Hot Science Cool Talks

UT Environmental Science Institute

# 77

# *From Fracking to the 40 Acres: Energy Challenges for UT, Texas, and the World*

**Dr. Michael Webber**

**February 24, 2012**


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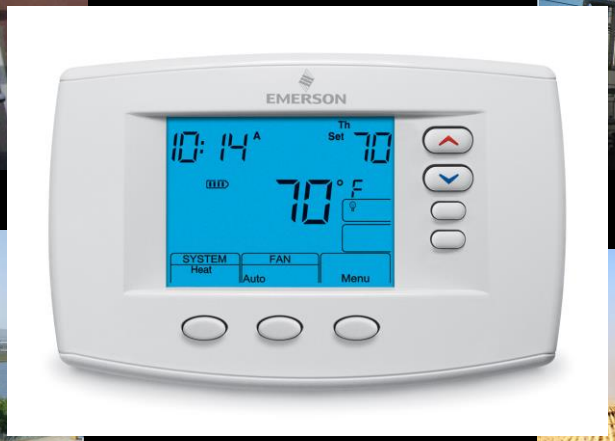
**Environmental Science Institute**
**Hot Science - Cool Talks**

**Michael E. Webber, Ph.D.**
**February 24, 2012**

# *Energy Is Good: It Enables Things We Like and Need*

Transportation

Industry



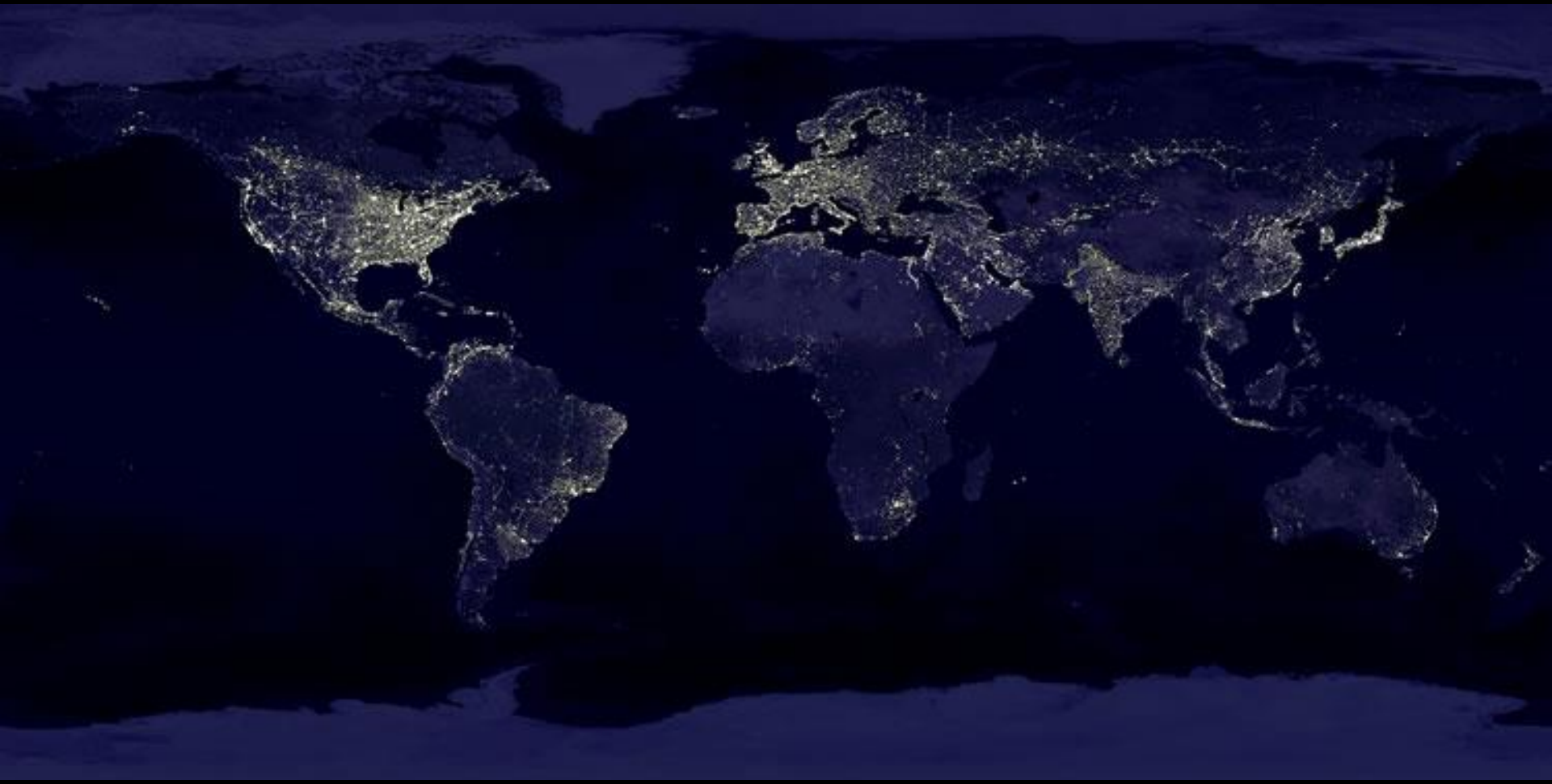

Home Comfort

Clean Water

Agriculture

http://www.themotorreport.com.au/18859/vfacts-market-down-but-some-surprising-winners
http://www.ccwater.com/photopages/index.asp
http://www.agrifoodforum.com/agricultural_products.html
http://www.emersonclimate.com
http://www.savewrt.com/index_files/industry.htm

# *The Global Map of Electricity Consumption and Wealth Are Identical*



http://www.princeton.edu/~ina/infographics/lights_earth.html

**Michael E. Webber, Ph.D.**

# *Energy Has Drawbacks, Too*

# *The Energy Problem Is Comprised of Three Converging Crises*

- **Three energy crises:**
  - **Resource Depletion**
  - **Environmental Degradation**
  - **National Security & Violent Extremism**
- **All three are related and amplify each other**

