

## Background

- Perpetual motion machines can run indefinitely without the supply of an outside power source. They are impossible to create in real life due to the Laws of Thermodynamics.
- The first Law of Thermodynamics states that energy cannot be created or destroyed, only transferred to another energy type. Perpetual motion machines of the first kind violate this law.
- The second Law of Thermodynamics states that entropy of the Universe increases and that the change in entropy can never be negative. Perpetual motion machines of the second kind violate this law.
- Efficiency is the ratio of useful work performed to the energy or heat taken in. It is represented by the equation,  $n = \frac{W_{out}}{W_{in}} \times 100\%$

## Inspiration

When we discussed engine cycles and efficiency in lecture, I was interested in finding ways to improve the efficiency and create systems that are more sustainable. Perpetual motion achieves this in theory but is not possible in real world applications. I wanted to study how to apply the idea of perpetual motion to improve efficiency of machines.

## Application

- Cogeneration is the combined generation of both electrical and thermal energy. Typically the secondary losses, such as steam or heat are gathered and utilized to help power subsystems.
- Collecting the heat from a car engine and converting that energy to help power electrical systems like the radio, clock, and break lights. The heat could also be used to regulate temperature within the car. This application is found in many hybrid cars. Toyota stated in 2017 that this method allowed an overall increase in efficiency of 65%.
- Power plants often send the output heat from one system to another to reduce the amount of energy needed from an external source. These power plants often operate 50 to 70 percent more efficiently.
- AC systems create a heat exchanger between the fresh outside air and the used warm air. This means the used air will help heat the new air, which allows less energy to be used to heat the cold air being brought into the building.



Figure 1 shows a perpetual motion machine of the first kind. As the wheel spins the balls would roll, creating a downward force. Theoretically this would allow the wheel to run indefinitely, but realistically there are losses due to friction.

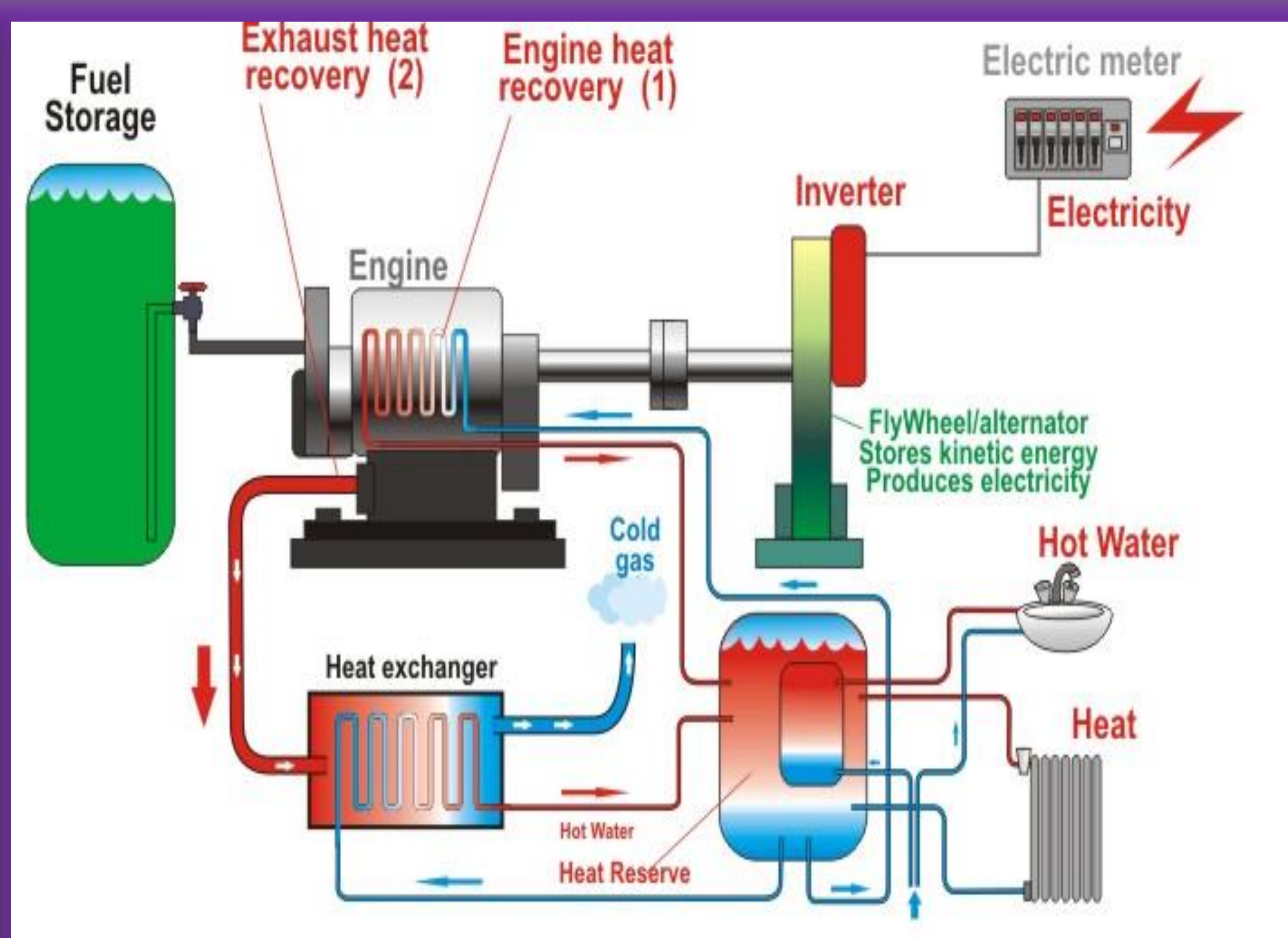


Figure 2 displays a common micro-cogeneration system. Similar systems are found in commercial buildings. Fuel is supplied to the engine which generates electricity. The engine byproduct (hot air) is then sent to a heat exchanger. The air's thermal energy is then transferred to a heat reserve, which will later be used for hot water or heating systems.



Figure 3 shows the Beverly clock, which has not been externally powered since 1864. The clock uses a pressurized chamber, that expands and contracts with the change in temperature. This chamber requires a change of 6 degrees Celsius to power the clock for an entire day.