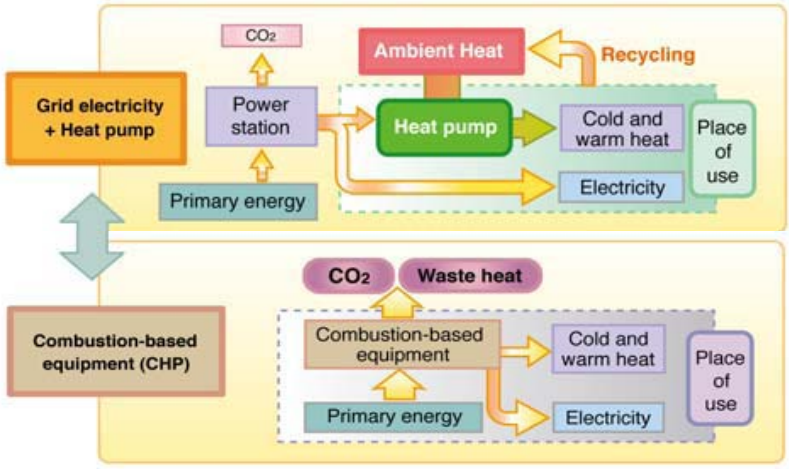
High Efficiency Heat Pumps by TEPCO

Tokyo Electric Power Company (TEPCO) is the largest electric power company in Japan and the largest privately owned electric utility in the world. TEPCO supplies electricity to meet the increasingly diversified and sophisticated demands of its over 28.09 million customers in the metropolitan Tokyo, which is the political, economic, and cultural center of Japan. As of March 31, 2007, TEPCO has the total assets of 12,924 billion yen, 38,108 employees, and the total generating capacity of 61,835MW.

Case Background: The key to resolving problems associated with global warming and securing energy supply lies in realizing dramatic improvements in energy utilization efficiency and de-carbonizing energies. A technology that can accomplish both these tasks simultaneously is the heat pump.

How a Heat Pump Works



Heat pumps are based on a simple heat transport engine that applies basic principles of thermodynamics. They convert unused "ambient heat" into heat of utilizable temperatures; using small amounts of electric power instead of using the resistant heat or the heat of combustion of fossil fuels. A heat pump's energy consumption efficiency is much higher than that of a combustion-based system. The amount of thermal energy that heat pumps transport is much larger than the input energy (normally electric power). As a result, collecting ambient heat by a heat pump after converting fossil fuels into electricity is a more efficient means of obtaining "heat" than burning fossil fuels directly.

Based on current energy demand projections for Japan, it has been estimated that by replacing fossil fuel-based direct combustion systems with heat pump equipment to meet the demand for cooling and heating and hot water supply, the decrease in primary energy consumption could lead to CO2 emissions reductions of up to 130 million tons per year, equivalent to about 10% of Japan's total emissions at present, without changing the amount of thermal energy available to users. According to a simulation by the IEA Heat Pump Center, more widespread use of heat pumps globally (about 30% of ownership of heat pumps) could cut global CO2 emissions by approx. 6% or 1.2 billion tons worldwide.

Case Description: Completed in October 2006, Sony City is Sony Corporation's new headquarters in Tokyo. Sony City is the first single private building to introduce heat pumps using unused heat from a public sewage treatment plant in Japan. The energy conversion coefficient of performance of this building exceeds top class district heating and cooling systems in Japan.

The heat-pump technology-based heating and cooling systems use waste heat from treated sewage water from a nearby public sewage treatment plant to power the heat pumps. Using large thermal storage for heating and cooling can lower energy costs by using special utility tariffs for the user of thermal storage tank. A combination of a high efficiency centrifugal chiller

and an inverter type chiller reduces energy use dramatically compared to conventional absorption type chillers, resulting in one of the most efficient cooling and heating system in Japan. This helps Sony reduce energy use and ensures more efficient resource use at its business facilities. Furthermore, Sony introduced a natrium and sulfur (NAS) battery service on its site and managed to shift the peak load caused by the new heat pumps from day to night. The NAS battery (with an output capacity of 2.5MW) stores electricity at night and discharges the stored electricity during day time to reduce electricity peak demand.

Achievements: The average *Coefficient of Performance - CoP (*a measure of the efficiency of energy conversion of a system) for this heating and cooling system in the year after commissioning was 5.19 (January 2007 – April 2008), exceeding the initial target of 5.18.

The environmental benefits of the Sony City project estimated by TEPCO are; (a) reduction of approximately 3,500 tons of CO2 per year, which is almost 70% less than a conventional gas absorption chiller and (b) reduced water use to 117,800 m3 or 92% less than a common office building.

Moreover, the COP of *Primary Energy Conversion* (this is calculated as the system COP of 5.18 multiplied by the thermal power generation efficiency in Japan of 37%) of the Sony City heat pump system is much higher than the most efficient District Heating and Cooling (DHC) systems in Japan and one of the highest among Japanese office buildings.

Reference: www.wbcsd.org