# *These Challenges Are Exacerbated by Macro Trends That Drive the Energy System*

- **Population Growth**
- **Economic Growth**
- **Urbanization**
- **Industrialization**
- **Electrification**
- **Motorization**

# *Approximately 1 Billion People Suffer From Chronic Hunger*

Source: UN World Food Program

www.theepochtimes.com/n2/world/ten-million-facing-food-crisis-in-horn-of-africa-58469.html

# *Approximately 1 Billion People Do Not Have Access to Clean Drinking Water*

- **Plus 80% of global population at high risk of threats to water security**

Source: UN, *Nature*

© Brian Fraunfelter

# *Approximately 2.5 Billion People Do Not Have Access to Sanitation*

http://www.plumbersurplus.com

http://endtheneglect.org

Source: UN

# *Approximately 5 Billion People Do Not Have Access to Computers or the Internet*

Source: Internet Worldstats

http://www.bhphotovideo.com

# *At least 2 Billion People Do Not Have Access to Telephones*

- **There are 5 billion mobile phone accounts globally**
  - **Maybe an allegory for distributed energy leapfrogging centralized energy?**

http://www.dazadi.com


Data Source: ITU

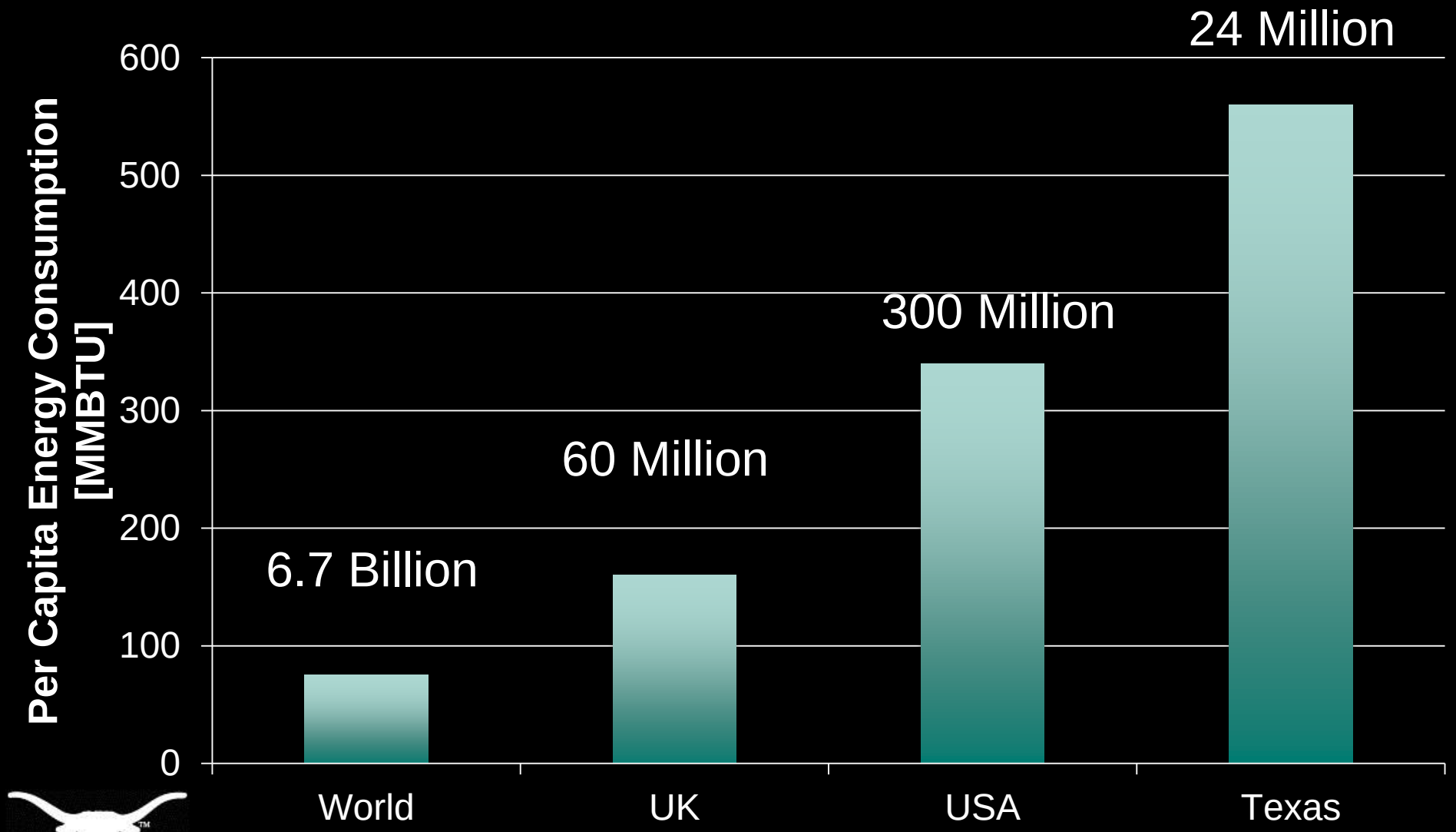
# *There are only 600 million cars and 250 million trucks globally* Source: WorldMapper

