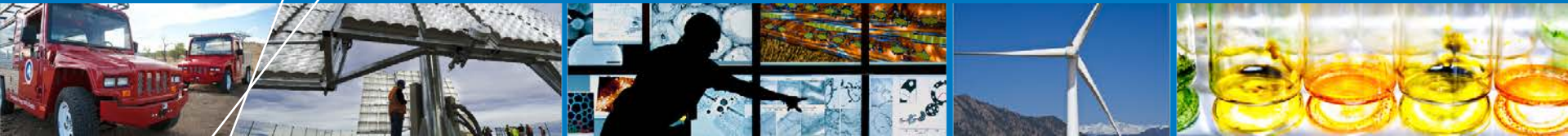




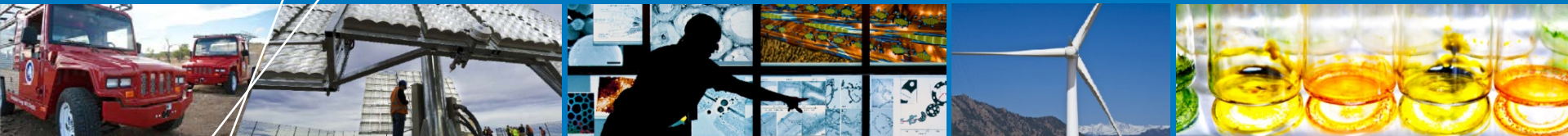
# REN21: North America



**Clean Energy Solutions Center**

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**SOLAR/WIND/BIO**

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NATURAL GAS**

**DISCUSSION**

# Top 5 Annual Investment/Additions 2012

## ANNUAL INVESTMENT/ADDITIONS/PRODUCTION IN 2012

	New capacity investment	Hydropower capacity	Solar PV capacity	Wind power capacity	Solar water collector (heating) capacity <sup>1</sup>	Biodiesel production	Ethanol production
<b>1</b>	China	China	Germany	United States	China	United States	United States
<b>2</b>	United States	Turkey	Italy	China	Turkey	Argentina	Brazil
<b>3</b>	Germany	Brazil/Vietnam	China	Germany	Germany	Germany/ Brazil	China
<b>4</b>	Japan	Russia	United States	India	India	France	Canada
<b>5</b>	Italy	Canada	Japan	United Kingdom	Brazil	Indonesia	France

**Mexico's investment increased more than fivefold, from USD 352 million in 2011 to USD 2 billion in 2012**

# Total Capacity: End of 2012

	Renewable power (incl. hydro)	Renewable power (not incl. hydro)	Renewable power per capita (not incl. hydro) <sup>2</sup>	Bio-power	Geothermal power	Hydropower	Concentrating solar thermal power (CSP)
1	China	China	Germany	United States	United States	China	Spain
2	United States	United States	Sweden	Brazil	Philippines	Brazil	United States
3	Brazil	Germany	Spain	China	Indonesia	United States	Algeria
4	Canada	Spain	Italy	Germany	Mexico	Canada	Egypt/Morocco
5	Germany	Italy	Canada	Sweden	Italy	Russia	Australia

	Solar PV	Solar PV per capita	Wind power	Solar water collector (heating) <sup>1</sup>	Solar water collector (heating) per capita <sup>1</sup>	Geothermal heat capacity	Geothermal direct heat use <sup>3</sup>
1	Germany	Germany	China	China	Cyprus	United States	China
2	Italy	Italy	United States	Germany	Israel	China	United States
3	United States	Belgium	Germany	Turkey	Austria	Sweden	Sweden
4	China	Czech Republic	Spain	Brazil	Barbados	Germany	Turkey
5	Japan	Greece	India	India	Greece	Japan	Japan/Iceland

Source: REN21 Renewables 2013 Global Status Report

# Contribution from Renewables: End 2012

Technology	Canada	USA
Biofuel production (billon litres)	1.9	54
Solar PV (GW)		7.2
Concentrated Solar Thermal Power (M/W)		507
Wind Power (GW)	6.2	60

Source: REN21 Renewables 2013 Global Status Report

## Share electricity generation from renewables:

- **Canada: 63% (final energy – 17%)**
- **Mexico: 16% (final energy – 6.9%)**
- **United States: 13%**

# North American key REN21 GSR stories

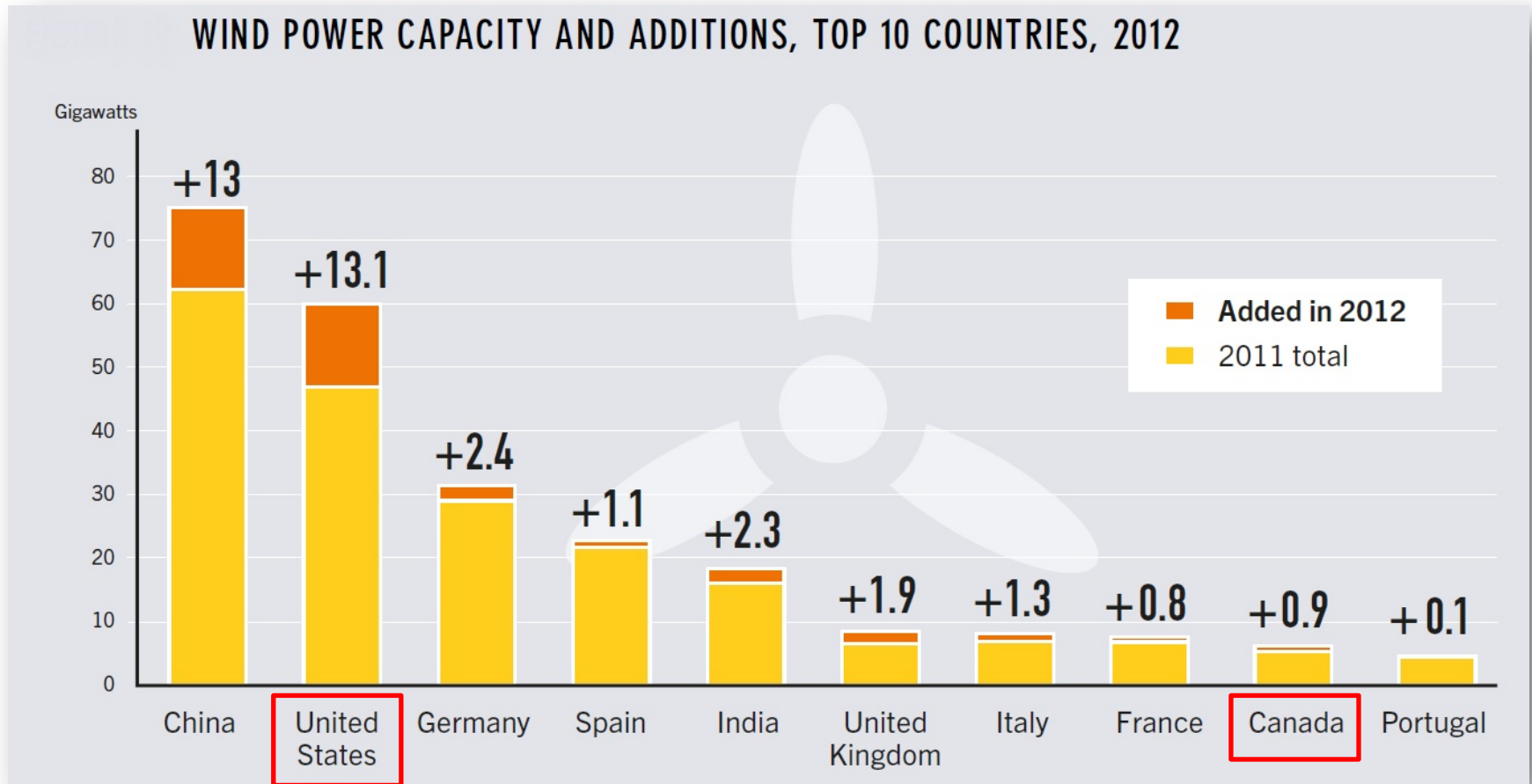
- North America is top ethanol consuming and producing region
- North America saw PV have 3.6 GW installed in 2012
- In U.S. big story was Q 4 wind installations – close to 13GW
- In U.S. RE = about 50% of total power installed
- Mexico saw build of 750MW hydro plant – 220M face
- Mexico saw investment go up 5x (353M to 2B)
- Canada ranked #5 in RE per capita (non-hydro)
- Calgary became 100% RES-E dependent for municipal functions



