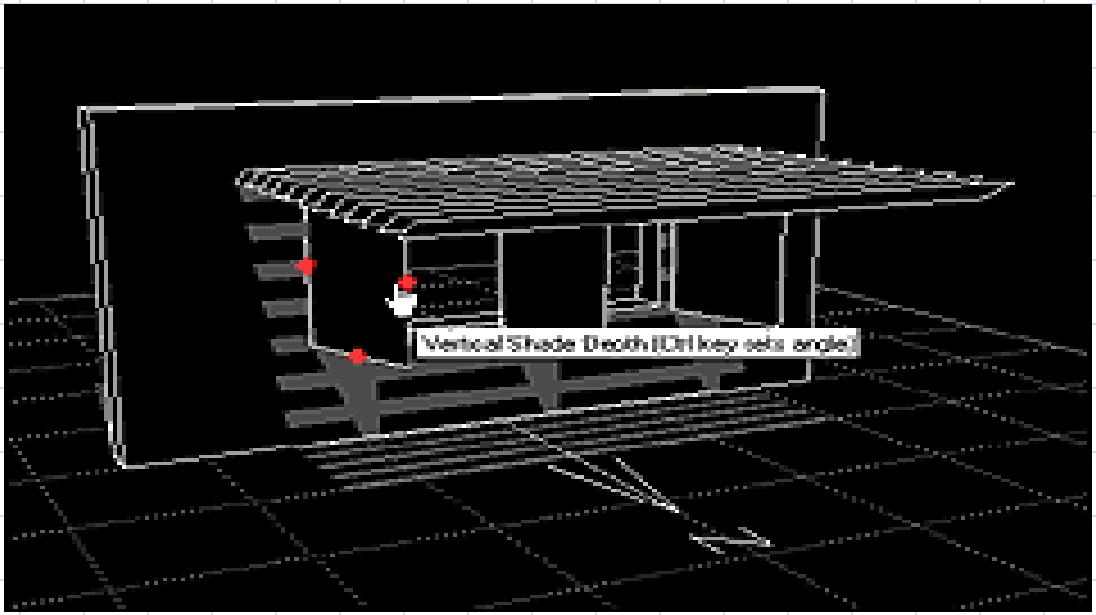
IPRO 330



- Window Solar Control

Team Members

- Team Leader

  Maen Alkhader *MMAE*

- Team Members

  Shivanee Patel *CPE*
  Mike Miller *CS*
  Asim Khan *EE*

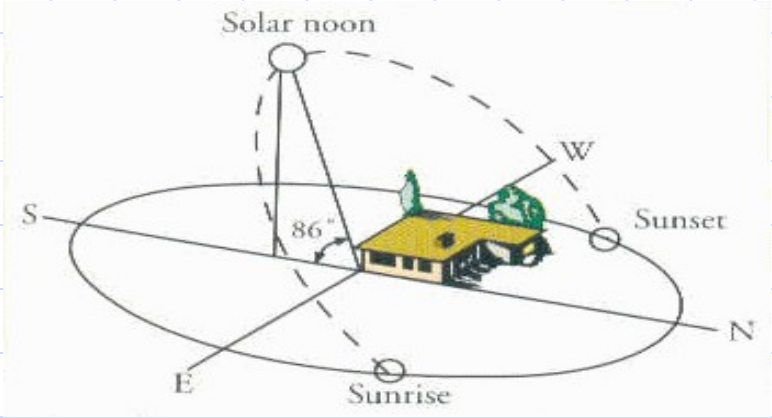
- Sponsor

  Community Energy Cooperative

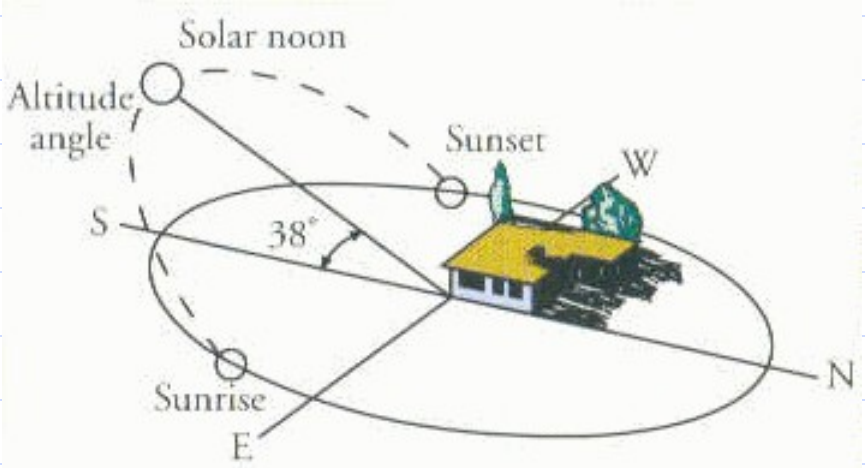
- Advisor

  Nancy Hamill Governale

Introduction



- Solar Problem
  - Energy Use
  - Peak Demand
  - Day Lighting

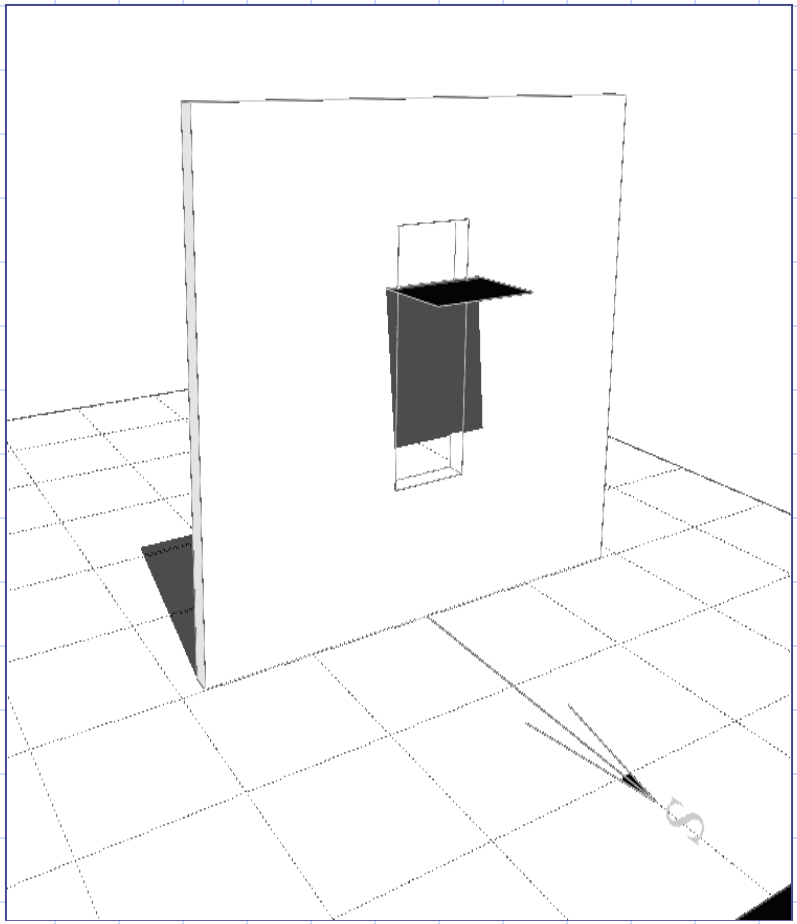


- Solar Awning
  - Definition

Steps Taken

- Statement of objective and goals
- Research Solar aspect
- Research current products' shortcomings
- Use knowledge gathered to develop designs
- Test awnings by simulation
- Study results
- Make a model of our product
- Present results

