Sustainable Energy

Sustainable energy includes distributed generation and co-generation and solar and wind power systems. A distributed system combines and regulates electric power generation from different power sources for increased and sustained power output. A co-generation system combines heat and power to generate electricity and useful heat. It uses waste heat from electricity generation to generate hot water or steam. The combined system is more efficient (nearly 40%) than a stand-alone generation system and has a reduced carbon footprint.

Current yearly-averaged global energy consumption is about 13×10^{12} watts or 13 terawatts, TW, which is estimated to be tripled by the end of the 21st century. With the anticipated shortage of fossil fuels and considering their effects on the global environment and limitations of other sources of energy such as nuclear energy, solar energy has the potential to provide ample amounts of clean energy for centuries to come. Solar energy at the top of the earth's atmosphere is about 170,000 TW. On average slightly higher than 70% or 120,000 TW of this energy is striking the earth's surface. As it can be seen, the solar energy potential far exceeds present and anticipated future human needs. However, solar energy is diffuse and intermittent. We do not have solar energy during the night or on a cloudy day. Thus, effective storage and distribution are critical to meeting the continuous energy demand.

Global wind energy is abundant. The total power of the atmospheric motion is estimated to be around 2×10^{15} watts or 2000 terawatts. The current rate of the world's energy consumption from all sources is about 10^{13} which is about 1% of the energy available from atmospheric motion. Thus, given the appropriate condition renewable energy including wind energy can provide more than enough energy to meet the needs of the world's population.

In the year 2,000 Archer and Jacobson of Stanford University performed an analysis of the global wind energy potential. Wind speeds were calculated at 80 m, the hub height of modern, 77-m diameter, and 1500 kW turbines. They generated a map of global wind energy. Based on their calculations, the global wind power potential for the year 2000 was estimated to be ~72 TW. As such, sufficient wind exists to supply all the world's energy needs (at approximately 15 Terawatt), although many practical barriers need to be overcome to realize this potential. In the United State, in 2020, wind turbines generate 8.4% of the total electricity generated. The three wind farms (Altamont Pass, Tehachapi, and San Gorgonio) produce more than 5% of California's electricity from wind turbines.

CEERS research includes innovation, design, and optimization of wind and solar systems, gas recovery and re-use, fuels, and emissions, building energy systems, net-zero, and exploration into new energy resources. With simulations, geometrical optimizations, and experiments, CEERS researchers and industry partners have developed high-efficiency wind turbine systems for urban applications and are in the

process of developing new systems for capturing wind energy from moving vehicles for electric power generation.

Research into reducing diesel and compressed natural gas engines has resulted in a patented humid air system for reducing NOx emissions of these engines as applied to the cargo-handling equipment. In transportation systems, as we have been exploring new methods and configurations for reducing the environmental impacts of transportation, we continue exploring alternatives and innovative systems for passenger and freight transportation.