

2050

Social Justice

Community

Innovation

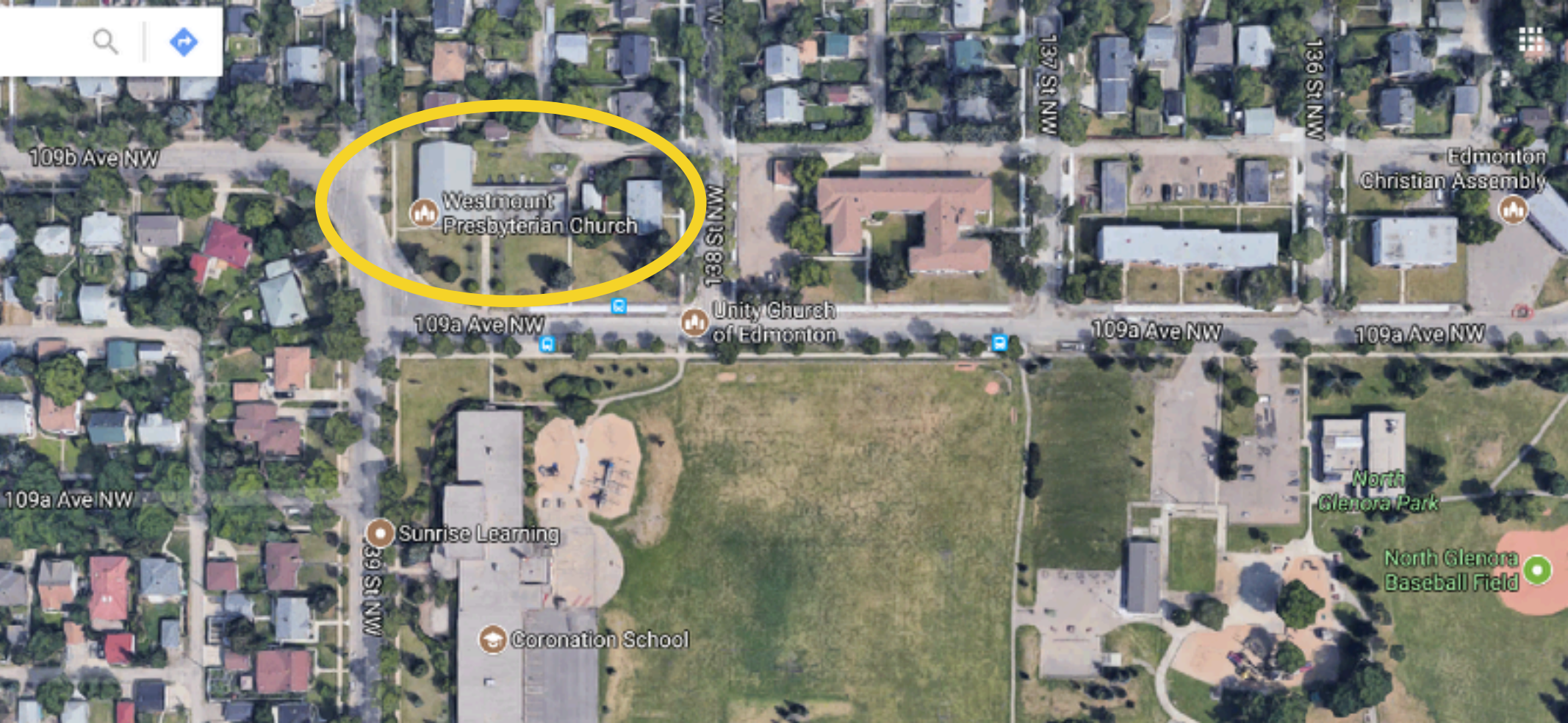
Building Science

