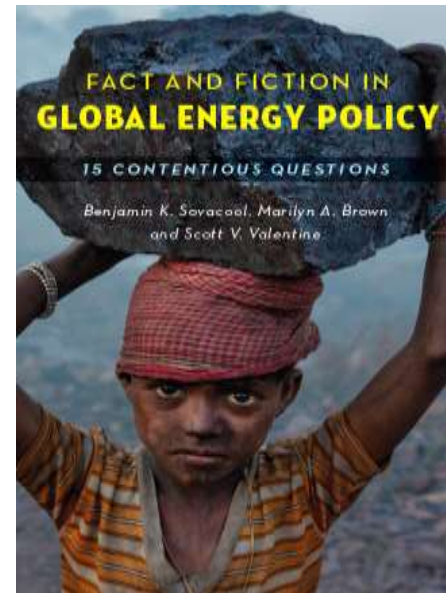


# Author Insights: Fact and Fiction....

**Marilyn A. Brown**

Brook Byers Professor of  
Sustainable Systems  
School of Public Policy  
Georgia Institute of Technology

**Southeast Solar Summit  
Atlanta  
October 20, 2016**



*Fact and Fiction in Global Energy Policy* by B. K. Sovacool, M.A. Brown, & S. Valentine, Johns Hopkins University Press, 2016.

# Some Comments and Dialog Prompted by “Fact and Fiction”



Deconstructing facts and frames in energy research: Maxims for evaluating contentious problems

Benjamin K. Sovacool<sup>a,b,c,2</sup>, Marilyn A. Brown<sup>c,1</sup>

“clearly laid out the competing perspectives on contentious energy questions with such sympathy, humility, and rigor.” Gabrielle Wong-Parodi (Carnegie Mellon)

“insightful, penetrating, and even witty...” Michael Vandenberg (Vanderbilt)



“Why can't we all get along?” A conceptual analysis and case study of contentious energy problems

Frank A. Felder

Edward J. Bloustein School of Planning and Public Policy, Rutgers University, 37 Livingston Ave., New Brunswick, NJ 08901, USA

“introduce[s] readers to the complex sociotechnological system that has emerged around the production and consumption of energy....” Elizabeth Doran and Brian Southwell (Duke)

# Different “Frames” or “World Views”

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Frame	Explanation
Technological optimists	We can design technologies to meet the growing demand for energy services and can repair whatever damage is done.
Free market libertarians	Energy is a collection of commodities such as electricity, coal, oil, and natural gas that is best managed by the free market.
Defenders of national security	Energy supply is a strategic resource that must be defended militarily.
Energy philanthropists	Energy services are a fundamental human right.
Environmental preservationists	Energy production and distribution can be an environmental bane.
...	

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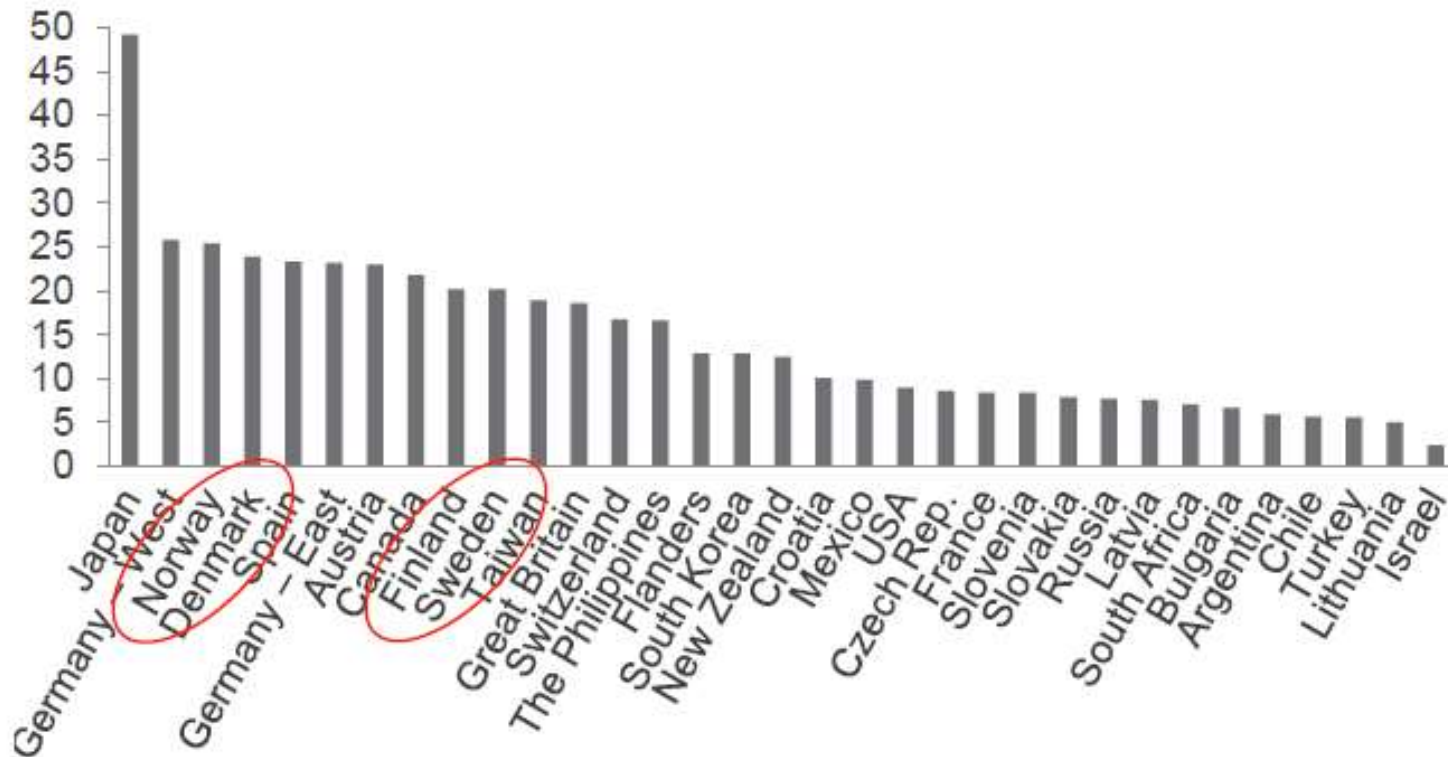
Understanding different “frames” can make people more reflective and informed.

