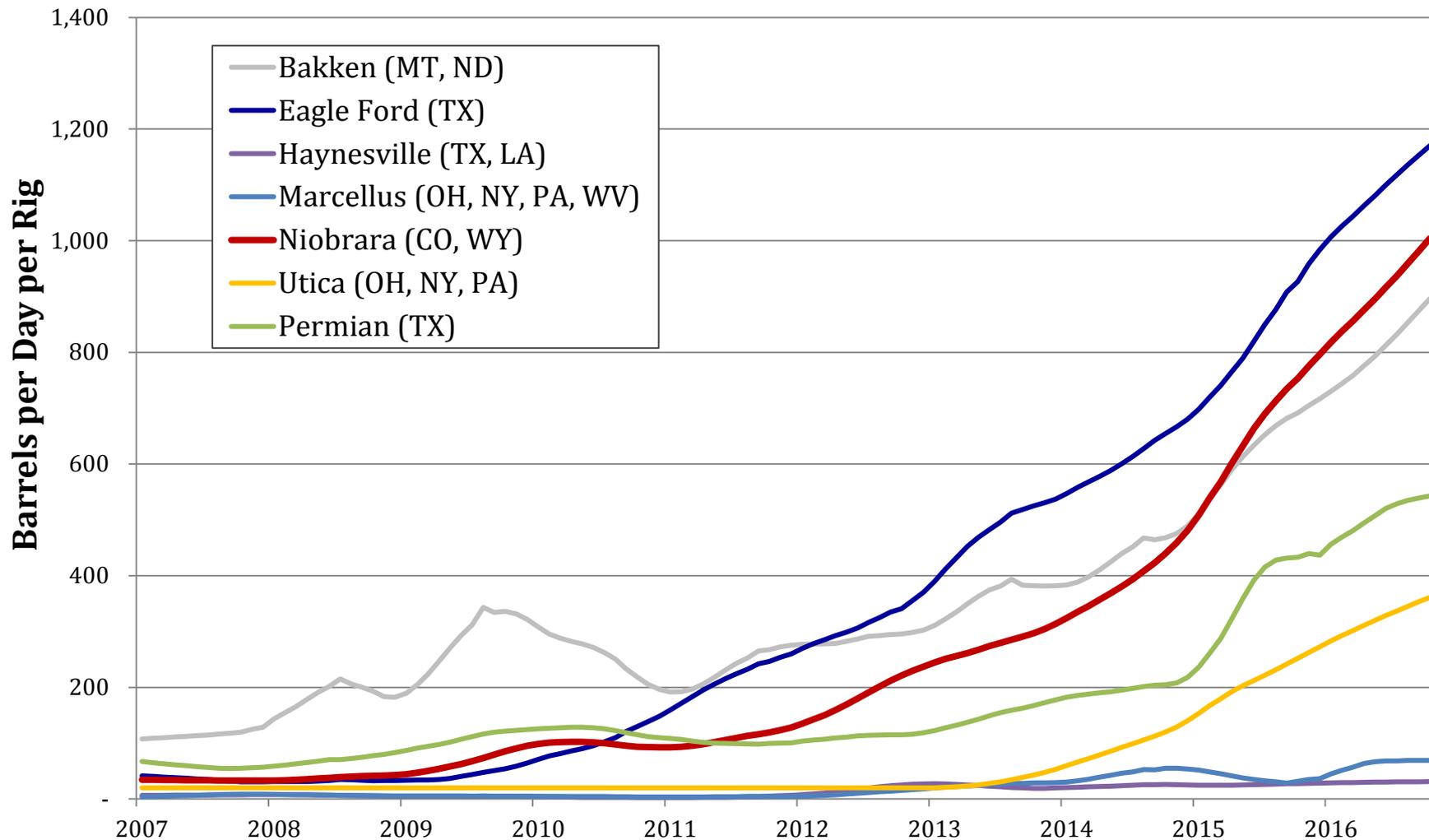
Source: Baker Hughes; Colorado Oil and Gas Conservation Commission

*2016 year-to-date represents January to September average; the compound annual growth rate (CAGR) reflects the 2012 to 2016 period.

Fig. 4

U.S. Shale Oil Drilling Efficiency by Major Resource Play

Productivity in the Niobrara formation has increased by nearly 11 times since 2011

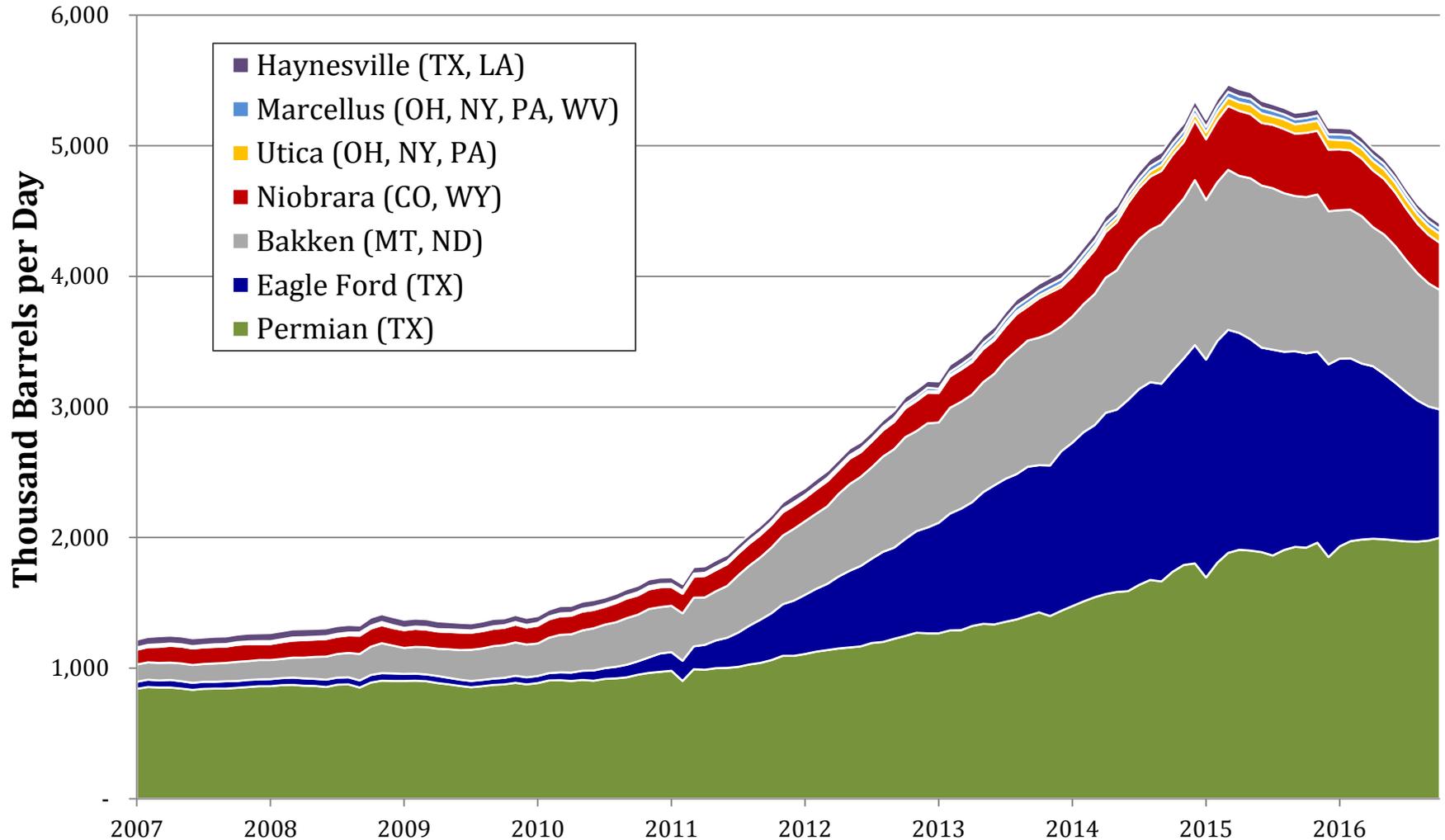


Source: U.S. Department of Energy, Energy Information Administration, Drilling Productivity Report

Note: Does not include legacy production; 2016 data through October

U.S. Shale Oil Production by Major Resource Play

Approximately 361,000 barrels per day in the Niobrara formation

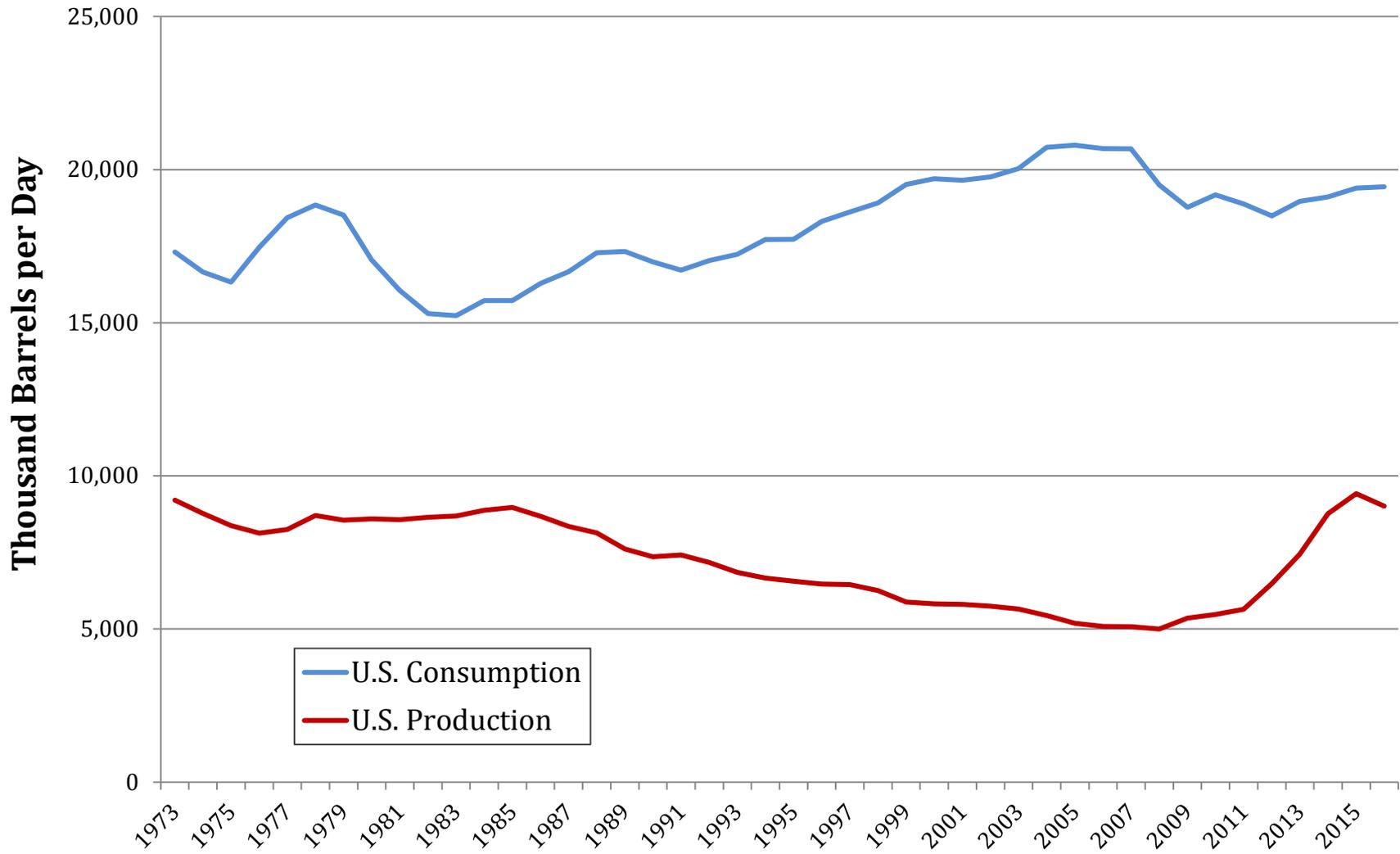


Source: U.S. Department of Energy, Energy Information Administration, Drilling Productivity Report

Note: Does not include legacy production; 2016 data through October

U.S. Crude Oil Production & Consumption, 1973-2016*

YTD 2016, U.S. refiners processed 19.4 million barrels per day compared to domestic U.S. production of 9 million barrels per day

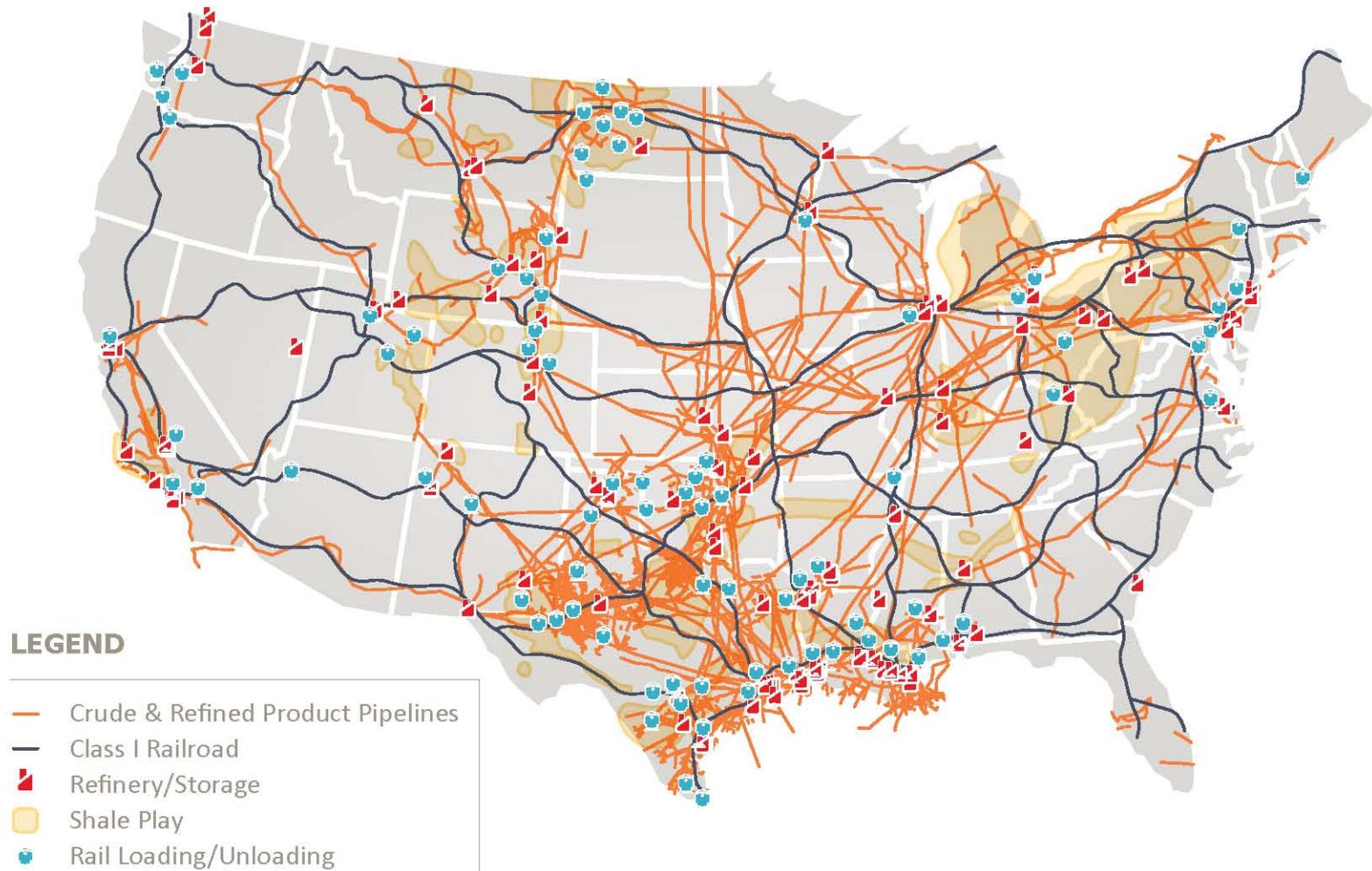


Source: U.S. Department of Energy, Energy Information Administration

*2016 year-to-date represents January to June average

Fig. 7

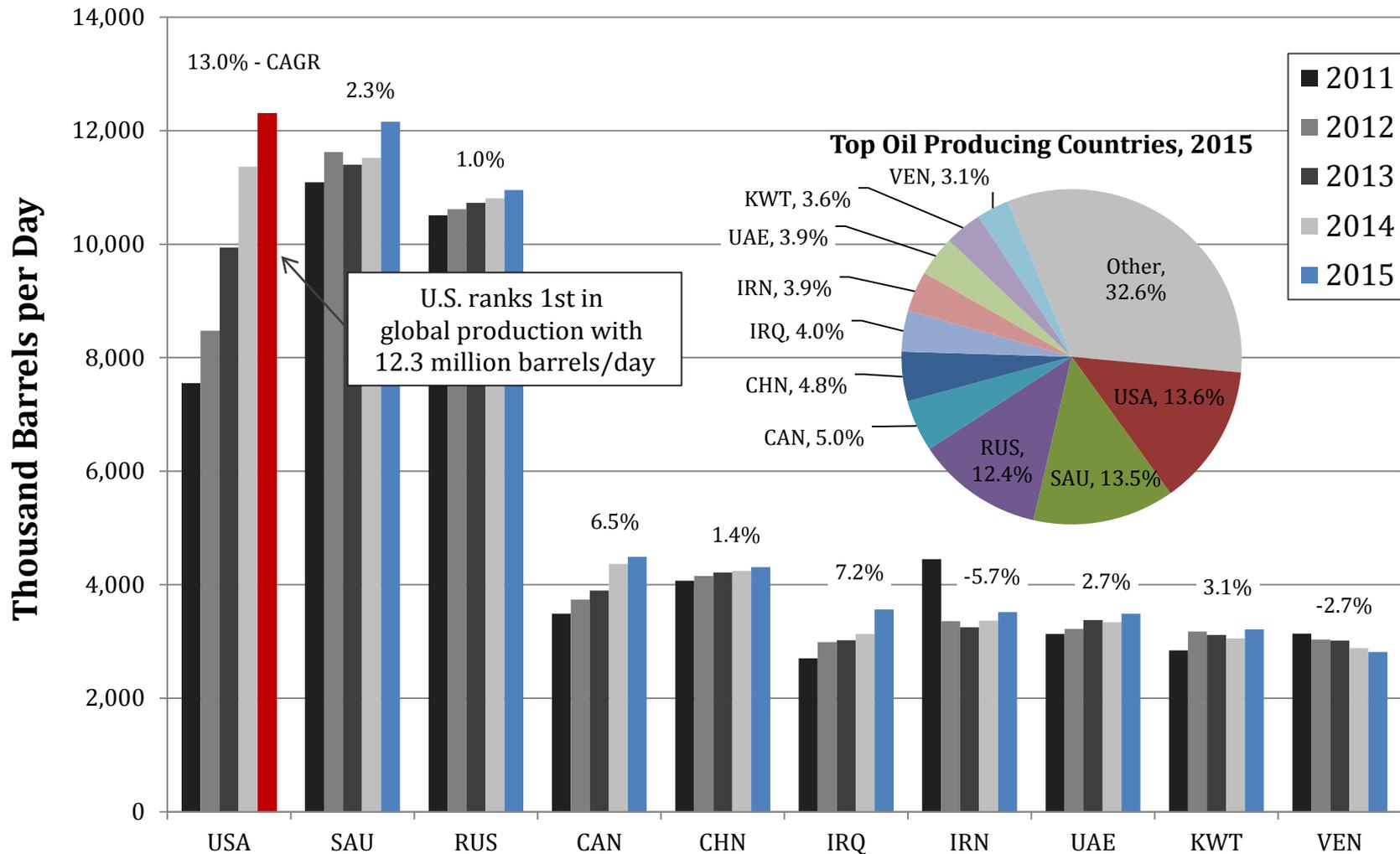
Map of Crude Oil and Refined Products Infrastructure



Source: American Energy Mapping (AEM) 2013

Global Oil Production Leaders, 2011-2015

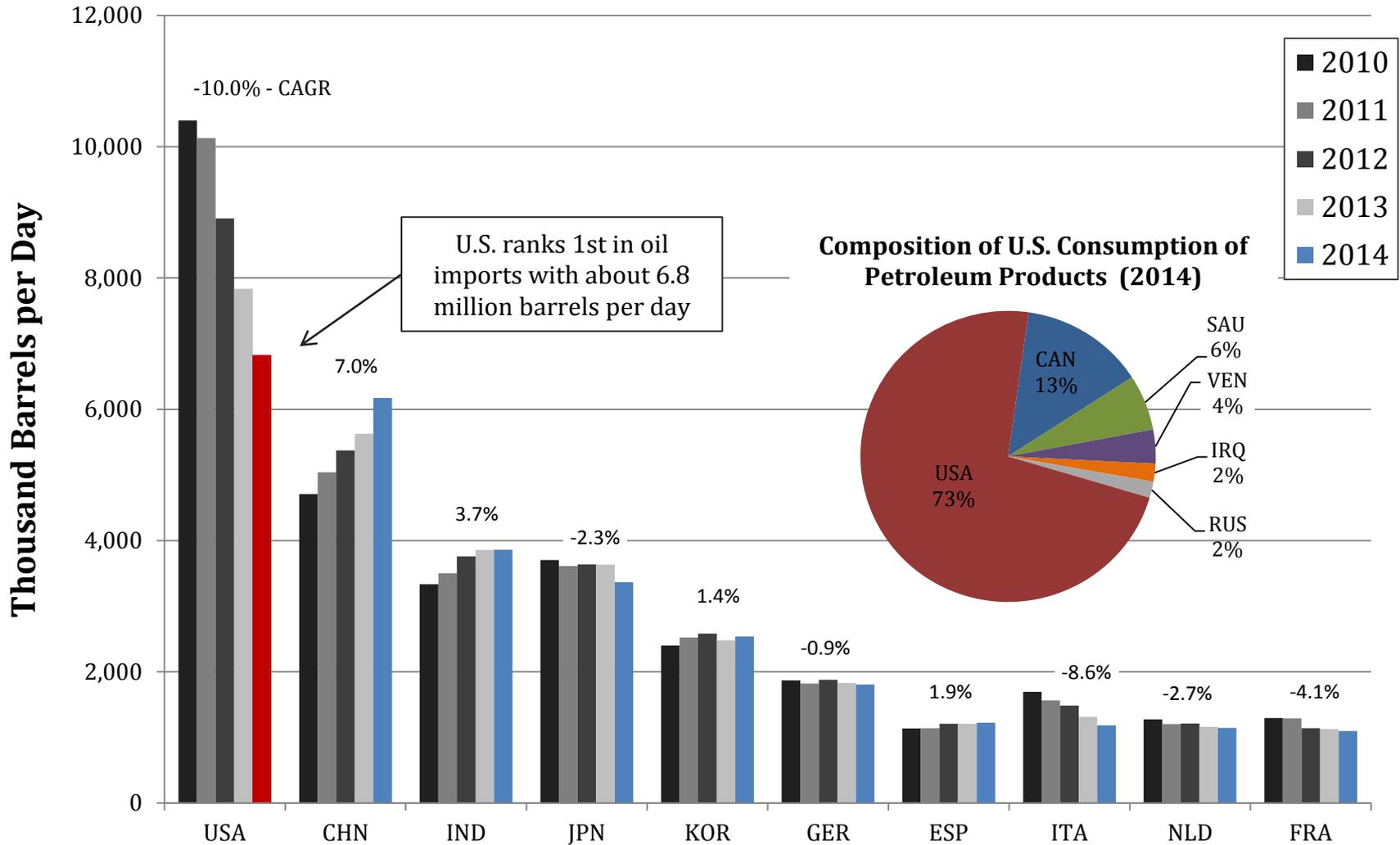
U.S. ranks 1st in global production with 12.3 million barrels/day



Source: International Energy Agency

Note: Includes crude oil, natural gas liquids, feedstocks, additives, and other hydrocarbons; 2015 data represents estimates; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Global Net Importers of Oil, 2010-2014



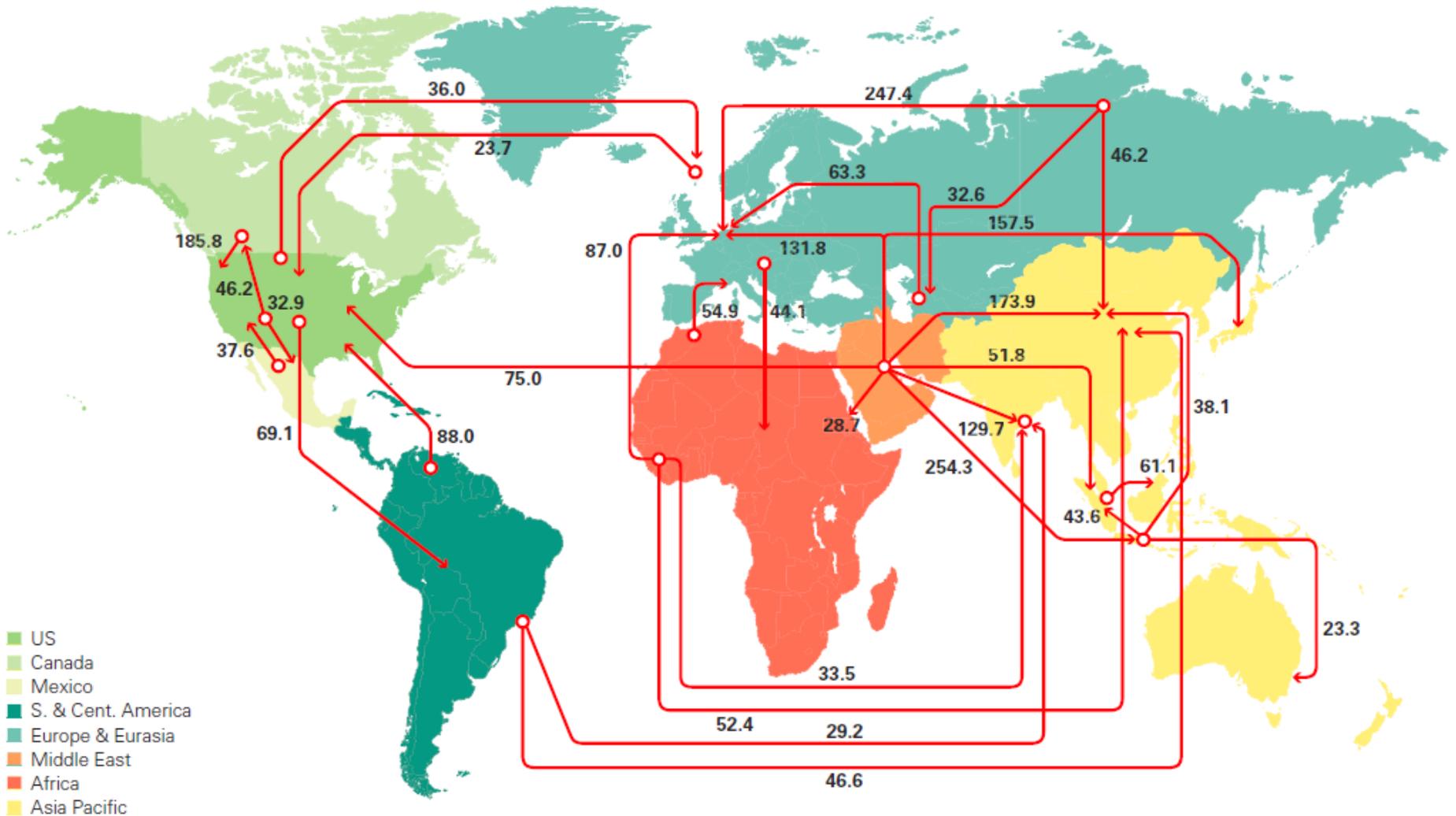
Source: International Energy Agency

Note: Includes crude oil, natural gas liquids, feedstocks, additives, and other hydrocarbons; 2014 data represents estimates; the compound annual growth rate (CAGR) reflects the 2010 to 2014 year period.

Fig. 10

Map of Major Oil and Products Trade Movements

Lifting the oil export ban is elevating the role of U.S. producers and refiners



Major trade movements 2015
Trade flows worldwide (million tonnes)

Fig. 11

Natural Gas



Natural Gas

Access to shale formations thousands of feet beneath the surface of the earth holds the key to future growth of domestic natural gas production.

In 2012, the United States surpassed Russia to become the world's largest natural gas producer with 65.5 billion cubic feet (Bcf) per day. The U.S. continued to expand its lead with production of 74.4 Bcf per day through 2015, amounting to more than 21 percent of total global natural gas production.

While the United States was the third-largest importer of natural gas in 2010 (7.2 Bcf per day), the U.S. fell to 10th in imports in 2015 (3.0 Bcf per day). As domestic production continues to swell, and as liquefied natural gas facilities come online, the U.S. stands to become a net exporter of natural gas.

While the U.S. production story is a positive one, it is important to note low natural gas prices are tempering growth and lowering annual production totals in several states. Nevertheless, long-term trends should benefit Colorado, as the state ranked sixth nationally in natural gas production in 2015 (4.4 Bcf per day), and ranked seventh in natural gas reserves in 2014 with 21 trillion cubic feet (Tcf).

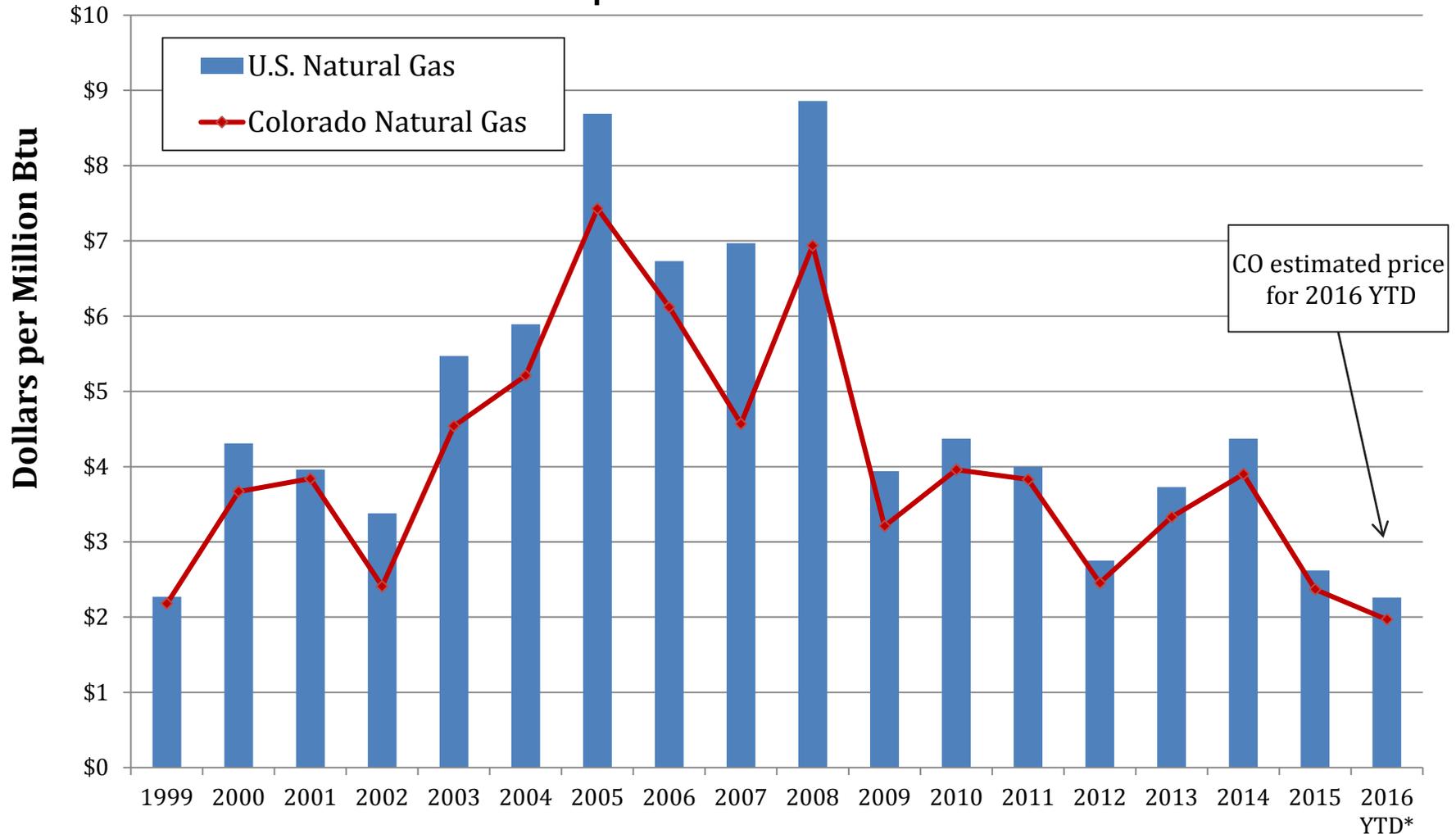
It is important to note that low natural gas prices, plus the 2010 Clean Air-Clean Jobs Act, are guiding a shift in the state's power generation portfolio. For example, Xcel Energy recently completed construction to shut down coal fired Cherokee Generating Stations 1, 2, and 3 in Adams County. That project shuttered more than 360 megawatts (MW) of coal generation, while adding 569 MW of natural gas generation. By the end of 2017, a fuel switch at Cherokee Generating Station 4 will add another 352 MW of local natural gas generation.

These investments and others demonstrate Colorado's burgeoning success in the natural gas sector.



Average Annual Natural Gas Prices, 1999-2016

Colorado wellhead prices trend below the benchmark trading price to account for fuel transportation costs to markets outside the state



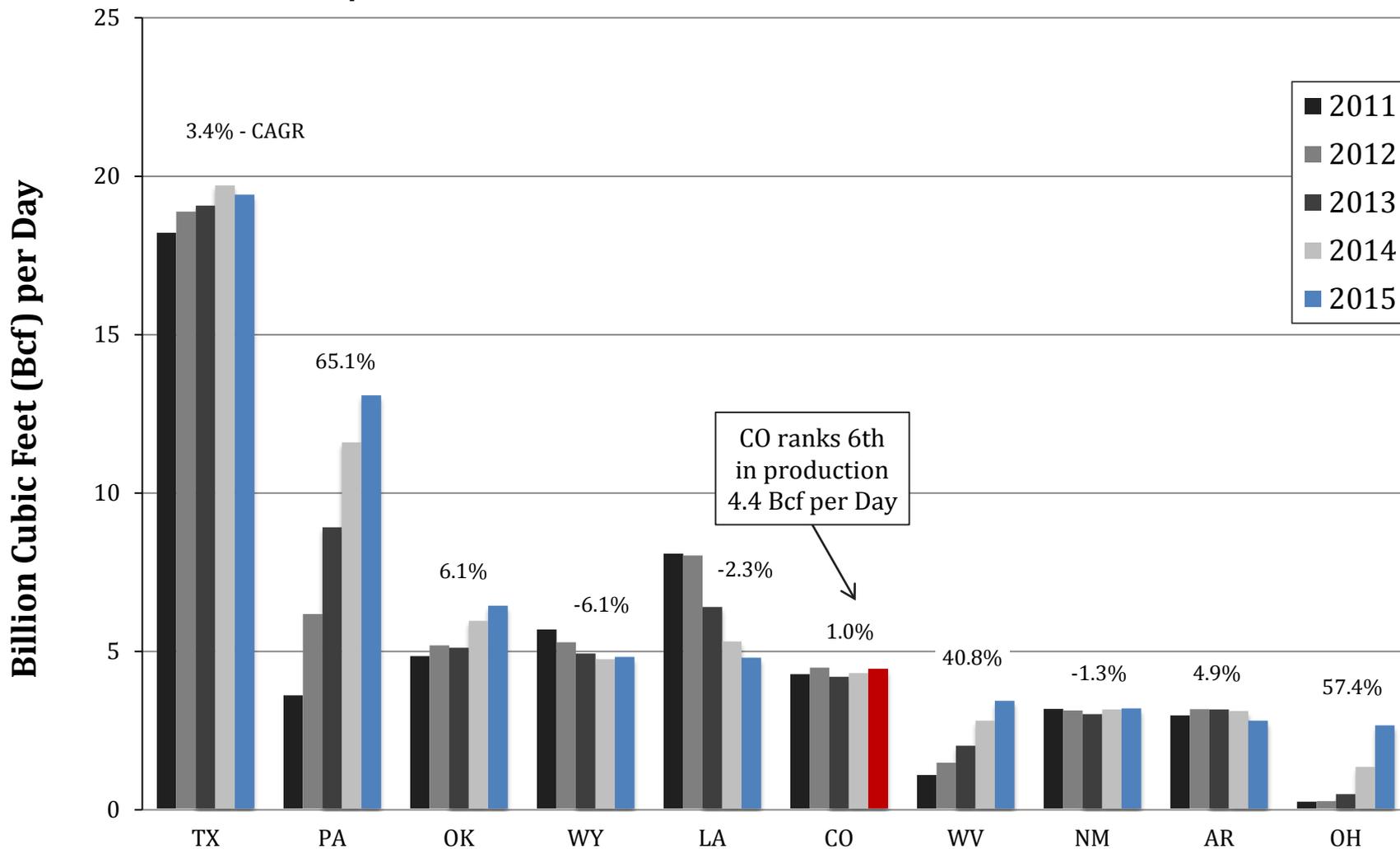
Source: U.S. Department of Energy, Energy Information Administration

Note: Henry Hub is a common trading benchmark price. Does not include 2014 polar vortex price spike for Colorado.

*2016 year-to-date data represents U.S. average daily spot price from January to August. 2012 to 2016 Colorado price estimated.

