$$C_{res}\,\dot{T}_{int}(t) = \frac{1}{R_i}\left(T_s(t)-T_{int}(t)\right) + \frac{1}{R_f}\left(T_{ext}(t)-T_{int}(t)\right) + 10\left(Q_{res}(t)+Q_{tank}(t)\right)$$

$$C_s\,\dot{T}_s(t) = \frac{1}{R_i}\left(T_{int}(t)-T_s(t)\right) + \frac{1}{R_o}\left(T_{ext}(t)-T_s(t)\right) + \underbrace{Q_s(t)}_{\text{external solar flux}}$$

R_f: 5 R_i: 2,5 R_o: 0,5 C_{res}: 5 C_s: 8

Electricity prices in France: $\boxed{0{,}182 \text{ Euro/kW·h}}$

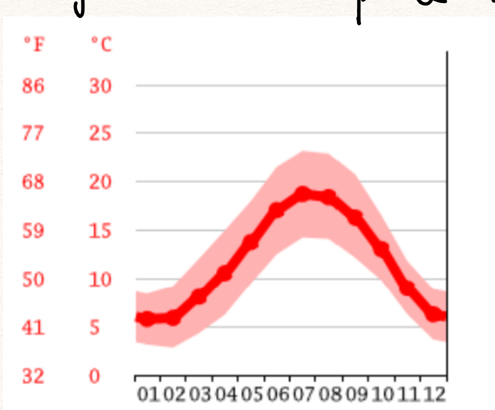
(Household)

(While, for Partie II, we should consider the variety of price from daytime to night)

	Summer	Winter	
Most comfortable temperature :	25,56°C	20 °C	(Reference)

In Rennes, solar radiation : 160 W/m²

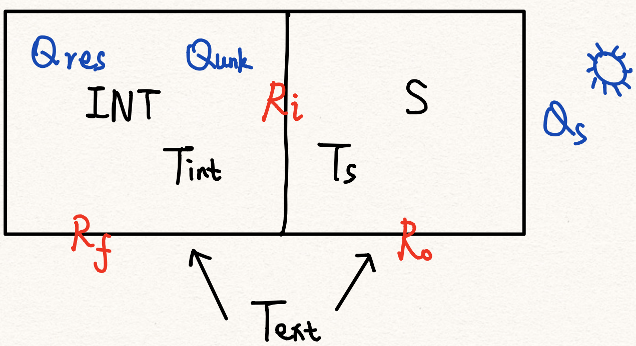
Average outside temperale in Rennes: 11,9 °C



(We should consider the outside temperature varies from daytime to night.)

Understand the two equations above:

we imagine that there is room INT (with "S" nearby)



Firstly, we neglect the disturbance input in the controller ($Q_s = 0$; $T_{ext} = 0$)

$$C_{res} \dot{T}_{int}(t) = \frac{1}{R_i}(T_s - T_{int}) + \frac{1}{R_f}(-T_{int}) + 10(Q_{res} + Q_{unk})$$

$$C_s \dot{T}_s(t) = \frac{1}{R_i}(T_{int} - T_s) + \frac{1}{R_o}(-T_s)$$

We define:

$$X = \begin{pmatrix} T_{int} \\ T_s \end{pmatrix} \qquad U = \begin{pmatrix} Q_{res} \\ Q_{unk} \end{pmatrix}$$

(We decided to put Qunk in X)

$$A_1 = \frac{1}{C_{res}} \left(\frac{1}{R_i}(-1, 1) + \frac{1}{R_f}(-1, 0) \right)$$

$$A = \begin{bmatrix} A_1 \\ A_2 \end{bmatrix}$$

$$A_2 = \frac{1}{C_s} \left(\frac{1}{R_i}(1, -1) + \frac{1}{R_o}(0, -1) \right)$$

$$B = \left[\frac{10}{C_{res}} , \frac{10}{C_{res}} ; 0 , 0 \right]$$

$$\boxed{\dot{X} = AX + Bu \qquad y = CX \qquad C = [1 \ 0}$$

$\boxed{\text{Reference:}}$ We consider it as constant at first.

$T_0 = 20$

Discretization:

$$x[k+1] = Ax[k] + Bu[k]; \qquad Y = \underbrace{F}_{N_p\times 2} x + \underbrace{H}_{N_p\times 2N_p} U$$

$$y[k] = C\,x[k]$$

$$\boxed{\text{Loss function: } \frac{1}{2}(T_{int} - T_0)^T W (T_{int} - T_0) + \frac{1}{2} Q_{res}^T R\, Q_{res}}$$

def: $Z = \begin{bmatrix} Y \\ U \end{bmatrix}_{3N_p\times 1}$

$$\frac{1}{2} Z^T \begin{pmatrix} I & & \\ & \lambda I & \\ & & 0 \end{pmatrix}_{3N_p^{2}} Z - (\underbrace{T_0^T}_{1\times N_p} \; \underbrace{0}_{1\times 2N_p}) Z$$

Constraints:

$$[I \; -H]\, Z = F x$$

$$\begin{bmatrix} 0 \\ \vdots \\ 0 \end{bmatrix}_{N_p\times 1} \le [\underbrace{0}_{N_p^{*}} \; \underbrace{I}_{N_p^{*}} \; \underbrace{0}_{N_p^{*}}]\, Z \le \begin{bmatrix} 1.5 \\ \vdots \\ 1.5 \end{bmatrix}_{N_p\times 1}$$

$$T_0 - \begin{bmatrix} 3 \\ \vdots \\ 3 \end{bmatrix} \le [\underbrace{I}_{N_p^{*}} \; \underbrace{0}_{N_p\times 2N_p}]\, Z \le T_0 + \begin{bmatrix} 3 \\ \vdots \\ 3 \end{bmatrix}$$

$\boxed{\text{Constraints :}}$

$0 \le [1 \quad 0]\, U \le 1{,}5$ Qres

$T_0 - 3 \le X \le T_0 + 3$ (the change of Temperature in a limited range to satisfy "comfortable)

with disturbance $D = \begin{pmatrix} T_{ext} \\ Q_s \end{pmatrix}$

$X_d = \begin{pmatrix} X \\ D \end{pmatrix}_{4\times1}$ $B_D = \begin{pmatrix} \frac{1}{C_{res}\cdot R_f} & 0 \\ \frac{1}{C_s \cdot R_o} & 1 \end{pmatrix}_{2\times2}$

$\dot{X}_d = (A \quad B_D)\, X_d + B U$