

## H.M. HASHEMIAN, Ph.D.

### BIOGRAPHY



**H.M. "HASH" HASHEMIAN** is President and Chief Executive Officer of Analysis and Measurement Services Corporation (AMS), a 42-year-old nuclear engineering consulting firm headquartered in Knoxville, Tennessee, and operating in the United States, Europe, and Asia. He has three doctorate degrees in engineering, including a Ph.D. in nuclear engineering, a Doctor of Engineering degree in electrical engineering, and a Ph.D. in computer engineering.

Dr. Hashemian is the author of three books: *Sensor Performance and Reliability* (ISA, 2005), *Maintenance of Process Instrumentation in Nuclear Power Plants* (Springer Verlag, 2006), and *Monitoring and Measuring I&C Performance in Nuclear Power Plants* (ISA, 2014). His books have been translated into Chinese, Japanese, Korean, and Russian. In addition, he is the author or co-author of 20 U.S. patents (17 awarded and 3 pending).

Dr. Hashemian is a Fellow of the American Nuclear Society, a Fellow of the Institute of Electrical and Electronics Engineers, a Fellow of the International Society of Automation, and an adjunct professor of nuclear engineering at the University of Tennessee.



INNOVATING **NUCLEAR** TECHNOLOGY

# The Future of Energy (Is Hard to Predict)



Presented by:

**H.M. Hashemian, Ph.D.**

*President and CEO, AMS Corporation*



Presented to:  
**State Energy Policy Council**  
*May 24, 2019*



# U.S. is Not Using as Much Electricity as Was Predicted

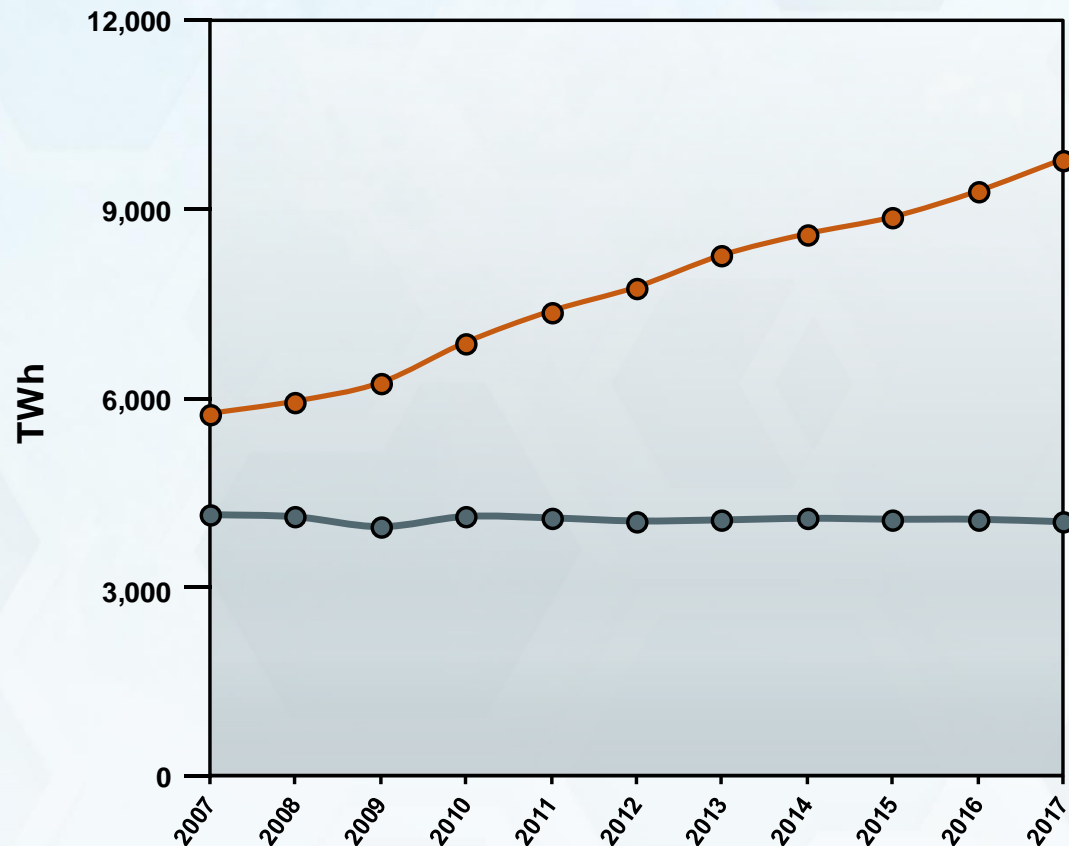


Asia



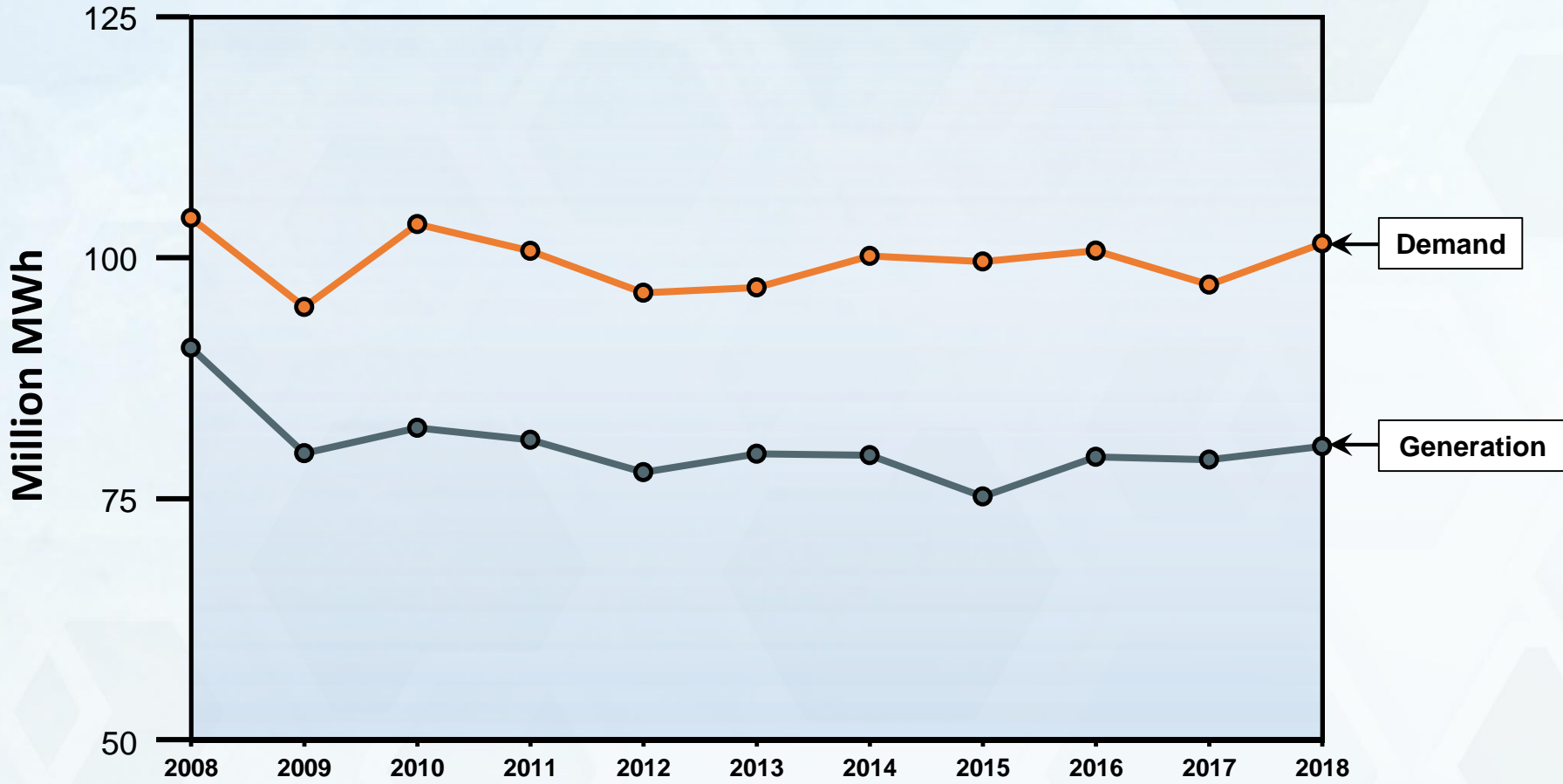
USA

- *Energy Conservation and Efficiency*
- *Heavy Industry Outsourcing*
- *Self-production*