# Different parts of the world have different views...

Percent Selecting Climate Change as Most Important

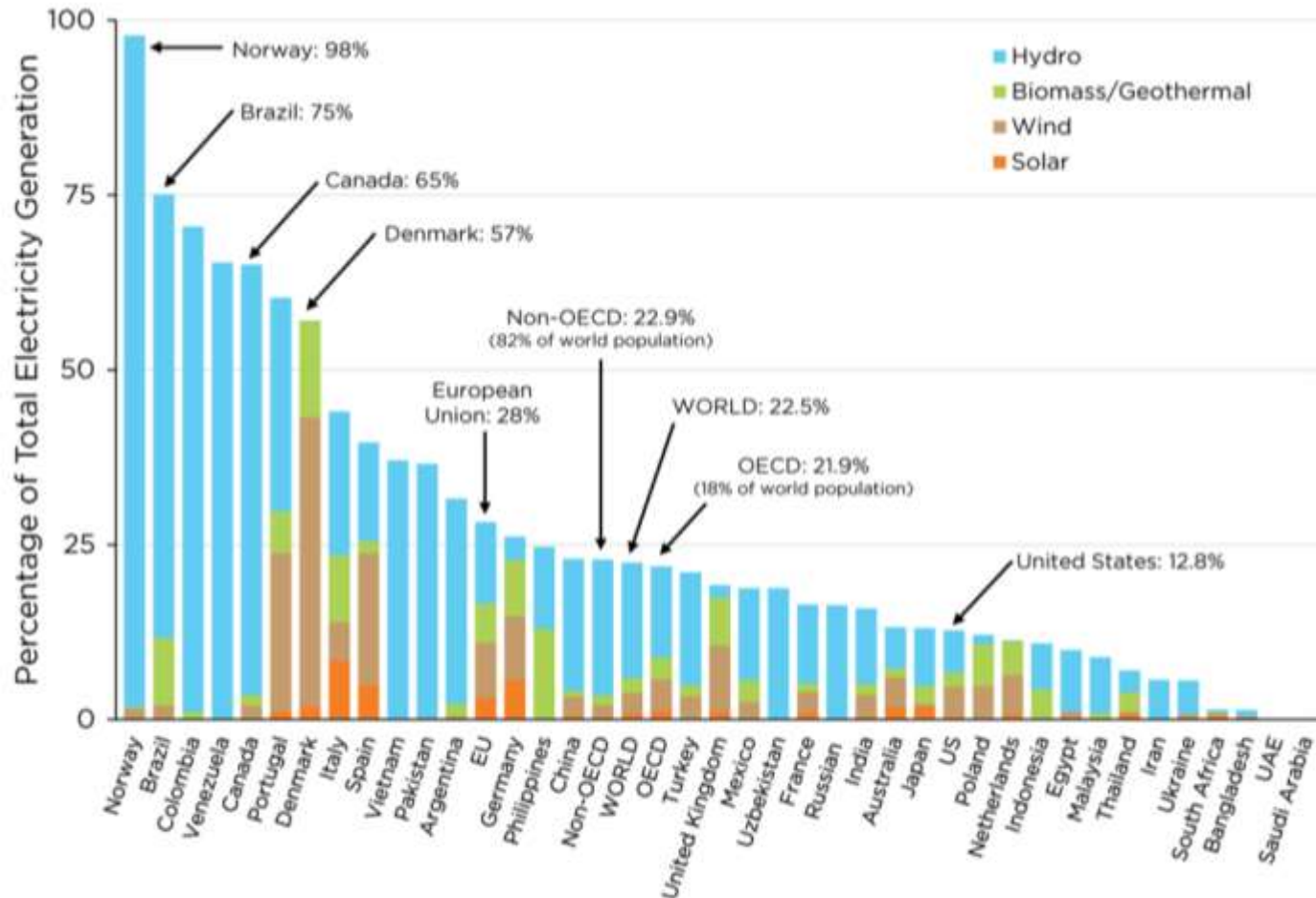
Environmental Problem (2010)

**NORC**  
at the UNIVERSITY of CHICAGO



Source: Sovacool from "Public Attitudes towards Climate Change and Other Global Environmental Issues"

# This View Influences the Prospects for Renewables



Percentage of electricity generated by renewables in selected countries, 2014.

Source: J. David Hughes, Global Sustainability Research, Inc. (data from *BP Statistical Review*, 2015)

# We Use the Hegelian Dialectic

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## Some of the 15 Contentious Questions

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Is shale gas the bridge to a clean energy future?

Is the car of the future electric?

Is clean coal an oxymoron?

Is mitigation or adaptation the best way to address climate change?

Can renewable energy be mainstreamed?

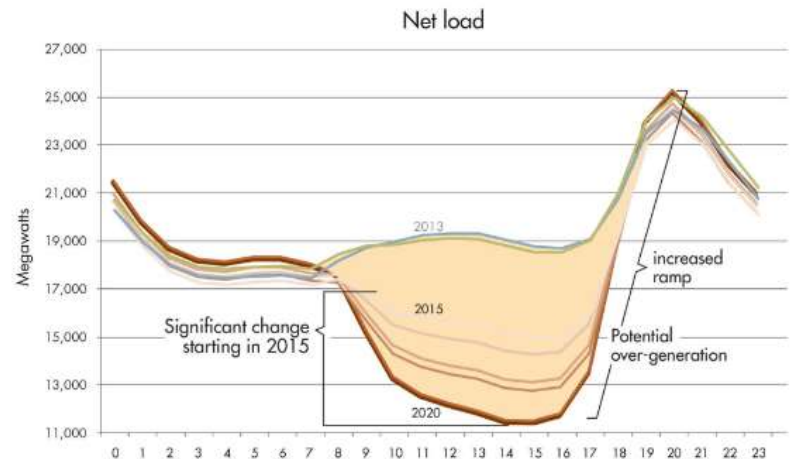
...

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Progress can improve by understanding competing sides of an argument.

