

A look ahead: How government policy and technology advances are shaping the demand for gas turbines



THE VOICE OF THE
GAS TURBINE INDUSTRY

Florida Turbine Technologies - **GE Power**
Meggitt Vibro-Meter - **OPRA Turbines**
Pratt & Whitney - **PW Power Systems**
Siemens Energy - **Solar Turbines**
Strategic Power Systems





Our Mission

The GTA serves as the unified voice for the gas turbine industry. Today Gas Turbines produce more than a quarter of our nation's electricity. They are a cornerstone energy conversion technology, providing electricity and heat for industries and communities.

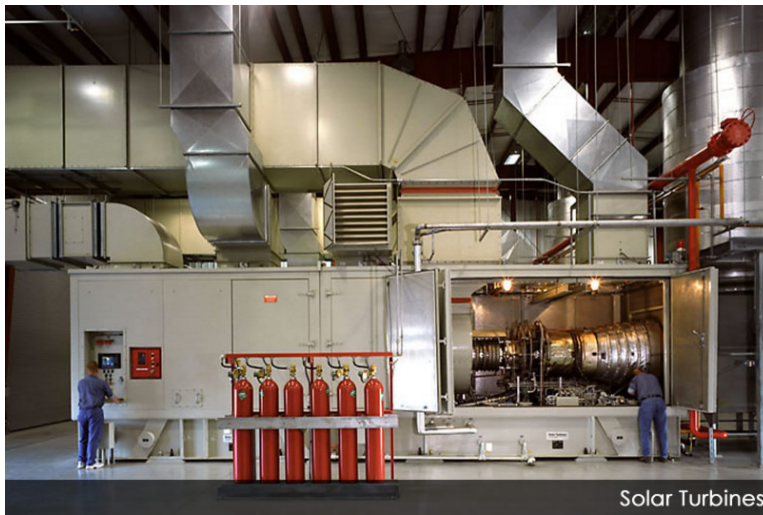
Gas turbines will play an increasingly important role in the achievement of national objectives related to energy and the environment. Recent technical advances make gas turbines the logical choice for new power generation and for replacing the aging fleet of thermal facilities operating on oil or coal:

- Flexible; permits **"Shadowing" renewables** to keep the power grid stable
- Use low-carbon, plentiful, cheap **natural gas** to reduce toxic and GHG emissions
- Lower **capital costs**;
- Easier **permitting**;
- **Quicker** to construct;
- Smaller **footprint**
- **Portable** (in smaller sizes) for emergency power and temporary needs

Policymakers and other stakeholders need to know how gas turbines can meet the evolving power generation needs of our nation. Representing all major power gas turbine equipment manufacturers, the mission of the Gas Turbine Association is to provide the information needed to fully realize this potential.



- Regulations (emissions, ghg) and policy (e.g. tax credits, subsidies) are driving rapid increases in renewable power
- Gas turbines are and will remain a major part of US power generation
- Increasing contribution from renewables is impacting non-renewables
- Gas turbine industry is responding by developing solutions to meet the new demand



Clean Power Plan (NSPS CO₂ Regulation) New, Modified, and Reconstructed Gas Turbines

- Sets CO₂ Performance Standard for Gas Turbines That Supply More Than 1/3 of Their Potential Electric Output and More Than 219,000 MWh (25 MW x 8760 hours) Net Electric Output to the Grid Per Year
 - Carefully steps around combined cycle and simple cycle operation definition
 - 1,000 lb/MWh CO₂ turbines operating at or near base load. (1,030 for net output)
 - 120 lb/MMBtu CO₂ (input basis) for turbines at less than 33% of design capacity
 - 120-160 lb/MMBtu CO₂ (input basis) for turbines designed for multi-fuel operation
- Emissions Standards are Based on a 12-month Rolling Average Including All Potential Operating Conditions
- Separate Emissions Level Proposal for Coal Plants
- Simple cycle turbines are not specifically called out, but are regulated by capacity factor.
 - The regulatory threshold for simple cycle gas turbines is 120 lb-CO₂/MMBtu of fuel for turbines operating less than 33% of the time.

- EGU – Electric Generating Unit
- GHG – GreenHouse Gas
- NSPS – New Source Performance Standard