Natural Gas Production by State, 2011-2015

Colorado's production has remained stable since 2011;
U.S. production has increased at a CAGR of 4.3% since 2011

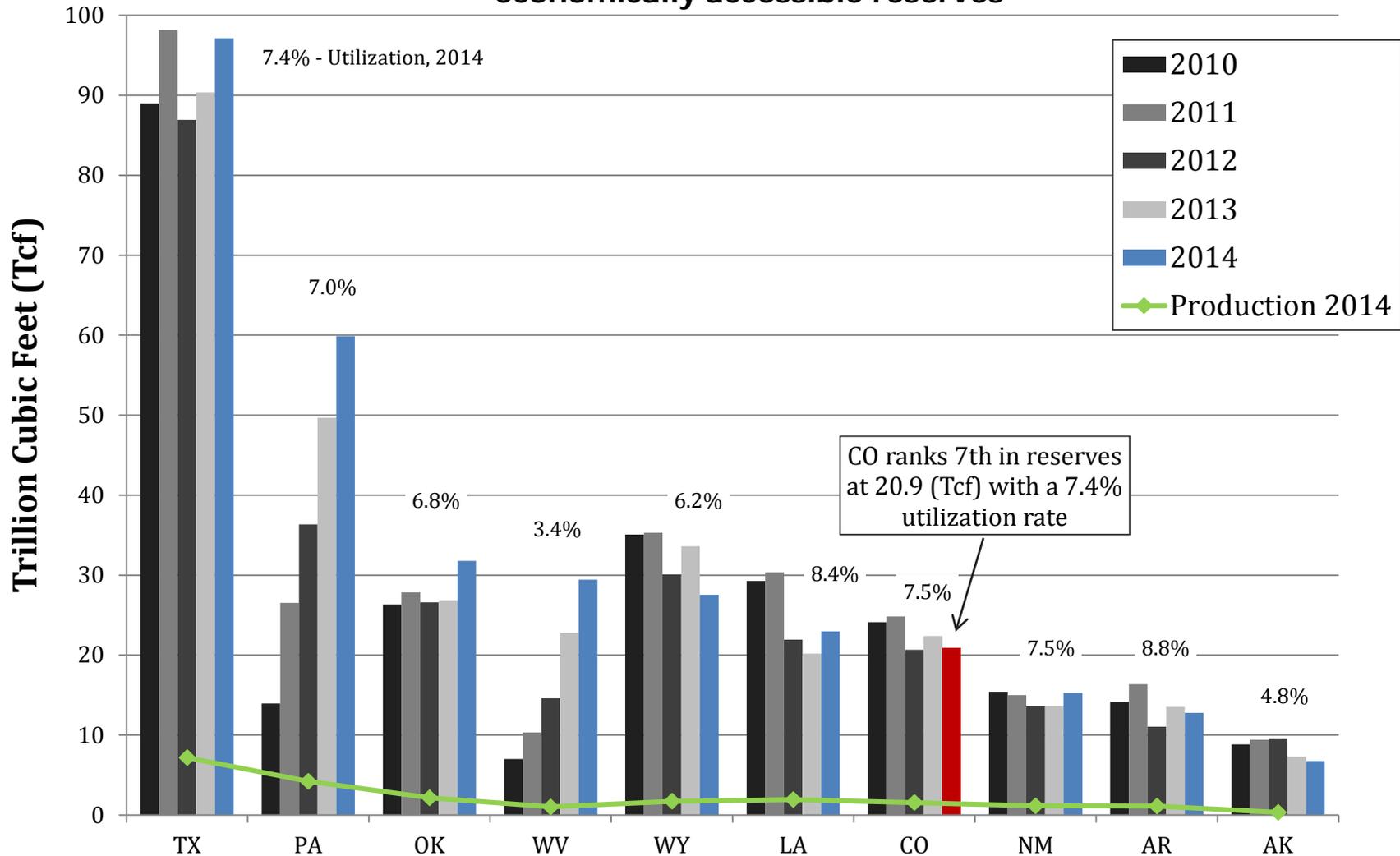


Source: U.S. Department of Energy, Energy Information Administration
Note: The compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Fig. 13

Natural Gas Reserves & Utilization Rate

Low natural gas prices have reduced the size of economically accessible reserves



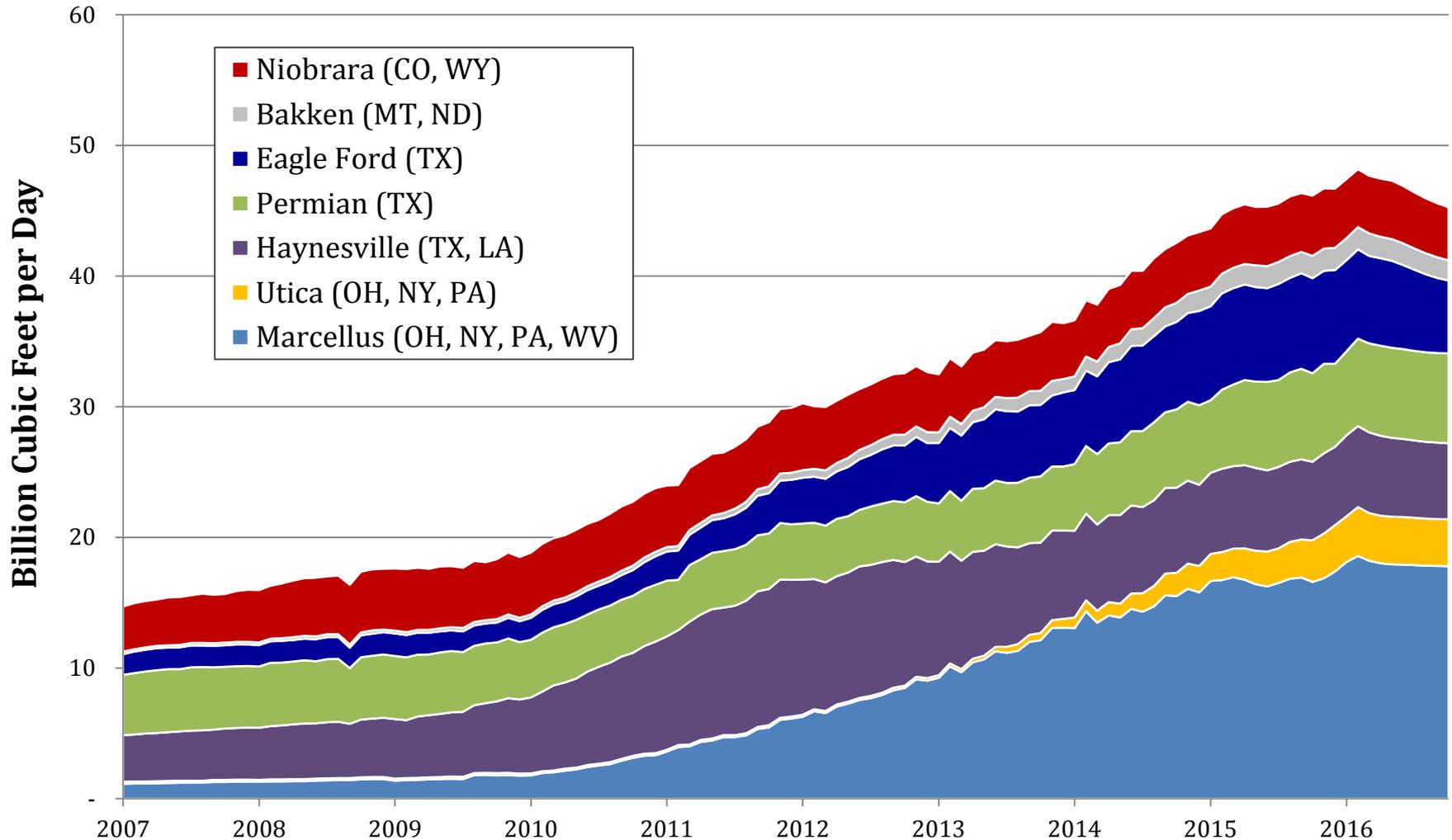
Source: U.S. Department of Energy, Energy Information Administration

Note: Top-10 states including Colorado; utilization rate is the amount of reserves developed/produced annually; reserves are defined as resources that can be recovered with reasonable certainty under existing economic and operating conditions

Fig. 14

U.S. Shale Gas Production by Major Resource Play

4.1 bcf per day in the Niobrara formation as of October 2016

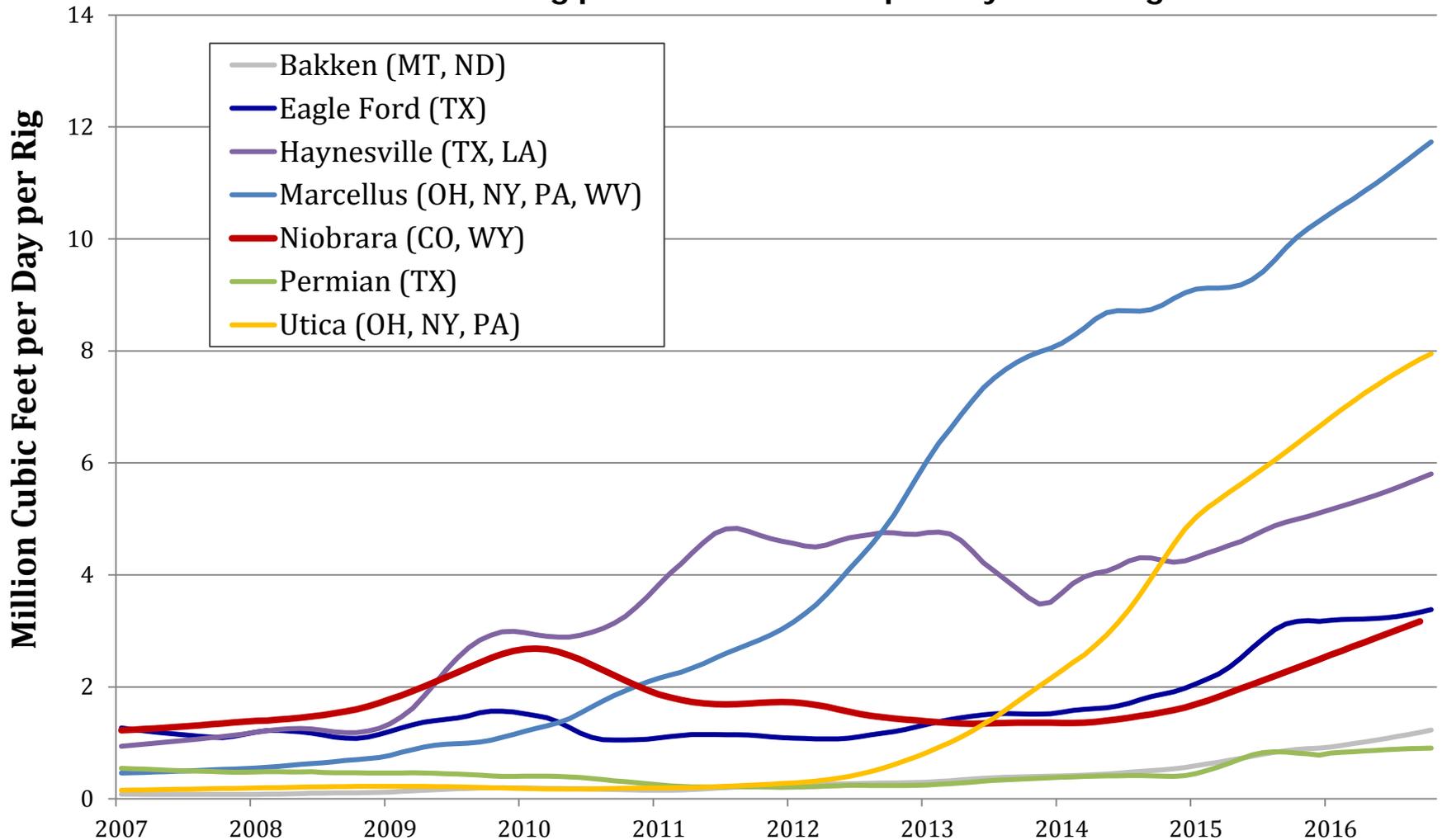


Source: U.S. Department of Energy, Energy Information Administration, Drilling Productivity Report
 Note: Excludes legacy production; 2016 data through October

Fig. 16

U.S. Shale Gas Drilling Efficiency by Major Resource Play

Each Niobrara rig produces 3.2 mmcf per day on average

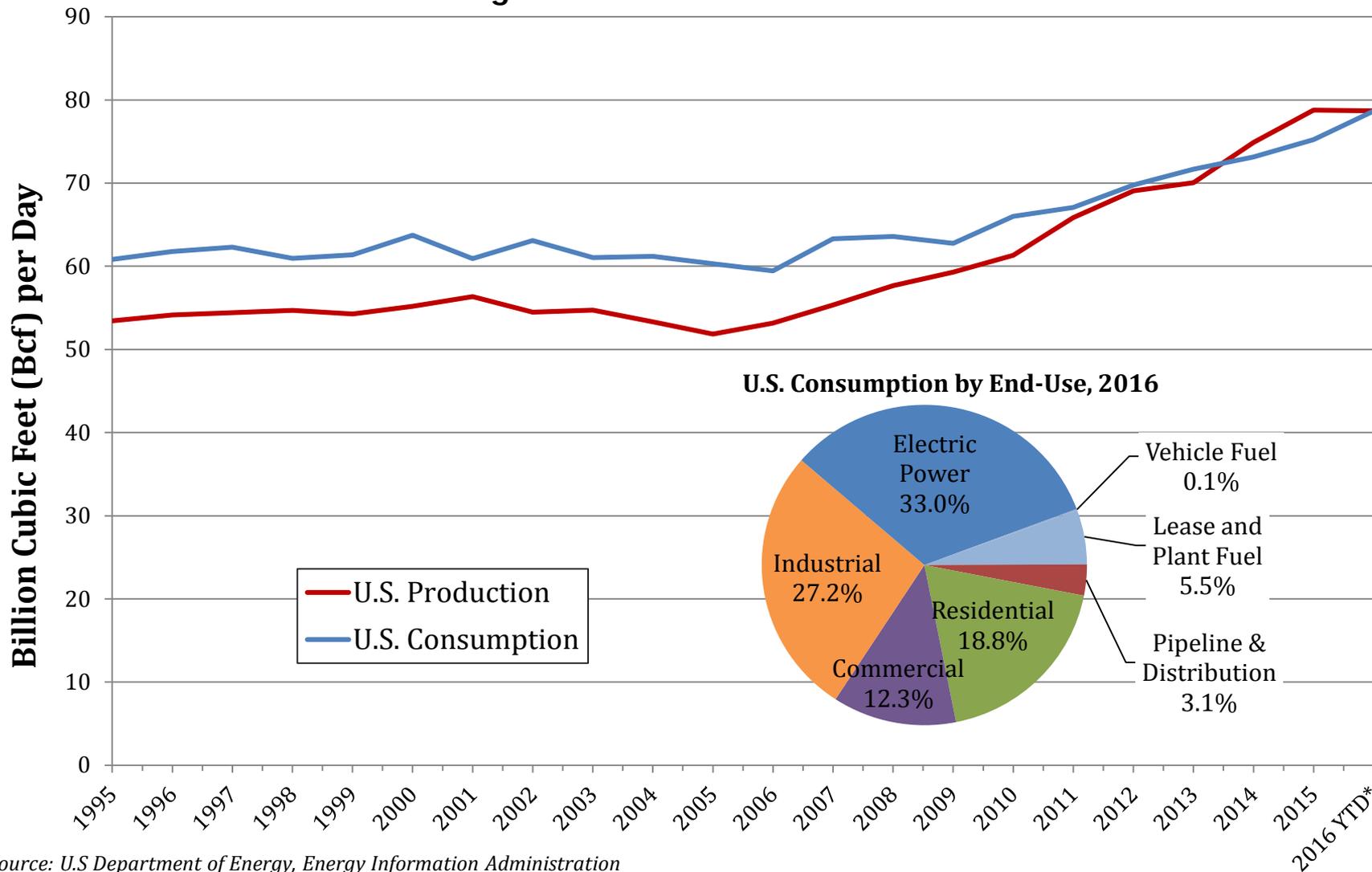


Source: U.S. Department of Energy, Energy Information Administration
 Note: Excludes legacy production; 2016 data through October

Fig. 17

U.S. Natural Gas Production & Consumption, 1995-2016

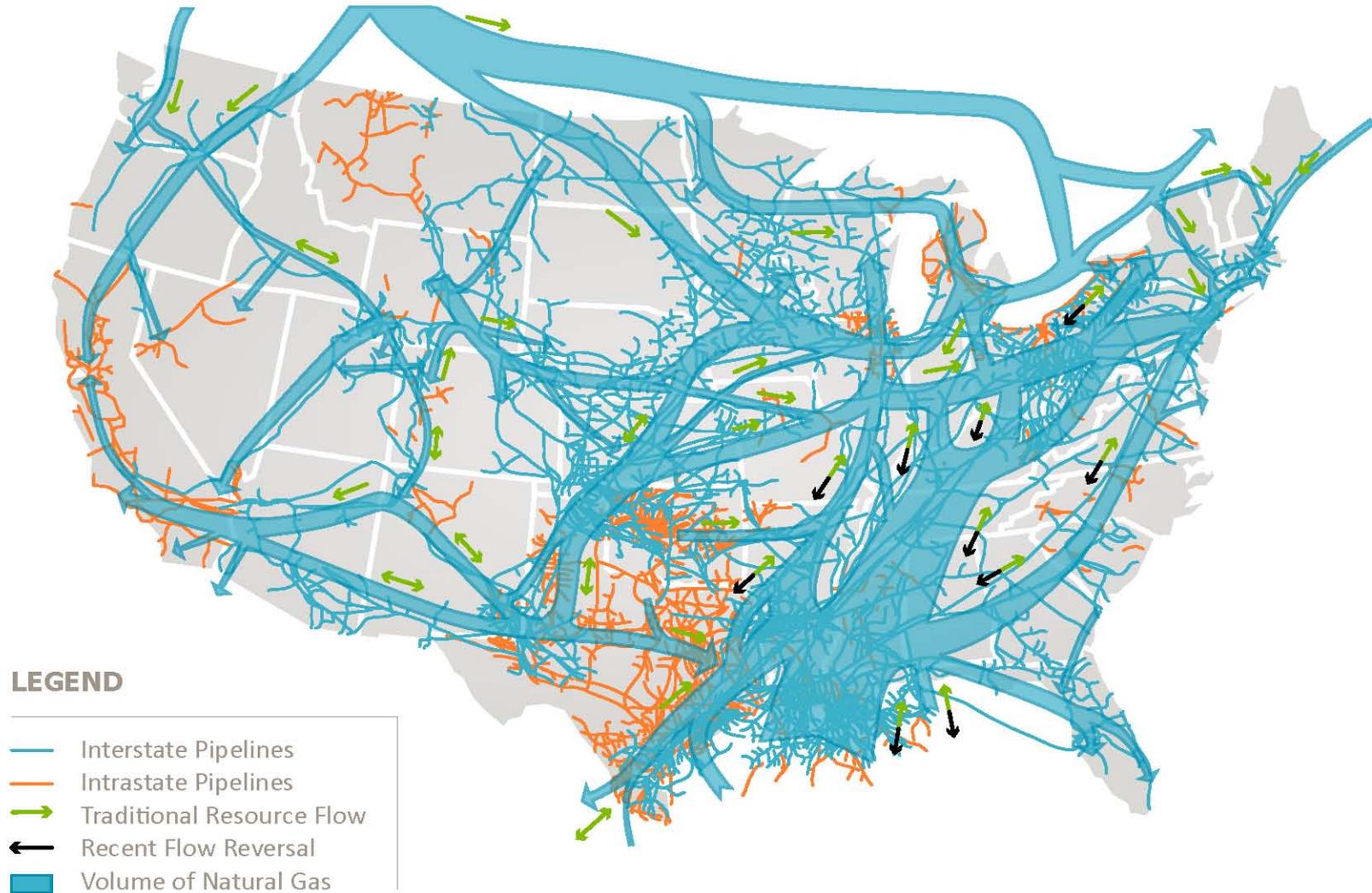
Domestic production has increased steadily since 2006; consumption surge due to GDP growth and fuel switch from coal



Source: U.S. Department of Energy, Energy Information Administration
 *2016 year-to-date represents January to June

Fig. 18

Map of Natural Gas Pipeline Infrastructure

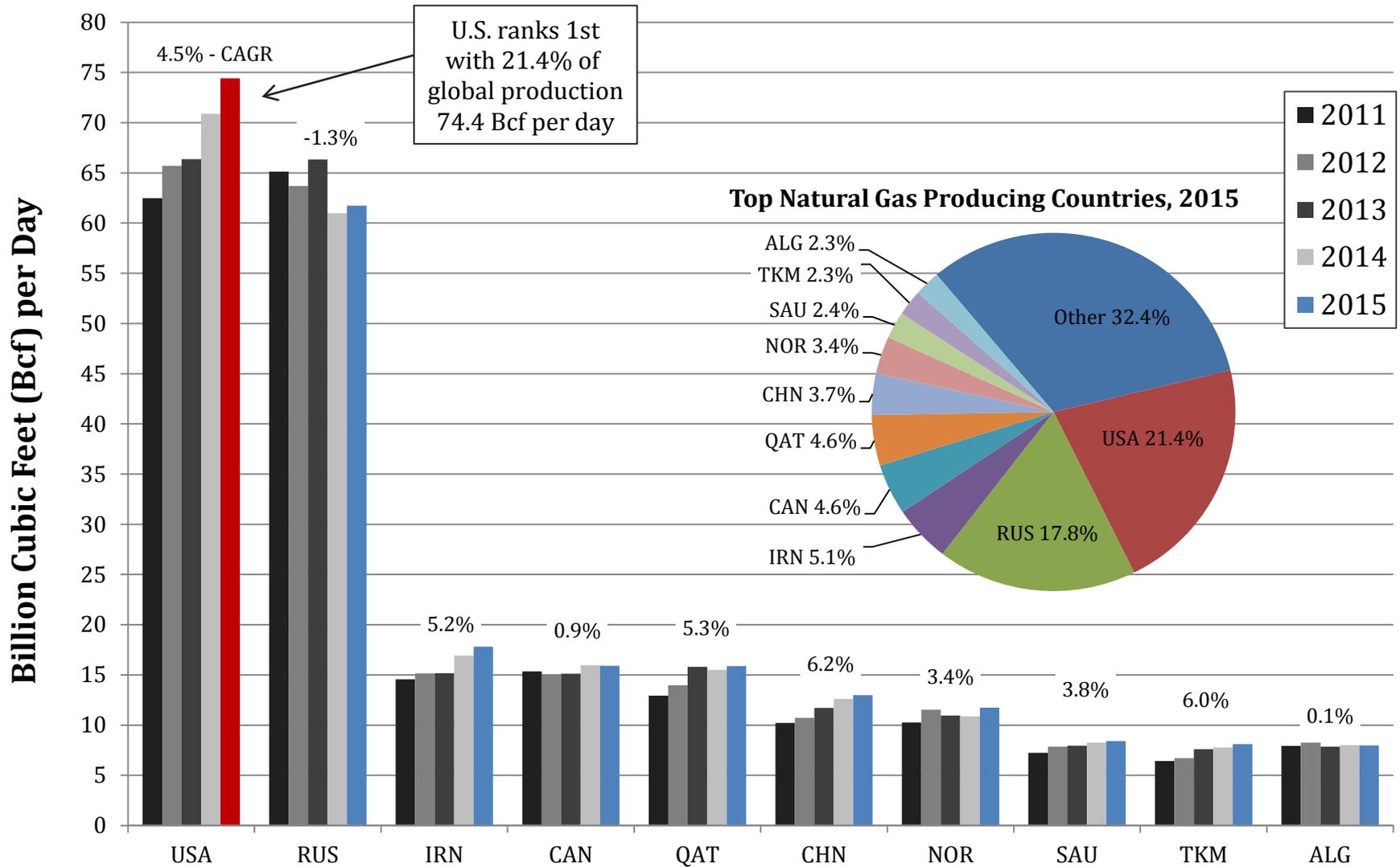


Source: Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

Fig. 19

Global Natural Gas Production Leaders, 2011-2015

U.S. is 1st and growing; top-10 producers account for 68% of global production



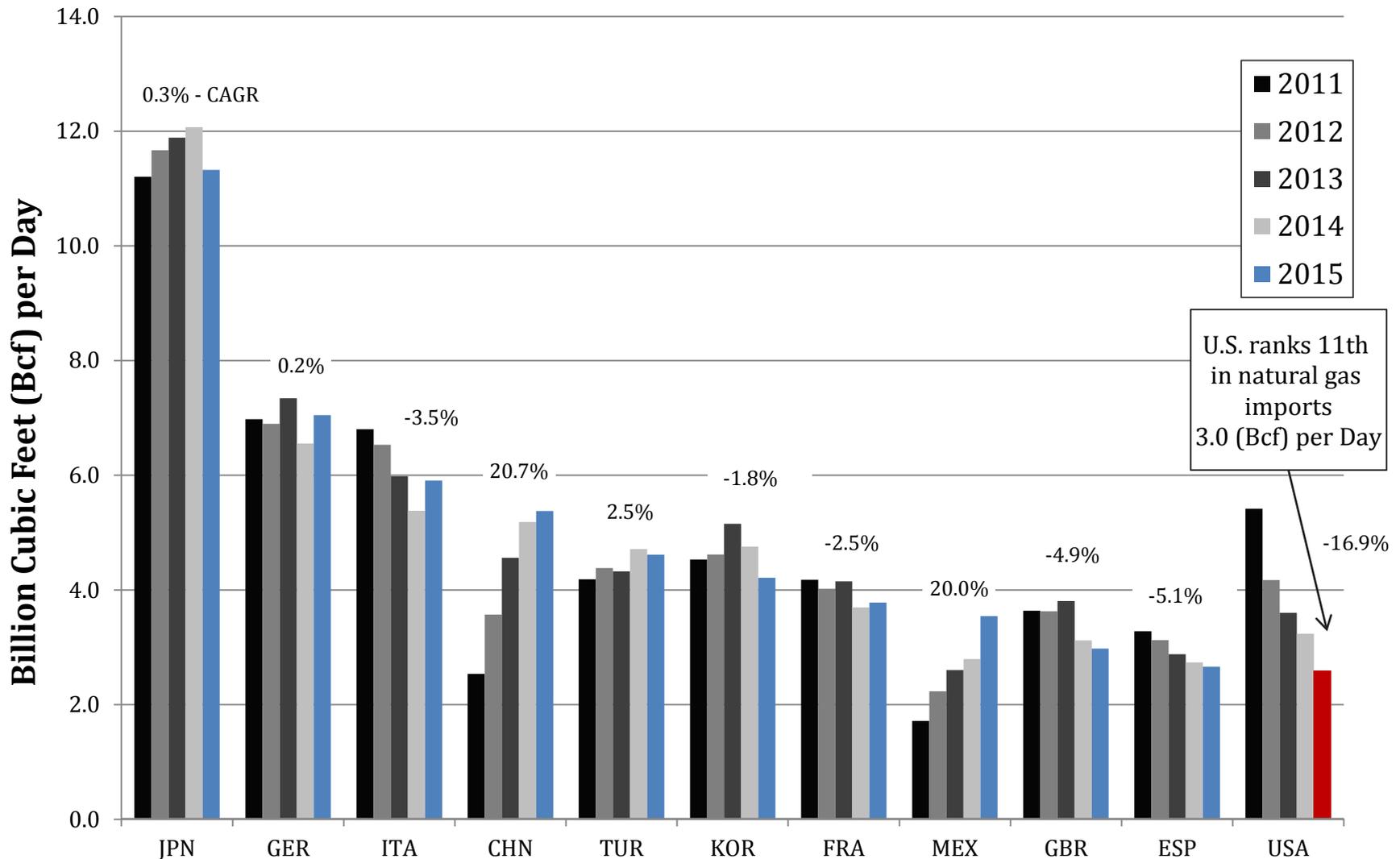
Source: International Energy Agency

Note: 2015 data represents estimates; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Fig. 20

Global Net Importers of Natural Gas, 2011-2015

U.S. imports declining due to increases in domestic production



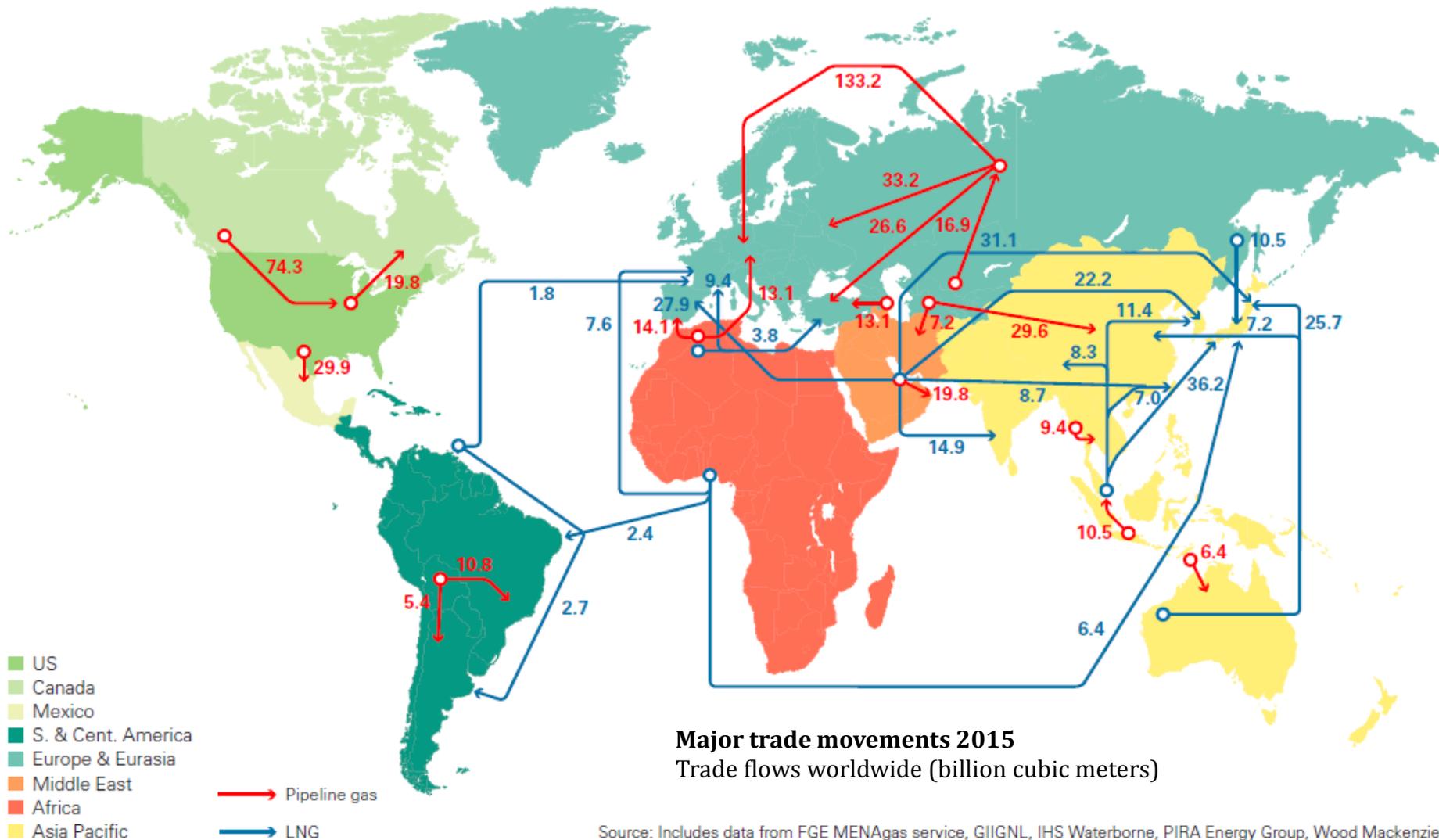
Source: International Energy Agency

Note: 2015 data represents estimates; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Fig. 21

Map of Major Natural Gas Trade Movements

U.S., Canada, and Mexico seemingly operate as a single natural gas market;
 Expect U.S. liquefied natural gas (LNG) to increase as more facilities are brought online



Source: Includes data from FGE MENA Gas service, GIIGNL, IHS Waterborne, PIRA Energy Group, Wood Mackenzie.

Fig. 22

Coal



Coal

Coal is the world's most plentiful natural resource. The United States has 262 billion short tons of proved coal reserves, while Russia has 173 billion and China has 126 billion. Altogether, these three nations represent nearly 60 percent of global reserves.

In 2015, the United States ranked second in coal production, with 895 million short tons, while China ranked first with 3.7 billion short tons. Combined, China and the U.S. represent over 55 percent of global production.

In 2015, Wyoming led U.S. coal production with 376 million short tons. Wyoming produced four times more coal than its nearest competitor, West Virginia. Colorado ranked 11th in production with 19 million short tons and ranked eighth in proved coal reserves with 9.5 billion short tons.

It is important to note that domestic coal production is trending downward in most states. Over the past five years, the compound average annual growth rate for Colorado coal production is -8.5 percent. A variety of factors are responsible for this trend, including lower natural gas prices, mandates for renewable energy, and recent legislation requiring the closure of coal plants or their conversion to natural gas, such as the Colorado Clean Air-Clean Jobs Act of 2010.

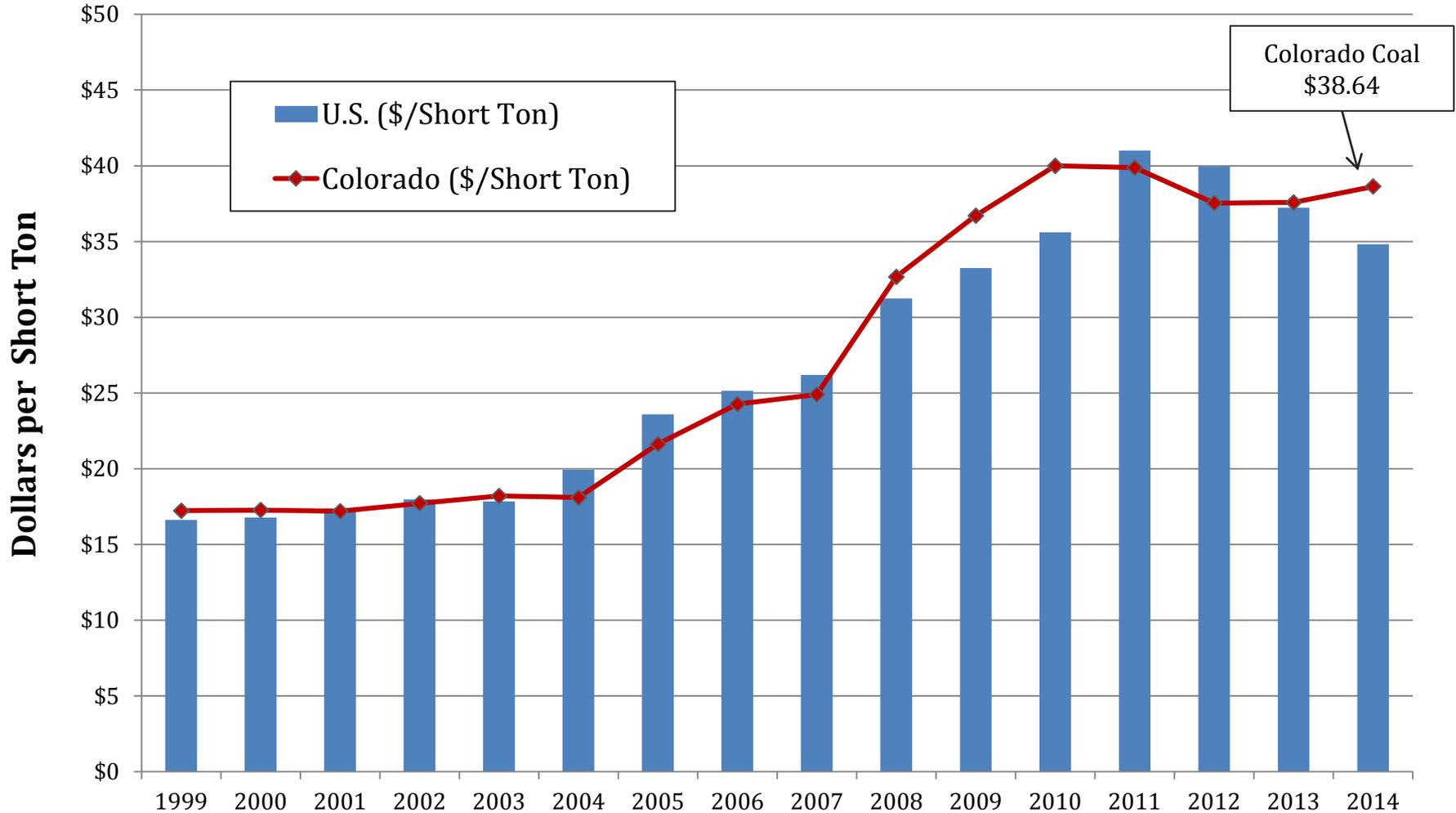
On the bright side, Colorado coal is widely considered to be a high-quality product. It is a low-sulfur, low-mercury coal that is often sold to utilities around the nation to meet Clean Air Act requirements. According to the Colorado Mining Association, approximately 65 percent of Colorado's coal is shipped beyond the state's borders, while 10 percent is sold to international buyers. Coal export markets are variable, but over the past five years we have seen a downward trajectory, with the average annual growth rate for U.S. coal exports at -9.7 percent. In 2015, the U.S. ranked sixth in total exports with 63 million short tons.

In August 2015, the Environmental Protection Agency (EPA) finalized the Clean Power Plan, which aims to reduce carbon pollution from power generation by 32 percent by 2030 (from 2005 levels). However, President-Elect Donald Trump has said he would undo the rule. Legal challenges also remain. Consequently, from a policy perspective, there is a significant amount of uncertainty ahead for the U.S. coal industry.



