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1. Using the diagrams given in the presentation calculate how much (%) is the effect of applying different modifications (changing the gas, adding an extra pane, using a low emissivity coating) on the U value with respect to a benchmark case of double layer with air and no coating ? (keep the gap thickenss to be 13 mm)

	U FACTOR	DIFF WITH BENCHMARK	% OF DIFFERENCE
2 Panels -air	2,8 W/m²		
2 Panels -gas	2,6 W/m²	0,2	7,14%
2 Panels -air -film	1,8 W/m²	1	35,71%
2 Panels -gas -film	1,5 W/m²	1,3	46,42%
3 Panels -air	1,8 W/m²	1	35,71%
3 Panels -gas	1,6 W/m²	1,2	42,85%
3 Panels -air -film	1,0 W/m²	1	64,28%
3 Panels -gas -film	0,75 W/m²	2,05	73,21%

2. Consider the house that we analysed in the alst two examples, calculate the heating and cooling load of the other windows which are fixed 14.4 m2 on the west, fixed 3.6 m2 on the south and an operable 3.6 m2 on the south (the same window and frame type). How much does the total value change if I change the frame of the window from wooden one to aluminium ?

1 West Fixed Wooden Cooling

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR)$$
$$= 2.84 \ (7.9 - 0.46 * 11.9)$$
$$= 6.9 \ W/m^2$$

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR) + PXI * SHGC * IAC * FFs$$

$PXI = ED + Ed$ $SHGC = 0.54$ $IAC = 1$ $FFs = 0.56$
$$= 559 + 188$$
$$= 747$$

$$CFwindow = 6.9 * 747 * 0.54 * 1 * 0.56$$
$$= 224.72$$

$$WindowWest = CFwindow * Awindowwest$$
$$= 224.72 * 14.4$$
$$= 3235.96 \ W$$

2 West Fixed Aluminium Cooling

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR)$$
$$= 3.61 \ (7.9 - 0.46 * 11.9)$$
$$= 8.75 \ W/m^2$$

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR) + PXI * SHGC * IAC * FFs$$

$PXI = ED + Ed$ $SHGC = 0.56$ $IAC = 1$ $FFs = 0.56$
$$= 559 + 188$$
$$= 747$$

$$CFwindow = 8.75 + (\ 747 * 0.56 * 1 * 0.56)$$
$$= 243 \ W/m^2$$

$$WindowWest = CFwindow * Awindowwest$$
$$= 243 * 14.4$$
$$= 3499.33W$$

3 West Fixed Wooden Heating

$$HFwindowWest = UwindowWest + T \ Heating$$
$$= 2.84 + 24.8$$
$$= 70.4 \ W/m^2$$

$$QwindowWest = HFwindowWest + AwindowWest$$
$$= 70.4 * 14.4$$
$$= 1014,2 \ W/m^2$$

4 West Fixed Aluminium Heating

$$HFwindowWest = UwindowWest + T\ Heating$$
$$= 3.61 + 24.8$$
$$= 89.5\ W/m^2$$

$$QwindowWest = HFwindowWest + AwindowWest$$
$$= 89.5 * 14.4$$
$$= 1289\ W$$

1 South Fixed Wooden Cooling

$$CFwindow = Uwindow\ (T\ Cooling - 0.46DR)$$
$$= 2.84\ (7.9 - 0.46 * 11.9)$$
$$= 6.9\ W/m^2$$

$$CFwindow = Uwindow\ (T\ Cooling - 0.46DR) + PXI * SHGC * IAC * FFs$$

$$PXI = ED + Ed \qquad SHGC = 0.54 \qquad IAC = 1 \qquad FFs = 0.47$$
$$= 348 + 209$$
$$= 557$$

$$CFwindow = 6.9 + (557 * 0.54 * 1 * 0.47)$$
$$= 148.26\ W/m^2$$

$$WindowWest = CFwindow * Awindowwest$$
$$= 148.26 * 3.6$$
$$= 533.73W$$

2 South Fixed aluminium cooling

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR)$$
$$= 3.61(7.9 - 0.46 * 11.9)$$
$$= 8.75 W/m^2$$

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR) + PXI * SHGC * IAC * FFs$$

$$PXI = ED + Ed \qquad SHGC = 0.56 \qquad IAC = 1 \qquad FFs = 0.47$$
$$= 348 + 209$$
$$= 557$$

$$CFwindow = 8.75 + (\ 557 \ * 0.56 * 1 * 0.47)$$
$$= 155.35 W/m^2$$

$$WindowWest = CFwindow * Awindowwest$$
$$= 155.35 * 3.6$$
$$= 559.2 W$$

3 South Fixed wooden heating

$$HFwindowSouth = UwindowSouth * T \ Heating$$
$$= 2.84 * 24.8$$
$$= 70.4 \ W/m^2$$

$$QwindowSouth = HFwindowSouth + AwindowSouth$$
$$= 70.4 * 3.6$$
$$= 253.4 \ W$$

4 South Fixed aluminium heating

$$HFwindowSouth = UwindowSouth * T \ Heating$$
$$= 3.61 * 24.8$$
$$= 89.5 \ W/m^2$$

$$QwindowSouth = HFwindowSouth + AwindowSouth$$
$$= 89.5 * 3.6$$
$$= 322.3 \ W$$

1 South Fixed Wooden Cooling

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR)$$
$$= 2.87 \ (7.9 - 0.46 * 11.9)$$
$$= 6.96 \ W/m^2$$

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR) + PXI *SHGC * IAC *FFs$$

$$PXI = ED + Ed \qquad SHGC = 0.46 \qquad IAC = 1 \qquad FFs = 0.47$$
$$= 348 + 209$$
$$= 557$$

$$CFwindow = 6.96 + (\ 557 \ * 0.46 * 1 * 0.47)$$
$$= 127.38 \ W/m^2$$

$$WindowSouth = CFwindow * AwindowSouth$$
$$= 127.38 * 3.6$$
$$= 458.58W$$

2 South Operable Aluminium Cooling

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR)$$
$$= 4.62 \ (7.9 - 0.46 * 11.9)$$
$$= 11.2W/m^2$$

$$CFwindow = Uwindow \ (T \ Cooling - 0.46DR) + PXI *SHGC * IAC *FFs$$

$$PXI = ED + Ed \qquad SHGC = 0.55 \qquad IAC = 1 \qquad FFs = 0.47$$
$$= 348 + 209$$
$$= 557$$

$$CFwindow = 11.2 + (\ 557 \ * 0.55 * 1 * 0.47)$$
$$= 155.18 \ W/m^2$$

$$WindowSouth = CFwindow * AwindowSouth$$
$$= 155.18 * 3.6$$
$$= 558.66W$$

3 South Operable Wooden Heating

$$HFwindowSouth = UwindowSouth \ *T \ Heating$$
$$= 2.87 * 24.8$$
$$= 71.17 \ W/m^2$$

$$QwindowSouth = HFwindowSouth \ + AwindowSouth$$
$$= 71.17 * 3.6$$
$$= 256.2 \ W$$

4 South Operable aluminium Heating

$HFwindowSouth = UwindowSouth *T\ Heating$

$=4.62* 24.8$

$=114.57\ W/m^2$

$QwindowSouth = HFwindowSouth\ + AwindowSouth$

$= 114.57* 3.6$

$= 412.45\ W$