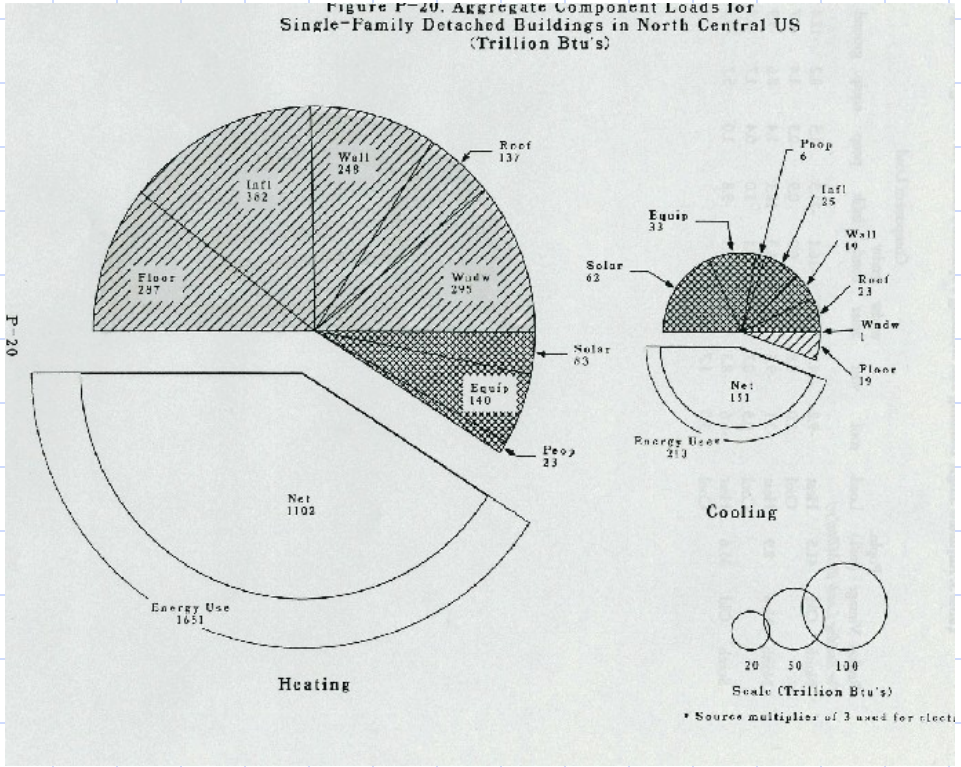
Solar Awning



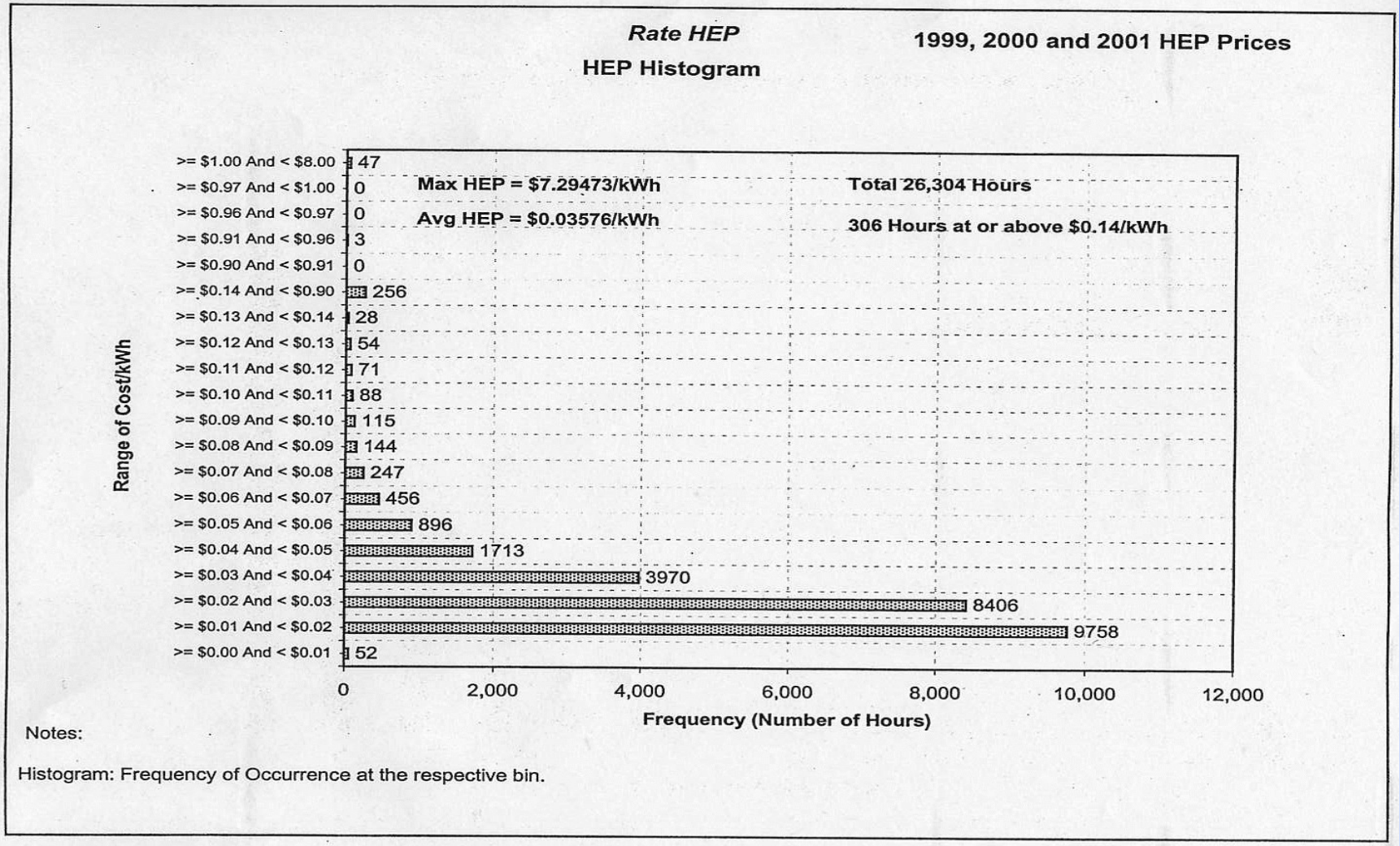
- This product should be
  - Inexpensive
  - Able to preserve window egress and ventilation functions
  - Easy to handle (permanently installed)
  - Able to produce substantial heat reduction
  - Able to allow solar heat in winter
  - Enhances day light brightness
  - Shouldn’t reduce window view
  - Shouldn’t alter the appearance of the building

Statement of Objective

- Develop an inexpensive Solar Awning which will be used primarily to reduce peak electric demand and improve cooling energy efficiency.



