

# **Global Power Sector Climate Policy Assessment**

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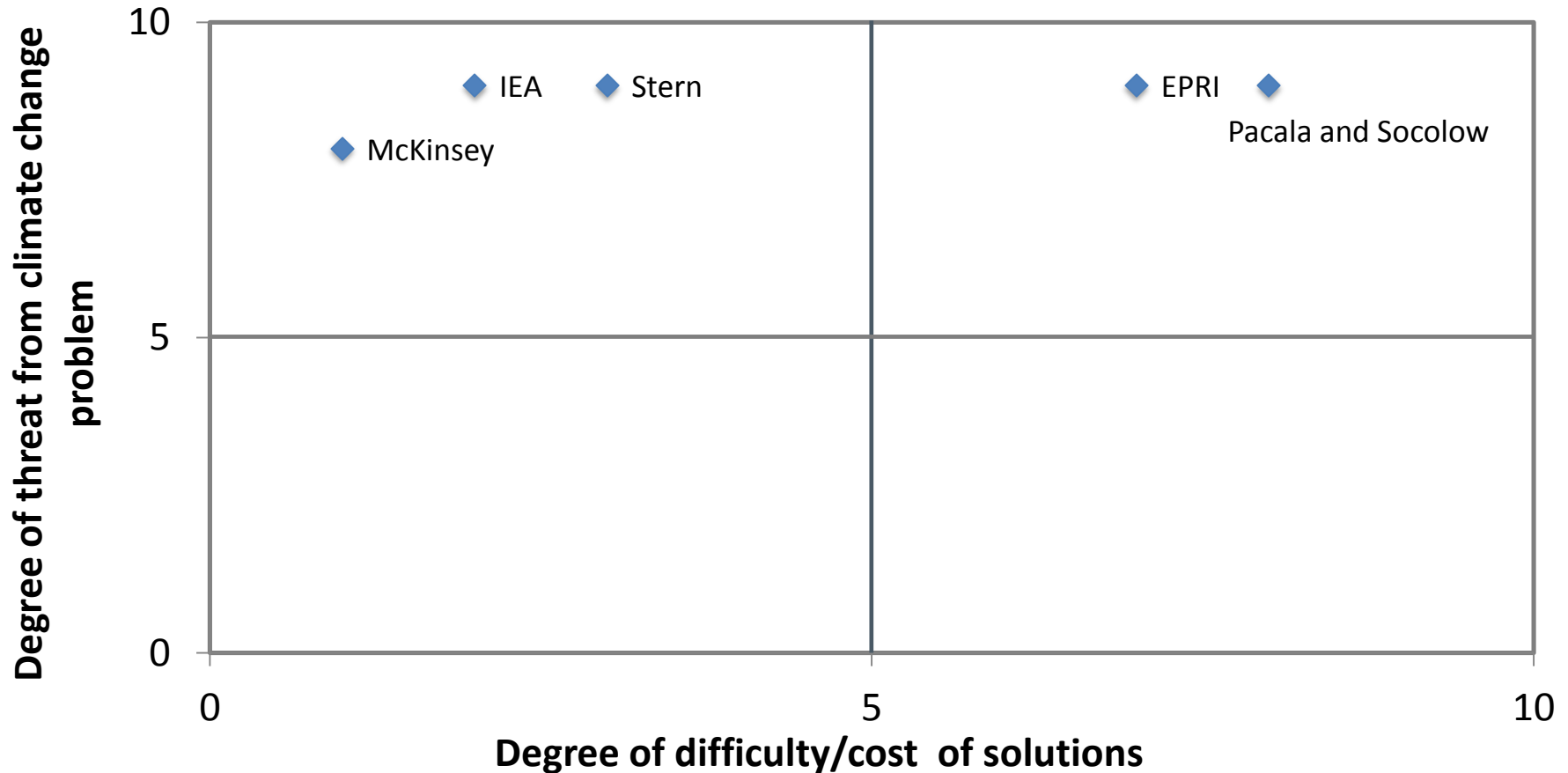
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October 26, 2015

# Global warming: Policy perceptions



Notes: IEA: World Energy Outlook Special Report 2015: Energy and Climate Change.

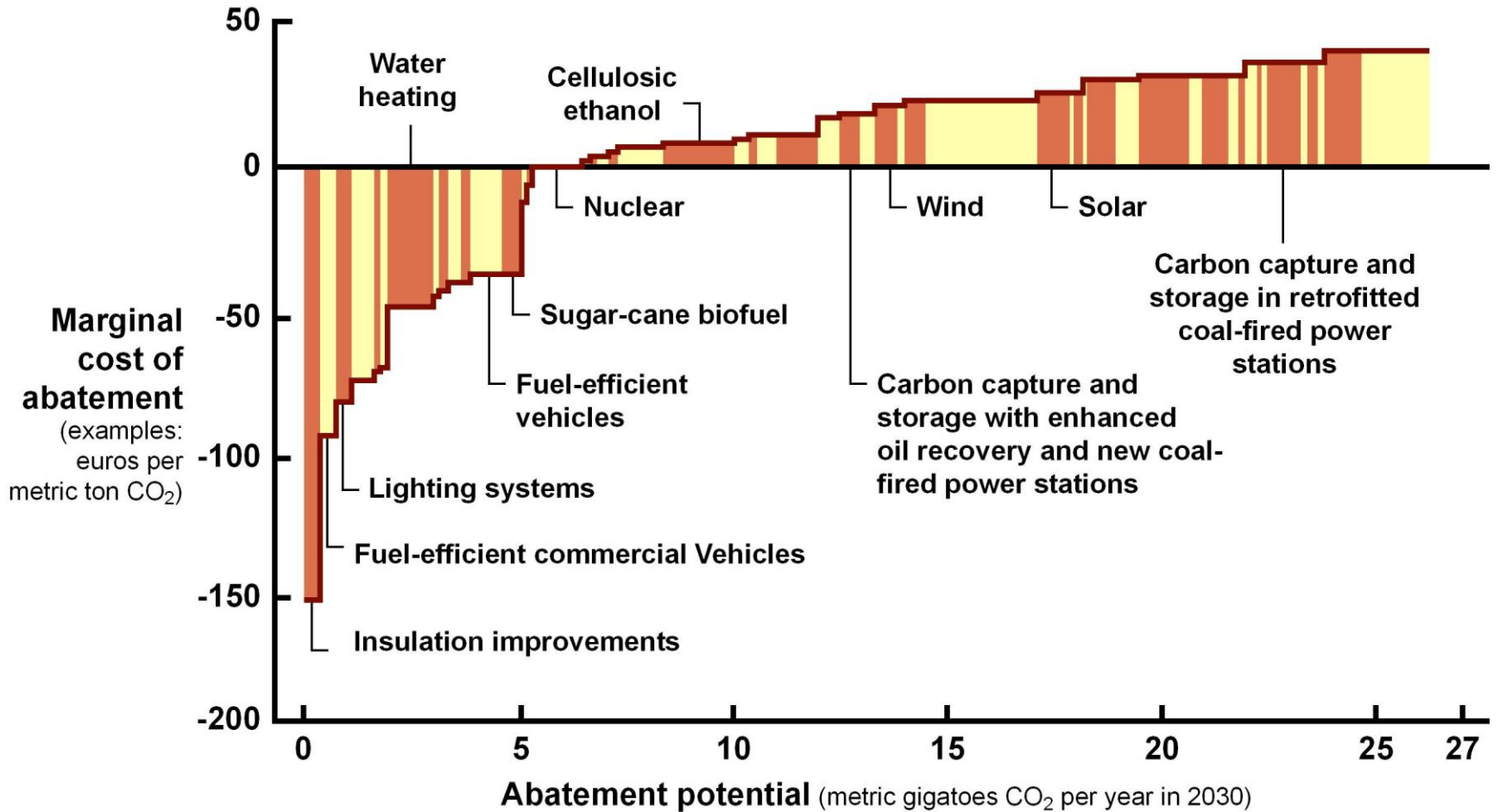
Stern: Stern Review on the Economics of Climate Change. Released October 2006.

