Global Energy Industry Outlook 2008

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Executive Summary

For the better half of 2007, oil has traded in a $10 band either side of $70 per barrel. The primary reason for this was because supply of oil has struggled to keep up with the other face of the energy market, demand. Economic growth around the globe in developed and developing economies alike has also kept the world needing more energy. However, to meet this, supply of oil has just barely managed to keep up. And oil prices seem set to rise further.

Looking towards 2008 and trying to understand what the global energy markets are going to look like during the year, here's what this short future outlook on global energy market in 2008 contains:

It is highly likely that global oil markets will remain stretched out, as global oil demand has continued to increase at a much faster rate than oil supply outside of the Organization of the Petroleum Exporting Countries (OPEC), putting pressure on OPEC and inventories to bridge the gap. Additional fundamental factors contributing to price volatility include ongoing geopolitical risks, OECD inventory tightness, and worldwide refining bottlenecks. As a consequence, crude oil prices are expected to remain high and volatile.

Working natural gas in storage reached a record 3.51 trillion cubic feet (tcf) as of October 26, 2007. This gives the indication that abundant level of storage and limited fuel switching capability have mitigated the impact of the recent price increases in petroleum markets on natural gas prices. This trend is likely to continue in 2008 as well. The Henry Hub spot price is expected to average about $7.30 per thousand cubic feet (mcf) in 2007 and $8.01 per mcf in 2008.

The International Energy Agency (IEA) forecasts that energy demand between now and 2030 will increase by a half, an annual average increase of 1.6%. Two-thirds of the new demand will come from developing nations, with China accounting for 30%.

What is new is the focus on the environmental impact of consuming as much energy as we do in the way that we do. And that is what provides the hope that the world can modify its demand for energy, or at least its fossil-fuel energy demand, through efficiency and conservation.

No doubt that the coming year is likely to witness the world using more coal and more natural gas. The expansion of nuclear energy is going to continue to be constrained by the length of time it takes to build plants and get the regulatory approvals to operate them. Safety concerns further add a roadblock to the entire process. The use of biofuels and renewable alternatives such as wind and solar power will grow rapidly, but they have such a small base of use they will not replace significant quantities of fossil fuels any time soon--nor diminish the competition between countries to secure supplies.

Read on further for a forecast of particular sectors.

Global Energy Consumption

No doubt that energy consumption from all sources is expected to increase drastically in not just 2008, but also in the coming years. Fossil fuels, especially coal, are expected to continue to provide the majority of the increase in marketed energy use worldwide. Oil and other petroleum products are also expected to continue to account for the largest share of world energy consumption, but their share is likely to fall over the next couple of years mainly due to increasing world oil prices.

Petroleum and other liquid fuels will no doubt remain the most important fuels for transportation in 2008, as there are really very few alternatives that can be expected to compete widely with petroleum-based liquids.

The rising price of oil is expected to have an impact on the usage and demand for natural gas as well. Natural gas consumption is likely to go up in 2008, as it will be used to displace the use of liquid fuels in the industrial and electric power sectors in many parts of the world. Additionally, natural gas has proven to be a far more efficient fuel for electric power generation and less carbon intensive than other fossil fuels, and as a result it is an attractive energy source for the world's power generation. Natural gas is also the world's fastest-growing energy source for electricity generation, leading to an increase in the electric power sector share of total natural gas use worldwide in 2008.

The price of natural gas will vary from region to region, with cost being dependent on the size of available resources and their distance from end-use markets. For example, in the United States, usage of relatively expensive domestic supplies of unconventional natural gas and imports of liquefied natural gas (LNG) is expected to increase in 2008, and the projected prices in the U.S. market is expected to higher. Similarly, in Russia and the Middle East, where domestic resources of natural gas are not only abundant but also readily accessible, natural gas prices are going to be among the lowest in the world.

Moving on to coal consumption, global coal consumption is expected to rise sharply in 2008 because with oil and natural gas prices expected to continue rising, coal will become appealing for nations with access to ample coal resources. This is especially going to be true for China, India, and the United States.