# Renewable Energy Support Policies

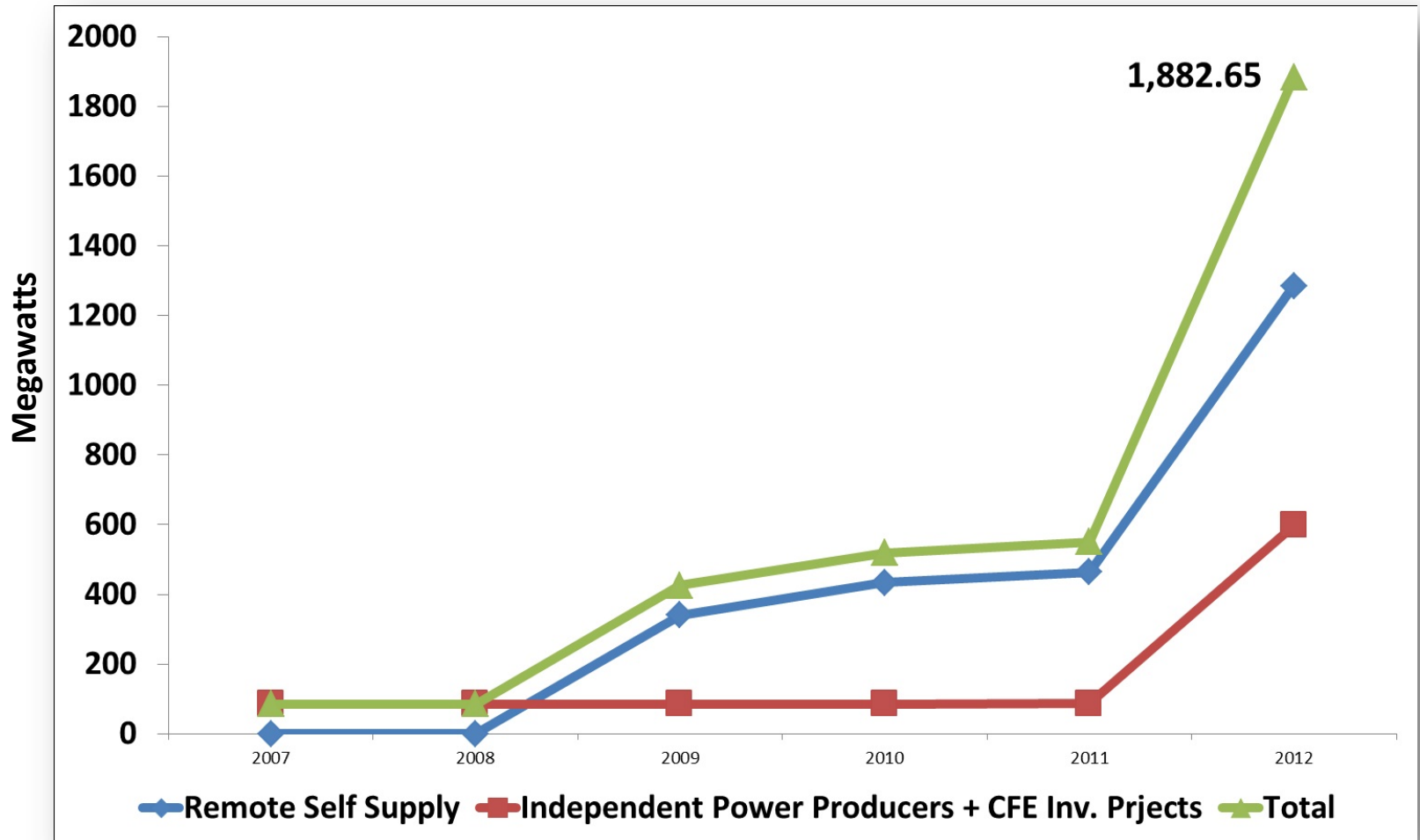
	REGULATORY POLICIES AND TARGETS							FISCAL INCENTIVES				PUBLIC FINANCING	
	Renewable energy targets	Feed-in tariff/premium payment	Electric utility quota obligation/RPS	Net metering	Biofuels obligation/mandate	Heat obligation/mandate	Tradable REC	Capital subsidy, grant, or rebate	Investment or production tax credits	Reductions in sales, energy, CO <sub>2</sub> , VAT, or other taxes	Energy production payment	Public investment, loans, or grants	Public competitive bidding/tendering
● indicates national level policy ○ indicates state/provincial level policy													
Canada	○	○	○	○	●			●	●	●		●	●
United States		○	○	○	●	○	○	●	●	●	●	●	●
Mexico	●			●		●			●			●	●