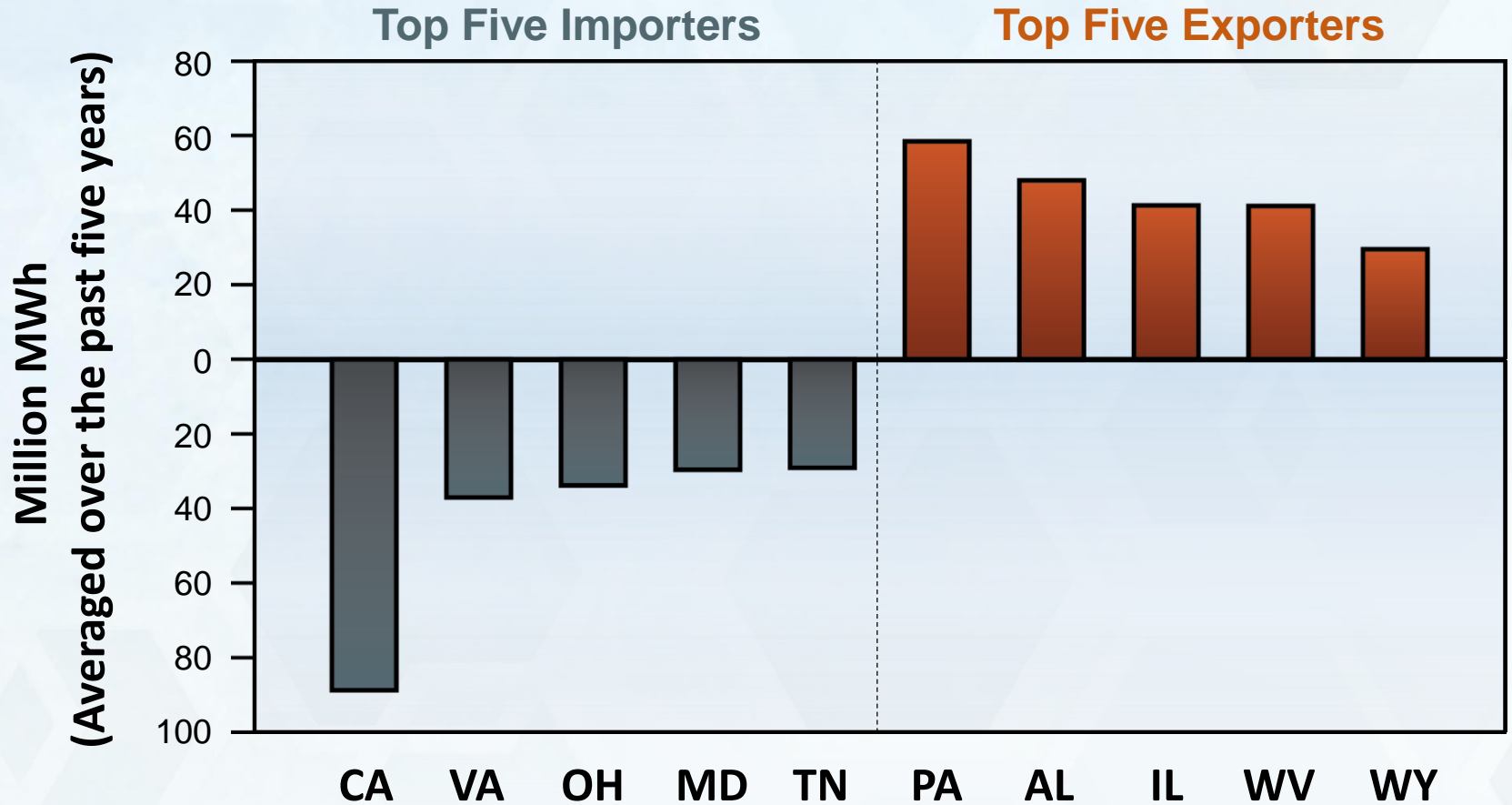


# Tennessee's Electricity Production and Consumption Has Not Changed Much Over the Past Decade



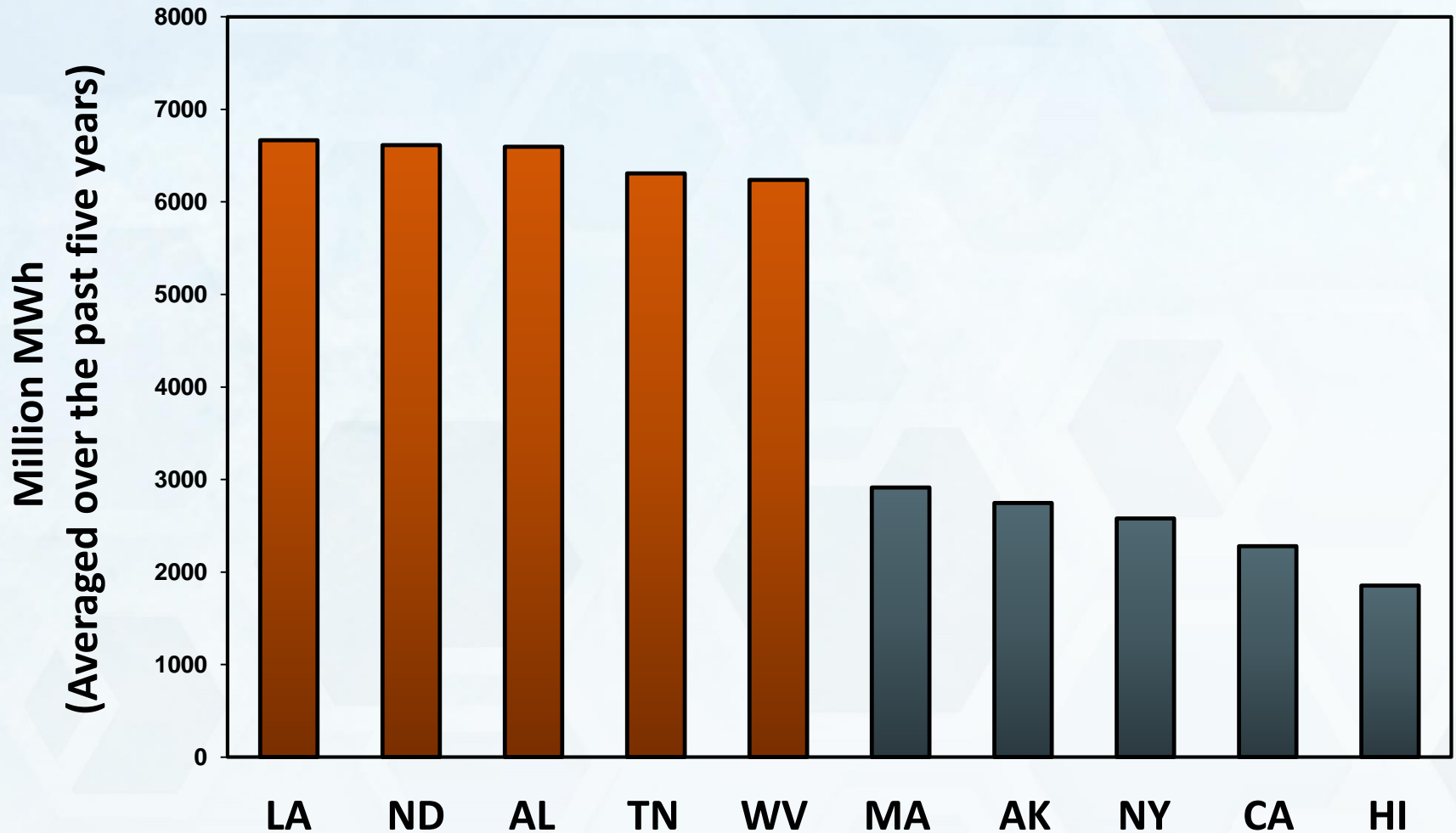


# Tennessee is on the Top Five Importers of Electricity





# Tennessee is Also on the Top Five Consumers per Capita of Residential Electricity







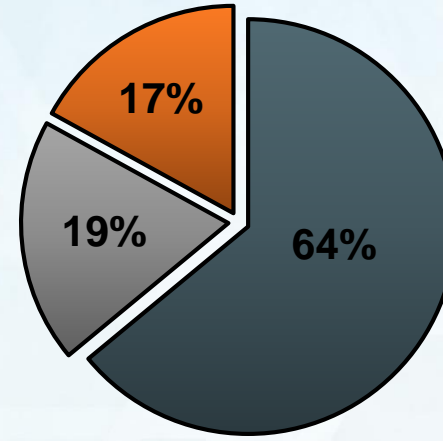
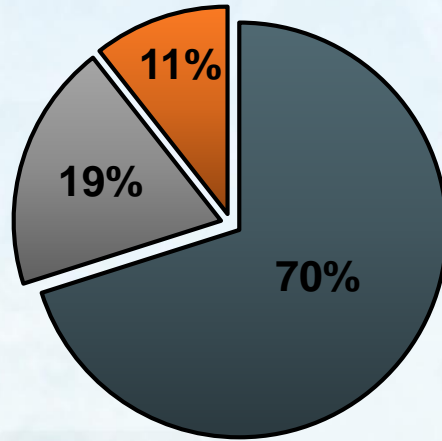
# Electricity Generation Mix

2008

2018



USA



Fossil Fuels



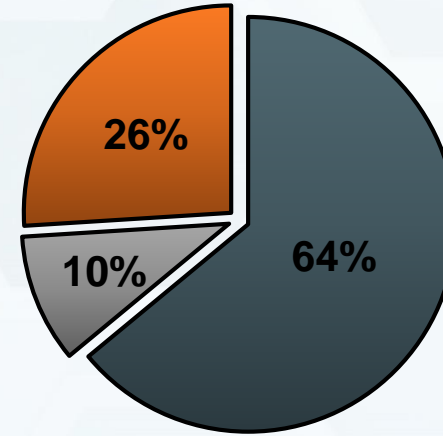
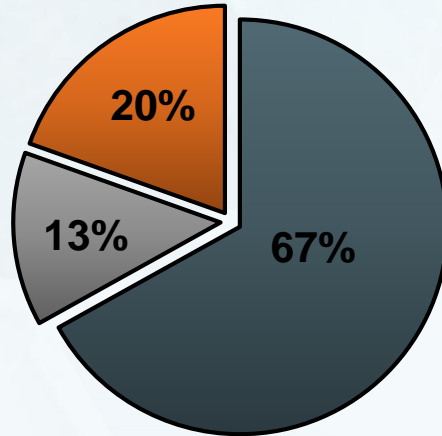
Nuclear



Renewables

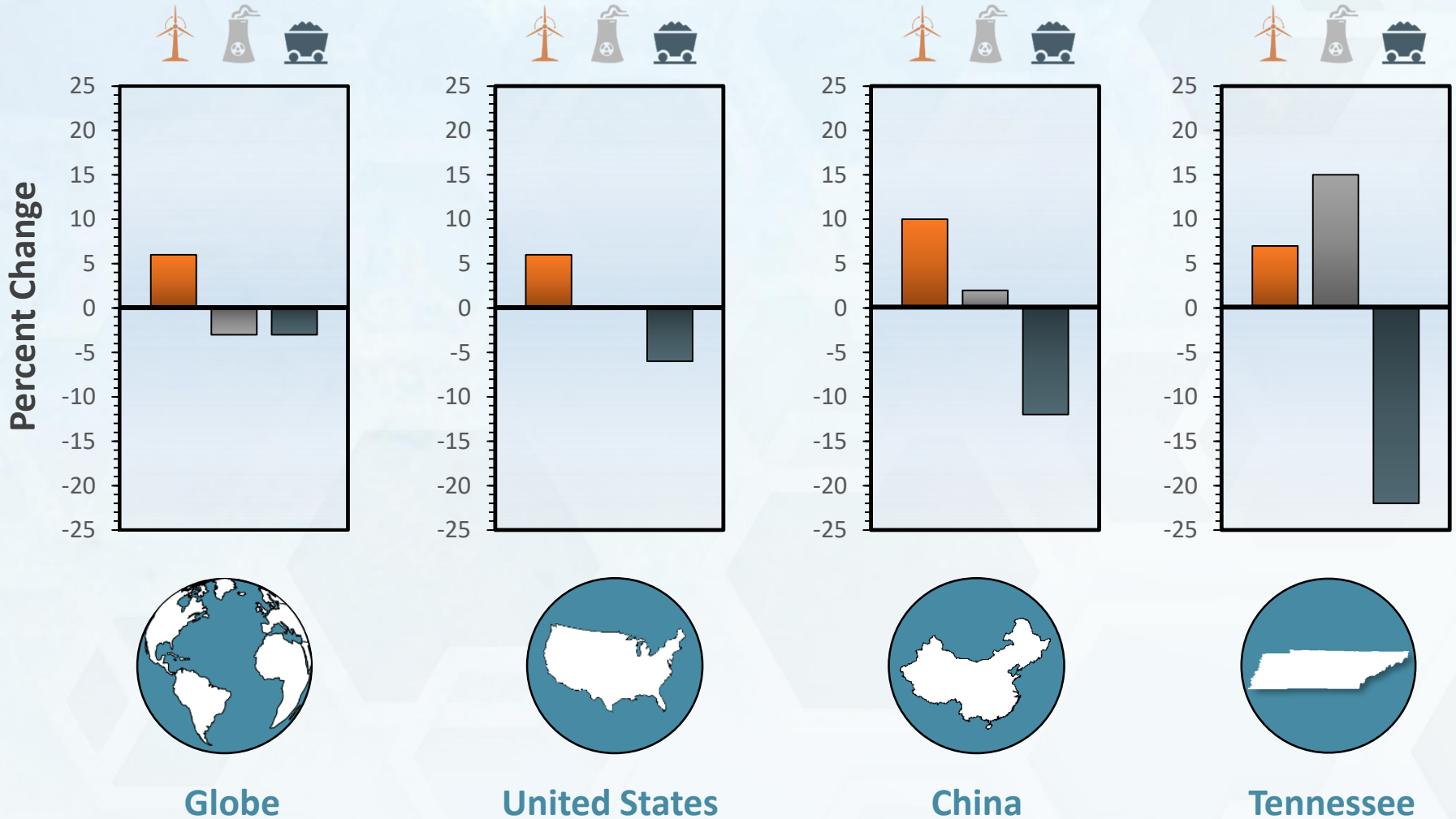


Globe





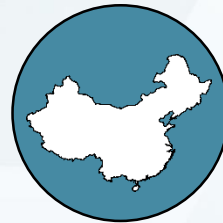
# Change in Electricity Generation Mix – (2008 -2018)