Climate

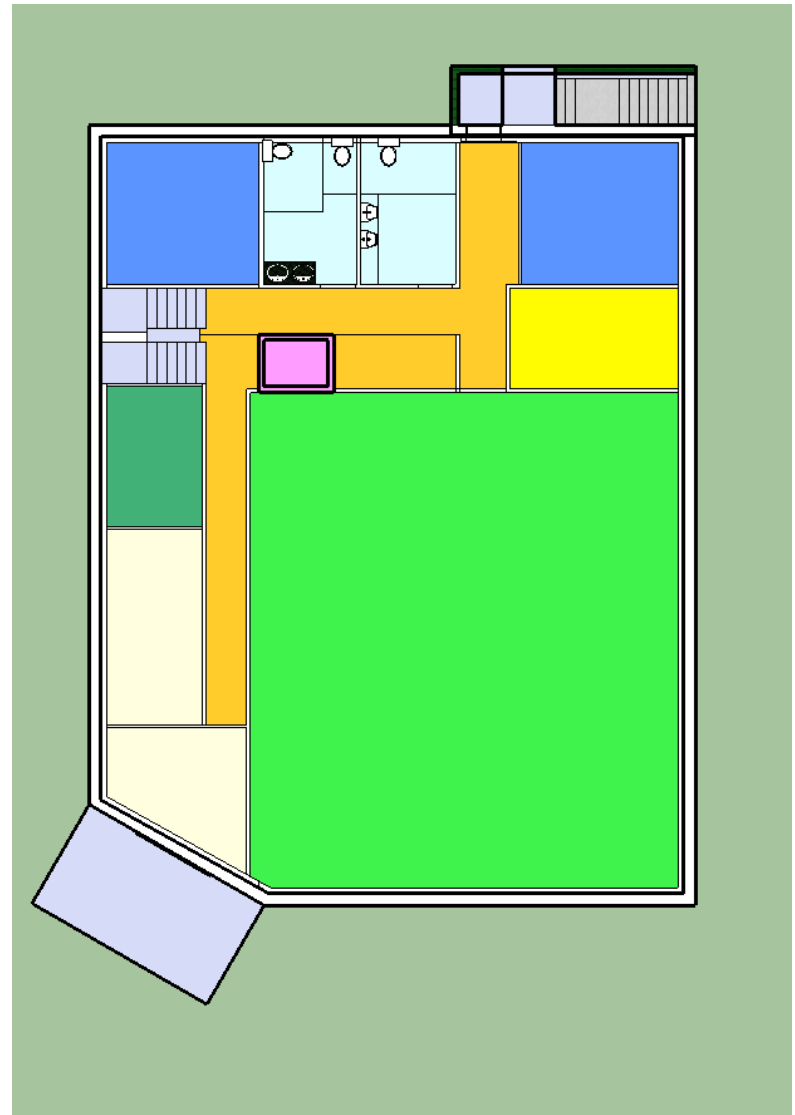
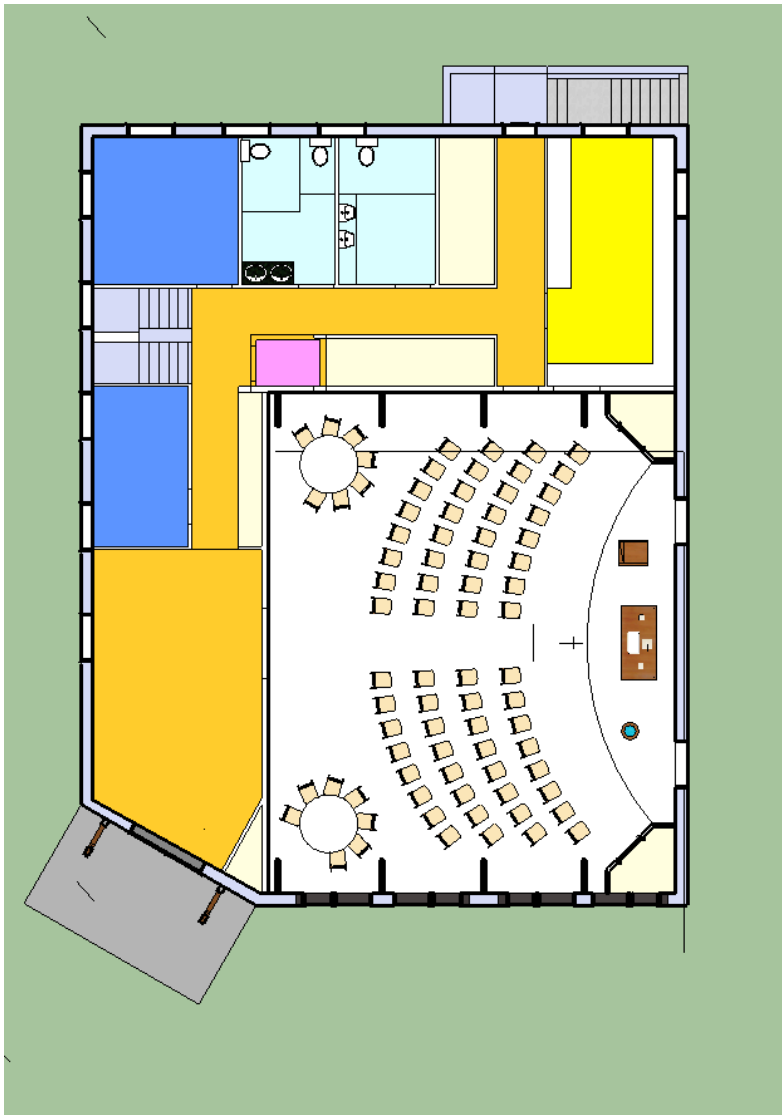