NSPS: New Source Performance Standard

09/05/2016

Fc Gas Intelligence Conference
Philadelphia, PA

Clean Power Plan

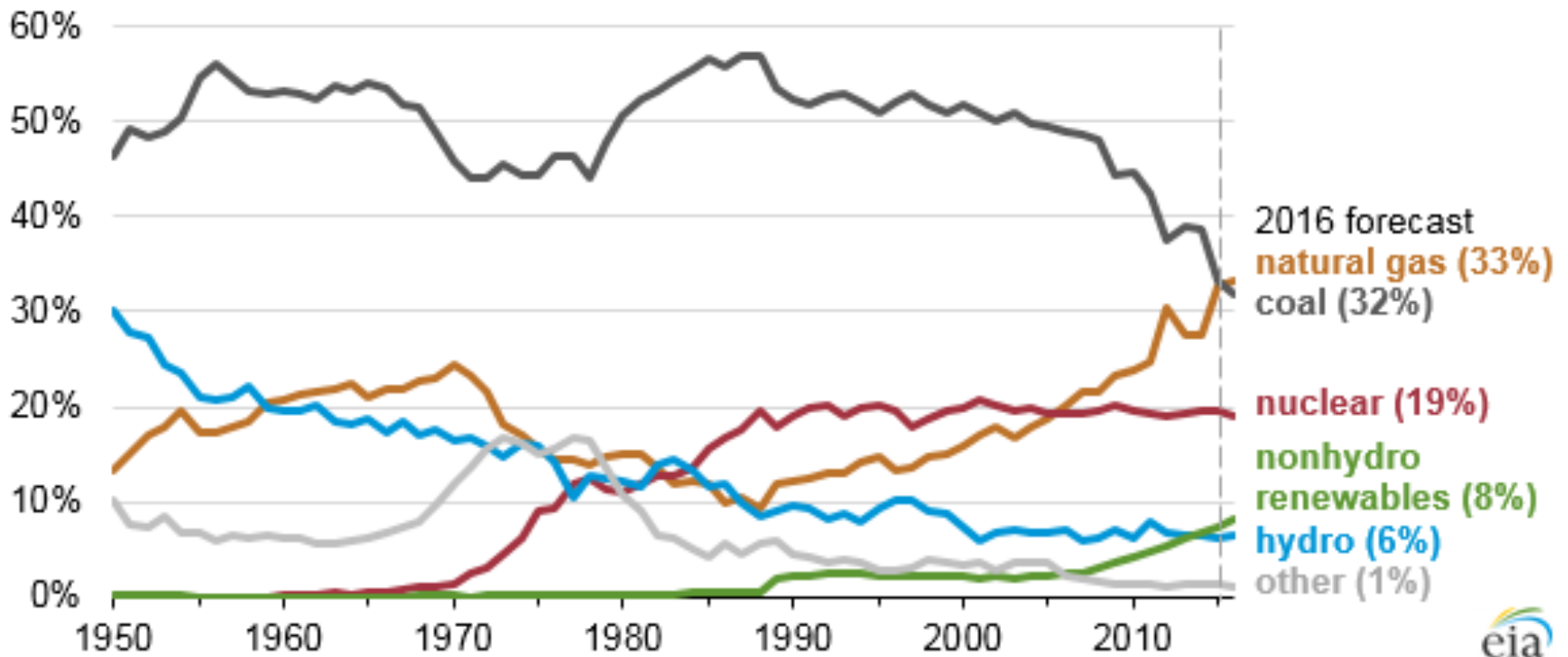
Existing Source Regulation (ESPS)

- ESPS: Proposal to Regulate CO₂ Emissions from Existing Power Plant (primarily coal fired thermal plants and gas turbines)
- Proposal allows states the leeway in how to regulate CO₂ emissions
 - They may limit output on a state level in tons of CO₂,
 - Or they may limit output at the state level in terms of the maximum emission rate (lb-CO₂ per MWh of energy)?
- States can have the final say on which path they choose.
 - They can even form energy and emission trading areas, much like NERC regions.
- Analysis of CO₂ emissions in the power industry suggested that increased combined cycle operation would net a significant reduction in CO₂ emissions
 - CO₂ emissions from combined cycles are about 1/3rd those of a coal plant
 - But not every state has a sufficient inventory of combined cycles in place
- Currently, the rule is being challenged by the majority of the states
- This portion of the Clean Power Plan was stayed by Supreme Court Decision in February, 2016

ESPS: Existing Source Performance Standard

Natural gas expected to surpass coal in mix of fuel used for U.S. power generation in 2016

Annual share of total U.S. electricity generation by source (1950-2016)
percent of total



Natural gas likely overtook coal as top U.S. power source in 2015

Last year looks like it was an unwelcome watershed for the embattled U.S. coal industry.

Power companies in 2015 for the first time may have burned more natural gas than coal to generate electricity, according to analysts who attribute it to the cheapest gas prices in 16 years and a record number of coal-fired plants retired from service because of the high cost of meeting environmental regulations.”