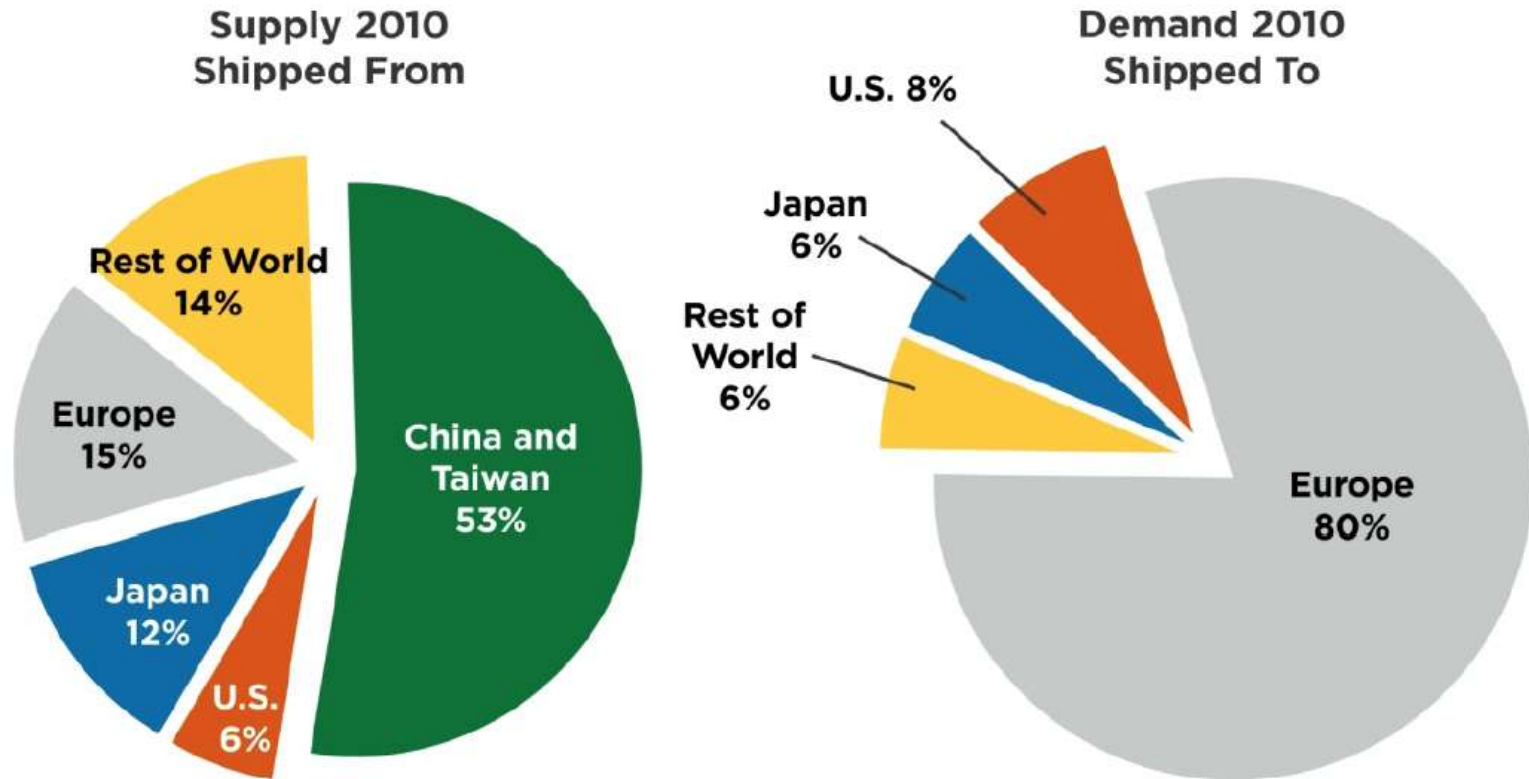
# The “Cons”

- RE requires substantial baseload power backup and increased ramping
- Renewable energy facilities require more land than nuclear or fossil fuel power plants (NIMBY >> BANANA)
- Renewables are expensive



Source: California ISO

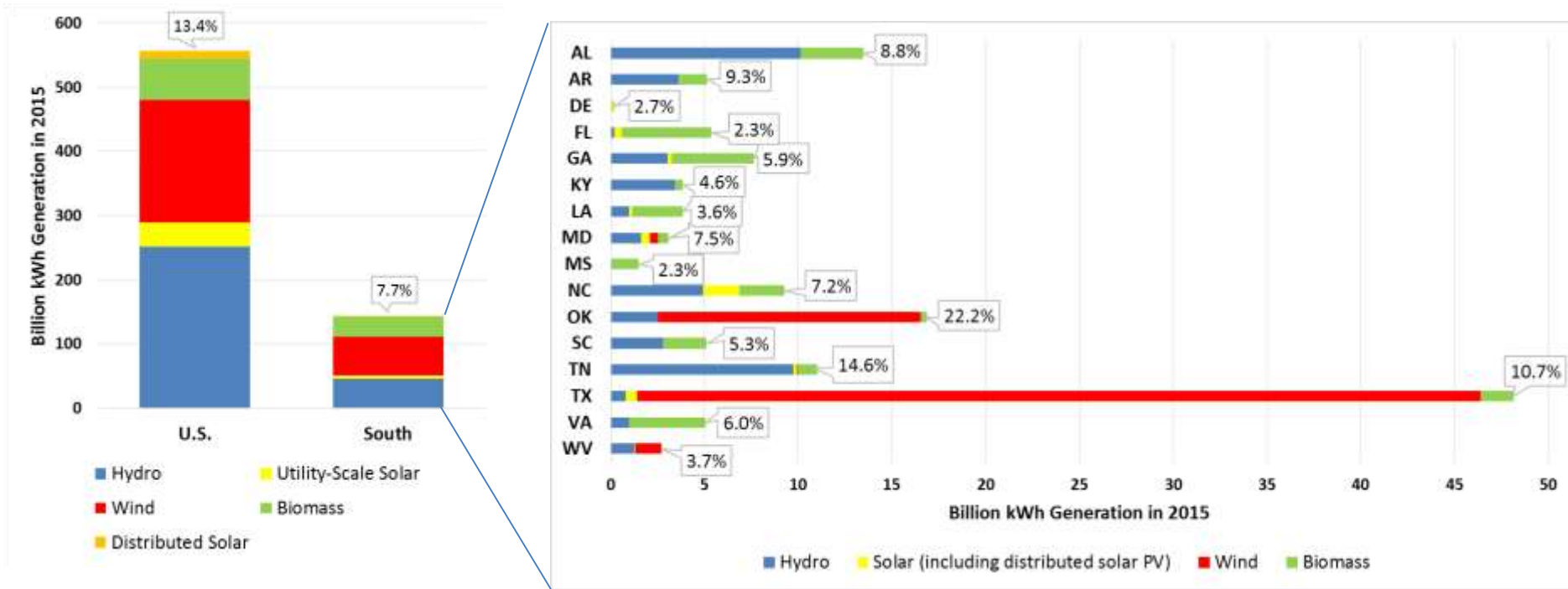
# The U.S. is <10% of Solar Shipments and <10% of Solar Demand



