Heat energy of uniform temperature is the ultimate fate of all energy. The power of sunlight and coal, electric power, water power, winds and tides do the work of the world, and in the end all unite to hasten the merry molecular dance.

Frederick Soddy

Arizona State University
SES 194

Energy in Everyday Life

Heat Reservoirs

Frank Timmes

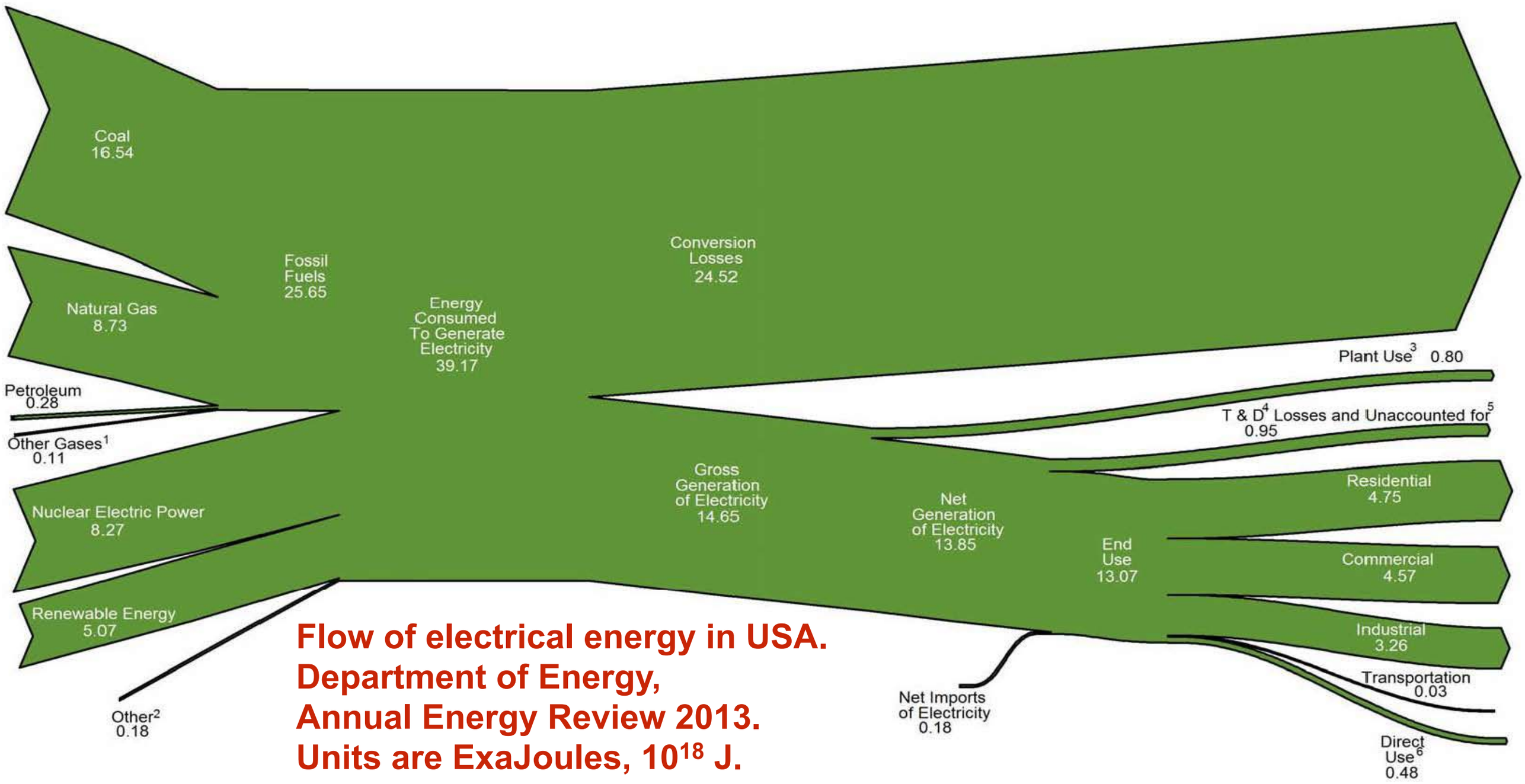
ftimmes@asu.edu

Chemical change by burning is involved in most of the ways we use to generate energy.