Average Annual Coal Prices, 1999-2014

Prices declined nationally, but increased in Colorado due to captive mines selling at a fixed price with less coal sold on weaker open markets

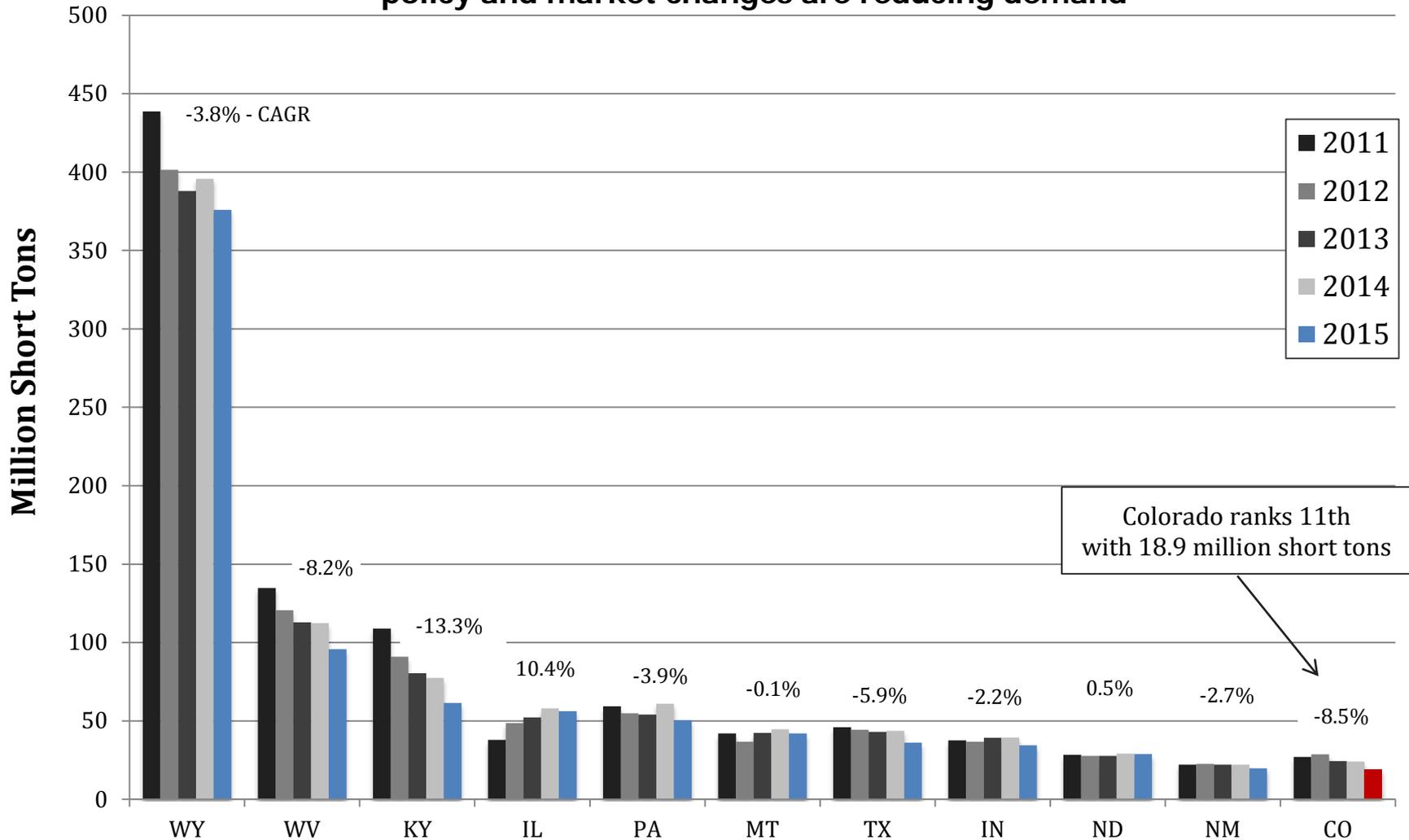


Source: U.S. Department of Energy, Energy Information Administration
Note: Short ton equals 2,000 pounds

Fig. 23

U.S. Coal Production by State, 2011-2015

56% of Colorado coal is shipped out of state; 14% shipped internationally; policy and market changes are reducing demand



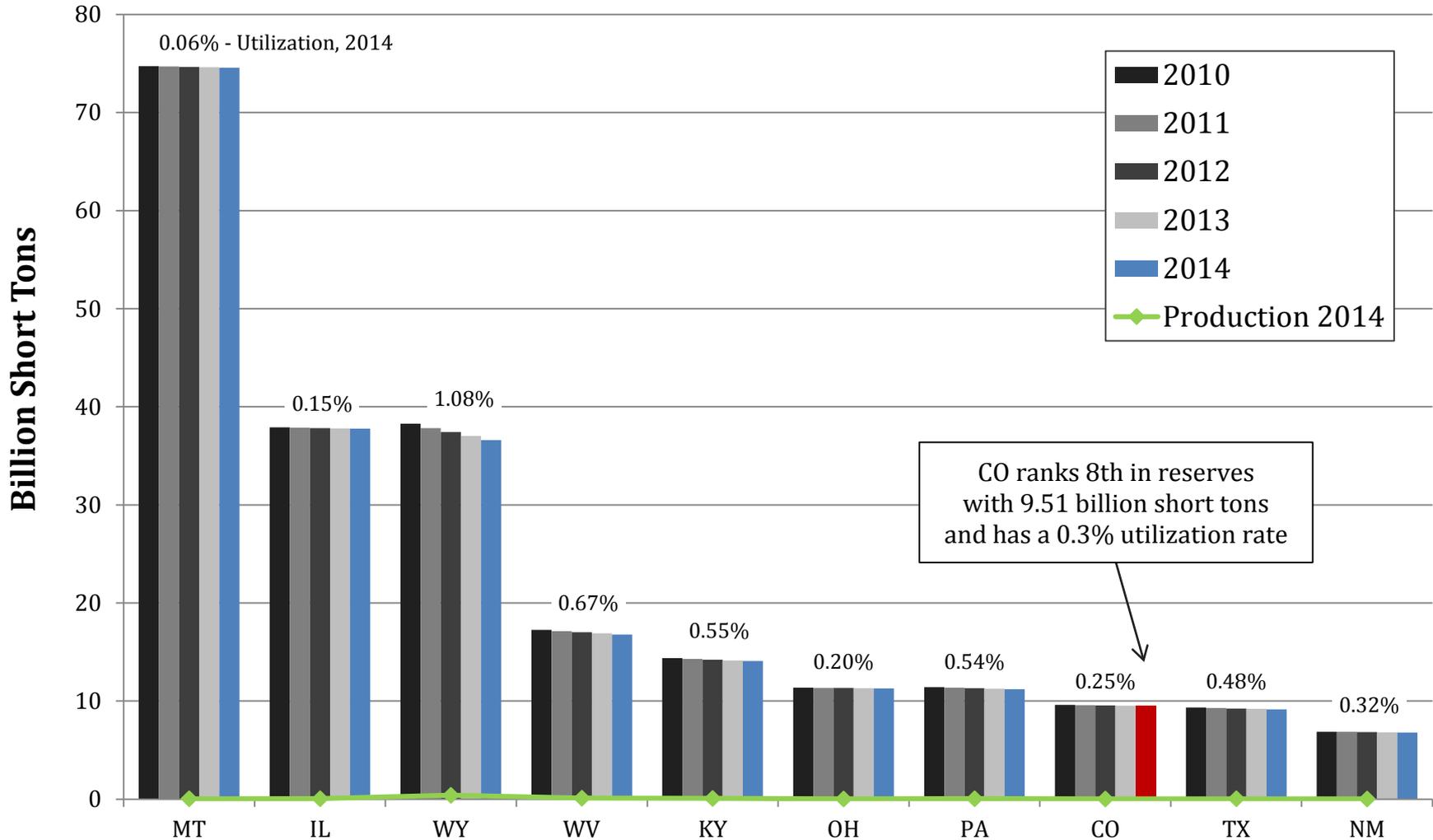
Source: U.S. Department of Energy, Energy Information Administration

Note: Short ton equals 2,000 pounds; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Fig. 24

U.S. Coal Reserves & Utilization Rate

Percent equals utilization rate of state reserves; coal reserves are massive, contributing to an extremely small utilization rate



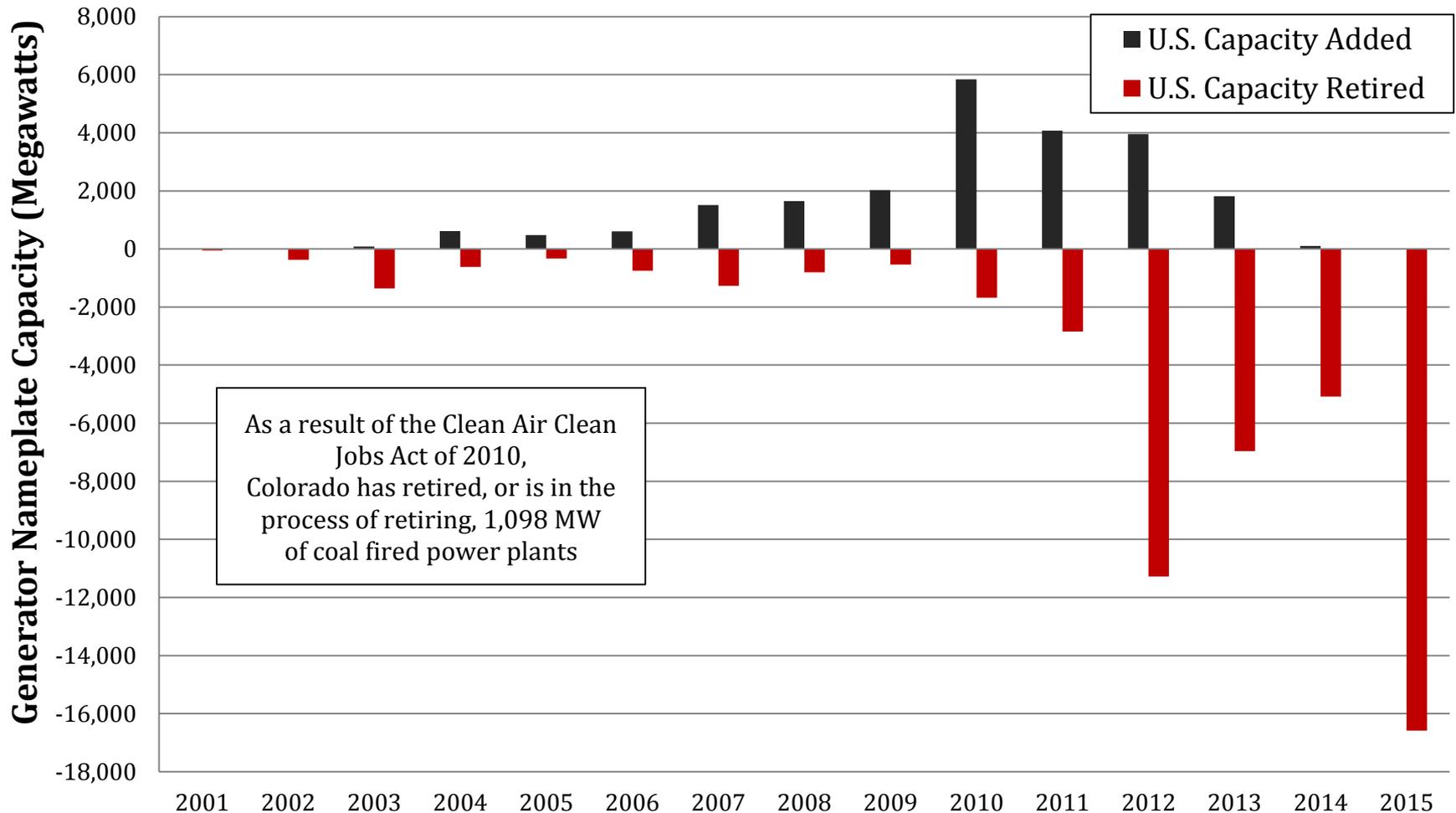
Source: U.S. Department of Energy, Energy Information Administration

Note: Reserves are "Estimated Recoverable Reserves"; short ton equals 2,000 pounds; 2014 is most recent year for domestic coal reserves data

Fig. 25

U.S. Coal Capacity Installations and Retirements, 2001-2015

Domestic demand decreasing due to changing policies and economics

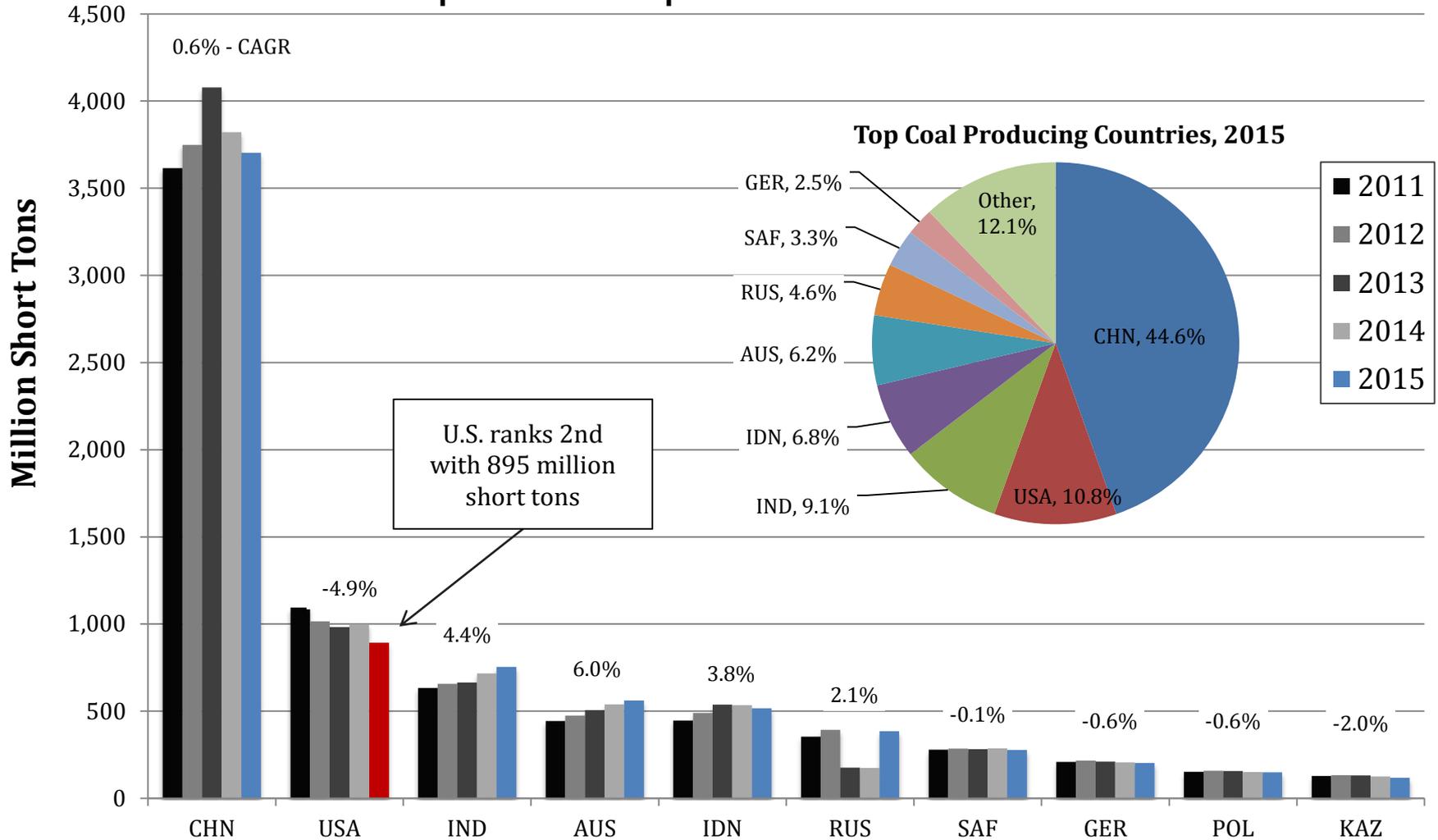


Source: U.S. Department of Energy, Energy Information Administration

Fig. 26

Global Coal Production Leaders, 2011-2015

U.S. production decreasing as resource diversity expands;
Chinese production surpassed the U.S. in the mid-1980's



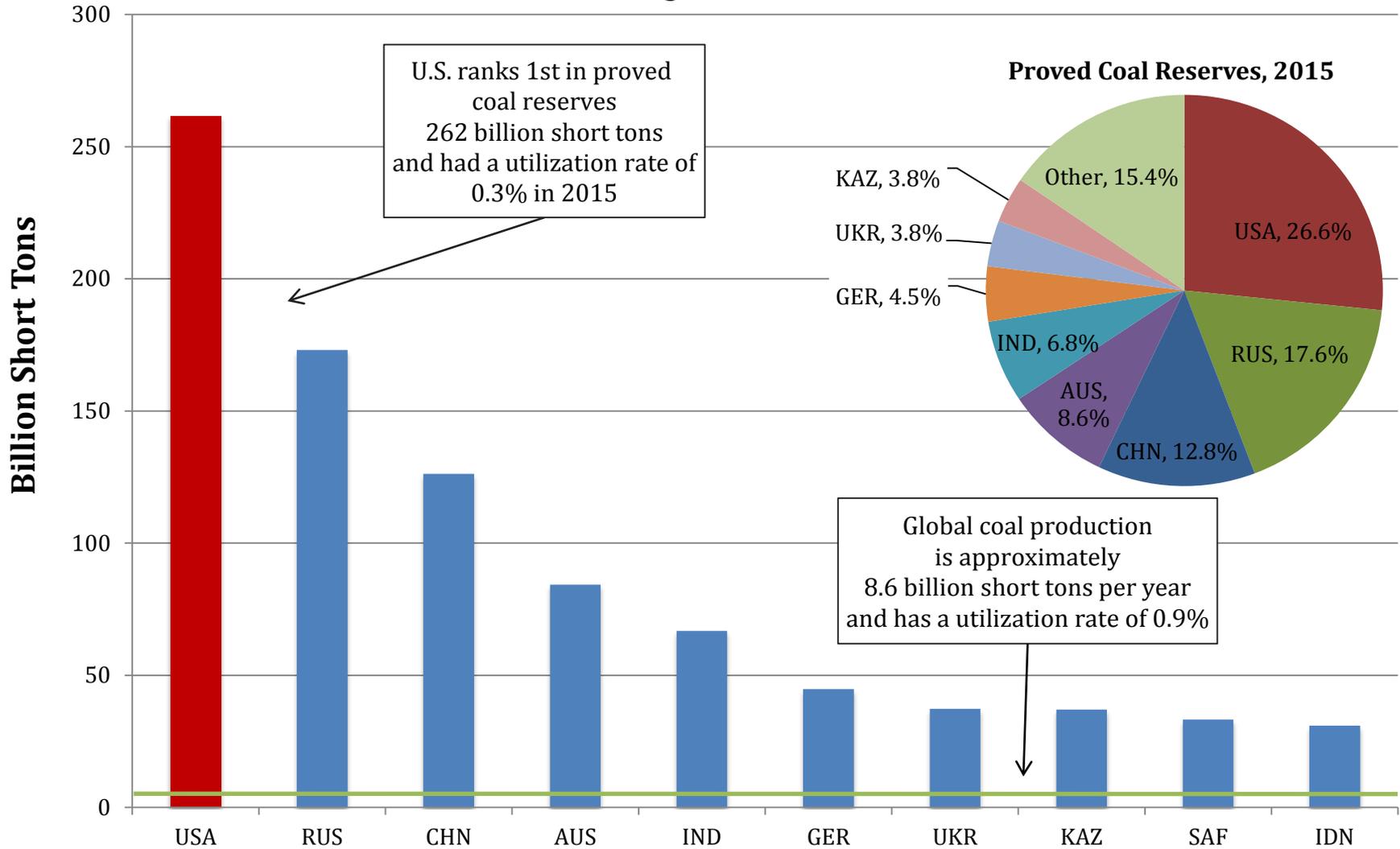
Source: International Energy Agency

Note: Includes steam coal, coking coal, lignite, and recovered coal; 2015 data represents estimates; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Fig. 27

Global Proved Coal Reserves, 2015

The U.S. holds the largest coal reserves in the world

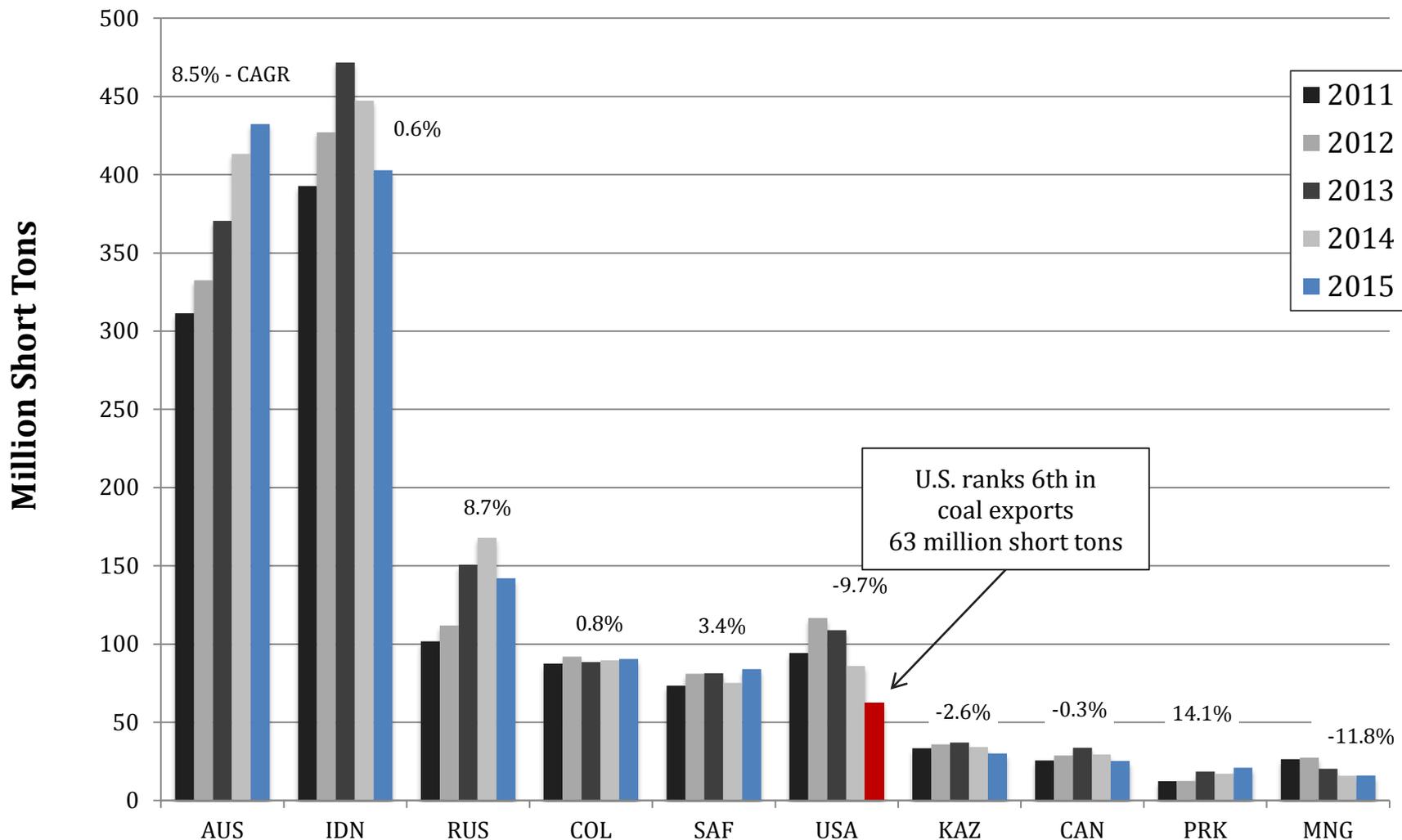


Source: BP Statistical Review of World Energy, June 2016

Note: Short ton equals 2,000 pounds; recoverable amounts based on current economics and technology; includes anthracite, bituminous, sub-bituminous, and lignite

Global Net Exporters of Coal, 2011-2015

U.S. exports peaked in 2012; reduced Asian demand leading to lower U.S. exports

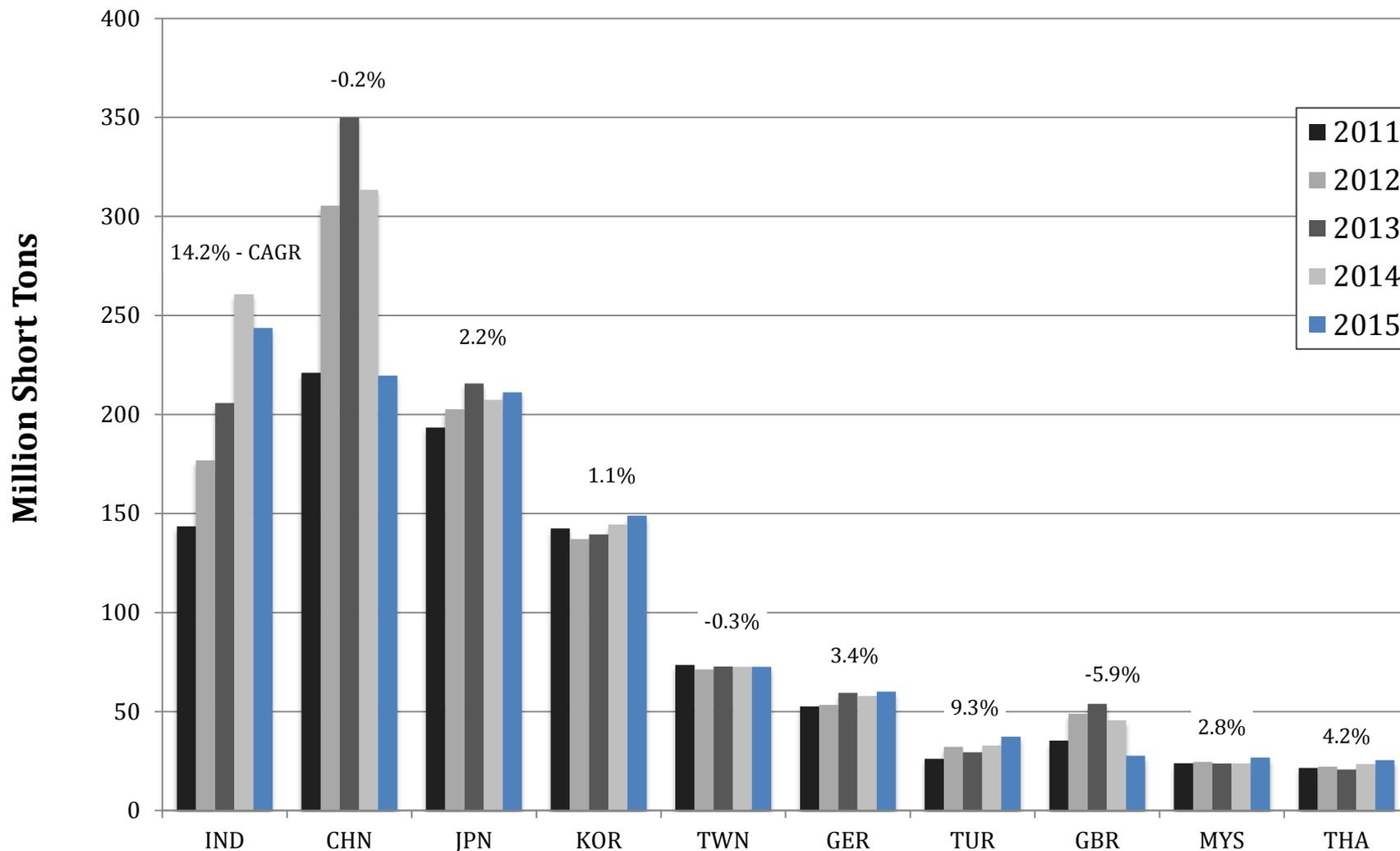


Source: International Energy Agency

Note: Includes steam coal, coking coal, lignite, and recovered coal; 2015 data represents estimates; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Global Net Importers of Coal, 2011-2015

U.S. is not a top-10 importer of coal



Source: International Energy Agency

Note: Includes steam coal, coking coal, lignite, and recovered coal; 2015 data represents estimates; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Cleantech



Cleantech

Clean energy adoption has grown worldwide as a result of technology advancements, aggressive policies, improved economics, and changes in consumer preferences.

According to the *Renewables 2016 Global Status Report*, by the end of 2015, there was enough renewable generation capacity installed to supply 24 percent of the world's electricity demand. In total, worldwide renewable power capacity—including hydropower—exceeded 1,849 gigawatts (GW) in 2015, up 9 percent from 2014.

Global investment in new renewable generation and fuels has put together a remarkable track record: \$279 billion (2011), \$250 billion (2012), \$232 billion (2013), \$270 billion (2014), and \$286 billion in 2015. This history of healthy financial support shows no signs of slowing down.

Within the United States, Colorado is a national leader in adopting clean energy technologies. In 2015, Colorado ranked ninth in installed solar capacity with 447 megawatts (MW). As of October 2016, Colorado ranked 10th in installed wind capacity with 2,960 MW. Colorado also ranks third in cumulative square footage of LEED-certified space per capita, and it ranks 10th in the adoption of alternative fuel vehicles on a per capita basis.

The economics further demonstrate Colorado's leadership. In 2016, Colorado ranked eighth in cleantech venture capital investments at \$20.5 million, as part of a combined cleantech investment total of more than \$121 million. Furthermore, according to the 2016 Metro Denver EDC annual *Energy Industry Cluster Study*, Colorado ranked fourth nationally in cleantech employment concentration. This includes 26,270 direct cleantech workers supporting an additional 86,100 indirect workers, with an economic impact of \$4.6 billion annually. In 2015, the average annual salary for a Colorado cleantech worker was \$79,100, just below the national average of \$79,358.

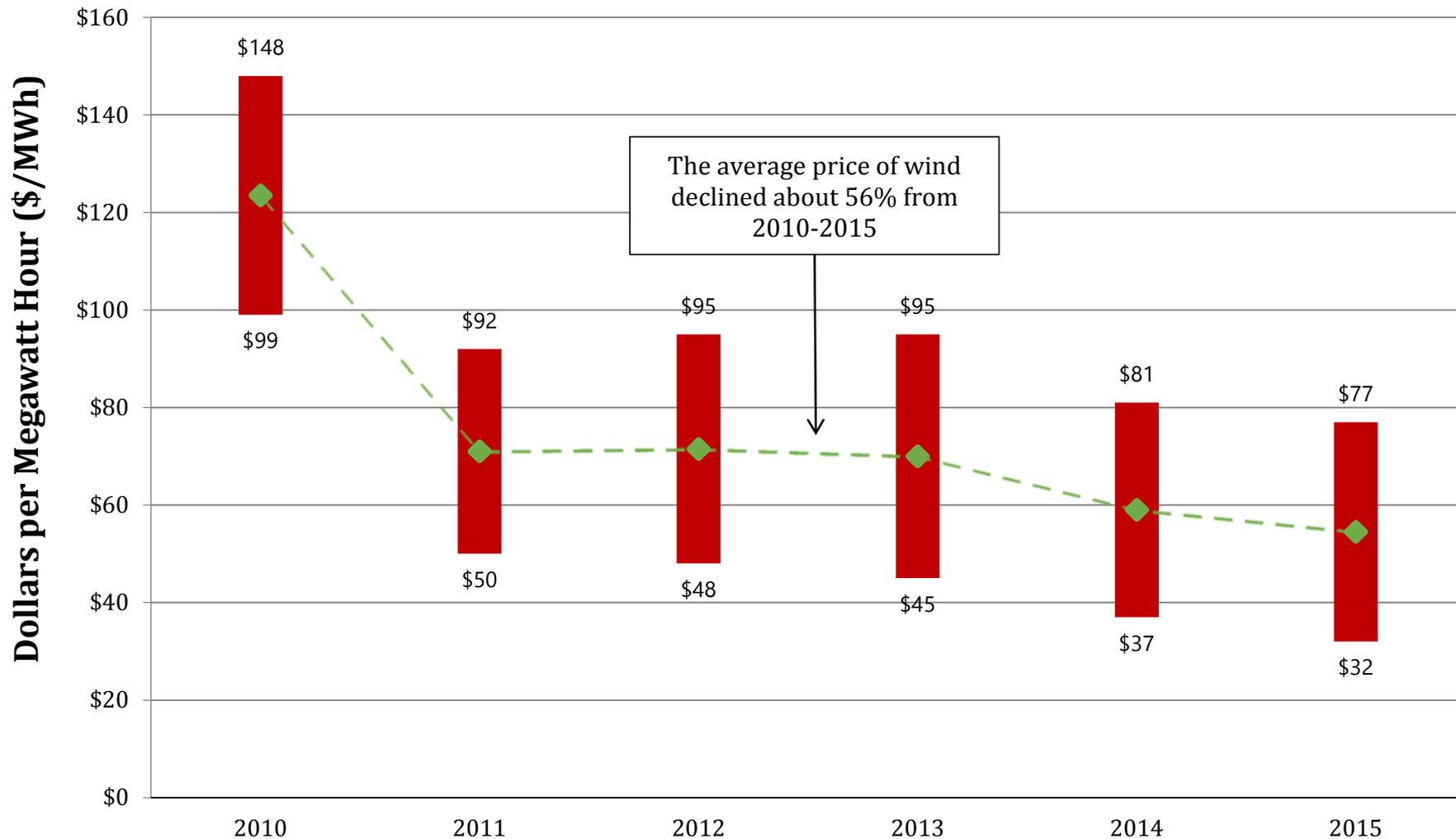
A final piece of the puzzle is Colorado's leadership in research and development. The National Renewable Energy Laboratory (NREL), located in Golden, Colorado is the only U.S. Department of Energy laboratory solely committed to the research, development, commercialization, and deployment of renewable energy technologies. Adding the research, development, and commercialization of clean energy technologies at Colorado School of Mines, the University of Colorado, and Colorado State University, and the state's leadership in the advancement of clean energy becomes clear.

Taken together, Colorado has cemented its role as a national leader in cleantech.



Price of Wind, 2010-2015

U.S. levelized (unsubsidized) cost of wind has decreased significantly since 2010



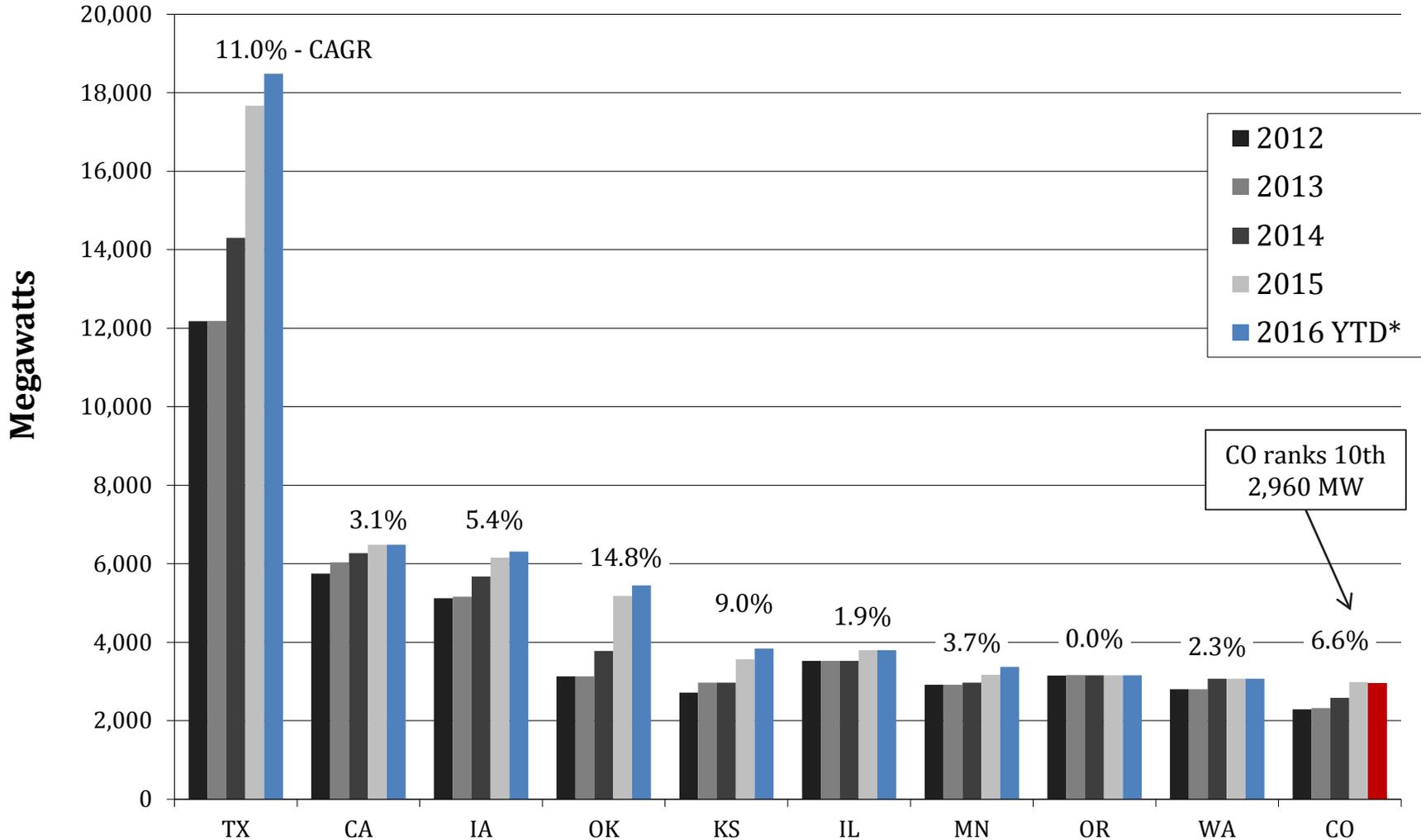
Source: Lazard

Note: \$/MWh range is due to site and type of technology; levelized cost does not include tax incentives; price range expressed on annual basis.

Fig. 31

Total Installed Wind Capacity, 2012-2016

Approximately 101 MW of new wind capacity is projected to come online in Colorado in 2017



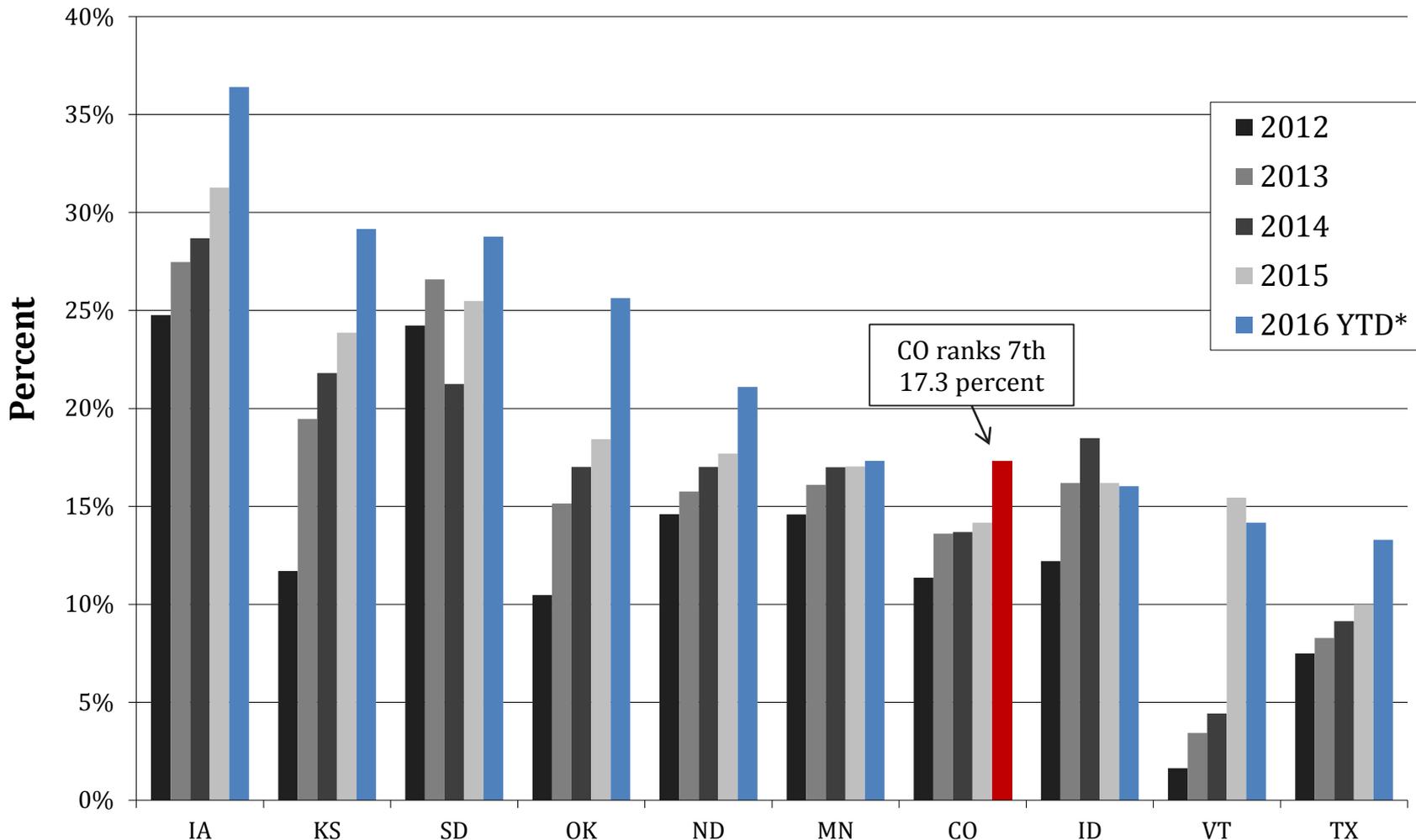
Source: SNL Energy

Note: *2016 year-to-date represents capacity as of October; the compound annual growth rate (CAGR) reflects the 2012 to 2016 period.