-Reuters

Wed Jan 20, 2016 3:19pm EST

<http://www.reuters.com/article/us-usa-natgas-coal-idUSKCN0UY2LT>

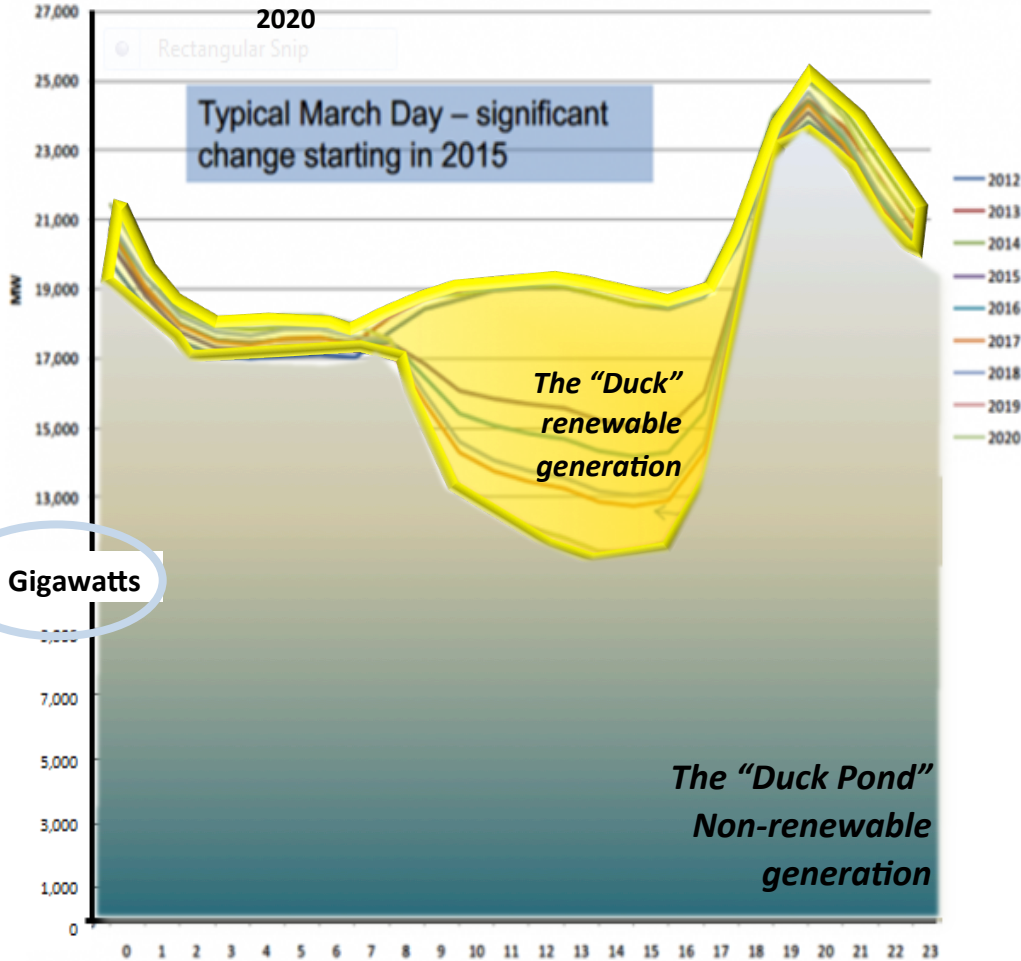
Power Generation on Grids with renewables