Globe



United States



China

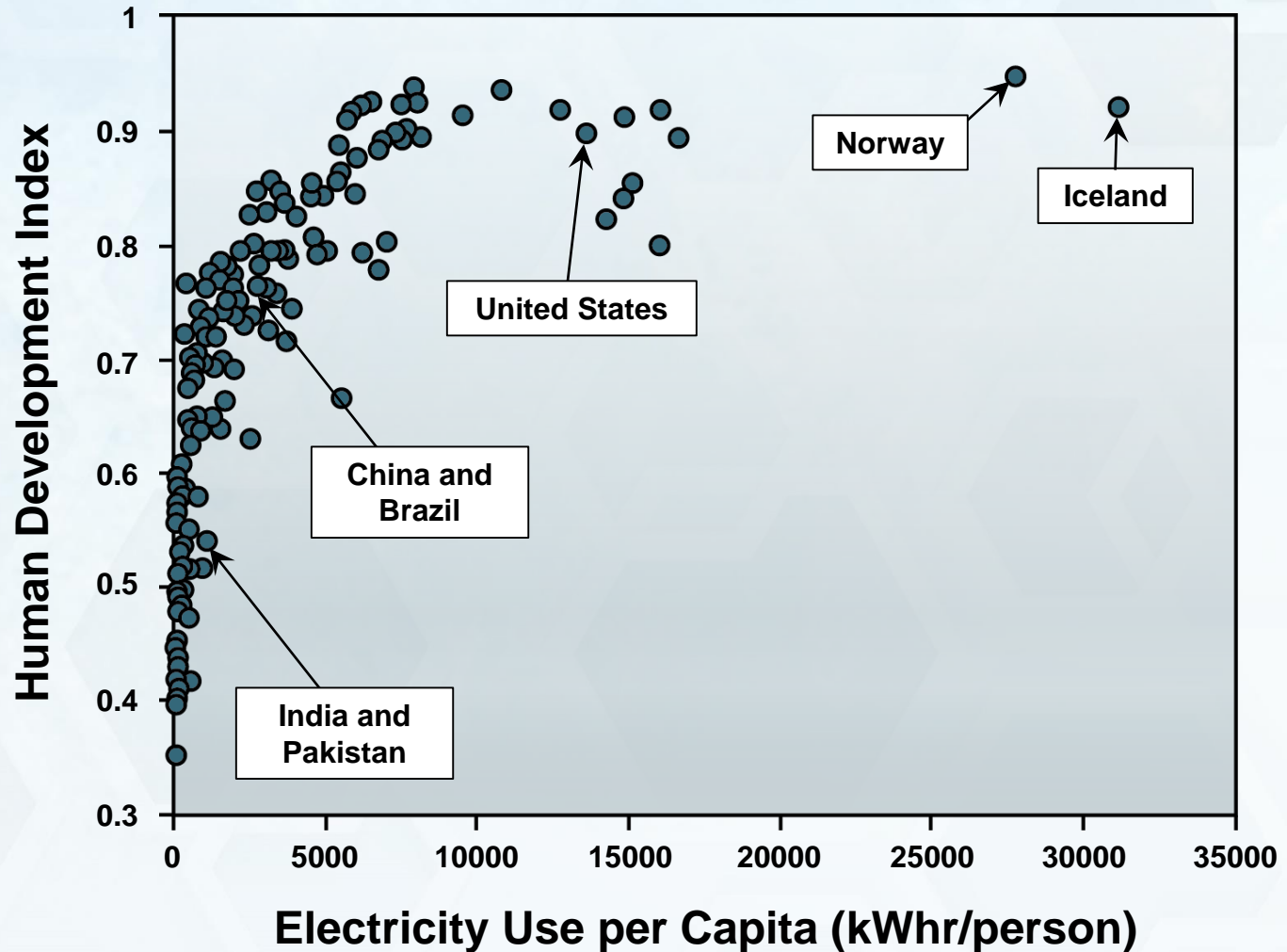


Tennessee



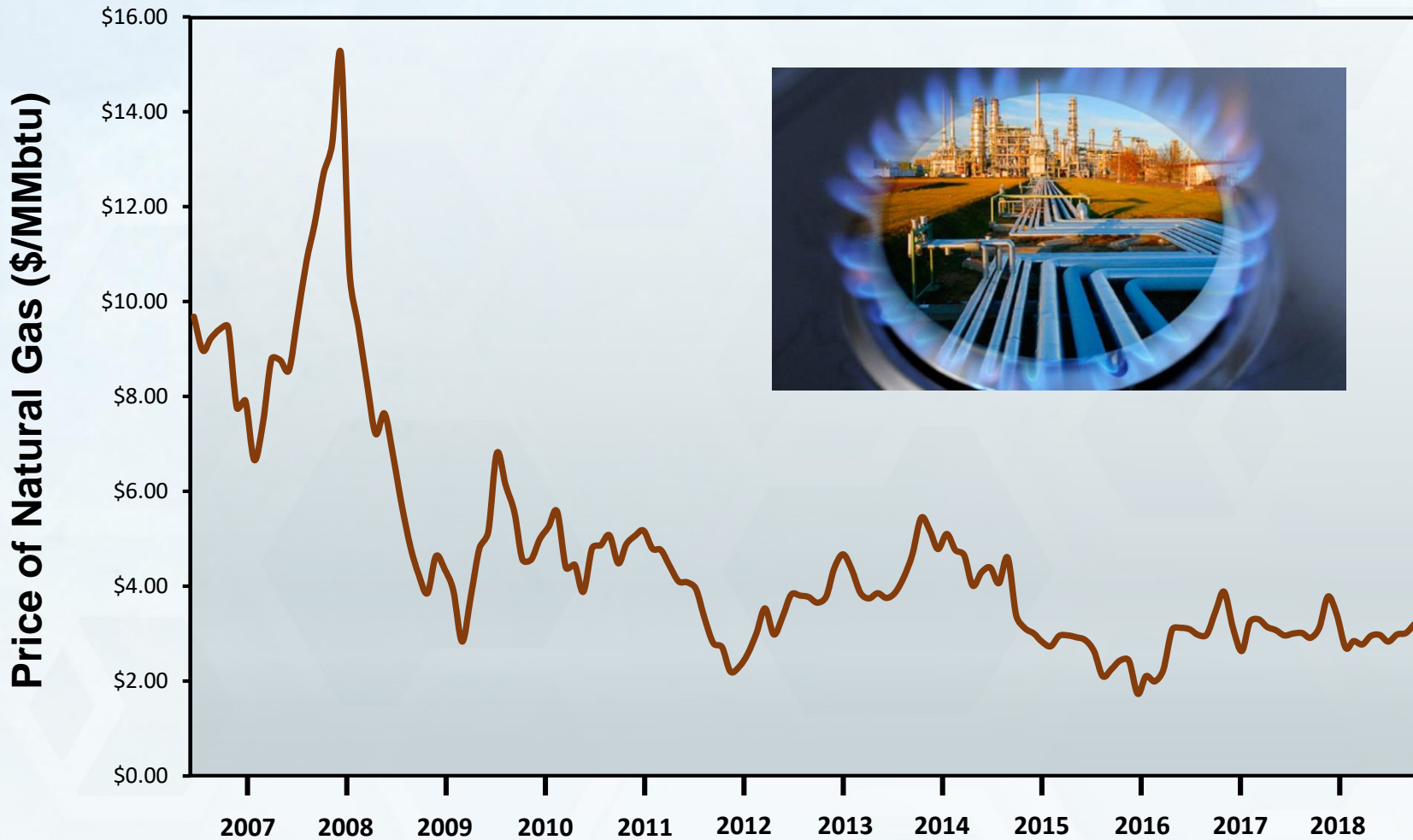


# Developed Countries Use More Electricity (MIT Study 2018)



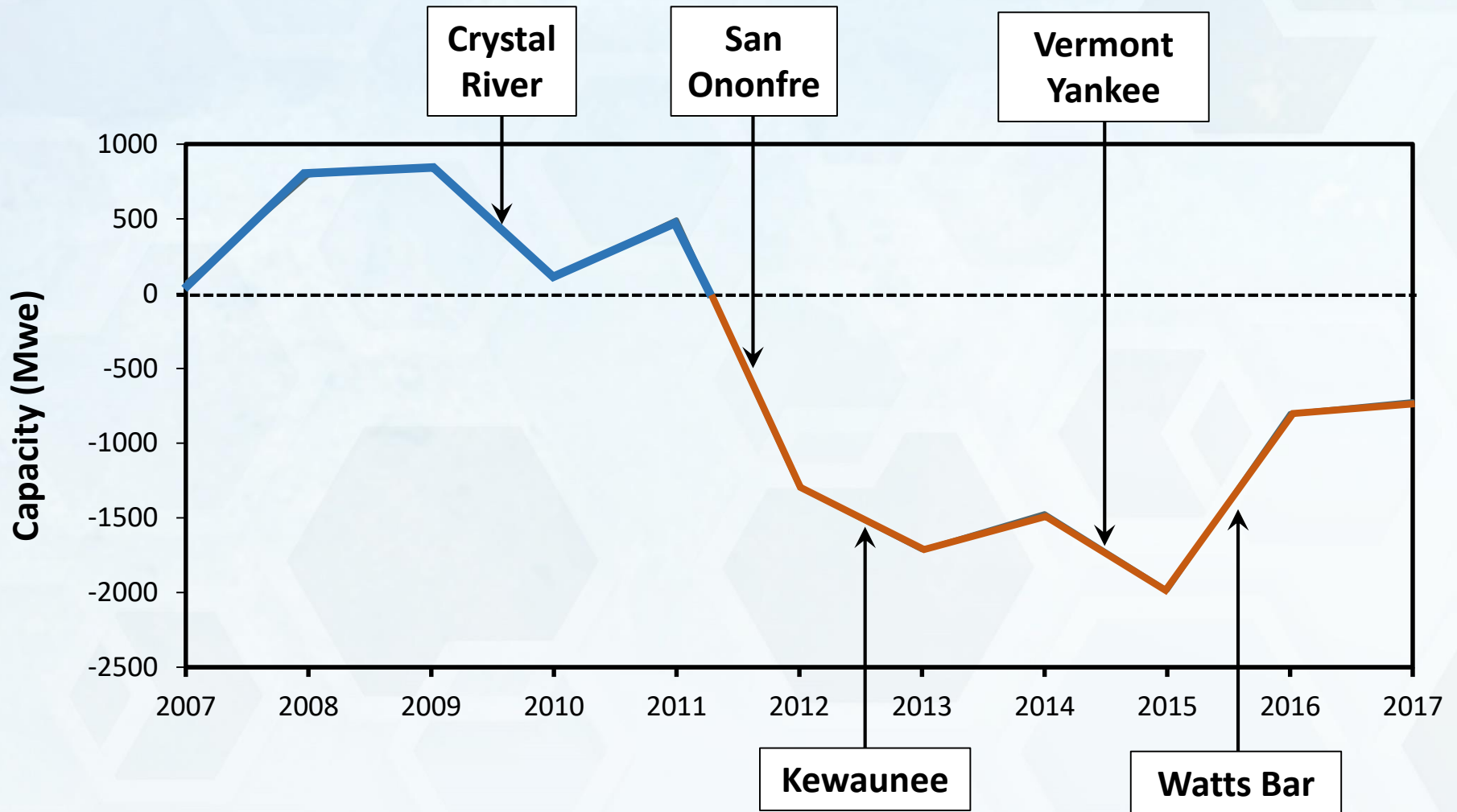


# USA is No Longer Dependent on Foreign Source of Energy *(Thanks to Fracking)*



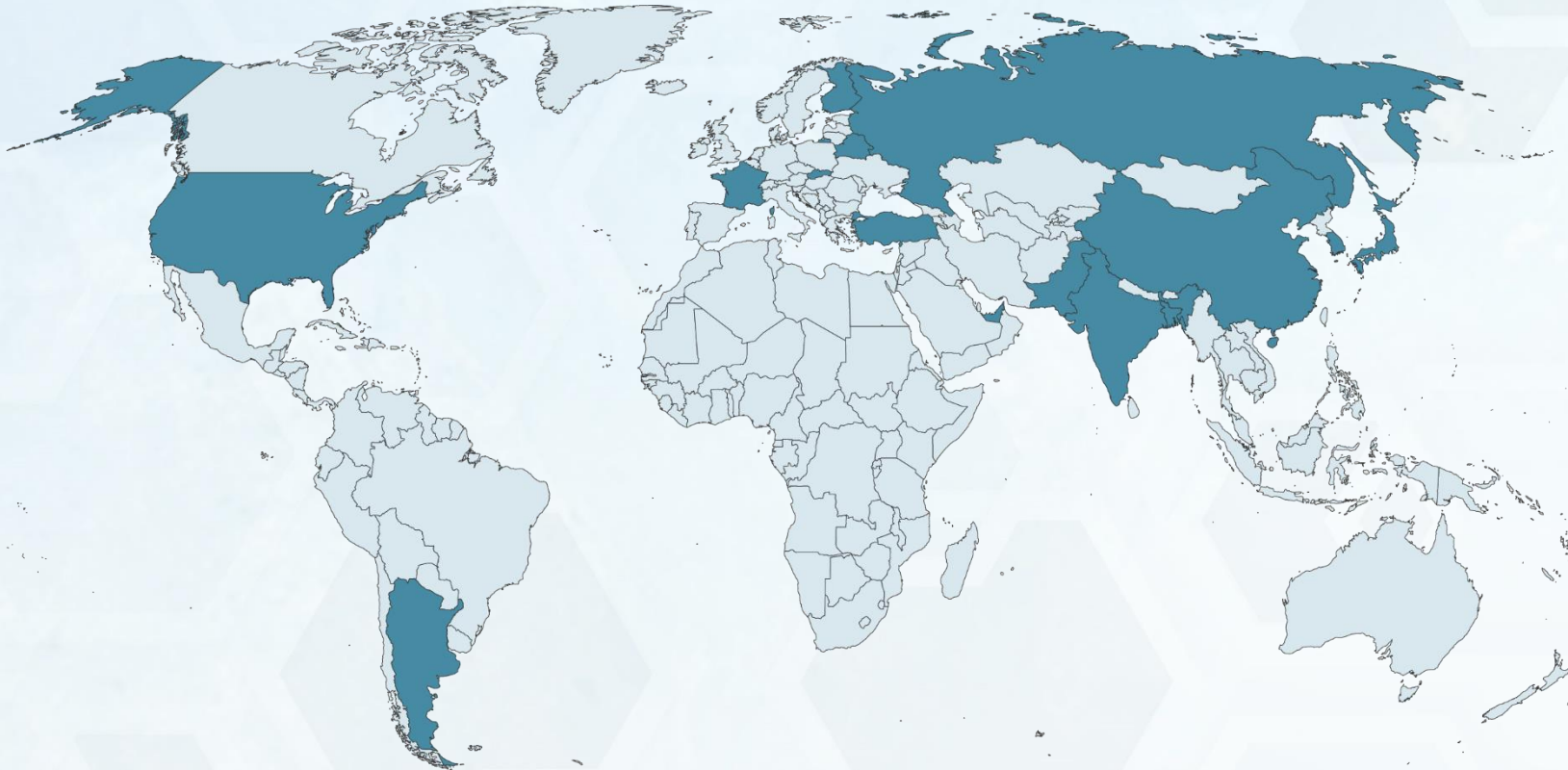


# U.S. Nuclear Production Rate Was Maintained Through Uprates Until 5 Years Ago





# Nuclear is Doing Good Outside USA



**China – 11**

**Finland – 1**

**Russia – 6**

**UAE – 4**

**USA – 2**

**Ukraine – 2**

**Korea – 4**

**France – 1**

**Slovakia – 2**

**Argentina – 1**

**Turkey – 1**

**Brazil – 1**

**Belarus – 2**

**India – 7**

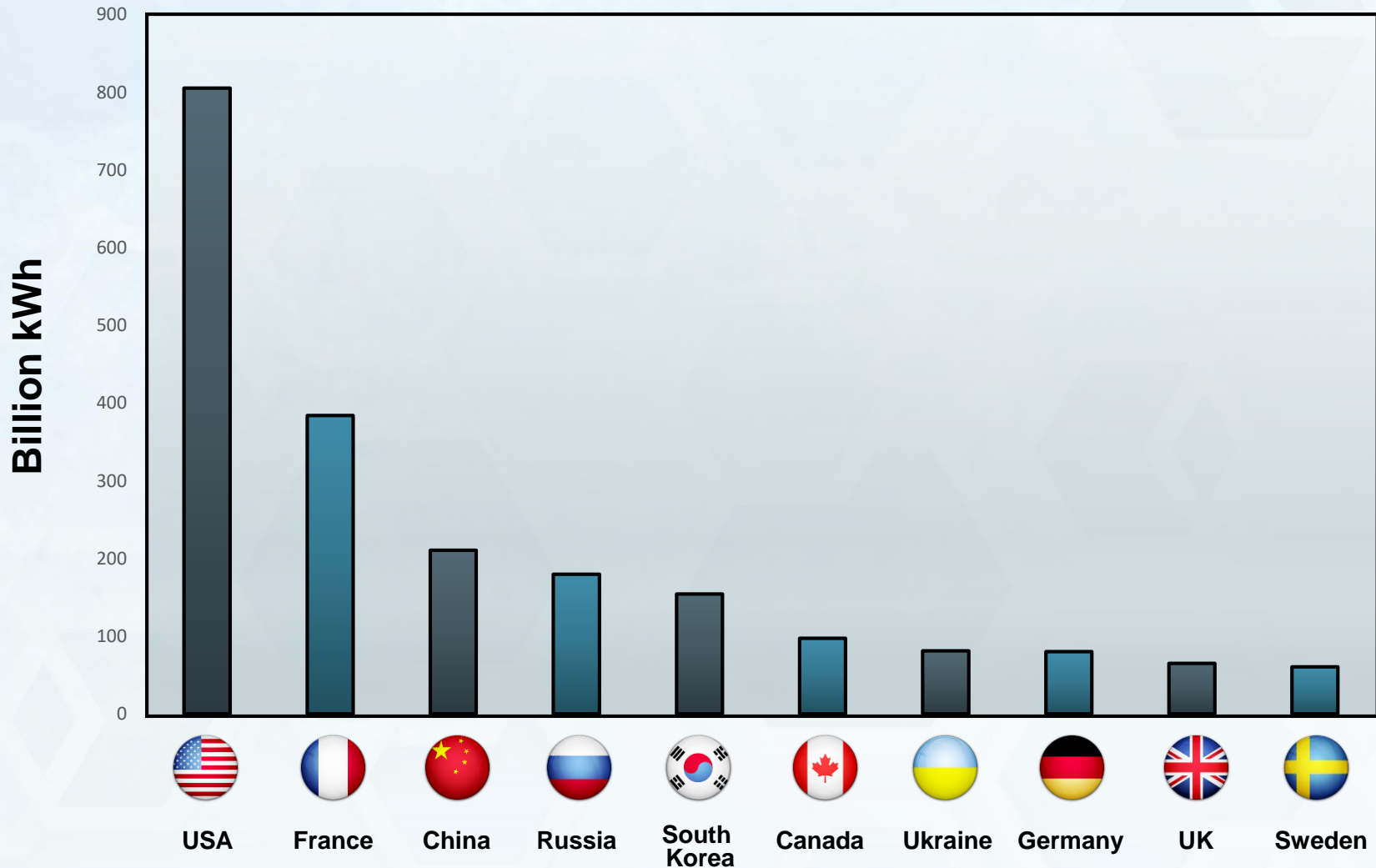
**Japan – 2**

**Pakistan – 2**

**Bangladesh – 2**



# USA is Still the Largest Producer of Nuclear Electricity







# SMRs in Deployment Status

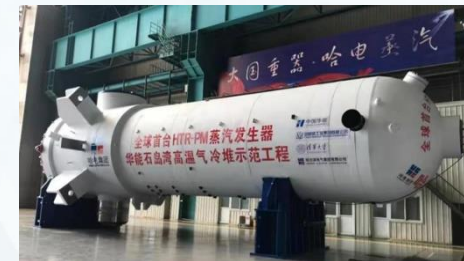
- **Russia's Floating Nuclear Power Unit**

*Two 32 MWe Nuclear Reactors*



- **China's High-Temperature Gas-Cooled Reactor**

*Two 105 MWe Nuclear Reactors*



- **Argentina's Integral Pressurized Water Reactor CAREM**

*One 30 MWe Reactor*

- **NuScale 50 Mwe Reactor to be Constructed at INL**