http://goodnewsfromindonesia.org/traffic-jams-no-more-we-hope/

# *All Those People Want…*

- **Food**
- **Water**
- **Sanitation**
- **Computers**
- **Phones**
- **Cars**

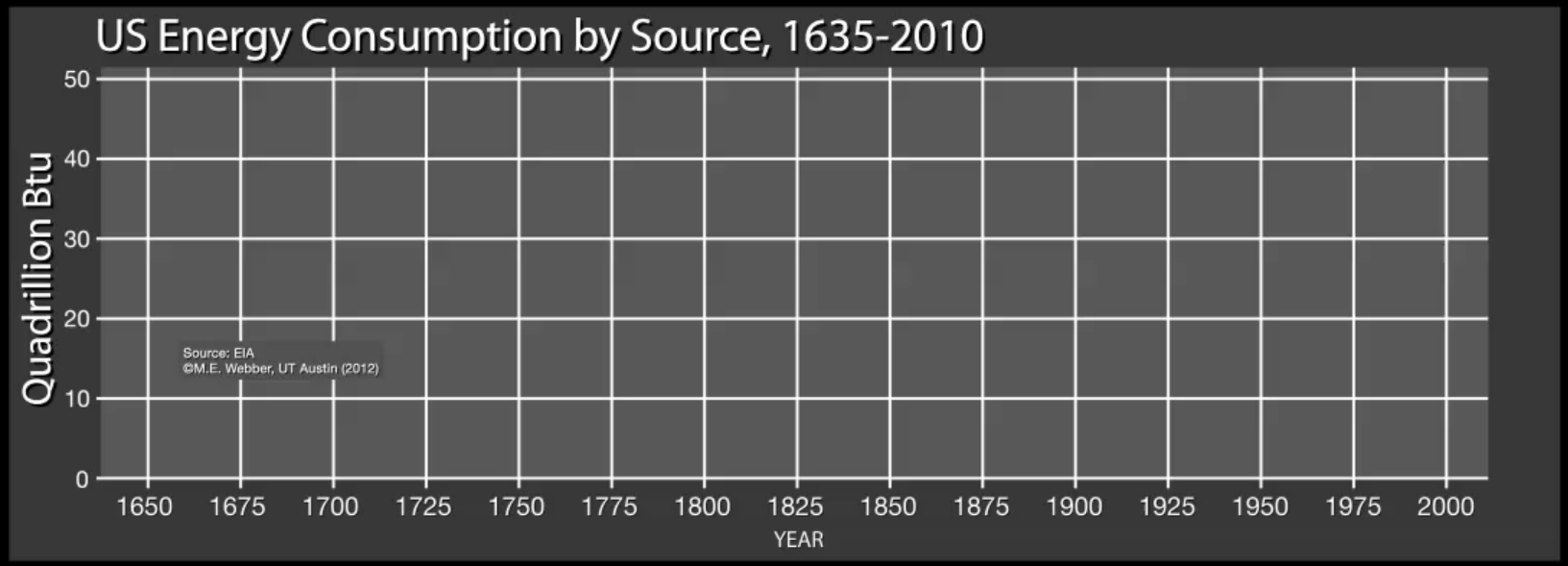
# *Annual Per Capita Energy Consumption Varies From 75 (global) to 560 (Texas) MMBTU*