Meanwhile, strong economic development in many of the non-OECD countries is likely to boost demand for electricity to run newly purchased home appliances for air conditioning, cooking, space and water heating, and refrigeration and to support the expansion of commercial services, including hospitals, office buildings, and shopping malls. In the OECD nations, where infrastructures are well established and population growth is slower, electricity generation is expected to grow by 1.3% in 2008.

Natural gas and coal will continue to provide the massive shares of the total energy used for electricity generation worldwide in 2008. The environmental benefits and efficiency

of natural gas will keep the demand high for its usage in electricity generation. However, higher oil and natural gas prices are bound to have an impact on this and ultimately make coal the economic choice in countries where coal resources are abundant.

Further, higher fossil fuel prices, energy security concerns, and environmental considerations are expected to improve the prospects for new nuclear power capacity in many parts of the world in 2008. Decline in the use of nuclear power is likely to be witnessed in OECD Europe where many countries have plans or mandates to phase out nuclear power. Retirement, not replacement, will occur for some older reactors.

The use of hydroelectricity and other grid-connected renewable energy sources is expected to continue to expand over 2008. Rising fossil fuel costs, particularly for natural gas in the electric power sector, along with government policies and programs to support renewable energy, will allow renewable fuels to compete economically during the year.

Global Petroleum Markets

Tight fundamentals are expected to continue to put upward pressure on oil prices during 2008. Despite the commitment from OPEC to increase output beginning in November 2007, strong demand, limited surplus capacity, falling inventories and geopolitical concerns continue to trouble the market. Increasing consumption of oil and the realization that additional OPEC production may not be sufficient to stop the inventory decline are keeping markets firm. At the same time, the market is operating with limited surplus production capacity, leaving it vulnerable to supply disruptions.

World oil consumption is expected to continue to rise in spite of higher oil prices. EIA projects that world oil consumption will increase by 1.5 million bbl/d in 2008. It can be assumed that China, the United States, Russia, and Middle Eastern countries will continue to be the main drivers of increased global oil use. The possibility of slower economic growth due to higher prices and turmoil in the financial markets is the main threat to sustained oil consumption growth.

Non-OPEC production is likely to continue to rise through 2008. Non-OPEC supply in 2008 is forecasted to increase by 0.9 million bbl/d. Increases in Brazil, the United States, Russia, and Canada will more than offset lower production in a number of countries, including Mexico, the United Kingdom, Norway, and Egypt. Russia and the other countries of the former Soviet Union combined are expected to account for more than half of the gain in non-OPEC supplies in 2008. However, non-OPEC supply is expected to increase by less than global oil consumption until the second half of 2008 at the earliest, putting pressure on OPEC and inventories to bridge this gap.

Meanwhile, OPEC has agreed to reassess the market situation at its meeting on December 5, 2007. While OPEC has not yet signaled the need for a change in its production policy, EIA projects that OPEC crude production in 2008 could average about 31.7 million bbl/d, an increase of more than 700,000 bbl/d from fourth quarter 2007 levels. Under this scenario, OPEC and world surplus production capacity will remain fairly low at around 2 to 3 million bbl/d.

Global Natural Gas Markets

In 2008, total global natural gas consumption is projected to grow by 0.9%. In the residential sector, consumption is expected to increase by two % in 2008, with 0.9 and 1.3% growth expected in the commercial and electric power sectors, respectively. Consumption in the industrial sector is projected to decline by 0.7% in 2007 and will likely remain relatively unchanged in 2008.

Total U.S. natural gas production is expected to rise by 1.3% in 2008. Ongoing efforts to develop unconventional reserves are expected to increase Lower-48 onshore production by 0.3% in 2008. Although production in the Gulf is expected to decline by 2.8% in 2007, the development of deepwater supply sources is expected to lead to production growth of 7.4% in 2008.

Imports of liquefied natural gas (LNG) have slowed down considerably since the start of 2007, reflecting changes in global LNG supply and demand. Several LNG producers are experiencing difficulties maintaining full production levels at the same time as strong demand in other parts of the world has resulted in higher prices, which divert cargos away from the United States. For example, Japan, which is the world's largest importer of LNG, is using more LNG for electricity generation following an earthquake that resulted in the ongoing shutdown of a major nuclear power plant.