# Energy and Environment – Paris Climate Agreement



**Limit the increase in global average temperature to below 2°C (3.6°F)**



# Politics of Climate Change



*Over the past seven years, we've transformed the United States into the global leader in fighting climate change. This agreement represents the best chance we have to save the one planet that we've got.*

December 2015

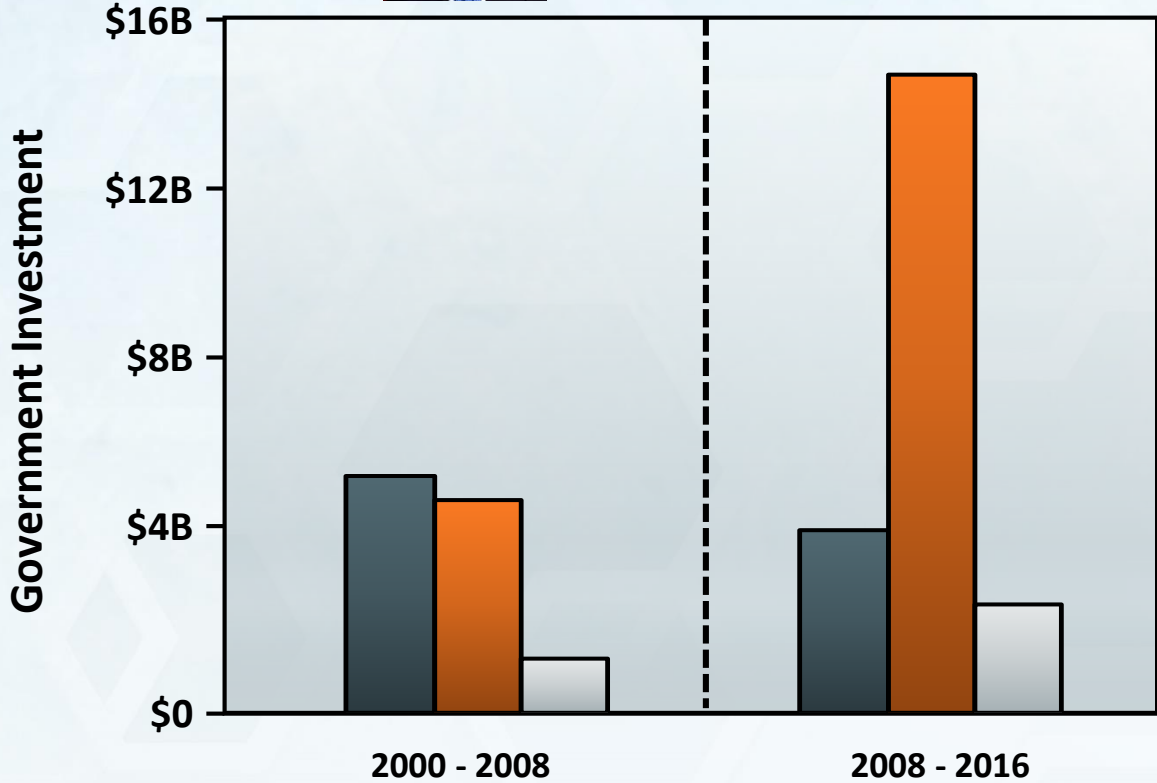


*The Paris Climate Accord is simply the latest example of Washington entering into an agreement that disadvantages the United States to the exclusive benefit of other countries...*

June 2017



# Effect of Government Subsidies



Fossil Fuels



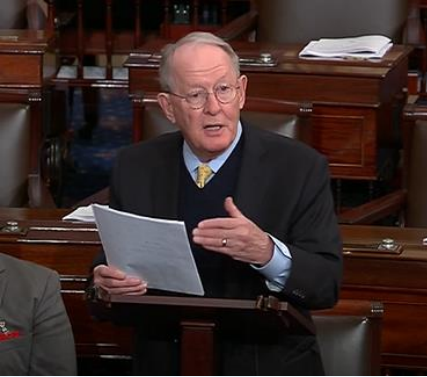
Renewables



Nuclear



# New Manhattan Project for Clean Energy 2019



## *Senator Lamar Alexander, R-Tennessee*

*Proposes doubling energy research funding over the next five years to address nine “grand challenges” including:*

- **Advanced Nuclear Energy**
- **Natural Gas**
- **Carbon Capture**
- **Better Batteries**
- **Greener Buildings**
- **Electric Vehicles**
- **Cheaper Solar Power**
- **Fusion Energy**
- **Advanced Computing**

*“Relying on wind when nuclear plants are available is the equivalent of going to war in sailboats when nuclear ships are available.”*