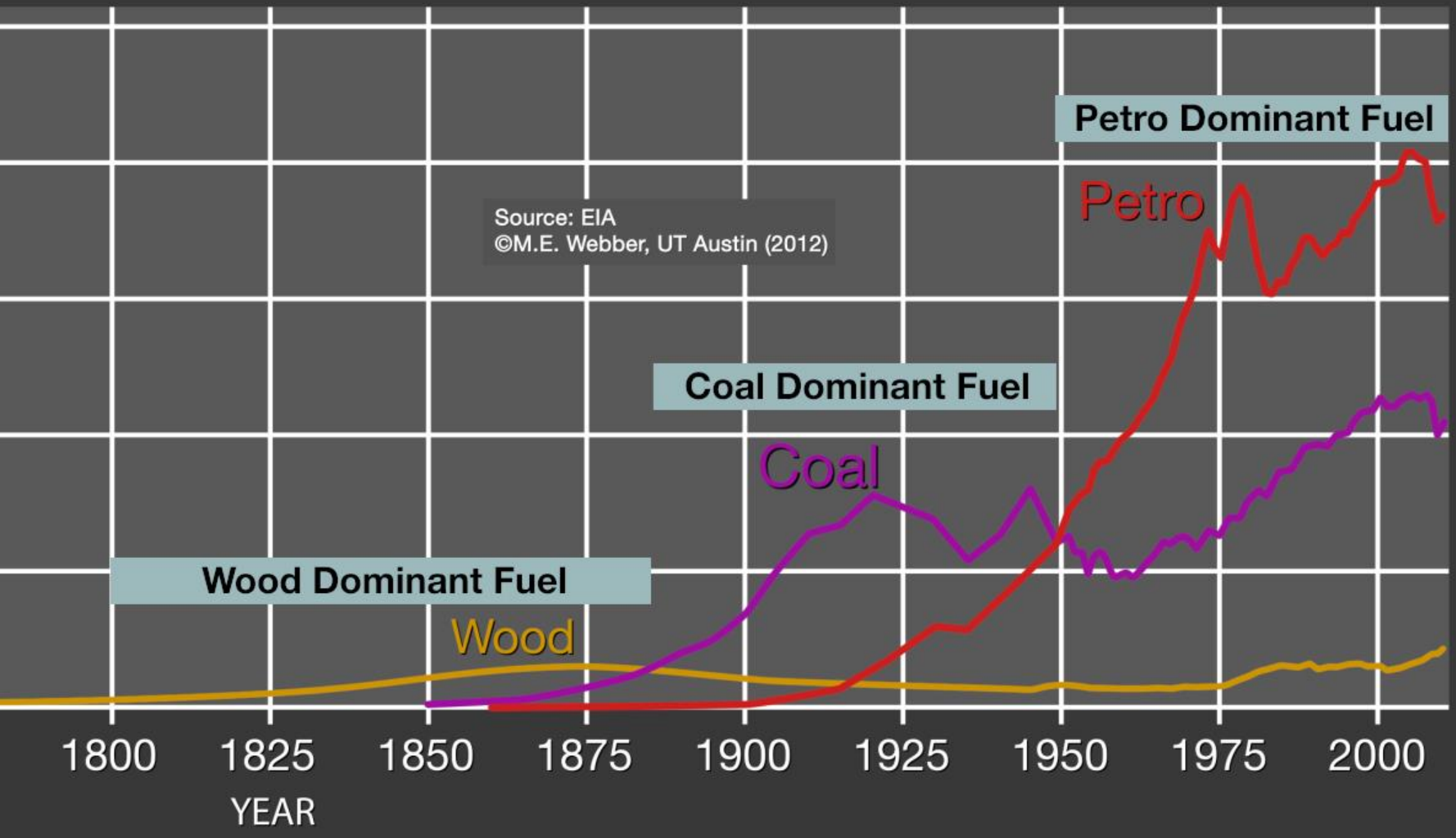

Source: Energy Information Administration

# *Changing Our Energy Mix is One Part of the Solution*

# Our Energy Mix Has Changed Over Time



# Energy Transitions Take a Long Time

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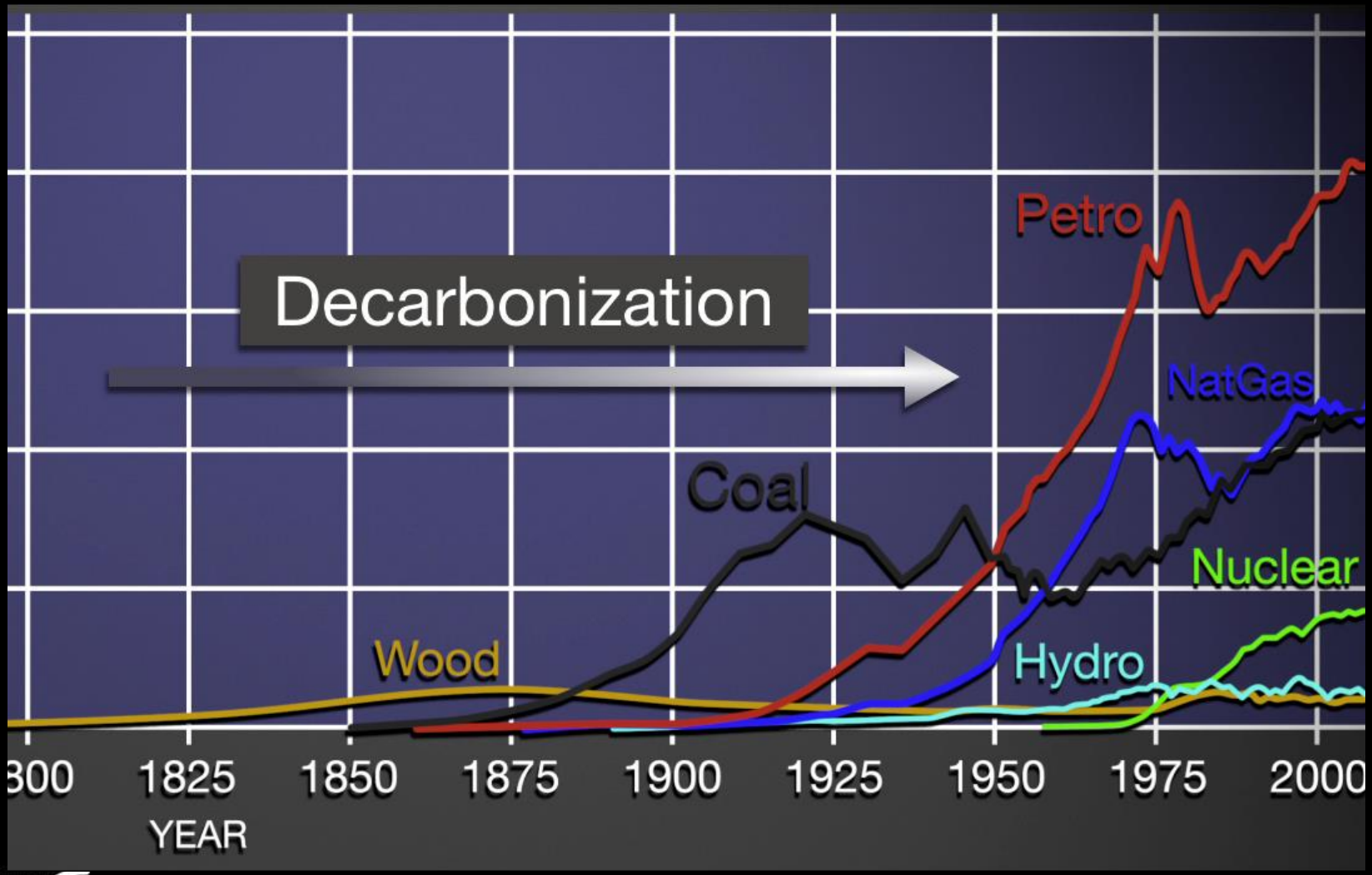
# *Energy Transitions Show a Trend of Decarbonization*




Source: Energy Information Administration

# *So What's the Future of Energy?*

*"It's tough to make predictions, especially about the future."*

Yogi Berra

# *We Know That the Energy System of the Future Will Be Different, We Just Don't Know What They Will Be, Yet*

# *The Energy Transition Will Be Comprised of Three Shifts*

- **A change in total demand for energy**
  - **Population growth pushes total demand up**
  - **Economic growth pushes per capita demand up**
- **A change in our end uses of energy**
  - **All societies electrify over time**
  - **All societies motorize over time**
- **A change in our sources of energy**
  - **Domestic sources**
  - **Low-carbon sources**
  - **Sustainable sources**