# Wind Capacity and Additions



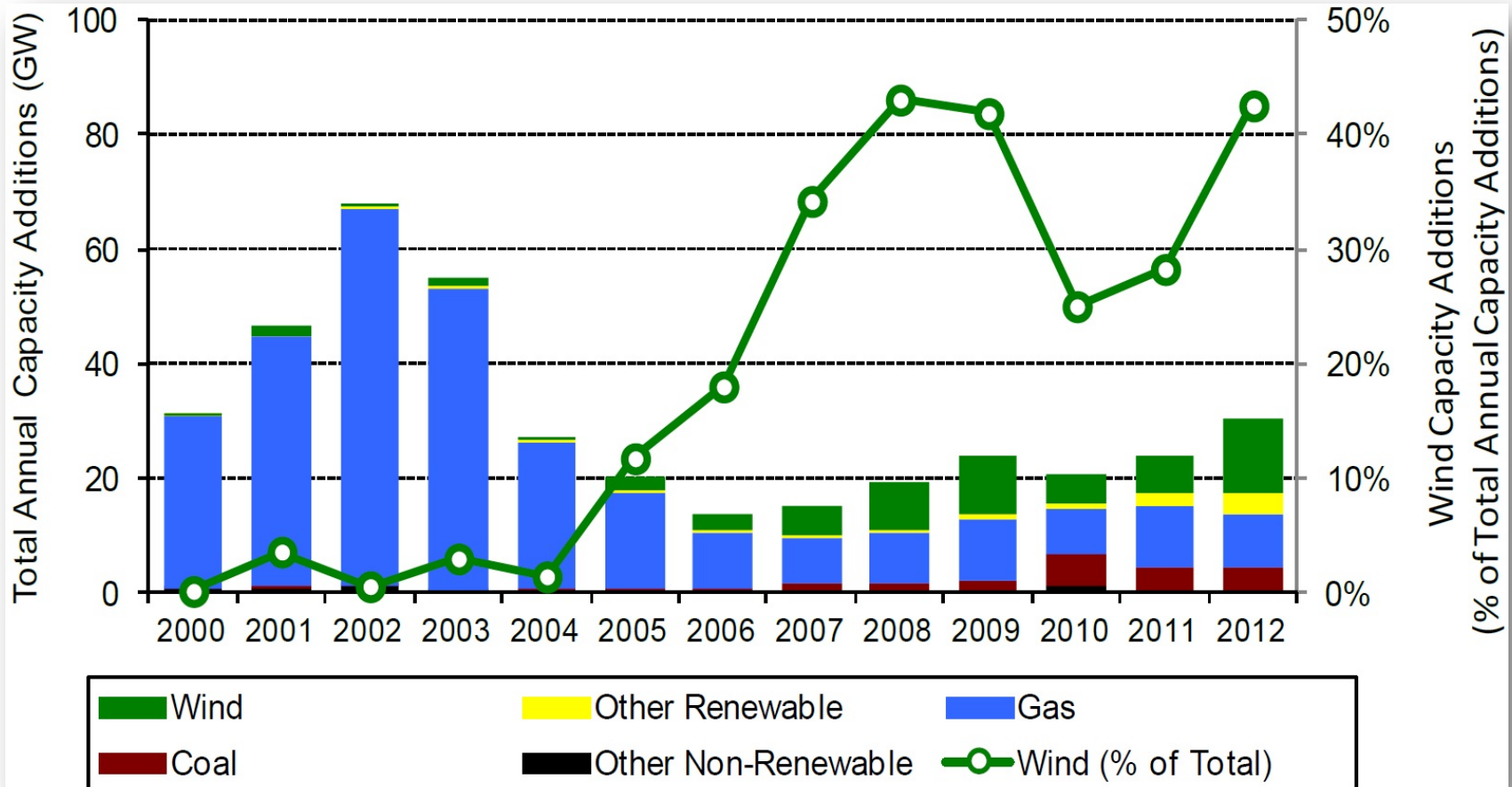


# Mexico Wind Capacity Growth

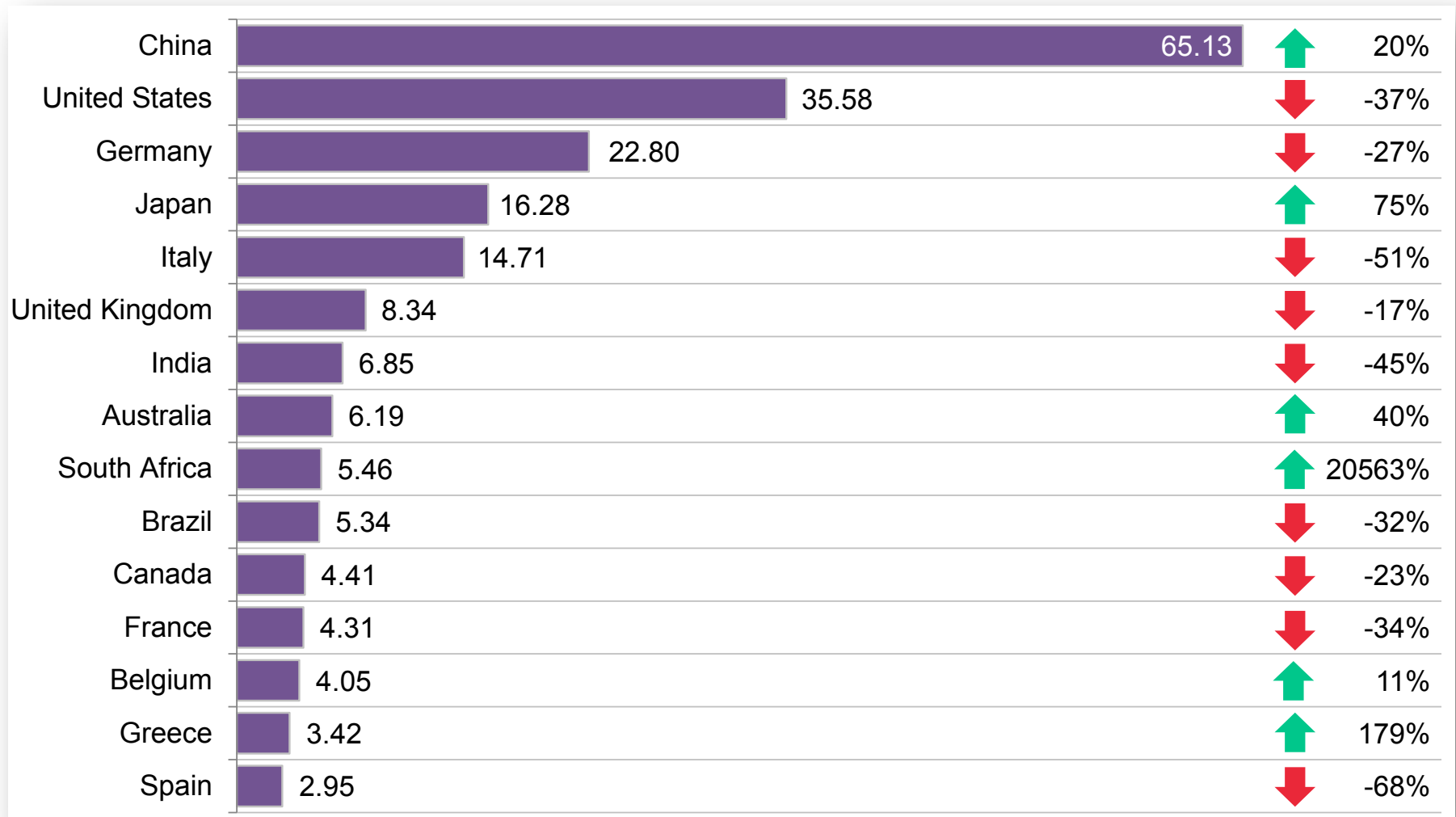


Source: Comision Federal de Electricidad