*Alexander, 2015*

*Alexander, 2019*





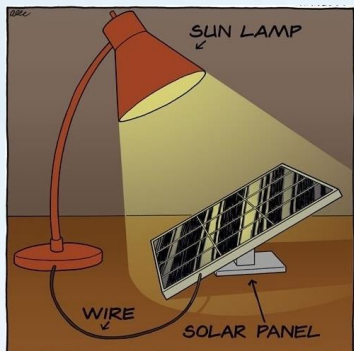
# The Future of Energy Changes Everyday

- Political support and opinions influence domestic energy production
- No one energy source is the answer to the global demand

**The only predictable aspect of future energy is that it will require a diverse mix of technologies.**



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**Thank You!**



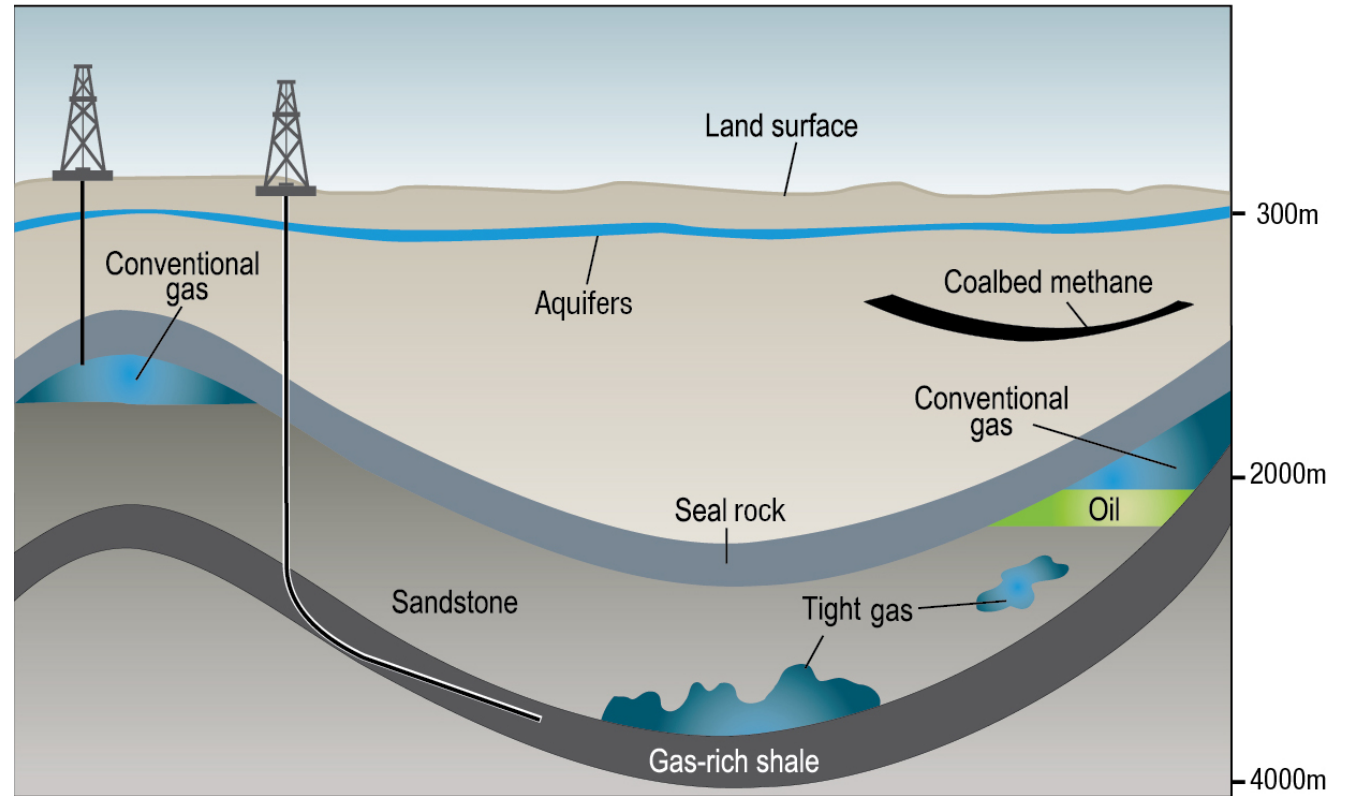
# TN State Energy Policy Council

Natural Gas Industry in Tennessee



# What is Natural Gas?

- Odorless, colorless, high energy, consisting primarily of methane and other hydrocarbons
- Naturally abundant in the United States
- Cleanest burning of the fossil fuels and emits lower levels of potentially harmful byproducts
- Typically found near oil deposits



# Natural Gas Historically

- The first American Natural Gas company, the Fredonia Gas Light Company, was formed in 1858 in Fredonia, New York
- Almost exclusively used as a source of light during most of the 19<sup>th</sup> century until the advent of electricity and electric lights
- In 1885, Robert Bunsen invented the Bunsen burner which could safely create a flame to be used for cooking and heating.
- Natural Gas discovered Pre-WWII usually vented to atmosphere or burnt as there was no effective transport for it
- Post-WWII pipe rolling, metallurgy, and welding techniques greatly improved pipeline reliability and allowed for a pipeline construction boom that lasted into the 1960's
- Currently Natural Gas is widely used in industry, homes, electric generation, and even transportation



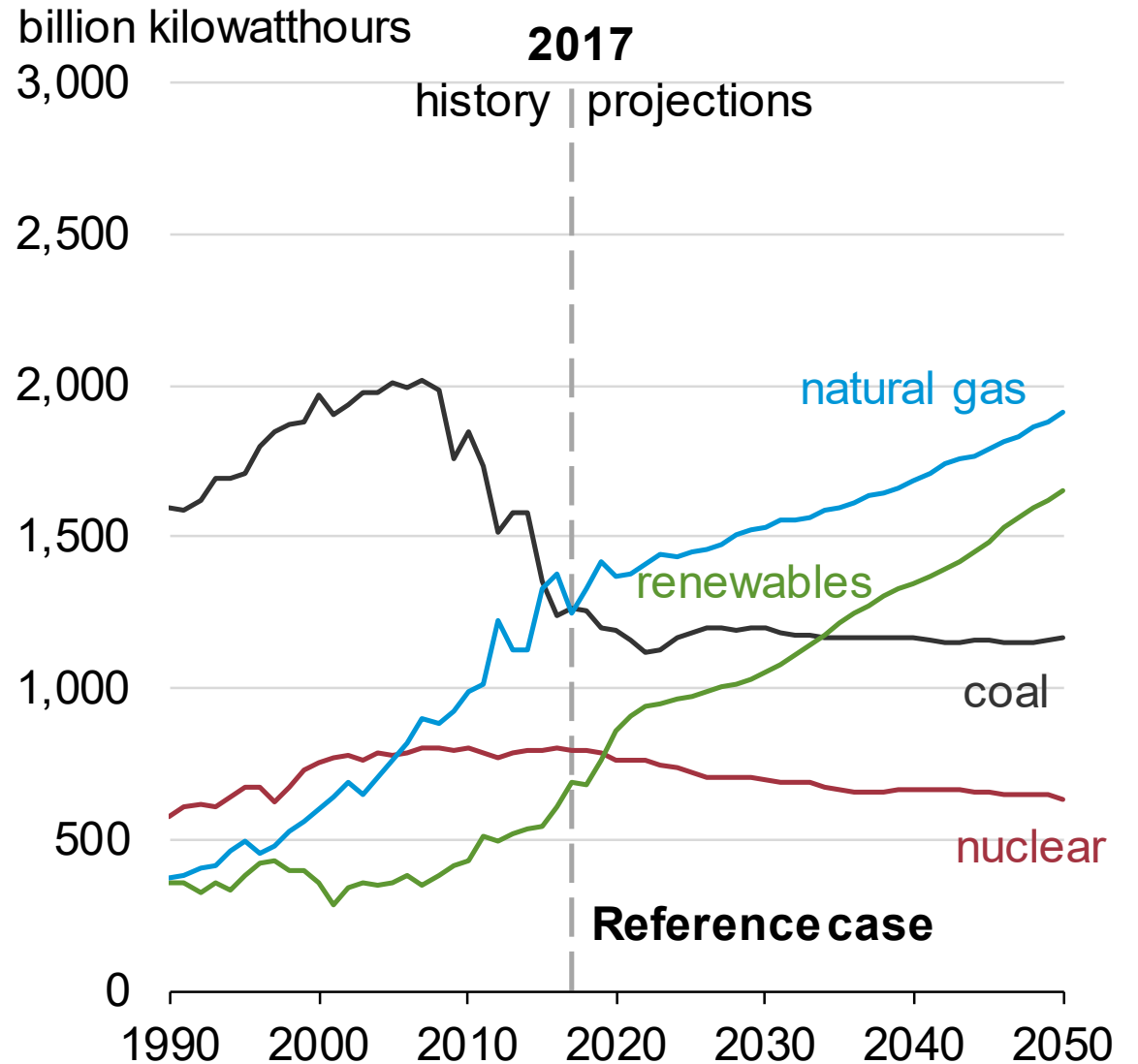
# Societal Benefits of Natural Gas

- Efficient natural gas direct use in buildings can significantly reduce consumer energy costs, full-fuel-cycle (source) energy consumption, and greenhouse gas emissions compared to electric resistance technologies.
- Natural gas end use technologies societal benefits:
  - Low life-cycle costs to consumers
  - High source energy efficiency
  - Comparably low carbon emissions
  - Compatibility with renewables (e.g., renewable natural gas, hydrogen, solar thermal)
  - High deliverability to meet seasonal space heating loads
  - Energy security, reliability, and resilience
  - Domestic employment and economic development

## Projected Use of Natural Gas

- Fossil fuel generation continues as majority power generation source through 2050
  - 57% of 2050 total generation is fossil fuels (gas+coal)
  - Nuclear generation falls to 12% of total
- Renewable generation increases significantly compared to 2017
  - 1651 BkWh in 2050; 691 BkWh in 2017
  - 30% of 2050 total generation is renewable (wind, solar, hydro)

## Electricity generation from selected fuels



Source: EIA Annual Energy Outlook 2018

## Efficient Uses of Natural Gas

- Natural Gas Vehicles (NGV)
  - More than 160,000 NGVs in United States and roughly 15.2 million NGVs worldwide
  - Good for use in high mileage centrally fueled fleets
  - Reduced greenhouse gas emissions
  - Typically offer shorter range than traditional fueled vehicles
  - Normally less maintenance and fuel costs





## Efficient Uses of Natural Gas

- Compressed Natural Gas (CNG)
  - Made by compressing Natural Gas to less than 1% of its volume at standard atmospheric pressure
  - Used in NGV fueling stations and in NGVs
  - Distributed by the existing natural gas network
  - CNG is typically compressed to 3600psi
  - One Gallon of Gasoline Equivalent (GGE) requires .51 cubic feet of space in a CNG tank
  - KUB GGE current public price: \$1.888



