Thermal energy storage for solar heating and cooling

Solar heating and cooling technologies collect the thermal energy from the sun and use this heat to provide hot water, space heating, cooling and pool heating for residential, commercial and industrial applications. These technologies displace the need to use electricity or natural gas.

Thermal energy can be generated from many renewable sources, such as solar, biomass, and geothermal. These systems are known collectively as renewable heating and cooling technologies. Systems which change sunshine into usable thermal energy are referred to as solar heating and cooling (SHC) technologies.

Solar Water Heating

Solar water heating systems can be installed on every home in the U.S., and are composed of three main elements: the solar collector, insulated piping, and a hot water storage tank.

Solar Cooling

There are two kinds of solar cooling systems: desiccant systems and absorption chiller systems. In a desiccant system, air passes over a common desiccant or “drying material” such as silica gel to draw moisture from the air and make the air more comfortable. The desiccant is regenerated by using solar heat to dry it out.

The Economics of Solar Heating and Cooling

•Typical commercial applications include space heating, cooling, and water heating. Building types that are particularly well-suited for these solar applications, according to SEIA, include “military facilities, manufacturing plants, large multi-family residential buildings and affordable housing, municipal facilities, hotels, elderly and student housing, hospitals, sport centers, and agricultural operations.

•EIA notes that capital expenditures (CAPEX) for solar heating and cooling systems are often higher than conventional fuel systems, but on the other hand, operational expenses (OPEX) are much lower because the fuel is generated and supplied for free. Budgeting fuel expenses becomes a thing of the past, lowering OPEX significantly with the transition to clean, renewable solar heating and cooling technologies.

•Solar cooling applications are very useful, as air conditioning represents a major strain on the electrical grid when weather is very hot outside. Using this same heat and strong sunshine to produce solar air conditioning is an ideal solution to reduce this strain. Also referred to as solar-assisted cooling, properly sized residential solar cooling systems may also be used for space heating during winter months.

•Solar heating systems are very effective at capturing the sun’s energy. With today’s technology, SEIA reports that solar heating systems “typically produce 45 kWhth to 102 kWhth per square foot of installed collector area per year (or 1.5 to 3.5 therms/ft2 in equivalent heat units), which is up to 80% of all the available solar energy hitting the surface of the collector.”

Geothermal Energy

•Geothermal energy is heat derived within the sub-surface of the earth. Water and/or steam carry the geothermal energy to the Earth's surface. Depending on its characteristics, geothermal energy can be used for heating and cooling purposes or be harnessed to generate clean electricity.

•A renewable energy source because the water is replenished by rainfall and the heat is continuously produced inside the earth.

•Geothermal energy is generated in the earth's core about 4000 miles below the surface.

•Temperature hotter than the earth's surface are continuously produced inside the surface by slow decay of radiactive particles, a process that happens in all rocks.

•It is contained in the rocks and fluids beneath the earth's crust and can be found as far down to the earth's hot molten rock, magma.

•To produce power from geothermal energy, wells are dug a mile deep into underground reservoirs to access the steam and hot water there, which can then be used to drive turbines connected to electricity generators. There are three types of geothermal power plants; dry steam, flash and binary.

•It's clean and sustainable. Resources of geothermal energy range from the shallow ground to hot **water** and hot rock found a few miles beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma.

Role of Thermodynamics

•The production of electricity from a geothermal source is about producing work from heat.

•Electricity production from heat will never be successful unless appropriate respect is paid to the second law of thermodynamics.

•The type of energy conversion system used to produce electrical power from a geothermal resource depends on the type and quality (temperature) of the resource.

•Geothermal power is generated by using steam or a secondary hydrocarbon vapor to turn a turbine-generator set to produce electrons.

•Geothermal energy is thermal energy generated and stored in the Earth. Thermal energy is the energy that determines the temperature of matter. The geothermal energy of the Earth's crust originates from the original formation of the planet and from radioactive decay of materials.

•Geothermal energy can be used for heating and cooling purposes or be harnessed to generate clean electricity.

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Magneto hydrodynamics (MHD)

•**Magneto hydrodynamics** (**MHD)**; also magneto-fluid dynamics or hydromagnetics) is the study of the magnetic properties and behavior of electrically conducting fluids. The word "**magneto hydrodynamics**" is derived from magneto- meaning magnetic field, hydro- meaning water, and dynamics meaning movement.

•The fundamental concept behind MHD is that magnetic fields can induce currents in a moving conductive fluid, which in turn polarizes the fluid and reciprocally changes the magnetic field itself. The set of equations that describe MHD are a combination of the Navier–Stokes equations of fluid dynamics and Maxwell's equations of electromagnetism. These differential equations must be solved simultaneously, either analytically or numerically.

•The efficiency of conductive substances should be increased to increase the operational efficiency of a power generating device.

•The required efficiency can be achieved when a gas is heated to become plasma/fluid or adding other ionizable substances like the salts of alkali metals.

• To design and implement an MHD generator, several issues like economics, efficiency, contaminated hypo ducts are considered.