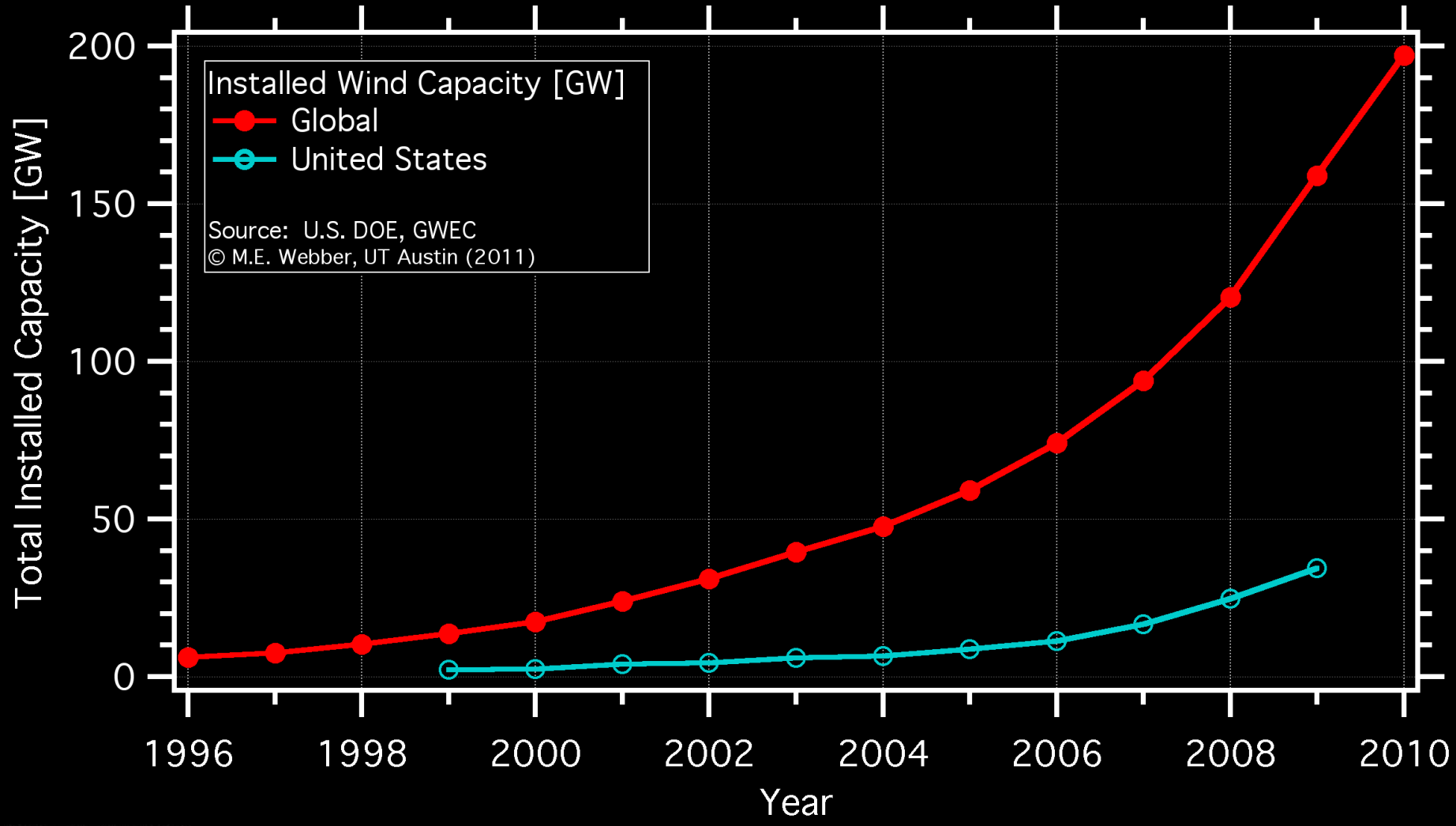
# *An Optimistic Vision of the Future*

- **Energy will get smarter**
  - **Real-time, flexible, self-healing,…**
- **Energy will get cleaner**
  - **Renewable energy prices will keep falling**
- **Energy will be self-fueled for Transportation**
  - **Electric cars with home-charged solar panels**
  - **NG vehicles with home filling**
- **Systems will become distributed**
  - **Distributed power generation**
  - **Distributed water collection, treatment and use**

# *UT and Texas Are Key Parts of The Solution*

- **Electrochemistry**
- **Novel materials for photovoltaic panels**
- **Next-generation biofuels from algae**
- **Carbon Capture & Sequestration**
- **World-leading smart grid research**
- **A super-efficient power plant**
- **Wind power on its own lands**

# Wind Has Enjoyed Phenomenal Growth

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# *Texas Is The World's 6th Largest Wind Power*

| Country | Total Installed Wind Capacity [MW] |
|---|---|
| China | 52,800 |
| United States | 42,432 |
| Germany | 27,981 |
| Spain | 21,150 |
| India | 14,550 |
| *Texas* | *10,135* |
| Italy | 6,200 |
| France | 6,060 |
| United Kingdom | 5,707 |

Global data through June 2011 (World Wind Energy Association)
Texas data through 2010 (American Wind Energy Association)