# Wind Power Was the Largest Source of U.S. Generating Capacity Additions in 2012



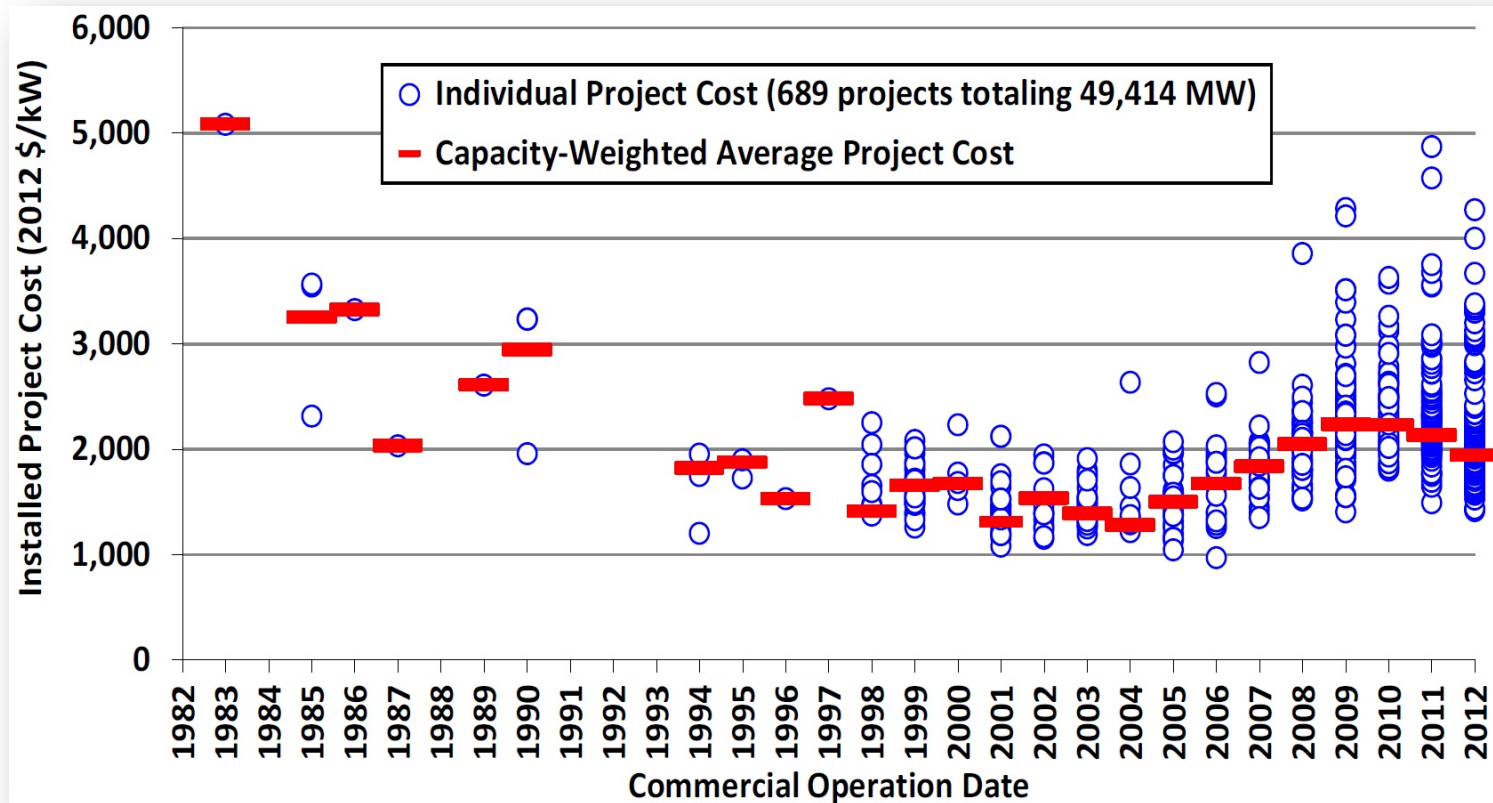
# Top 15 Countries for New Investment in Clean Energy in 2012 and % Change on 2011 (\$bn)