**China dominates solar shipments;  
Europe dominates solar demand.**



# It's a Long way to 100% Renewables



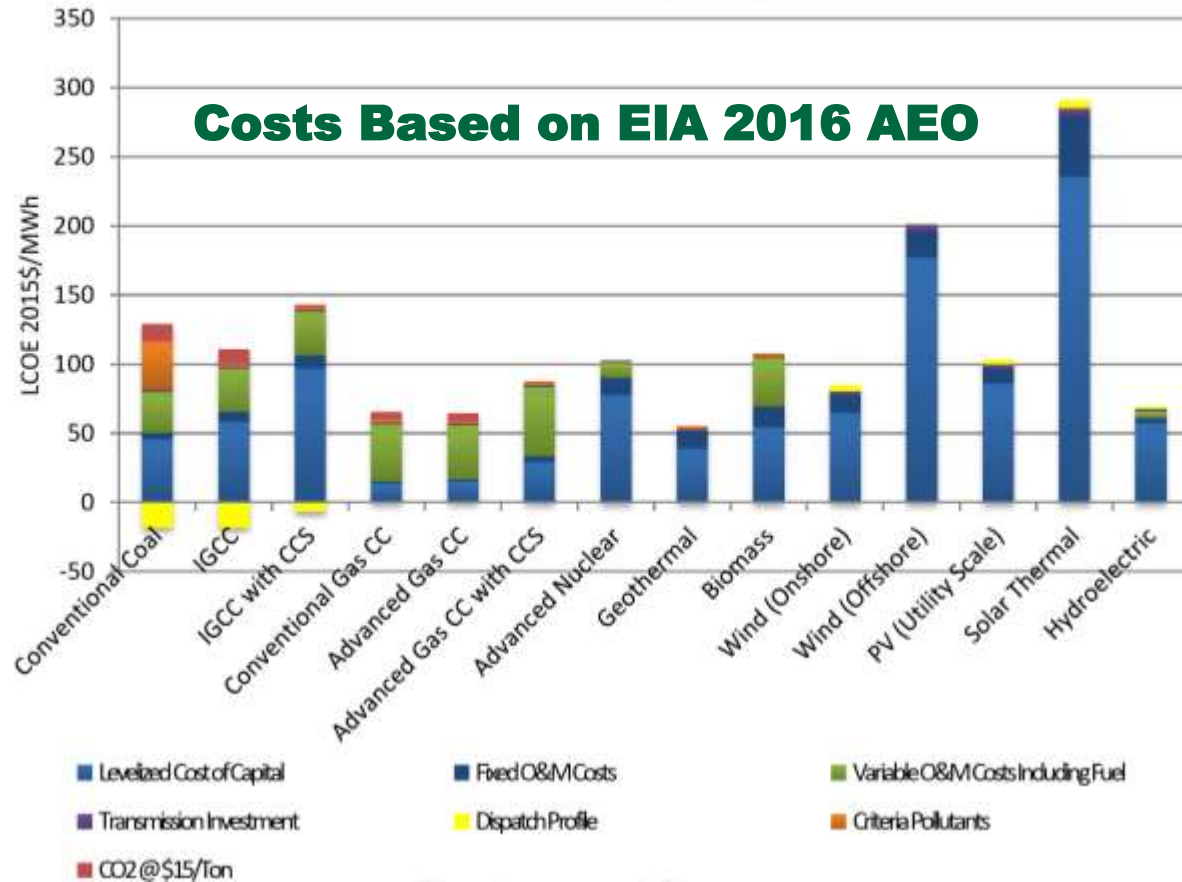
Source: U.S. Energy Information Administration, [Electric Power Monthly](#), Table 1.1A, 1.2C-E, 6.2B.

State level data is also available at <https://www.eia.gov/electricity/data/state/>

Note: Distributed generations are estimated. Utility-scale generations are based on reported generation data.

# It's Hard to Compete with Natural Gas

Levelized Cost of Electricity New Entry  
in 2022 - CO<sub>2</sub> @ \$15/T.

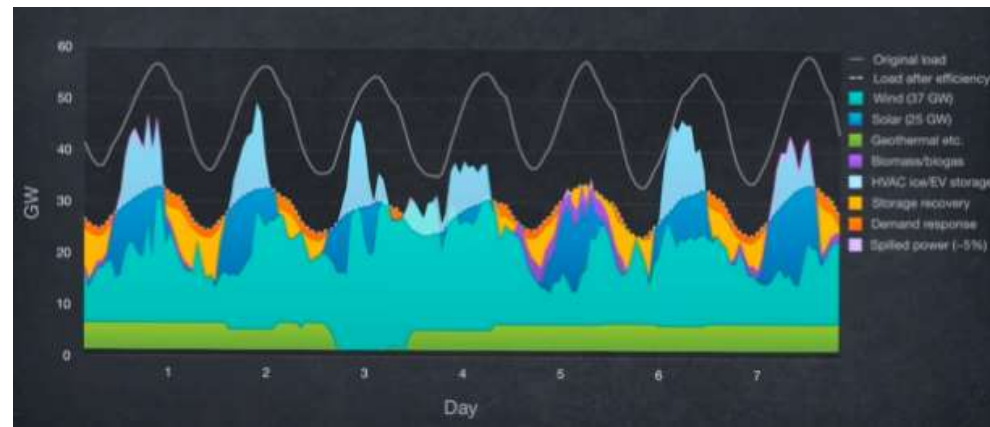


National Academies. 2016. The Power of Change: Innovation for Development and Deployment of Increasingly Clean Electric Power Technologies