We utilize the heat of combustion in our power plants and transportation modes.

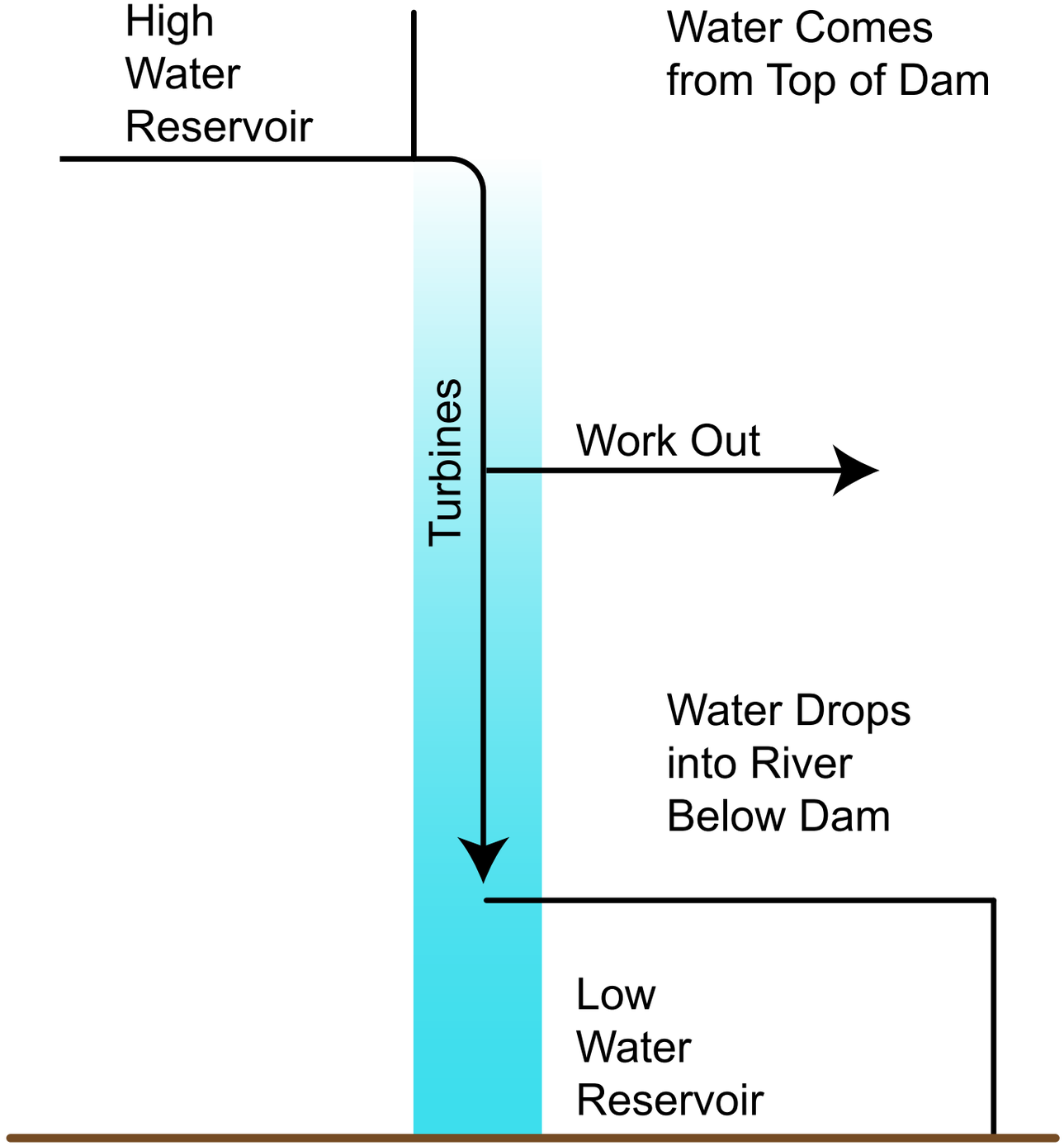
Most of our energy generating methods are inherently inefficient: twice as much energy is lost as is used.