Note: Excludes corporate and government R&D

Source: Bloomberg New Energy Finance

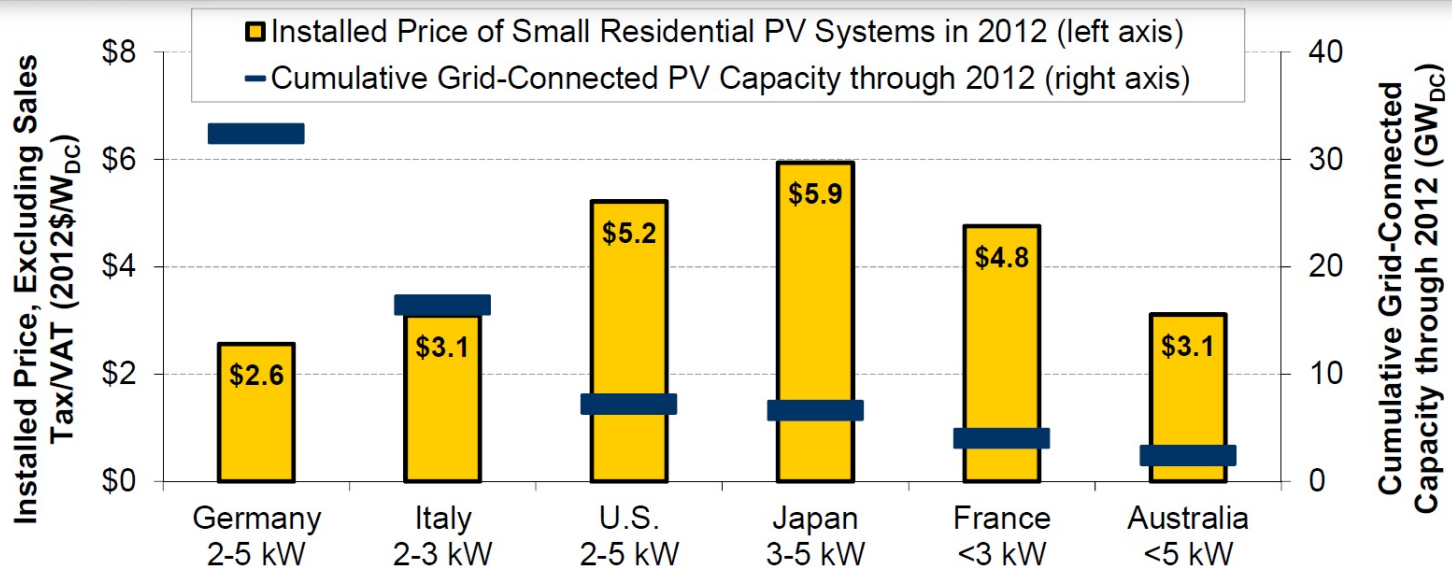
# Reported Installed Wind Project Costs Continued to Trend Lower in 2012



- In 2012, the average cost was ~\$1,940/kW, down ~\$200/kW from 2011, and down \$300/kW from the peak in 2009-10
- Whereas turbine prices peaked in 2008/2009, project-level installed costs peaked in 2009/2010, reflecting the normal passage of time between when a turbine supply agreement is signed and when those turbines are actually installed

# U.S. Installed PV Price and Capacity Comparison

Lower installed prices in other major PV markets largely reflects differences in “soft costs,” which may be driven partly by differing levels of deployment scale, though other factors are also likely important.

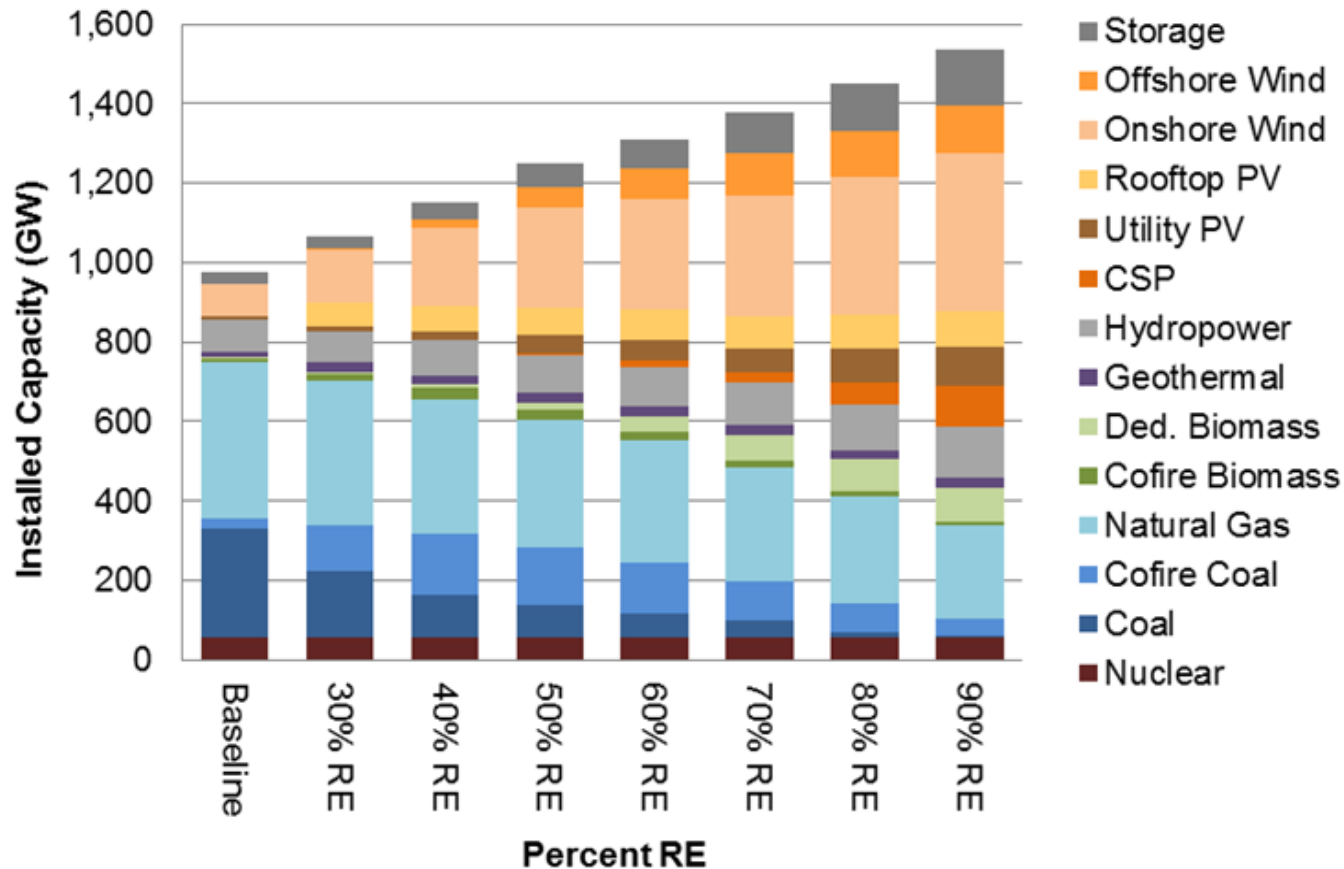


Notes: The U.S. data point represents the median price of 2-5 kW residential systems installed in 2012, and unlike other figures presented in this report excludes sales tax. Data for Germany are based on price quotes for individual systems, collected by EuPD (2013). All other installed price data represent the “turnkey price of typical PV applications” for the particular size range shown, as reported in each country’s IEA PVPS Country Report (Castello et al. 2013, Durand 2013, Watt and Passey 2013, Yamada and Ikki 2013). Cumulative installed capacity data for each country derive from REN21 (2013).