# Pros

- There is sufficient renewable energy potential to meet demand
- The cost advantage of fossil fuel technologies is artificial
- The cost profiles of renewable and conventional energy technologies are converging
- Over the past decade, management of stochastic flows has improved

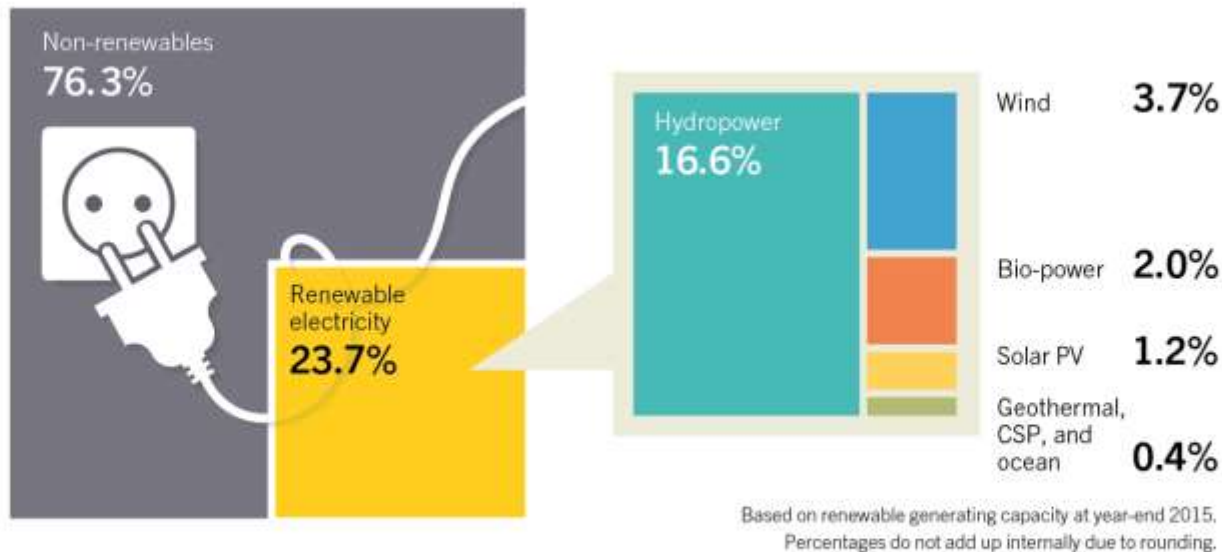
## Choreographing Variable Renewable Generation (ERCOT power pool, Texas summer week)



<http://cleantechnica.com/2014/08/08/rmi-blows-lid-baseload-power-myth-video/>

# Renewable Energy Shares are Growing Across the Globe

Estimated Renewable Energy Share of Global Electricity Production, End-2015



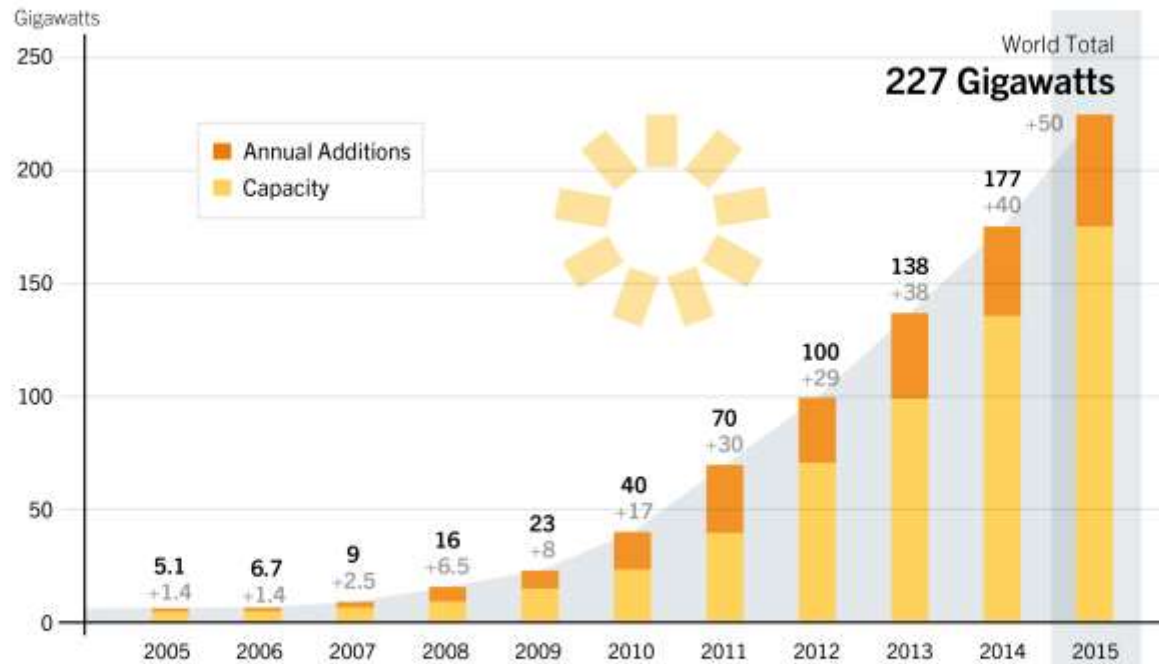
REN21 *Renewables 2016 Global Status Report*



An estimated 22 countries had enough PV capacity at end-2015 to meet more than 1% of their electricity demand, with far higher shares in some countries (e.g., Italy 7.8%, Greece 6.5% and Germany 6.4%).

# Solar PV Global Rates are Accelerating

Solar PV Global Capacity and Annual Additions, 2005–2015



REN21 *Renewables 2016 Global Status Report*



The 2015 solar PV market was up 25% over 2014 to a record 50 GW, lifting the global total to 227 GW.