Is that necessary? Let's look at the limits on efficiency.



Flow of electrical energy in USA.
Department of Energy,
Annual Energy Review 2013.
Units are ExaJoules, 10^{18} J.

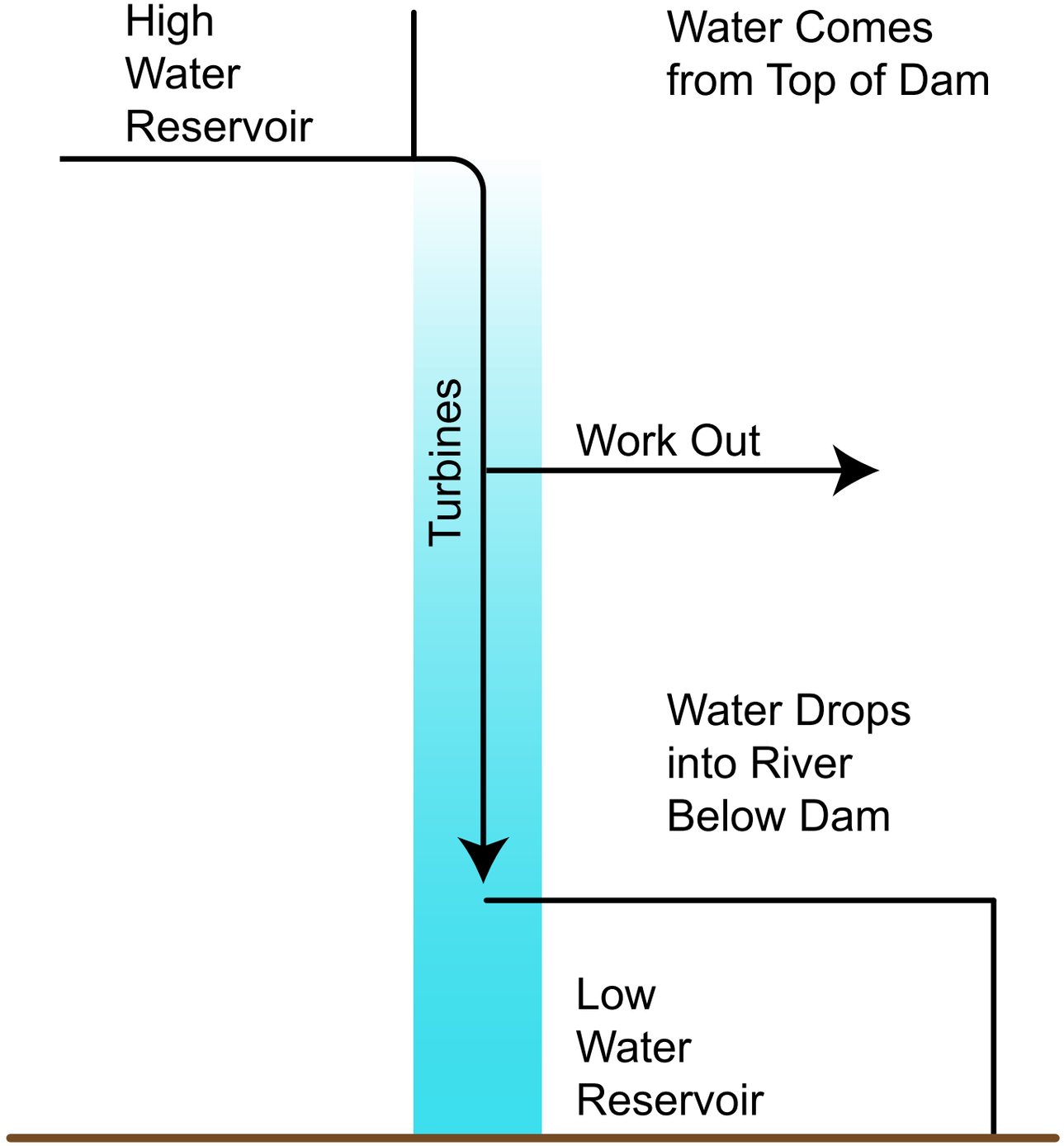
Heat transfer from a warmer to a colder body (by conduction, radiation or convection) resembles the transfer of water from a higher level to a lower level.