Global Electricity Markets

World demand for electricity is expected to grow in 2008, with the majority of this growth coming from countries outside the OECD. This is primarily due to the relative maturity of electricity infrastructure in the more developed OECD region, as well as the expectation that populations in the OECD countries generally will grow slowly or decline over the next 25 years. In addition, fast-paced growth in the developing non-OECD economies translates to rising standards of living and robust growth in consumer demand for lighting and appliances.

Among the energy end-use sectors, the most rapid growth in 2008 in total world demand for electricity is projected for the buildings (residential and commercial) sectors. The most rapid rate of increase in electricity demand is projected for the commercial sector, both worldwide and by region, reflecting the expected growth of service activities as strong economic growth, particularly among the non-OECD countries, increases the demand for office space, hospitals, hotels, and other institutions or organizations.

The mix of primary fuels used to generate electricity has changed a great deal over the past two decades on a worldwide basis. Coal has continued to be the fuel most widely used for electricity generation, although generation from nuclear power increased rapidly from the 1970s through the mid-1980s, and natural-gas-fired generation grew rapidly in the 1980s and 1990s. The use of oil for electricity generation has been declining since the mid-1970s, when the oil embargo by Arab producers in 1973-1974 and the Iranian Revolution in 1979 produced oil price shocks.

More recently, high world oil prices - which have been trending upward since 2003 - have further eroded the role of petroleum in the power sector. Higher world oil prices have encouraged a shift from oil-fired generation to natural gas and nuclear power and have reinforced coal's important role as an energy source for electricity generation. Today, relatively high world oil prices in combination with concerns about the environmental consequences of greenhouse gas emissions are raising renewed interest in nuclear power and renewable energy sources as alternatives to the use of coal and natural gas for electric power generation.

While natural gas is the fastest-growing energy source for electricity generation globally, coal is expected to continue to provide the largest share of the energy used for electric power production in 2008.

The prospects for nuclear power have improved in recent years and higher capacity utilization rates have been reported for many existing nuclear facilities. Extensions to their operating lives are expected for most of the existing plants in OECD countries and countries of non-OECD Europe and Eurasia (including Russia) in 2008.

Electricity generation from hydroelectric and other renewable energy resources is projected to increase as well in 2008. The reason behind this is the increasing oil and natural gas prices, which are expected to persist in 2008, and thus encourage the use of renewables.

Global Coal Market

Coal consumption is expected to rise in the year 2008. Regionally, increased use of coal in non-OECD countries is likely to account for 85% of the total growth in world coal consumption.

Although coal currently is the second-largest fuel source of energy-related carbon dioxide emissions (behind oil), accounting for 41% of the world total in 2007, it is projected to become the largest source by 2010. The two key factors underlying the increase are a more rapid projected growth rate for world coal consumption than for oil consumption and the fact that carbon dioxide emissions per unit of energy output are higher for coal than for oil or natural gas.

Although coal deposits are widely distributed, 67% of the world's recoverable reserves are located in four countries: the United States (27%), Russia (17%), China (13%), and India (10%). Coal consumption is expected to obviously increase in these four countries especially.

Glossary

Acid Rain: Sulfur dioxide (SO2) and nitrogen oxides (NOx), along with other chemical compounds, are released during the combustion of fossil fuels. When these gases react in the atmosphere with water, oxygen, and other chemicals, they form acidic compounds. Sunlight increases the rate of most of these reactions. The resulting substances are wet (acid rain, snow, or fog) or dry (acidic gases or particulates) and may drift far from the original source before falling to the earth. The negative effects of these acidic deposits include damage to forests, soil, and aquatic ecosystems, damage to infrastructure and human health, and reduced visibility.

Ampere (amp): A unit of electrical current or rate of flow of electrons. One volt across one ohm of resistance causes a current flow of one ampere. Amperes are used by utilities and electrical engineers to measure electrical flow.

Bioenergy: Energy or electricity produced using biomass as a fuel.

