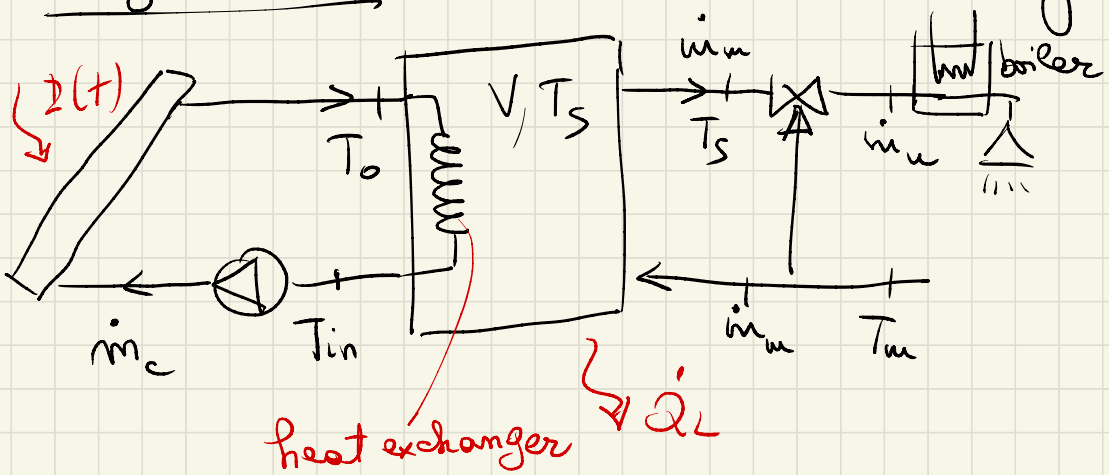
Assignment 2 - Solar thermal + storage



Collector model

$$\dot{m}_c \, c \, (T_o - T_{in}) = \eta(T_{in}) \, I(t) \, A$$

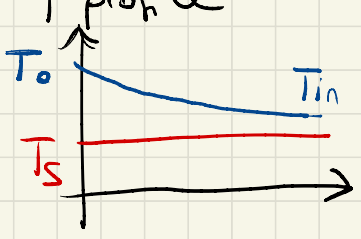
$$\eta(T_{in}) = \eta_0 - U \cdot \frac{T_{in} - T_a}{I}$$

Flow rate choice

$$\dot{m}_c = \begin{cases} \dot{m}_c = \text{const}, & \text{if } I > 0 \ \& \ \eta > 0 \\ 0, & \text{otherwise} \end{cases}$$

Heat exchanger model

T profile



$$\dot{Q}_{exch} = \dot{m}_c \, c \, (T_o - T_{in}) =$$

$$= \varepsilon \, \dot{m} \, c \, (T_o - T_s)$$

effectiveness → given

$$\Rightarrow T_{in} = T_o - \varepsilon (T_o - T_s)$$

DYNAMICS

Thermal energy balance

$$\begin{cases} 1)\ \dot{m}_c c (T_o - T_{in}) = \eta(T_{in}) I(t) A \\ 2)\ T_{in} = T_o - \varepsilon (T_o - T_s) \\ 3)\ \dot{m}_c c (T_o - T_{in}) - \dot{Q}_L - h A (T_s - T_{home}) = \\ \quad = M_s c \dot{T}_s \end{cases}$$

Algebraic. Find $T_{in}(T_s)$, $T_o(T_s)$

solve for T_s

with

$$4)\ \dot{Q}_L = \begin{cases} \dot{m}_u c (T_u - T_w), & \text{if } T_u \le T_s \\ \dot{m}_u c (T_s - T_w), & \text{if } T_u > T_s \end{cases}$$

$$5)\ \dot{Q}_{boiler} = \begin{cases} 0, & T_u \le T_s \\ \dot{m}_u c (T_u - T_s), & T_u < T_s \end{cases}$$

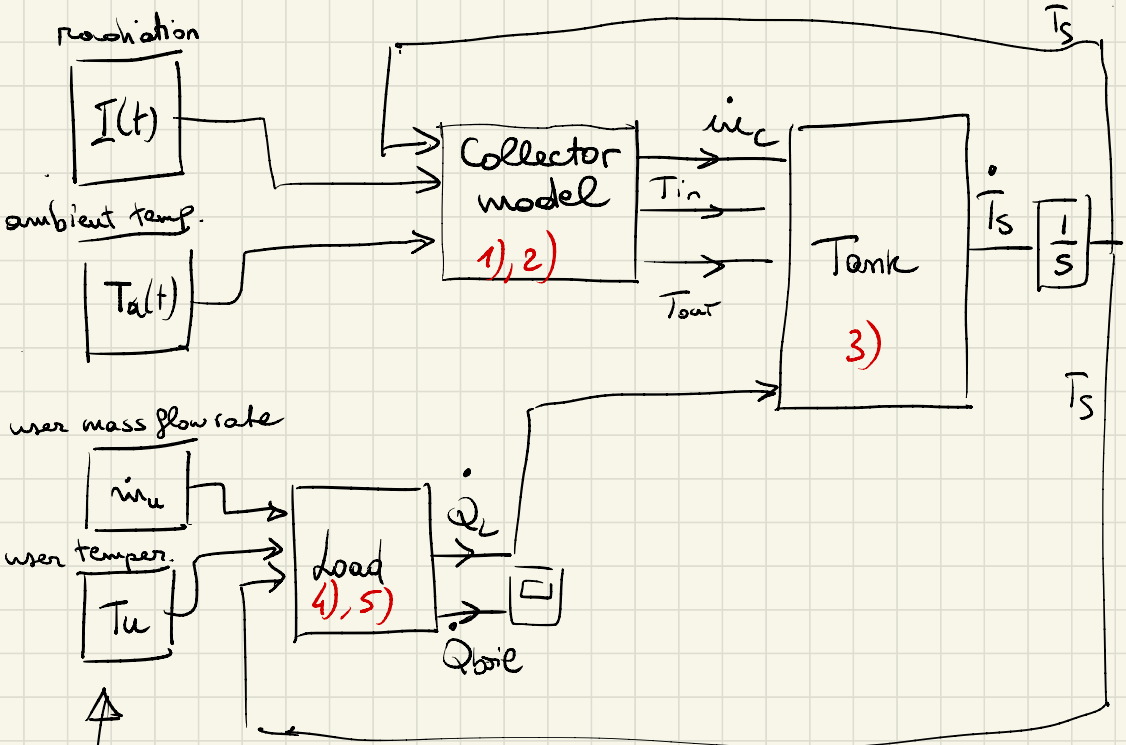
Energy extracted from panel

$$E_c = \int \eta(T_{in})\, I \, dt$$

Energy provided by the boiler

$$E_b = \int \dot{Q}_{boiler}\, dt$$

Possible structure of Simulink block diagram



Blocks (e.g. repeating sequence interpolated) that output the radiation, ambient temperature, user consumed flow rate and requested temperature as a function of time