Work can be extracted from water damned in a reservoir by allowing it to fall and run turbines in powerhouses, thus producing electricity.

This is hydroelectric energy generation.

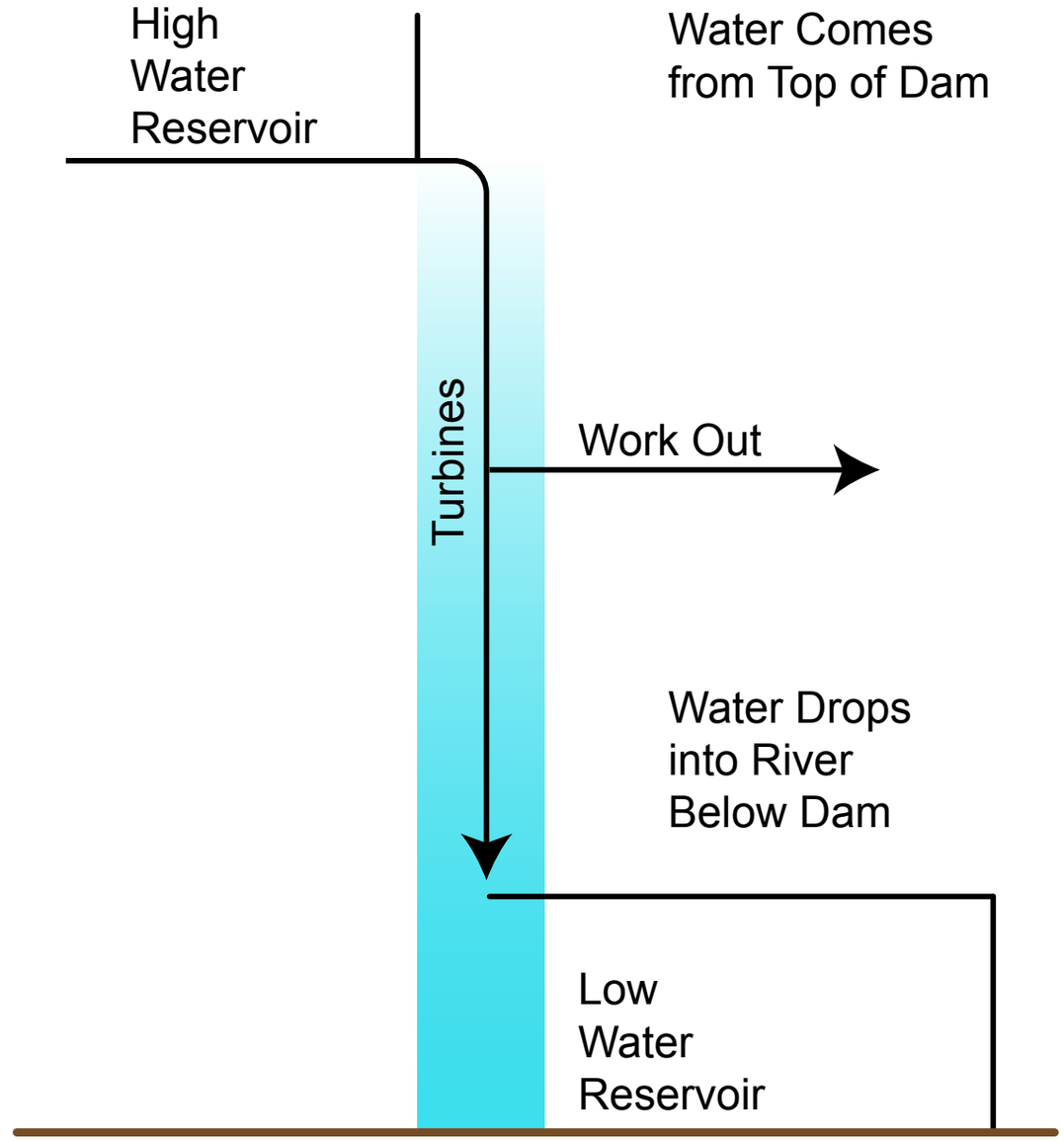
At the top of the dam all the water is at one height. There is no way to have water do work while remaining at one height.