Peak Demand

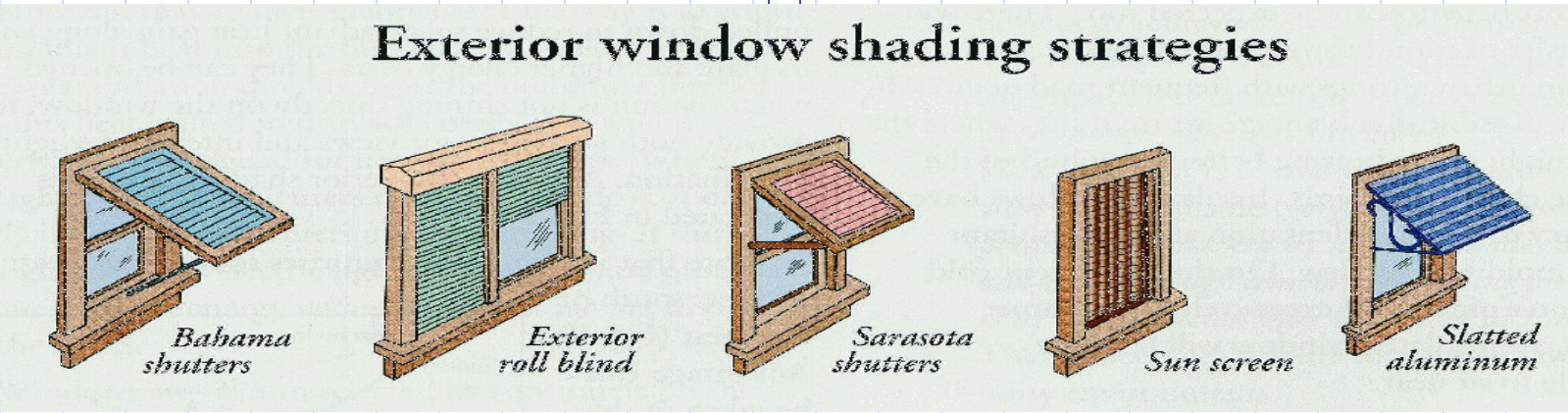

Rate HEP
HEP Histogram
1999, 2000 and 2001 HEP Prices
Max HEP = $7.29473/kWh
Avg HEP = $0.03576/kWh
Total 26,304 Hours
306 Hours at or above $0.14/kWh
>= $1.00 And < $8.00 47
>= $0.97 And < $1.00 0
>= $0.96 And < $0.97 0
>= $0.91 And < $0.96 3
>= $0.90 And < $0.91 0
>= $0.14 And < $0.90 256
>= $0.13 And < $0.14 28
>= $0.12 And < $0.13 54
>= $0.11 And < $0.12 71
>= $0.10 And < $0.11 88
>= $0.09 And < $0.10 115
>= $0.08 And < $0.09 144
>= $0.07 And < $0.08 247
>= $0.06 And < $0.07 456
>= $0.05 And < $0.06 896
>= $0.04 And < $0.05 1713
>= $0.03 And < $0.04 3970
>= $0.02 And < $0.03 8406
>= $0.01 And < $0.02 9758
>= $0.00 And < $0.01 52
Range of Cost/kWh
0
2,000
4,000
6,000
8,000
10,000
12,000
Frequency (Number of Hours)
Notes:
Histogram: Frequency of Occurrence at the respective bin.
three year data1.xls/HEP_Histogram_Hrs 01/30/2002

Research

- Solar Aspect
  - Heat gain from the sun
  - Sun Angle
  - Daylighting
- Current Products
  - Awnings
  - Blinds
  - Glazing
  - Windows

Existing Awnings

- Pros
  - Block Solar Radiation
  - Aesthetics
  - Variety
- Cons
  - Block Solar Radiation (winter)
  - Block Day Lighting
  - Expensive
  - No Solar in Design