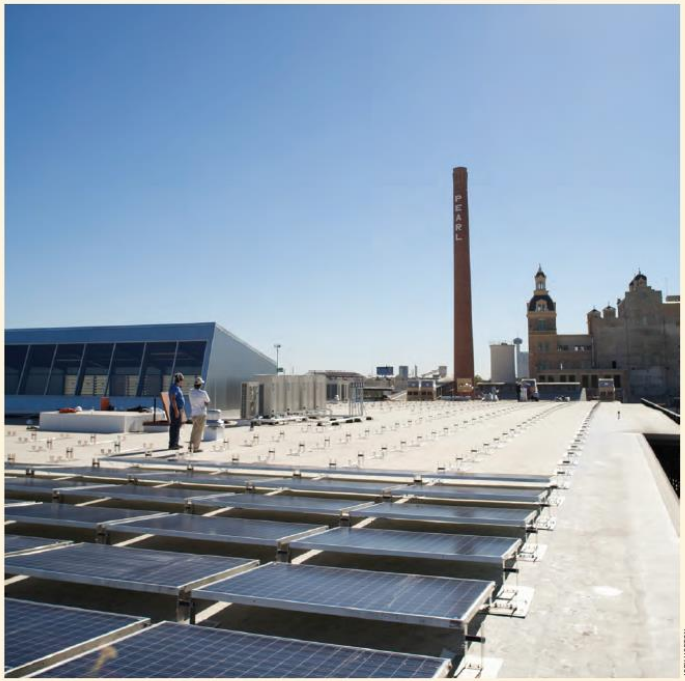
# *Texas Is NOT Top 10 in Solar PV in USA*

| State | Total Installed Solar Capacity [MW] |
|---|---|
| California | 1,102 |
| New Jersey | 128 |
| Nevada | 100 |
| Colorado | 59 |
| Arizona | 50 |
| Florida | 39 |
| New York | 34 |
| Hawaii | 27 |
| Connecticut | 20 |
| Massachusetts | 18 |

Data through 2009 (Solar Energy Industries Association)

# *Texas Will Do For Solar In the Next Decade What It Did For Wind In the Last Decade*

## TEXAS: THE NEXT SOLAR SUPERPOWER?




JODY HORTON

The former Pearl Brewery in San Antonio, Texas, is home to a 200-kilowatt photovoltaic array, the largest installation in the state. In addition to its vast natural resources, Texas also has the man-made resources that are beneficial for a booming solar market.

## Green Star State


***PRIDE OF PLACE:*** *Texas has more oil and gas than any other state. Guess what? We also have the most renewable resources.*
*Illustration by Sarah King*

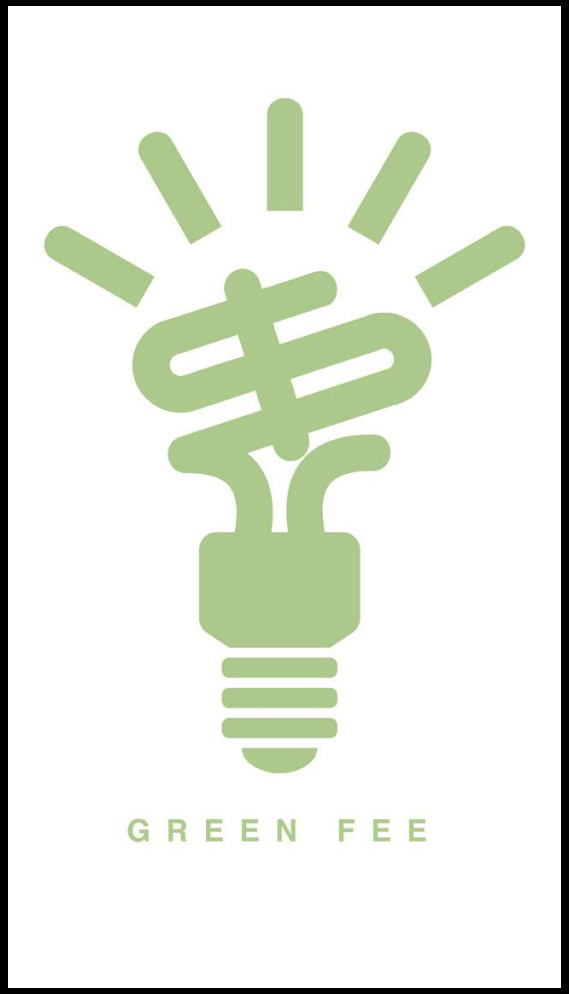
Everything you—and our legislators up at the Capitol—need to know about how to make Texas an energy leader for the twenty-first century.

