Given:
Electric power is to be generated by installing a hydraulic turbine–generator at a site 70 m below the free surface of a large water reservoir that can supply water at a rate of 1500 kg/s steadily. Neglect losses in the pipes.

Required:
If the mechanical power output of the turbine is 800 kW and the electric power generation is 750 kW, determine the turbine efficiency and the combined turbine-generator efficiency of this plant.

Solution:
The elevation change is given as

$$h := 70\ \text{m}$$

The mass flow rate of the water is defined as

$$m' := 1500\ \frac{\text{kg}}{\text{s}}$$

The power output of the turbine is

$$E'_{turb} := 800\ \text{kW}$$

The power ouptut of the generator is

$$E'_{gen} := 750\ \text{kW}$$

The mechanical energy extracted from the fluid is given by the expression below.

$$\Delta E'_{mech} = m' \cdot \left(\frac{P_2 - P_1}{\rho} + \frac{V_2^{\,2} - V_1^{\,2}}{2} + g_e \cdot \left(z_2 - z_1 \right) \right)$$

Recognizing that the pressure at state 1 and 2 are both at atmospheric conditions, the change in pressure term goes to zero. This is shown below.

$$\Delta E'_{mech} = m' \cdot \left(\frac{V_2^{\,2} - V_1^{\,2}}{2} + g_e \cdot \left(z_2 - z_1 \right) \right)$$

Similarly, the velocities are state 1 and 2 are relatively low (i.e. approximately zero). So the change in the squares of the velocities goes to zero. This is shown below.

$$\Delta E'_{mech} = m'\ g_e \cdot \left(z_2 - z_1 \right) \qquad \text{or} \qquad \Delta E'_{mech} := m'\ g_e \cdot h = 1.03\ \text{MW}$$

The efficiency of the turbine is then

$$\eta_{turb} := \frac{E'_{turb}}{\Delta E'_{mech}} = 77.69\ \%$$

The efficiency of the turbine-generator system is then

$$\eta_{turb\text{-}gen} := \frac{E'_{gen}}{\Delta E'_{mech}} = 72.84\ \%$$

Discussion:
These answers are reasonable. It is expected that the efficiency of the turbine-generator system would be less than that of just the turbine. The efficiency of just the generator could also be determined. This is shown below.

$$\eta_{gen} := \frac{E'_{gen}}{E'_{turb}} = 93.75\ \%$$

The efficiency of the turbine-generator system is then found by

$$\eta_{turb\text{-}gen} := \eta_{turb} \cdot \eta_{gen} = 72.84\ \%$$

This matches the previous answer.