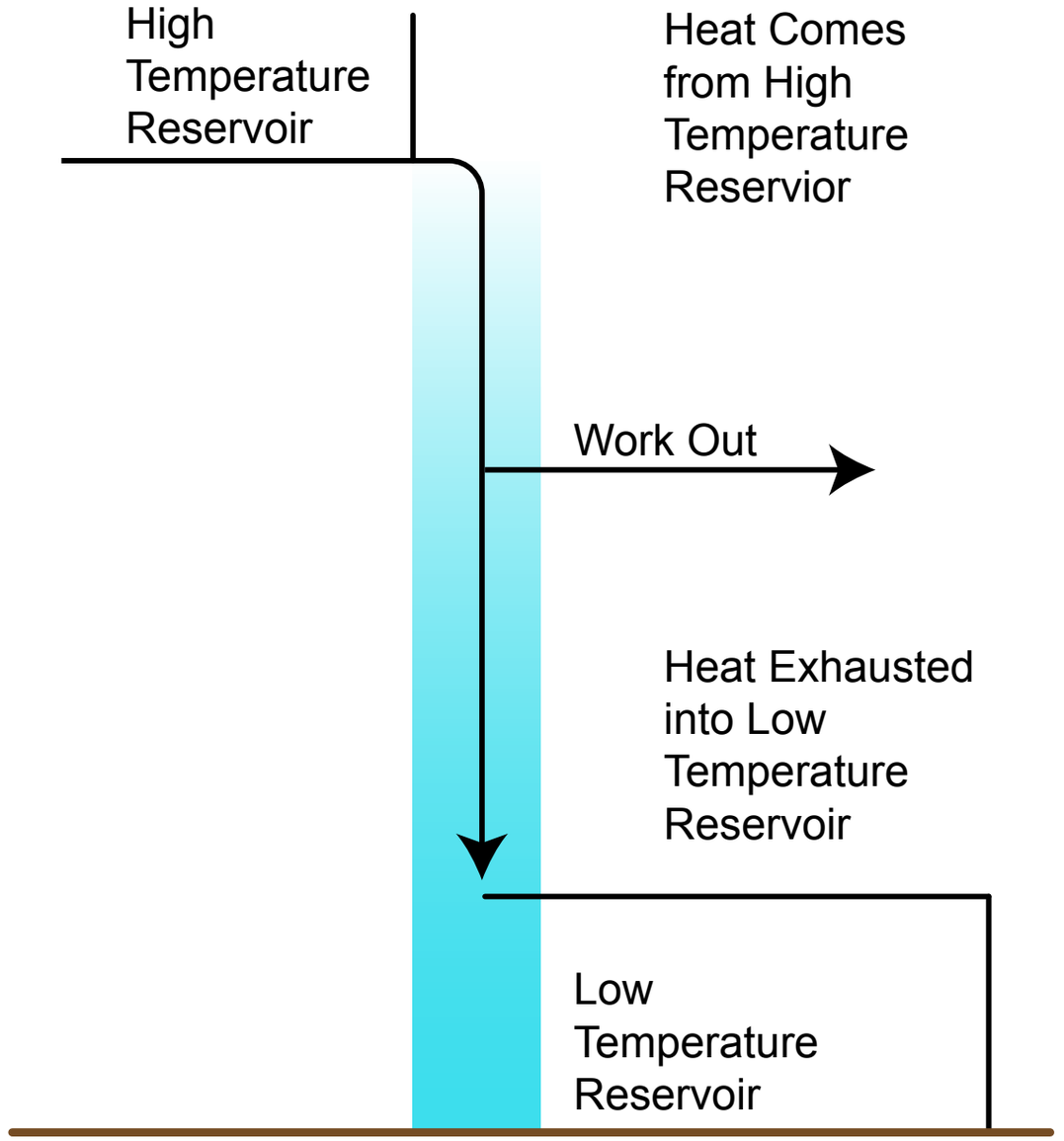


There must be a height difference to allow gravitational potential energy to be converted into work.

Similarly, a body at a given temperature is a reservoir, holding a large amount of thermal energy at one temperature.