CAISO Net Load – 2012 through

2020

Rectangular Snip

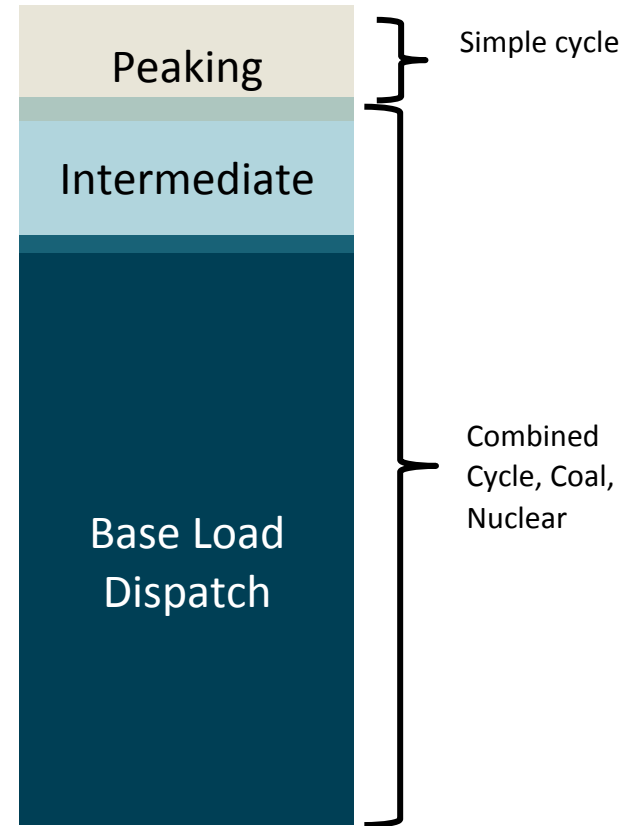
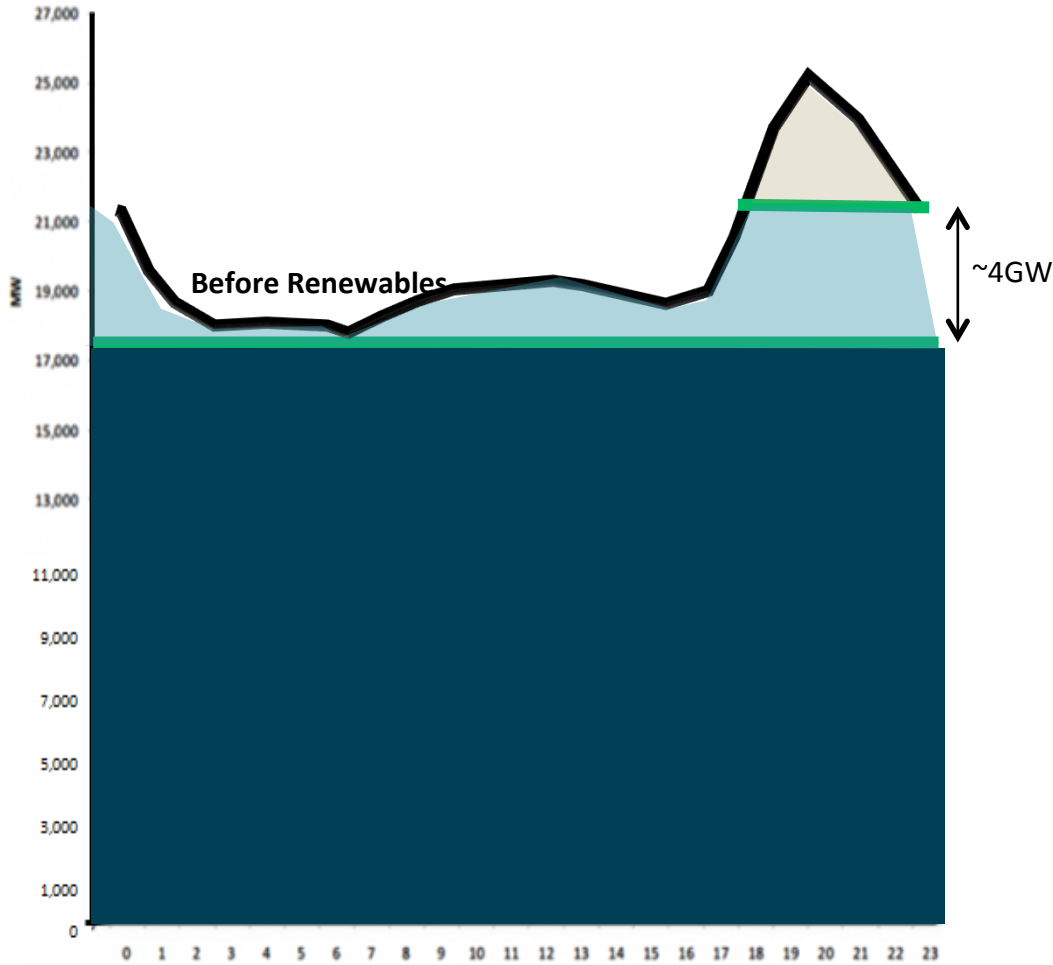
Typical March Day – significant change starting in 2015