Biodiesel: Biodiesel is a type of biofuel made by combining animal fat or vegetable oil (such as soybean oil or recycled restaurant grease) with alcohol and can be directly substituted for diesel as a stand-alone fuel (called B100, for 100% biodiesel) or be used as an additive (called B20, for 20% bio-diesel). Biodiesel can be used in vehicles (newer cars, usually 1994 or later, are required for B100) and is beginning to be used in on-site electricity generation and heating applications.

Biofuel: Biofuels are renewable liquid fuels made from plant matter rather than fossil fuels. Today's primary biofuels are ethanol and biodiesel. Biofuels can help reduce air toxics emissions, greenhouse gas buildup, and dependence on imported oil, while supporting United States agriculture.

Biomass: A type of renewable fuels that includes trees and other crops and residues, solid waste, sewage, and liquid fuels derived from agricultural products. Some of the common energy sources derived from biomass are landfill gas, anaerobic digester gas, methane, and biofuels including biodiesel, bio-oil, and ethanol. Biomass gasification is an emerging clean energy technology. See the Bioenergy section of the MTC website for more details.

Biomass Gasification: This is a highly efficient process for converting woody biomass (wood chips, pellets, and other wood residues) into energy that can then be converted into electricity.

Bio-oil: Solid biomass can be converted into a carbon-rich liquid, which can be used to produce chemicals and fuels. This liquid, or bio-oil, is produced through a process called pyrolysis, in which the biomass is broken down into liquid in an oxygen-free, high-temperature environment.

Carbon Dioxide (CO2): Carbon dioxide is one of the most common greenhouse gases in the atmosphere and is regulated through the natural carbon cycle, where carbon dioxide is emitted into the air and reabsorbed by vegetation and water. This cycle is upset by the emission of additional carbon dioxide from human activities. Because natural cycles cannot absorb these additional emissions, a large portion of carbon dioxide remains in the atmosphere and increases climate change. The primary human source of carbon dioxide is the burning of fossil fuels for electricity, heat, and transportation.

Carbon Monoxide (CO): This gas is created when the carbon in fossil fuels is not entirely burned during combustion and can have serious impacts on human health. The majority of carbon monoxide emissions come from the use of fossil fuels in transportation. Lesser quantities come from electricity production and natural events like forest fires. Improperly adjusted gas stoves can also release high levels of indoor carbon monoxide. When released into the air, carbon monoxide can exacerbate heart disease and damage the human nervous system. Carbon monoxide also has an indirect effect on global climate change, and is a criteria pollutant.

Chemical Energy: Chemical energy is generated from chemical reactions in which the chemical bonds of a substance are broken and rearranged to form new molecules that can provide energy. Chemical energy can be transformed into thermal energy, mechanical energy, and electrical energy. Respective examples of these conversions include burning wood, digestion of food, and the chemical process used in nuclear power plants.

Clean Energy: Clean energy can be generally defined as energy from renewable sources such as biomass, wind, or solar power. The goal of clean energy is to have a low environmental impact, with low or zero emissions, and a minimal impact on the physical surroundings. Hydropower can be defined as clean energy due to zero emissions, but today's hydropower still often has substantial impacts on aquatic ecosystems. Waste-burning and wood-burning plants that capture emissions can be clean energy generators. Fossil fuels do not provide clean energy because of their emissions and environmental impacts. Learn more about clean energy technologies.

Coal: Coal is a fossil fuel that currently provides about half of the country's electricity. Coal power plants create more emissions per unit of generated electricity than other fuels, and are required to install pollution control devices to curb pollution. Like natural gas and oil, coal is a nonrenewable resource because it cannot be replenished on a human time scale.

Concentrating Solar Power (CSP): Concentrating solar power plants collect the sun's energy through different mirror configurations, converting the high-temperature heat collected into electricity through use of a generator. There are three different types of CSP systems: trough systems, power tower systems, and solar dish/engine systems. Each system uses a different method for collecting solar energy.

Criteria Pollutants: These are man-made pollutants such as carbon monoxide, nitrogen oxides, nonmethane volatile organic compounds (NMVOCs), and sulfur dioxide that have indirect effects on global warming. They are primarily emitted as byproducts of fossil fuel and biomass combustion. Lead and particulates are also criteria pollutants. Although these pollutants only remain in the atmosphere for a short time, the chemical reactions that remove carbon monoxide, NMVOCs, and nitrogen oxides from the atmosphere promote the formation of ozone, which is harmful to people and animals at ground level.