Fig. 32

Wind Net Generation as a Percent of Total, 2012-2016

U.S. net generation from wind increased at a compound annual growth rate (CAGR) of nearly 10 percent from 2010 to 2015; Colorado's has increased nearly 17%



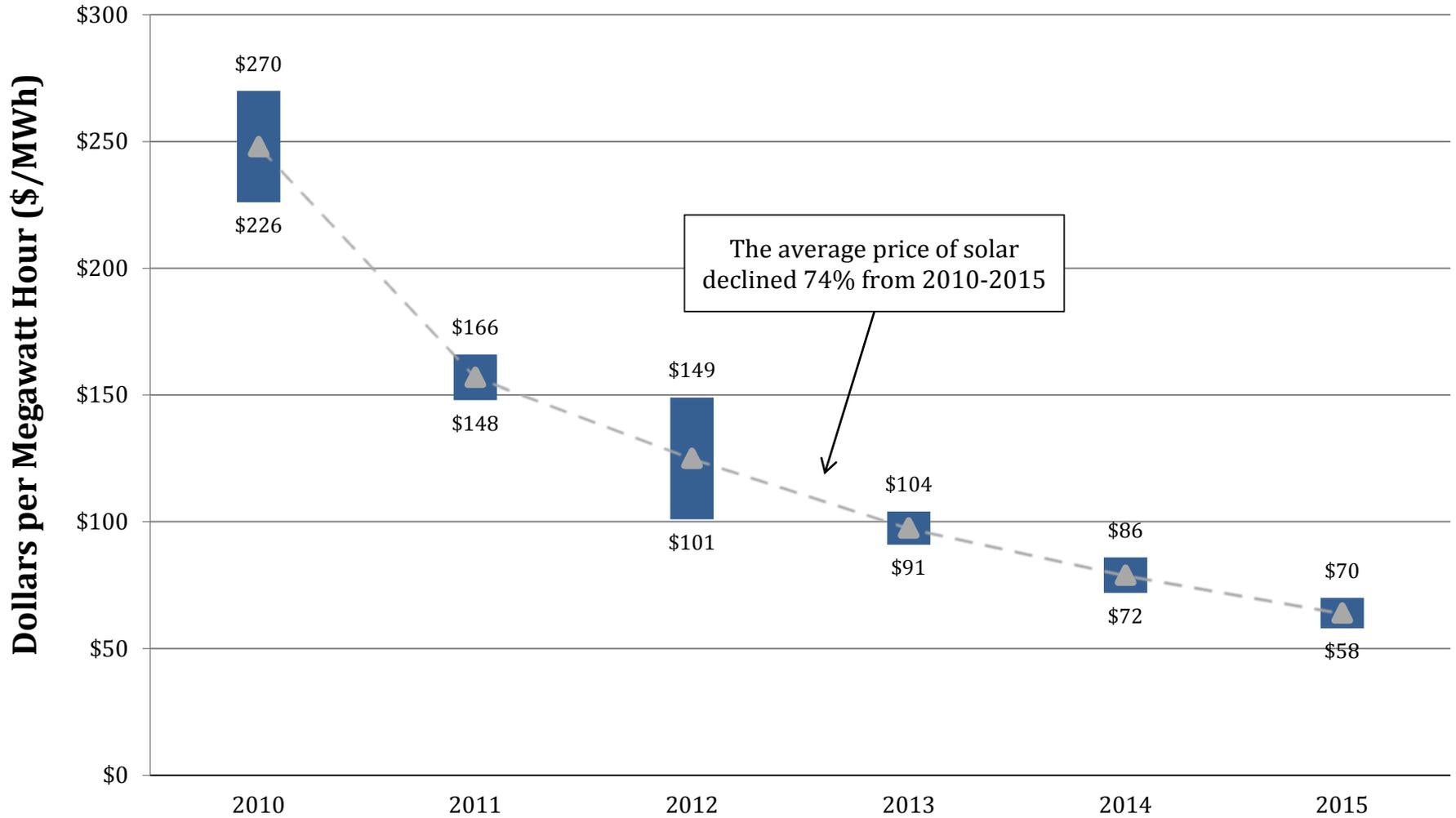
Source: U.S. Department of Energy, Energy Information Administration

*2016 year-to-date represents January to July

Fig. 33

Price of Solar, 2010-2015

U.S. levelized (unsubsidized) cost of solar has decreased significantly since 2010

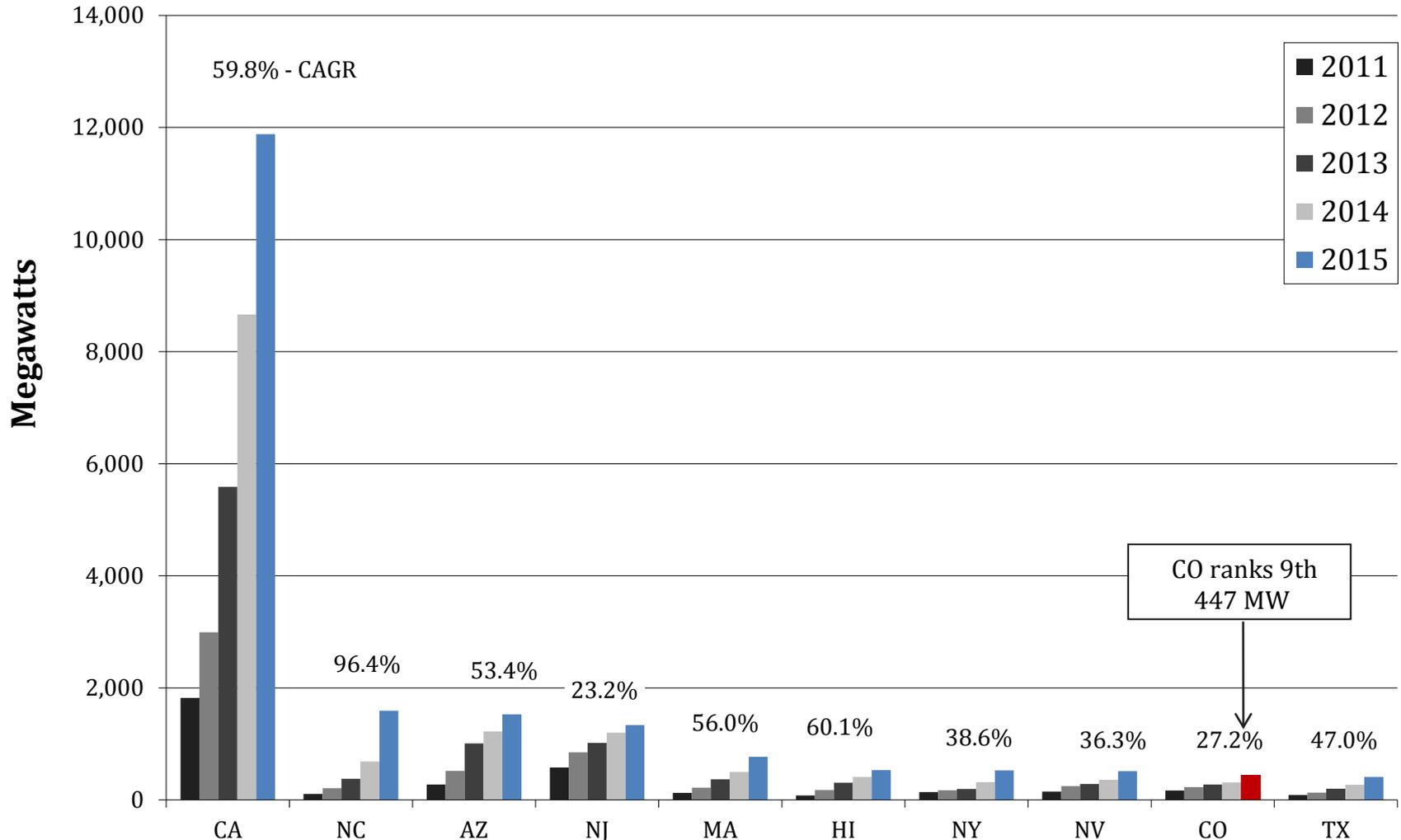


Source: Lazard

Note: \$/MWh range is due to site and type of technology; levelized cost does not include tax incentives; price range expressed on annual basis. Cost is for crystalline utility scale solar.

Total Installed Solar Capacity, 2011-2015

Approximately 74 MW of new solar capacity is projected to come online in Colorado in 2017; over half of U.S. installed solar capacity (22.5 GW) is in California

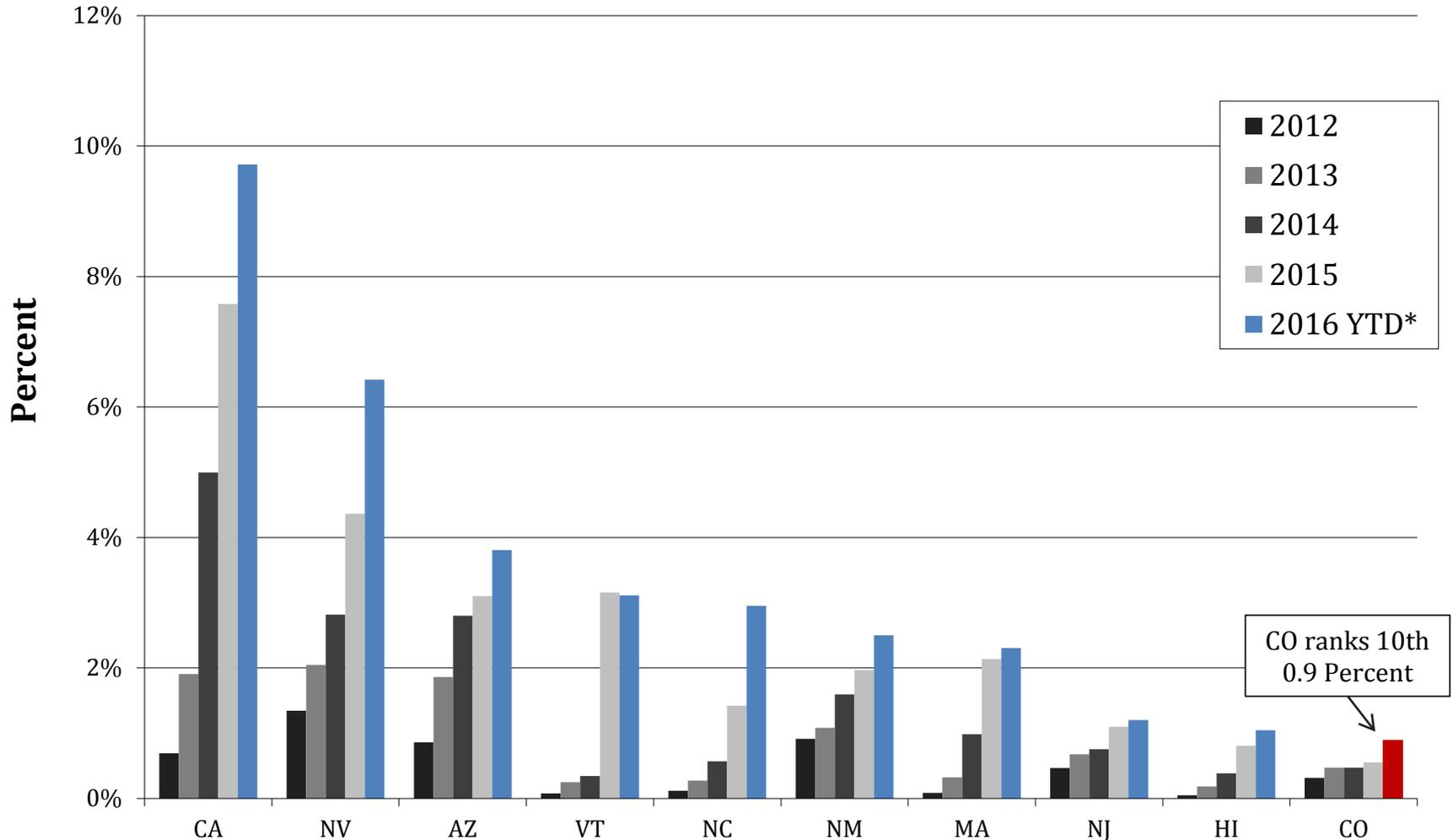


Source: Solar Electric Power Association (SEPA); solar includes residential, commercial, and utility-scale installations; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Fig. 35

Solar Net Generation as a Percent of Total, 2012-2016

U.S. net generation from solar (about 1% in 2015) increased at a CAGR of about 48 percent from 2012 to 2016



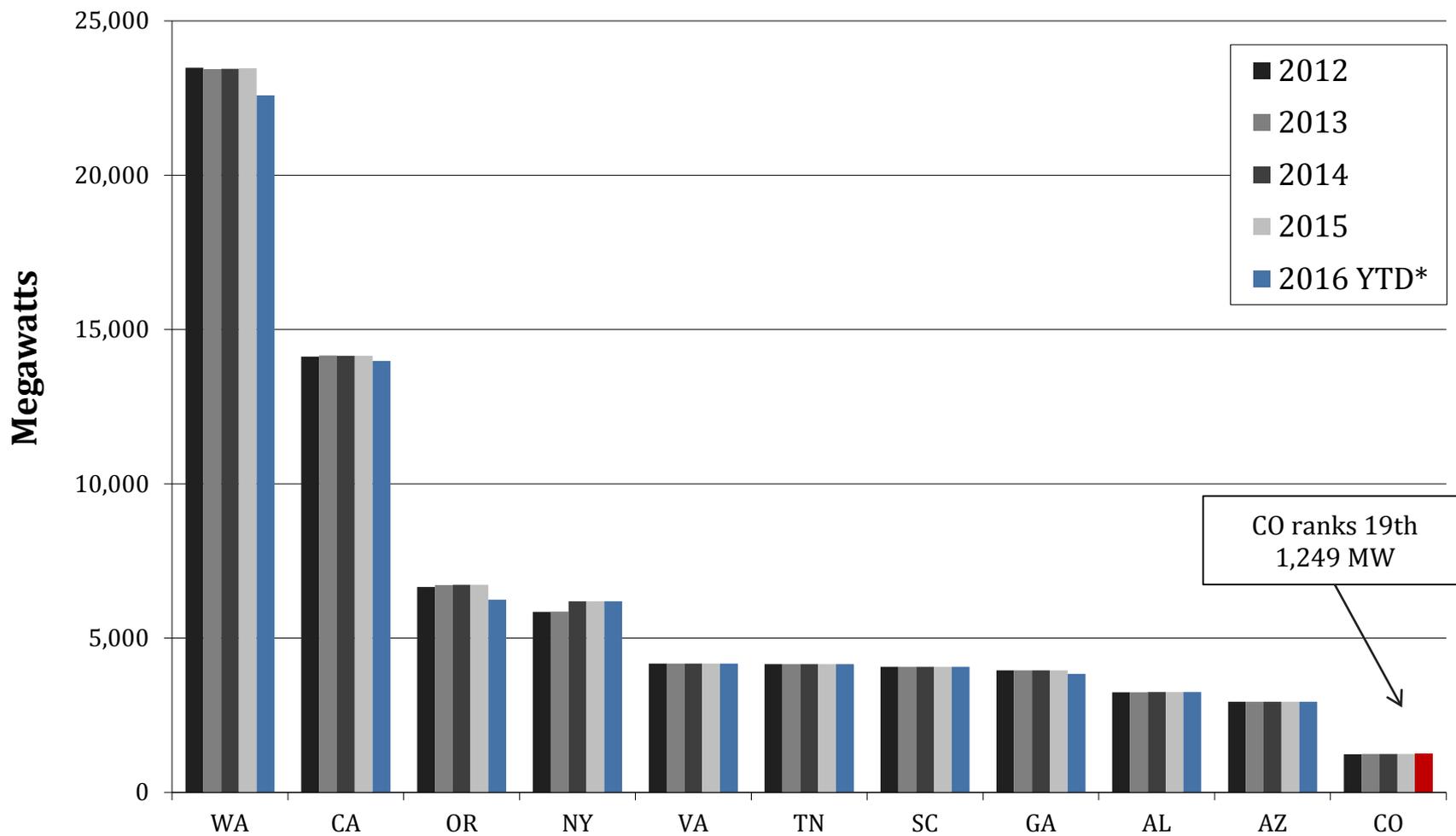
Source: U.S. Department of Energy, Energy Information Administration

*2016 year-to-date represents January to July

Fig. 36

Total Installed Hydropower Capacity, 2012-2016

Recent federal legislation enabled over 17 MW of small hydro projects in Colorado; more than 10 MW are currently under development



Source: SNL Energy

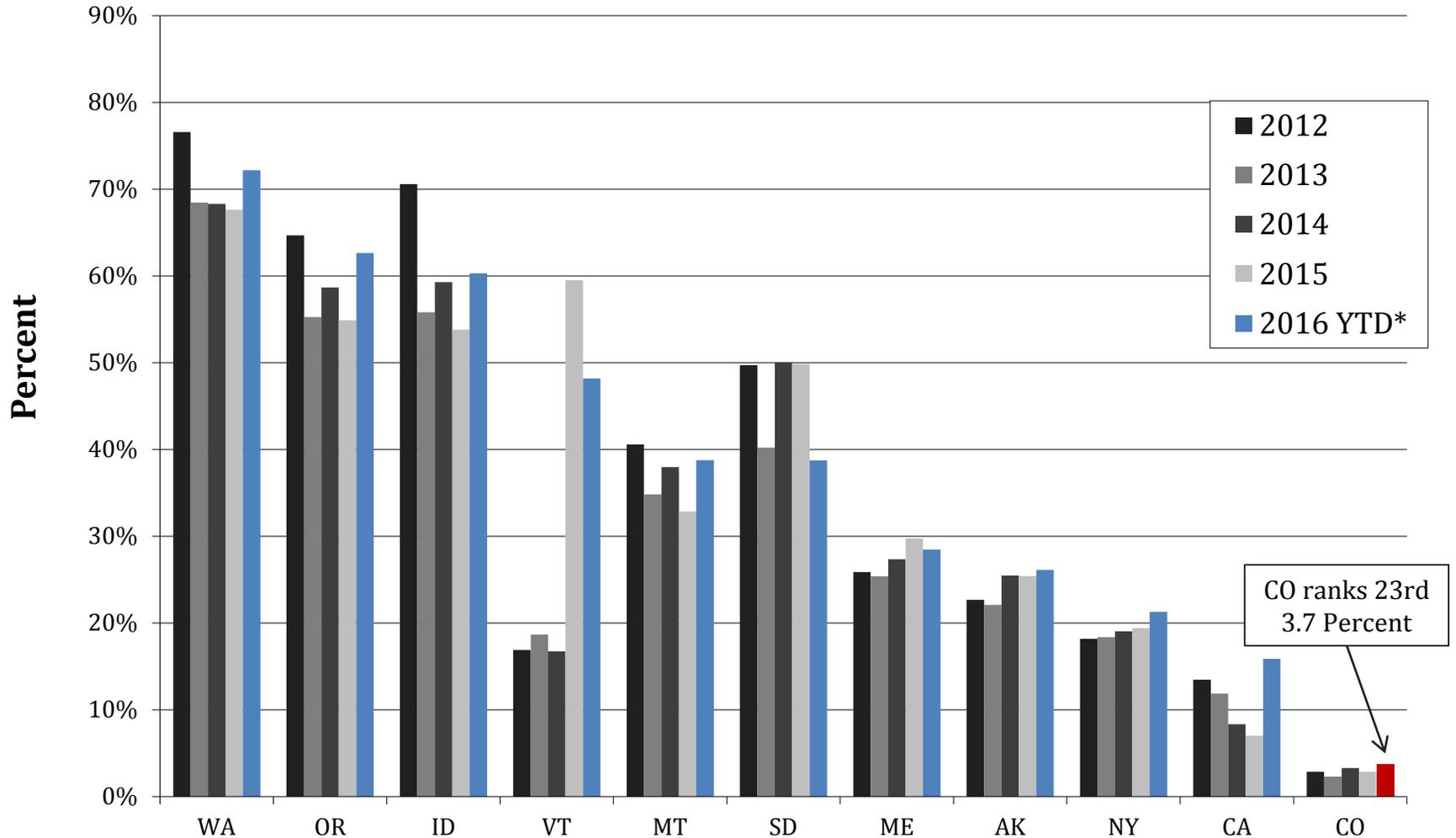
Note: Top-10 states plus Colorado.

*2016 year-to-date represents capacity as of October

Fig. 37

Hydro Net Generation as a Percent of Total, 2012-2016

U.S. net generation (about 6 percent in 2015) from hydroelectricity remains relatively stable from year to year

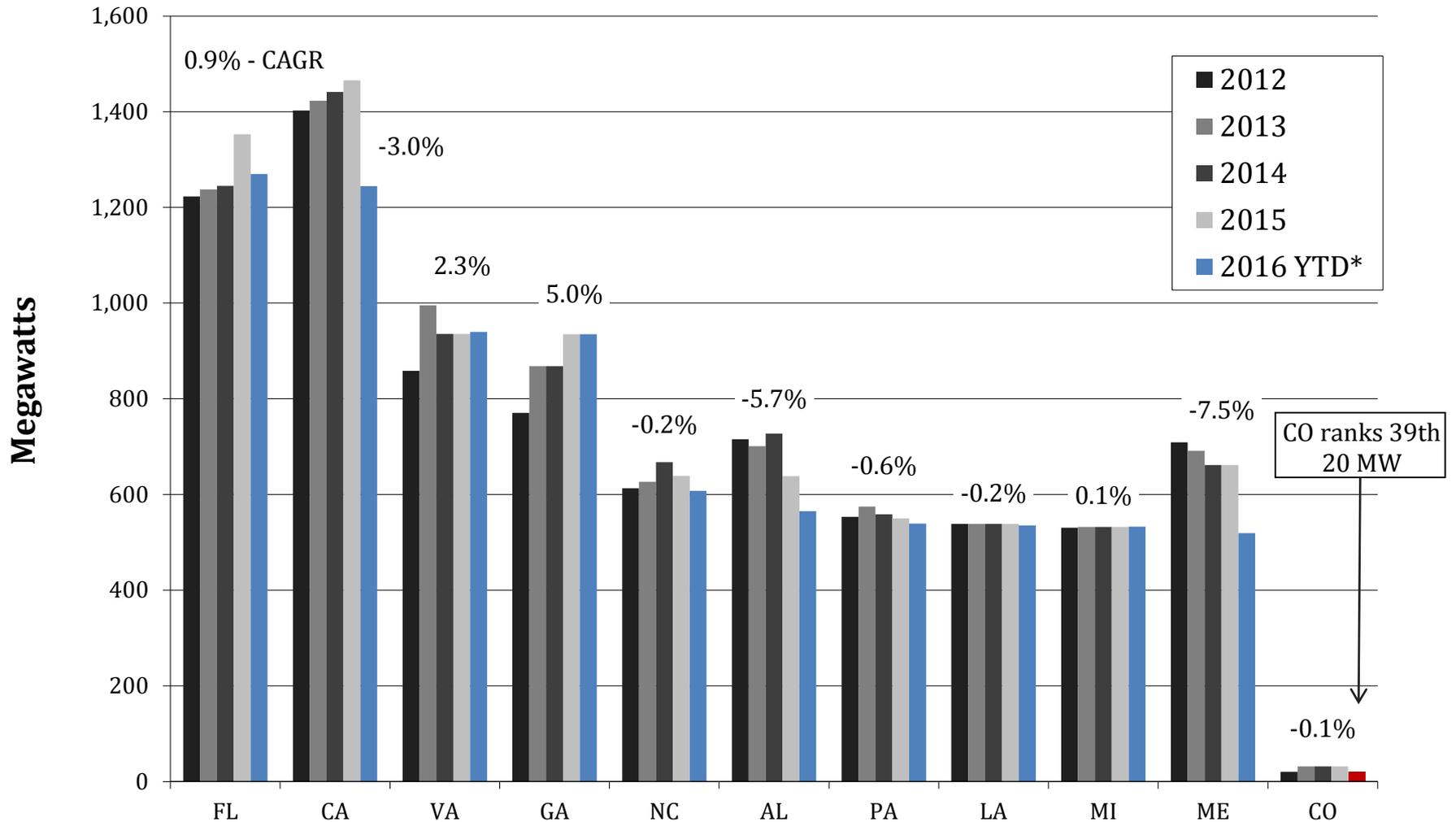


Source: U.S. Department of Energy, Energy Information Administration

*2016 year-to-date represents January to July

Total Installed Biomass Capacity, 2012-2016

5 MW woody biomass-electricity plant in Pagosa Springs is being considered by the La Plata Electric Association



Source: SNL Energy

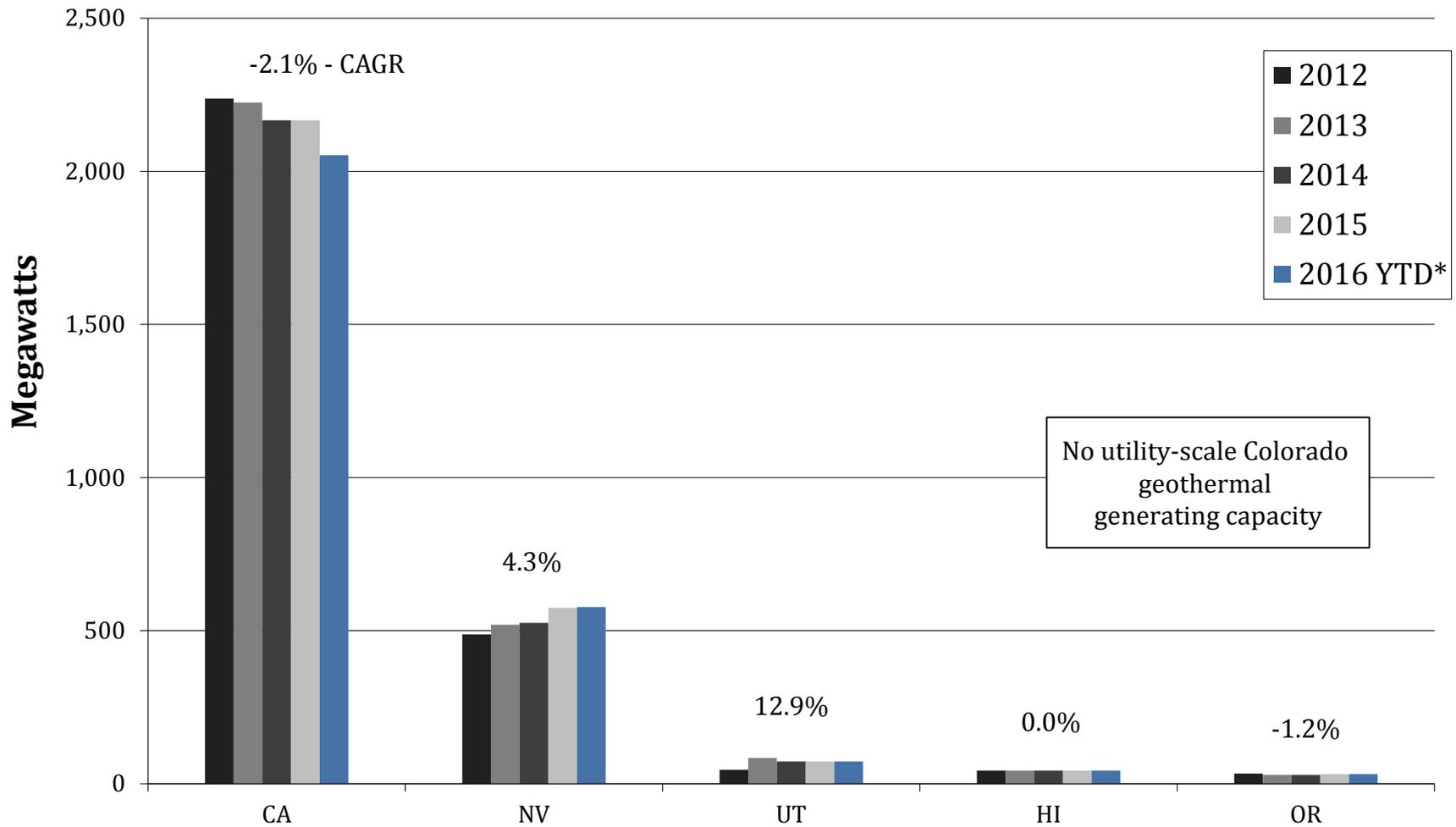
Note: Top-10 states plus Colorado; biomass includes wood, biomass solids and liquids, landfill gas, sludge, and agricultural byproducts.

Note: *2016 year-to-date represents capacity as of October; the compound annual growth rate (CAGR) reflects the 2012 to 2016 period.

Fig. 39

Total Installed Geothermal Capacity, 2012-2016

Two proposed Colorado projects in Gunnison and Chaffee counties would install about 10 MW of capacity



Source: SNL Energy

Note: Vast majority of states have no utility-scale geothermal capacity

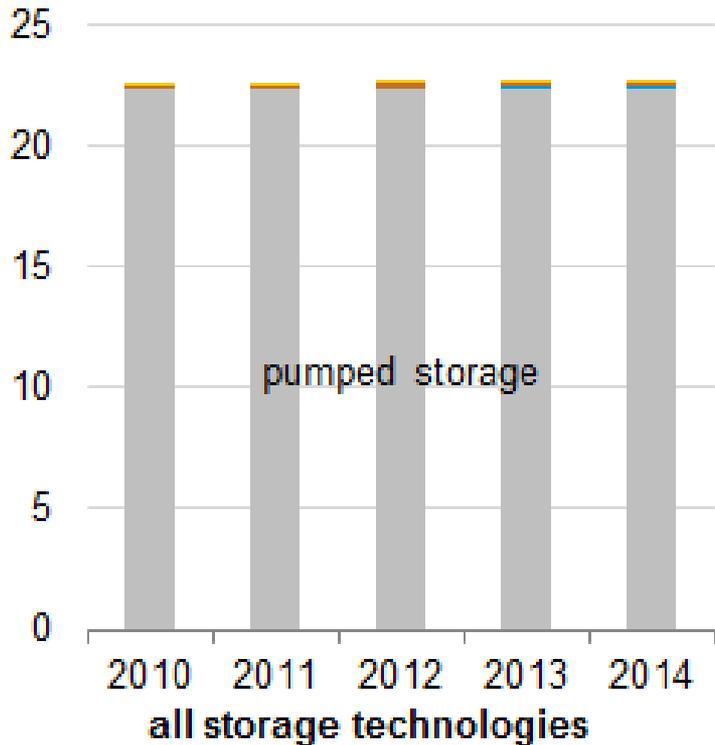
Note: *2016 year-to-date represents capacity as of October; the compound annual growth rate (CAGR) reflects the 2012 to 2016 period.

Fig. 40

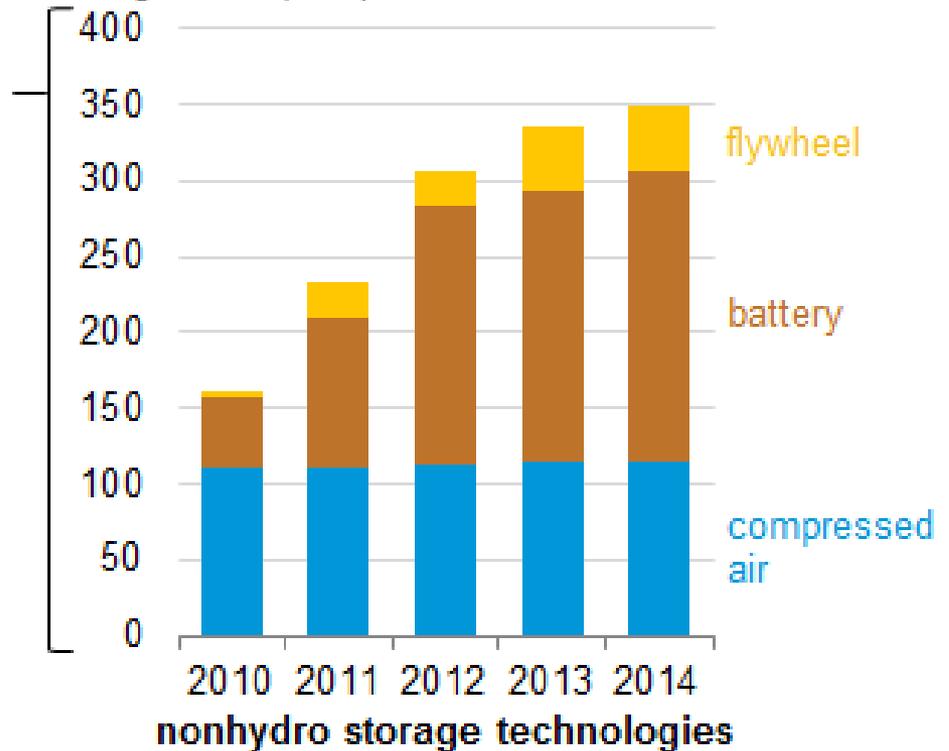
Total Energy Storage Capacity

Non-hydro electricity storage is a tiny fraction of total storage, but it is increasing as new policies are implemented and prices decrease

Electric power sector storage capacity
gigawatts (GW)



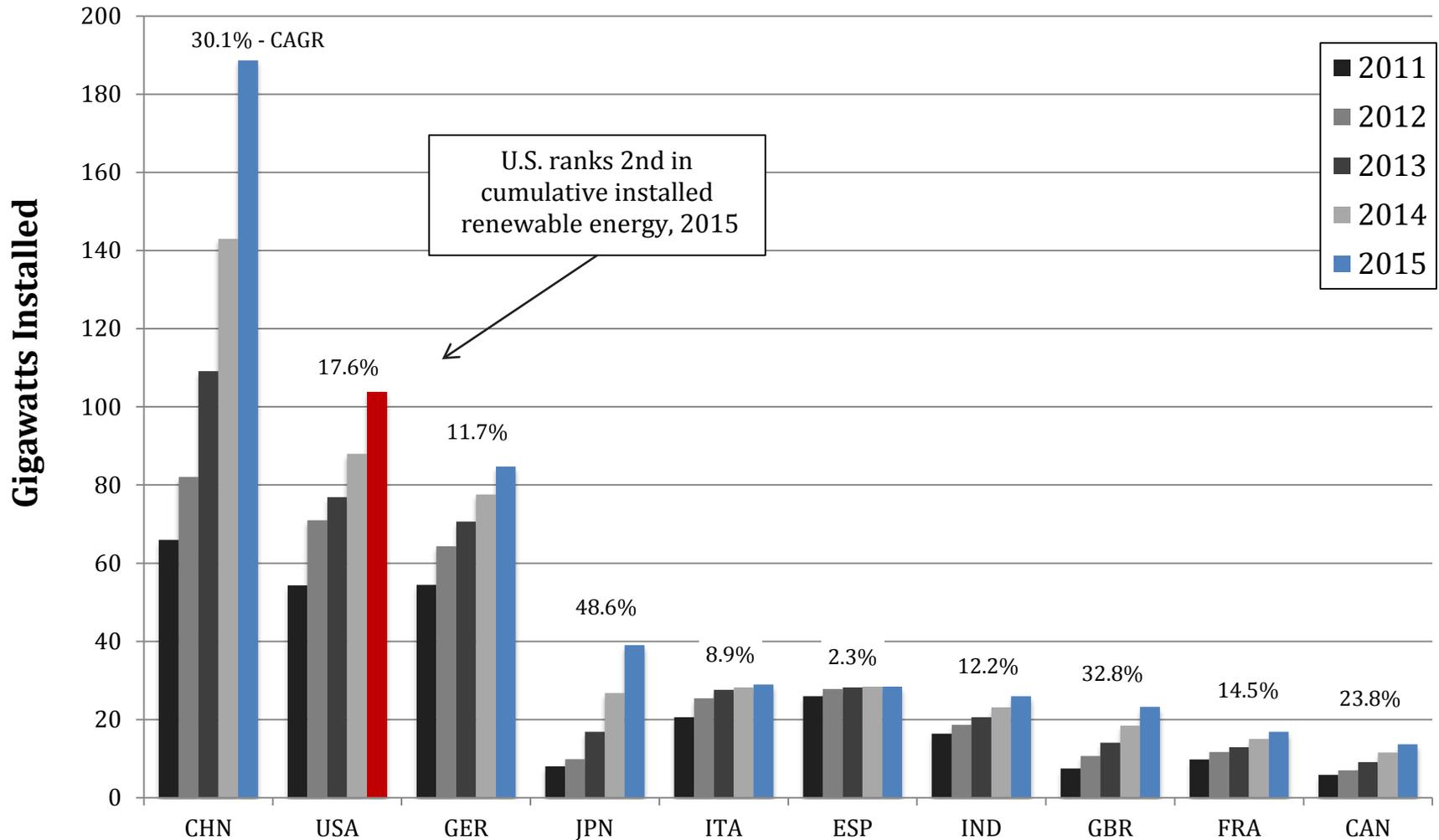
megawatts (MW)



Source: U.S. Department of Energy, Energy Information Administration

Global Cumulative Installed Renewable Energy Capacity, 2011-2015

Worldwide installed renewable energy (solar, wind, geothermal) capacity is 678 GW

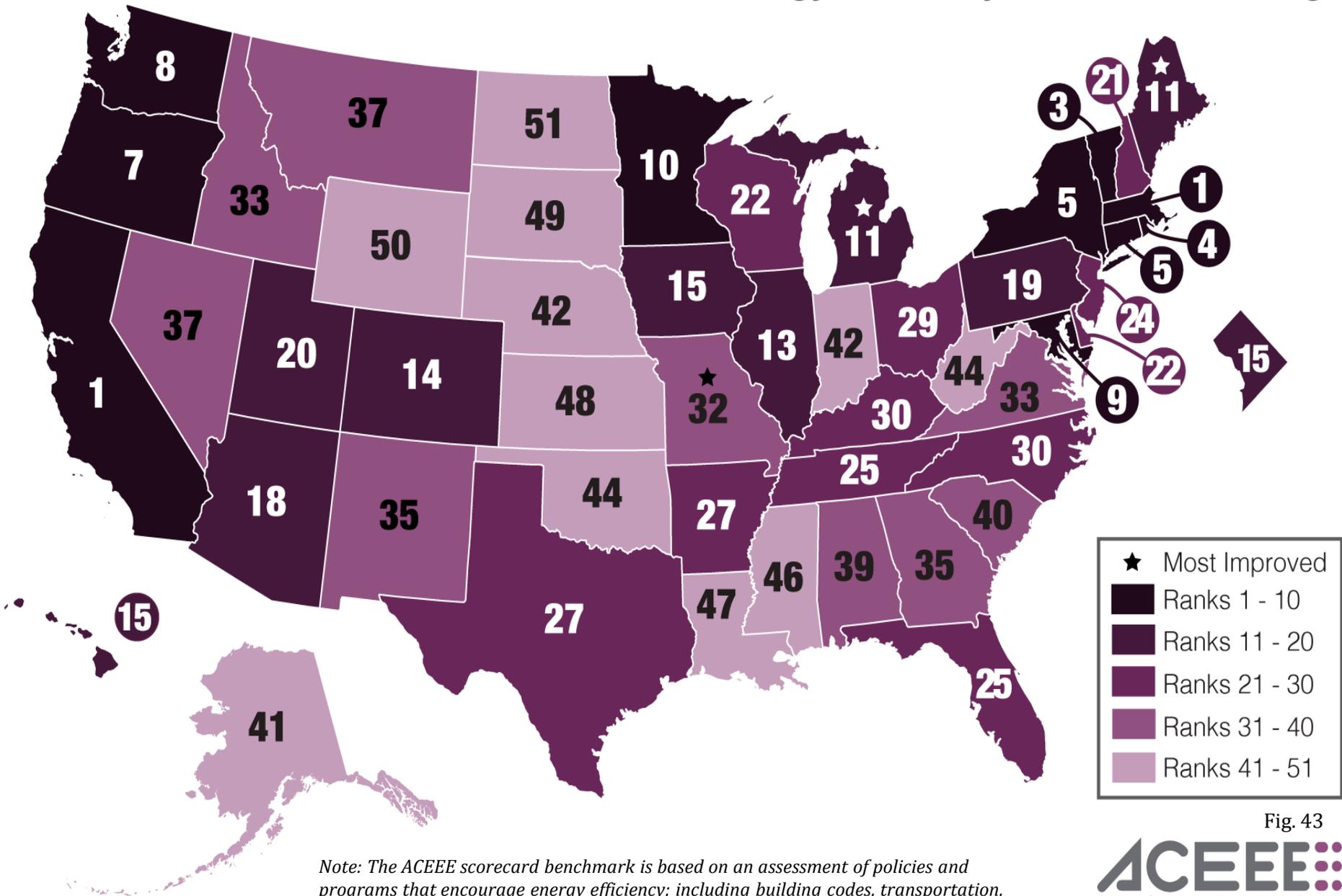


Sources: BP Statistical Review of World Energy, June 2016

Note: Listed renewables are non-hydro; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Fig. 42

2016 State Energy Efficiency Scorecard Rankings

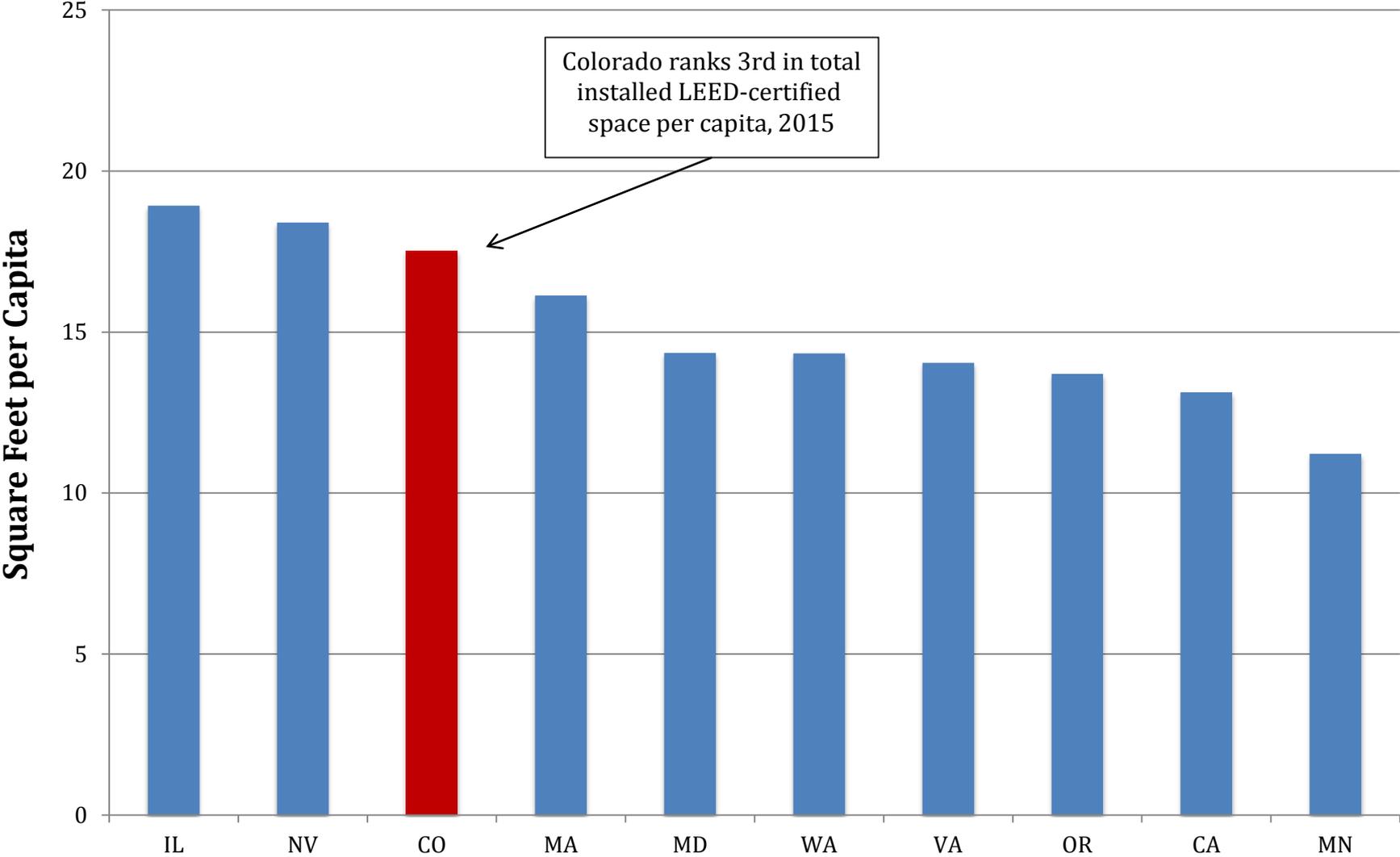


Note: The ACEEE scorecard benchmark is based on an assessment of policies and programs that encourage energy efficiency; including building codes, transportation, state initiatives, and appliance and equipment standards.