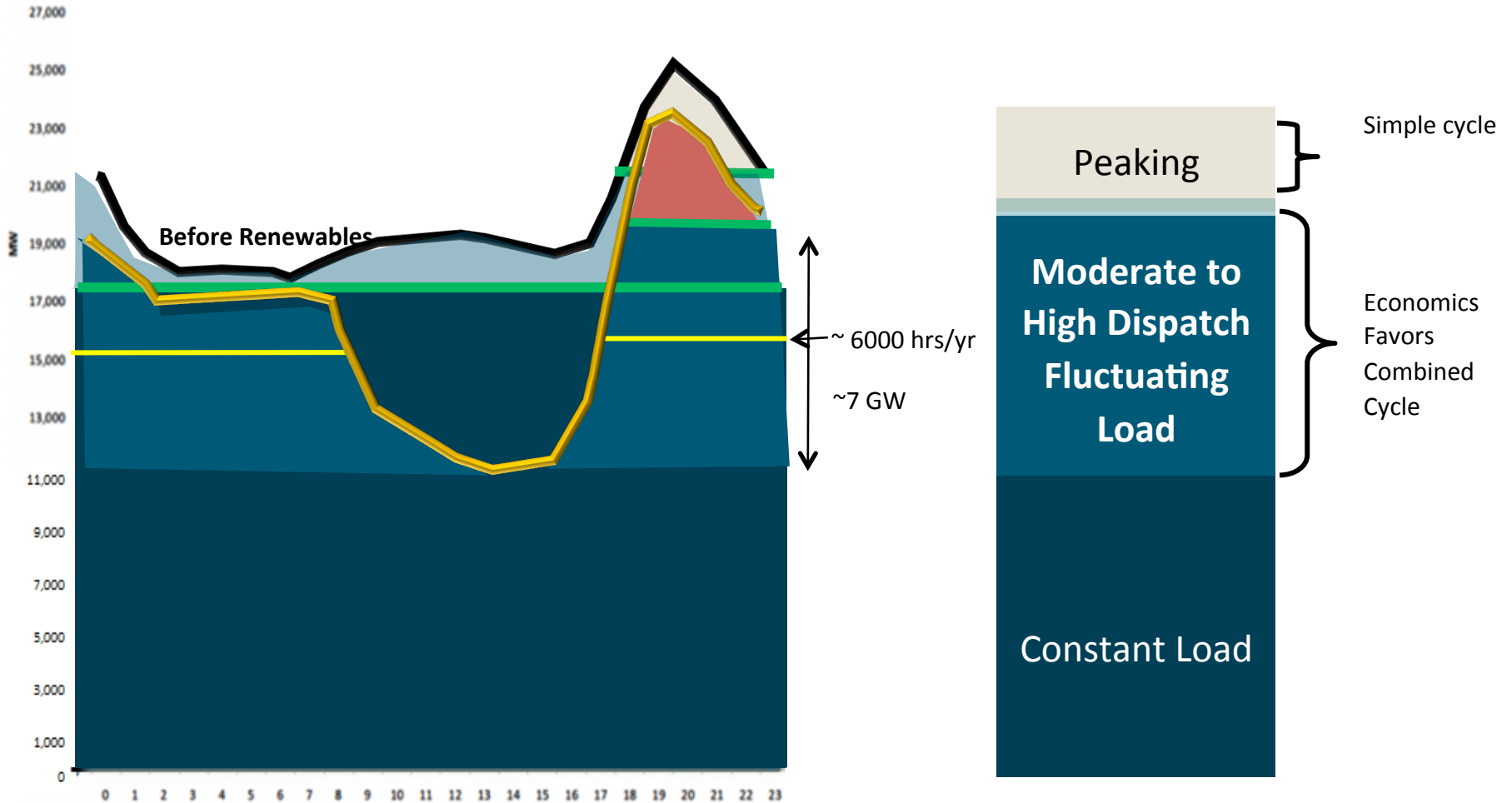
Lots of non-renewable generation is operating all of the time

The non-renewables remain more environmentally influential than the renewable generation

Power Generation on Grids without renewables



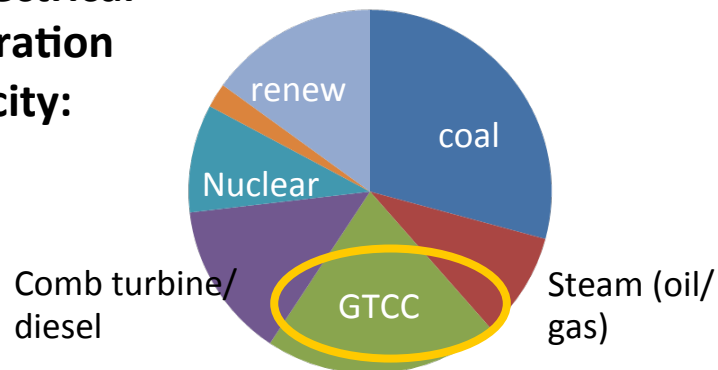
Power Generation on Grids with renewables



Gas Turbine: Key Part of US Electrical Generation ... and Growing

US Electrical Generation Capacity:

2013



Gas Turbine – Combined Cycle (GTCC) is **21%** of US Electric Power Generation

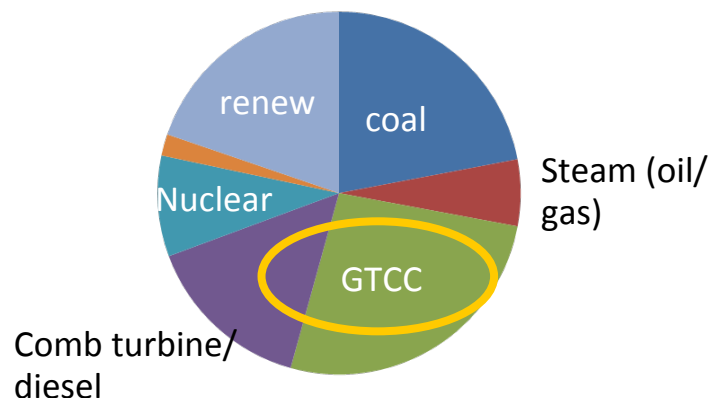
EIA Base Case Projects **>40% growth** in US GTCC capacity by 2040