Source: RENEWABLES 2016 GLOBAL STATUS REPORT

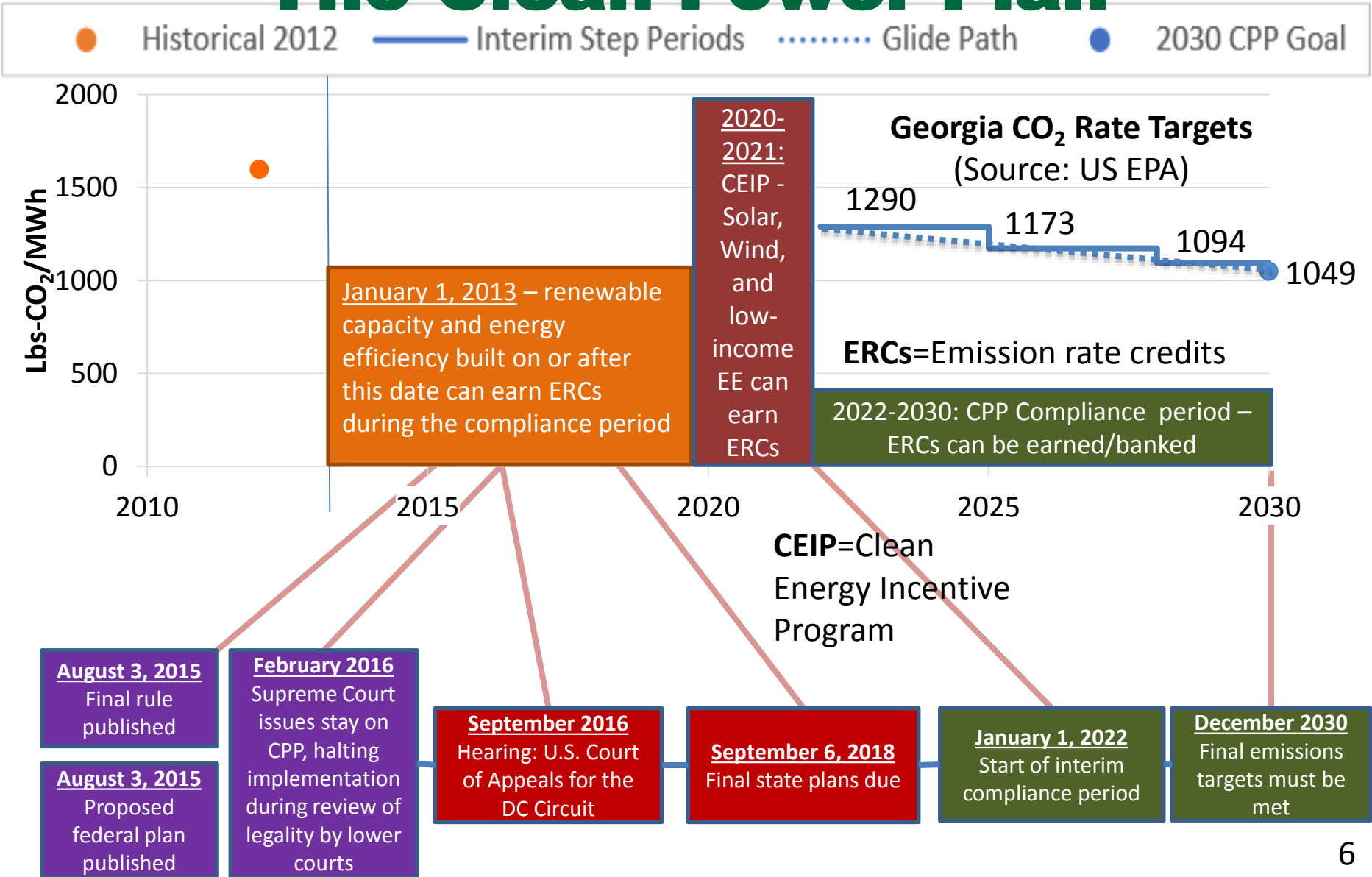
# Global Climate Policy is Moving Forward