Daylighting (Natural Lighting): Daylighting is the use of various design techniques to enhance the use of natural light in a building. Daylighting decreases reliance on electric lights and mechanical systems through the use of windows, skylights, light shelves, and other techniques that maximize sunlight while minimizing glare and excess heat. Green buildings often use daylighting.

Direct Current (DC): A direct current means that electrical current flows in a single direction through a conductor. DC must be converted to alternating current (AC) to be used for a typical 120-volt or 220-volt household appliance. DC is used directly in industrial applications and appliances that use battery power.

Electric Utility: An entity that owns and operates transmission and/or distribution facilities and delivers electric energy to customers. It may be an investor-owned, municipal, state, or federal electric utility, or a rural electric cooperative. Find your local Massachusetts utility.

Electrical Circuit: The path followed by electrons from a power source such as a photovoltaic (solar) panel, through an electrical system to create light, motion, battery power, and other power. The circuit is completed when the electrons return to the power source, creating a continuous flow of electricity.

Electrical Current: The flow of electrons through an electrical wire, or transmission or distribution line. Current is measured in amperes.

Electrical Energy: Electrical energy is the flow of electrons along a circuit. The movement of electrons creates an electric current which can be connected to an end use like lighting or appliances. Electrical energy can also be transformed into mechanical energy (using an elevator) or thermal energy (by using a space heater). Conversely, mechanical, thermal, and other forms of energy can be converted to create electricity, as in wind turbines and biomass facilities respectively. Electrical energy is usually measured in kilowatt-hours (kWh) or megawatt-hours (MW).

Electrical Grid (Electric Grid): The grid can most easily be understood as a web of connections between power plants and the consumer of electricity. This web transfers electricity from power plants through transmission substations, high voltage transmission lines, distribution substations, and distribution lines to the consumer.

Emissions: Emissions are gases and particles released into the air as byproducts of a natural or man-made process. One of these processes is the burning of fuels to create electricity and other forms of energy. The emissions from burning fossil fuels contribute significantly to global warming and poor air quality. Small sets of emissions are responsible for the majority of human impacts on global climate change and health. These gases and particulates come from a variety of sources and can be categorized as greenhouse gas emissions (which affect climate change) and air quality emissions (which affect health as well as the environment).

Energy: The ability to do work or the ability to move an object. Energy occurs in two primary states, potential and kinetic. This energy can occur in a number of forms including electrical, thermal (heat), chemical, radiant, and mechanical energy.

Energy Efficiency: Energy efficiency refers to products or systems designed to use less energy for the same or higher performance than regular products or systems. Energy-efficient buildings are designed to use less energy than traditional buildings; see green buildings for details. Saving energy through efficiency also saves money on utility bills and protects the environment by reducing fossil fuel consumption and emissions. Combining energy efficiency with renewable energy is even better for the environment.

Ethanol: A biofuel derived from grain and corn that can be used instead of or as an additive to gasoline. Ethanol is primarily used in transportation applications.

Fossil Fuels: Fossil fuels (oil, coal, and natural gas) come from the long-term decomposition of plant and animal matter from millions of years ago. These fossil fuels are the main sources of energy used by Americans today to generate electricity, heat, and fuel for transportation. Because fossil fuels cannot be replenished on a human time scale once they are extracted and burned, they are a non-renewable resource. The byproducts of fossil fuel combustion, including carbon dioxide (CO2) and methane, are emissions that increase the "greenhouse" effect that causes global climate change.

Fuel Cells: A fuel cell is an electrochemical device used to create electricity. Much like a battery, it converts chemical energy to electrical energy. But unlike a typical battery, which holds a limited fuel supply in a sealed container, a fuel cell uses an ongoing supply of fuel to create a continuous flow of electricity. Fuels like natural gas and methane gas are used to produce hydrogen and oxygen. The hydrogen and oxygen are then fed to two terminals in the fuel cell to cause a chemical reaction that produces electricity with heat and water as byproducts. Learn more about fuel cells.