McKinsey: Greenhouse gas abatement cost curves. Originally published by McKinsey, February 2007.

EPRI: The Power to Reduce CO2 Emissions: The Full Portfolio. EPRI, 2007

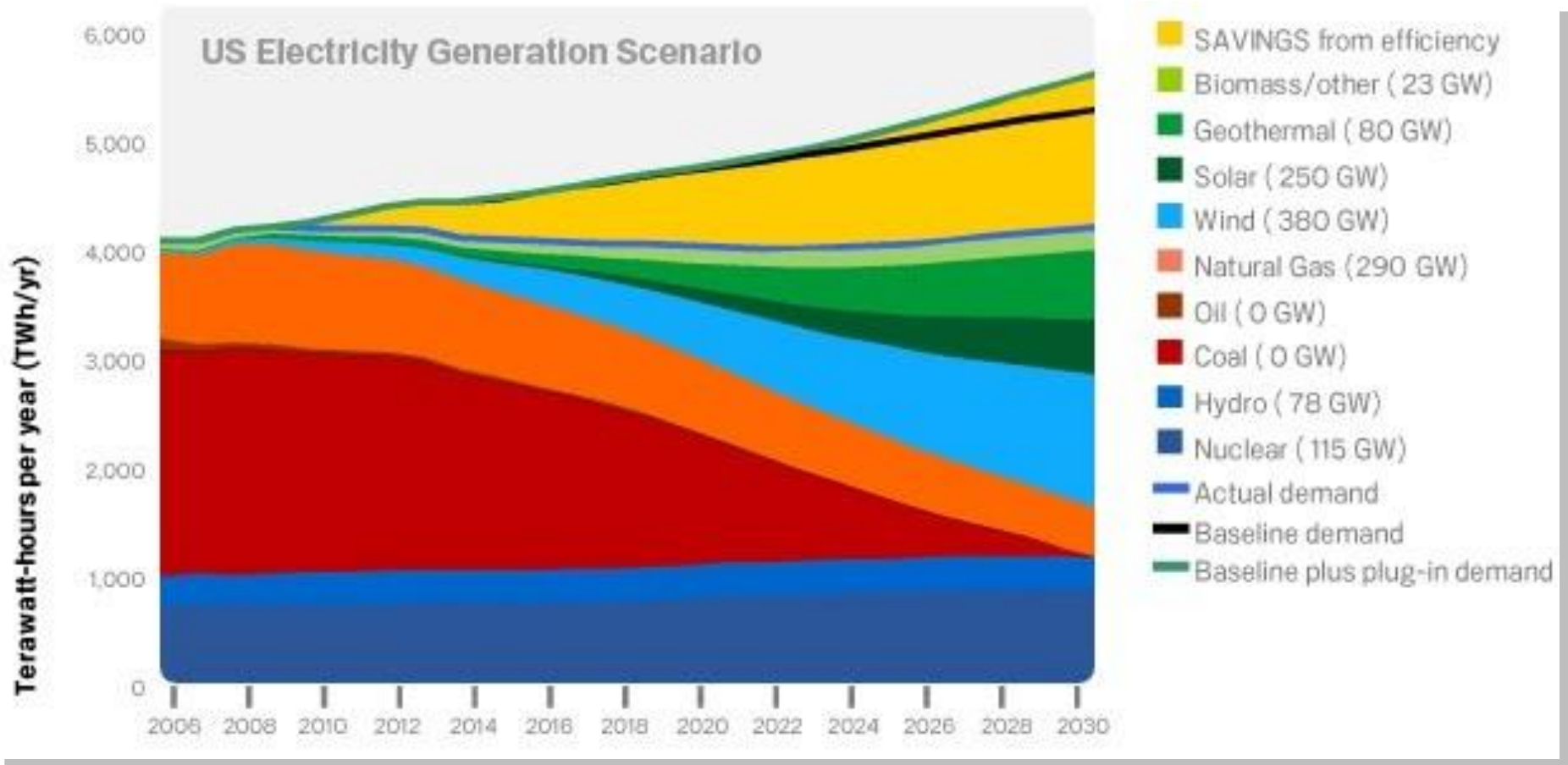
Pacala and Socolow: Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. Science, August 2004.

# McKinsey: Global GHG abatement curve 2007



Source: Vattenfall; reproduced with permission.

