LIC

```
U <- 1.5  # sq. meter/K building envelope conductance (assumption - 12" brick)  SI
A <- 8000  # sq. meter envelope area (assumption based on Pluto + other NYC DCAS data)  SI
V <- 37800  # cubic meter ventilation/inflitration flow rate (assumption) (1-3, step 0.5)  SI
n <- 1  # air change per hr.
rho <- 1.2  # kg/m cubed 0.00234 density of air (calc. based on IAT 68F)  SI
cp <- 0.27  # watt hrs./cubic meter in K specific heat of air (calc. based on IAT 68F)  SI
CS <- 2695  # cooling slope (from lm)
TcpC <- 62.76  # cooling CP (from CP model)
Tset <- 76  # cooling setpoint (assumption)


# 3PC Model
Ei <- 25200  # baseload (non-weather sensitive usage)
Toa <- 80  # sample temp. (VARIABLE)

E <- Ei + (CS * (Toa - TcpC))  # E = expected kWh at Toa - CP MODEL EQUATION
# cat(E, "=", Ei, "+ (", CS, "* (", Toa, "-", TcpC, "))" )
cat("Expected kWh at Toa:", E)
```

```
## Expected kWh at Toa: 71661.8
```

```
# Cooling Coefficient
CC <- ((((U * A) + (V * n * rho * cp)) / 1000) * 0.556) * (30*24) # convert from watts to kw, = kwh per
cat("Cooling Coefficient:", CC)
```

```
## Cooling Coefficient: 9706.639
```

```
# Efficency
Effc <- CC / (CS)
cat("Cooling efficiency:", Effc)
```

```
## Cooling efficiency: 3.601721
```

```
# Qi - sum of internal loads from electricity use, solar gain and occupants
#TcpC <- Tset - Qi / CC
Qi <- -CC * (TcpC - Tset) # Just kWh (not per degree)
cat("Internal loads:", Qi)
```

```
## Internal loads: 128515.9
```

```
options(scipen=999)
library(devtools)
```

```
## Warning: package 'devtools' was built under R version 3.3.2
```

```
parameters <- c(U, A, V, rho, cp, CS, TcpC, Tset, Ei, Toa, E, CC, Effc, Qi)
as.data.frame(parameters)
```

```
##       parameters
## 1       1.500000
## 2    8000.000000
## 3   37800.000000
## 4       1.200000
## 5       0.270000
## 6    2695.000000
## 7      62.760000
## 8      76.000000
## 9   25200.000000
## 10     80.000000
## 11  71661.800000
## 12   9706.639104
## 13      3.601721
## 14 128515.901737
```

```
names(parameters) <- c('U', 'A', 'V', 'rho', 'cp', 'CS', 'TcpC', 'Tset', 'Ei', 'Toa', 'E', 'CC', 'Effc'
parameters <- round(parameters, 5)
parameters
```

```
##            U           A           V         rho          cp
##      1.50000   8000.00000  37800.00000      1.20000      0.27000
##           CS         TcpC         Tset           Ei          Toa
##   2695.00000     62.76000     76.00000  25200.00000     80.00000
##            E          CC         Effc           Qi
##  71661.80000   9706.63910      3.60172 128515.90174
```

Simulation

Assumptions made for model can be simulated

Sim #1: Toa – use CP Model Equation and simulate Toa from 10-100 degrees F in steps of 5 degrees

Sim #2: Tset – substitute other values from 50 to 75, in steps of 5 degrees – this simulates setting the thermostat lower or higher

Sim #3: U – substitute other values: 0.25, 0.18, 0.12, 0.09 – this simulates adding insulation, etc. to tighten building envelope

Sim #4: V – substitute other values: 1 to 3, in steps of 0.5 – this simulates improved/worse ventilation/infiltration flow rate (lower is)

```
U <- 0.31  # building envelope conductance (assumption - 12" brick)
V <- 2  # ventilation/inflitration flow rate (assumption) (1-3, step 0.5)
Tset <- 74  # cooling setpoint (assumption)
Toa <- 80  # sample temp. (VARIABLE)
```

```r
# CP Model Equation
E <- Ei + (CS * (Toa - TcpC))  # E = expected kWh at Toa - CP MODEL EQUATION
cat("Expected kWh at Toa:", E)
```

```
## Expected kWh at Toa: 71661.8
```

```r
# Cooling Coefficient
CC <- (U * A) + (V * rho * cp)
cat("Cooling Coefficient:", CC)
```

```
## Cooling Coefficient: 2480.648
```

```r
# Efficency
Effc <- CC / CS
cat("Cooling efficiency:", Effc)
```

```
## Cooling efficiency: 0.9204631
```

```r
# Qi - sum of internal loads from electricity use, solar gain and occupants
#TcpC <- Tset - Qi / CC
Qi <- -CC * (TcpC - Tset)
cat("Internal loads:", Qi)
```

```
## Internal loads: 27882.48
```