Fig. 43

Cumulative LEED-Certified Space per Capita, 2015

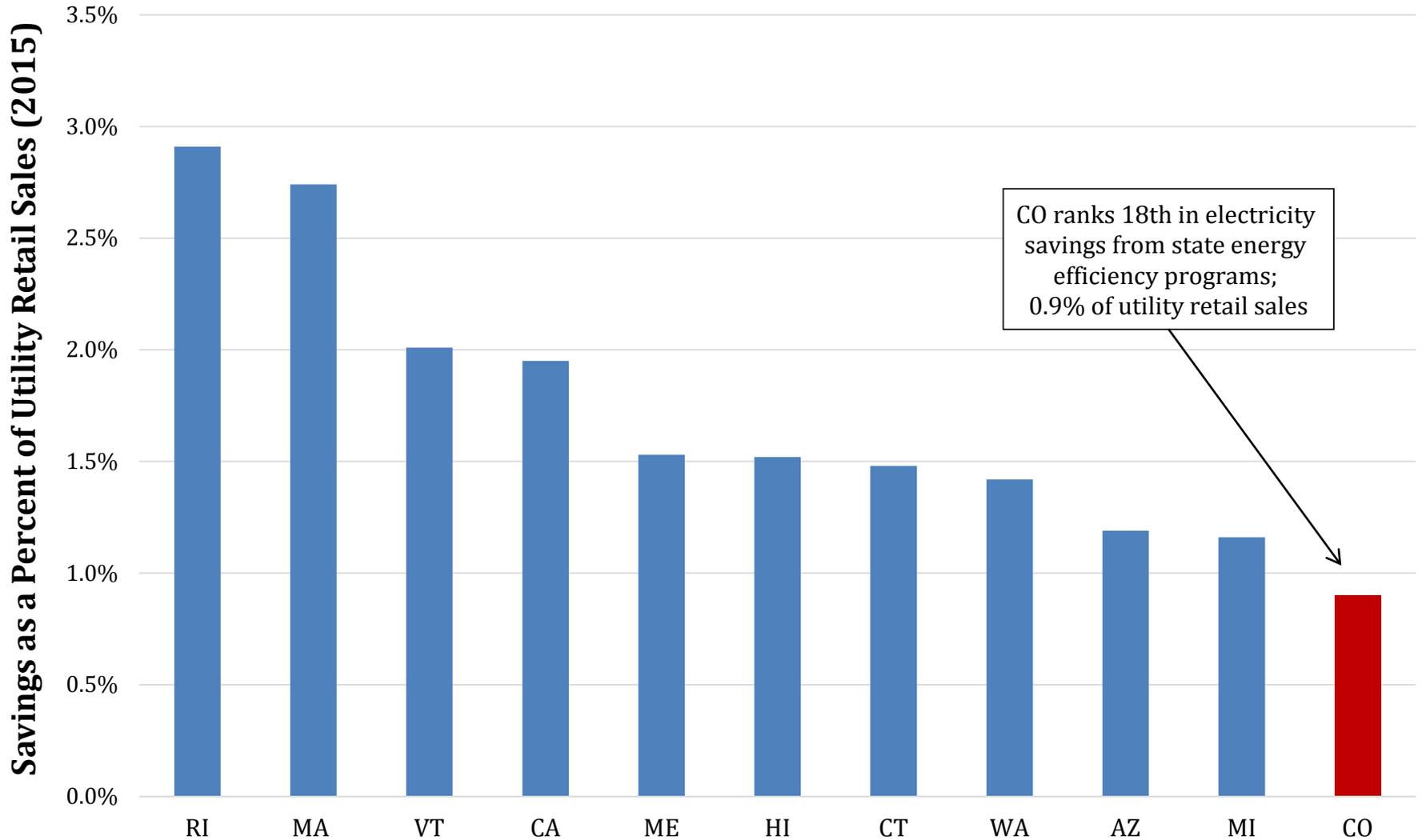
Colorado has nearly 94 million total square feet of LEED certified space



Source: U.S. Green Building Council
Note: Data through August 2015

Fig. 44

Net Electricity Savings from State Energy Efficiency Programs, 2015



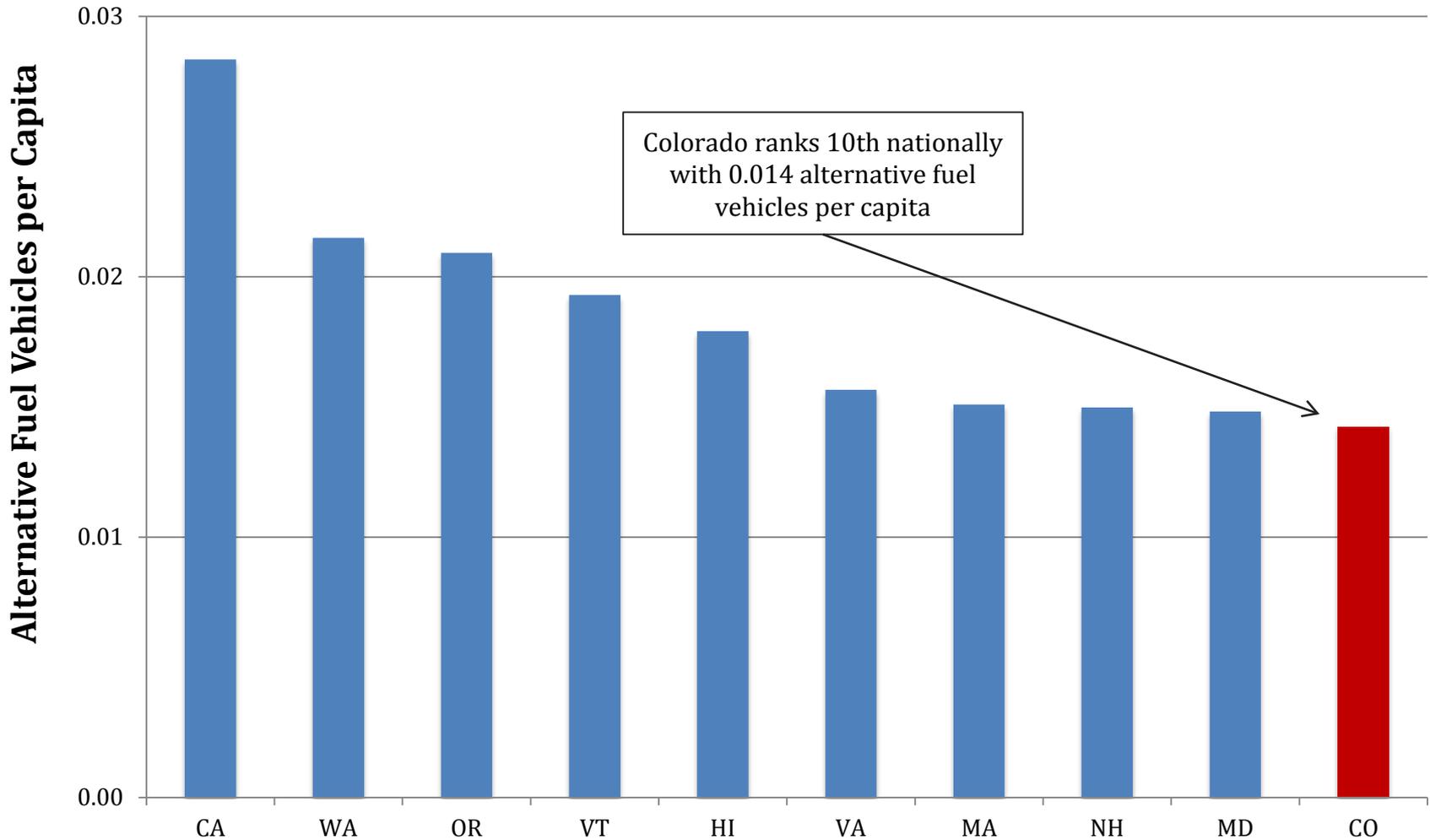
Source: American Council for an Energy-Efficient Economy (ACEEE) - 2016 State Energy Efficiency Scorecard

Note: In a few cases where 2015 data was unavailable, 2014 data was used

Fig. 45

Alternative Fuel Vehicles per Capita, 2015

There are 77,730 total alternative fuel vehicles in Colorado

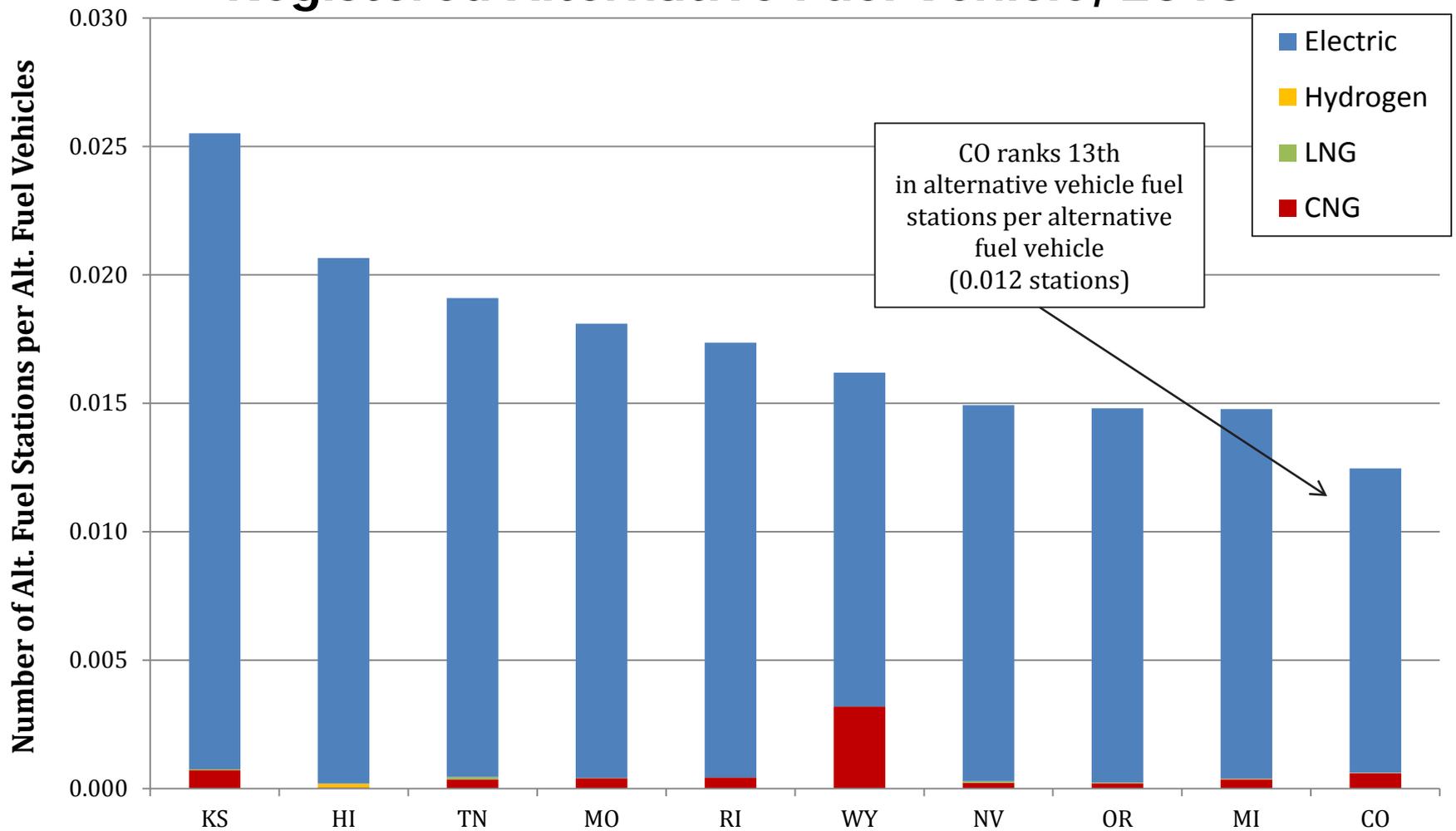


Source: National Renewable Energy Laboratory; R.L. Polk; U.S. Census Bureau

Note: Includes compressed natural gas, converted compressed natural gas, EV, HEV, PHEV, LPG

Fig. 46

Alternative Fuel Vehicle Stations per Registered Alternative Fuel Vehicle, 2016

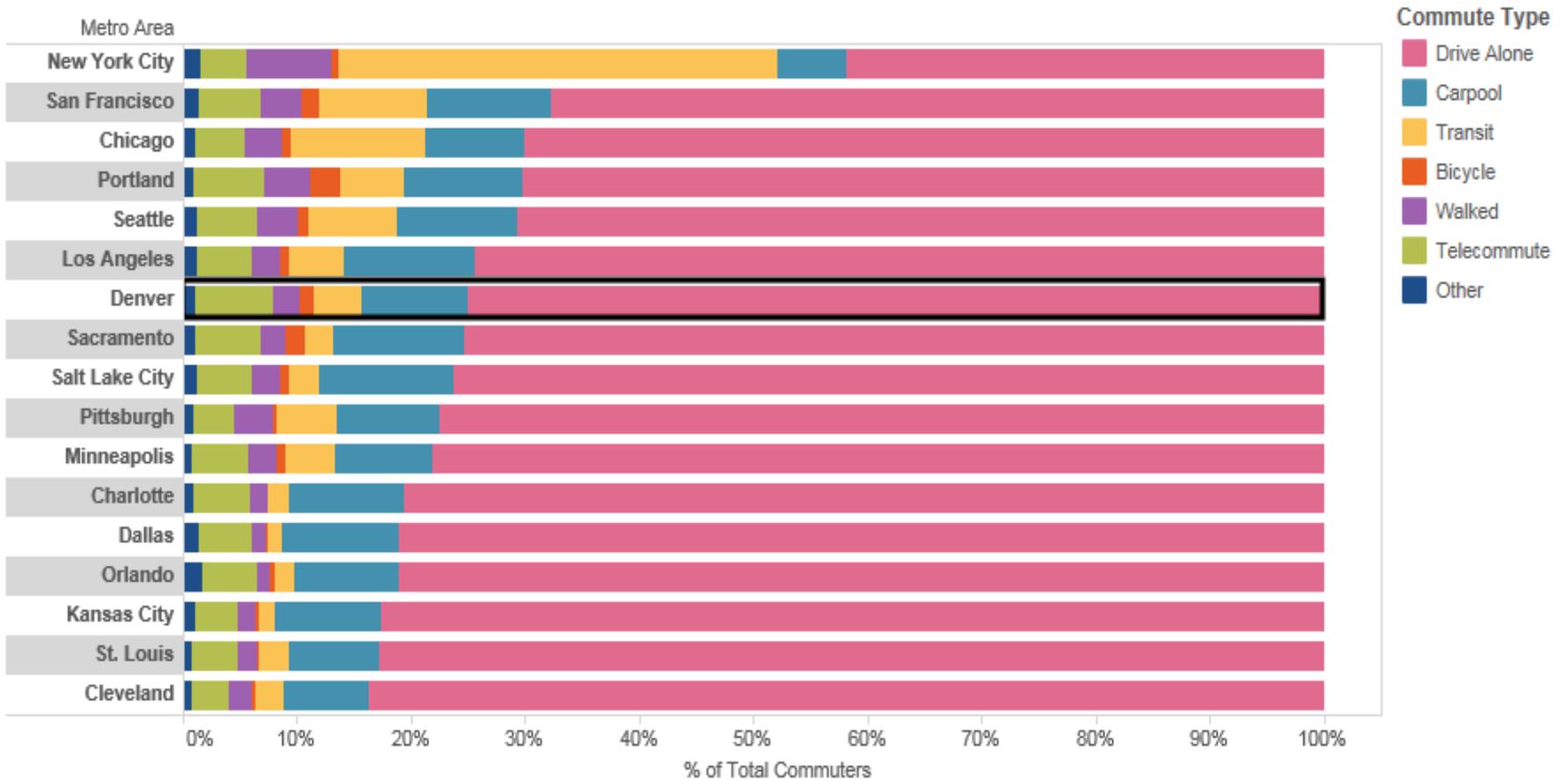


Source: Department of Energy, Alternative Fuels Data Center; Department of Transportation, Federal Highway Administration; NREL; R.L. Polk
 Note: Includes compressed natural gas (CNG), liquefied natural gas (LNG), hydrogen, and electric; top-10 states plus Colorado; vehicle registration data for 2015; includes all public, private, and commercial autos, buses, trucks, and motorcycles; National Association of Convenience Stores (NACS) and IHS Automotive estimate 257.9 million registered vehicles in the U.S. and 152,995 retail fueling stations, for an estimated 0.0006 stations per vehicle.

Fig. 47

Metro Mobility, 2015

Denver metro remains automobile dependent, but transit and bicycle infrastructure investments may reduce some of that dependence over time

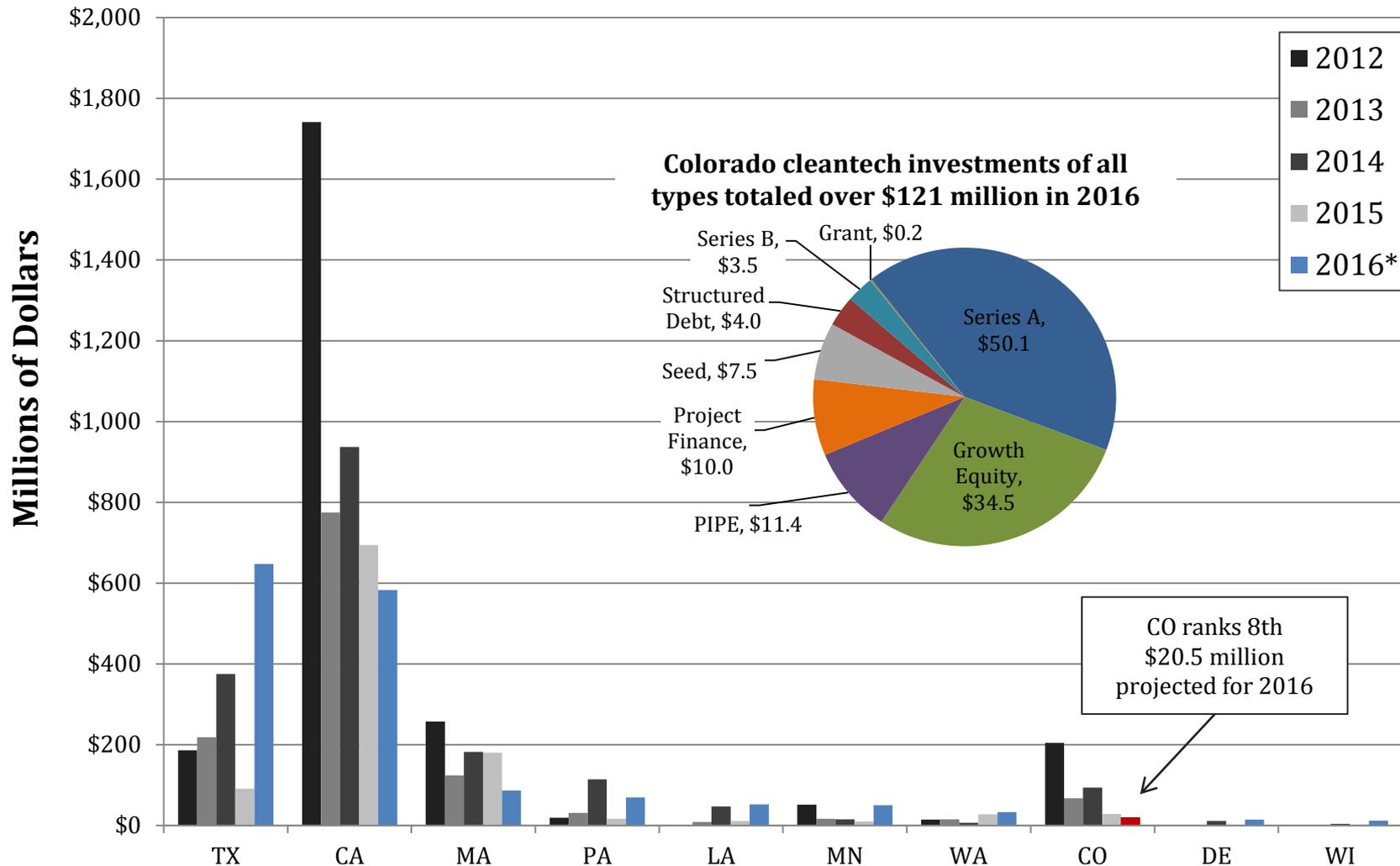


Source: Denver Regional Council of Governments (DRCOG)

Fig. 48

Cleantech Venture Capital Investments, 2012-2016

U.S. (\$4.3 billion) and Colorado (\$248 million) investment peaked in 2011



Source: PricewaterhouseCoopers, MoneyTree Report

Note: Private Investment in Public Equity (PIPE) is used to quickly raise capital by privately selling publicly-traded common or preferred shares at a discounted rate relative to the market price to an accredited investor; *2016 projection based on data for the first and second quarters.

Fig. 49

Power



Power

U.S. electric power generation is rapidly diversifying. In 2015, coal and natural gas tied as the largest sources of U.S. electric power generation at 33 percent apiece, followed by nuclear at 20 percent, hydropower 7 percent, renewables 7 percent, and oil falling below 1 percent. Coal represented 43 percent of net generation as recent as 2011, but the expansion of natural gas and renewable energy is altering the national power generation landscape.

Colorado's electric generation profile is experiencing similar change. In 2015, coal represented 60 percent, natural gas 21 percent, wind 14 percent, hydropower 4 percent, and solar at nearly 1 percent. Just a few years ago coal represented around 70 percent of Colorado's annual net generation, but natural gas and renewable energy are expanding quickly.

One way to compare generation technologies is to assess the levelized (unsubsidized) costs of new power plant facilities. Regional variations occur due to differing state policies and local infrastructure needs; however, levelized cost analysis makes power-plant-to-power-plant comparisons possible.

Nationally, low natural gas prices and decreasing costs for renewables have pushed certain technologies to the top of the list, including advanced natural gas combined cycle, wind, hydropower, and geothermal. It is important to note that solar photovoltaics (PV) are suddenly the fifth-cheapest electric generation technology on a levelized basis, falling below biomass, advanced nuclear, and advanced coal. This electric power competitiveness, particularly for wind and solar, was made possible by the fact wind power costs dropped 56 percent since 2010, while solar dropped 74 percent over the same period.

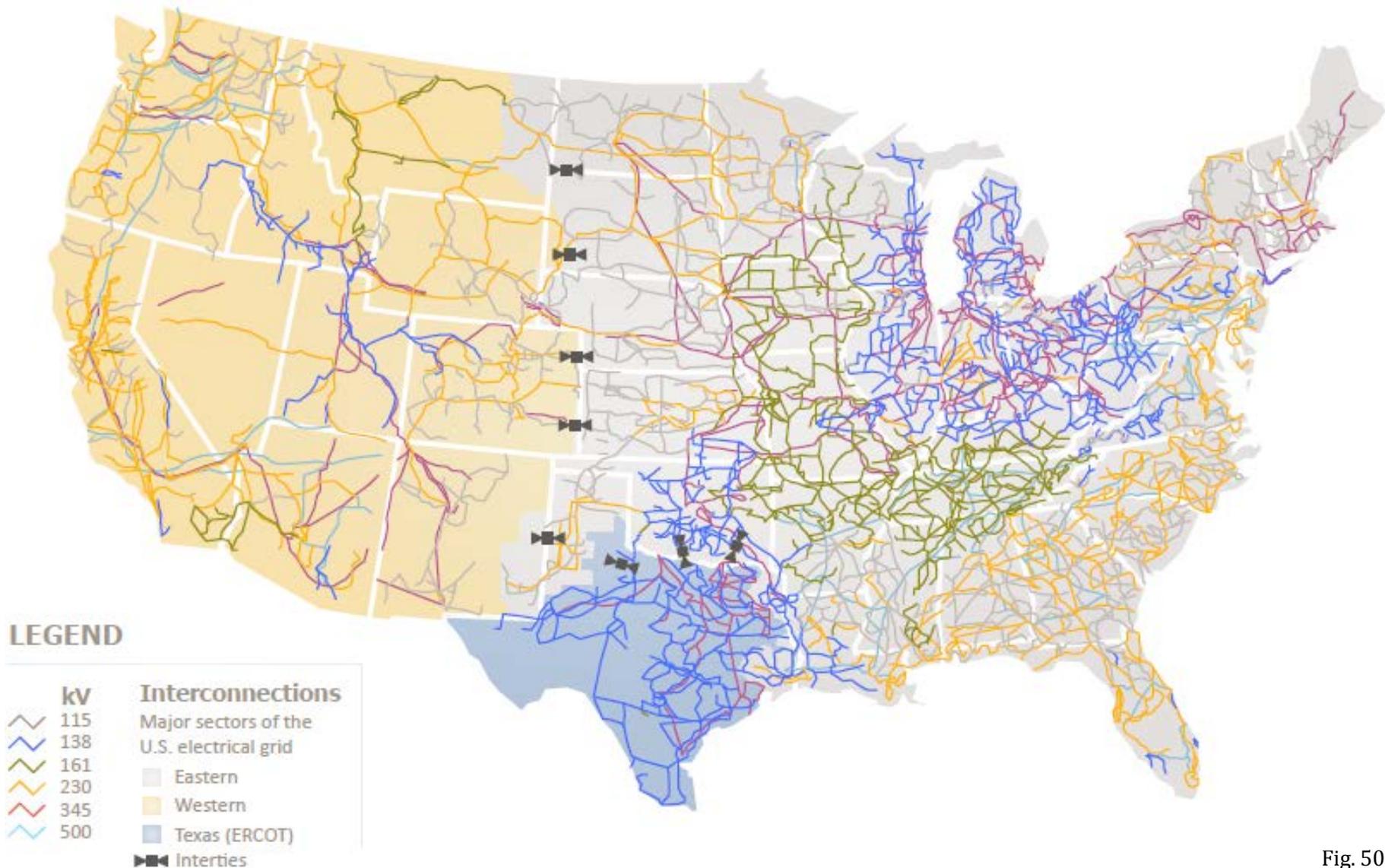
Colorado has a blend of municipal utilities, rural cooperatives, and investor-owned utilities (IOUs). Colorado's growing power generation diversity is in part a result of the state's renewable electricity standard (RES), also referred to as a renewable portfolio standard (RPS). Colorado's RPS for IOUs is 30 percent by 2020, while the RPS for cooperatives is 20 percent by 2020. Colorado's RPS policies are not as aggressive as California's 50 percent by 2030, but they influence market activity. In 2017, over 100MW of new wind capacity and approximately 75MW of new solar capacity are projected to come online. With new solar power agreements made at the Public Utility Commission, and an approved 600MW wind project in the pipeline, the outlook for Colorado renewables beyond 2017 is significant.

Coal will continue to dominate Colorado's electric generation portfolio for years to come, but the combination of policies and steep price decreases will lead to additional natural gas and renewable energy generation for the foreseeable future.

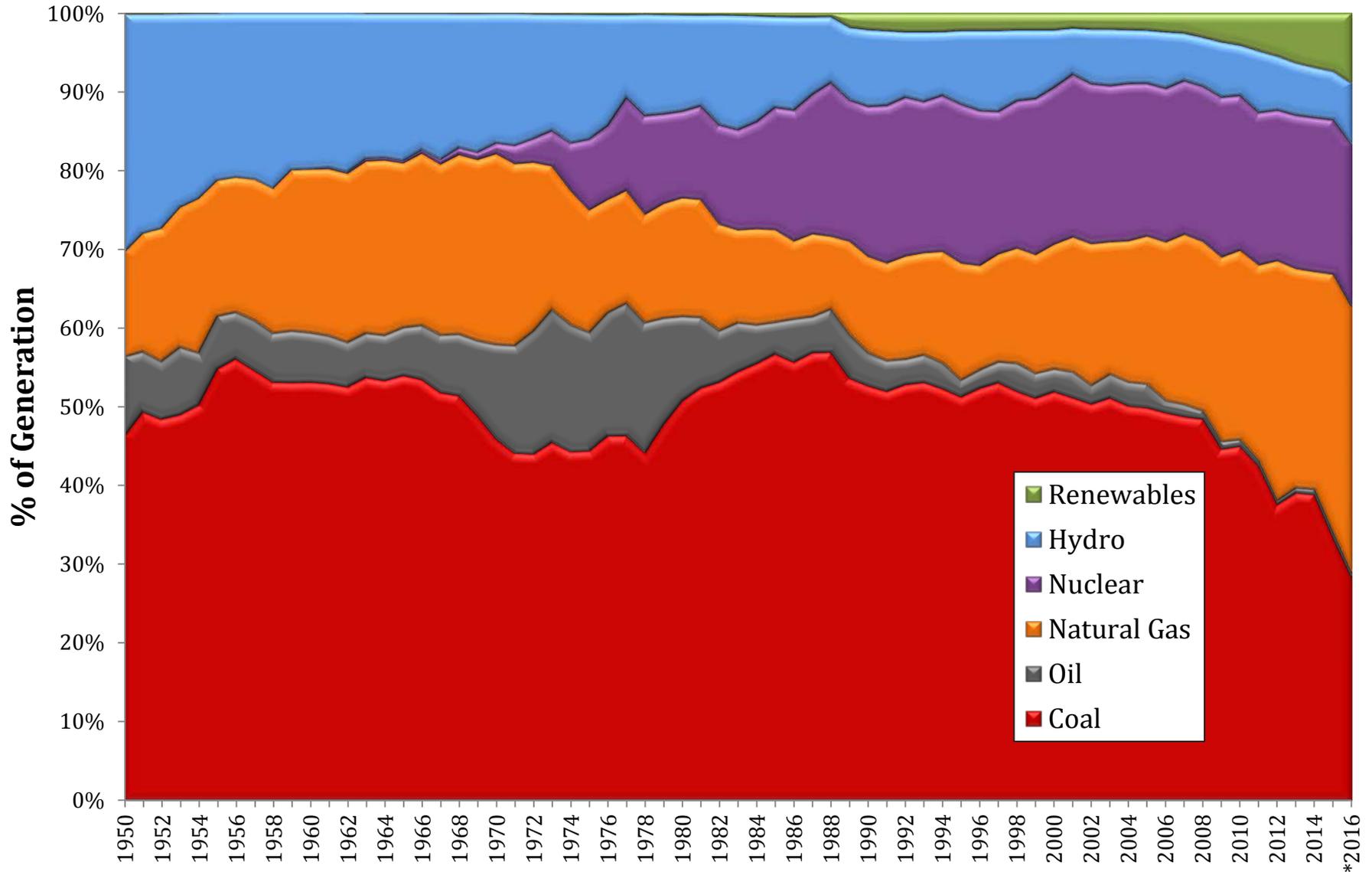


Map of Major Electric Transmission Lines

East, West, and Texas Interconnections are distinct operating regions; expansion of renewables and adoption of regional emissions plans may require new transmission

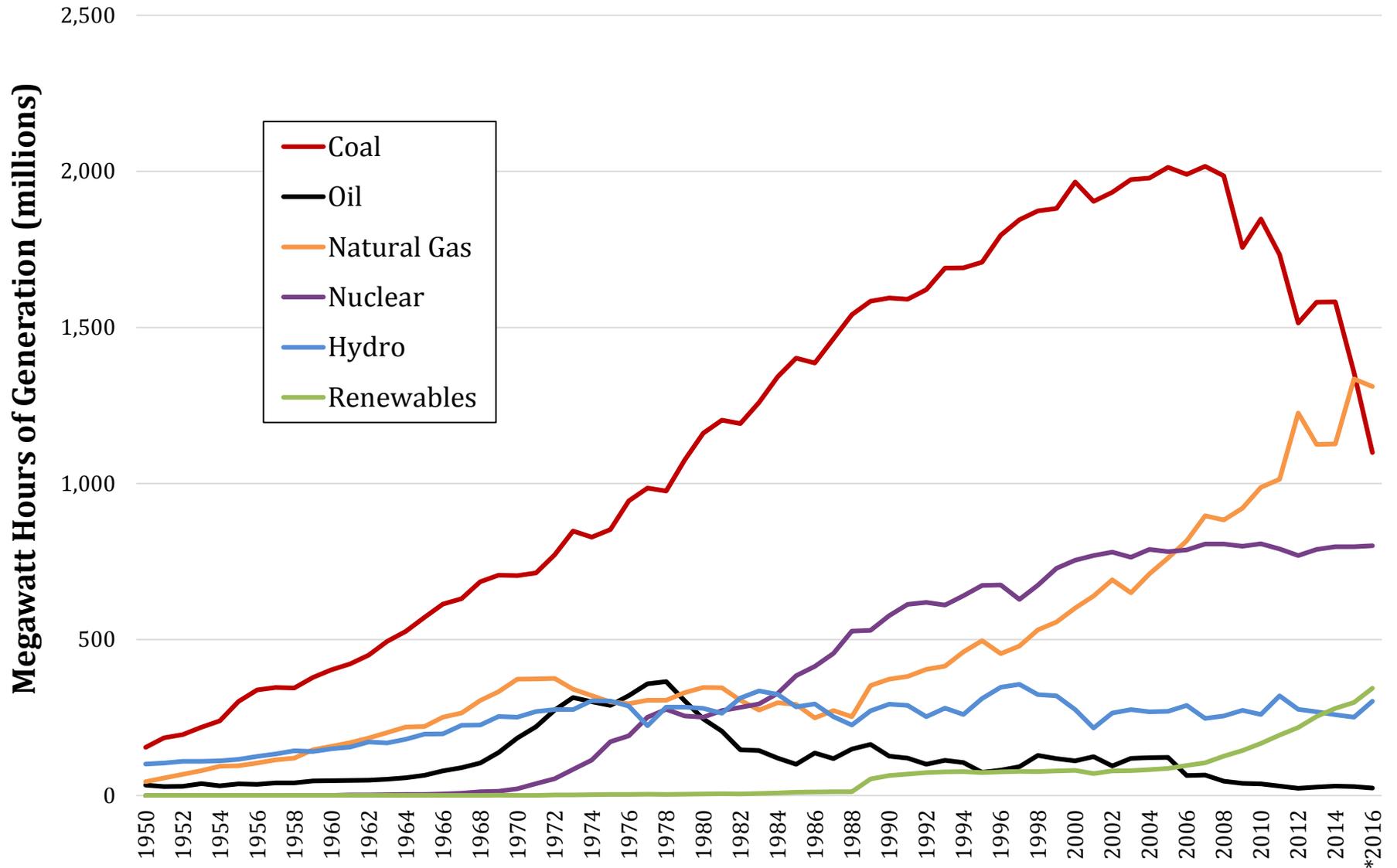


U.S. Net Generation by Market Share, 1950-2016



Source: U.S. Department of Energy, Energy Information Administration; *2016 data is an estimate

U.S. Net Generation by Resource, 1950-2016

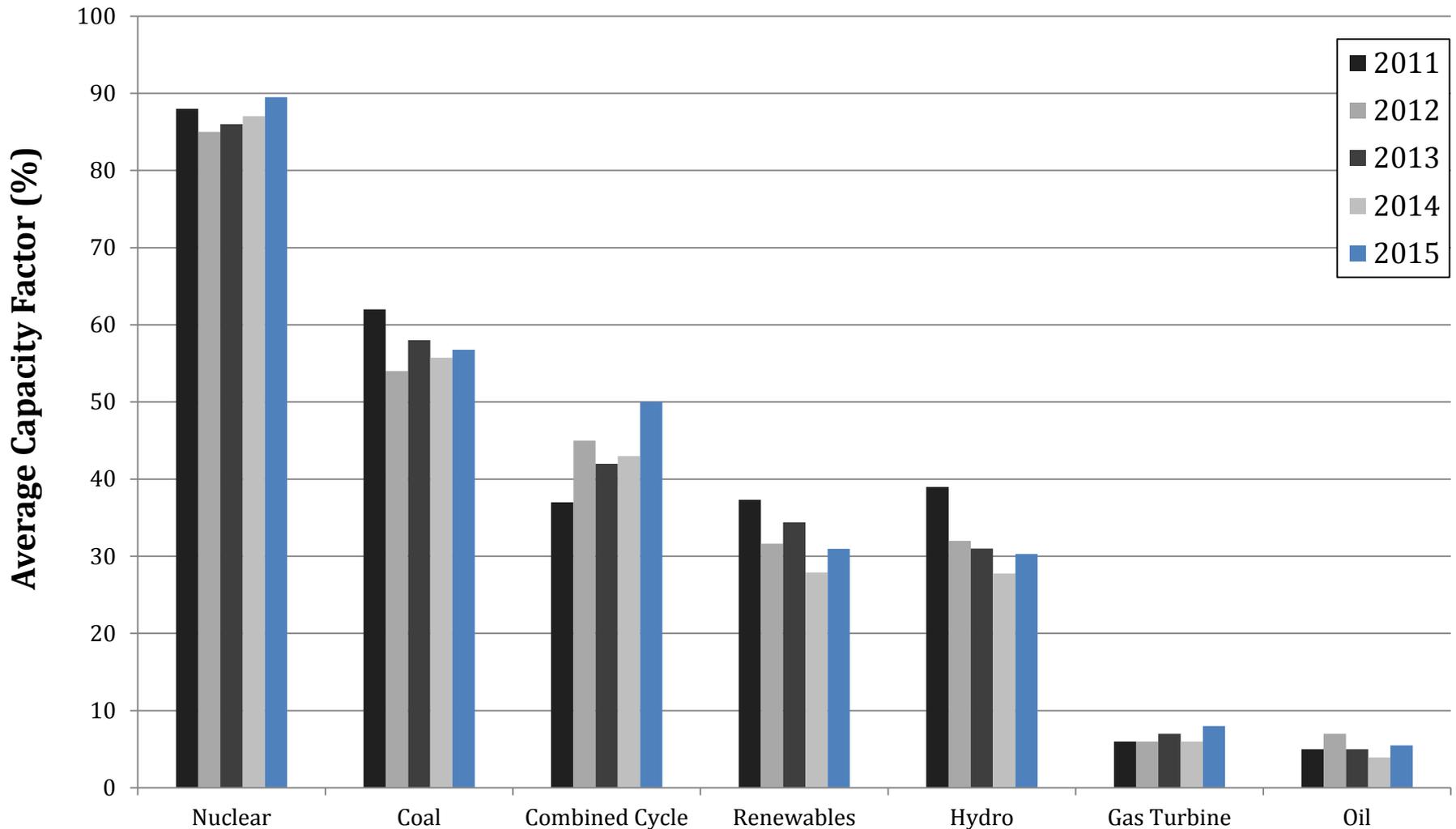


Source: U.S. Department of Energy, Energy Information Administration
 *2016 data is an estimate