Blinds

- Pros
  Block Solar Radiation

  Doesn't obstruct view

- Cons
  Block Day Lighting

  Doesn't fully Block Solar Radiation

  No Solar in Design

New Windows/Glazing

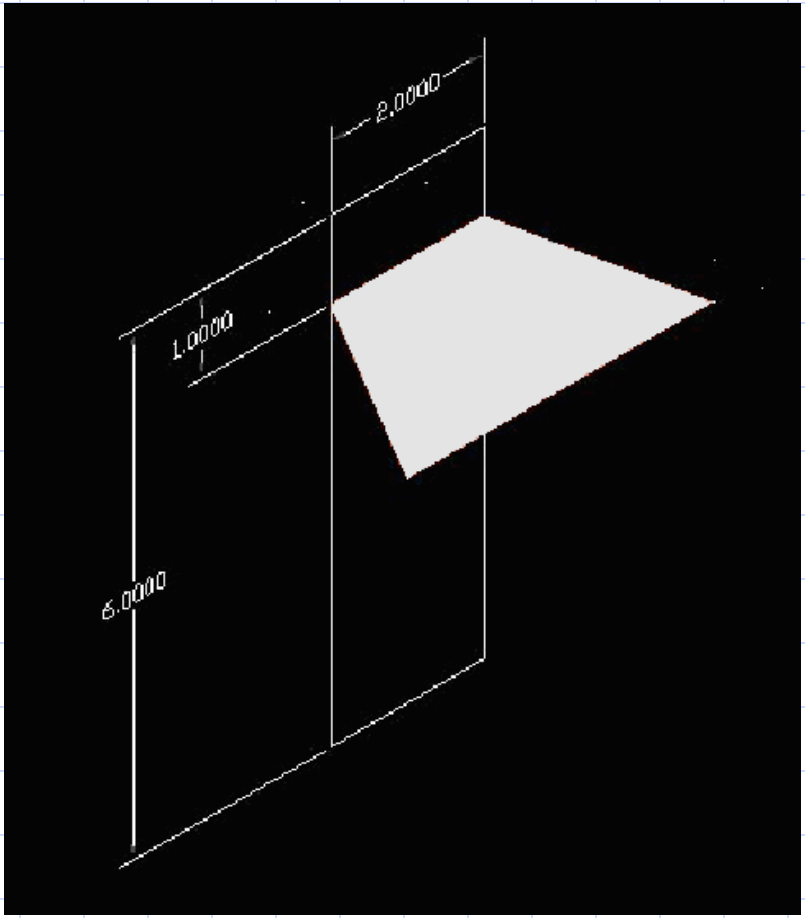
- Pros
  Block Solar Radiation

  Doesn't obstruct view

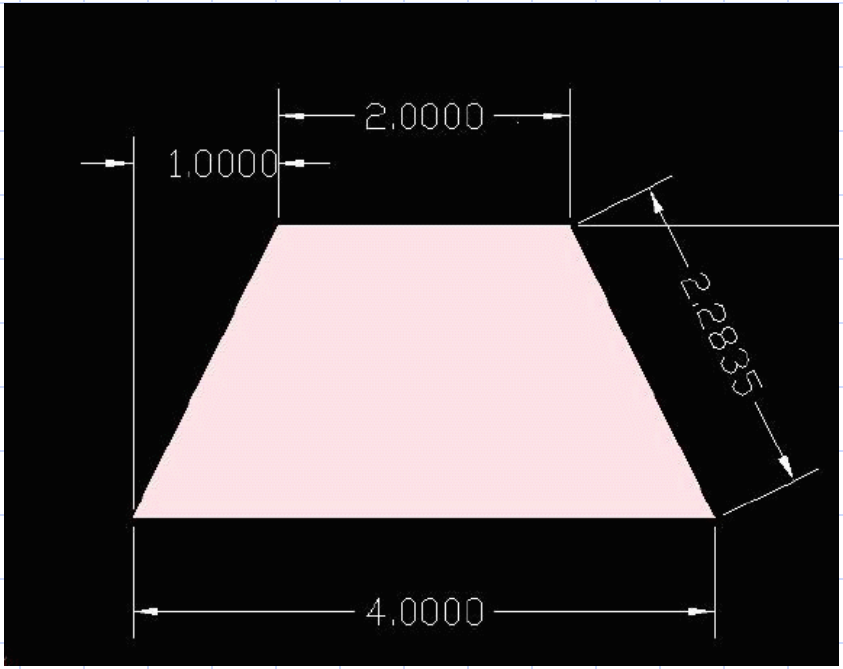
  No decrease in Day Lighting

- Cons
  - Very Expensive

Flat Awning

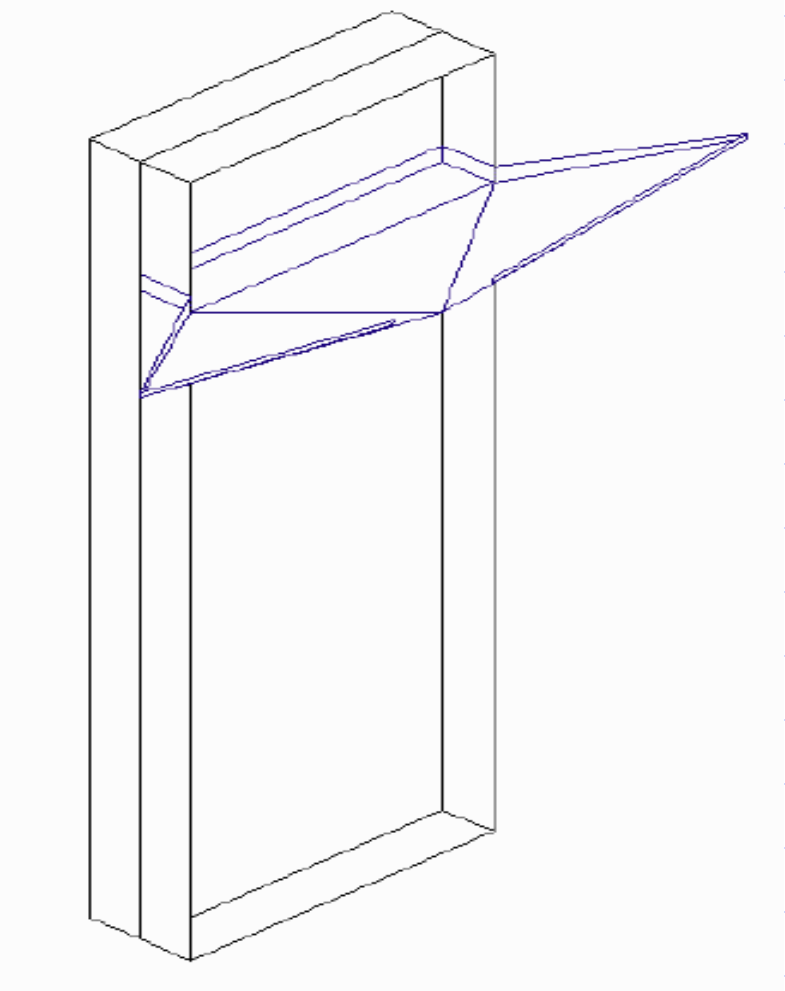


▼ Top View

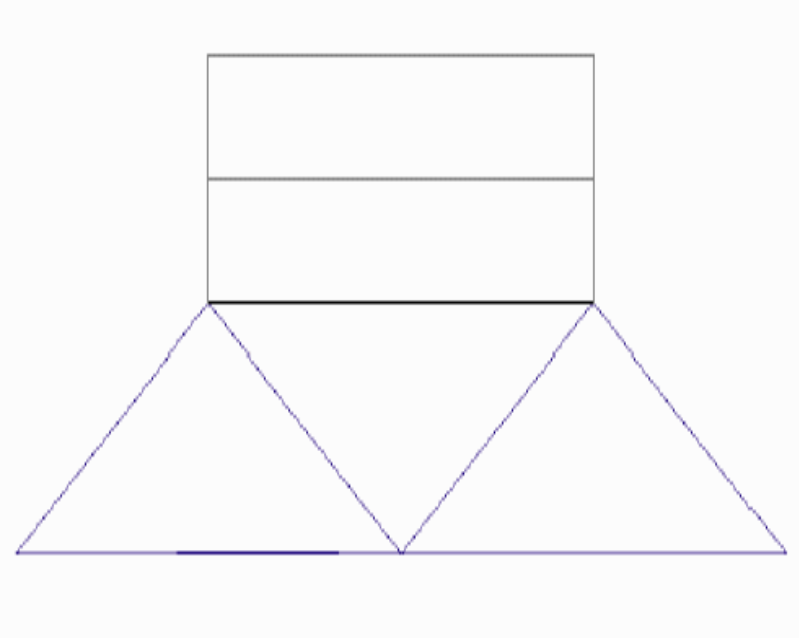