Global Climate Change (GCC): Global climate change is a significant alteration from one climatic condition to another, beyond the usual alterations in various climates throughout the globe, as the result of human activities. The greatest of these is fossil fuel combustion, which traps greenhouse gases in the atmosphere that cause gradual changes in Earth's temperatures over hundreds of years. The term "global warming" may also be

used but refers more specifically to temperature, whereas global climate change encompasses the broader changes associated with elevated greenhouse gas levels, such as dryer deserts, increased numbers of hurricanes, and warmer oceans.

Greenhouse Gases: While gases like carbon dioxide, methane, nitrous oxide, ozone, and water vapor naturally occur in earth's atmosphere, human activities can artificially increase concentrations, notably through fossil fuel combustion to produce heat and electricity. These gases are dubbed greenhouse gases because they remain in the atmosphere and intensify the sun's heat as it radiates to the earth, similar to a greenhouse's glass walls heating and moisturizing the air inside of it. Greenhouse gases are the primary source of global climate change (GCC). Learn more about greenhouse gases and GCC.

Hydropower (Hydroelectricity): Hydropower, or hydroelectricity, is a clean energy technology that uses moving water to produce electricity. In a hydroelectric system, water flows downstream through a hydraulic turbine that spins and in turn rotates adjacent generators to transform the rotational energy into electricity. When the water exits the turbine it is returned to the stream or riverbed. Hydraulic turbines are generally located near dams that increase the height from which water falls to increase the potential for energy generation. Learn more about hydropower.

Investor-Owned Utility: A publicly held utility that typically serves multiple towns or regions and often combines transmission and distribution services. The Massachusetts DTE regulates standards, rates, and other aspects of investor-owned utilities. These utilities are also required under the Massachusetts Electric Restructuring Act of 1997 to collect energy efficiency and renewable energy funding for use in public funds.

Joule (J): A unit of electrical energy equal to the work done when a current of one ampere passes through a resistance of one ohm for one second (synonymous with watt-second).

Kilowatt (kW): A standard unit of electrical power equal to 1000 watts. The term "kilowatt" (in addition to the measurements of "watt" and "megawatt") is commonly used to describe the capacity of an electric generator, particularly in reference to small solar photovoltaic and other generating systems.

Kilowatt-hour (kWh): 1,000 watts or 1 kilowatt acting over a period of 1 hour. One kilowatt-hour is equal to 1,000 watt-hours and is equal to 3600 kJ. The primary difference between a kilowatt and a kilowatt-hour is that "kilowatt" measures the capacity of an electric generator and "kilowatt-hour" measures the actual amount of electricity it produces over a certain period of time.

Kinetic Energy: Kinetic energy is the release of potential energy to create motion, ultimately to do work. An example of kinetic energy is the energy carried by wind.

Landfill Gas: Landfill gas is created when food, wood, and other organic waste in a landfill decomposes under anaerobic – or oxygen-free – conditions. Because landfill gas is about 50% methane, it can be used as a source of energy similar to natural gas (which is about 90% methane). Carbon dioxide (CO2) is the other primary component of landfill gas. Since landfill gas is generated continuously, it provides a reliable fuel for a range of energy applications, including heating and electric power generation.

Mechanical Energy: Mechanical energy refers to an object that is doing work by being in motion. Mechanical energy can be transformed into electrical energy or thermal energy. Examples include wind turbines and refrigerators, respectively.

Megawatt (MW): A standard unit of electrical power equal to 1,000 kilowatts, or 1 million watts. Like watts and kilowatts, the term "megawatt" is used as a standard measure of electric power plant generating capacity. It is most commonly used for large systems like wind turbines, biomass plants, and coal, natural gas, and nuclear plants.

Megawatt-hour (MWh): 1 megawatt acting over a period of 1 hour. One megawatt-hour is equal to 1,000 kilowatt-hours or 1 million watt-hours. The primary difference between a megawatt and a megawatt-hour is that "megawatt" measures the capacity of an electric generator and "megawatt-hour" measures the actual amount of electricity it produces over a certain period of time.

