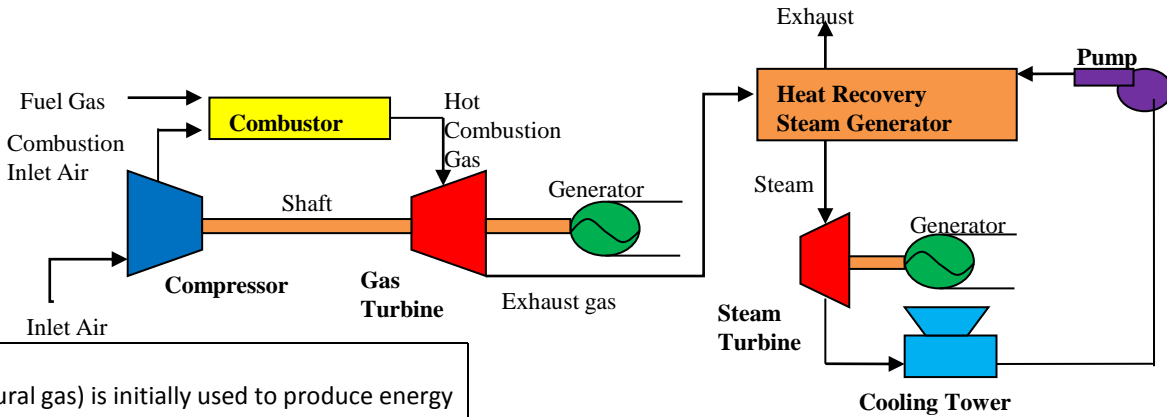


# Gas Turbine Combined Cycle (GTCC)

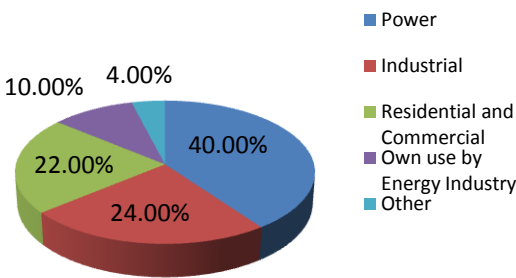


Above: Layout of GTCC. Note that there are *two* generators.

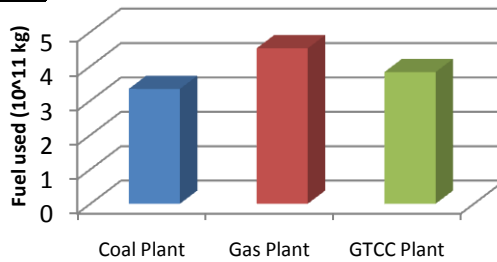
**GTCC Basics:**

- The fuel (natural gas) is initially used to produce energy in the first (natural gas turbine) process.
- The waste gas from the gas turbine provides heat to a steam turbine to obtain even more energy.
- This system has a higher efficiency than a simple gas turbine cycle.

