Theoretical Model of Flat Plate Collector (FPC) with a Thermosiphon.

Assumptions

- Quasi stead state
- No shading
- Ideal flow (laminar, 1D, uniform)
- Hottel Whillier Bliss equation

Calculations

The model was developed based on the following equations for a thermosiphon FPC from the paper used.

$$\varphi = N\frac{L_c}{L_{ct}}\left(\frac{d_c}{d_{ct}}\right)^4 \tag{15}$$

$$C = \frac{gN\pi A_c d_c^4\left(\frac{L_c \sin\theta}{2} + H\right)}{128L_c(1 + \varphi)} \tag{22}$$

$$\dot{M} = C^{1/2}\left(\frac{\rho_o \beta}{\nu C_p}F'[I(\tau\alpha) - U_L(T_m - T_{amb})]\right)^{1/2} \tag{21}$$

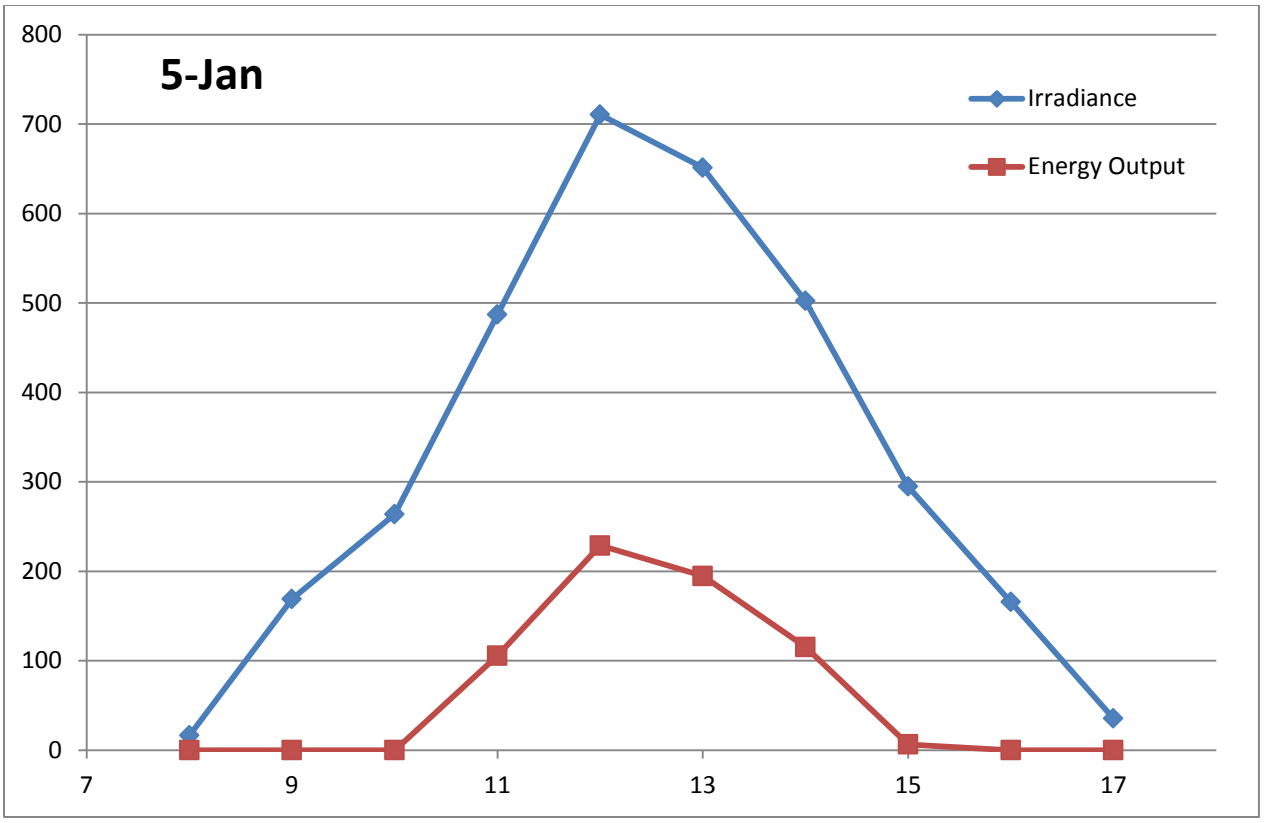
$$T_o - T_i = \frac{A_c F'}{\dot{M}C_p}[I(\tau\alpha) - U_L(T_m - T_{amb})] \tag{19}$$