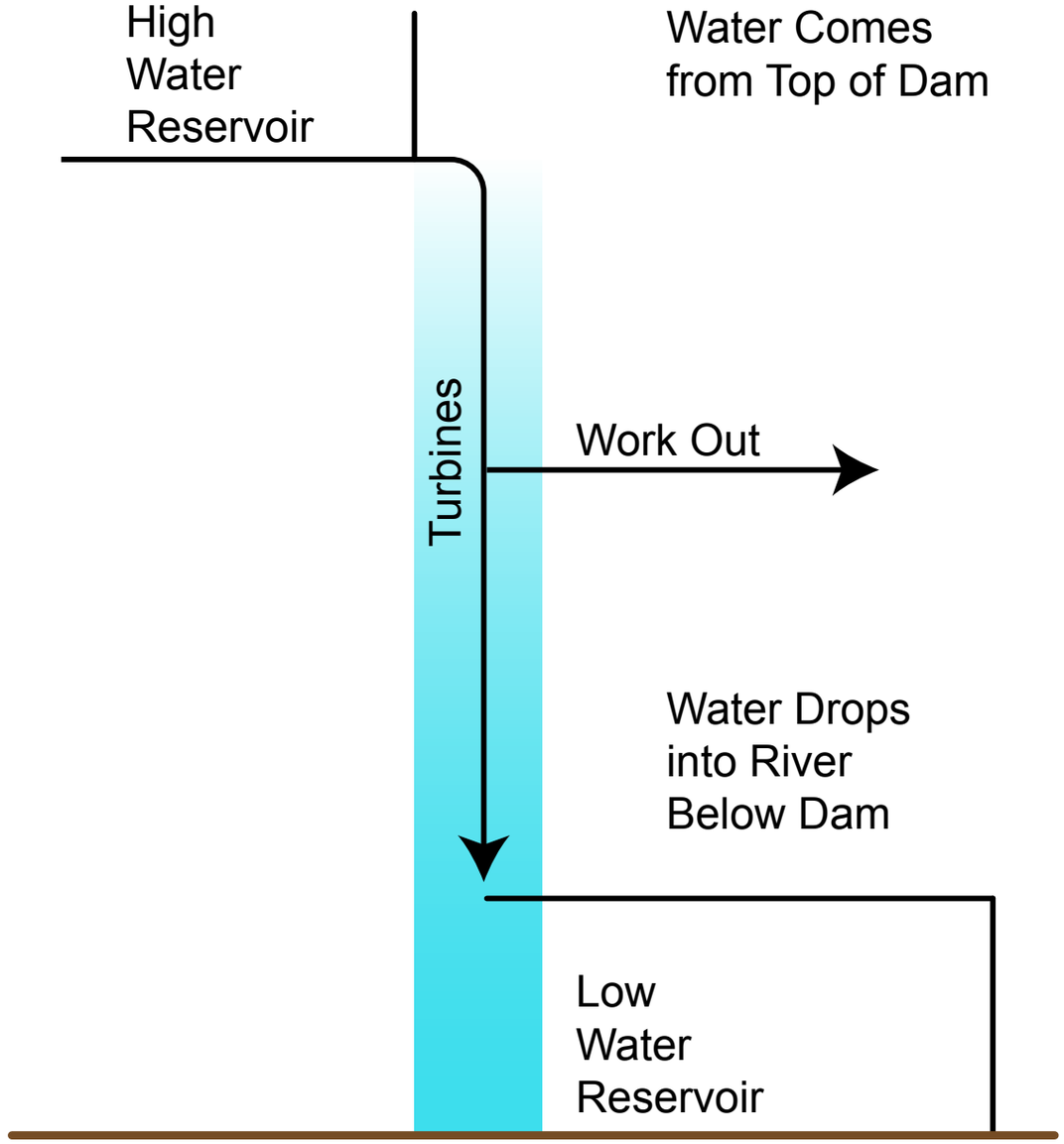
Work is produced by heat flowing down the high temperature reservoir to the low temperature reservoir.