Methane Gas: Methane is a common, naturally occurring and human-produced gas that can have serious climate change impacts when it is not captured. When captured, it can be used as a fuel. Methane produced by decomposition in landfills and through other human activities can be burned to produce energy for turbines and even fuel cells.

Municipal Utility: Municipally owned utilities are owned and operated by the individual towns and cities they serve. These utilities are responsible for customer billing, wire, pole, and meter maintenance, connecting new customers, distribution of electricity, and restoring power after an outage. These utilities are not required to collect energy efficiency and renewable energy funding for use in public funds, but some have elected to establish their own energy efficiency funds and install clean energy in their local service areas.

Natural Gas: Natural gas is a fossil fuel made of about 50% methane, a potent greenhouse gas. Like coal and oil, natural gas is a nonrenewable resource because it cannot be replenished on a human time scale. According to the U.S. EPA, natural gas power plants provide about 14% of the electricity produced in the United States, ranking third behind coal and nuclear power.

Nitrogen Oxides (NOx): Nitrogen oxides are byproducts of nitrous oxide from fossil fuel combustion. They are called criteria pollutants (along with carbon monoxide, sulfur dioxide, nonmethane volatile organic compounds, lead, and particulates). They contribute

to acid rain, smog, and respiratory problems, and have an indirect impact on global climate change.

Nitrous Oxides (N2O): Nitrous oxides are greenhouse gases. The natural sources and cycles of nitrous oxides are not as well understood as those of carbon dioxide and methane, but their primary natural source appears to be bacterial breakdown of chemicals in soil. Human activities that increase nitrous oxide levels in the atmosphere (and the corresponding risk of climate change) include fossil fuel burning, use of nitrogen-based fertilizers in farming, and emissions from industrial processes.

Nuclear Energy: Nuclear energy relies on the splitting of uranium atoms in a process called fission, which generates heat for producing steam that then turns a turbine to produce electricity. While nuclear power plants do not emit air pollutants, nuclear wastes and abandoned uranium mines pose health risks from radiation for as long as 250,000 years if not contained properly.

Ohm: A measure of the electrical resistance of a material equal to the resistance of a circuit in which the potential difference of 1 volt produces a current of 1 ampere. Utilities and electrical engineers to measure the resistance of wires conducting electricity use ohms.

Oil: Oil, a liquid fossil fuel, is used in enormous quantities worldwide. Oil contains carbon, nitrogen, sulfur, mercury, lead, and arsenic, all of which are emitted when oil is burned to produce energy. Advancements have been made in producing cleaner-burning oil; however, its emissions are still significant. Oil is a nonrenewable resource, like coal and natural gas, and oil spills have caused severe damage to natural environments.

Ozone (O3): Ozone is a unique emission because it is not directly produced by human sources. Instead, it is created as a result of chemical reactions between human-produced emissions and other gases in the atmosphere. Ozone is also unique because it is considered beneficial in some places and detrimental in others. When ozone is in the earth's upper atmosphere it is considered good because it protects the earth from the sun's radiation. But when ozone is created in the lower atmosphere, it creates smog, which can cause respiratory problems and damage to plant and animal life. In the lower atmosphere, ozone is typically created when volatile organic compounds (VOCs) or nitrogen oxides react with other atmospheric gases.

Particulates: Particulates are criteria pollutants that include dust, dirt, soot, smoke, and other miniscule solids released into the air and can affect heart and respiratory health. Particulates can be composed of many different chemicals. Their human sources vary but come largely from construction activities like road building. Particulates can also form when emissions from fossil fuels react with sunlight and water vapor to create solid particles in the air.

Potential Energy: Potential energy is stored energy, waiting to be released. An example of potential energy is the energy embodied in ocean waves, which can be captured through ocean energy technologies to produce kinetic energy.

Power: Power is the rate at which work is done. The ratio of work and time determines the amount of power used. For example, imagine that two people start at the bottom of a mountain with the goal of reaching the top. The first person hikes to the top in a short amount of time. The second person scales the rocks to the top, which takes a much longer amount of time. Both did the same amount of work (they reached the top of the mountain), but the hiker has more power since the distance traveled was completed in a shorter amount of time. Power is expressed in Watts.