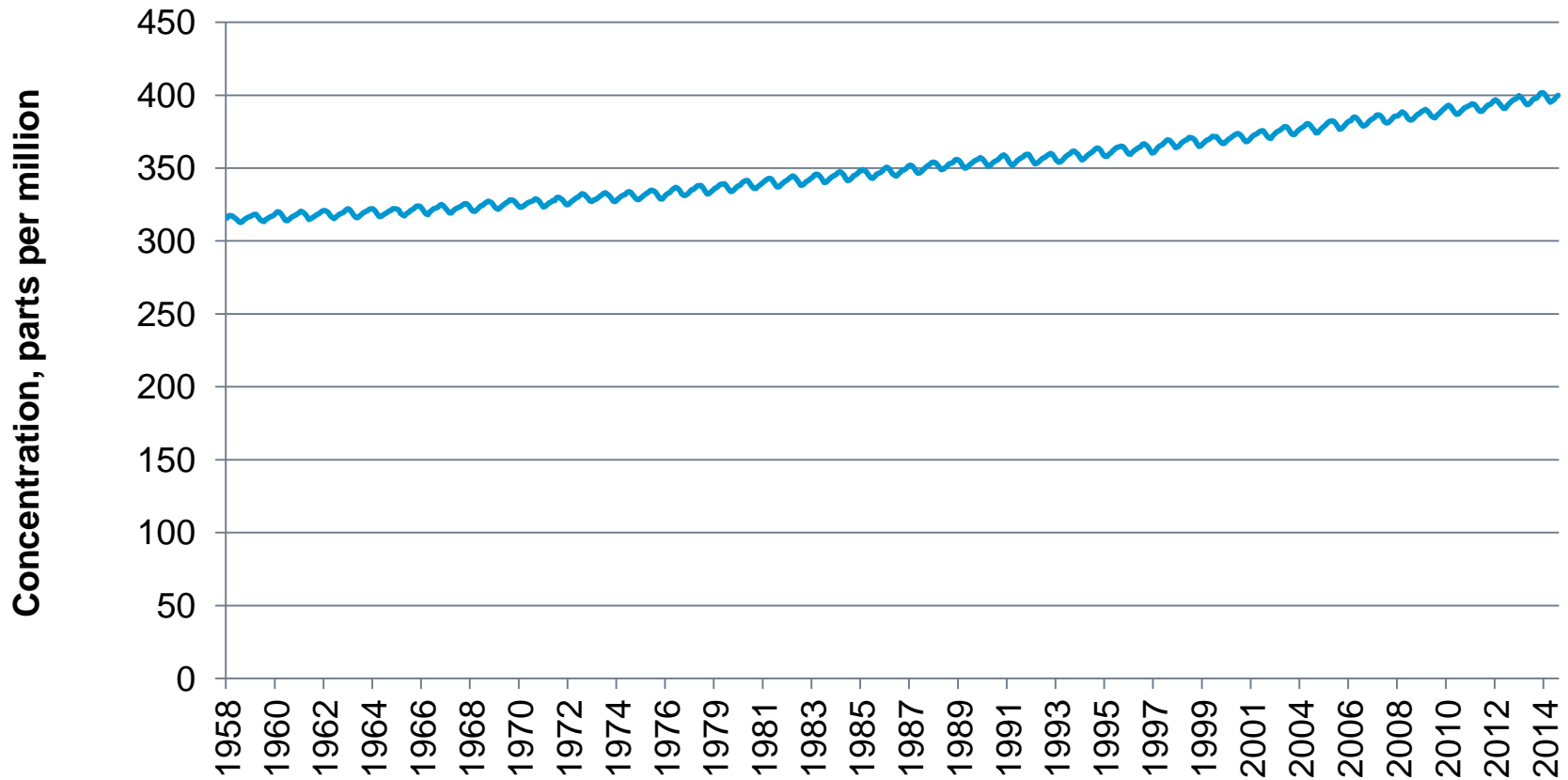
# Green vision future



Source: Jon Wellinghoff, Chairman of the Federal Energy Regulatory Commission, presentation to CERAWEEK, March 10, 2011.

# Root cause of global warming

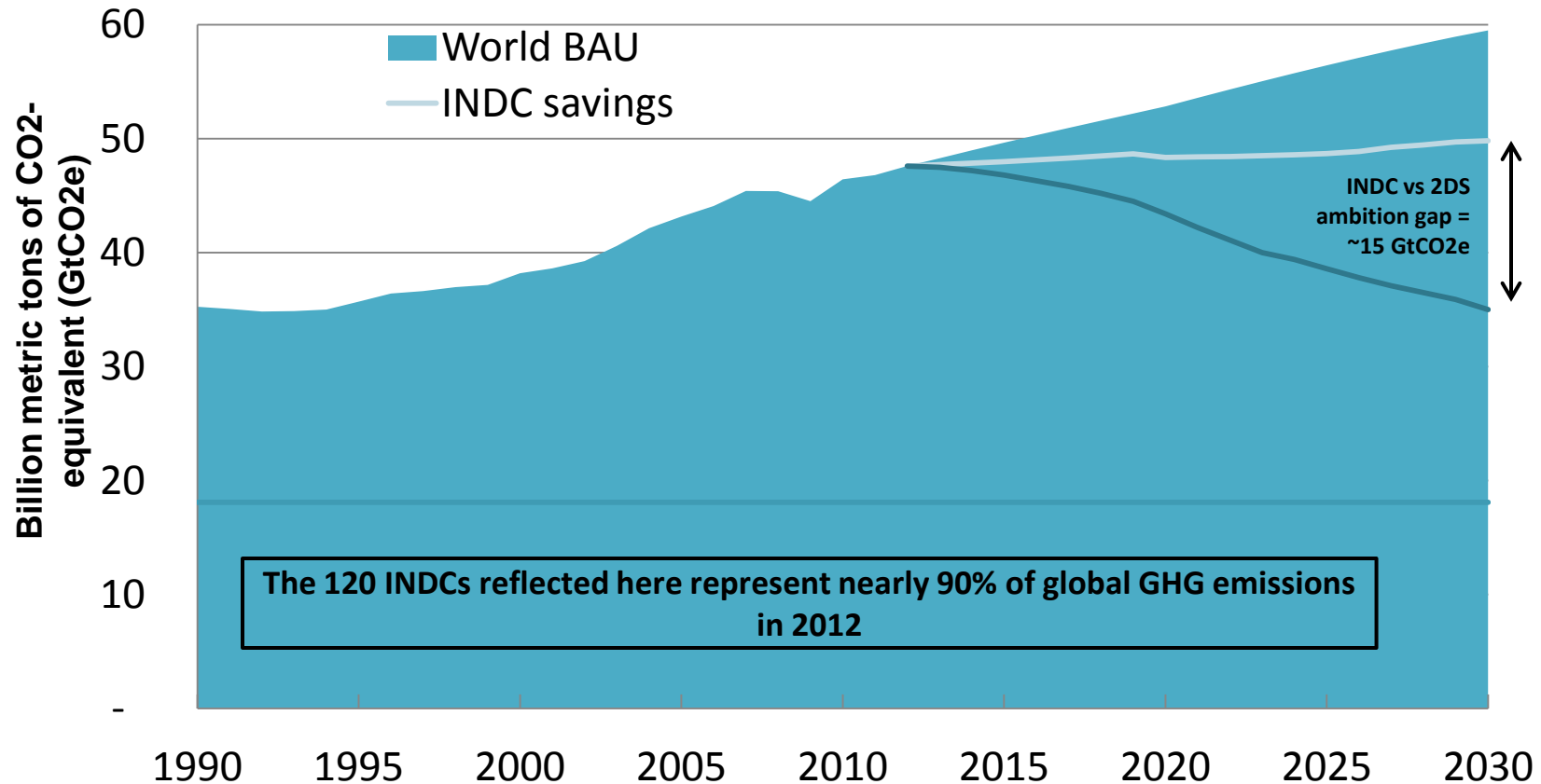
Atmospheric CO2 concentration, March 1958 - January 2015



Source: NOAA-ESRL, Mauna Loa Observatory

## INDC emissions trend relative to BAU path

Global GHG emissions\*, BAU\*\* vs major INDC targets and 2 degree scenario\*\*\*



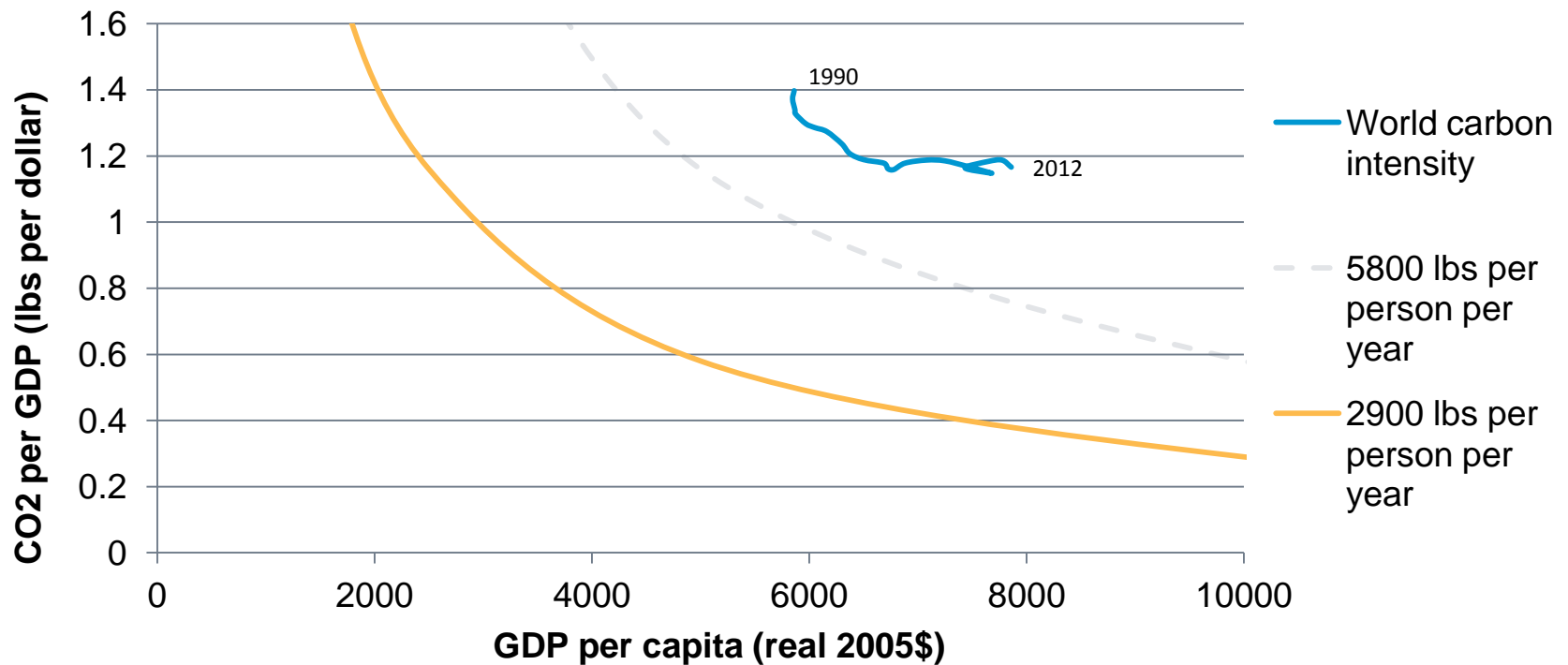
Source: IHS Enerav. UNFCCC. World Resources Institute. IPCC. official sources