Fig. 52

Average U.S. Capacity Factor by Resource, 2011-2015

The average capacity factor of a power plant is the ratio of actual output per year compared to the output of operating at full nameplate capacity



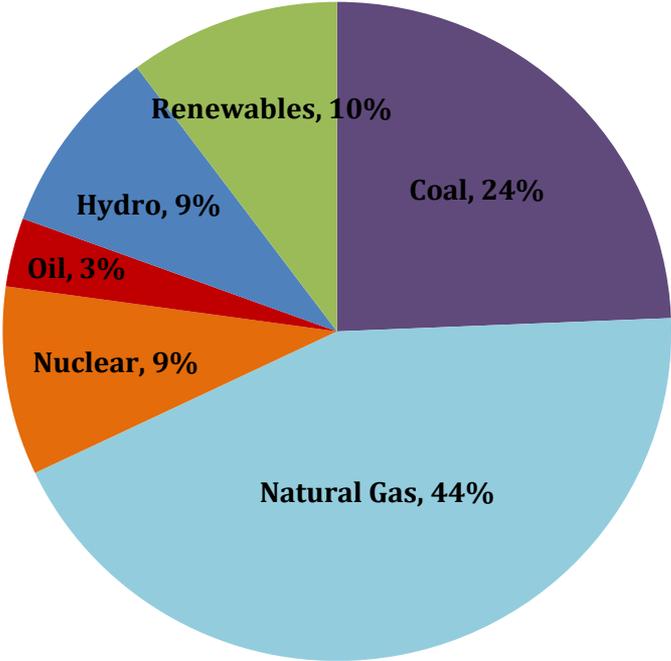
Source: SNL Energy

Fig. 53

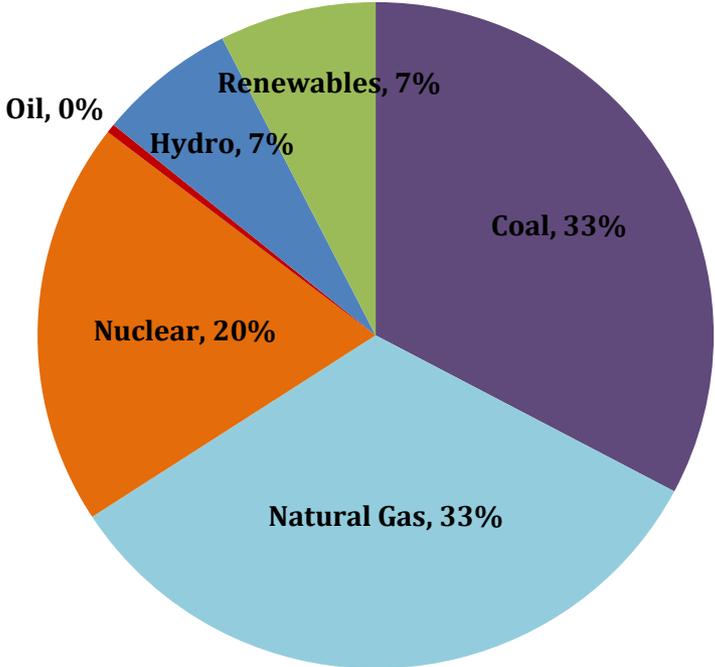
U.S. Nameplate Capacity and Net Generation, 2015

Available installed capacity compared to utilized capacity

U.S. Operating Nameplate Capacity
1.1 terawatts of installed capacity



U.S. Net Generation by Resource
4,065 terawatt hours of total generation



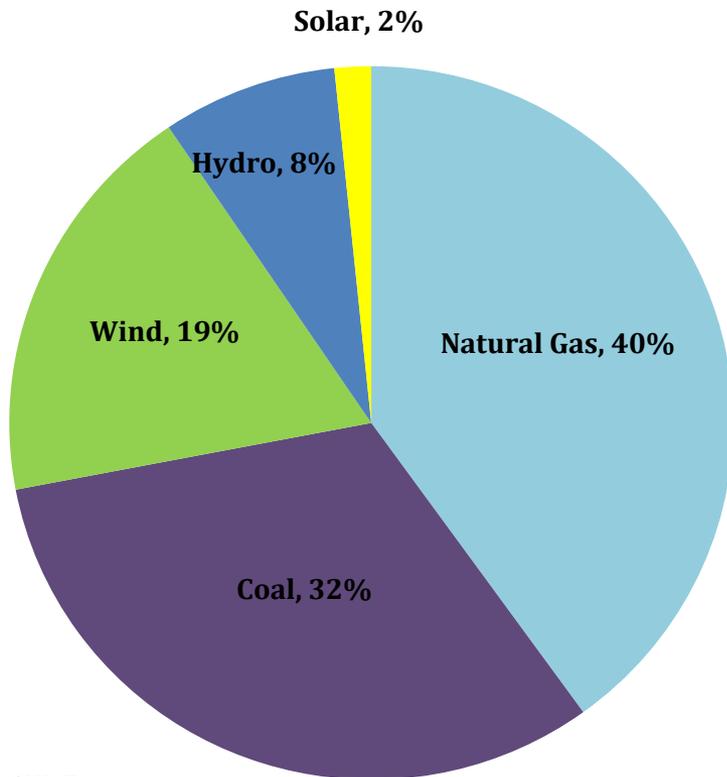
Source: SNL Energy, figures exclude idled power plants and distributed generation

Colorado Nameplate Capacity and Net Generation, 2015

Available installed capacity compared to utilized capacity

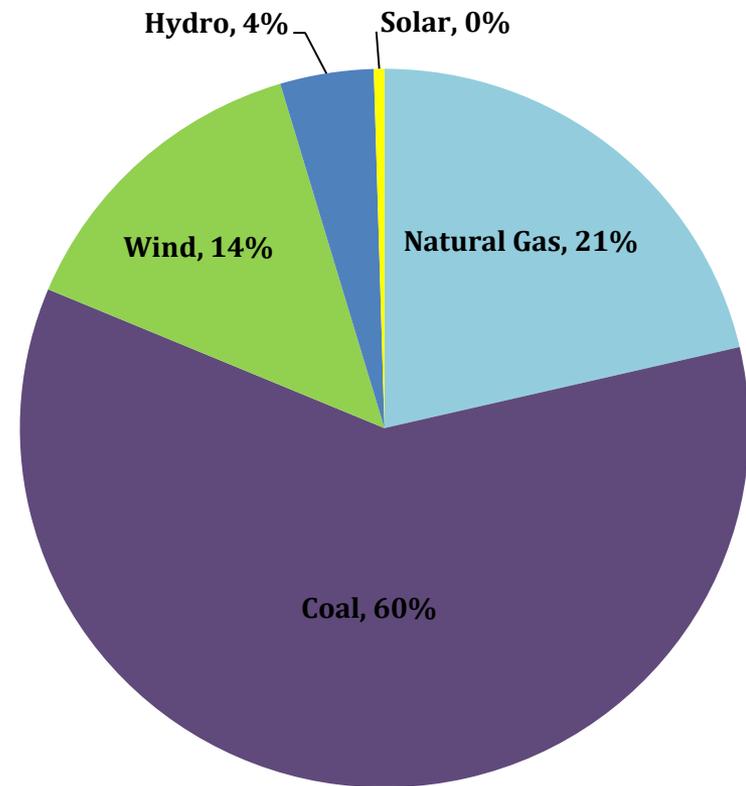
Colorado Operating Nameplate Capacity

16 gigawatts of installed capacity



Colorado Net Generation by Resource

53,112 gigawatt hours of total generation



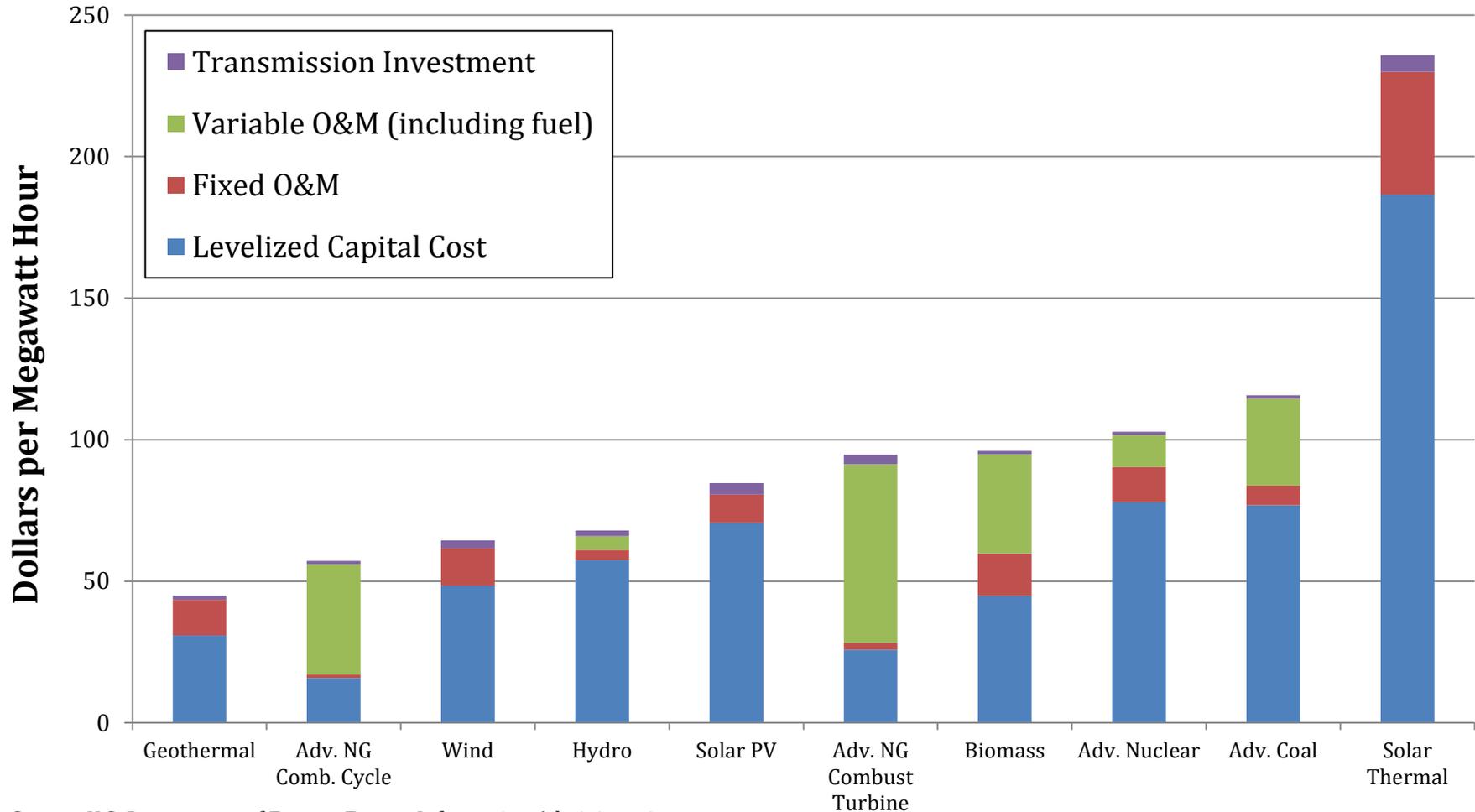
Source: SNL Energy

Note: Electricity use by sector - Industrial (28%), Residential (34%), Commercial (38%)

Note: Figures exclude idled power plants and distributed generation

Levelized Costs for Electric Generation Plants

Levelized (unsubsidized) costs for wind and solar photovoltaics is comparable to other resources when assuming a plant start date of 2022



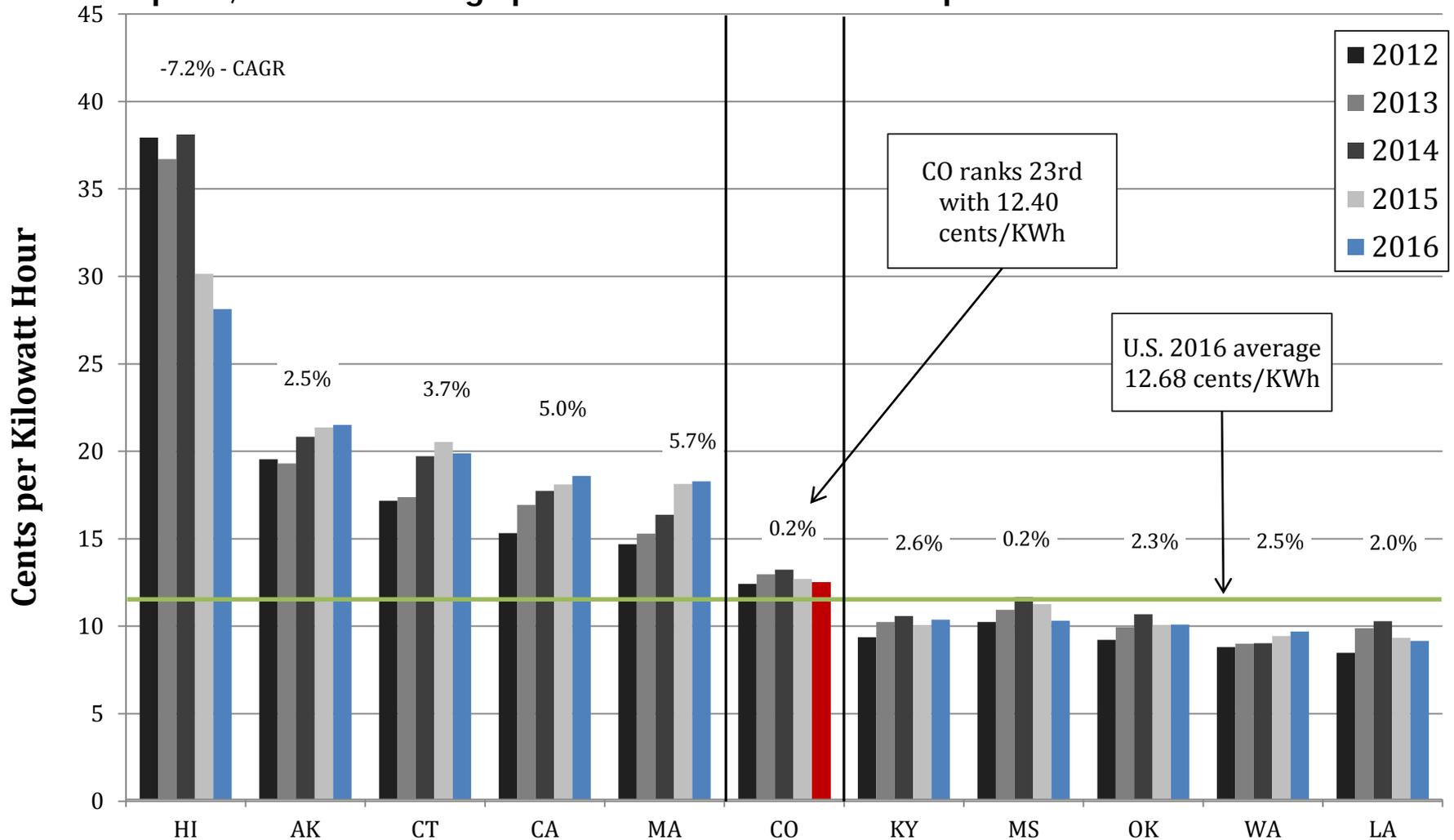
Source: U.S. Department of Energy, Energy Information Administration

Note: Assuming plant start data of 2022, the total levelized cost measures competitiveness of different generating technologies. 2022 is referenced due to the long lead time required for some technologies and projects; estimates expressed above will vary by region; levelized costs include transmission, fuel, operations, maintenance, and capital. Cost represents unsubsidized cost.

Fig. 56

Average Residential Summer Retail Electric Price, 2012-16

Top-5, Colorado, Bottom-5; Colorado has the 23rd-most expensive residential retail electricity price; the U.S. average price has increased at a 1.4 percent CAGR since 2012

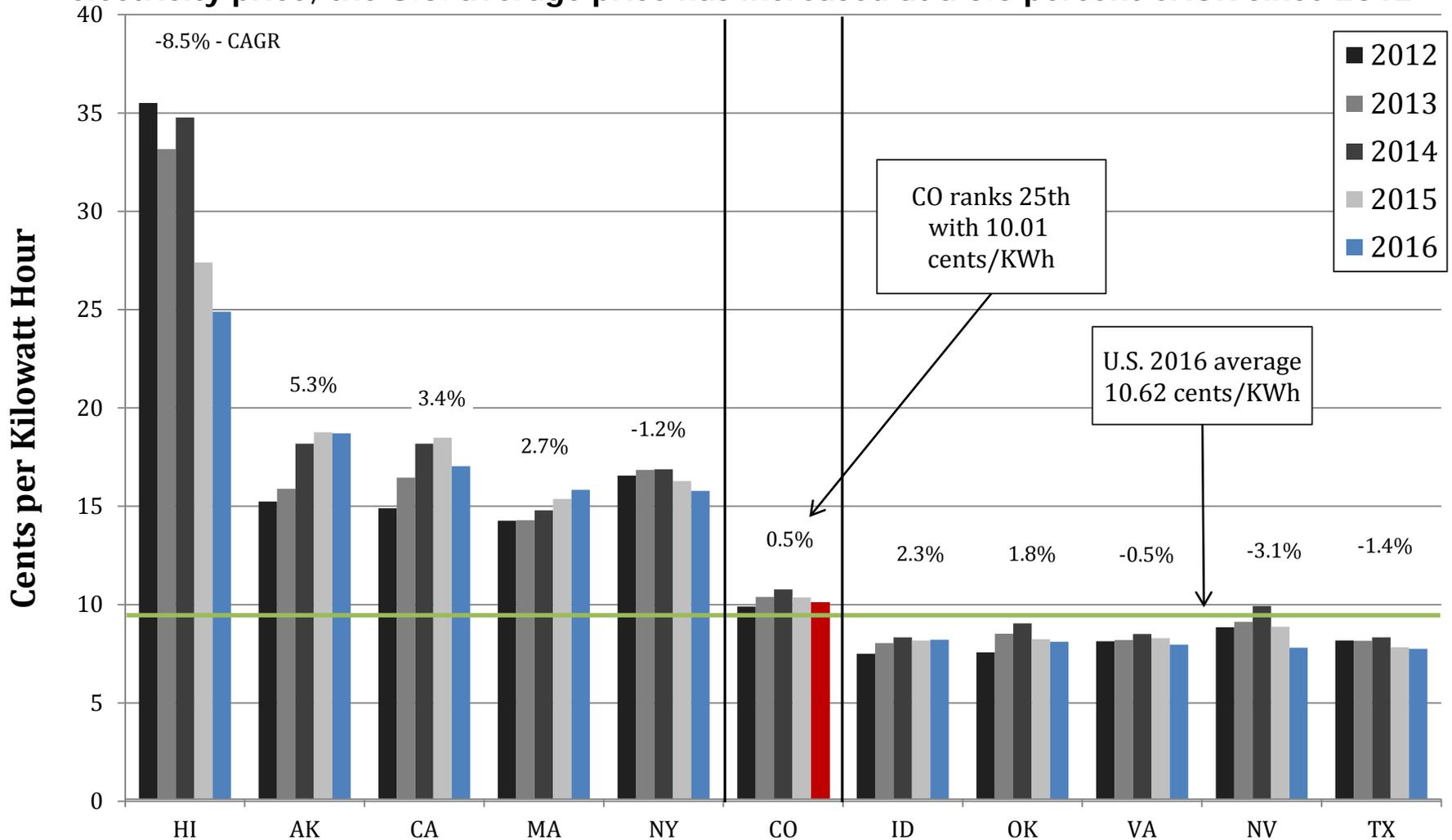


Source: U.S. Census; U.S. Department of Energy, Energy Information Administration

Note: Top-five and bottom-five states plus Colorado. Represents average price for July of each year; the compound annual growth rate (CAGR) reflects the 2012 to 2016 period.

Average Commercial Summer Retail Electric Price, 2012-16

Top-5, Colorado, Bottom-5; Colorado has the 25th most expensive commercial retail electricity price; the U.S. average price has increased at a 0.5 percent CAGR since 2012

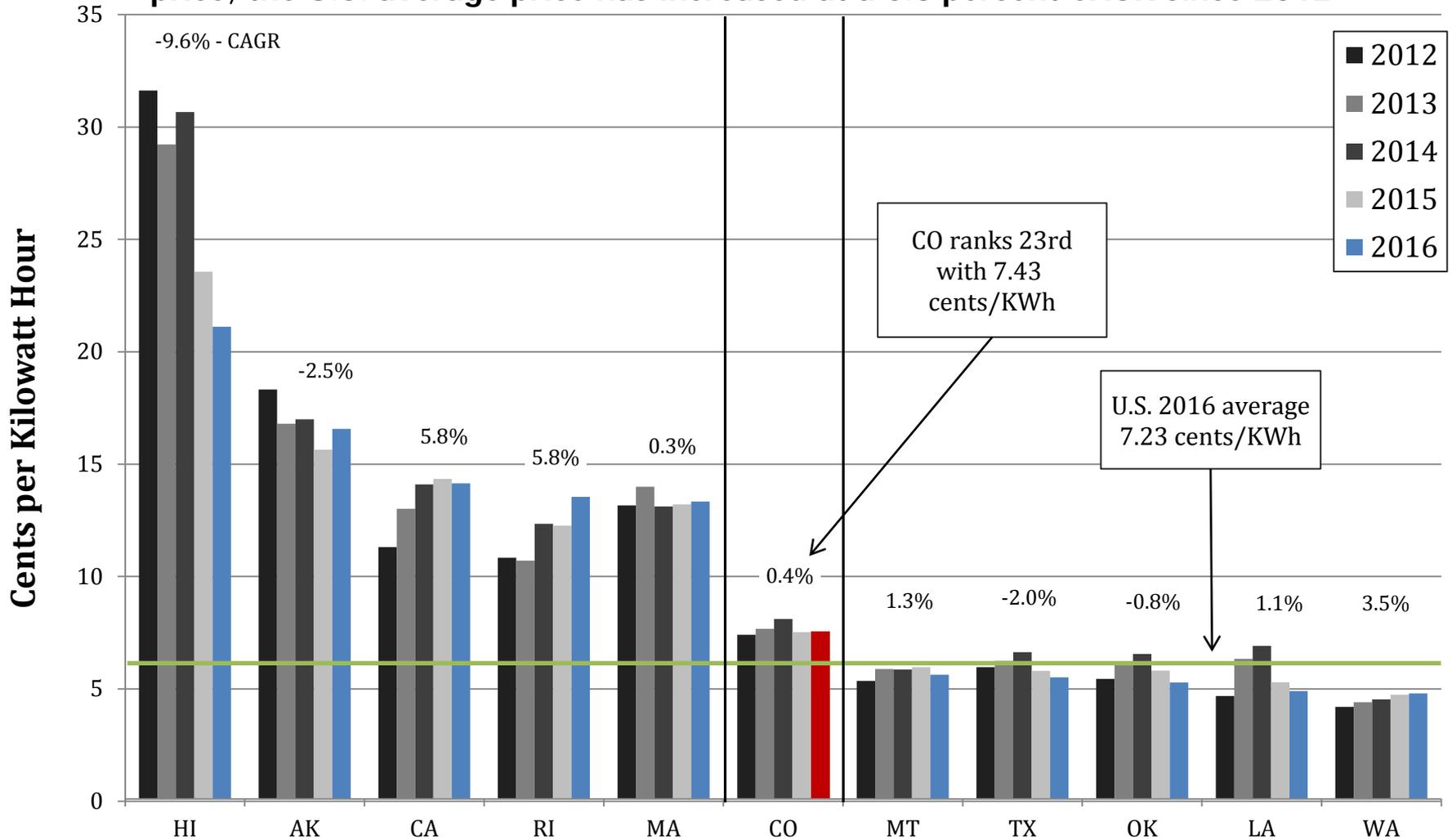


Source: U.S. Census; U.S. Department of Energy, Energy Information Administration

Note: Top-five and bottom-five states plus Colorado. Represents average price for July of each year; the compound annual growth rate (CAGR) reflects the 2012 to 2016 period.

Average Industrial Summer Retail Electric Price, 2012-16

Top-5, Colorado, Bottom-5; Colorado has the 23rd-most expensive industrial retail electricity price; the U.S. average price has increased at a 0.3 percent CAGR since 2012

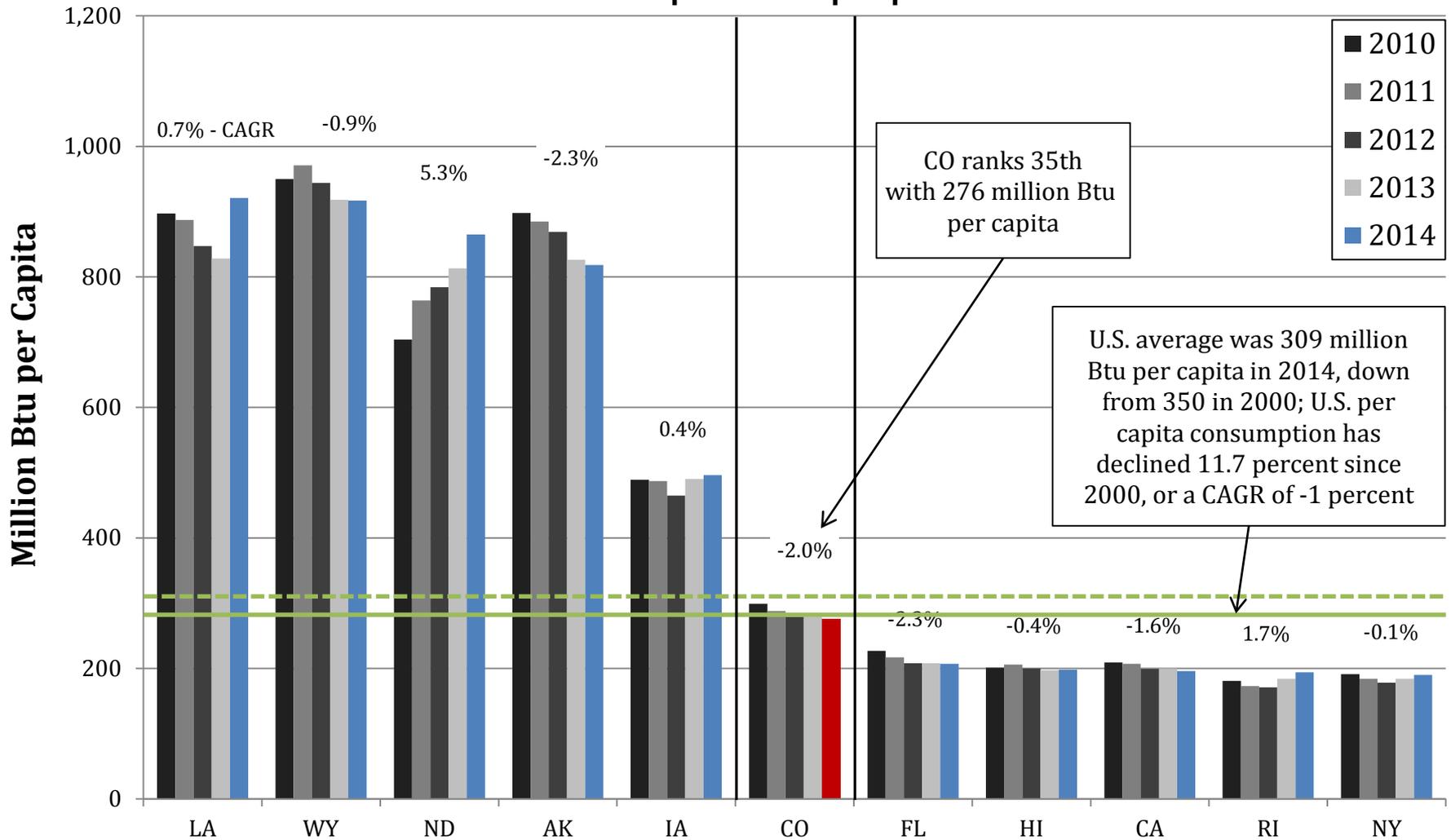


Source: U.S. Census; U.S. Department of Energy, Energy Information Administration

Note: Top-five and bottom-five states plus Colorado. Represents average price for July of each year; the compound annual growth rate (CAGR) reflects the 2012 to 2016 period.

U.S. per Capita Energy Consumption, 2010-2014

Top-5, Colorado, Bottom-5; Colorado has a low energy (Btu) consumption rate per person



Source: U.S. Department of Energy, Energy Information Administration

Note: Top-five and bottom-five states plus Colorado; dotted green line represents 2000 U.S. average, solid green line is 2014 average; the compound annual growth rate (CAGR) reflects the 2010 to 2014 period.

Emissions



Emissions

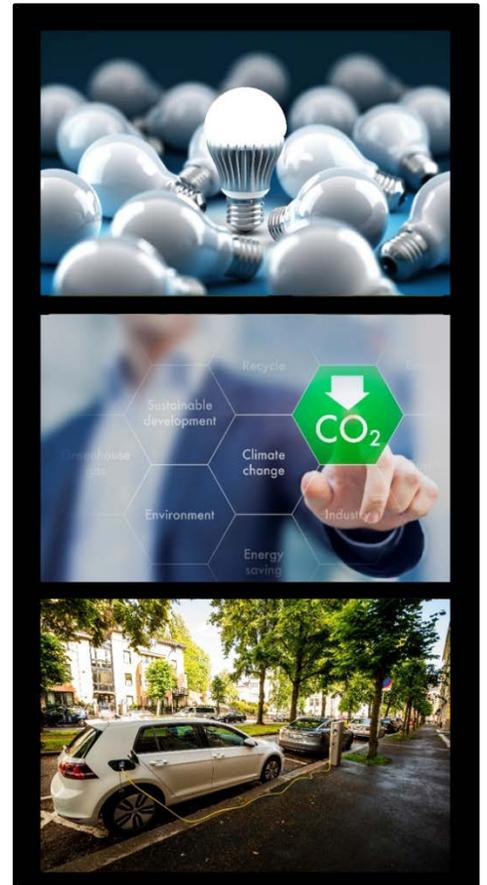
The United States is the world's second-largest CO₂ emitter per capita behind Saudi Arabia. However, annual U.S. emission totals are on the descent, falling from 21.2 metric tons per capita in 2000 to 17.1 metric tons per capita in 2015, according to the *BP Statistical Review of World Energy*.

On a total carbon emissions by country basis, the U.S. ranks second behind China. In 2015, China produced 9.2 billion metric tons of carbon, while the U.S. produced 5.5 billion metric tons. A distant third was India with 2.2 billion metric tons. It is important to note that China and the U.S. alone represent nearly 44 percent of global carbon emissions.

At the state level, Colorado ranked 25th in carbon emissions per capita in 2014 with 17 metric tons, which is a decrease from 20 metric tons in 2005 and 19 metrics tons in 2010.

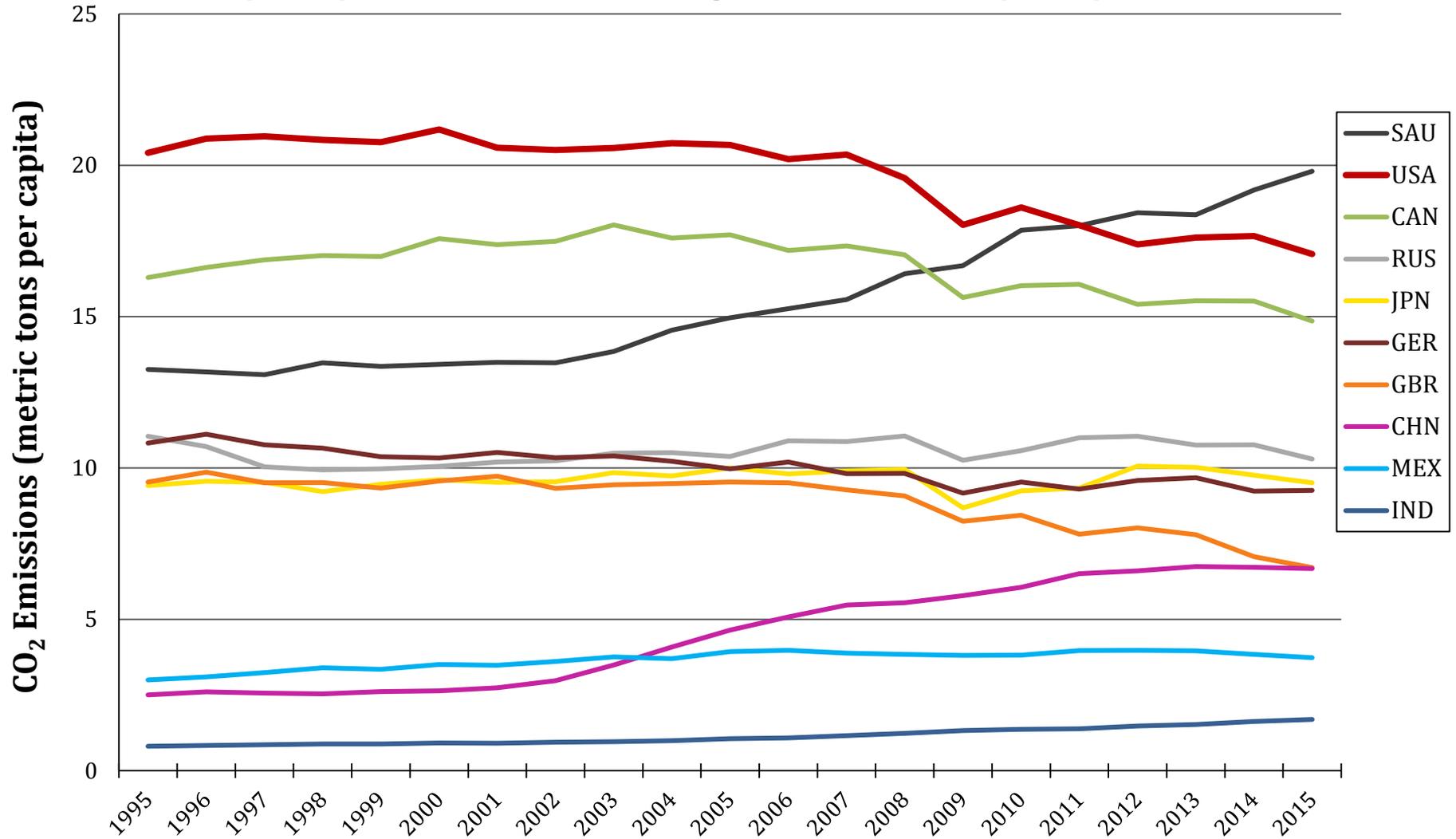
Interestingly, emission decreases are occurring across the country. Looking at these decreases through an economic lens proves fascinating. Many believe emission levels are tied to gross domestic product (GDP) declines and growth. However, while that may have been the case historically, the analysis of state CO₂ emission from fossil fuel combustion per \$1 million of state GDP shows a clear separation between economic growth and emissions. In fact, many states saw CO₂ emission peaks on a per capita basis between 2000 and 2005, while then uniformly experiencing emission decreases up through the Great Recession and recovery to 2014. As one example, Colorado CO₂ emissions dropped from 393 metric tons per \$1 million of state GDP in 2005, to 326 metric tons in 2014.

As more natural gas, renewable energy, energy efficiency technologies, alternative fuel vehicles, and healthy business and lifestyle changes take place, one can speculate this trend will continue.



Global CO₂ Emissions per Capita, 1995-2015

U.S. per capita emissions decreasing; 17.1 metric tons per capita in 2015

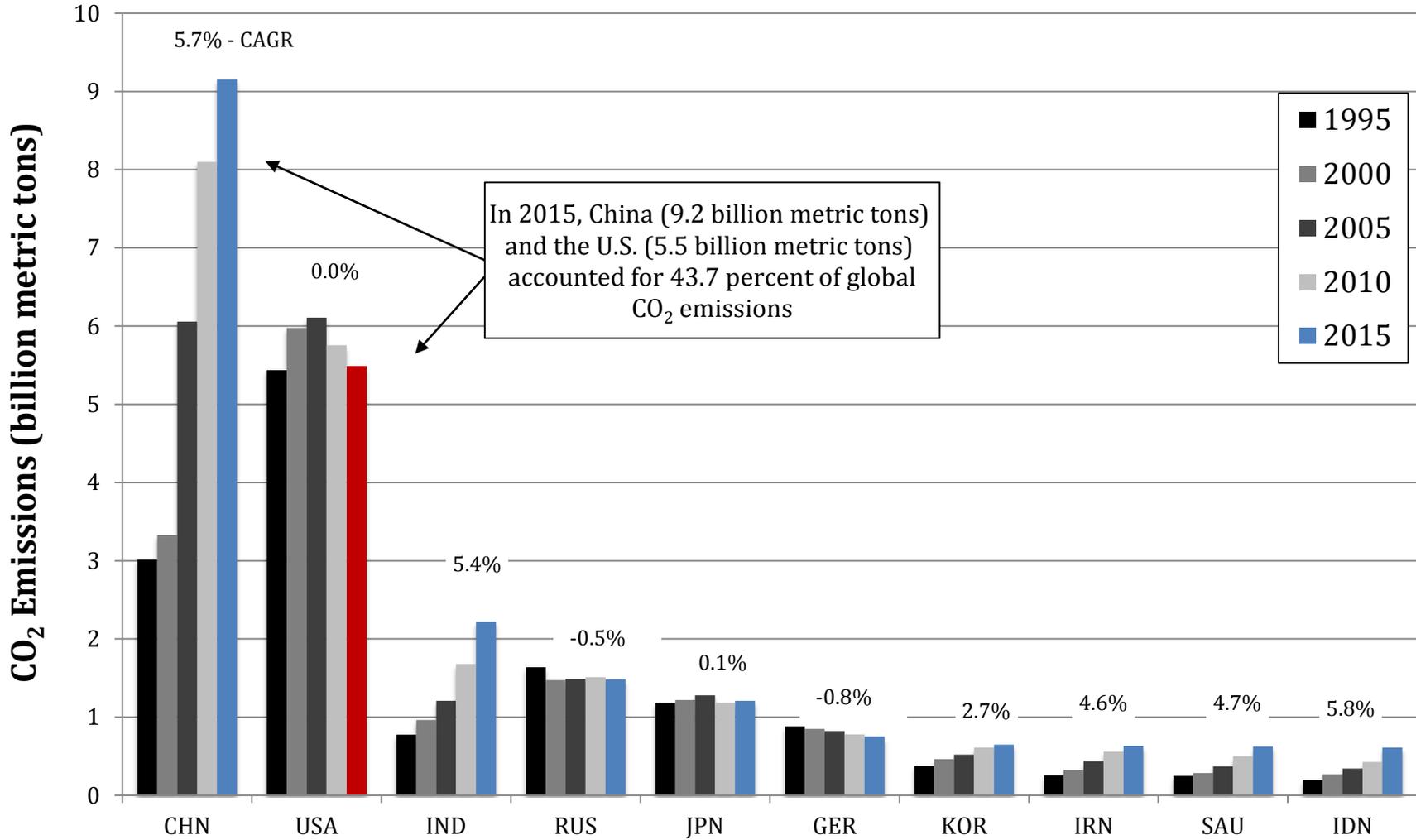


Source: BP Statistical Review; The World Bank

Note: Carbon emissions reflect consumption of oil, gas and coal, and are based on standard global average conversion factors. This does not include carbon that is sequestered, other sources of carbon emissions, or other greenhouse gases.