# Renewable Electricity Futures: A Transformation of the U.S. Electricity System

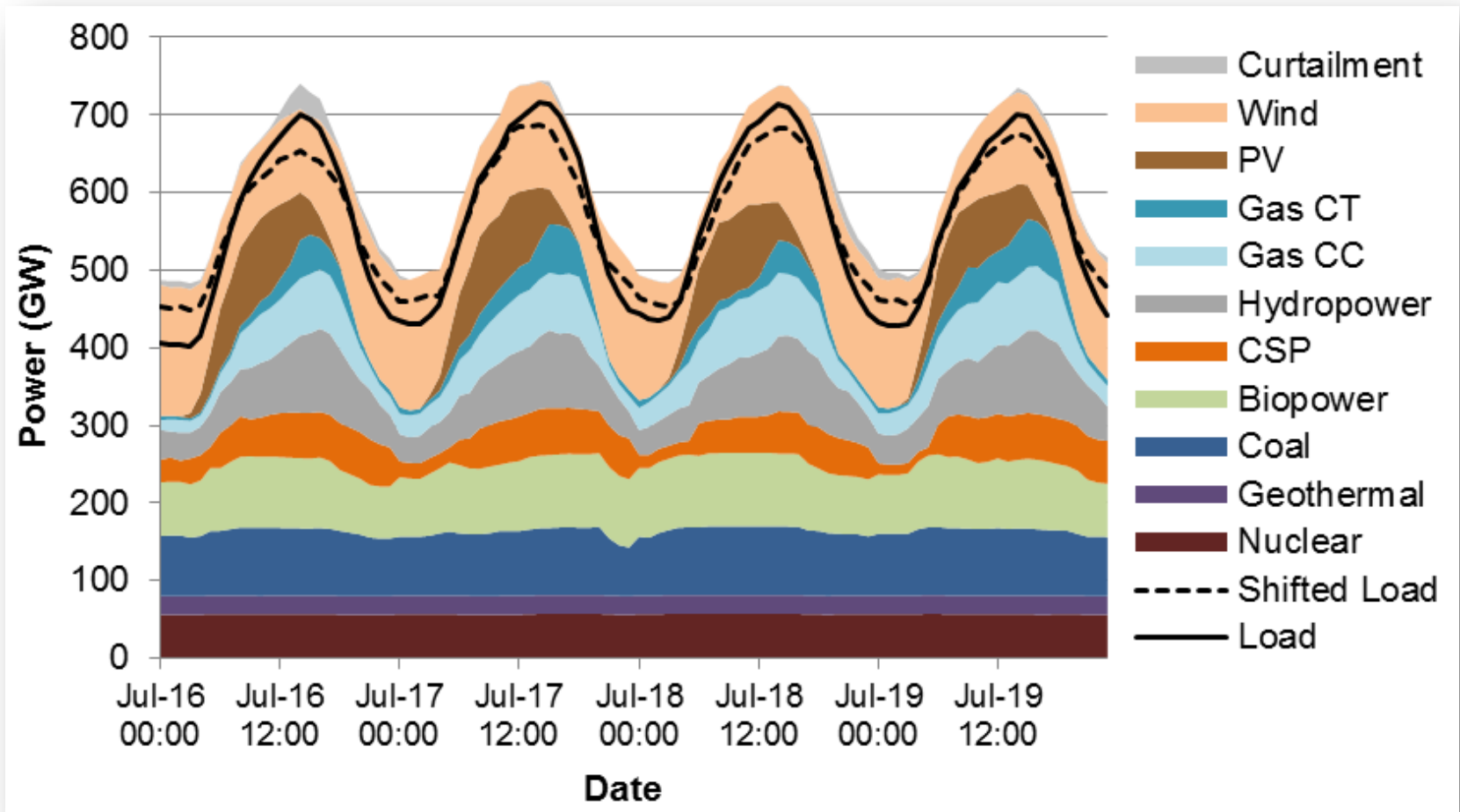


RE generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050—while meeting electricity demand on an hourly basis in every region of the country.



# United States Renewable Electricity Futures

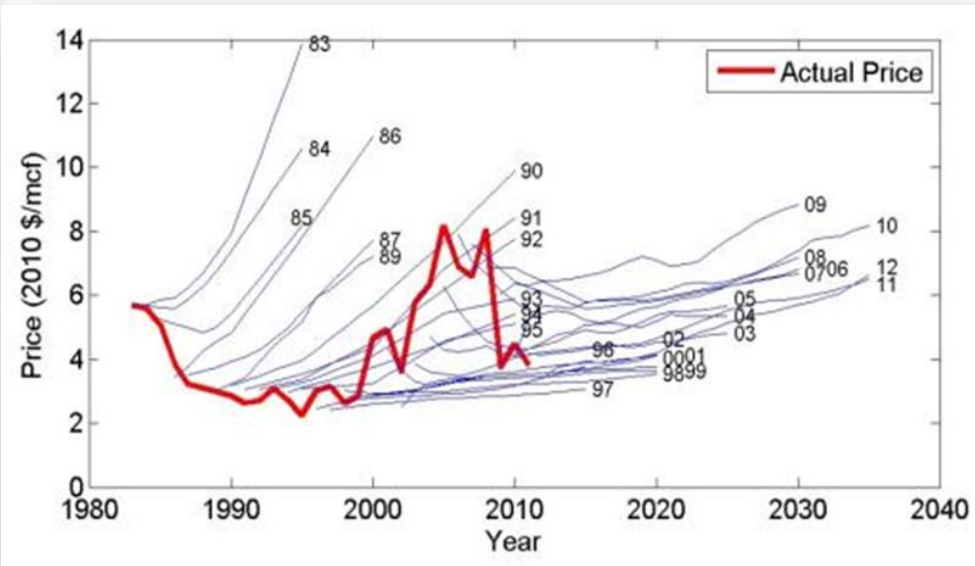
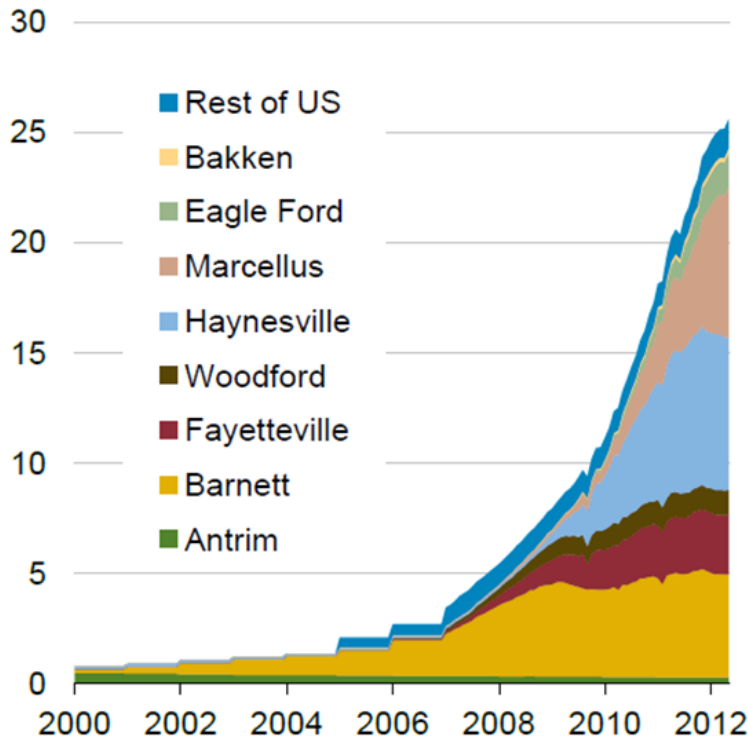
## U.S. Nationwide Dispatch by Generator Type During Annual Peak Coincident Load



