The Brayton cycle describes any gas power system where heat transfer occurs at constant pressure. An example is collecting solar radiation to heat pressurized air that then moves through a turbine, a cooler, and a compressor before returning to the heater.

One such system is the upper-critical CO$_2$ unit being studied at Sandia National Laboratories in Albuquerque. In its simplest configuration 8 MPa CO$_2$ at 27 C is compressed to 20 MPa before being heated to 650 C by the focused solar radiation. A turbine expands the CO$_2$ to back to 8 MPa where it passes through a cooler that returns it to 300 K.

Start by assuming adiabatic and reversible rotating machinery and calculate the cycle thermal efficiency. Then assume 200 MW of solar power are supplied and compute the CO$_2$ mass flow rate[kg/s]. Finally, determine the net power out[MW].

The compressor and turbine do not allow reversible operation. Instead, the actual turbine exhaust temperature is 800 K, while the actual compressor outlet temperature is 380 K. Compute the new cycle thermal efficiency, the new net power produced (given the same 200 MW of solar power input), and the new CO$_2$ mass flow rate[kg/s]. Finally, calculate the entropy generation [MW/K] for the compressor and the turbine.
The solar-powered Brayton cycle described in SP38 is modified to include reheat and compressor staging. When that is done, it takes the form shown in the following figure.

Supercritical CO₂ Brayton Cycle

Calculate the cycle thermal efficiency for this new configuration.
Rolls-Royce makes a host of gas turbine engines, one of which is shown below. This two-spool design uses the high pressure turbine to drive the high pressure compressor and the low pressure turbine to drive the low pressure compressor and fan.

Use operating conditions given in the figure to determine the cycle thermal efficiency. In this case, the net work is a combination of the work of the fan, compressor, and turbine as well as the kinetic energy of air at the nozzle exit. The velocity of the flow at the nozzle exit is 375 m/s.