◄ 3D View

Sponsor Awning

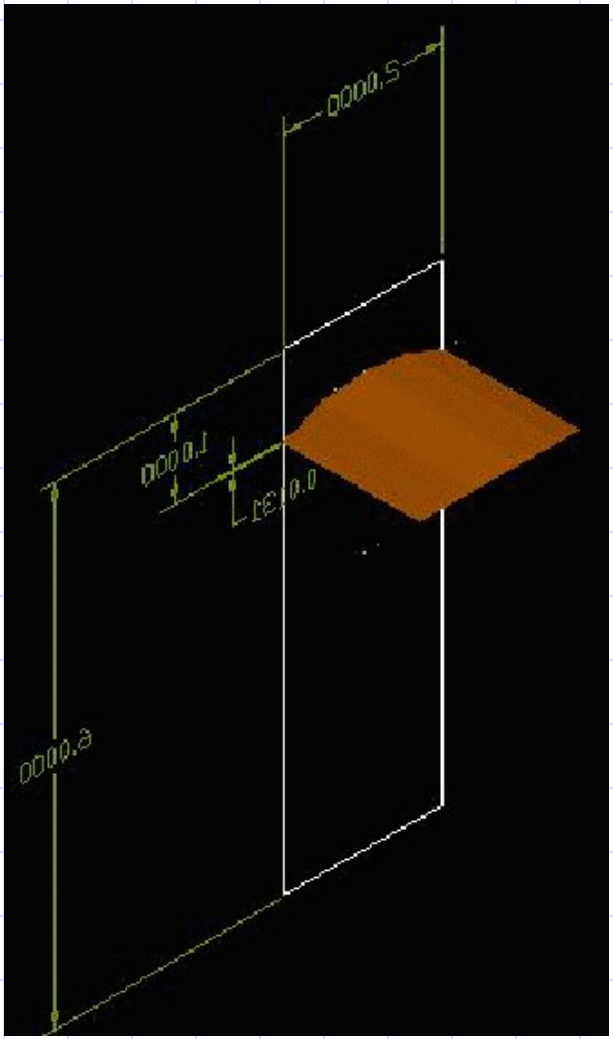


▼ Top View

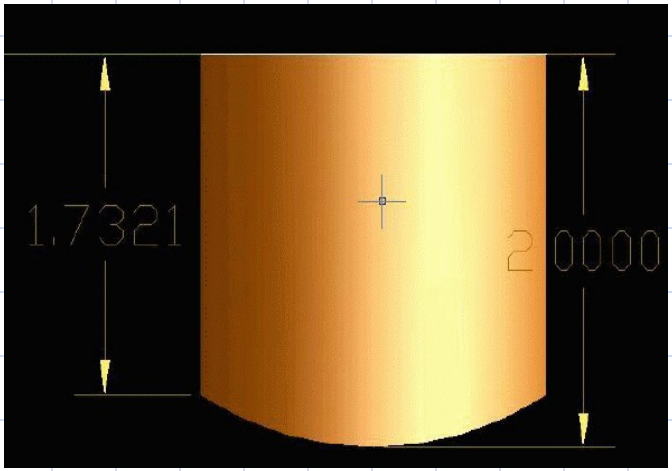


◄ 3D View

Curved Awning

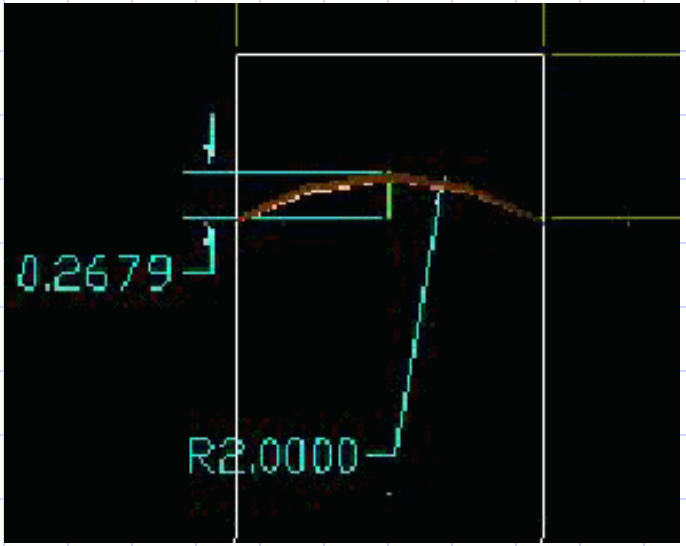


◄3D View



◄ Top View

►Front View

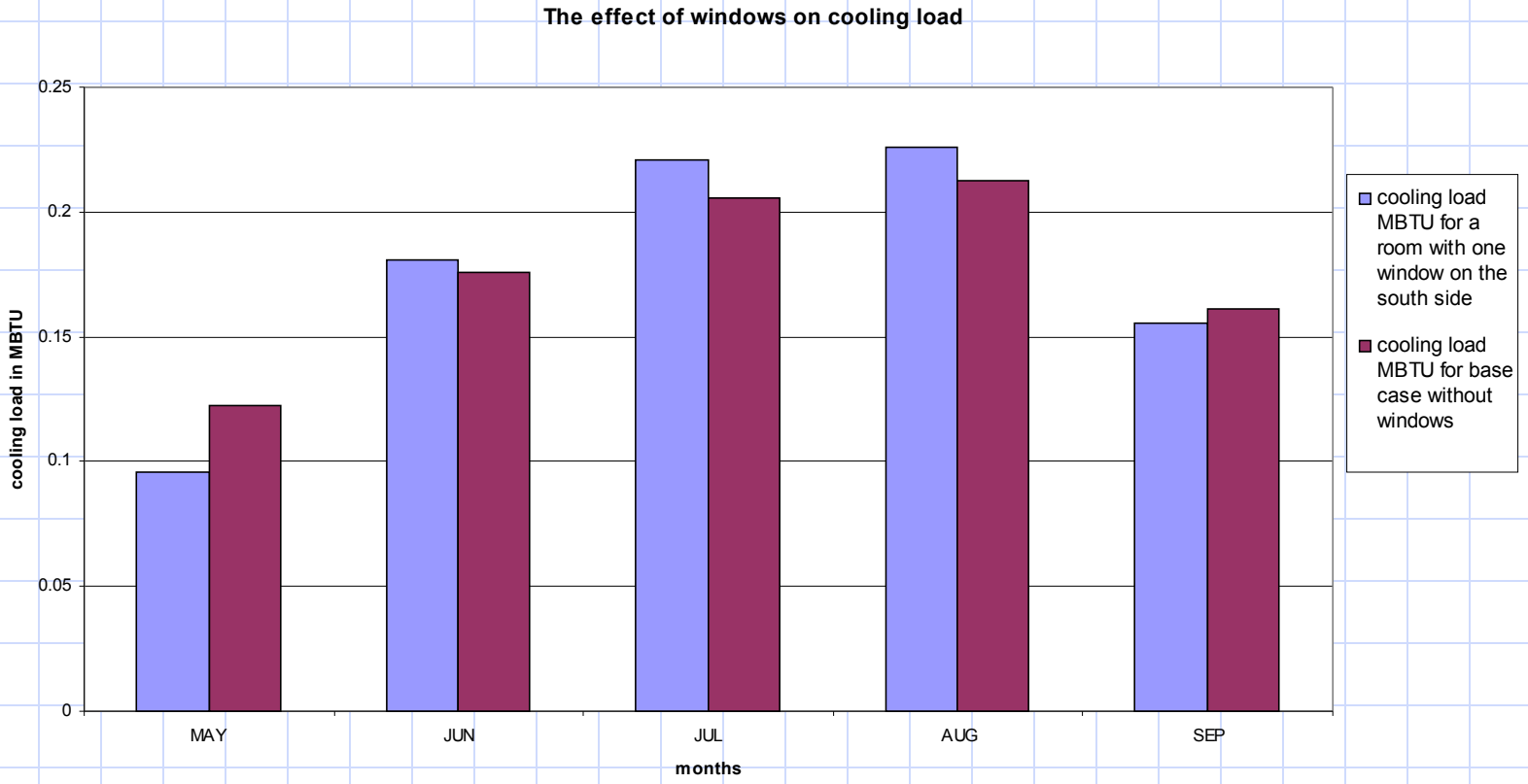


Testing with DOE 2.1

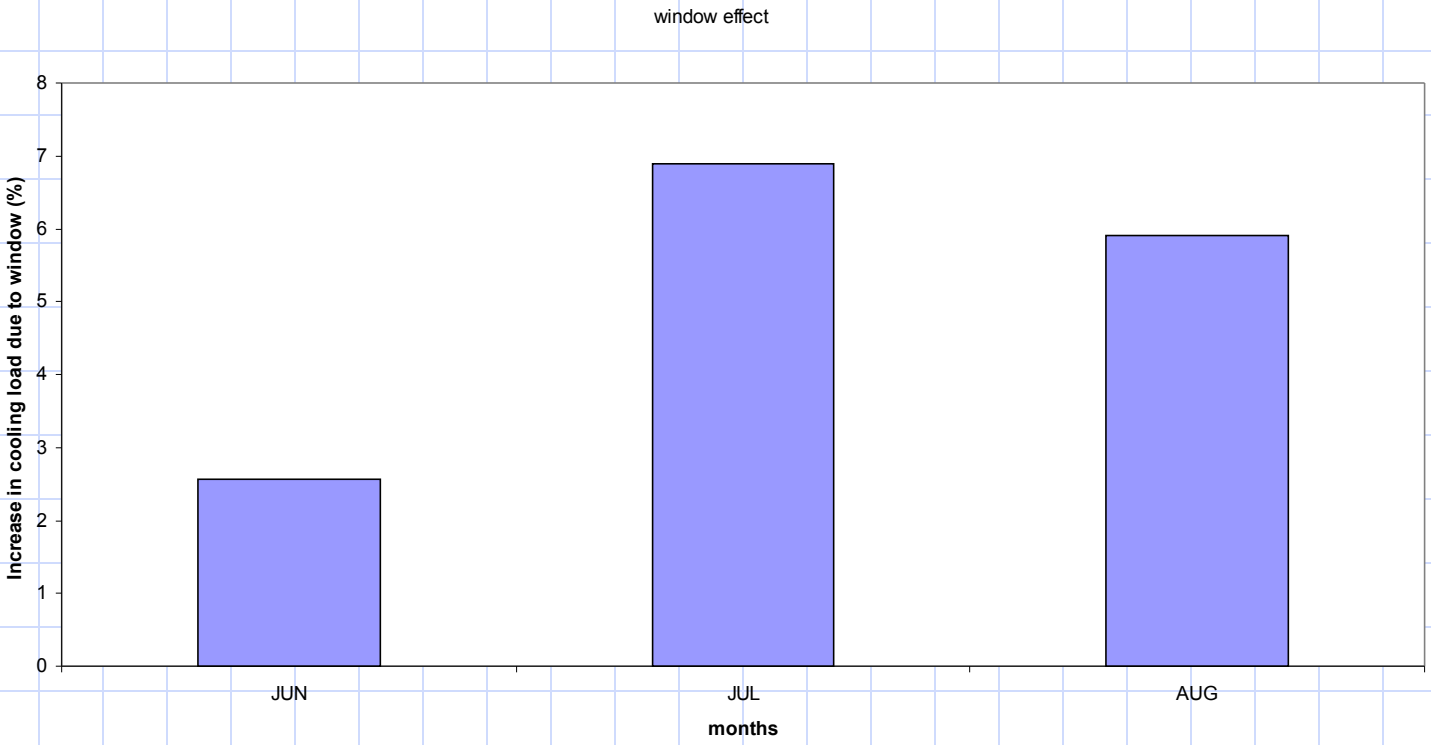
- Assumptions
  - Room Dimensions (12ft*12ft*9ft)
  - Window Dimensions (2ft*4.5ft)
  - U factor for the glass
  - U factor for the wall