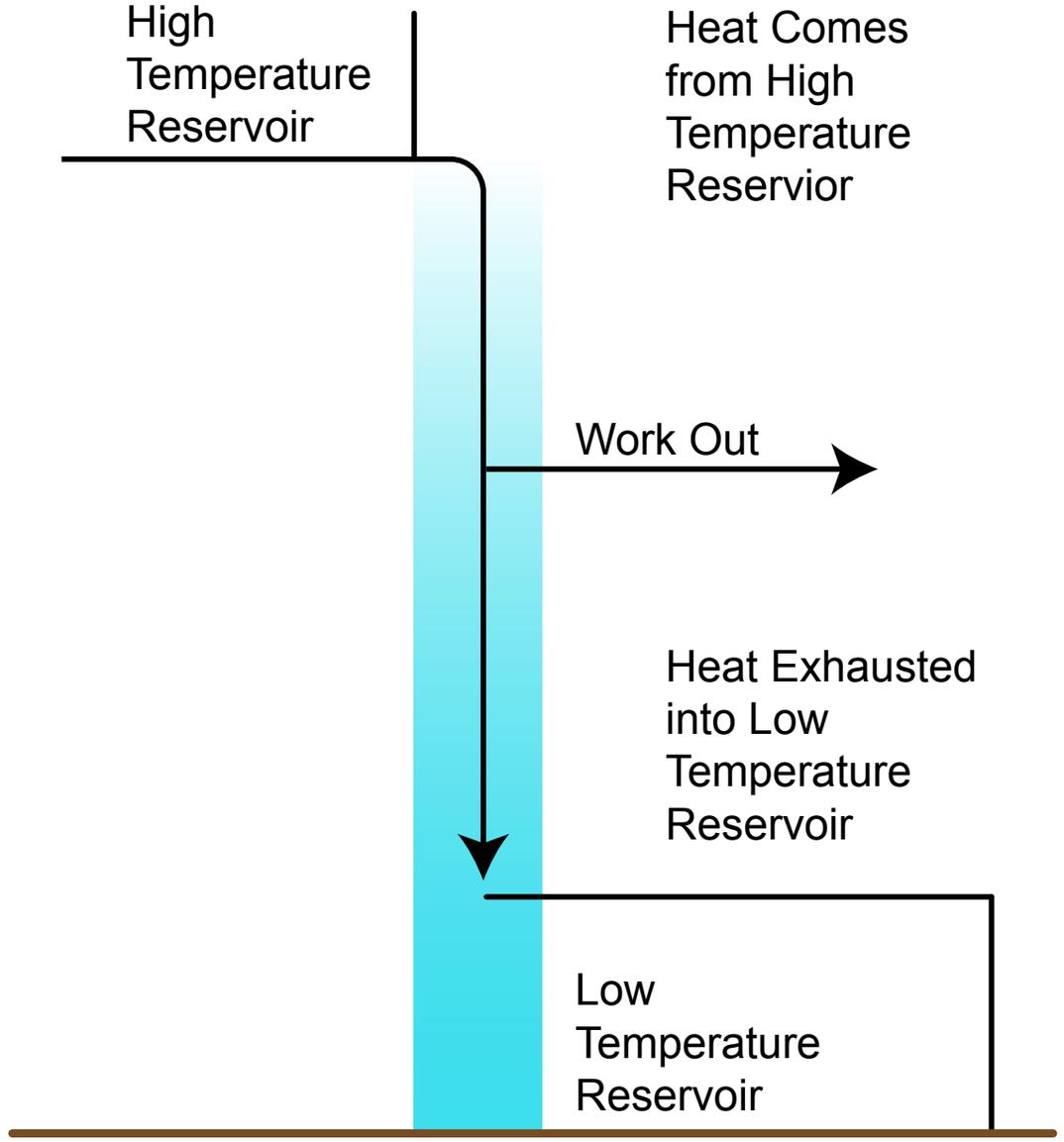




Likewise, it is not possible to get work from the thermal energy in a reservoir at a fixed temperature.

There must be a difference in temperature for thermal energy to be converted into work.





Air molecules in the atmosphere form an immense reservoir of energy, but it is not possible to run cars on this energy.

We must transfer energy from a higher to a lower temperature to do work.

We, thus, burn gasoline to produce a high temperature region.