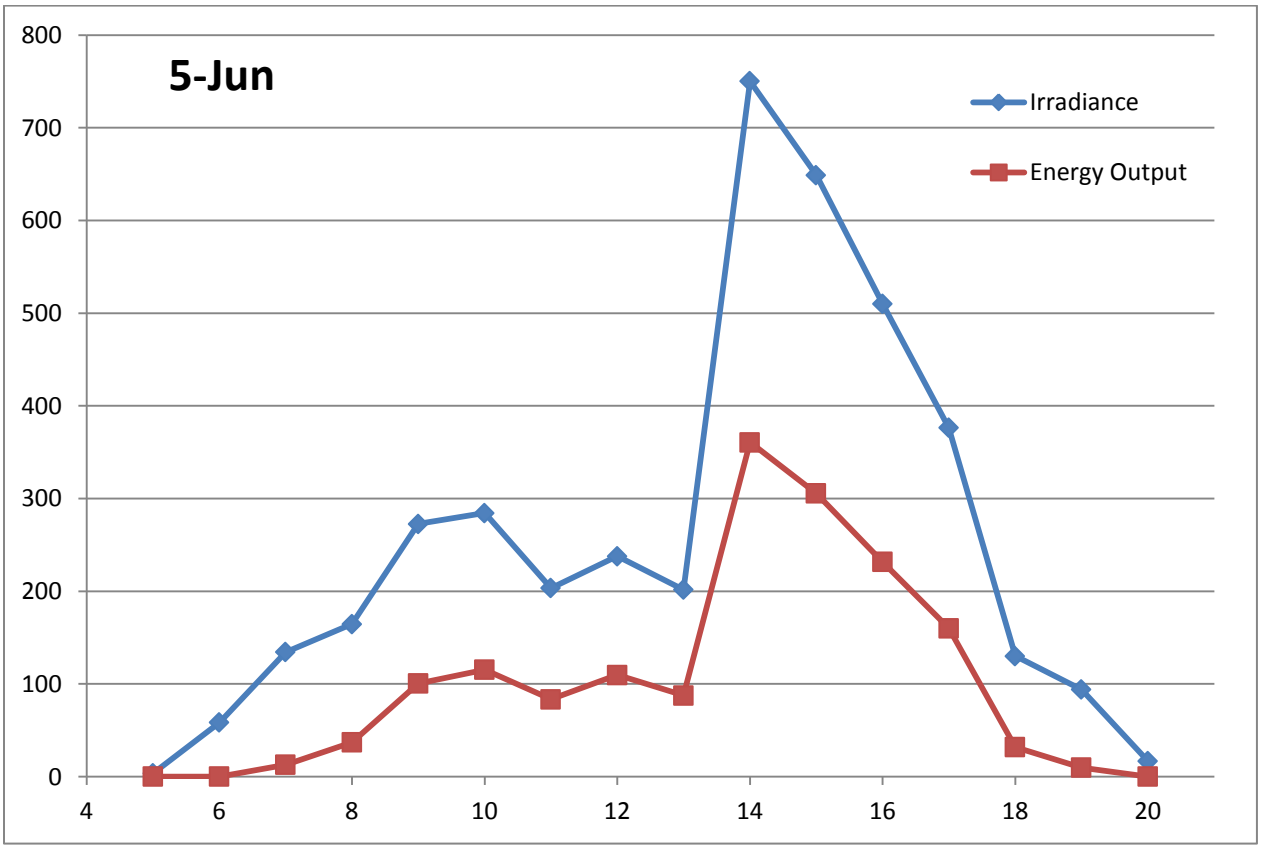
The following basic energy equation was used to find the energy into the fluid

$$Q = \dot{m} * C_P * N * \Delta T$$

Sample Days

Using the model developed we predicted the energy added to the system for January 5th and June 5th resulting in the following plots.


5-Jan
Irradiance
Energy Output
800
700
600
500
400
300
200
100
0
7
9
11
13
15
17


5-Jun
Irradiance
Energy Output
800
700
600
500
400
300
200
100
0
4
6
8
10
12
14
16
18
20

Conclusion

Date	5 January	5 June
Total Daily Irradiance (W)	3,675	4,557
Total Energy Input to Still (W)	651	1,646
Efficiency	17.7%	36.1%

Using this model we predict a usable energy input to the solar still even during the winter in Rochester. The efficiency decreases, but the overall collector provides an acceptable amount of usable energy.