EIA:

“natural gas turbines are the most economical way to meet growth”

“natural gas-fired plants account for more than 50% of [capacity] additions in all cases except ‘high oil prices’

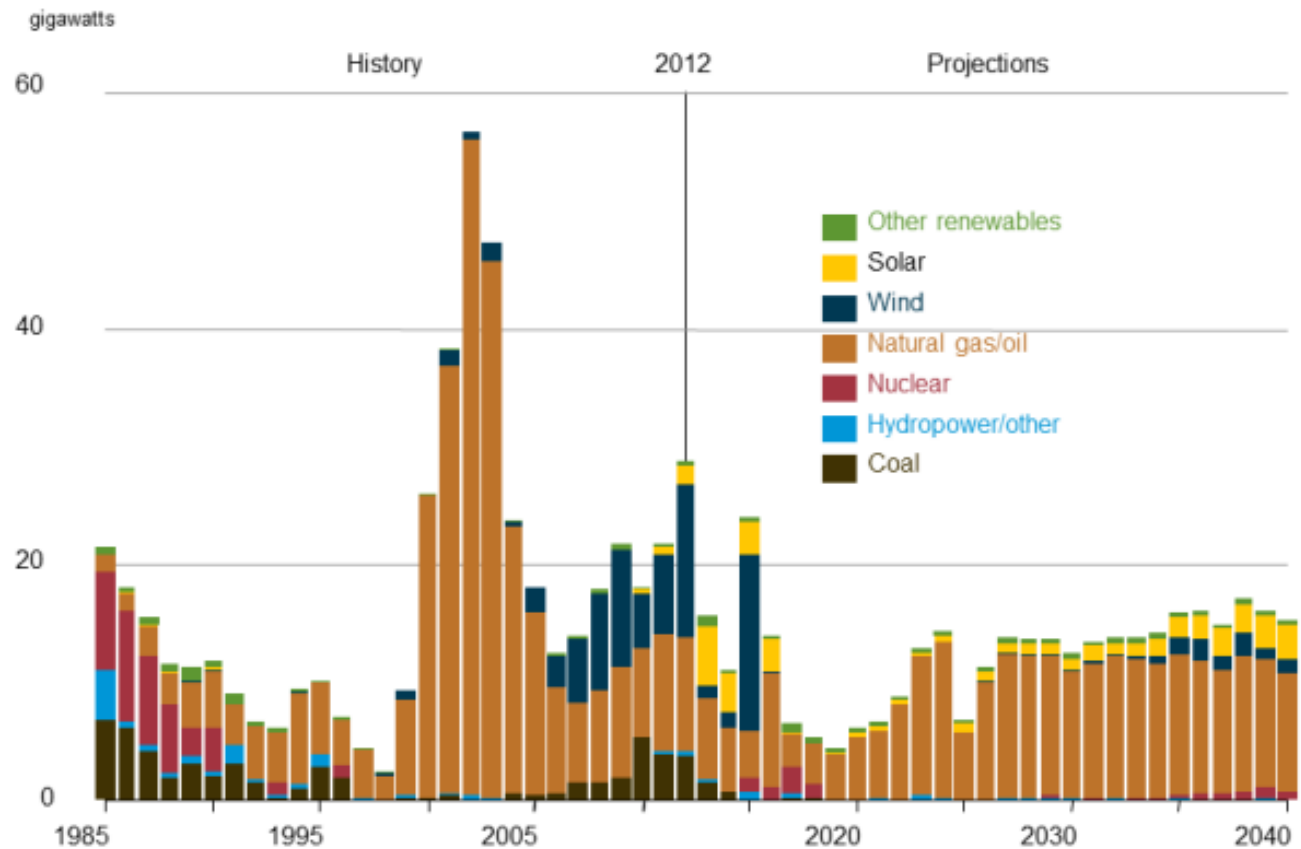
EIA 2040 Projection
(Base case)



Generating Capacity Additions

Reference Case through 2040

Figure MT-32. Additions to electricity generating capacity in the Reference case, 1985-2040

