York Center Church of the Brethren
Heating Loss and Impact of Insulation Upgrade

Ceiling

Estimate of heat loss through uninsulated ceiling of York Center

Heat loss in Btu/hr = Area x (Tin –Tout, deg F)/ R-value
(Ref: http://yccob.org/Green/HomeHeatingEnergy.pdf)

R for wood is 1.25 per inch
R for shingles is 0.44
(Ref: http://yccob.org/Green/R-ValueTable.pdf)
The ceiling has a 2 inch wood decking with asphalt shingles:
R = 1.25 x 2 + 0.44 = ~ 3

Roof area ~ 2500 sq ft

For one heating degree-day, (Tin –Tout, deg F) =1
Heat Loss 2500 x 1 x 24 hr/3 = 20,000 Btu/heating-degree day

Chicago has ~ 6000 heating-degree days per year
(Ref: http://yccob.org/Green/ChiHeatDegDays.pdf)

Heat loss per year ~ 20,000 x 6000 = 120,000,000 Btu = 1200 therm (100,000 Btu = 1 therm)

Assuming a heating efficiency of 40% [60%], annual therms to replace the heat loss:
1200/.4 = 3000 [2000]therms

In 2008, the church used a total of 6400 therms at a cost of $6,620, or ~ $1 per therm,
So annual cost to replace the heat loss through the ceiling is ~$3000 [$2000].

Estimate of adding R-14 insulation with air gap and plywood cover to the current roof
R new = (2 inch decking, R = 2.5) + (Insulation w/air gap and 7/16 inch OSB, R = 14) +
(Shingles, R = 0.44)
= ~ 17
Or approximately 6 times higher R value, which reduces the therm heat loss and cost
by a factor of 6 to 3000 [2000]/6 = 500 [333] therms, $3000 [$2000]/6 =$500 [$333]:

Savings: 3000-500 [2000-333]= 2500 [1667] therms with value of $2,500 [$1,667]

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*6000 heating-degree days is for a base of 60 deg F. For inside heating to 70 deg F, the heating degree-days is larger.

Windows

Estimate of annual saving in energy and cost by replacing current windows/storms with high efficiency double pane windows:

The R-value goes from ~2 to ~ 3

Using a similar calculation that was used for the roof:
Area for a single window = 15 sq ft

Loss heating per degree-day (current) = 15 x 1 x 24 hr/2 = 180 Btu/Heating-degree day

Heat loss per year ~ 180 x 6000 *= 1,080,000 Btu = 10.8 therm

Assuming a heating efficiency of 40% [60%], annual therms to replace the heat loss:
10.8/.4 [.6] = 27 [17.7]therms, or $27 [$17.67]/yr per window per year
(27 [17.7]/15 = 1.8 [1.2] therms, $1.80 [$1.20] per sq ft of windows)

With the double pane windows with R = 3:
Heat loss per year ~ 120 x 6000 = 720,000 Btu = 7.2 therm

Assuming a heating efficiency of 40% [60%], annual therms to replace the heat loss:
7.2/.4 [.6] = 18 [12] therms, or $18 [$12] /yr per window per year

Savings per window: 27-18 [17.7 – 12] = 9 [6] therms with value of $9 [$6]
(Savings per sq ft of window: 9 [6]/15 = 0.6 therm, $0.60 [$0.40] per sq ft)

Total for church.: Estimate 1250 sq ft of windows
Assuming a heating efficiency of 40% [60%], annual therms to replace the heat loss:
1.8 [1.2] x 1250 = 2250 [1500] therms, $2250 [$1500]

Savings with the double pane windows with R = 3:
0.6 [0.4] x 1250 = 750 [500] therms, $600 [$500].

Outer Walls

Current
R = (8 inch concrete block, R 1.11) + (4 inch brick, R = 0.8) + (air gap, R = 1)
= ~ 3

Heating loss per degree-day (current) per sq ft = 1 x 1 x 24 hr/3
= 8 Btu/Heating-degree day/sq ft

Heat loss per year per sq ft ~ 8 x 6000 *= 48,000 Btu = 0.48 therm

Assuming a heating efficiency of 40% [60%], annual therms to replace the heat loss:
(0.48/0.4 [0.6] = 1.2 [0.8] therms, $1.20 [$0.80] per sq ft of wall)

For 3750 sq ft of wall space: 4500 [3000] therms, $4500 [$3000]

Adding (2 inch polystyrene, R = 10) + (0.5 inch air gap, R = 1) + (5/8 inch drywall, R = 0.56):
R added = 11.6, combined with existing concrete and brick (R = 3):
R total = 14.6

Heating loss per degree-day per sq ft = 1 x 1 x 24 hr/14.6
= 1.64 Btu/Heating-degree day/sq ft

Heat loss per year ~ 1.64 x 6000 *= ~ 10,000 Btu = 0.1 therm

Assuming a heating efficiency of 40% [60%], annual therms to replace the heat loss:
(0.1/0.4 [0.6] = .25 [0.167] therms, per sq ft of wall)

For 3750 sq ft of wall space: 940 therms [625], $940 [$625]

Annual savings: 4500 - 940 [3000 – 625] therms = 3560 [2375] therms, $3560 [$2375]

Combined [based on 60% furnace heating efficiency]

Component	Current insulation	Upgrade insulation
Roof	2000	333
Windows	1500	500
Walls	3000	625
Sum	6500	1458 (5042 therm, 78% reduction)

4/29/2009