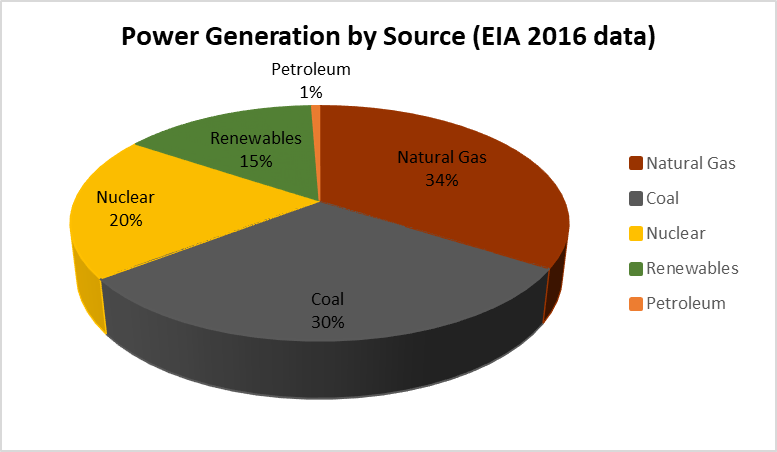
# Renewable Energy

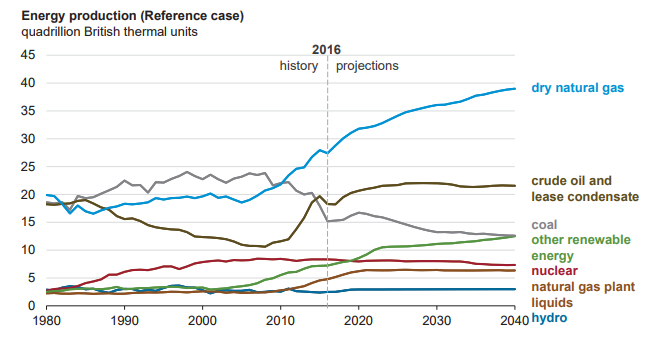
**General:**

* In the last several years, natural gas has surpassed coal as the greatest source of power generation.
* Currently, the two biggest renewable energy sources are hydroelectric and wind.

**Figure 1. 2016 Electricity Generation by Power Source**

*(Courtesy, US Energy Information Administration, www.eia.gov*





**Solar**

* General:
  + The sun is our greatest power source.
  + 173,000 terawatts of energy are hitting the earth at any one moment (10,000x the world’s energy use!).
  + Solar panels can help capture this energy and convert it into electricity for us to use.
* Efficiency:
  + Typical solar panels convert ~14% of available energy to electricity.
  + The best solar panels convert up to 22%.
    - Efficiency is improving every year!
  + Typical lifespan of solar panels is at least 25 years (energysage.com).
  + Contrary to popular belief, solar panels can still capture energy on cloudy day.
  + The amount of installed solar capacity installed in the last 10 years has smashed 2006 goals by 4813%!
  + They are even beginning to make solar panel roof shingles to renewably power your home!



Solar Roof via Tesla.com

**Ground Source Heat Pumps:**

* Ground source heat pumps utilize the relatively constant heat of the Earth (~50 degrees F) to heat and cool homes.
  + How it works:
    - They work by passing fluid (usually water and antifreeze) through a tubing system in the ground.
    - As the fluid passes through the pipes, it either picks up heat from the earth (heating mode) or expels heat into the earth (cooling mode).
    - The fluid then returns to heat or cool the house via a heat exchanger.
* GPHS are typically 25%-50% more efficient than standard home heating/cooling systems (furnace, A/C, electric baseboards) and have substantial emissions reductions.
* Systems last 25 years for in-home components; 50+ years for the ground loop (energy.gov).

**Hydroelectric:**

* Water is constantly moving around the globe in the form of rivers, oceans, clouds, and precipitation. Capturing energy from the movement of water is a great way to generate renewable electricity. In fact, hydropower is the biggest generator of renewable energy in the US.
  + How it works:
    - Water moving downstream flows through turbines (such as those housed in a dam), causing the turbines to spin, which drives a generator to produce electricity.
    - The reservoir behind the dam acts similar to a battery-- storing the water’s kinetic energy until it is needed. When energy demands are high, water can be released to spin through the turbines to generate electricity.
  + While hydroelectric power doesn’t lead to as much air and water pollution, it can significantly alter the surrounding environment, negatively impacting plants, wildlife, and people living in nearby communities.