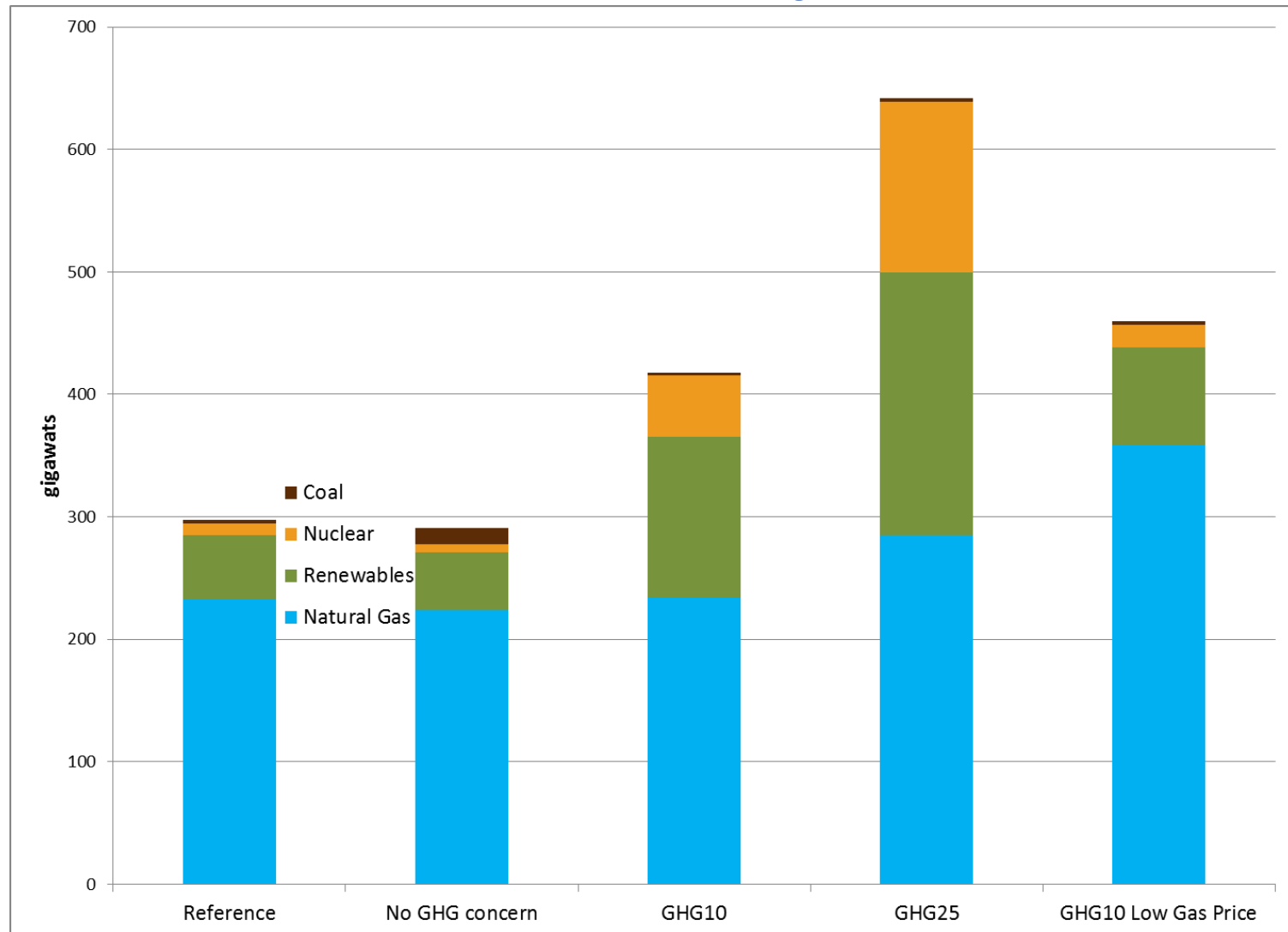


EIA Case Descriptions

- Reference Case (RC) - GDP 2.4%/y from 2012 - 40. Oil ~ \$141/barrel (2012\$) in 2040
- Low Economic Growth - GDP at 1.9% from 2012 to 2040
- High Economic Growth - GDP at 2.8% from 2012 to 2040
- No Sunset - RC and assumes extension of all existing tax credits and policies
- Low Renewable Technology Cost - CAPX for non-hydro renewables are 20% < than RC
- High Coal Cost (HCC) - Productivity growth rates 2.3 % pts lower than RC per yr.
- Accelerated Coal Retirements (AC) - Begins w/HCC case & assumes OPX increase 3%/yr.
- High Oil and Gas Resource - recovery 50% higher & well spacing 50% lower than RC
- Low Oil and Gas Resource - ultimate recovery 50% lower than RC
- No GHG Concern - No GHG reduction policy and investment decisions not altered
- GHG \$10 - carbon price at \$10 / metric T in 2015 and rising by 5 %/yr through 2040
- GHG \$25 - price for carbon dioxide starting at \$25 / metric T
- Greenhouse Gas \$10 and Low Gas Prices - GHG10 and High Oil & Gas cases

