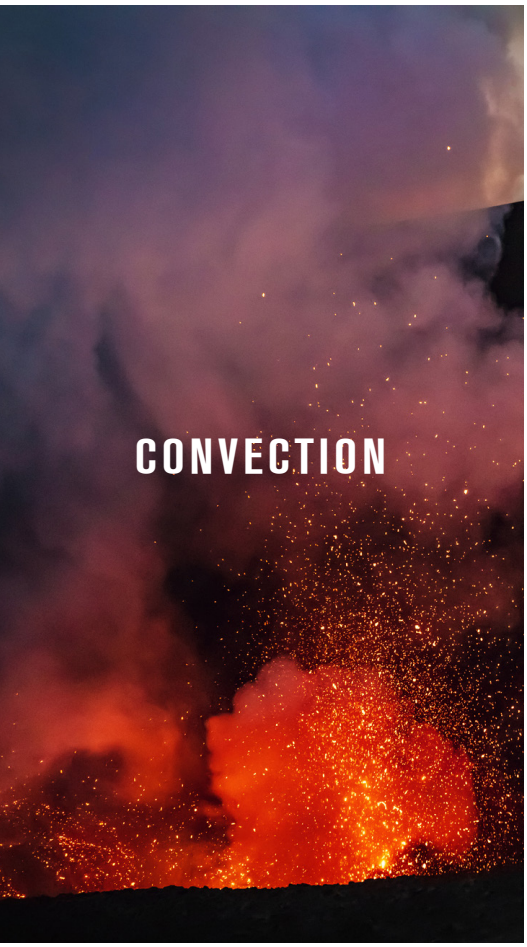

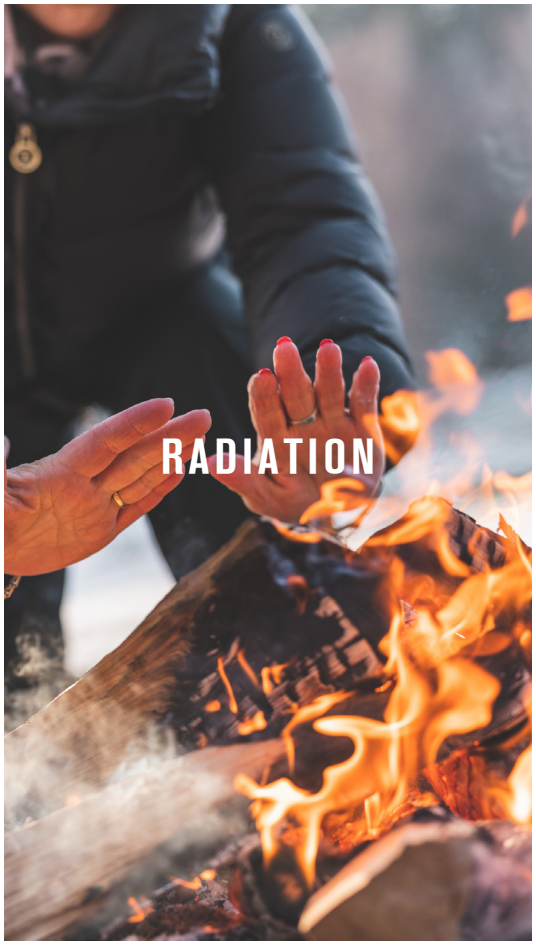

THERMAL ENERGY

WHAT IS IT?

Thermal energy is another form of energy. It is hot or cold or just right. The flow of thermal energy is a form of energy transfer – as thermal energy flows toward equilibrium until there is no temperature differential. Warmth flows to cooler until they have the same temperature. That flow of thermal energy has multiple pathways – it can be via radiation, like a radiant heater or a fireplace that releases heat into a cool room. Or thermal energy can move by conduction, such as when the handle of a pan on the stove gets warmer as the pan bottom sits on the burner. Or thermal energy can move by convection – where hot air rises and cold air sinks, or where hot water in a pan on the stove rises and pushes cold water down toward the hot bottom of the pan.

Sharing thermal energy is low-hanging fruit for industrial symbiosis. Many users of thermal energy do not realize how often we squander it. The goal is to try and keep the same thermal energy circulating within the system or to add complementary uses that can benefit from that energy. Overall, this reduces the need for additional sources of thermal energy which can reduce electrical use, or the burning of fuels that create air pollution.

What is most important to understand about thermal energy is that the technology to recapture it and use it again can be quite cost effective and simple to operate. Want to lower your hot water bill? If you coil a pipe loop under your driveway before paving and connect it to a heat exchanger, you might be able to reduce your summertime hot water bill to near zero as the sun on the pavement heats the water in the pipes below. In this example, using environmentally safe antifreeze in that pipe loop would make sense.