## The Paris Agreement:

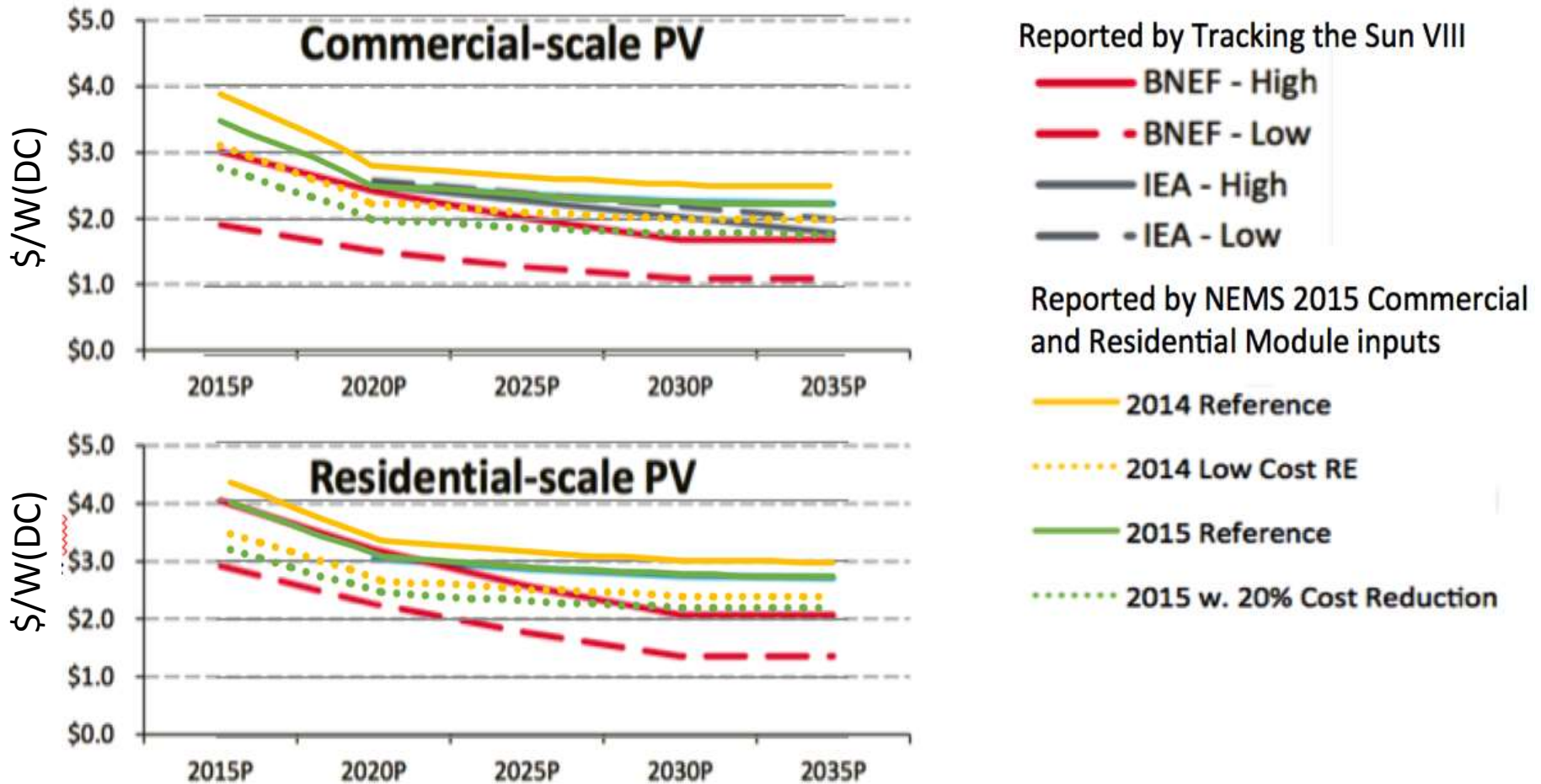


- “strengthen the global response to the threat of climate change by
  - a) Holding the increase in the global average temperature to **well below 2°C above pre-industrial levels** and to pursue efforts to limit the temperature to 1.5°C above pre-industrial levels,
  - b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience
  - c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development.”
- “...achieve a **balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century**”
- “Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.”

# U.S. Climate Policy is Moving: The Clean Power Plan



# The Inexorable March of Technology

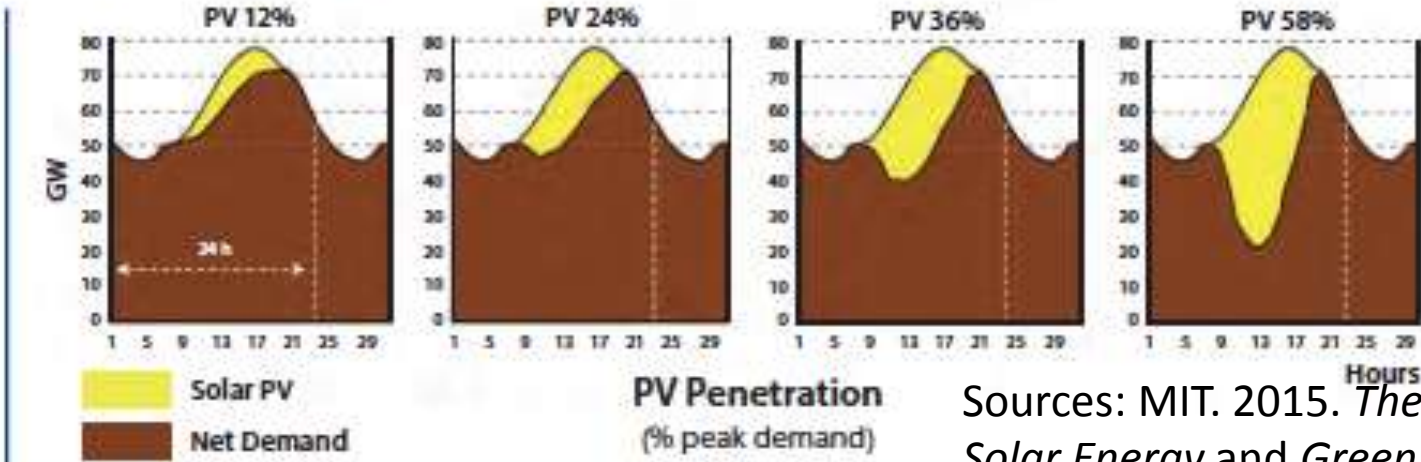


Sources: Photovoltaic System Pricing Trends: Historical, Recent, and Near-Term Projections, 2015 Edition; NEMS 2015 Edition Kgentk and Rsgentk input file



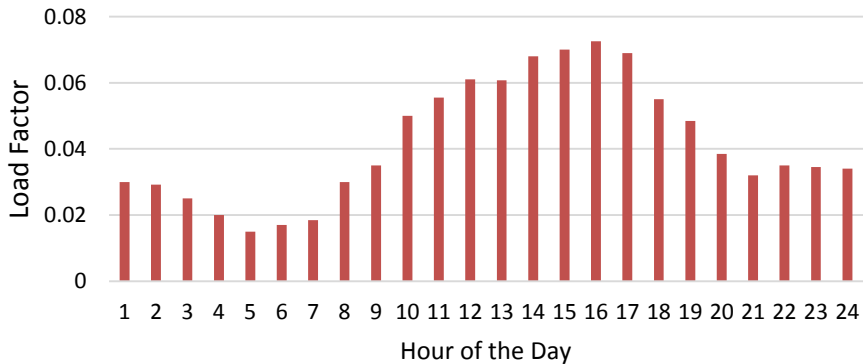
# Smarter Deployment – Matching Load to Generation & Locating PV to Benefit the Grid

Figure 8.1 ERCOT Net Load for a Typical Summer Day at Different Levels of Solar PV Penetration