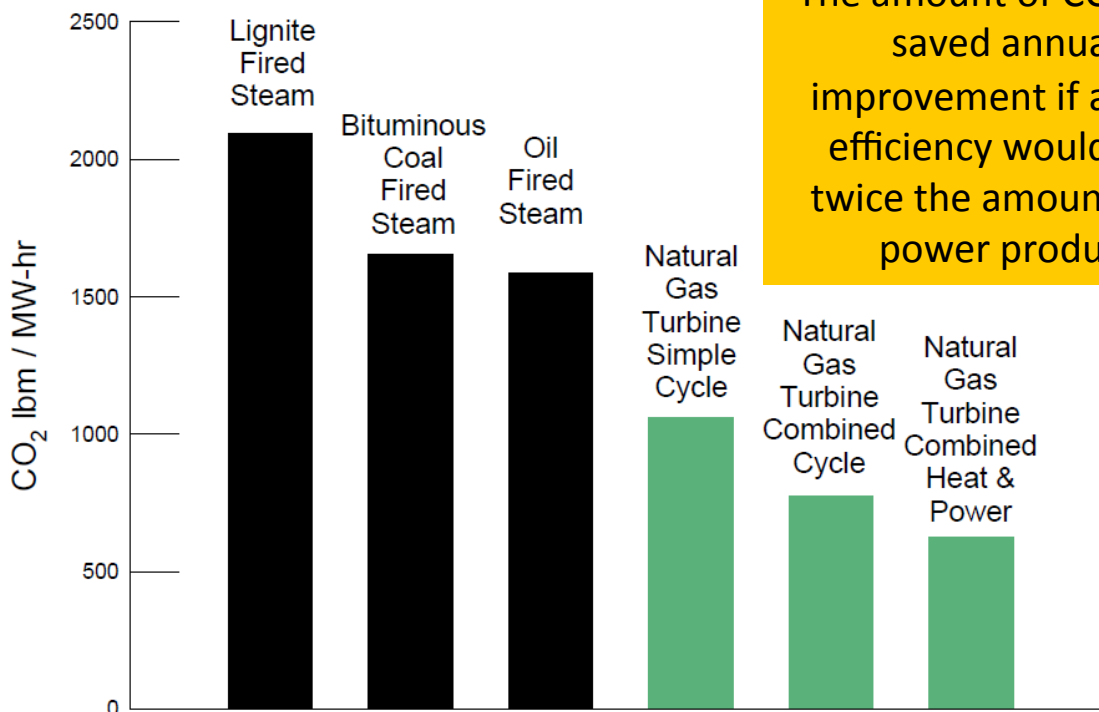
Generating Capacity Additions by Fuel

GHG Scenarios, through 2040



Gas Turbines: Cleaner use of fossil fuel

CO₂ Creation



Fun Fact

The amount of CO₂ that would be saved annually by a 1% improvement if average GT fleet efficiency would be more than twice the amount saved by solar power produced in 2014

High Thermodynamic Efficiency + Low Carbon Fuel = Low CO₂ Emissions



Advancing US Gas Turbine Technology

Good for the US

US Jobs:

High tech jobs. 2013 study¹ estimated about 100,000 direct and another 100,000 indirect jobs tied to US gas turbines

Clean burning – US CO2 emission reductions:

Conversion of an average US coal plant² to a modern gas turbine power plant burning natural gas reduces CO2 emissions by 69% and significantly reduces Nox, Sox, and heavy metals

US High Tech R&D:

US expertise and test facilities at OEMs ... at Universities ... at small businesses

Efficiency:

Efficient use of our domestic gas supplies. Gas turbines in combined cycle power plants can now reach 61%. DOE has set a goal for 65% efficiency.

Proven Platform:

In 2015 32%³ of US electricity came from gas turbines. Technology advancements have a clear avenue to application to achieve real impact.

Economical Power:

EIA Annual Energy Outlook 2015 - “natural gas turbines are the most economical way to meet growth”

Key Technology for Future Power Plants:

EIA Annual Energy Outlook 2015 says “natural gas fired plants account for more than 50% of [capacity] additions in all cases except “high oil prices”

Risks

Foreign Investment

Foreign national initiatives and investments risk loss of lead position for USA

Reduced DOE Investment

DOE funding is small ... down by two-thirds compared to mid-nineties
FY17 President budget proposal cuts the already small DOE funding of gas turbine technology from \$15M to \$10M

Risk to US Leading Position

Loss of lead position would lead to loss of manufacturing jobs and weakening of high-value exports, potentially affecting trade balance

Requests

Short Term Need: FY17

Fund DOE-Fossil Energy Gas turbine research at \$20M... minimum needed to move existing Phase 1 programs to Phase 2

Address Longer Term: Authorization Bill

HR 2961 was introduced in the 114th Congress proposing an important gas turbine technology program that would address this shortfall

The America Competes Reauthorization Act of 2015, HR 1806 passed last fall by the House also included this program

Pass either bill

¹ Competitiveness of US Gas Turbine Manufacturers, ICF International, Exhibit 4-3 March 29 2013

² EIA Annual Energy Outlook 2015; Table 8.2 “Avg Tested heat Rates”

³ EIA Electric Power Monthly – Feb 26, 2016



Thank You for Your Attention!