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Note: \* Excludes emissions from land use change and forestry (LUCF) if possible; INDC targets adjusted to focus on industrial GHG emissions. \*\* Business as usual (BAU) based on economic and policy conditions at the end of 2012 and is consistent with IPCC's AR5 low BAU projection. \*\*\* The Intergovernmental Panel on Climate Change estimates that to limit global average temperature rise to under 2 degrees Celsius this century, emissions would need to fall by 66% from 2010 emissions levels by 2050 and up to 100% by 2100.

# Climate policy track record

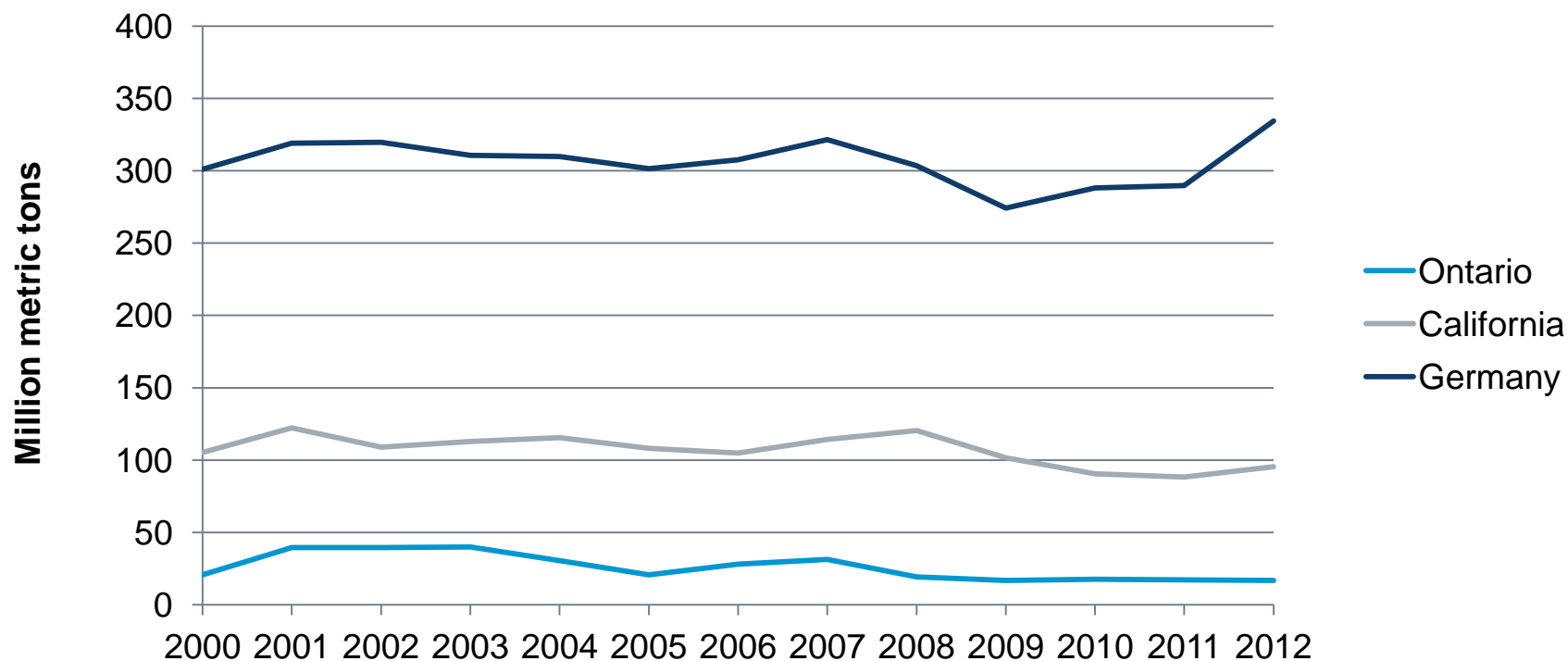
World carbon intensity and economic development (1990-2012)



Notes:: The 2,900 lbs per capita per year curve represents a carbon footprint consistent with the annual average remaining IPCC's carbon budget.  
Source: IHS, EIA, World Bank

# Power sector CO2 emissions: Ontario, California, Germany, 2000-12

## Power sector CO2 emissions



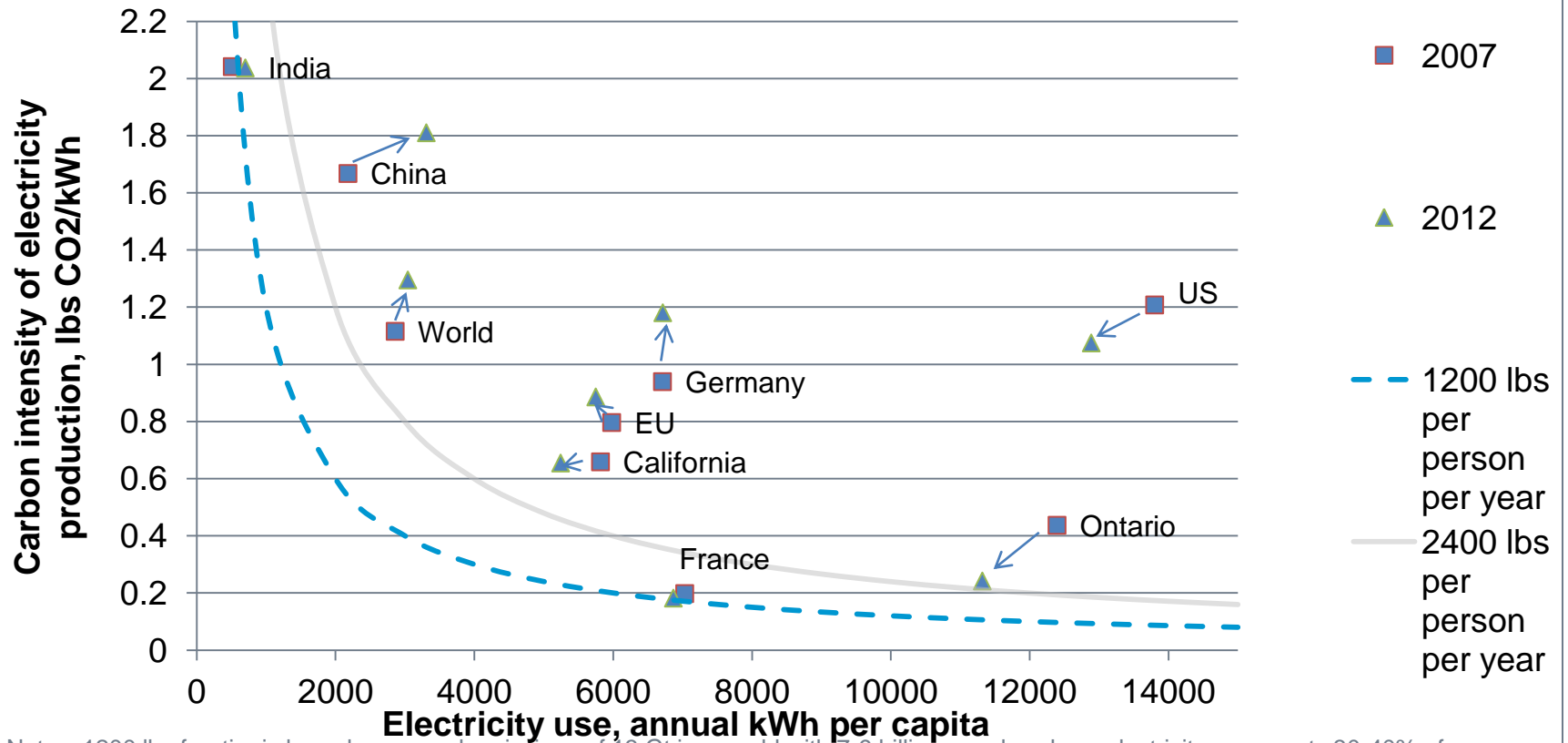
Source: IHS, IEA, California Air Resources Board

