**13. Energy**
**How can growing energy demand be met safely and efficiently?**

World energy demand could nearly double by 2030, with China and India accounting for over half of the increase. Without major policy and technological changes, fossil fuels will meet 80% of primary energy demand by 2030. If so, then large-scale carbon capture, storage, and/or reuse should become a top priority to reduce global climate change. To stop carbon emissions from the energy sector by 2030, IEA estimates it will cost an additional $3.6 trillion in power plants and $5.7 trillion in energy efficiency, or 0.6% of world GDP per year from 2010 to 2030. In the meantime, 20 of the largest non-OECD countries spent $310 billion on energy subsidies in 2007, contributing to increased CO2 emissions. Some 73 countries have national renewable energy goals.

In 2008, for the first time, the majority of U.S. and EU increases in the production of electricity came from renewable sources instead of fossil or nuclear sources. Excluding biomass, non-hydro renewable sources are expected to grow at an average 7.2% per year until 2030. Renewable sources will overtake gas soon after 2010 to become the second-largest source of electricity after coal. Meanwhile, over a quarter of humanity has no access to electricity and a third still relies on traditional biomass for cooking and heating, while billions of gallons of petroleum are wasted in traffic jams around the world.

China now produces more cars than the U.S. and Japan. Given the exponential growth of cars in Asia, decarbonizing transport fuels should be a global priority. Prices for electric car batteries are low enough to make fully electric cars competitive, and cars have successfully run on compressed air. Massive saltwater irrigation of coasts can grow halophyte plants and algae to produce 190,000 liters of biofuels per hectare per year instead of letting less-efficient freshwater biofuel production (now 4% of global gasoline consumption) have catastrophic effects on food supply and prices. CO2 emissions from coal plants might be re-used to produce algae for biofuels and maybe carbon nanotubes. The global market for liquid biofuels was worth $30.3 billion in 2008 and should increase to $42.8 billion in 2013.

Japan plans to have a working space solar power system in orbit by 2030; such systems could meet the world’s electricity requirements indefinitely without nuclear waste or GHG emissions. Eventually, such a system of satellites could manage base-load electricity on a global basis. Drilling to hot rock (two to five kilometers down) could make geothermal energy available where conventional geothermal has not been possible. A total of 436 nuclear reactors are operating today; 45 are under construction and more than 300 are either on order or being proposed. Another Chernobyl-type accident or nuclear hijacking could halt expansion of nuclear power.

Innovations are accelerating: concentrator photovoltaics that dramatically reduce costs; waste heat from power plants, human bodies, and microchips to produce electricity; genomics to create hydrogen-producing photosynthesis; solar energy to produce hydrogen; microbial fuel cells to generate electricity; and compact florescent light bulbs and light-emitting diodes to significantly conserve energy, as would nanotubes that conduct electricity. Solar farms can focus sunlight atop towers with Stirling engines and other generators. Estimates for the potential of wind energy continue to increase, but maintenance problems grow. Plastic nanotech photovoltaics printed on buildings and other surfaces could cut costs and increase efficiency. The transition to a hydrogen infrastructure may be too expensive and too late to affect climate change, while plug-in hybrids, flex-fuel, electric, and compressed air vehicles could provide alternatives to petroleum-only vehicles sooner. Unused nighttime power production could supply electric and plug-in hybrid cars. National unique all-electric car programs are being implemented in Denmark and Israel, with discussions being held in 30 other countries.

A global collective intelligence (described in the CD Chapter 5) could provide the overviews and details necessary to create more coherent energy policy and better informed consumer choices. Meanwhile, approximately 1,000 coal plants, with production lives of 40 years, are in some stage of planning or construction around the world without CO2 capture. Environmental movements may try to close down such plants, just as they stopped growth in nuclear energy 30 years ago.

Challenge 13 will have been addressed seriously when the total energy production from environmentally benign processes surpasses other sources for five years in a row and when atmospheric CO2 additions drop for at least five years.

**Regional Considerations**

**Africa:** About 25% of sub-Saharan Africans have no home access to electricity and spend twice as much per kilowatt-hour as people in other emerging market regions; the region will need to spend $563 billion over the next 25 years to increase generation capacity by 270 gigawatts and avoid a power crisis. The continent’s electric demand can be met by proposed dams on the Congo River, with some potential exports to Europe. Algeria plans to export 6,000 megawatts of solar-generated power to Europe by 2020. By 2050, 10–25% of Europe’s electricity needs could be met by North African solar thermal plants. With support from development partners, African leaders agreed to invest $10 billion annually between 2009 and 2014 in renewable energy.

**Asia and Oceania:** Japan plans to have 14 gigawatts of solar photovoltaic capacity by 2020 and 53 gigawatts by 2030, in addition to its solar power satellite system goal for 2030. China now uses more coal than the U.S., Europe, and Japan combined, yet at the same time China has emerged as the world’s leading builder of more efficient, less polluting coal power plants. China already surpassed its wind energy target by 2010 and announced an almost 10-fold increase of its 2020 goals for renewable with the implementation of its solar photovoltaic roof plan. Half of the households in India have no access to electricity. India’s $3,000 car may accelerate car ownership in developing countries. The UAE announced its bid to host the headquarters of the International Renewable Energy Agency (Irena) in Abu Dhabi. Samsung released the Blue Earth solar-powered phone made from recycled water bottles. Australia plans to build the world's largest solar energy plant.

**Europe:** Azerbaijan, Egypt, Georgia, and Turkey have agreed to supply the EU with specific volumes of gas, reducing its dependence on Russia. In addition to its 20% renewable target by 2020, the EU agreed to satisfy 10% of its transport fuel needs from renewable sources, including biofuels, hydrogen, and green electricity, by 2020. European ethanol production increased 60% in 2008, up from an 11% growth in 2007. Europe plans to build 50 new coal plants in five years. The Norwegian Minister of Finance and the Socialist Party proposed a bill that bans sales of new gasoline-powered cars in Norway from 2015. Russia plans to have 25% of its energy from nuclear sources by 2020.

**Latin America:** Brazil gets 32% of its energy from biomass and is the third largest producer of energy from biomass after China and India. Costa Rica plans to become carbon-neutral by 2021. Brazil produces ethanol for 60 cents per gallon, meeting 40% of its automotive needs; 90% of automobiles produced in Brazil are flex-fuel (can use ethanol or gasoline), and the country has discovered over 40 billion barrels of possible offshore oil under the pre-salt formations in the Santos field. If Venezuela used advanced technologies, its heavy oil reserves would be larger than those of Saudi Arabia.

**North America:** Algae farms may cost $12,000 per hectare, or $46.2 billion per year, for all the algae needed to replace U.S. dependence on petroleum for transport, compared with the $100–150 billion the U.S. spends each year buying crude oil. U.S. plans to invest $150 billion over 10 years in renewable energy and President Obama wants 39 mpg for cars by 2016. California requires refineries, producers, and importers of motor fuels to reduce the carbon intensity of their products by 10% by 2020. Pacific Gas & Electric Co. of California agreed to buy 200 megawatts of space-based solar power by 2016 from Solaren. “Off-peak” night time electricity production and transmission capacity could fuel 84% of the 220 million U.S. vehicles if they were plug-in hybrid electrics. Recycling waste heat from nuclear power plants to home air conditioners and even body heat to recharge batteries could reduce CO2 by 10–20% in the U.S. Project Green Freedom is developing electrochemical separation of carbon from the air to produce methanol and gasoline. Quebec and British Columbia have introduced carbon taxes.