Building a model

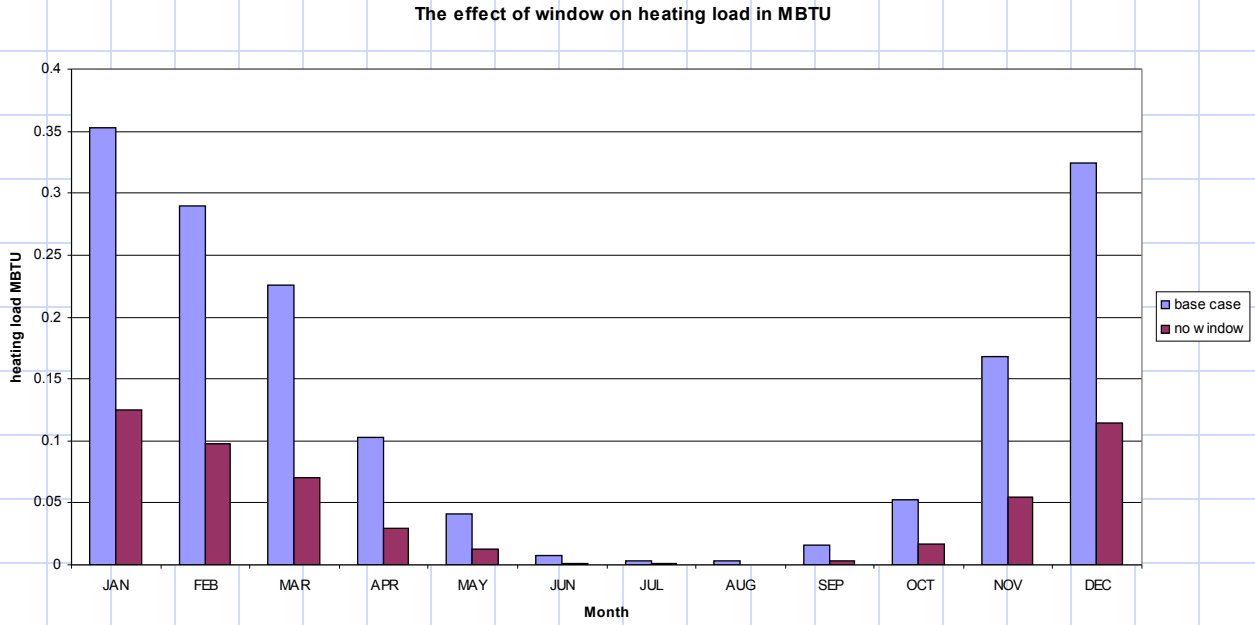
Results


The effect of windows on cooling load
cooling load in MBTU
0.25
0.2
0.15
0.1
0.05
0
MAY
JUN
JUL
AUG
SEP
months
cooling load MBTU for a room with one window on the south side
cooling load MBTU for base case without windows

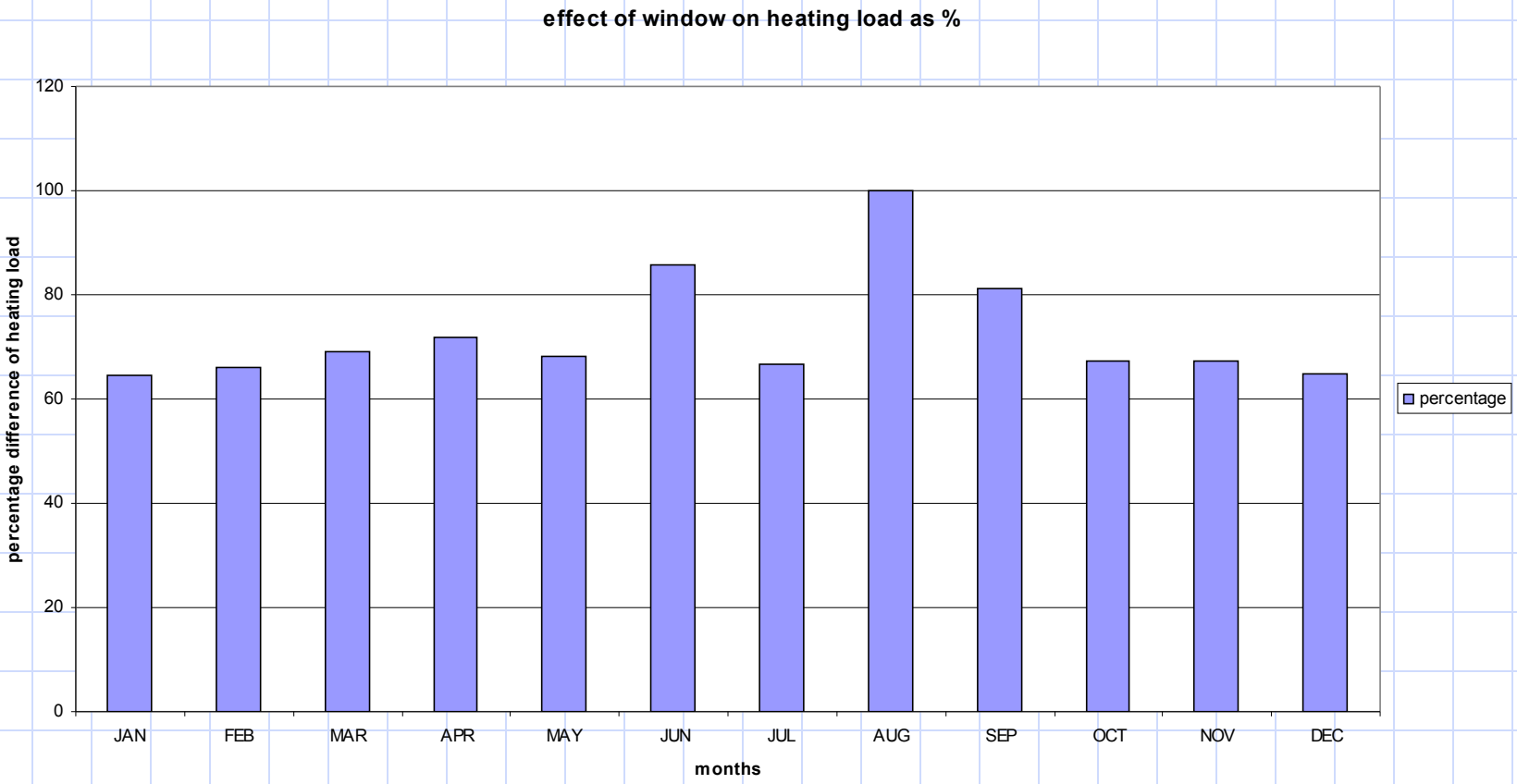
Window Effect on cooling load (%)