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# Per capita electricity carbon footprint versus 1200 lbs CO2/year frontier

## Electricity carbon intensity v. electricity usage, 2007 and 2012



Notes: 1200 lbs frontier is based on annual emissions of 13 Gt in a world with 7-9 billion people, where electricity represents 30-40% of emissions.

Source: IEA (emissions), EIA (electricity consumption), World Bank (population)

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# EU objectives for 20/20/20 targets in 2020, 2008

**The climate and energy package is a set of binding legislation which aims to ensure the European Union meets its ambitious climate and energy targets for 2020.**

A 20% reduction in EU greenhouse gas emissions from 1990 levels;

Raising the share of EU energy consumption produced from renewable resources to 20%;

A 20% improvement in the EU's energy efficiency.

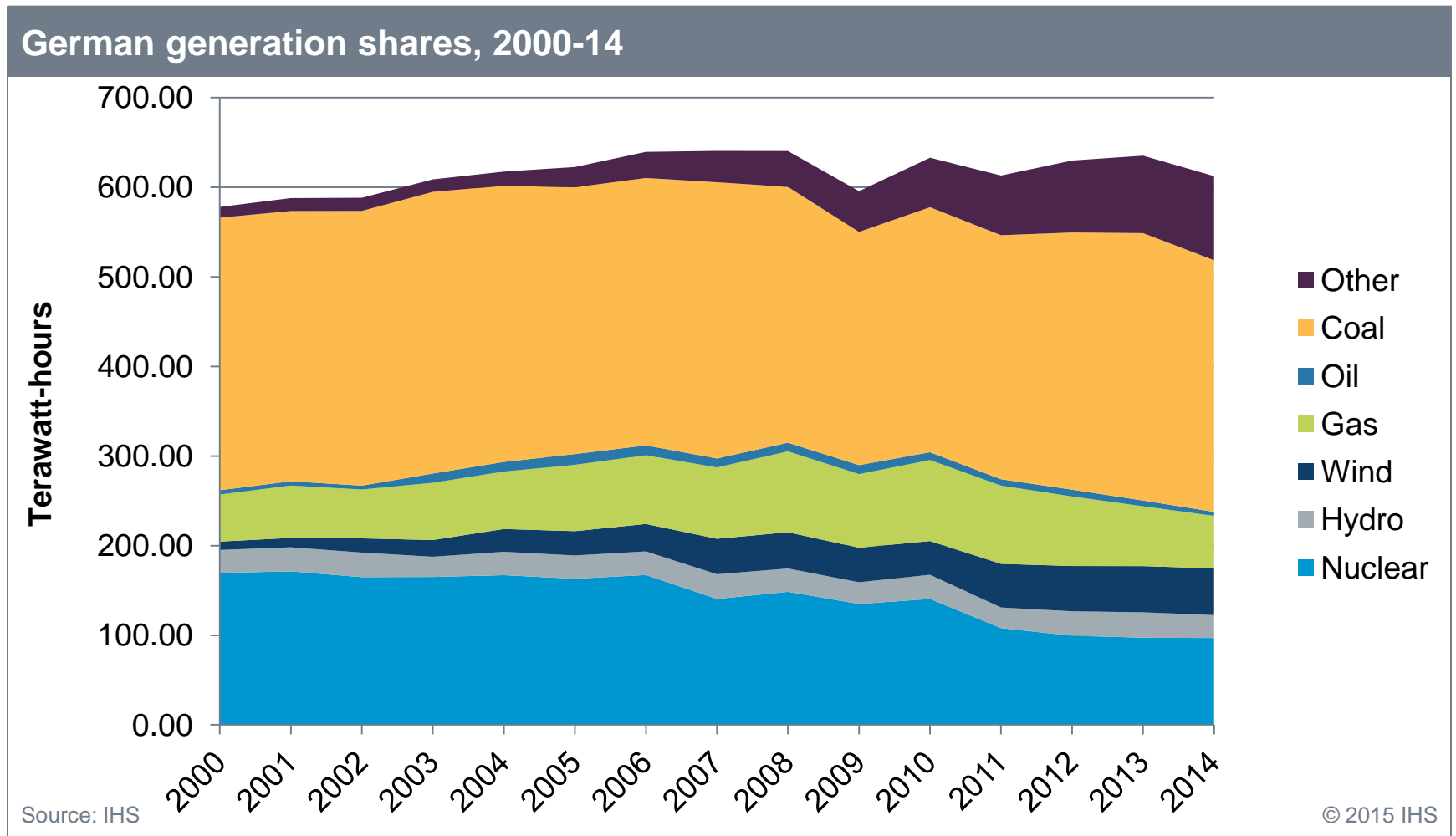
**“To develop a broader growth strategy to boost international competitiveness and create jobs by making a decisive transition to a smarter and sustainable low carbon economy.”**

—European climate and energy package, released 23 January 2008, adopted 12 December 2008