CSI Center for Sustainable Infrastructure

PDF POPUP FROM IED TOOL

MARCH 5, 2020

MOST COMMON USES

Thermal energy is used in many processes from making pizzas to pottery, from kiln-dried lumber to air conditioning. But once that primary use is over, the remaining energy could be redirected or stored for other complementary uses.

HOW IS IT MADE?

- Thermal energy comes from sunlight that carries energy that gets partially reflected as daylight and partially absorbed by different materials that then emit heat.
- Thermal energy is stored in the soils allowing for a steady source of 55-degree temperature once below the frost layer.
- Thermal energy is a byproduct of many industrial processes as well as any combustion process.
- Thermal energy is transferred through urban piping systems where drinking water is delivered at about 45-degrees and wastewater flows through sewers from the mid-40s to above 70-degrees F.
- Thermal energy is used to make things warmer or cooler.
  - Combustion:
    - Use natural gas or wood waste to fire boilers to create steam to drive turbines to create electricity
    - Use natural gas or wood waste boilers to create hot water for hydronic systems (see below)
    - Some fuel cell technology uses combustion of hydrogen to generate heat and electricity
  - Electricity
    - Use electricity where resistance in heating elements radiates heat
    - Use electricity to drive heat pumps that efficiently create both hot and cold water or air for indoor air comfort
  - Chemical reactions
    - Some fuel cells use chemical reactions that are not consumption to generate heat and electricity

DESTINATION/FATE

It is typical to use thermal energy one time and then let it escape to the atmosphere or to the water around us. For example, when someone takes a hot shower our bathroom systems direct all that nice warm thermal energy straight down the drain. If we had a storage tank with a heat exchanger in it, we could pre-heat tomorrow's showers by reusing the heat from today. New apartment houses in Washington State and the province of British Columbia are doing that using heat exchangers that rely on conduction to transfer the energy. The baseline question is, why let that thermal energy leave the building when it can be used again and again?

When evaluating industrial symbiosis opportunities, a smokestack might be a pretty good indicator that thermal energy is being rejected. Whatever that stack is piping up into the atmosphere is usually warmer than surrounding air. That indicates a heat source that could potentially be reused for complementary processes. In summers, if we can fry an egg on the sidewalk, that's thermal energy from the sun that is being wasted and making the day feel even hotter. If we could capture that heat cost effectively before it is radiated into the air, we could use our parking lot or driveway to preheat some other water user such as domestic hot water, or to preheat water that we use in our factory to run equipment.

Thermal energy is often wasted, too, in water that is sent into the environment – whether it is stormwater flowing from rainstorms or polluted water flowing into treatment systems. Using that wasted heat can reduce other pollution by can make for a healthier environment for heat-sensitive species of fish and wildlife.

- Thermal energy can be stored.
  - Store thermal energy for a building's air conditioning by freezing water at night into ice where as it melts the next day can augment the air conditioning system
  - Use phase change materials to buffer heating and cooling for buildings. The phase change materials can be woven into the building finishes or used as an element of centralized storage for the building
  - Use buildings or the mass of materials to store thermal energy. For example thick-walled adobe houses absorb heat all day to keep the inside cool and then that heat is naturally radiated back into the house in the evening to help keep it warmer.

OPPORTUNITES FOR INTEGRATION

- Recover low quality thermal energy as power for micro and mini-grids.
- Combine low quality thermal energy from sources such as geothermal and biomass.
- Offset fossil carbon extraction with renewable carbon from biomass. Thermal energy is the most efficient conversion of renewable carbon from biomass to energy.
- Use local residues to generate thermal energy and manage environmental concerns at the local and community level.

CONCERNS

- Because we waste thermal energy, we have phenomena called the Urban Heat Island affect. Therefore, cities are typically warmer than the surrounding countryside because of the radiant heat emerging from paving and the hot air exhausted by air conditioning systems. Green infrastructure like trees and roof gardens are promoted to cool urban heat islands.
- Combustion is often used to create additional thermal energy, but it is often hotter than needed. If we need water at 120-degrees F to use in a building, it wastes energy when it rises into a chimney or vent.
- Combustion nearly always causes some air pollution emissions that have profound human health and environmental impacts.
- Combustion of fossil fuels releases CO2 which has been identified as a significant impact on the climate systems because the carbon is not returned to the ground.
- Thermal energy can be a pollutant for fish and wildlife species if it gets into flowing water, lakes, or bays