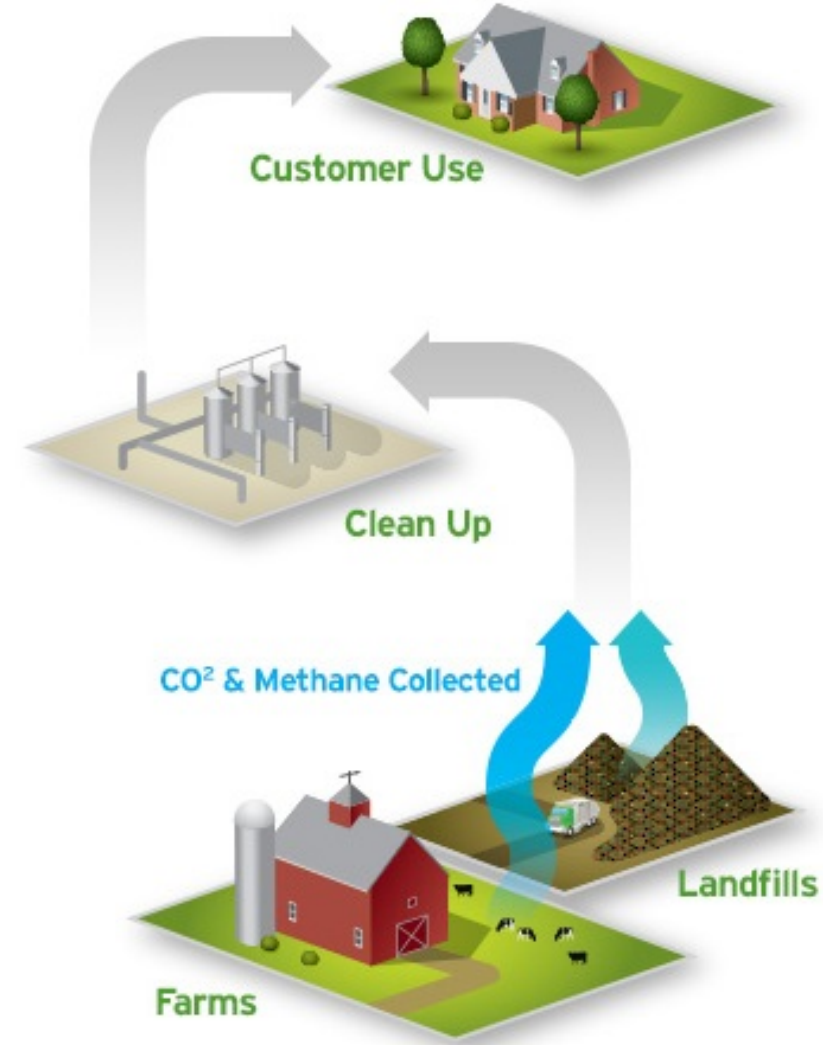
# Future of Natural Gas

- Liquefied Natural Gas (LNG)
  - Natural Gas that has been cooled to a liquid state (-260 F)
  - 600x smaller in volume than its gaseous state
  - Easier to transport where pipelines are not feasible
  - special tankers on ships, trucks, or trains
  - Delivered to terminals where it is returned to gaseous state and transported by pipeline



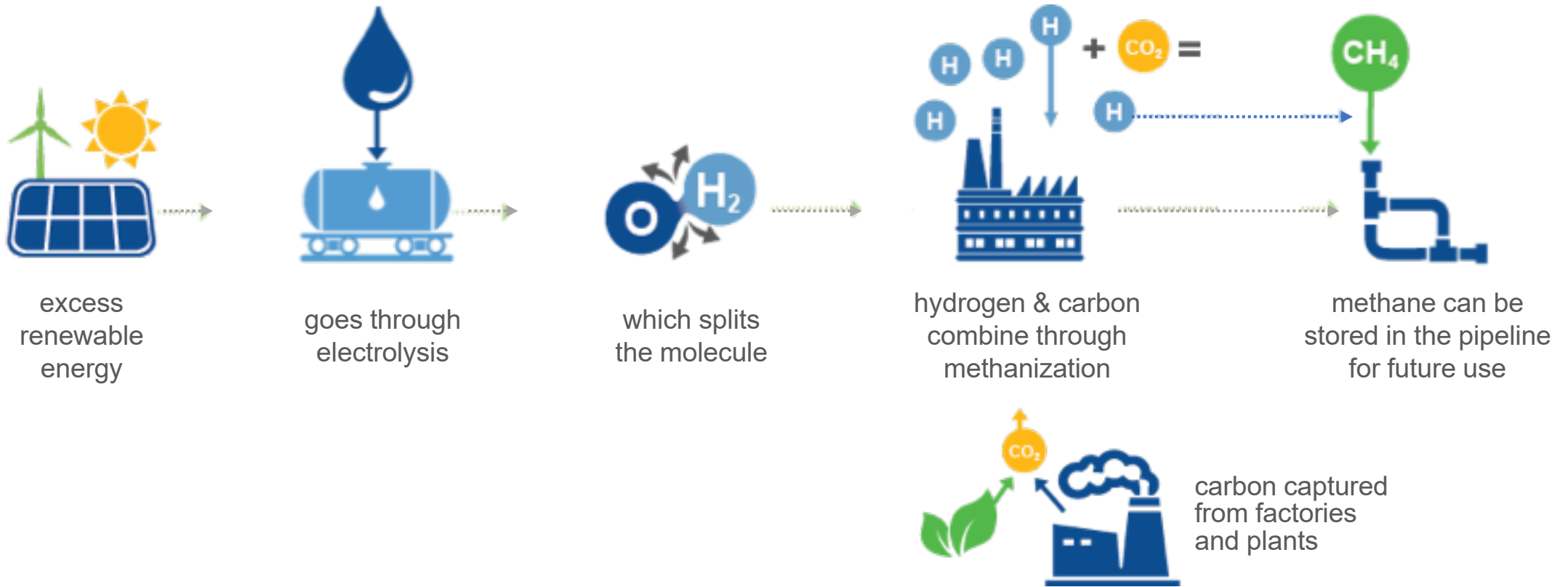
# Future of Natural Gas

- Renewable Natural Gas (RNG)
  - RNG or biomethane is pipeline quality gas that is produced from various biomass sources through a biochemical process.
  - Biogas can be sourced from landfills, livestock and wastewater treatment
  - Can be used in NGVs





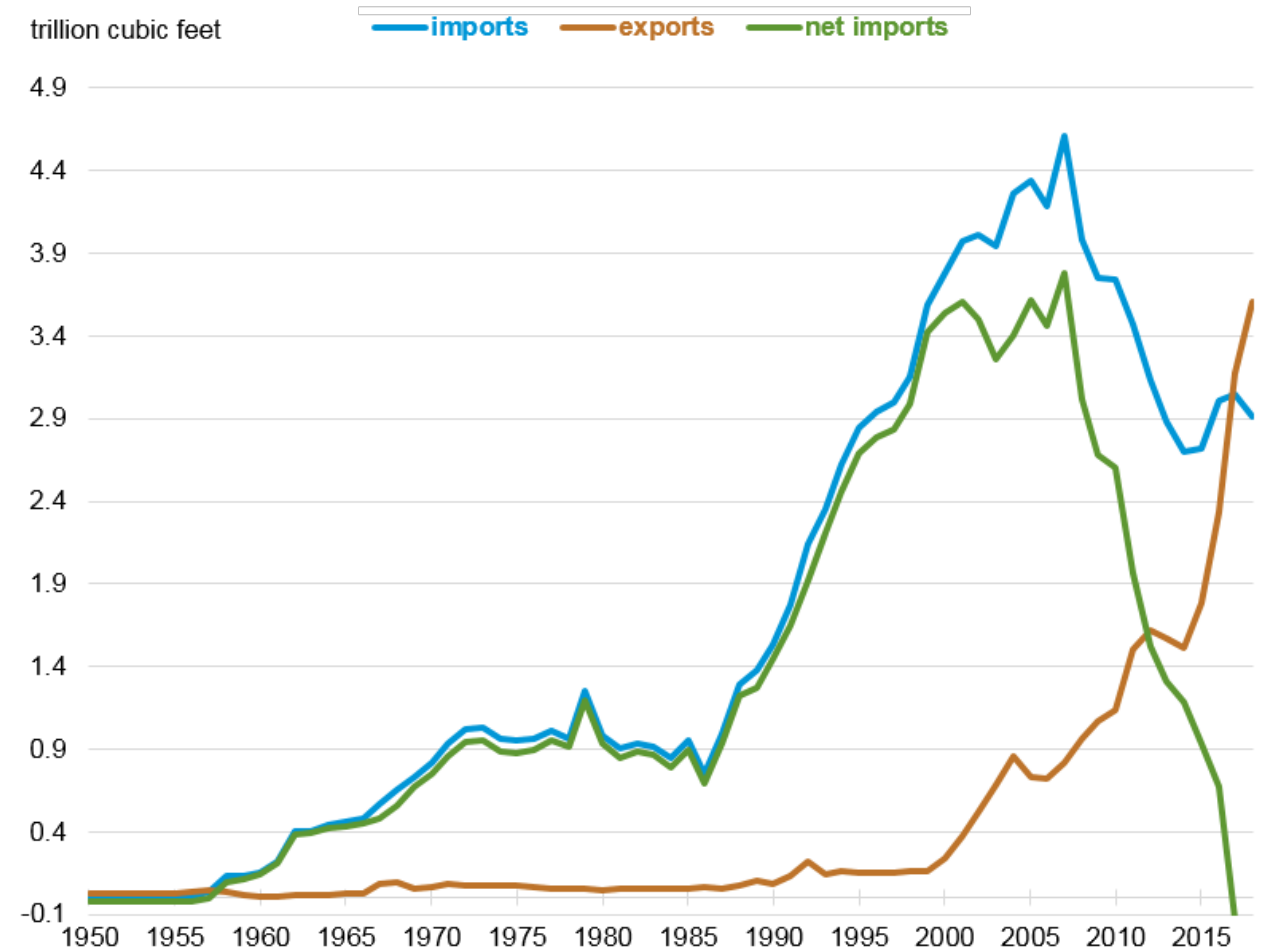
# Power to Gas



# Future of Natural Gas

- United States has been the worlds largest Natural Gas Producer since 2009
  - In 2017, the United States became a net exporter of Natural Gas for the first time
  - In 2018, the U.S. Natural Gas exports were a record shattering 3.83 trillion cubic feet
  - Growing demand for U.S. Liquefied Natural Gas abroad in a few Asian countries (Japan, China, Vietnam, Thailand, and Phillipines) who have an increasing dependence on Natural Gas

U.S. natural gas imports, exports, and net imports, 1950–2018



Source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 4.1, April 2019



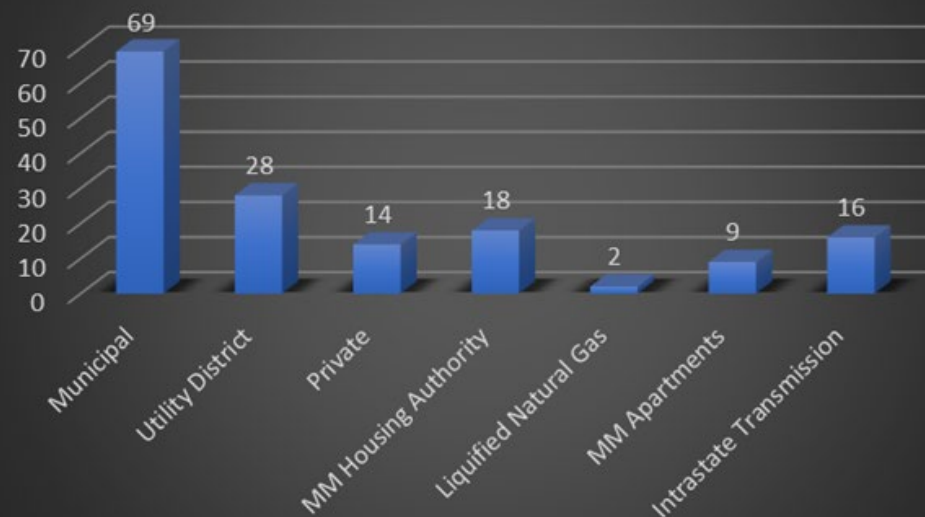
# Tennessee Gas Association



*Natural Gas, Naturally Better*

- Established in 1962
- 400 members
  - Municipal gas systems
  - Utility districts
  - Gas authorities
  - Private and public gas companies
  - Pipelines
  - Gas marketers
  - Affiliated members
  - Housing authorities