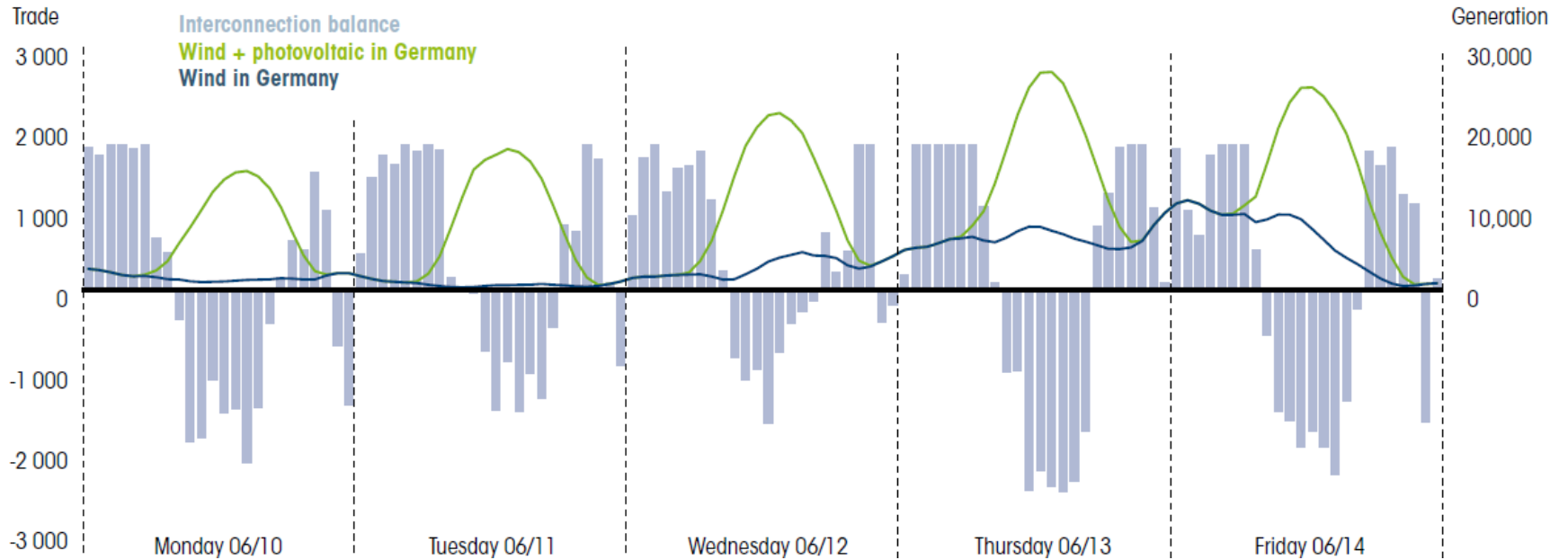
# German power supply, 2014

<b>German power supply, 2014</b>			
<b>Type</b>	<b>Capacity (GW)</b>	<b>Production (TWh)</b>	<b>Share of production</b>
Coal	50.4	274.8	48%
Solar	38.7	34.6	6%
Wind	37.8	61.2	11%
Gas	21.7	50.7	9%
Nuclear	12.0	88.4	15%
Hydro	11.7	27.4	5%
Other	8.1	34.9	6%
<b>Total</b>	<b>185.0</b>	<b>576.5</b>	<b>100%</b>
Source: IHS			© 2015 IHS