Radiant Energy: Radiant energy comes from a light source, such as the sun. Energy released from the sun is in the form of photons. These tiny particles, invisible to the human eye, move in a way similar to a wave. Radiant energy can be transformed into electrical energy using solar panels.

Renewable Energy: Renewable energy comes from sources that can be replenished on a human time scale, such as biomass (wood), or that are essentially inexhaustible, such as waste and geothermal, wind, and solar energy. Fossil fuels are non-renewable energy sources; there is a finite supply of them. Renewable energy is also often clean energy; it can be generated with few or zero emissions and little to no environmental damage.

Smog: Smog is air pollution mainly consisting of ozone and nitrogen oxides, which creates a visible brownish haze (particularly in cities in the summer). Smog can cause breathing problems and greatly reduces visibility in the air. Power plants and vehicles are major causes of smog.

Solar Heating: Solar heating converts the sun's power into heat for hot water, space heating, and swimming pools. Passive solar heating uses large windows to let in more light and warmth, while active solar heating uses specially designed mechanical systems to intensify the sun's heat for use indoors.

Solar Photovoltaics (PV): PV converts sunlight directly into electricity. PV is made from semiconductor materials, and does not create any pollution, noise, or other impacts on the environment. Homes and businesses may incorporate solar panels and arrays as a source of clean energy.

Solar Photovoltaic Cell: A PV cell is the most basic element of a solar photovoltaic system. Each cell is made from semiconductor materials, and creates an electrical charge in reaction to sunlight that can be transformed into a current of electricity.

Solar Power: The sun's energy can be used to generate electricity, provide hot water, and to heat, cool, and light buildings. This can be achieved using solar photovoltaic panels, concentrating solar power, and passive solar design.

Sulfur Dioxide (SO2): Sulfur dioxide is a criteria pollutant that contributes to respiratory problems and the creation of acid rain. Sulfur dioxide is created by burning fossil fuels with trace amounts of sulfur, like coal and oil. Smaller amounts can be created during industrial metal processing. The major source of sulfur dioxide is the use of fossil fuels in electricity production.

Thermal Energy: Thermal energy is the use of heat as a source of energy. Thermal energy can be used directly or can be transformed into mechanical energy (using a steam engine), which can then be transformed into electrical energy. Thermal energy is usually measured in British thermal units (Btu).

Volt: A unit of electrical force equal to the amount of electromotive force that will cause a steady current of one ampere to flow through a resistance of one ohm. High-voltage electricity moves faster than low-voltage electricity, as seen in the difference between high-voltage transmission lines used to move electricity quickly throughout a region and lower-voltage distribution lines used to move electricity directly to customers.

Voltage: The amount of electromotive force, measured in volts that exists between two points. Voltage is used to describe the amount of power produced by a generator.

Water Efficiency: Water efficiency refers to practices, products, or systems that use less water than traditional products or systems without sacrificing performance. Water-efficient products can include graywater use and low-flow water fixtures (such as toilets or faucets). Water-efficient practices can include landscaping with plants that require less water, use of rainwater for irrigation, and storm water management.

Watt (W): The rate of energy transfer equivalent to one ampere under an electrical pressure of one volt. One watt equals 1/746 horsepower, or one joule per second. It is the product of voltage and current (amperage). The term "watt" (in addition to the larger measurements of kilowatt and megawatt) is commonly used to describe the capacity of an electric generator. For example, a 1,000-watt photovoltaic system has the capacity to produce 1,000 watts of power at any given time, though it may not consistently produce this much.

Watt-second (Ws): One Joule equals one watt-second.

Watt-hour (Wh): The energy produced by 1 watt of power acting over a period of 1 hour. The Wh is the basis for the more commonly used measurements kilowatt-hour and megawatt-hour.

Wind Power: Wind power uses the kinetic energy of flowing air to create mechanical energy in a wind turbine that can be transformed into pollution-free electricity. Learn more about wind power and wind turbines.

Work: Work is the transfer of energy to move an object a certain distance, such as a horse pulling a plow from one side of a field to another. Work is expressed in Joules. The rate at which work is performed is power.