**TGA Members**



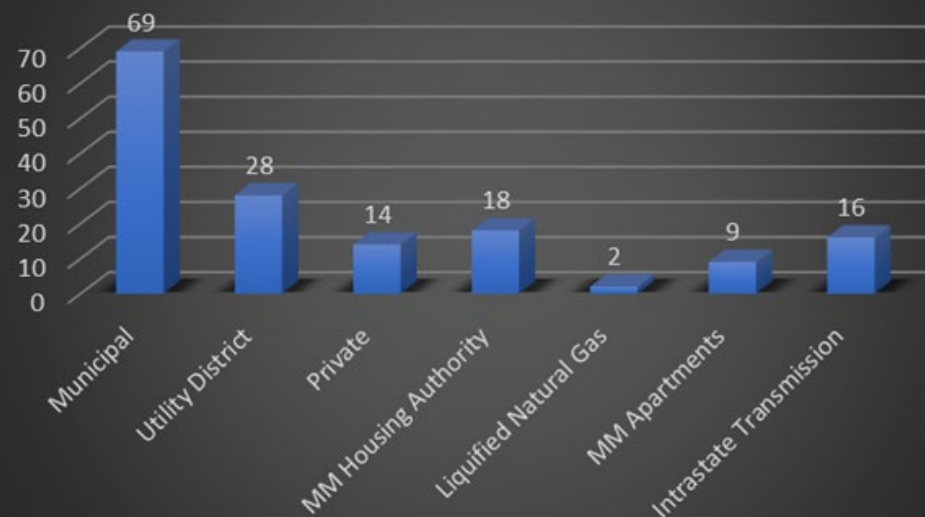
# Tennessee Gas Association



*Natural Gas, Naturally Better*

- Representing approximately 10,000 Tennessee employees serving the natural gas industry with over 1.2 million customers and 32,000 miles of distribution line
- Tennessee has 99 gas systems, which is more than any other state
  - of those 99 systems, 95 are TGA members
- Setting the **PACE** for Advancing Natural Gas in Tennessee
  - Promote
  - Advocate
  - Collaborate
  - Educate

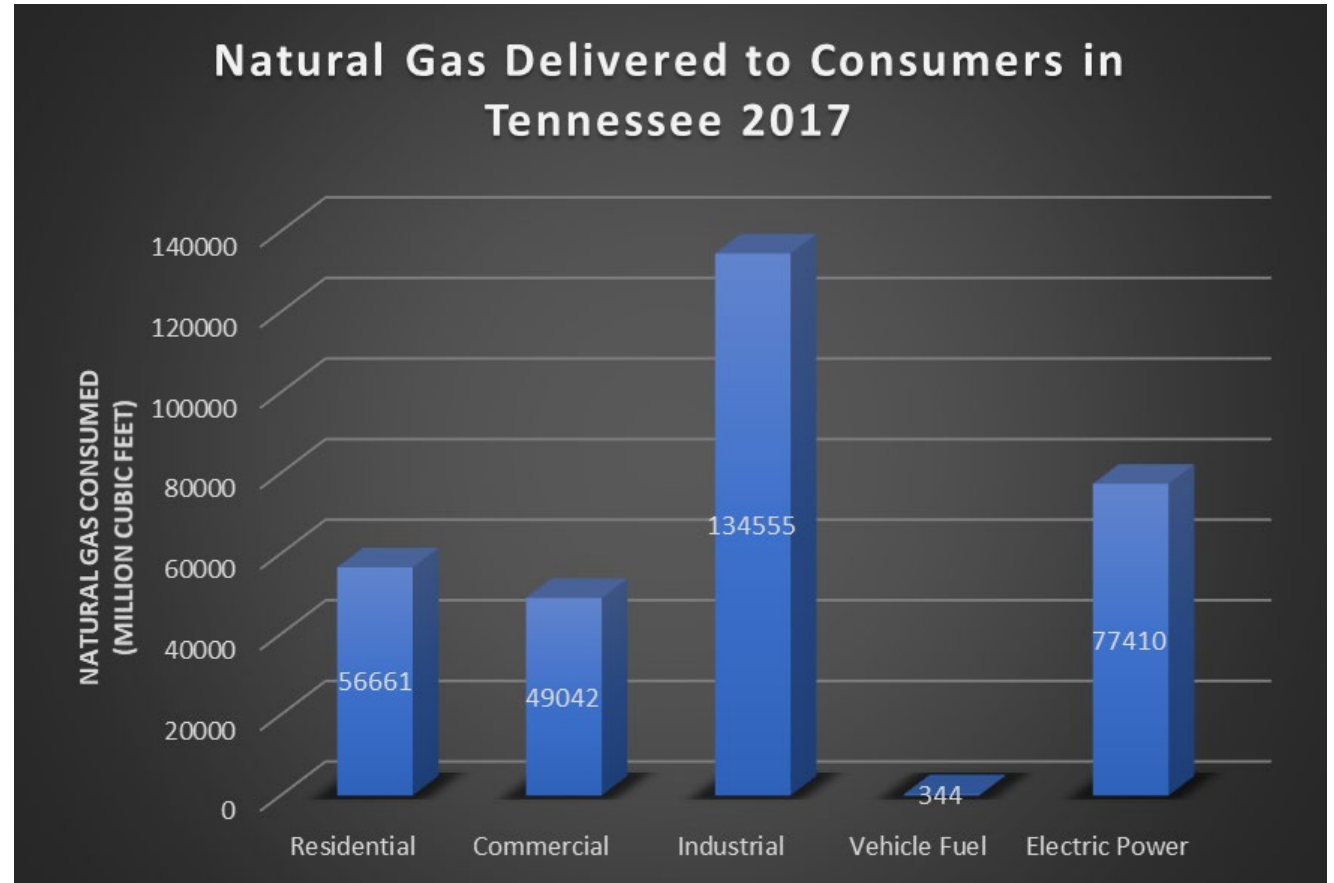
**TGA Members**





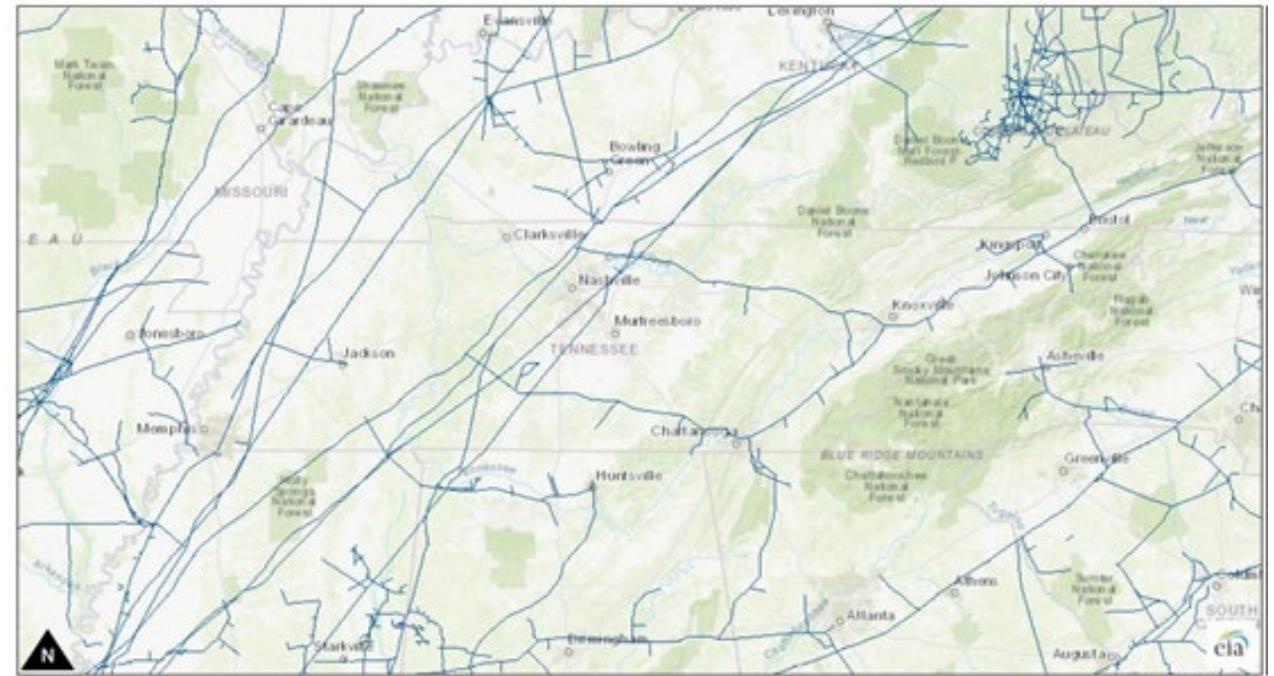
# Natural Gas Use in Tennessee

- U.S. Energy Information Administration estimates
  - 339.3 trillion BTU of Natural Gas was consumed by TN in 2016
  - TN ranked 24<sup>th</sup> in consumption in 2016
- Notably, Natural Gas use in Tennessee for Electric Power has increased more than ten-fold between 2007 and 2017
  - Accounting for nearly  $\frac{1}{4}$  of Natural Gas consumed by the state
- 15.34% of Tennessee's energy needs were met with Natural Gas in 2016



# Tennessee Natural Gas Supply

- In 2018, interstate pipelines running through Tennessee flowed 23,874 million cubic feet of Natural Gas per day
- In 2017, Tennessee only consumed 323,540 million cubic feet of Natural Gas
- Historically the majority of Natural Gas entered Tennessee from the South through Mississippi
- In 2016, for the first time, Natural Gas entering from the Marcellus and Utica shale productive regions made it so that the majority of Natural Gas to enter Tennessee was through the north rather than the south

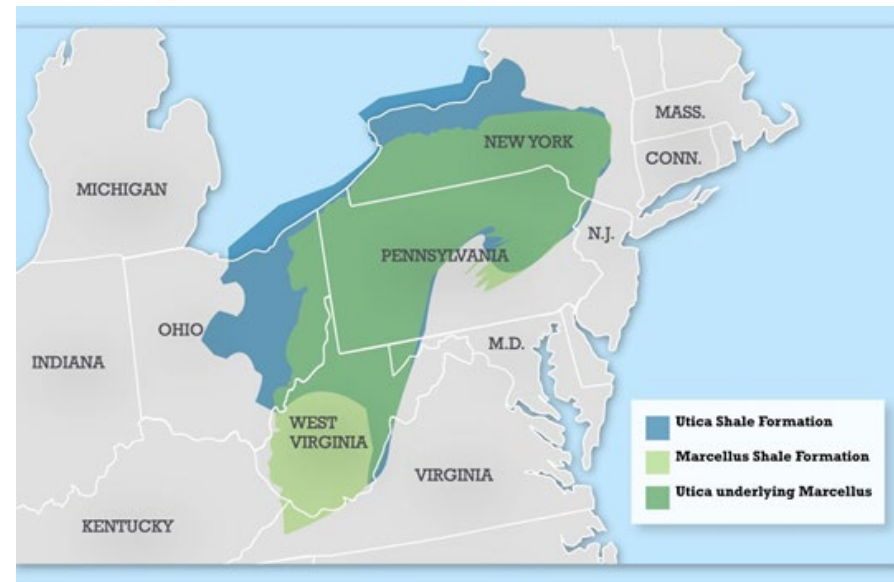


Credits

N N N N N N

0 10 20 30 40 50 60 70 80 90 100 Miles

— Natural Gas Inter/Intrastate Pipeline (z)



## Major Pipelines in Tennessee

- East Tennessee Natural Gas Pipeline: 1,536 miles
- Texas Eastern: 9,071 miles
- Texas Gas Pipeline: 5,980 miles
- Columbia Gulf: 3,368 miles
- Tennessee Gas: 11,750 miles
- ANR: 10,600 miles
- Trunkline: 3,059 miles



Questions?