*by Michael Webber*

# *Prediction #1: Within a Decade, Texas Will Have More Installed Solar Capacity Than Any Other State*

- **We have a lot of cheap, flat, sunny land**
- **We have transmission capacity in place**
- **We have excess natural gas-fired back-up capacity**
- **We have competitive markets with real-time prices that favor peak producers such as solar**
- **We have growing electricity demand**

# *UT Is Shining a Light on Solar*




SECO

State Energy Conservation Office

Parking and Transportation Services

# *We Installed >0.5 MW of Solar on Campus*

- **300 kW at the Pickle Research Campus**
- **29 kW at the Manor Garage**
- **196 kW at the Facilities Complex**

# *The Manor Garage Project is Visible from The Stadium, Capitol, and I-35*

- **Panels from First Solar (Thin film), Sharp (Multicrystalline), and Sunpower (Monocrystalline)**
- **LED lighting by Firefly (Austin, TX)**
- **Installation by Meridian Solar (Austin, TX)**

# *The Facilities Project is Visible from I-35*

- **Panels from SolarWorld**
- **Inverters by Ideal Power Converters (Austin, TX)**
- **EV Charger by Gridbot (Austin, TX)**
- **Installation by Meridian Solar (Austin, TX)**


# *UT Is Already Stepping Up On Solar*

The University of Texas at Austin
Facilities Complex, FC3
200 kW Solar PV Power Project

Installation Time Lapse
December 2011

Webber Energy Group

# *The Trends for Natural Gas Also Look Very Positive*

- **Flexible use**
  - **Direct use on site (heating, power,…)**
  - **Use at power plants**
  - **Use in industry**
  - **Use in transportation**
- **Lower emissions than coal & oil**
- **Less water-intensive than coal, oil, nuclear & biofuels**
- **Domestically produced**

# *Natural Gas Is Not Problem-Free*

- **Water**
  - **Quality: Risks of contamination**
  - **Quantity: competition with local uses, depletion of reservoirs**
- **Land**
  - **Surface disturbance from production activity**
- **Air**
  - **Risks of leaks on-site and through the distribution system**

# *Texas Is The World's 3rd Largest Gas Producer*

| Country | Total Annual Gas Production [TCF] |
|---|---|
| United States | 26,177 |
| Russia | 20,610 |
| *Texas* | *7,654* |
| Algeria | 6,954 |
| Canada | 6,928 |
| Iran | 6,579 |
| Norway | 5,104 |
| Qatar | 3,630 |
| Saudi Arabia | 3,165 |

Global data through 2009 (U.S. EIA)

# *The Key Enabler For The Rise of Natural Gas Is Production From Shale Formations*

# *Hydraulic Fracturing — Fracking — For Shale Gas Production Was Pioneered in Texas*

Courtesy “Haynesville” (Kallenberg & Bullard, 2011)

# *Prediction #2: Within 1 to 2 Decades, Natural Gas Will Overtake Petroleum As The Dominant Energy Source in the USA*

- **Petroleum use will drop by mandate**
  - **Increased fuel economy standards**
  - **Increased biofuels production**
- **Petroleum use will drop because of price pressures**
  - **Natgas is $2.60 per MMBTU of energy**
  - **Diesel is $18.10 per MMBTU of energy**
- **Coal use will drop because of environmental standards**
  - **Mercury, $SO_x$, $NO_x$, PM and $CO_2$ restrictions**

# *Prediction #2: Within 1 to 2 Decades, Natural Gas Will Overtake Petroleum As The Dominant Energy Source in the USA*

- **Natgas will be king by 2032**
  - **If petroleum declines 0.9% annually**
    - **Biofuels mandate = 0.9% annual decline**
  - **If natgas grows 0.9% annually**

- **Natgas will be king by 2022**
  - **If petroleum declines 1.8% annually**
  - **If natgas grows 1.8% annually**
    - **By displacing 25% of diesel use**
    - **By displacing 25% of coal use**

# *We Have A Chance To Improve Our Energy System*

# *Most Important, The World Needs Educators Who Will Train Students To Be The Energy Leaders Of The Future*

http://blog.aynrandcenter.org/does-american-business-need-uncle-sams-help/

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# *Dr. Michael Webber*

Michael Webber is Co-Director of the Clean Energy Incubator at the Austin Technology Incubator, and Assistant Professor of Mechanical Engineering at the University of Texas at Austin, where he trains a new generation of energy leaders through research and education at the intersection of engineering, policy, and commercialization.

He has authored more than 150 scientific articles, columns, books and book chapters, including a compendium of his commentary titled "Changing the Way America Thinks About Energy", which was published in May 2009. A highly sought public speaker, Dr. Webber has given more than 175 lectures, speeches, and invited talks in the last few years, including testimony for hearings of the U.S. Senate Energy and Natural Resources committee, keynotes for scientific conferences, lectures at the United Nations, and briefings for executives at some of the nation's leading companies.

Michael is on the board of advisors for *Scientific American*, holds four patents, and is one of the originators of the Pecan Street Project, which is a $30 million public-private partnership for smart grid innovation and deployment.