Global CO₂ Emissions by Country, 1995-2015

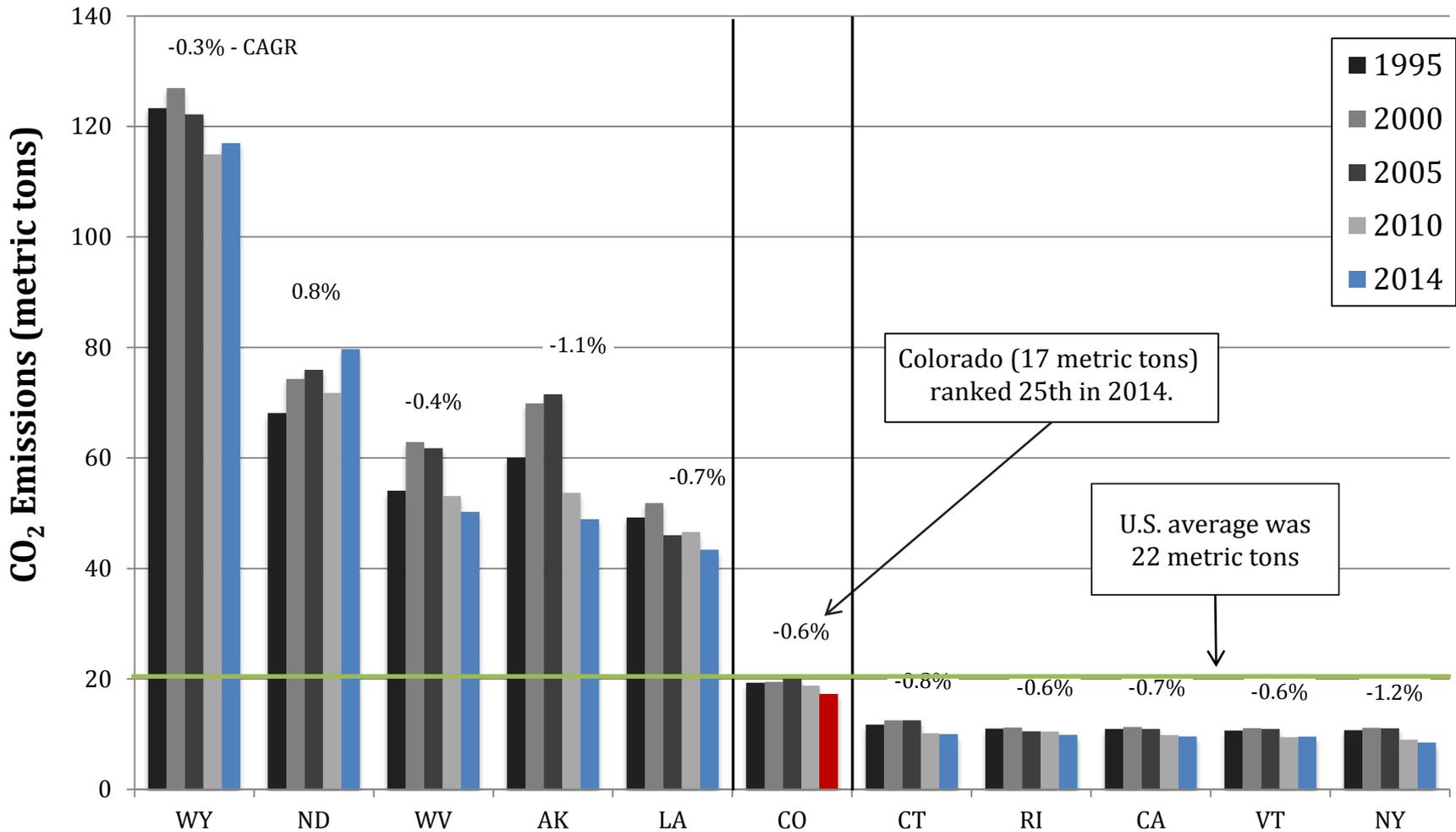
CO₂ accounts for approximately 80% of Global GHG emissions; Global energy related CO₂ emissions in 2015 were 33.5 billion metric tons



Source: BP Statistical Review Note: Carbon emissions reflect consumption of oil, gas and coal, and are based on standard global average conversion factors. This does not include carbon that is sequestered, other sources of carbon emissions, or other greenhouse gases; the compound annual growth rate (CAGR) reflects the 1995 to 2015 period.

State CO₂ Emissions per Capita, 1995-2014

Top-5, Colorado, Bottom-5; Colorado per capita emissions decreasing

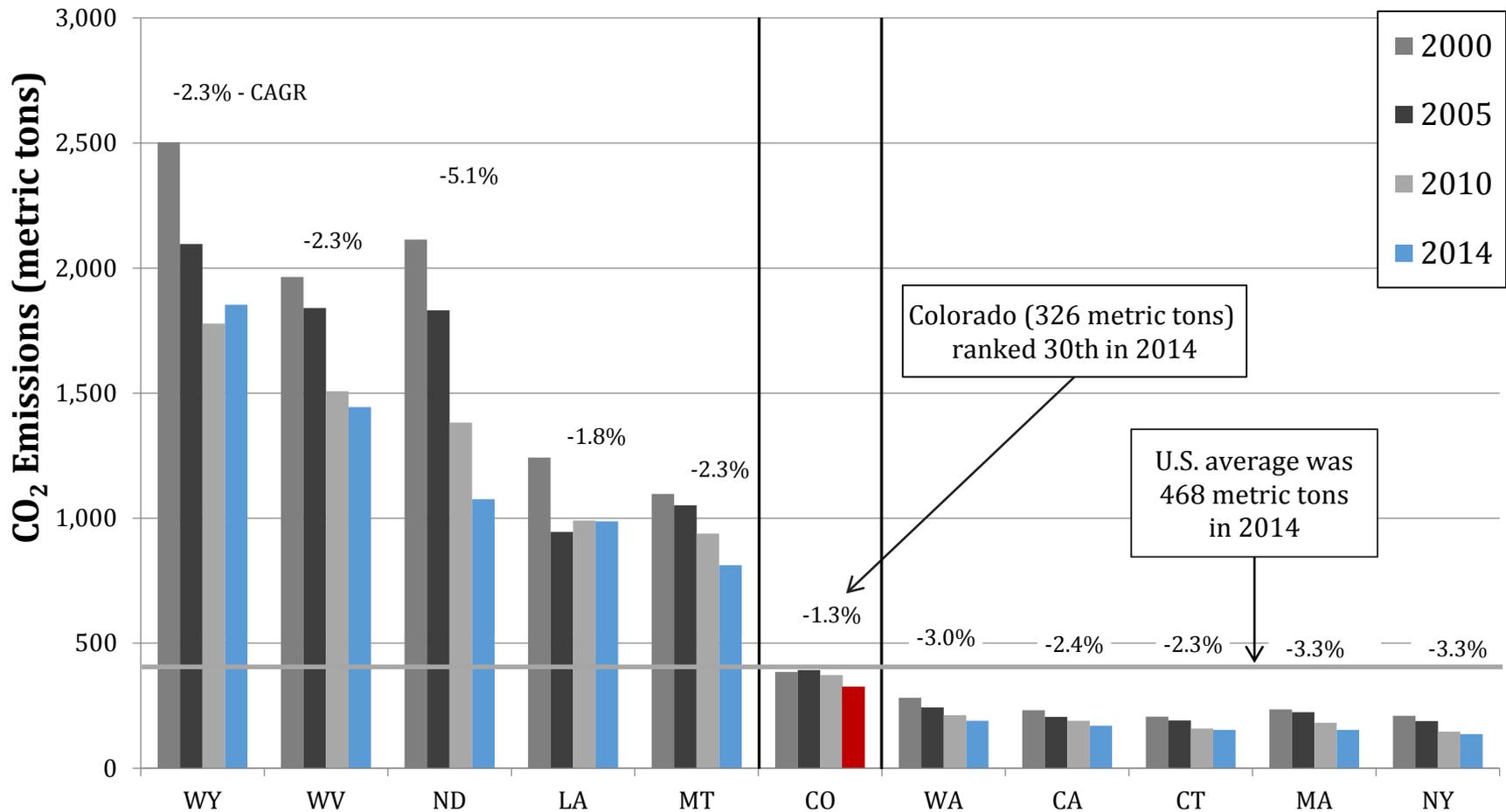


Source: Energy Information Administration; U.S. Census Bureau; U.S. Environmental Protection Agency

Note: Top-five and bottom-five states plus Colorado. CO₂ emissions from fossil fuel combustion only; the compound annual growth rate (CAGR) reflects the 1995 to 2014 period.

State CO₂ Emissions from Fossil Fuel Combustion per \$1M State GDP, 2000-2014

Top-5, Colorado, Bottom-5; Decreasing CO₂ emissions per \$1M of state GDP is an indicator of changing economic activity and energy efficiency



Source: Energy Information Administration Note: Top-five and bottom-five states plus Colorado. CO₂ emissions from fossil fuel combustion only; the compound annual growth rate (CAGR) reflects the 2000 to 2014 period.

Fig. 64

Policies & Programs



Policies & Programs

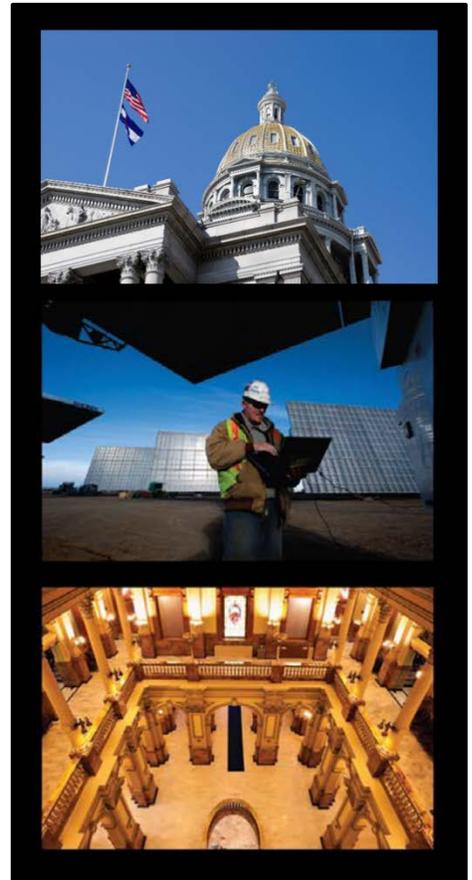
The United States lacks a comprehensive national energy policy. Instead, our country draws from a variety of federal policies that often have short- to medium-term shelf lives. Those policies influence the nation's research and development communities, support the construction and retirement of power generation facilities, instruct energy development processes on public lands, incentivize commercialization of new technologies, and support many other energy-related activities.

States also provide their own policy layer, forging creative solutions and collaborative approaches to energy development. Over time, successful state policies reveal national trends and identify which states are leading the pack. For example, 37 states have renewable portfolio standards (RPS) or goals, while 47 states have implemented net metering requirements, voluntary programs, or distributed generation compensation rules.

Colorado requires investor-owned utilities (IOUs) to adopt demand-side management programs to drive electricity savings and reduce peak demand. Colorado's 30 percent Renewable Portfolio Standard (RPS) by 2020 for IOUs, 20 percent by 2020 for qualifying rural electric cooperatives, and 10 percent by 2020 for qualifying municipalities, is arguably one of the more aggressive in the nation. Colorado's net metering policy requires IOUs to permit property owners to install distributed generation systems up to 120 percent of their average annual electric consumption, rebating or paying those property owners when excess onsite generation occurs. These policies and others actively drive many renewable energy and energy efficiency investments in Colorado.

On the fossil fuel front, Colorado maintains lower state gasoline taxes than most states. At 22 cents per gallon, Colorado ranks 40th, placing well below the national average of 30.5 cents per gallon. Colorado last raised its gas tax in 1991, while the federal gas tax was last raised to 18.4 cents in 1993. As new infrastructure investment conversations take place, Coloradans will need to consider raising the gas tax or look at other funding options.

Policy conversations also surround the use of public lands for energy development, and more than 35 percent of Colorado falls into the public lands category. Consequently, Colorado ranks fourth in the number of public acres leased for oil, gas, and mineral development. New federal and state regulations that ease or restrict development on public lands always have a significant impact on Colorado's energy industry.

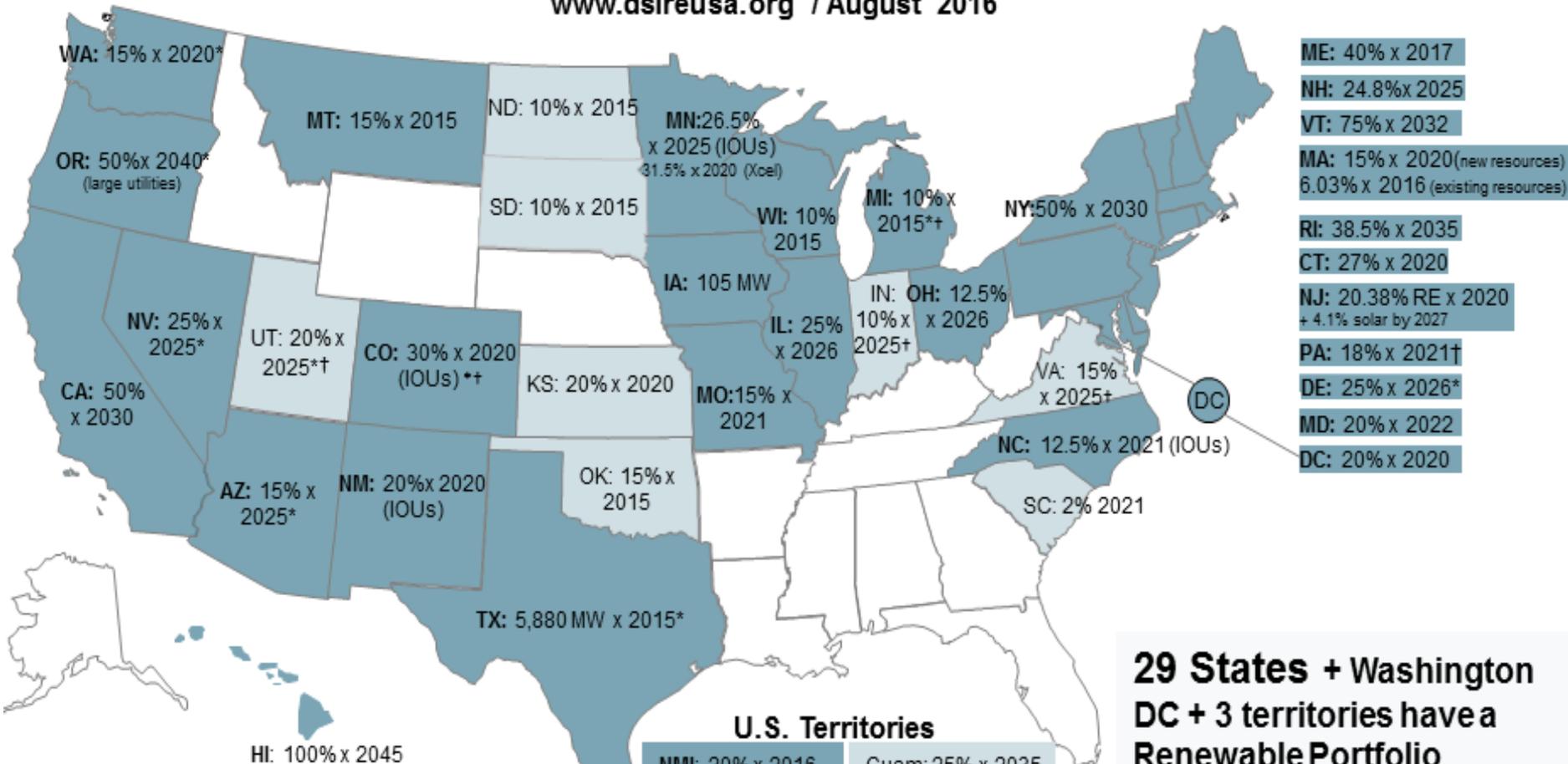


Finally, sustainable water use is another priority for Coloradans and citizens throughout the arid Rocky Mountain West. According to the Colorado Division of Water Resources, between 2011 and 2015, Colorado's water utilization profile consists of the following: agriculture at 86.5 percent, municipal 5.8 percent, recreation and fisheries 4.9 percent, and other at 2.7 percent. Taking a closer look at the "other" category, minimum stream flow makes up 1.7 percent of total Colorado water utilization, large industry 0.4 percent, thermoelectric power generation 0.28 percent, hydraulic fracturing 0.09 percent, wildlife 0.09 percent, snowmaking 0.03 percent, and other energy development 0.05 percent. Industrial water efficiency improvements, recycling, and reuse technologies are worthwhile pursuits, but it is important to keep resource utilization amounts in mind when discussing Colorado's water policies and regulations.

Renewable Energy Policies, 2016

Colorado has a Renewable Portfolio Standard (RPS) of 30 percent by 2020 for investor-owned utilities, 20 percent by 2020 for rural cooperatives, and 10 percent by 2020 for large municipalities

www.dsireusa.org / August 2016



29 States + Washington
DC + 3 territories have a
Renewable Portfolio
Standard
(8 states and 1 territories have
renewable portfolio goals)

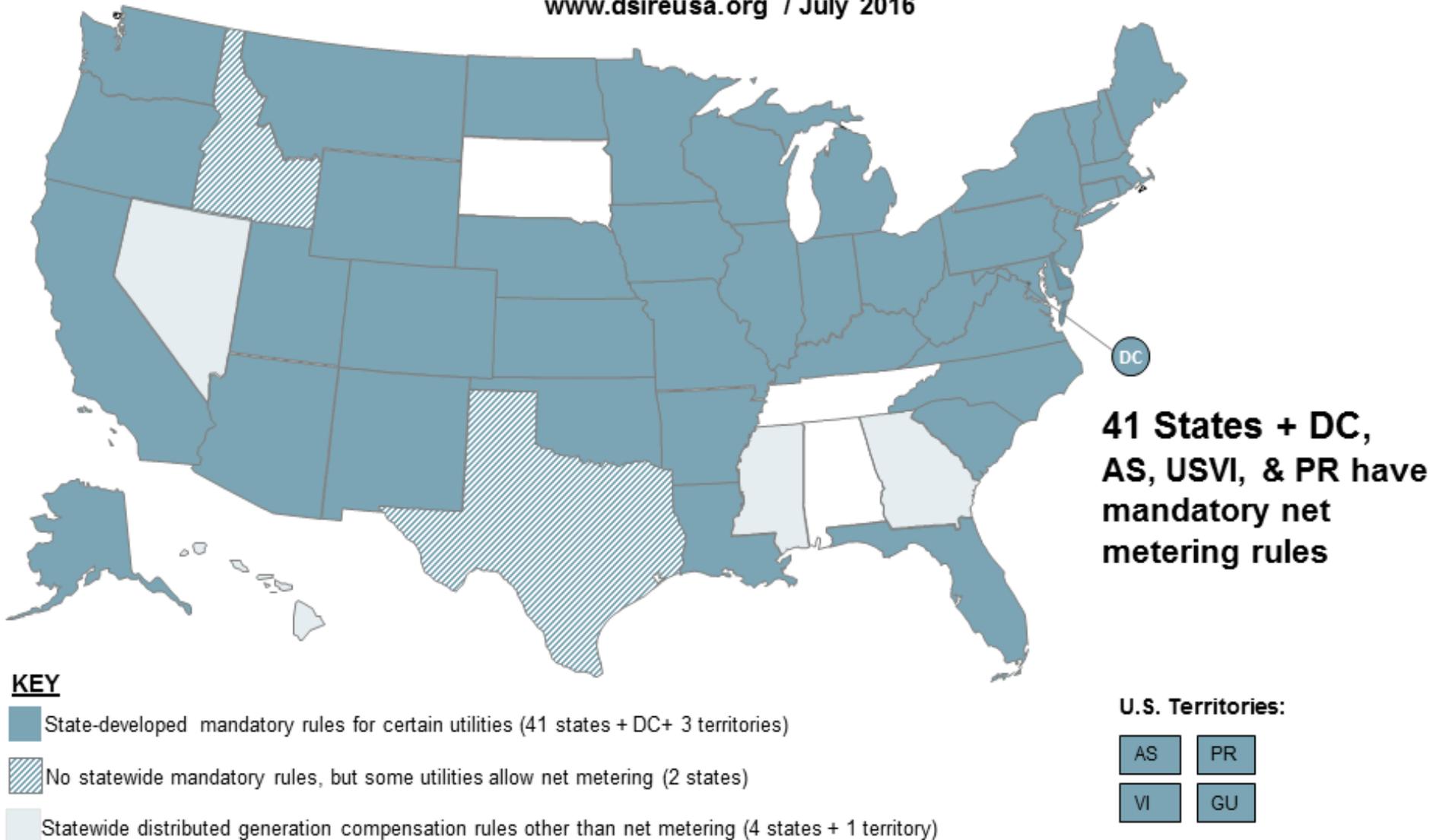
Note: In 2013, RPS statutes for Colorado's rural electric cooperatives were increased to 20% by 2020. In 2010, RPS statutes for Colorado's investor owned utilities were increased to 30% by 2020.

- Renewable portfolio standard
- Renewable portfolio goal
- *** Extra credit for solar or customer-sited renewables
- †** Includes non-renewable alternative resources

Net Metering Policies, 2016

Colorado requires a customer's excess generation be reimbursed by their utility; policy debates in other states may halt or alter this practice

www.dsireusa.org / July 2016

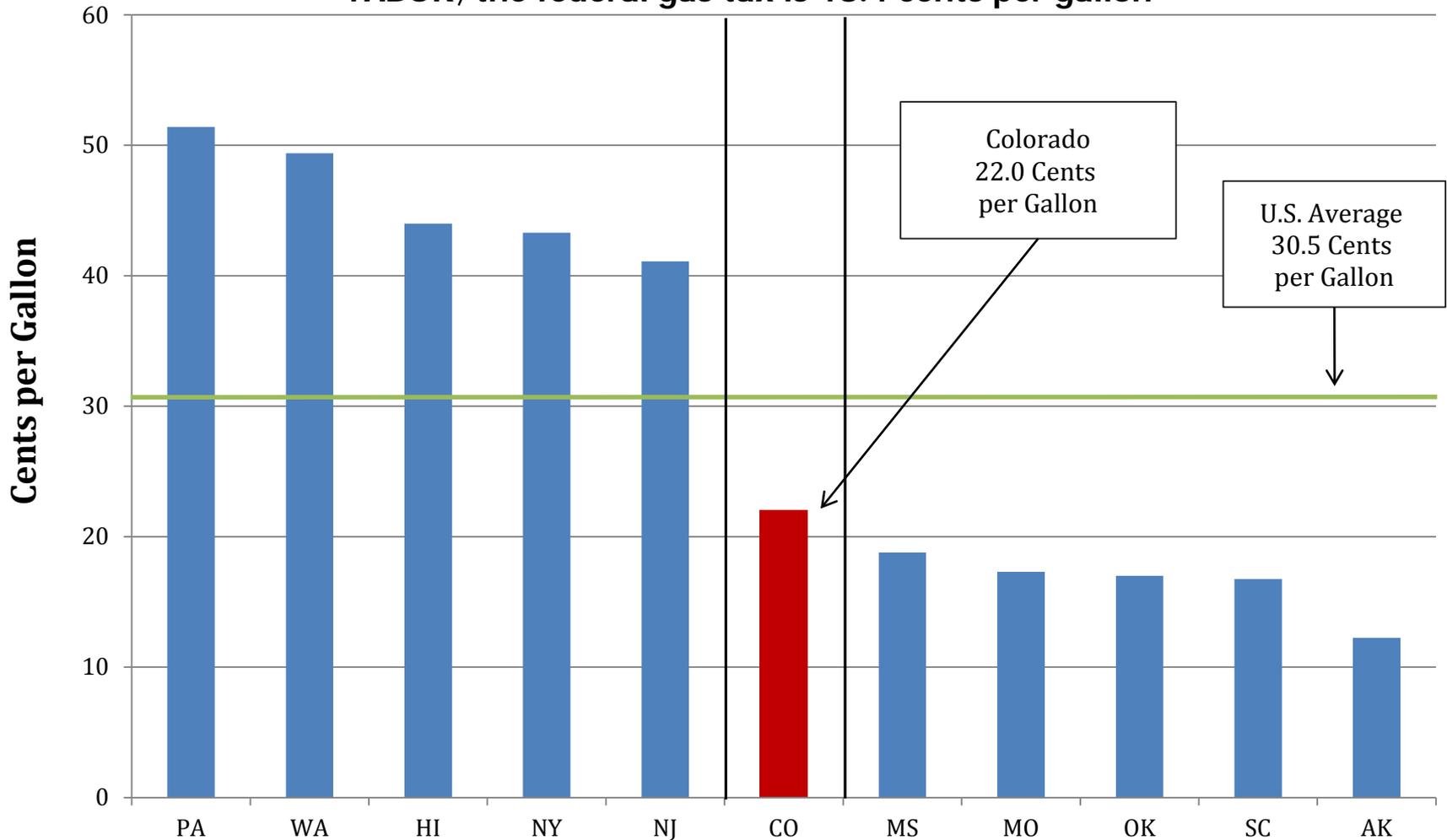


Note: Colorado IOU customers are permitted to install distributed generation systems and meter up to 120% of the customer's average annual consumption. Colorado municipality and co-op customers are permitted to install distributed generation systems up to 25 kW for non-residential and 10 kW for residential.

Fig. 66

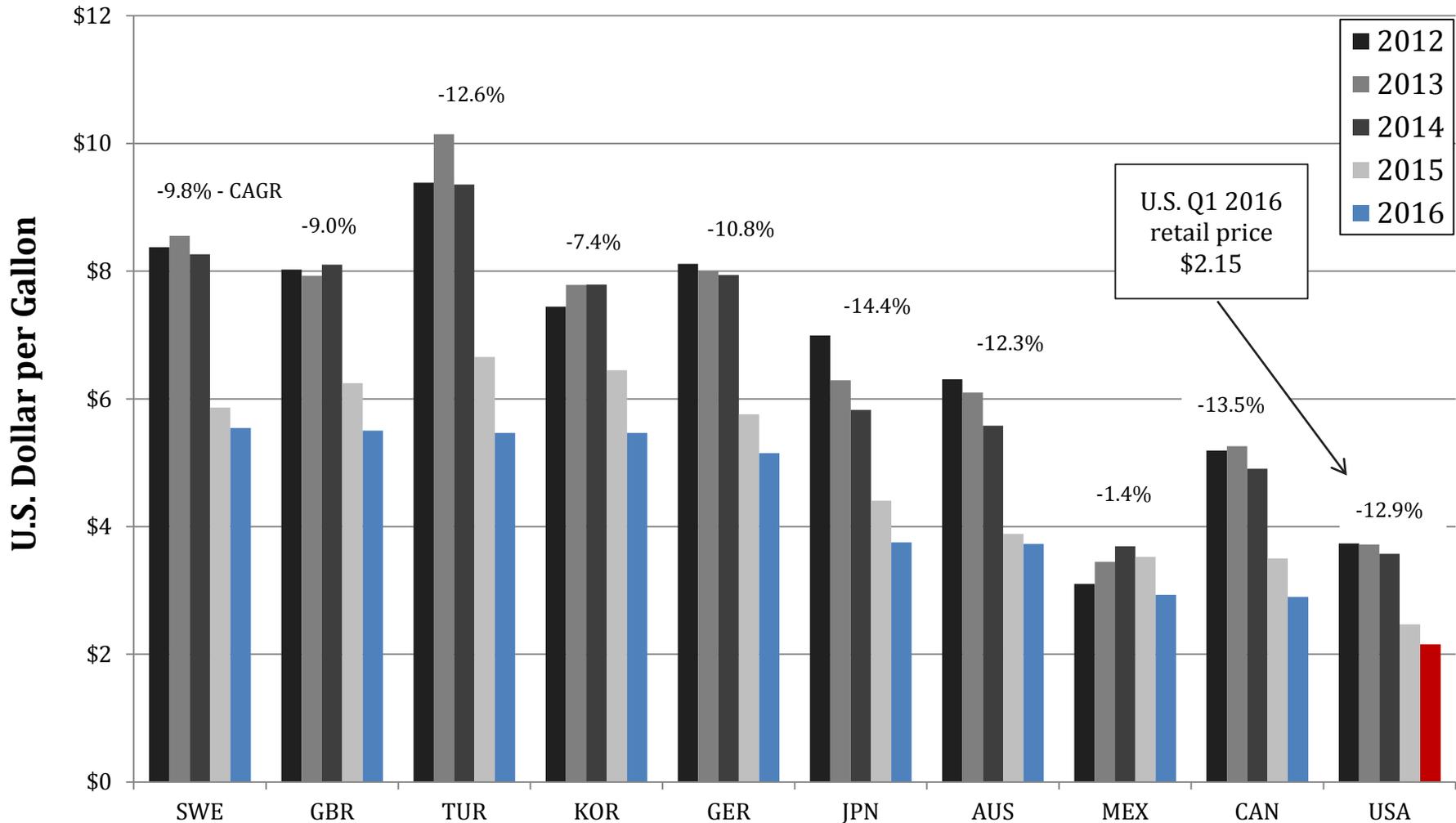
State Gasoline Tax, 2016

Top-5, Colorado, Bottom-5; Colorado ranks 40th nationally; the state gas tax last increased in 1991; any new increase requires voter approval due to TABOR; the federal gas tax is 18.4 cents per gallon



Global Retail Prices of Premium Unleaded, 2012-2016

U.S. gasoline is inexpensive compared to most developed countries;
fuel taxes contribute to higher prices around the world



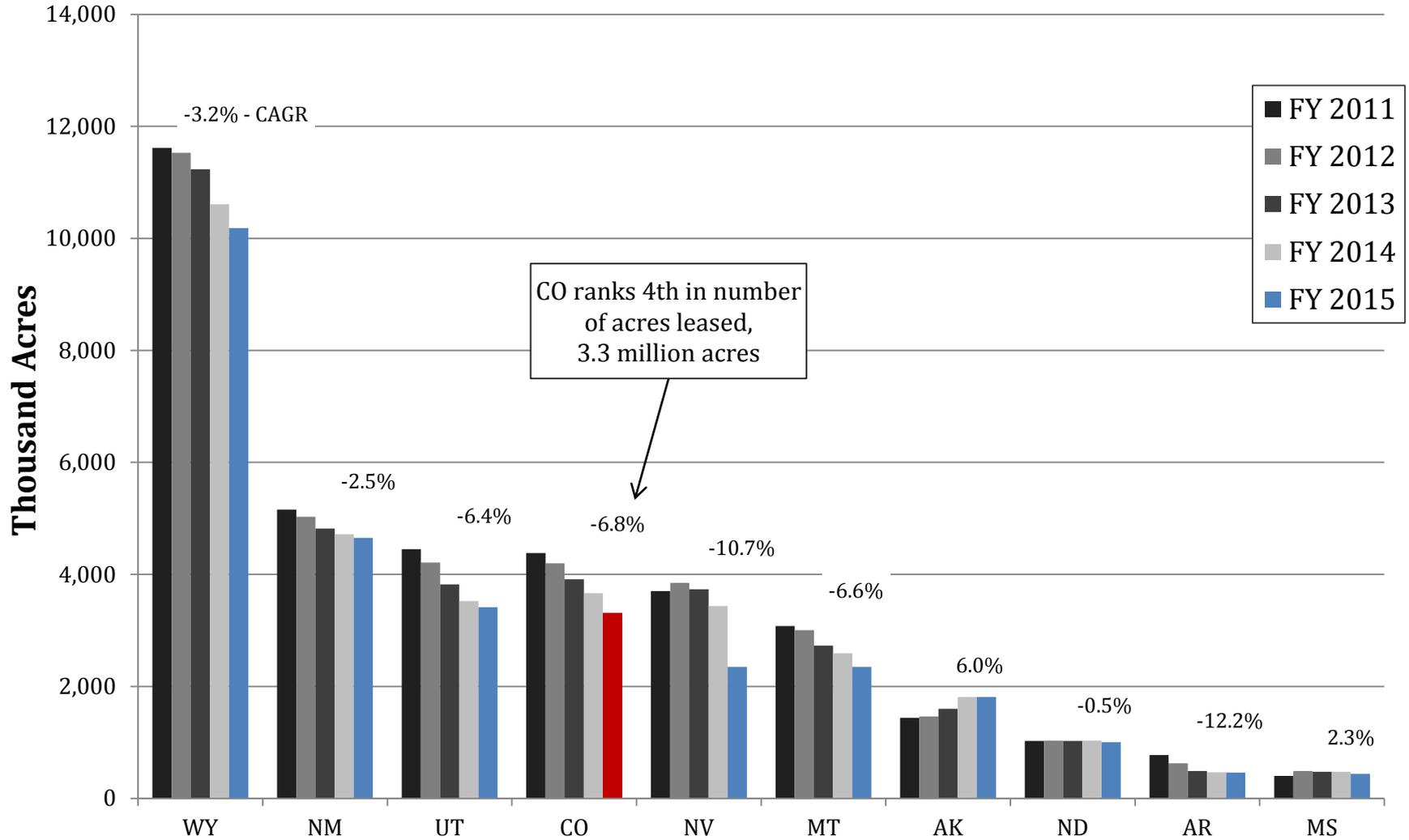
Source: International Energy Agency, Key World Energy Statistics

Note: Gasoline prices are from 1st quarter of each year; countries chosen to reflect various regional markets; the compound annual growth rate (CAGR) reflects the 2012 to 2016 period.

Fig. 68

Acres Leased for Drilling on Federal Lands

Colorado has 4th-highest number of acres leased; lower commodity prices and increased oil and gas activity on private lands contributes to nationwide decrease



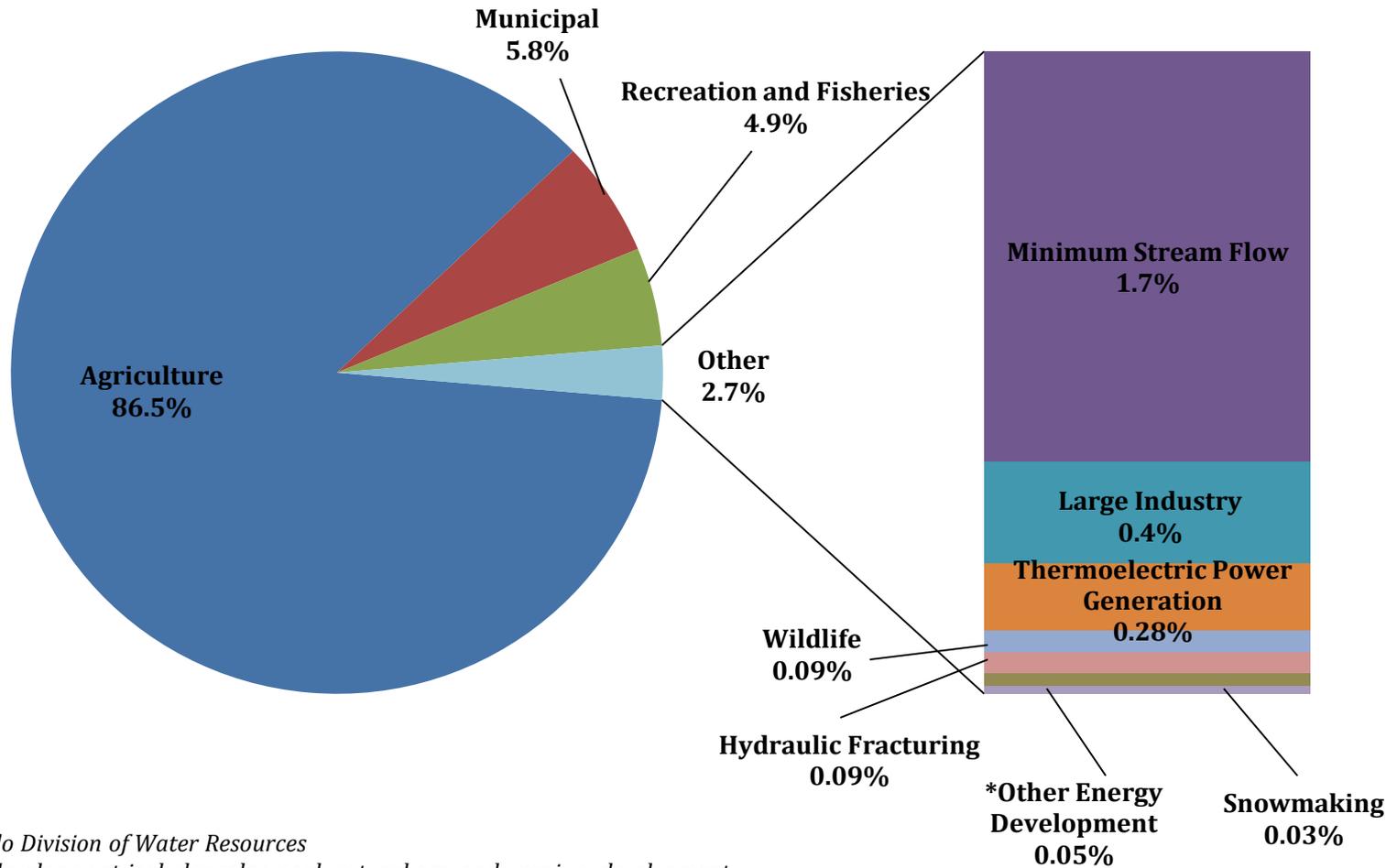
Source: Bureau of Land Management, Public Lands Statistics

Note: Number of acres under lease as of the last day of the fiscal year; the compound annual growth rate (CAGR) reflects the 2011 to 2015 period.

Fig. 69

Colorado Water Utilization by Sector, 2011-2015

Agriculture uses the majority of Colorado water; energy sector consumes less than 1% of total



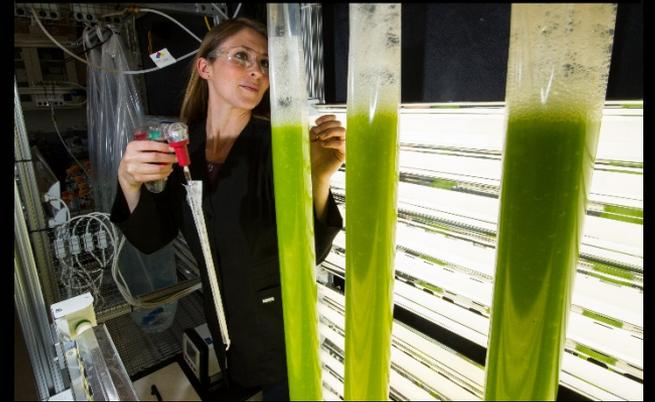
Source: Colorado Division of Water Resources

*Other energy development includes solar, coal, natural gas, and uranium development

Note: A small margin of error should be noted when analyzing final results. Total water amounts and percentages will vary slightly from year-to-year based on supplies from varying snowpack and demands resulting from varying climatic conditions.

Fig. 70

Employment & Industry



Employment & Industry

The energy industry is a key employment cluster in Colorado. The state possesses an abundance of resources, forward-looking state policies, strategic R&D facilities, and a culture of collaborative partnerships.

The fossil fuels and cleantech sectors epitomize Colorado's leadership. In 2016, the fossil fuels sector directly employed 44,370 workers, and the cleantech sector directly employed 26,270 workers. These 70,640 direct energy workers support an additional 204,120 indirect workers across the state, for a total of 274,760 energy industry employees statewide.

The 2016 economic impact of these energy industry employees was \$14.9 billion.

As of 2014, the energy industry represented 9.6 percent of Colorado's Gross Domestic Product. That amounts to \$25.6 billion for all energy goods and services produced in the state.

Colorado average annual salaries for both cleantech and fossil fuels jobs historically trend above national averages. In 2015, average fossil fuels salaries in Colorado were \$106,996, while nationally they were \$101,672. While Colorado fossil fuels wages consistently remain above the national average, Colorado cleantech salaries recently dipped below the national average. In 2015, average Colorado cleantech salaries were \$79,100, while nationally they were \$79,358.