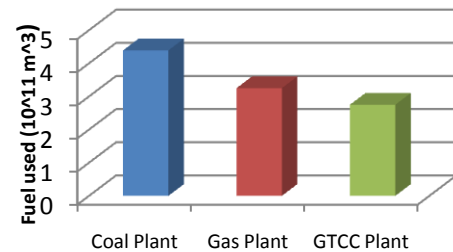
**Natural Gas Use by Sector**



**Fuel Use in one year, by Mass**

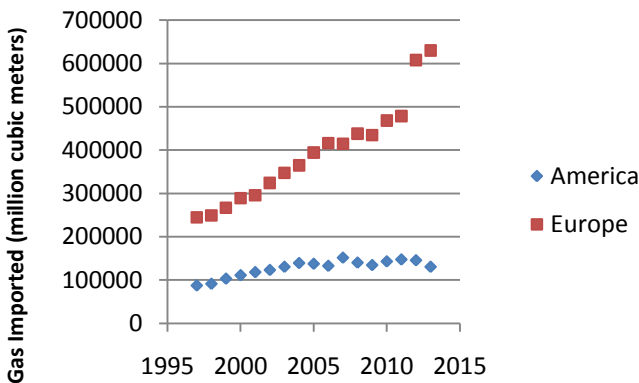


**Fuel Use in one year, by Volume**

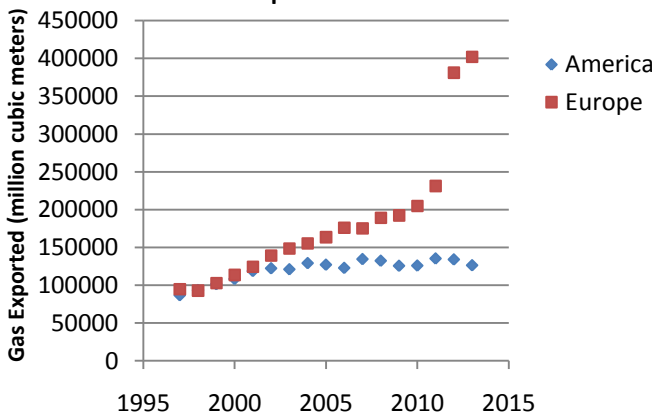


Figures show fuel used by a 250 MW power plant operating at full capacity for 4000 hours per year.

**Gross Imports of Natural Gas**



**Gross Exports of Natural Gas**



**Natural Gas Basics:**

- Natural gas is made up of hydrocarbons (methane, butane, and pentane) mixed with carbon dioxide, nitrogen, and hydrogen sulphide.
- Natural gas contains 53.2 MJ of energy per kg and 38.2 MJ per cubic meter. For comparison, coal contains 53.2 MJ of energy per kg and 38.2 MJ per cubic meter.
- Demand in 2012 for natural gas was approximately 3.427 billion cubic meters.
- Recoverable (including to-be-discovered) deposits of natural gas which can be extracted using conventional methods totaled 400,000 billion cubic meters. Factoring in unconventional deposits and the current rate of gas consumption, this supply would last for roughly 220 years.

**Technologies and Issues:**

**Hydraulic Fracking:**

This technology forces pressurized sand, water, and chemicals through a pipeline to crack otherwise impenetrable rock formations which contain unconventional natural gas. The gas then flows back through the pipeline. The process has caused production of natural gas to increase and the price of natural gas to drop.

**Fracking Consequences:**

This process uses large amounts of water, which becomes contaminated with chemicals, to extract the gas. In addition, the hazardous mixture can leak out of poorly-designed containment areas.

**Expense of Construction:**

GTCC plants are more complex and expensive to build than traditional gas turbine plants. Some of this cost can be offset by the savings in fuel cost for the power plant. Less fuel is needed to provide the same amount of power a traditional plant would provide.

# Gas Turbine Combined Cycle (GTCC)

## Layout of Plant: [1]

Figure is self-made using illustration as guide.

## GTCC Basics: [1]

## Fuel Use by mass and by volume of different plants per one year: [1,2,3,4]

Figure is self made.

## Natural Gas Use By Sector: [5]

Figure is self-made made.

## References:

[Numbers within brackets in each section indicates which source(s) the data came from]

- [1] Rubin, Edward, and Cliff Davidson. *Introduction to Engineering and the Environment*. New York: McGraw, 2001. Print.
- [2] *What is the Efficiency of different types of Power Plants?* U.S. Energy Information Administration, 3 February 2014. Web. Accessed 12 April 2014.
- [3] *Table 8.1. Average Operating Heat Rate for Selected Energy Sources*. U.S. Energy Information Administration, 3 February 2014. Web. Accessed 12 April 2014.
- [4] Supple, D. *Units and Conversions Fact Sheet*. MIT Energy Club, 2007. Print.
- [5] *FAQs: Natural Gas*. International Energy Agency. Web. Accessed 15 April 2014.
- [6] *Monthly gas data survey*. International Energy Agency, January 2014. Web. Accessed 15 April 2014.
- [7] *What is shale gas and why is it important?* U.S. Energy Information Administration, 5 December 2012. Web. Accessed 12 April 2014.

## Net Gross Imports and Exports: [6]

Data for each year taken from each Excel document, from December of the year after the year in question (January 2014 was used for data in year 2013). Figures are self-made.

## Technologies and Issues: [1,5,7]

## Natural Gas Basics: [4,5,7]