# The Elephant in the Room

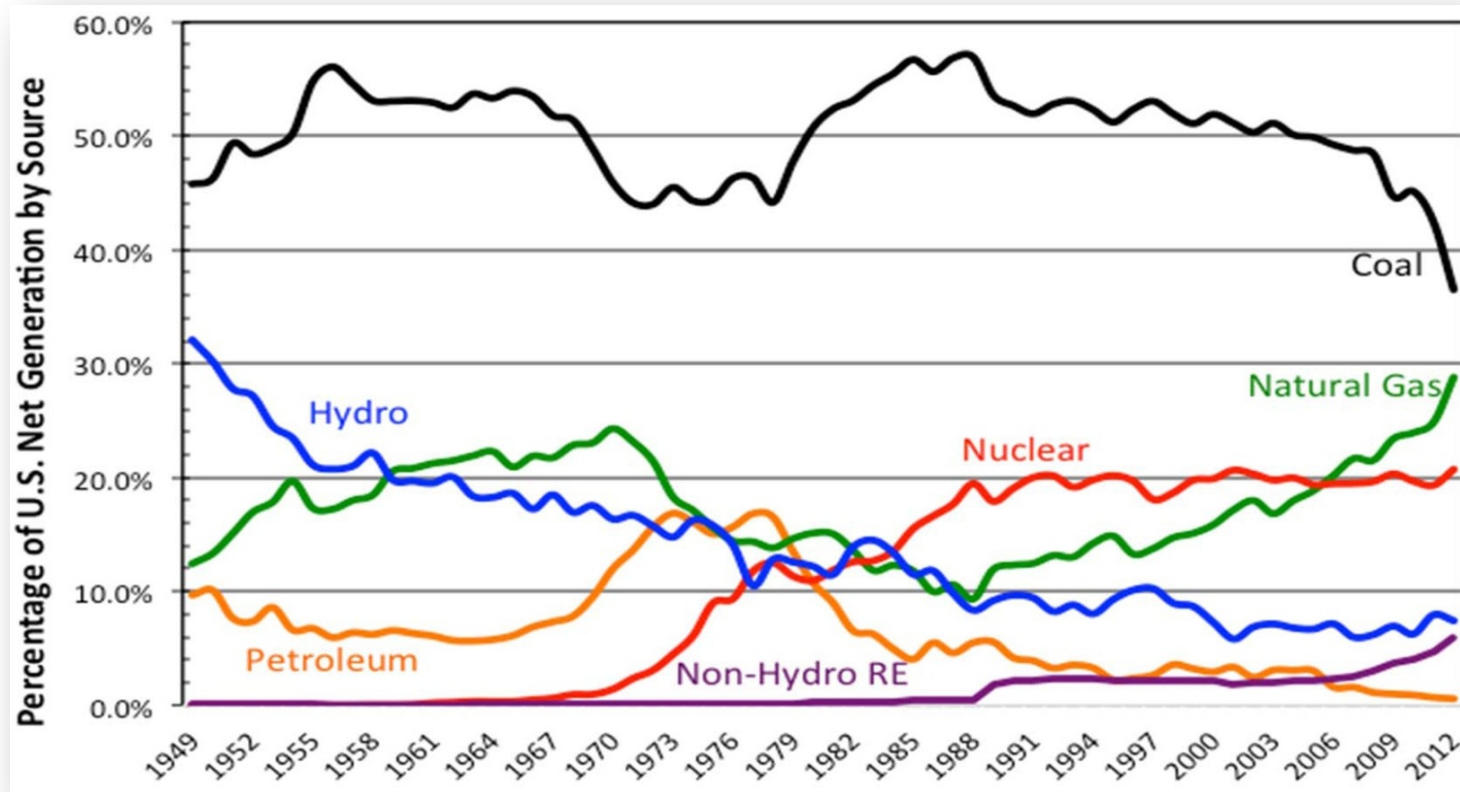
In North America renewable energy has to find ways to interact positively with large natural gas (and oil) resources.