# German generation shares, 2000-14



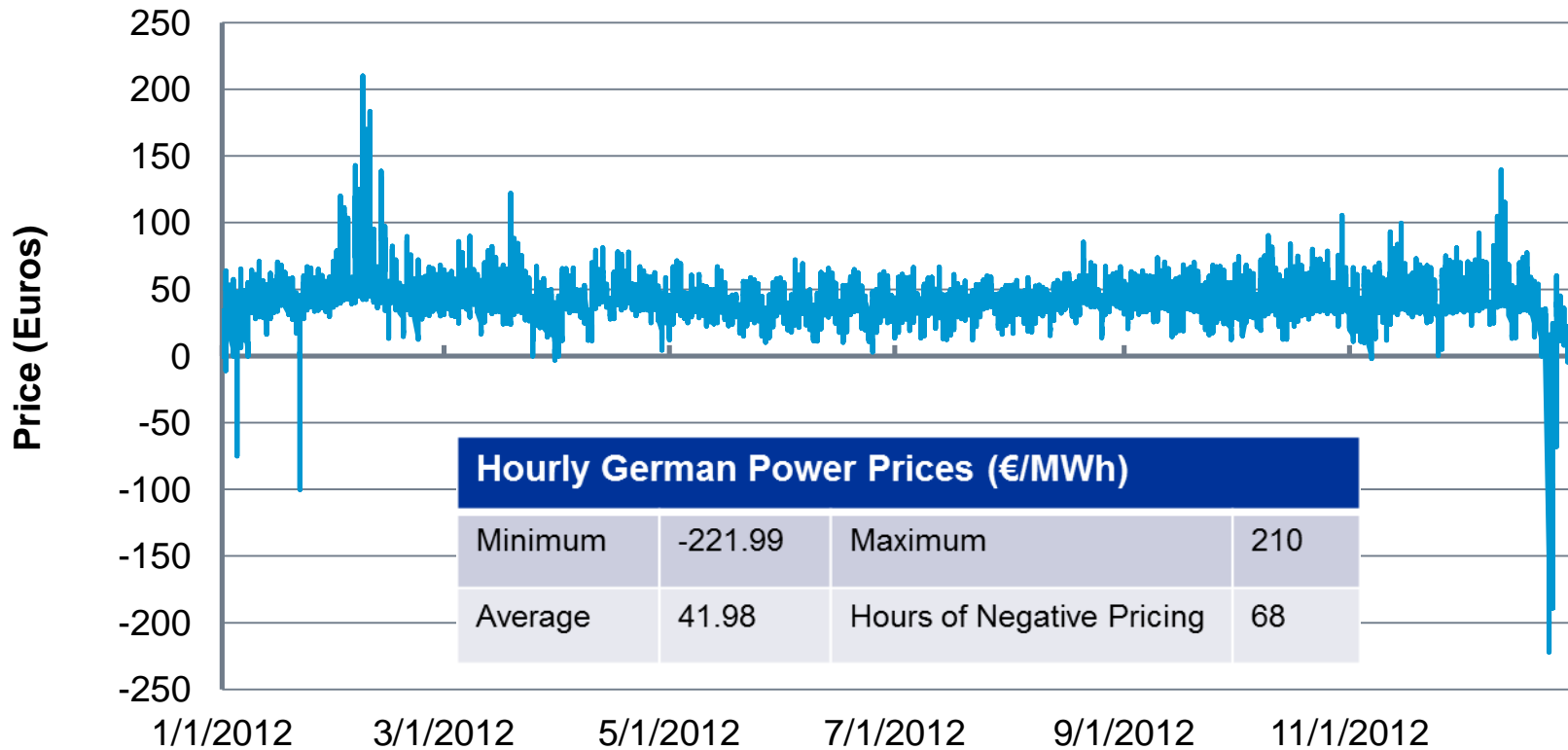
# Germany & France Interchange



Source: RTE Data from EDF

# Hourly German wholesale power prices, 2012

Hourly German Wholesale Power Prices, 2012

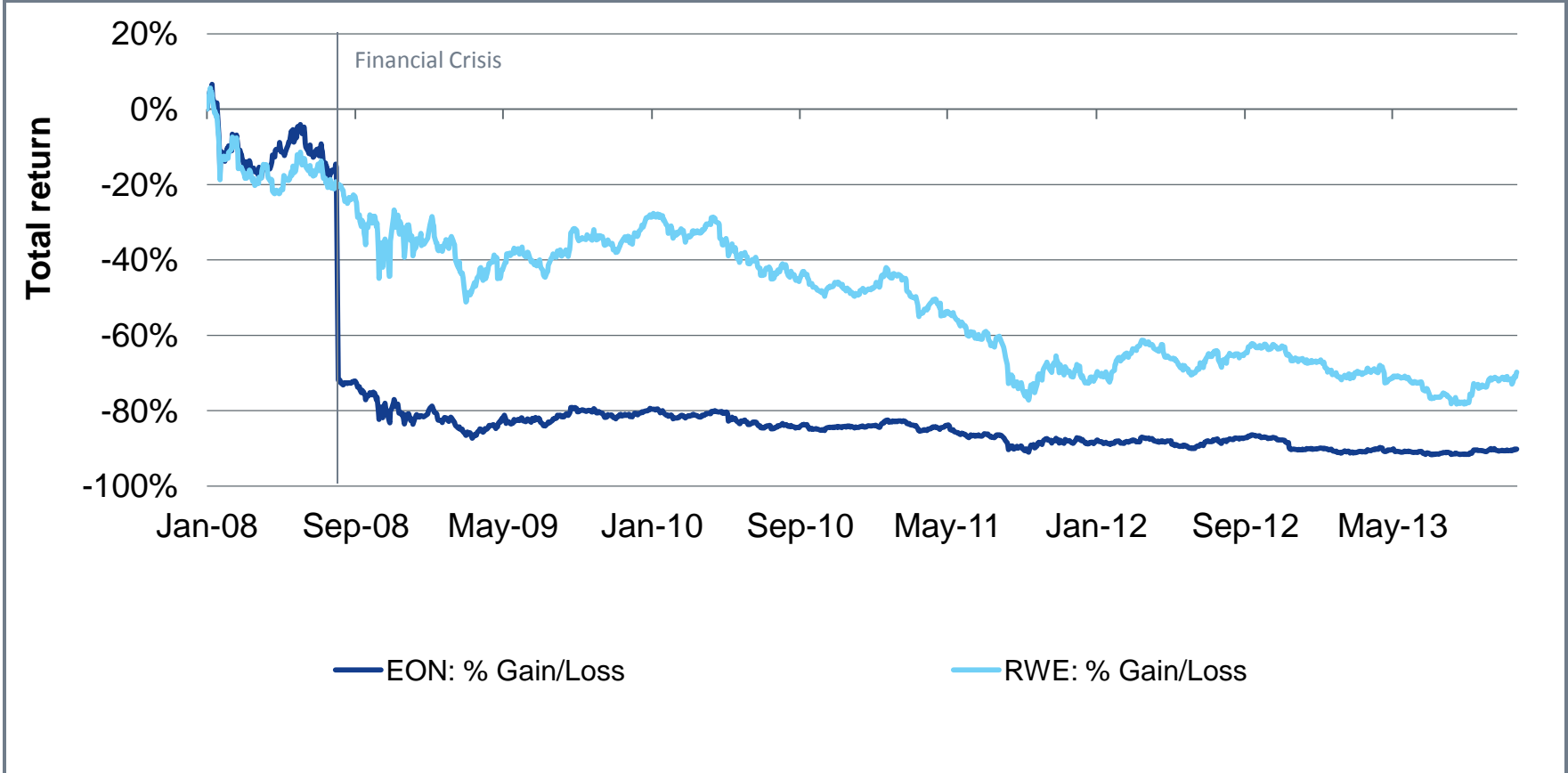


Source: IHS, EPEX spot auction data

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# RWE and E.ON stock price change

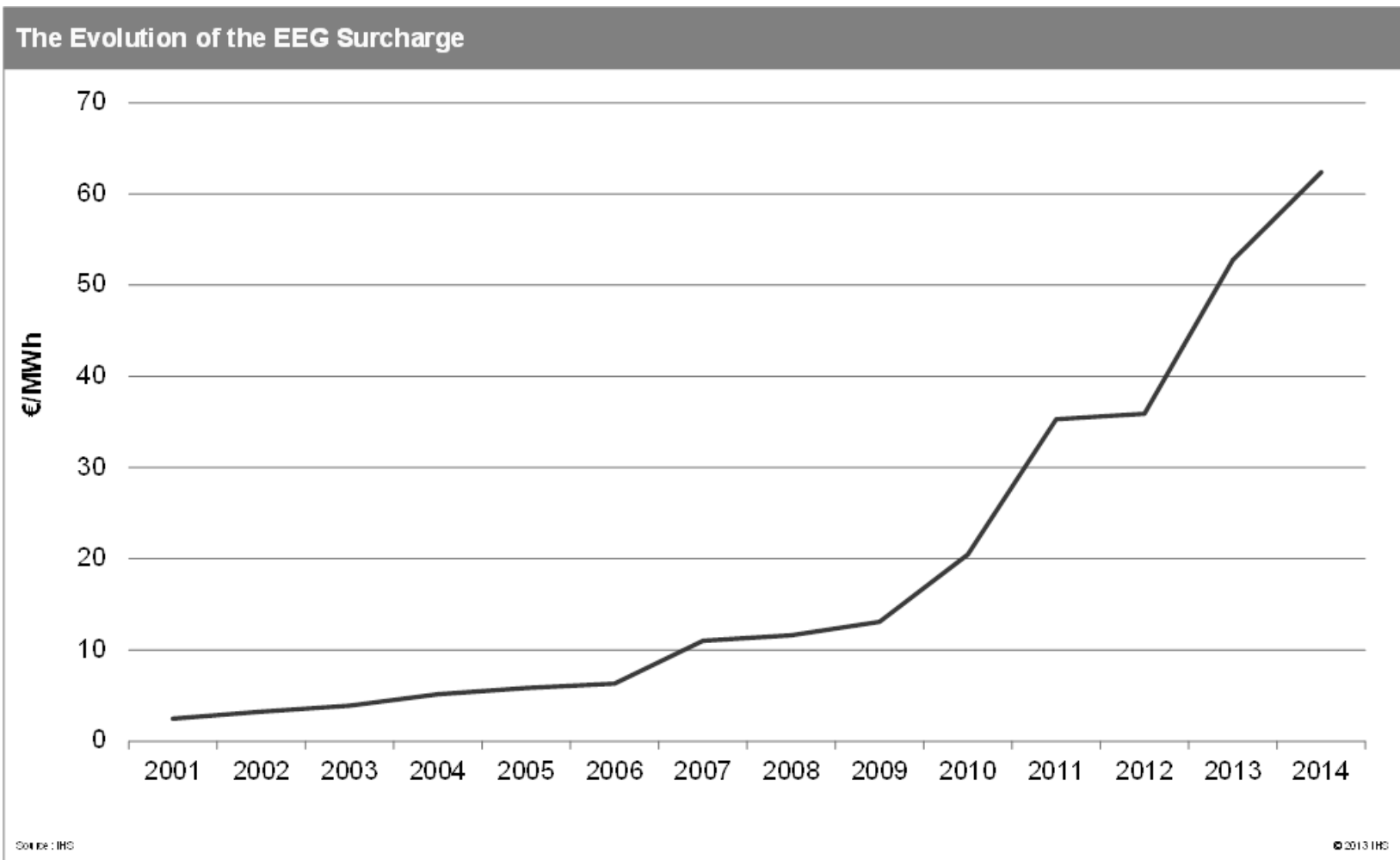
RWE and E.ON stock price change, January 2008 to November 2013