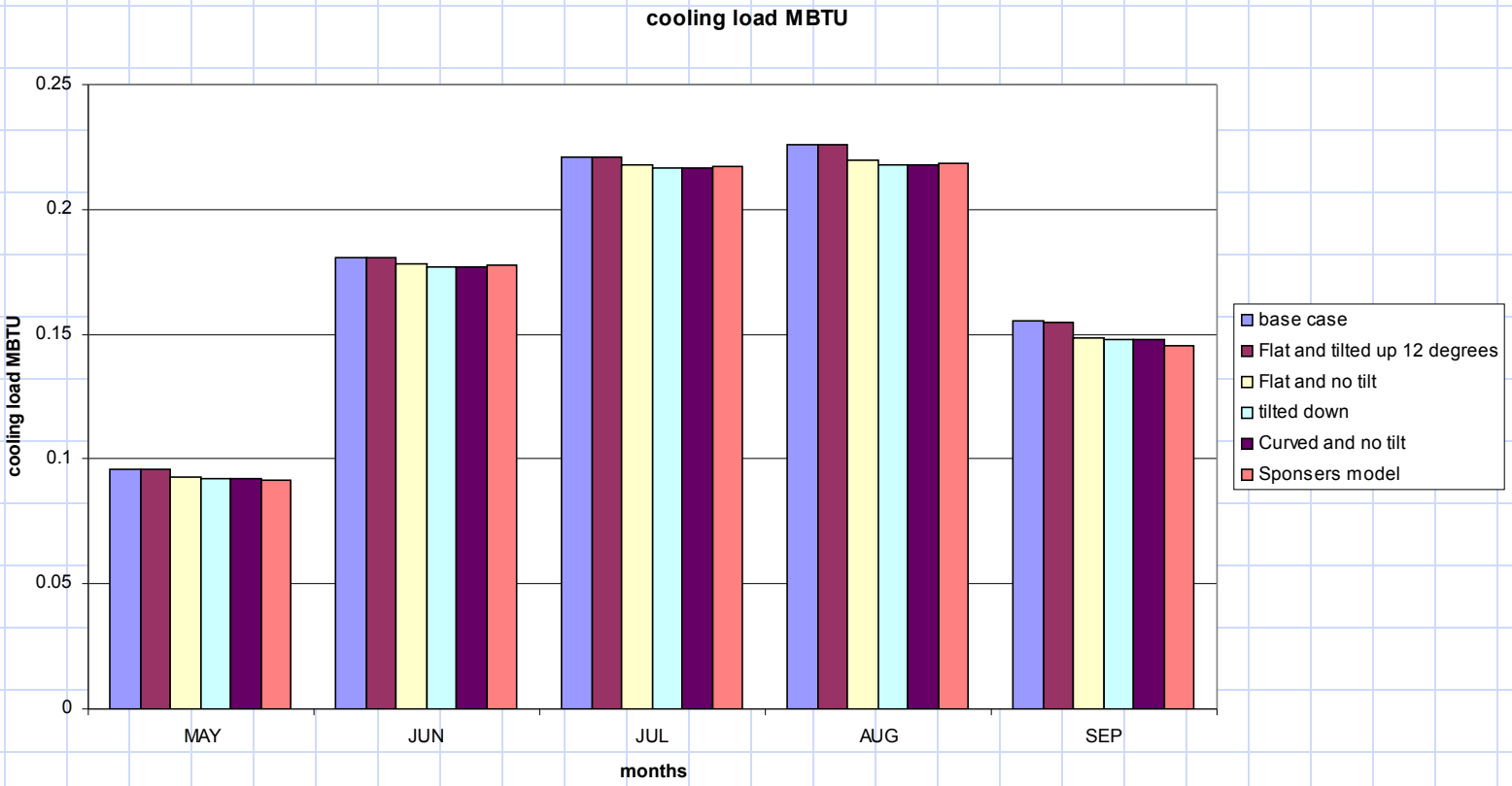
Window Effect on heating load (BTU)



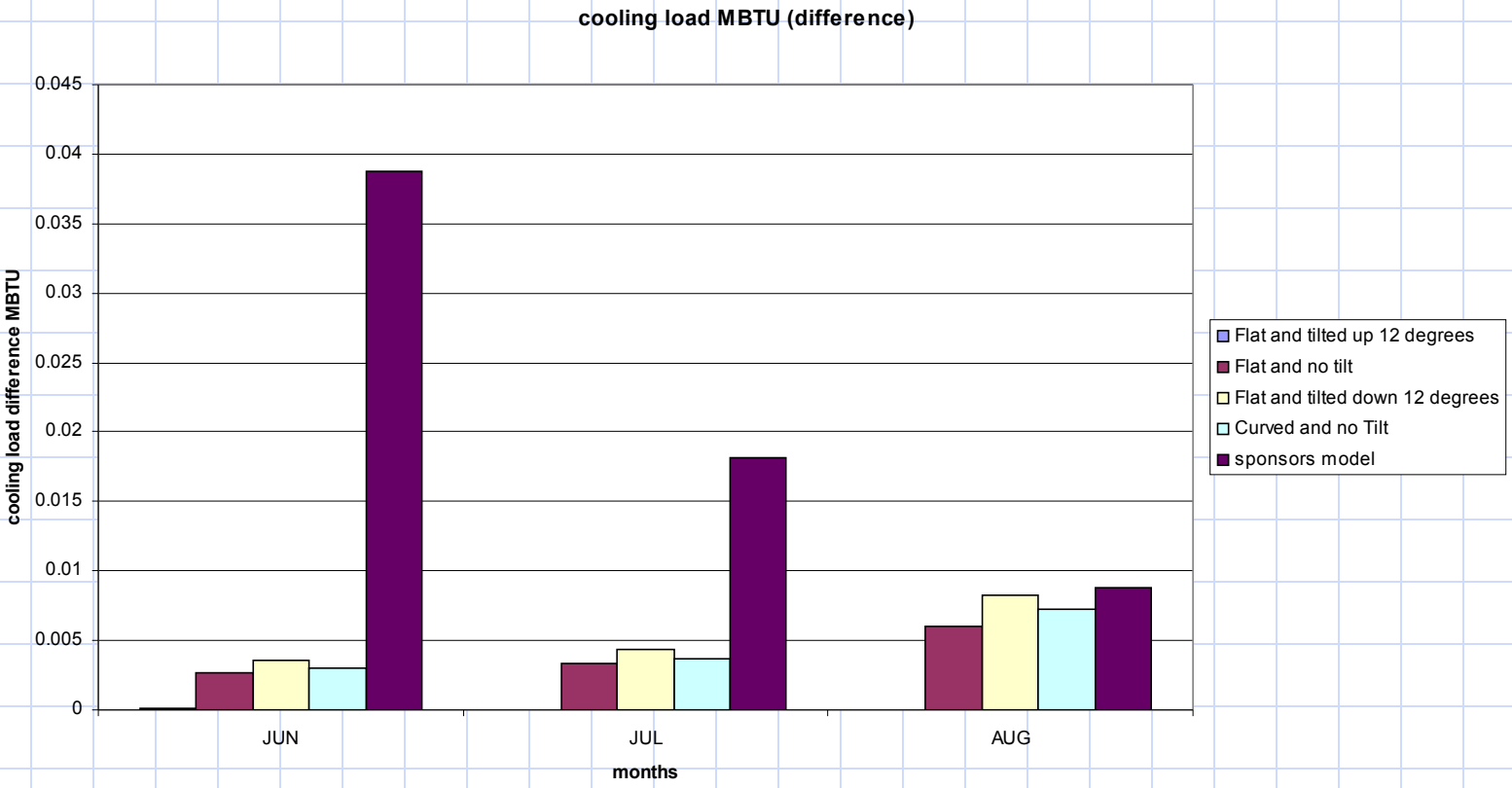
Window Effect on heating load (%)