**Wind:**

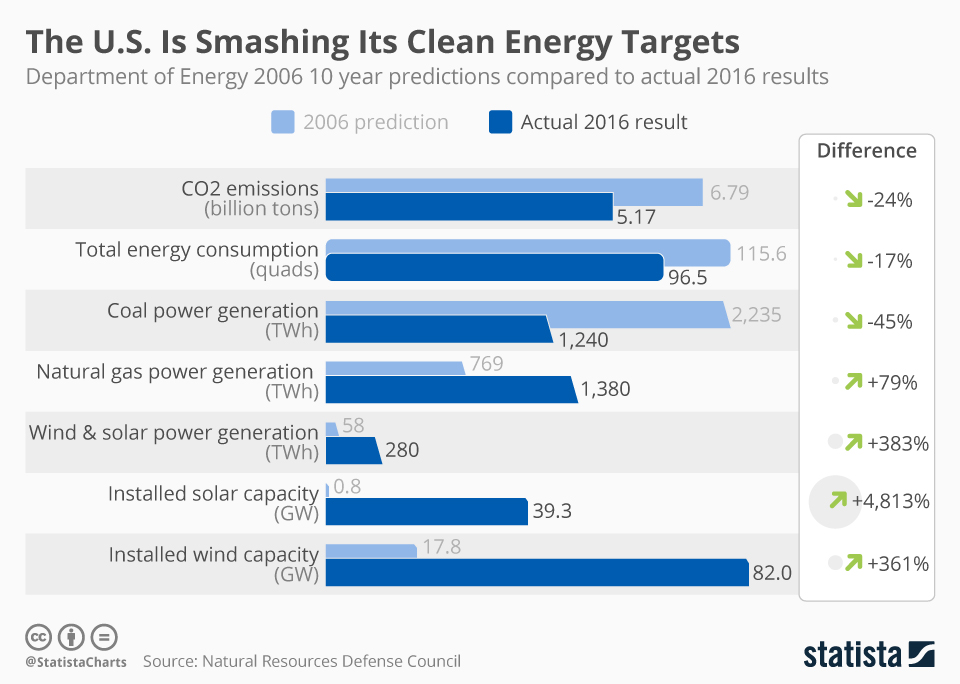
* Wind energy can be used in a similar scope as solar (to power homes or other small buildings).
  + How it works:
    - Wind drives a turbine which drives a generator which produces electricity.
    - A minimum wind speed of 4-6 mph is needed to reliably produce electricity.
    - Because wind speed increases with height, the taller the turbine the greater wind speed they’ll be able to access. However due to regulations, most turbines can only be 30m tall.
    - Wind energy is highly site specific, as wind speed varies greatly throughout the country (see map).
  + Wind turbines convert about 45% of the wind passing through the blades to electricity (energy.gov).
  + It is one of the lowest priced energy sources today! (energy.gov)
  + Unfortunately wind power can cause disruptions in bird and bat migrations, causing many fatalities every year. Practices are being implemented to help mitigate these fatalities.

**Biomass:**

* Biomass energy is energy derived from burning plants and other organic materials such as crops, woody plants, algae, and the organic components of municipal and industrial waste.
  + How it works:
    - Biomass can be burned directly as a power source, or converted into a variety of fuels that can be used to power equipment and machinery.
    - Common biomass feedstocks include lumber mill scraps, corn grain (ethanol), and soybeans (biodiesel).
    - This feedstock is converted into power or fuel to be used in a variety of instances.
  + Biomass reduces our dependence on fossil fuels.
  + Because biomass fuels can be made from many different organic products, locations can use whatever feedstock is most readily available.
  + Biomass doesn’t produce carbon emissions and can help reduce industrial waste.

**Where we’re heading:**

* Renewable energy like solar and wind have become much more economically viable options in the recent decade due to significant advancements in technology.
* According to recent analysis performed by the Natural Resources Defense Council, the US is greatly surpassing the clean energy targets it set in 2006.



**Questions for HS and above**

* Renewable energy sources account for what percentage of US energy production?
  + Less than 1%
  + 5-10%
  + **10-15%**
  + 20-25%
* What is the current efficiency that can be reached by a typical solar panel?
  + 8%
  + **14%**
  + 20%
  + 25%
* Biomass fuels can be made from which of the following feedstocks?
  + Lumber mill scraps
  + Corn grains
  + Soybeans
  + **All of the above**
* What is the minimum wind speed needed for a windmill to produce reliable electricity?
  + 1-2mph
  + **4-6mph**
  + 8-10mph
  + 10-12mph
* Which of the following are benefits of a ground source heat pump?
  + They are 25-50% more efficient than existing home heating systems
  + GSHPs release significantly less emissions than typical home heating systems
  + **A and B**
  + None of the above
* What are the two biggest sources of renewable energy
  + Solar and wind
  + **Wind and hydro**
  + Biomass and hydro
  + None of the above