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# Appendix

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## Major Pipelines in Tennessee

- East Tennessee Natural Gas Pipeline
  - 1,536 miles
  - 1.86 billion cubic feet per day
  - Owned and operated by Enbridge Inc.
  - Runs through East Tennessee into Middle Tennessee



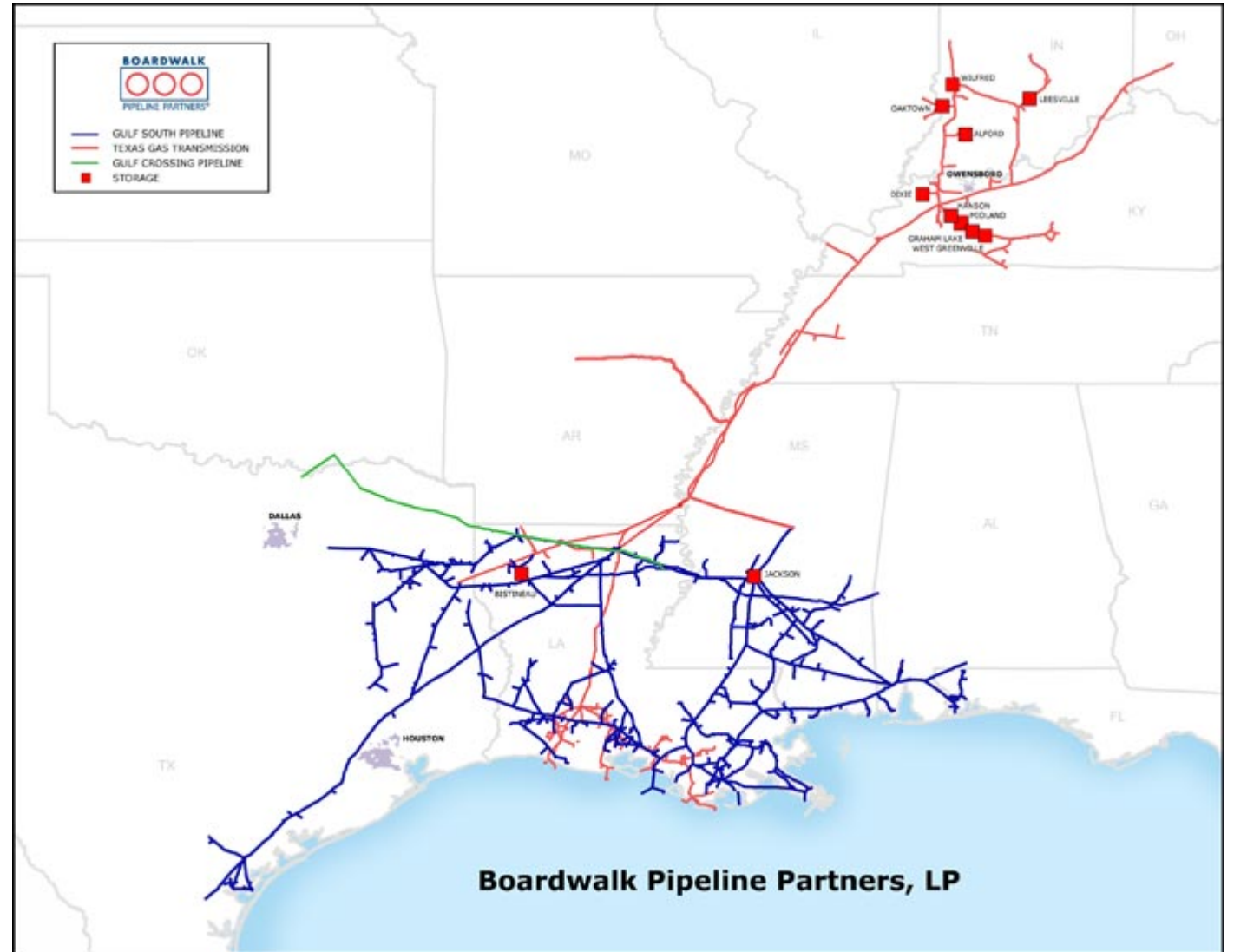
## Major Pipelines in Tennessee

- Texas Eastern Transmission Pipeline
  - 9,071 miles
  - 11.69 billion cubic feet per day
  - Owned and operated by Enbridge Inc.
  - Delivers Gas from Texas and the Gulf Coast to the Mid-Atlantic and Northeast
  - Runs through Middle Tennessee, East of Nashville



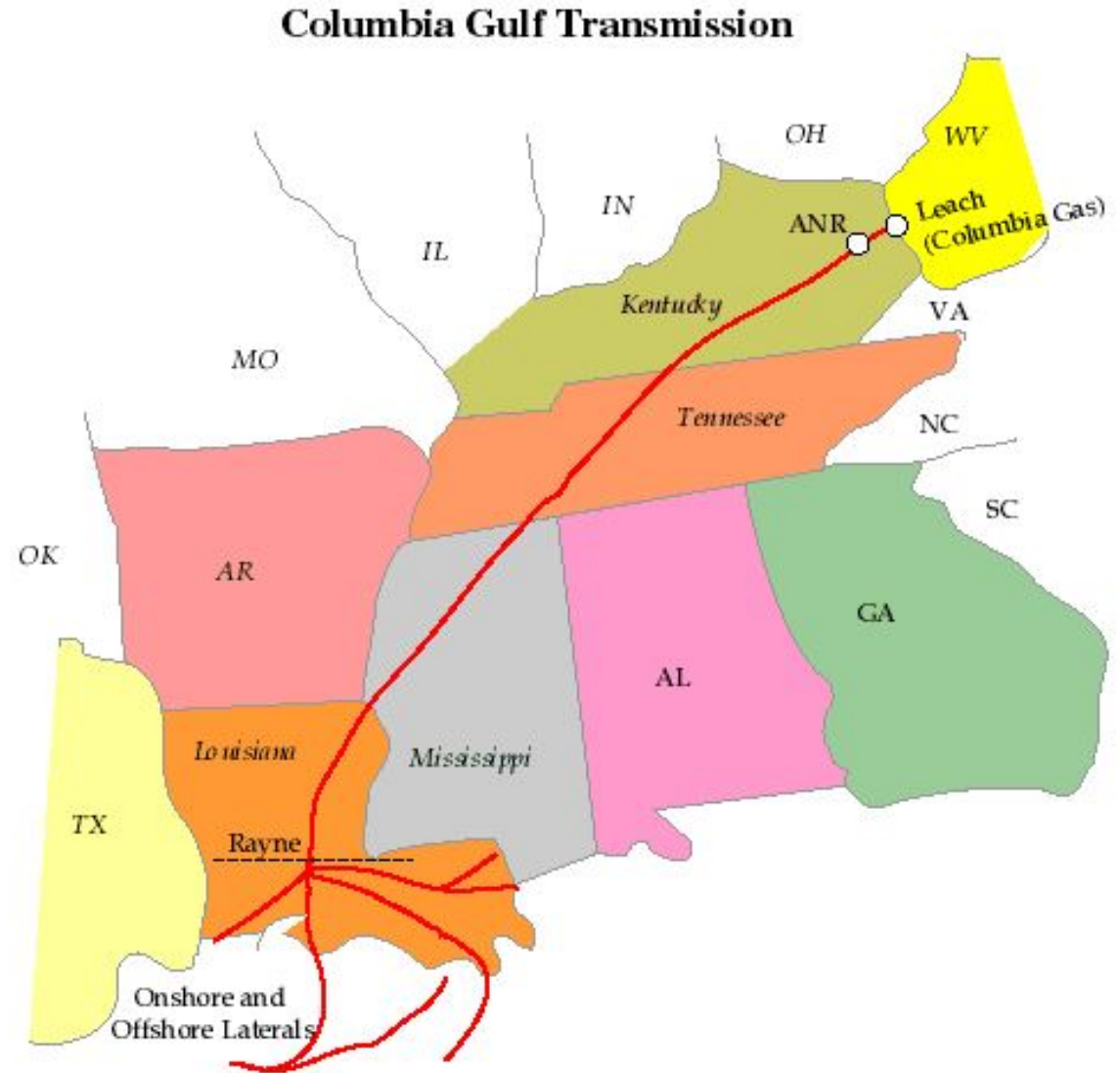
# Major Pipelines in Tennessee

- Texas Gas Pipeline
  - 5,980 miles
  - 2.4 billion cubic feet per day
  - Owned and operated by Boardwalk Pipeline Partners, LP
  - Delivers Gas from the Gulf to the Midwest
  - Runs through West Tennessee



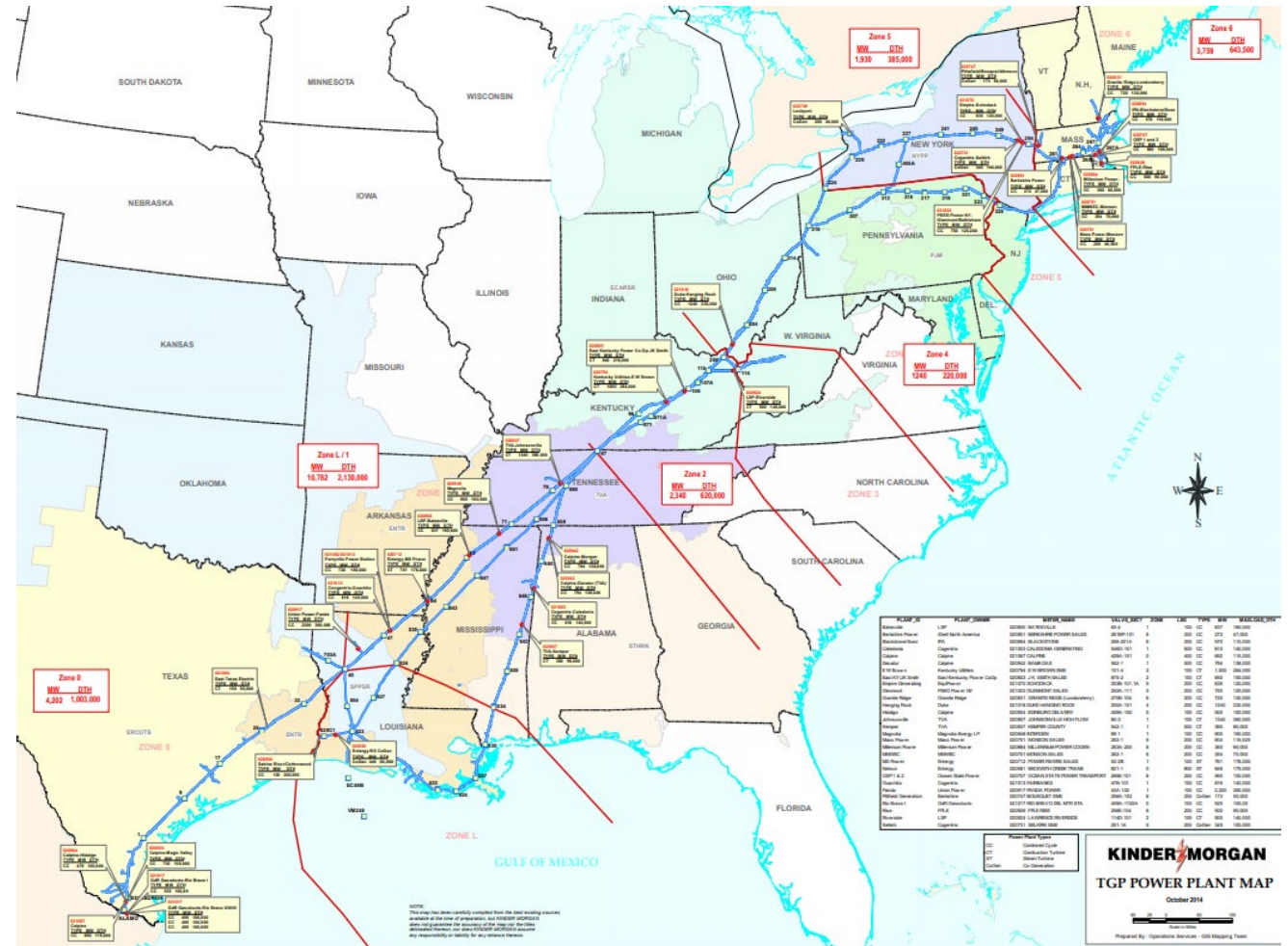
## Major Pipelines in Tennessee

- Columbia Gulf Transmission Pipeline
  - 3,368 miles
  - Owned and operated by TC Energy
  - Delivers Gas from the Gulf coast to the Columbia Gas Transmission Pipeline in the Northeast
  - Runs through Middle Tennessee East of Nashville



# Major Pipelines in Tennessee

- Tennessee Gas Pipeline
  - 11,750 miles
  - Owned and operated by Kinder Morgan.
  - Delivers Gas from the Gulf to the Northeast
  - Runs through Middle Tennessee, West of Nashville





# Major Pipelines in Tennessee

- ANR Pipeline
  - 10,600 miles
  - 6 billion cubic feet per day
  - Owned and operated by TC Energy
  - Delivers Gas from the Gulf to the Midwest
  - Runs through West Tennessee



# Major Pipelines in Tennessee

- Trunkline Pipeline
  - 3,059 miles
  - 1.5 billion cubic feet per day
  - Owned and operated by Trunkline Gas Company
  - Delivers Gas from the Gulf to the Midwest
  - Runs through West Tennessee