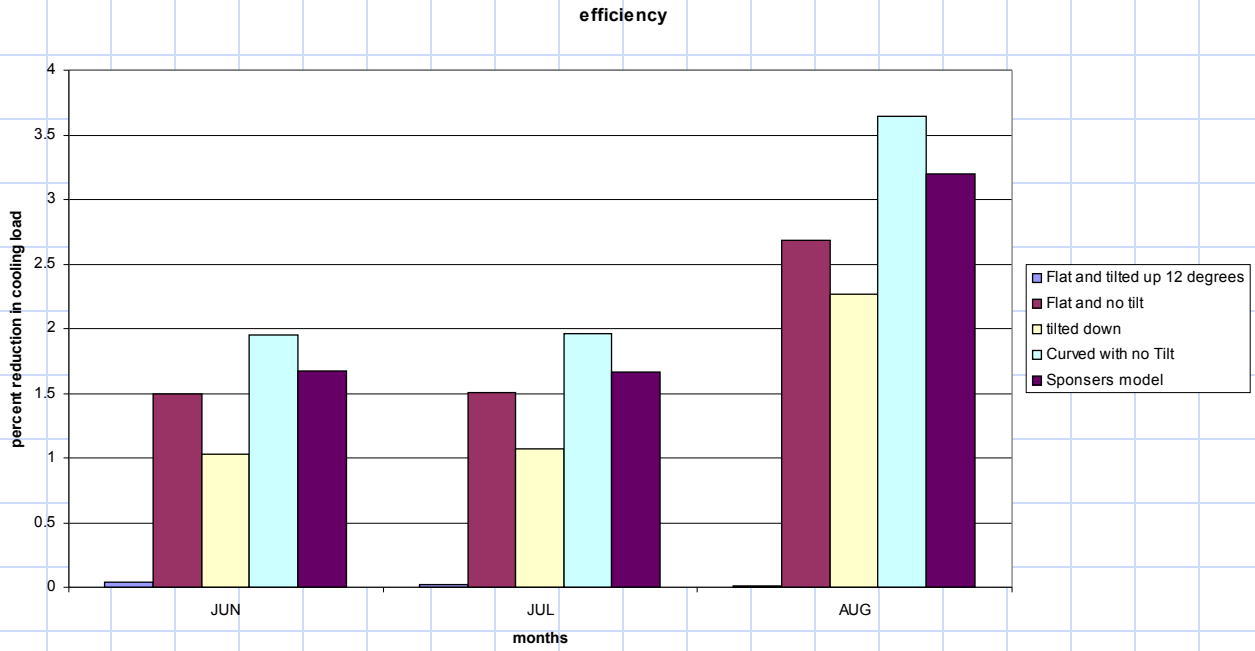
Awning Effect on cooling load (MBTU)



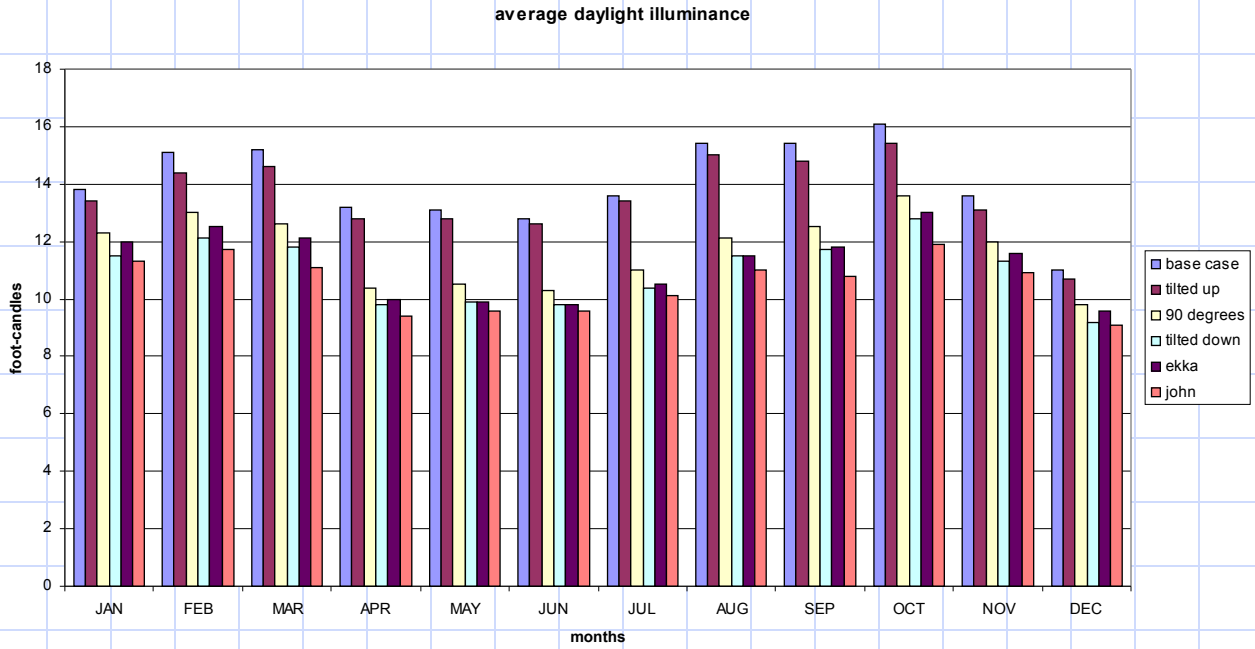
Comparison of Awnings on cooling load (MBTU)



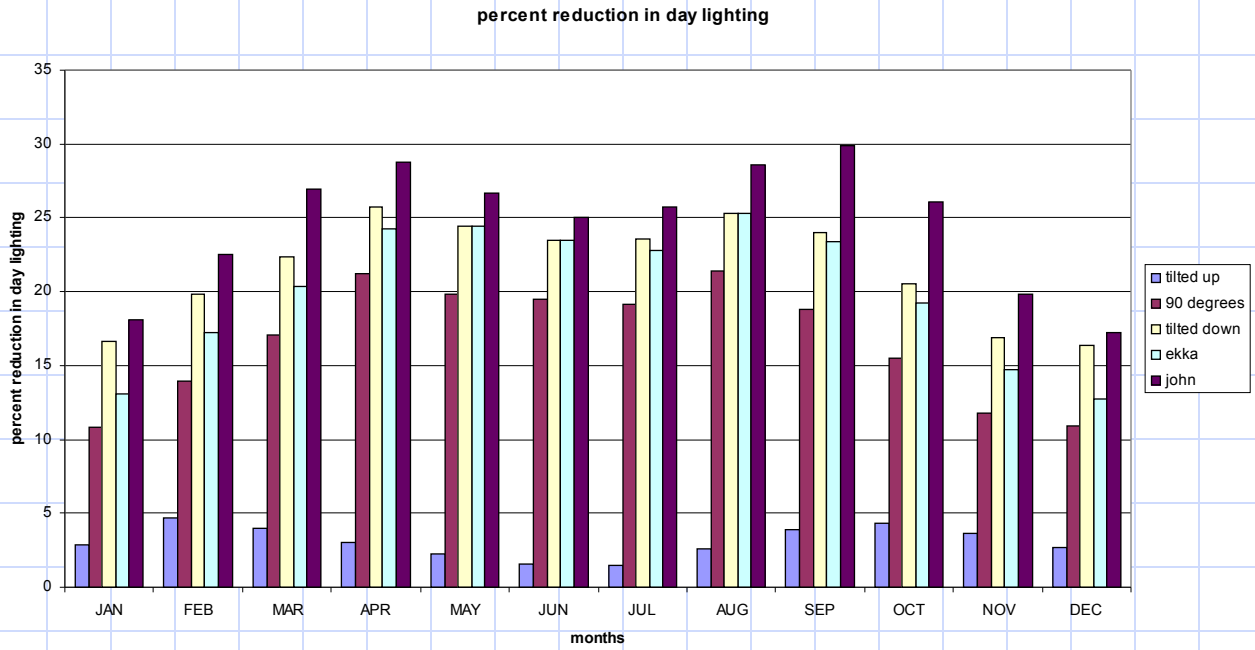
Efficiency of Awnings



Average Day Lighting



Percent Reduction in Day Lighting



Conclusion

- Inexpensive, simple design, cheap material.
- Achieved Energy savings
- Minimal decrease in Day Lighting
- Research involved only South windows
- Further research in Awnings for East-West Windows

Our Thanks...

- John Poterfield
- Ray
- Pong
- Ekka