shale gas production (dry)  
billion cubic feet per day



Source: Presentation by EIA Administrator

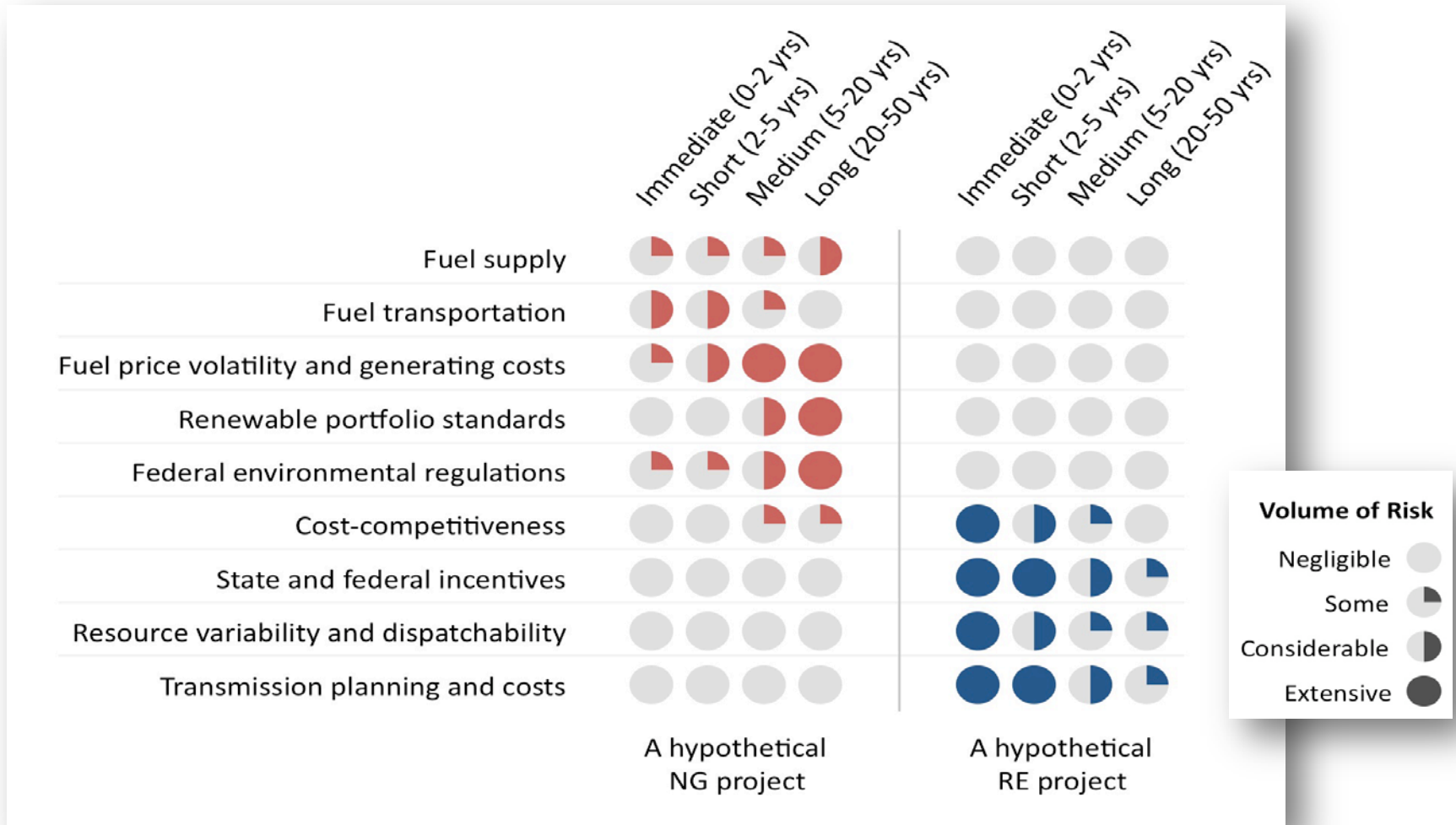
# Market Snapshot: Early U.S. Impacts of Low-Cost Natural Gas



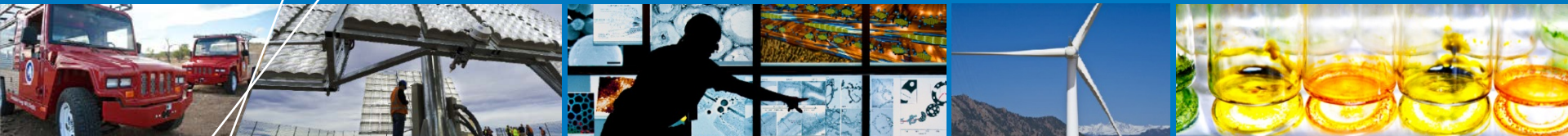
- Coal percentage down from 48% in 2008 to 36% in August 2012
- 300 million tons of annual burner-tip carbon dioxide mitigation (13% of total power sector)
- Trend could reverse itself depending on natural gas price relative to coal.

Source: EIA. (2012). "Annual Energy Review," *EIA Electric Power Monthly*. Data for 2012 includes generation through August

# Natural Gas & Renewables: Opportunities for Synergies



- Quantitative analysis of risks is needed
- Temporal focus is important given long asset lifetimes



Questions?

# References

- REN21. 2013. Renewables 2013 Global Status Report (Paris: REN21 Secretariat). ISBN 978-3-9815934-0-2. (Slides 2-5)
- Wiser, Ryan H., and Mark Bolinger. (2013). 2012 Wind Technologies Market Report, Edited by Galen L. Barbose, Naïm Darghouth, Ben Hoen, Andrew D. Mills, Samantha Weaver, Kevin Porter, Michael Buckley, Sari Fink, Frank Oteri and Suzanne Tegen. (Slides 6-8)
- Barbose, Galen L., Naïm Darghouth, Samantha Weaver, and Ryan H. Wiser. (2013). Tracking the Sun VI: An Historical Summary of the Installed Price of Photovoltaics in the United States from 1998 to 2012. (Slides 9-11)
- Hand, M.; DeMeo, E.; Hostick, D.; Mai, T.; Schlosser, C. A. (2013). Renewable Electricity Futures: Exploration of Up to 80% Renewable Electricity Penetration in the United States (Presentation). NREL (National Renewable Energy Laboratory). 29 pp.; NREL Report No. PR-6A20-54948. (Slides 16-17)
- Logan, J. (2013). Summary and Follow-on Recommendations of: Natural Gas and the Transformation of the U.S. Energy Sector: Electricity (Presentation). NREL (National Renewable Energy Laboratory). 24 pp.; NREL Report No. PR-6A20-57496. (Slides 13 and 15)
- Renewable Electricity Futures Study (2012). Hand, M.M.; Baldwin, S.; DeMeo, E.; Reilly, J.M.; Mai, T.; Arent, D.; Porro, G.; Meshek, M.; Sandor, D., editors. Lead authors include Mai, T.; Sandor, D.; Wiser, R.; Heath, G.; Augustine, C.; Bain, R.; Chapman, J.; Denholm, P.; Drury, E.; Hall, D.; Lantz, E.; Margolis, R.; Thresher, R.; Hostick, D.; Belzer, D.; Hadley, S.; Markel, T.; Marnay, C.; Milligan, M.; Ela, E.; Hein, J.; Schneider, T. (Slides