a. Steady $\Rightarrow E_{in} = E_{out}$

$$Q_{in} + W_{in} + \dot{m}\left(h + \frac{v^2}{2} + gz\right)_{in} = Q_{out} + W_{out} + \dot{m}\left(h + \frac{v^2}{2} + gz\right)_{out}$$

$$\dot{m}\left(h + \frac{v^2}{2}\right)_{in} = Q_{out} - Q_{in} + W_{out} + \dot{m}\left(h + \frac{v^2}{2}\right)_{out}$$

$$\dot{m}\left(h + \frac{v^2}{2}\right)_{in} = \Delta Q + W_{out} + \dot{m}\left(h + \frac{v^2}{2}\right)_{out}$$

$h_{out} = h_g @ 100\,kPa = 234.46\ kJ/kg$. $v_{out} = 20\,m/s$

$h_{in} = 340.55\ kJ/kg$. $v_{in} = 100\,m/s$

$$1500\left(340.55 + \frac{100^2}{2\cdot 1000}\right) = \Delta Q + 50000 + 1500\left(234.46 + \frac{20^2}{2\cdot 1000}\right)$$

$$518325 = \Delta Q + 50000 + 351990$$

$$116335 = \Delta Q \Rightarrow Q_{out} > Q_{in} \Rightarrow \text{this is a } Q_{out}$$

116335 kW

b. $\Delta S = \dot{m}(s_2 - s_1) = 1500(1.0836 - 0.95191) = 197.535\ kW/K$

$s_2 = 0.95191$

$s_1 = 1.0836$

$\Delta S = \frac{\Delta Q}{T} + S_{gen}$

$-197.535 = \frac{-116335}{25+273.15} + S_{gen}$

$S_{gen} = 192.65\ kW/K$

$\Delta Q_{out} = -116335$

$\Delta S_{out} = -197.535$

c. ~~Energy generation is from the second law, as this is not a reversible system. Energy has a flow into this system, so~~

Energy generation is due to this system being irreversible, as some parts of this turbine are irreversible, such as the energy conversion to W_{out}.