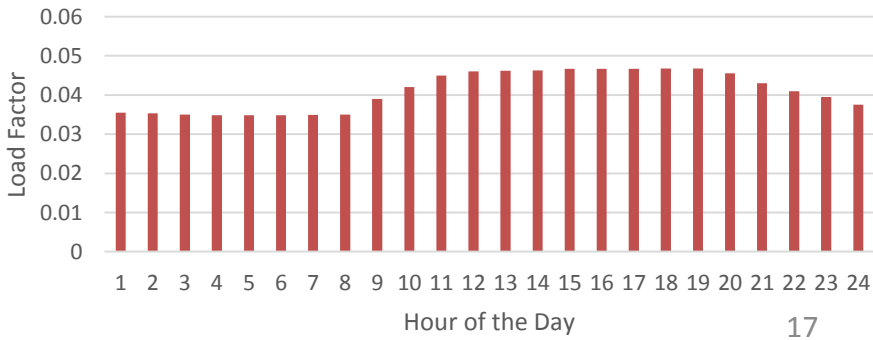


Sources: MIT. 2015. *The Future of Solar Energy and Green Savings*

Commercial Large Office Space Cooling, Chicago (COCCAC02): May, Week-day



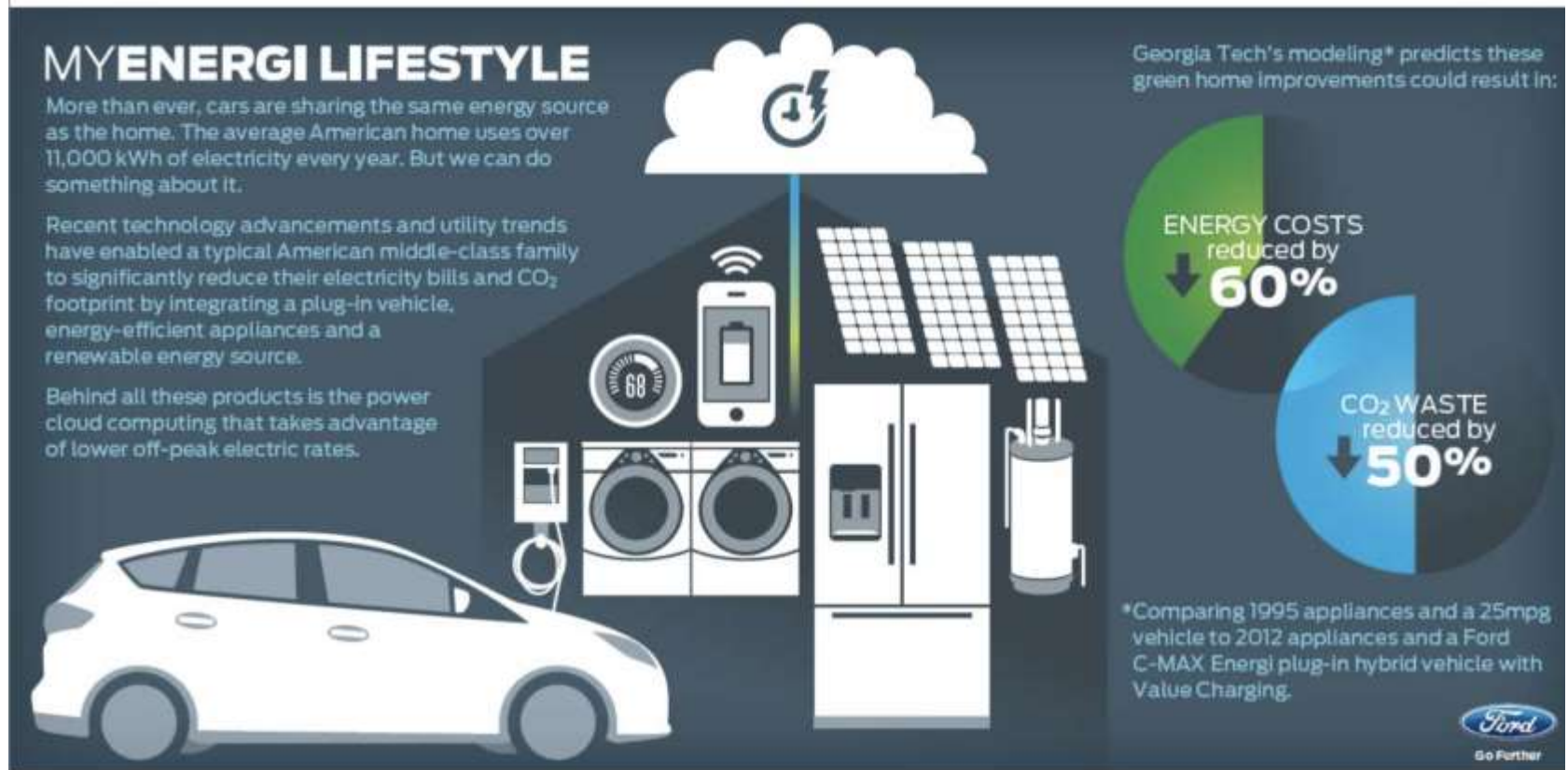
Commercial Hospital Ventilation, Topeka (CHSVNT02): August, PEAK-DAY



# Synthesis: Systems Integration & Diversification

- Viewing renewables as elements of a diverse energy mix offers numerous benefits
  - Integration with EE and demand response to reduce ramping
  - Integration with transportation for frequency support, ramping capability, and voltage control
- A diverse portfolio of technologies helps attenuate load imbalances
- Portfolio diversification allows states and nations to weather unexpected disruptions and exploit local geographical competencies
- Spreading out the supply of energy across technological platforms minimizes the damage that can be caused by sole reliance on a single technology.

# Synthesis: Systems Integration and Diversification



Copyright Georgia Institute of Technology, 2016

Source: Bert Bras (2016)

[http://cepl.gatech.edu/sites/default/files/attachments/BB\\_100Renewable\\_Aug4\\_2016.pdf#](http://cepl.gatech.edu/sites/default/files/attachments/BB_100Renewable_Aug4_2016.pdf#)

# For More Information

20

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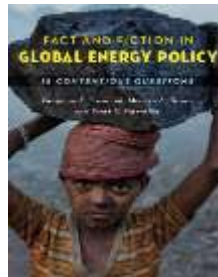
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**EXTRAS**

# TVA Renewable Generation Options