Source: IHS CERA, Google Finance

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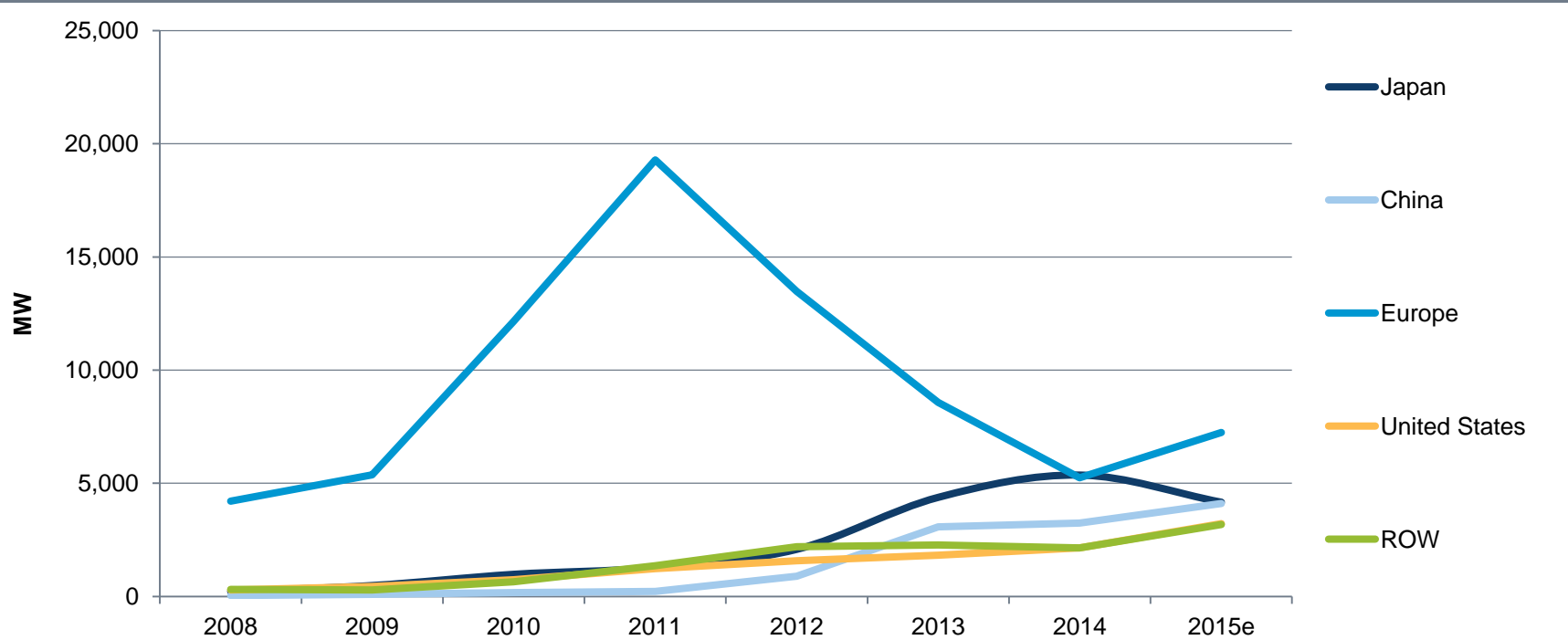
# Evolution of the EEG Surcharge in Germany





# Select countries / regions – Annual DG solar PV additions (< 5 MW)

Annual capacity additions of distributed solar PV (<5MW): 2008–2015e



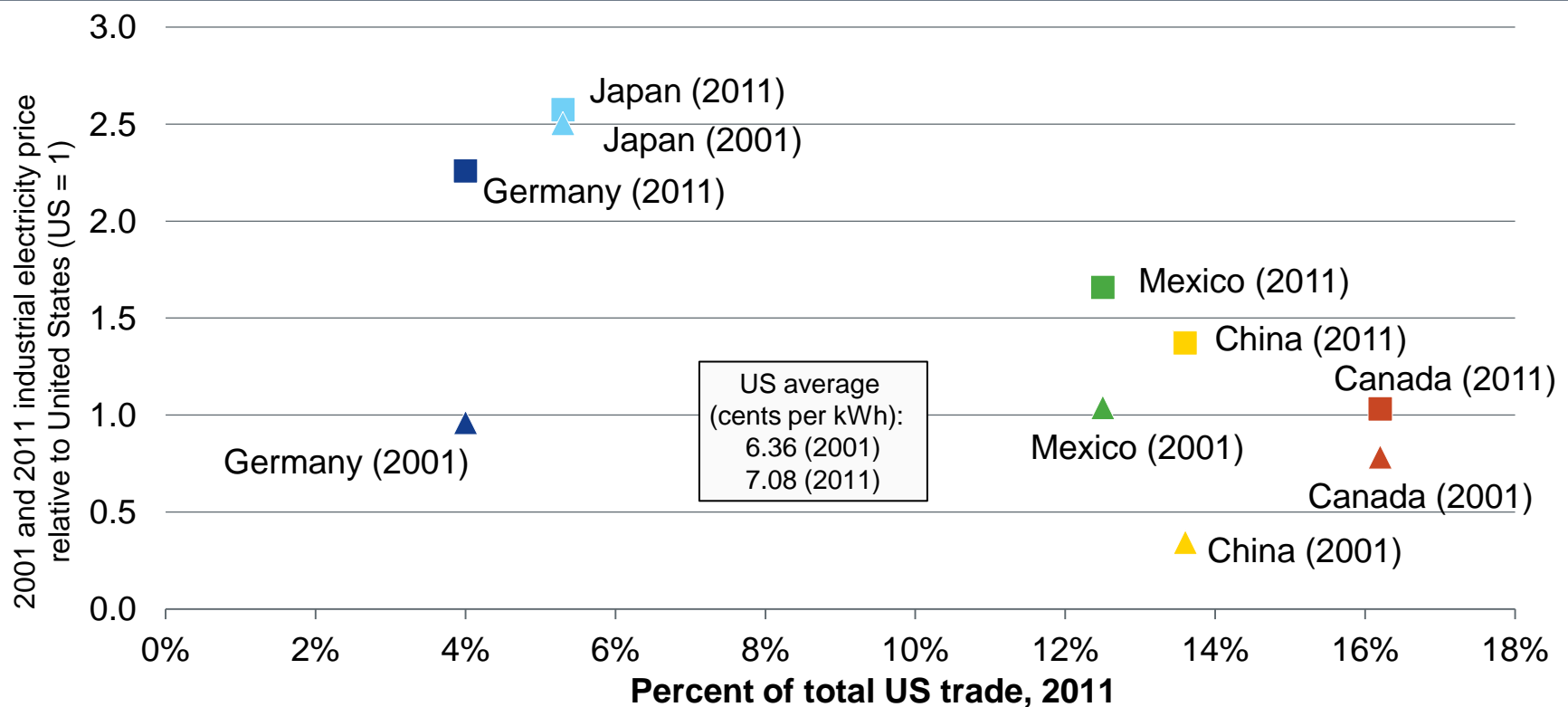
Notes: ROW = Rest of World. Includes all solar PV capacity that is less than 5 MW.  
Source: IHS

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Annual global distributed solar additions (< 5 MW) have been relatively flat for five years as a step decline in Europe has not yet been fully offset by rising growth in Japan, China, and the United States.

# Relative industrial electricity prices for top five US trading partners

Relative industrial electricity prices for top five US trading partners



Note: Total trade = exports plus imports

Source: IHS CERA, US Census Bureau, OECD/IEA

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## German utility transition

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- One-quarter of global installed solar PV is in Germany providing 5 percent of generation along with 9 percent from wind
- Nuclear generation declined from 30% of power supply in 2000 to 7% in 2012 and is scheduled for elimination by 2022.
- German real power prices increased 10% per year since 2000 and reduced economic competitiveness and delayed economic recovery.
- Intermittent generation integration challenges drove construction of coal-fired power plants
- German CO2 emissions began increasing
- Political backlash challenged cost recovery and destroyed utility valuations

# Policy Lessons

- Cost and performance characteristics limit the potential of wind and solar in climate action plans
- The cost to increase electric consumption efficiency is positive and increasing
- Nuclear impacts are too big to dismiss
- Costly imbalances exist between the marginal cost of CO<sub>2</sub> abatement actions in the power sector
- Cost impacts inevitably dictate the pace of change
- The appealing illusion of low cost solutions is an obstacle to effectively addressing climate change