Energy salaries are high, but energy costs are low for Colorado consumers. According to WalletHub's *2016 Most & Least Energy-Expensive States*, Coloradans spend an average of \$235 on total energy costs every month, which is the second-lowest in the nation.

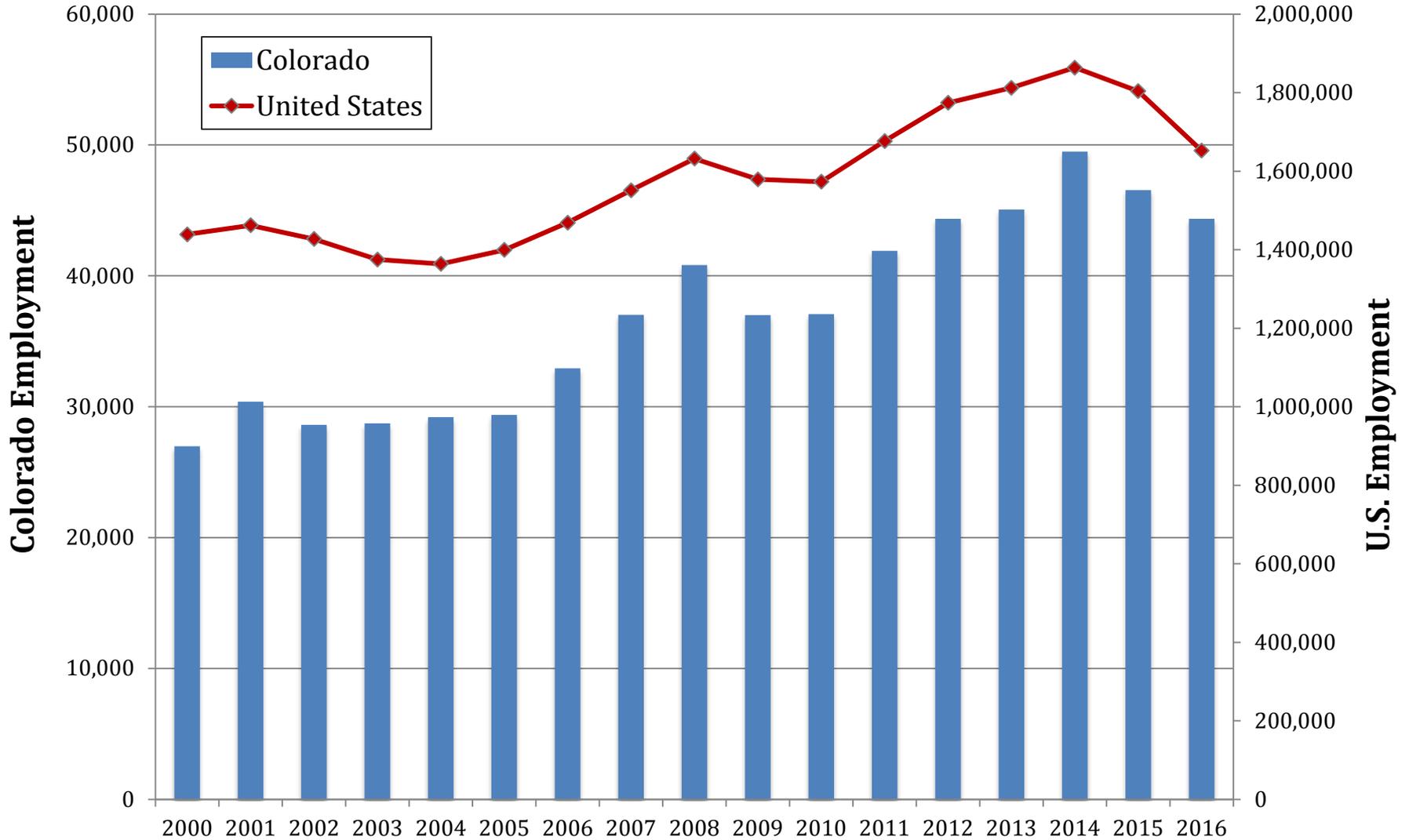
There are strengths on all sides of the energy equation that make Colorado a balanced energy leader. Colorado's energy diversity fuels competition, drives innovation, and spurs new investment, making it the Balanced Energy Capital of the West.

Note: *Resource Rich Colorado* focuses on Colorado's core energy resource assets, and complements the Metro Denver EDC's *Energy Industry Cluster Study*, which highlights employment, companies, wages, and industry trends in Colorado's energy sector. The information in this section comes directly from the *Energy Industry Cluster Study*, released annually in January and available on the Metro Denver EDC's website, www.metrodenver.org.



Fossil Fuels - Number of Employees

Colorado fossil fuels employed 44,370 direct workers in 2016

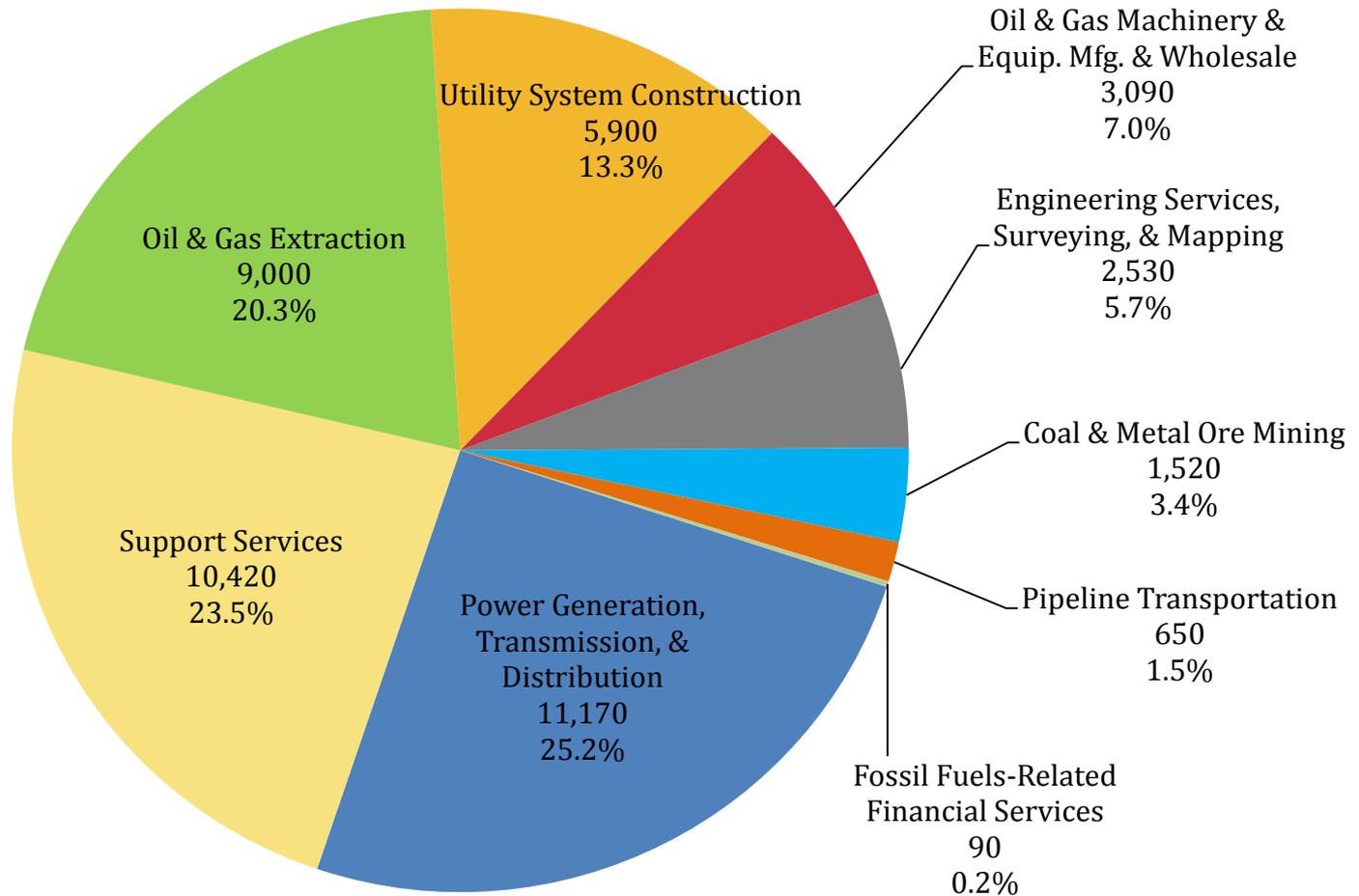


Source: Dun & Bradstreet, Inc.; Marketplace database, July-September, 2009-2010; Market Analysis Profile, 2011-2016

Note: Employment represents the coal, oil, gas, pipeline, refinery, generation, transmission, distribution, and engineering services sectors

Fig. 71

Colorado Fossil Fuels Employment by Industry Sector, 2016

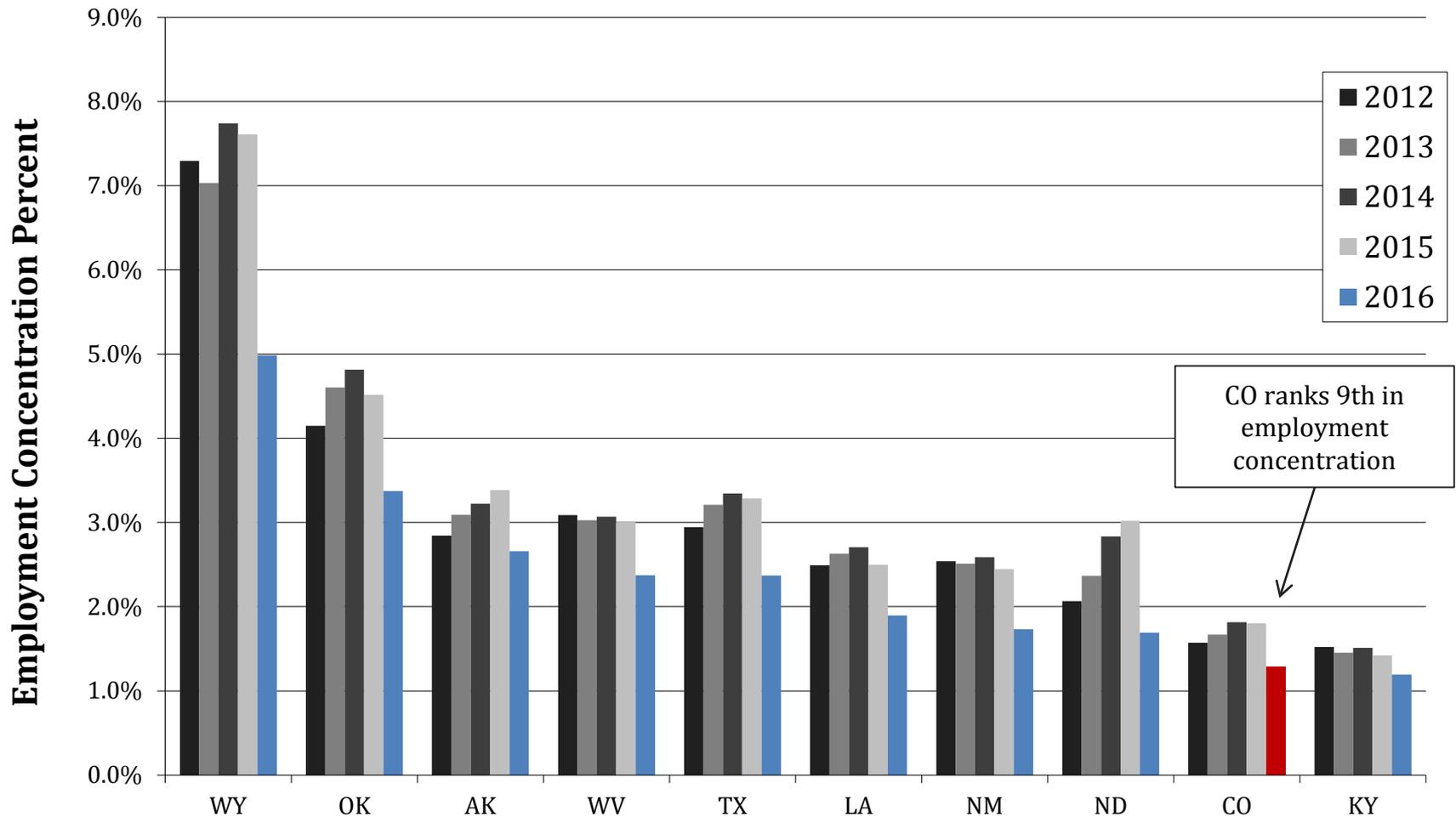


Source: 2016 Metro Denver EDC Energy Industry Cluster Study

Fig. 72

Fossil Fuels Employment Concentration, 2012-2016

Colorado ranks among the top-10 states for fossil fuel employment concentration

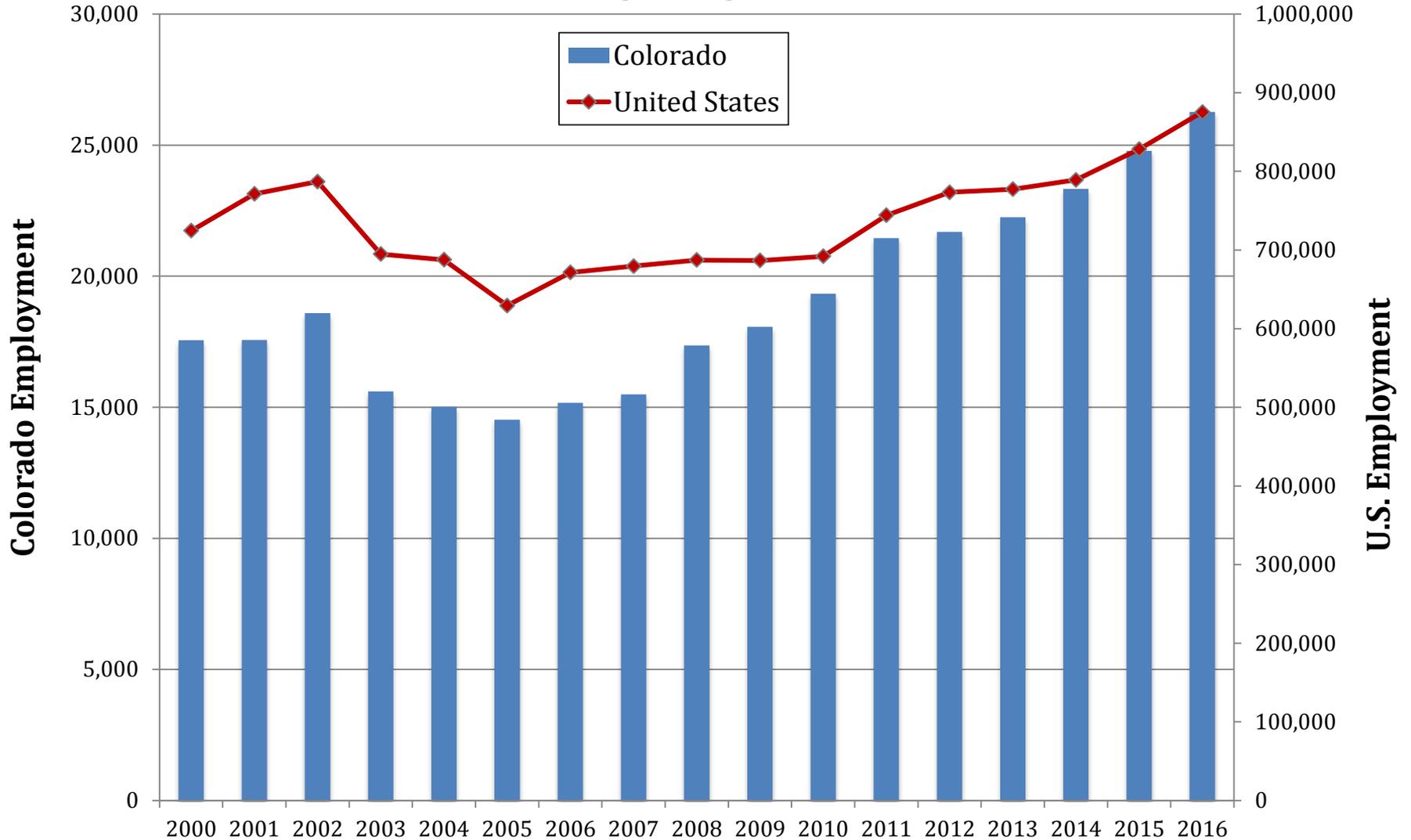


Source: Market Analysis Profile, 2012-2016

Fig. 73

Cleantech - Number of Employees

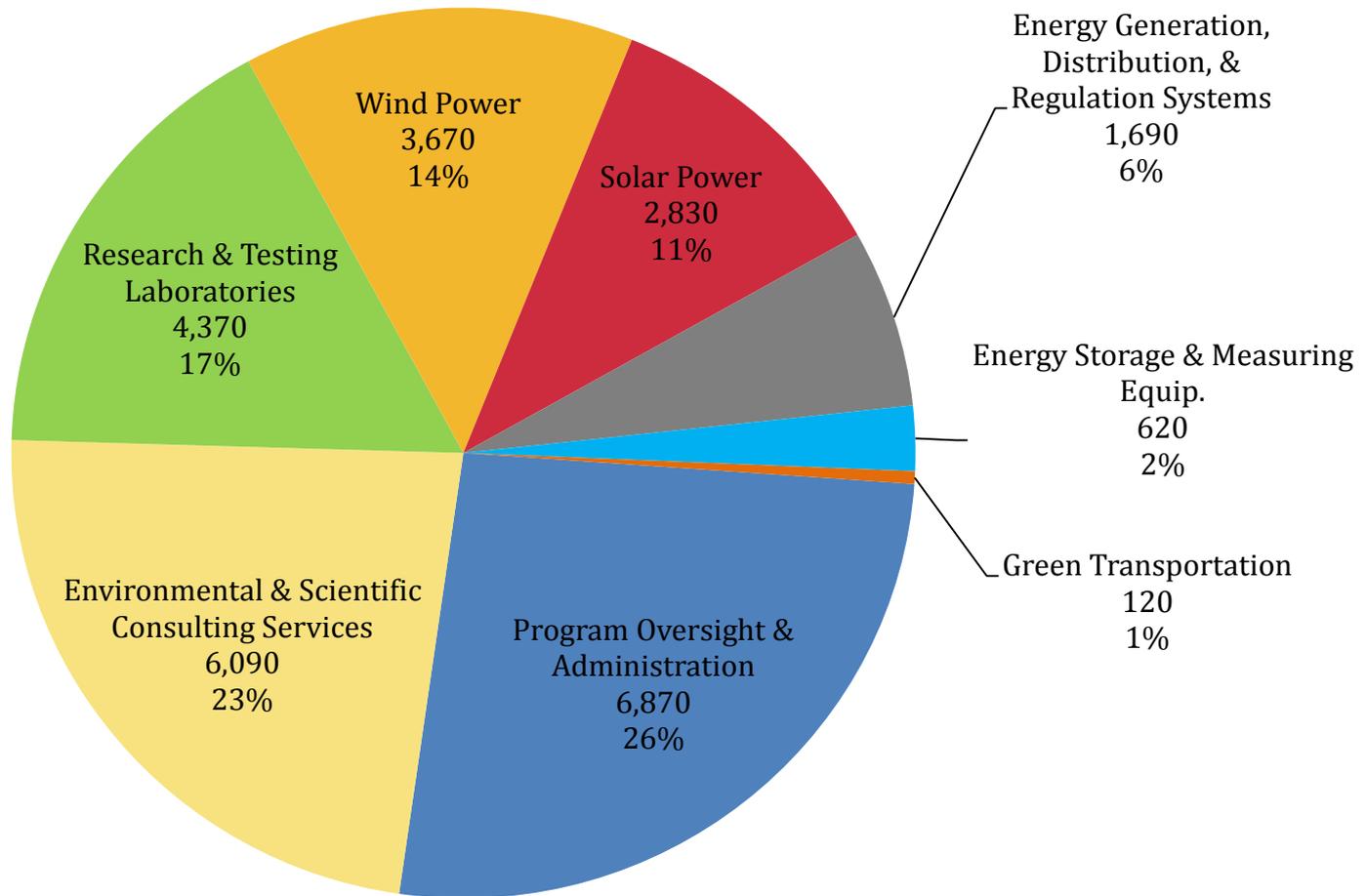
Colorado cleantech sector is growing; 26,270 direct workers in 2016



Source: Dun & Bradstreet, Inc.; Marketplace database, July-September, 2009-2010; Market Analysis Profile, 2011-2016

Note: Employment represents the solar, wind, geothermal, fuel cell, efficiency, storage, green transportation, cleantech R&D, and environmental consulting sectors

Colorado Cleantech Employment by Industry Sector, 2016

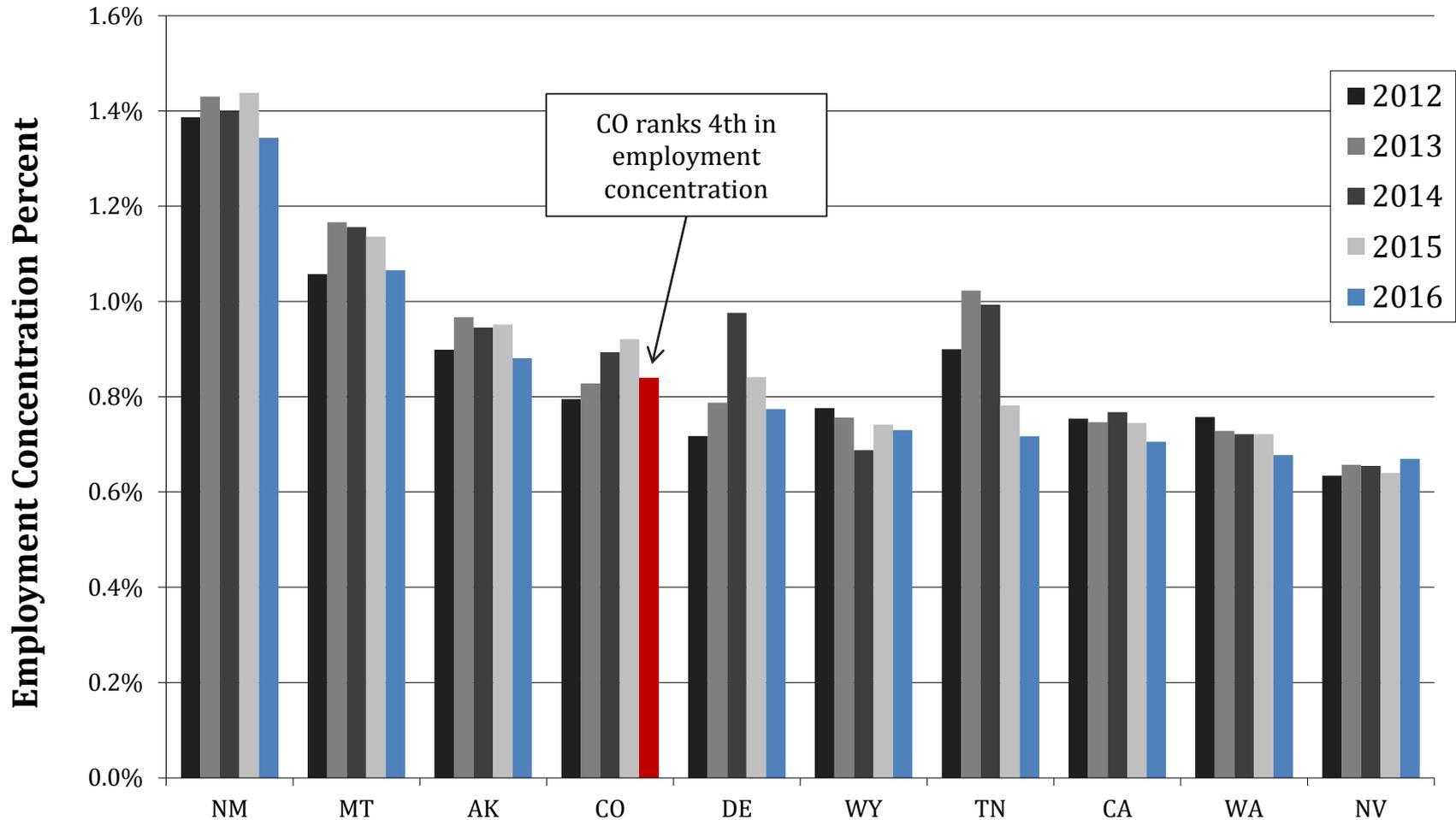


Source: 2016 Metro Denver EDC Energy Industry Cluster Study

Fig. 75

Cleantech Employment Concentration, 2012-2016

The relative contribution of Colorado's cleantech sector to overall employment declined in 2016, due to faster employment growth in other sectors

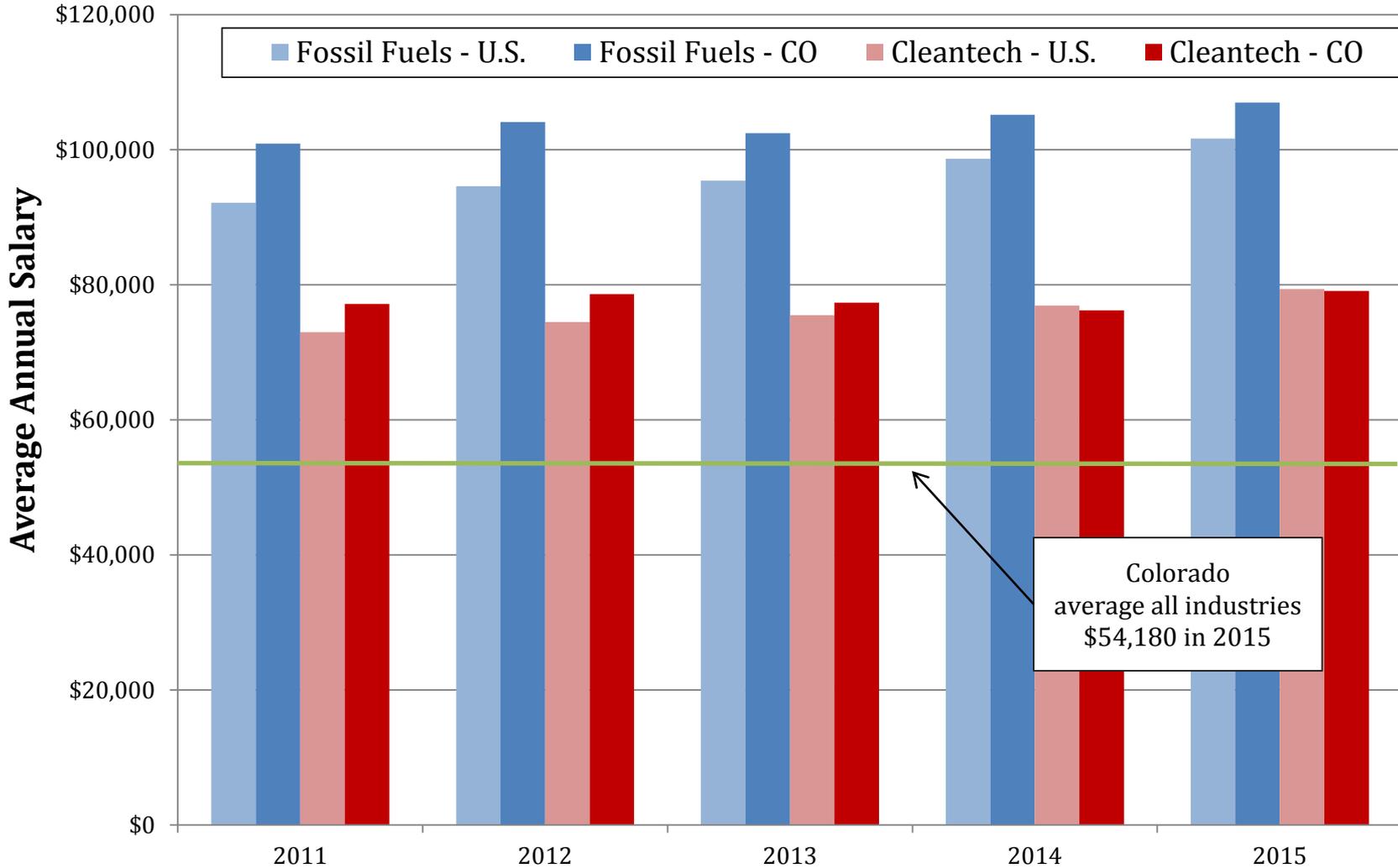


Source: Market Analysis Profile, 2012-2016

Fig. 76

Average Annual Salary

Colorado fossil fuel wages (\$107,000) tend to be higher than cleantech wages (\$79,100);
Colorado cleantech salaries declining compared to national average

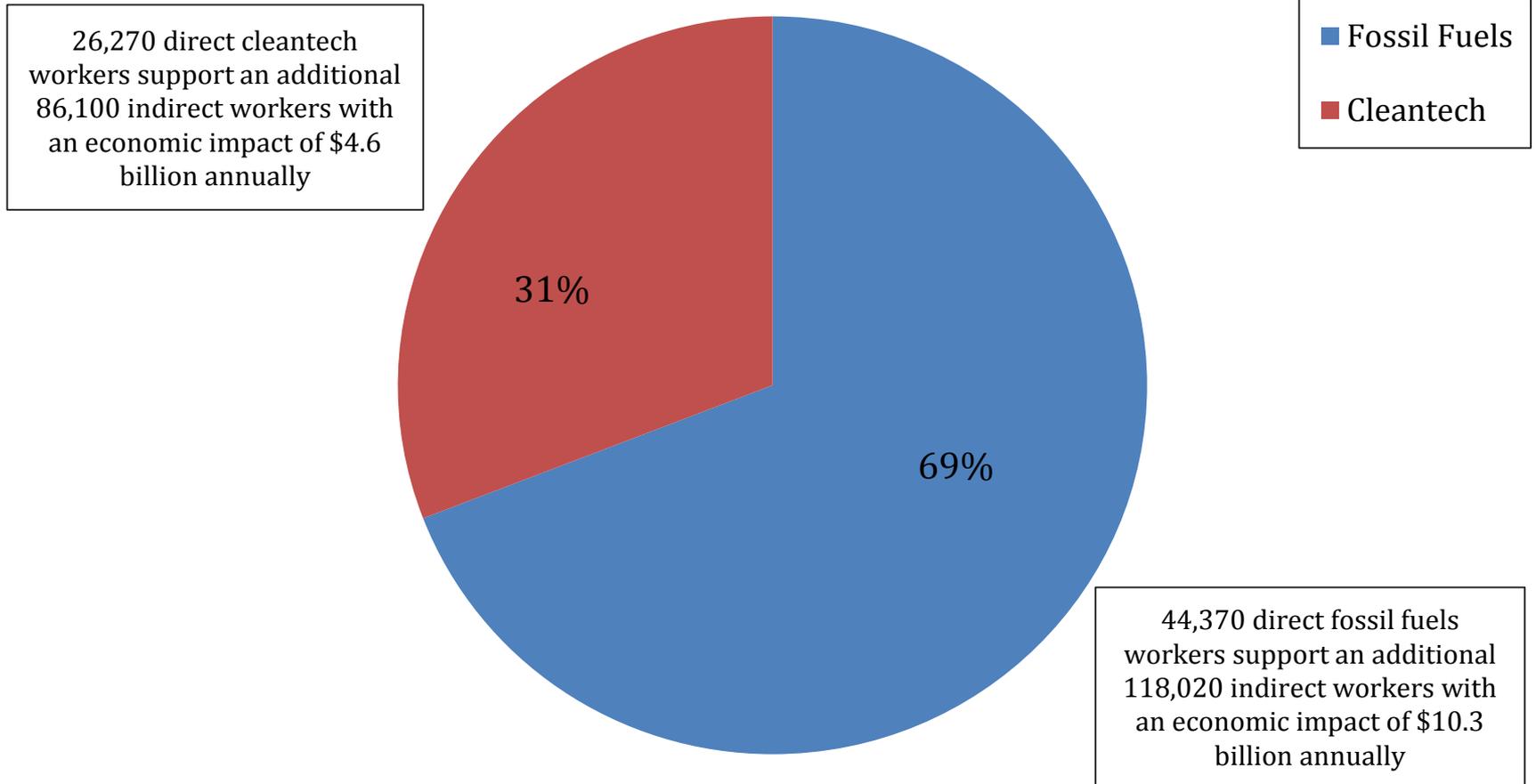


Source: 2016 Metro Denver EDC Energy Industry Cluster Study

Fig. 77

Economic Impact, 2016

The economic impact of Colorado's energy industry is \$14.9 billion; 70,640 direct energy workers support an additional 204,120 indirect workers, for a total of 274,760 employees statewide

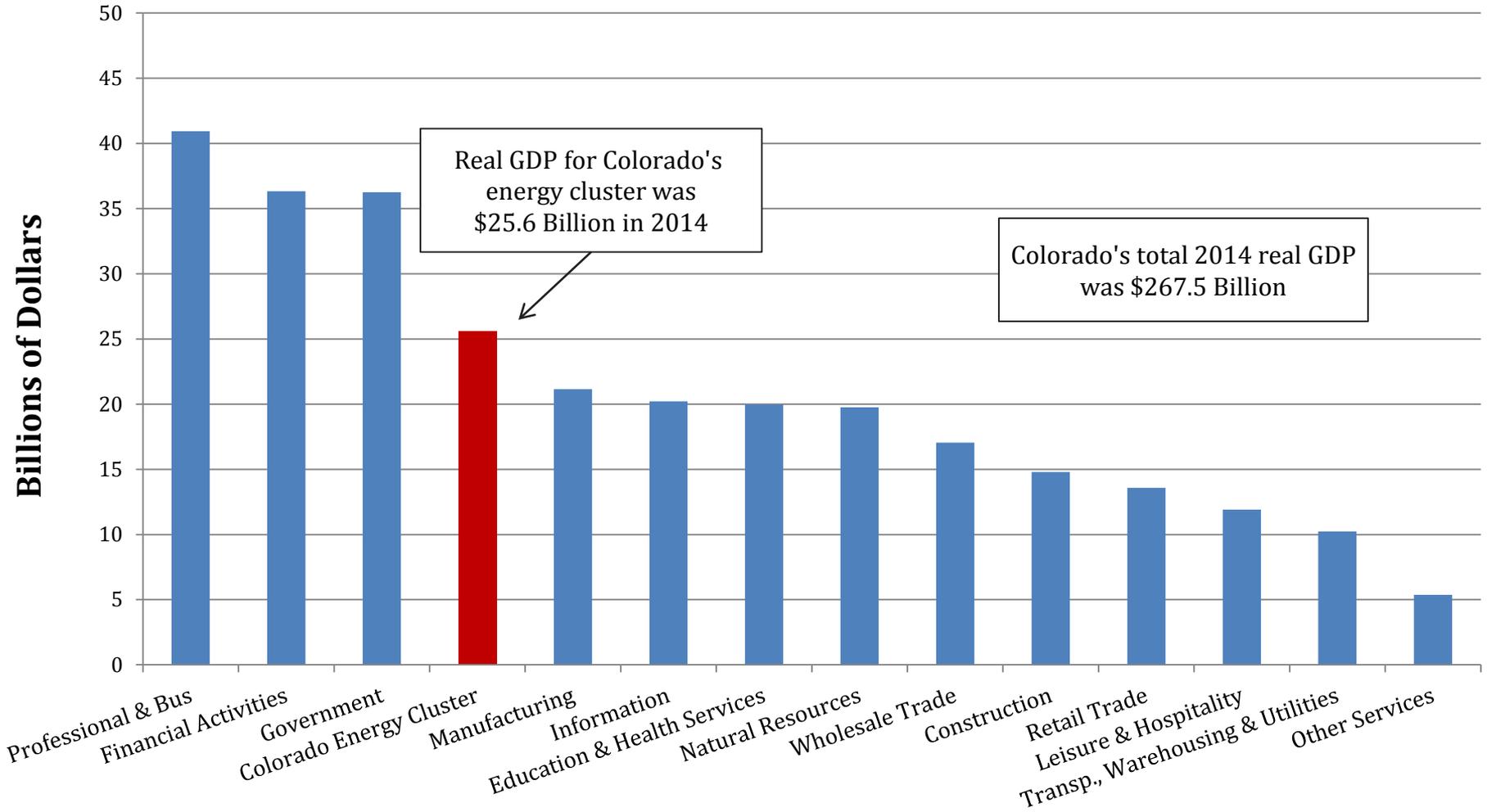


Source: 2016 Metro Denver EDC Energy Industry Cluster Study
Note: Economic impacts represent the benefits of employee earnings

Fig. 78

Colorado GDP by Sector, 2014

The energy cluster in Colorado represents 9.6 percent of the state's Gross Domestic Product (GDP); GDP is the value of all final goods and services produced in the state



Source: U.S. Department of Commerce, Bureau of Economic Analysis; Economic Modeling Specialists International (EMSI).
Note: Data represents real GDP in chained 2009 dollars. Colorado energy cluster GDP is not discrete; it consists of parts of several sectors including natural resources, utilities, construction, manufacturing, trade, transportation, and professional and business services.

Fig. 79

Resource Rich Colorado

Eighth Edition, December 2016

Explanation of Industries – State Gross Domestic Product (GDP)

Professional & Business Services – Includes professional, scientific, and technical services; management of companies and enterprises; and administrative and support services

Financial Activities – Includes financial services, insurance, real estate, rental, and leasing activities

Government – Includes federal, state, and local governmental activities

Colorado Energy Cluster – Colorado’s energy cluster consists of the fossil fuels and cleantech industries, and includes both operating and support service companies as defined by the Metro Denver Economic Development Corp. Energy cluster GDP was estimated through data provided by EMSI and measured against totals from all sectors defined by the U.S. Bureau of Economic Analysis.

Manufacturing – Includes all industries that are engaged in mechanical, physical, or chemical transformation of materials, substances, or components into new products

Information – Includes software publishing; other publishing industries; motion picture and sound recording; broadcasting and telecommunications; and data processing and Internet publishing

Education & Health Services – Includes industries in education, ambulatory health care services, hospitals, nursing and residential care facilities, and social assistance

Natural Resources – Includes mining, oil and gas extraction, mining support, oil and gas support, agriculture, fishing, forestry, and hunting

Wholesale Trade – Includes businesses generally engaged in purchase and sales of goods for resale, goods sold to other wholesalers or retailers, sale of capital or durable non-consumer goods, and the sale of raw and intermediate materials and supplies used in production

Construction – Includes residential, nonresidential, heavy, and civil engineering construction activities

Retail Trade – Includes businesses generally engaged in the sale of merchandise in small quantities to the general public

Leisure & Hospitality – Includes arts, entertainment, recreation, accommodation, and food services

Transportation, Warehousing, & Utilities – Includes road, rail, water, pipeline, and air transportation; warehousing; and utilities such as electric power generation, transmission, and distribution

Other services – Includes repair and maintenance, personal care, laundry, and religious, grant-making, civic, professional, and other organizations

*For more information please visit, <http://www.census.gov/eos/www/naics/index.html>

Resource Rich Colorado

Eighth Edition, December 2016

List of Country Codes

<i>Country</i>	<i>Three-Digit Country Code</i>
Algeria	ALG
Australia	AUS
Canada	CAN
China	CHN
Columbia	COL
European Union	EU
France	FRA
Germany	GER
Iran	IRN
Iraq	IRQ
India	IND
Indonesia	IDN
Italy	ITA
Japan	JPN
Kazakhstan	KAZ
Korea, Republic of	KOR
Korea, Democratic People's Republic of	PRK
Kuwait	KWT
Malaysia	MYS
Mexico	MEX
Mongolia	MNG
Netherlands	NLD
Norway	NOR
Qatar	QAT
Russian Federation	RUS
Saudi Arabia	SAU
Spain	ESP
South Africa	SAF
Sweden	SWE
Taiwan	TWN
Turkey	TUR
Ukraine	UKR
United Arab Emirates	UAE
United Kingdom	GBR
United States	USA
Venezuela	VEN



An industry affiliate of:



Metro Denver
Economic Development Corporation

1445 Market Street
Denver, CO 80202
www.metrodenver.org/cec