HABITAT
studio

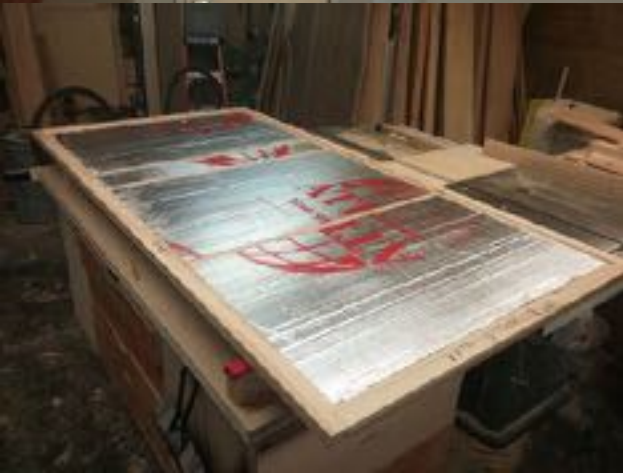
Building your vision





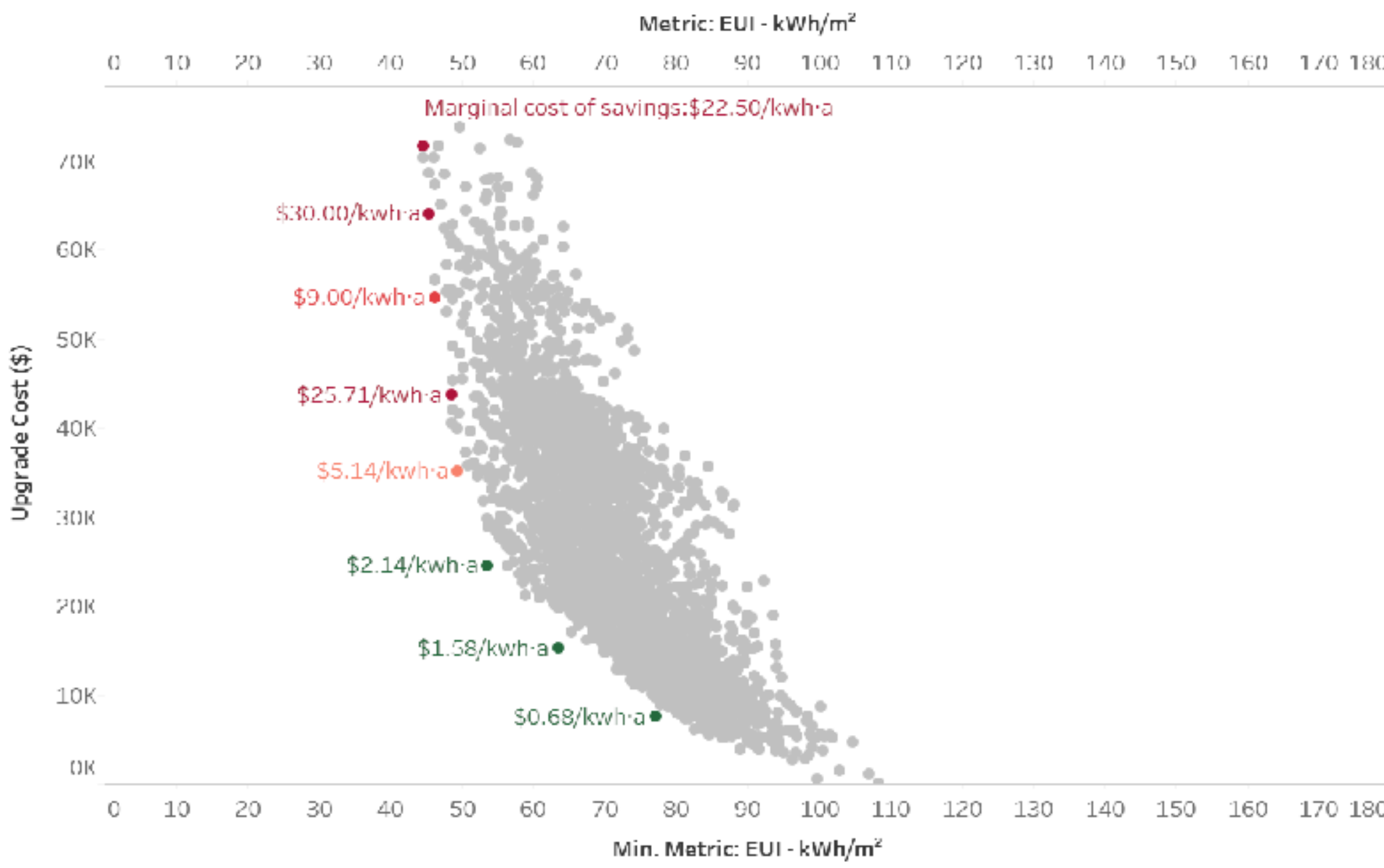






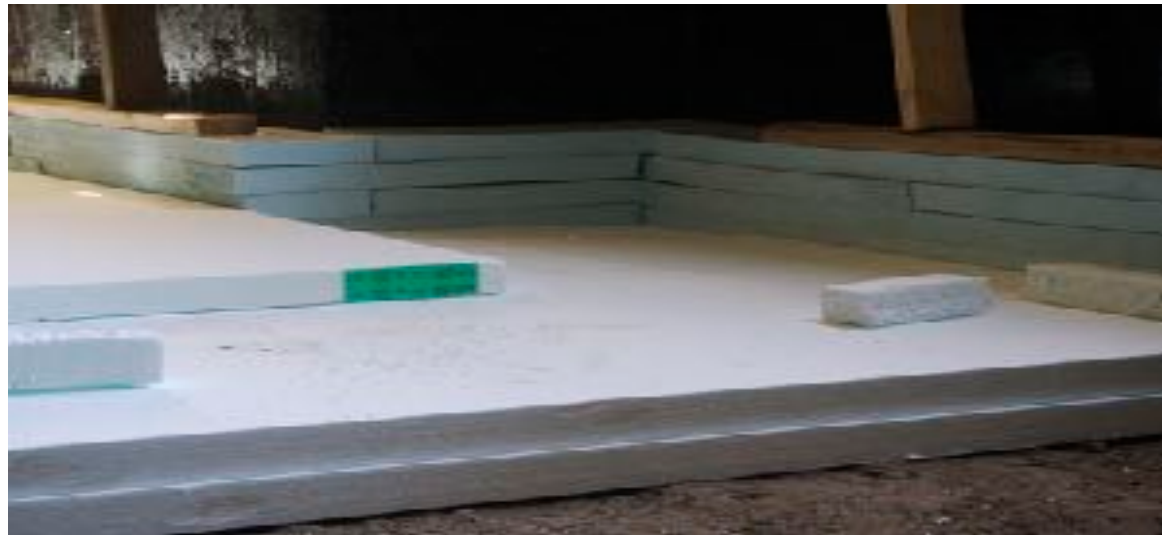
How much insulation is enough?

Marginal Cost of Energy Savings: Vancouver, BC



Cost of Church Underslab Insulation Increments

<u>SLAB INSULATION</u>	R16	R16 - R24	R24 - R40	R40 - R56	R56 - R64	R16 - R64
Heat loss -kWh/m ² /A *	28	24.8	22.1	20.6	20.1	20.1
Energy Saving of Increment kWh/A	0*	1672.32	1411.02	783.9	261.3	4128
Cost of Increment		\$3,210.00	\$6,420.00	\$6,420.00	\$3,210.00	\$19260
Cost/kWh/A of Increment		\$1.92	\$4.55	\$8.19	\$12.28	\$4.67



* From PHPP9 using the 'Variants' function

** Based on Edmonton Climate ~ 9000°F HDD
 PHIUS + HD target 9.4 kBTU/ft²/A or 29.6kWh/m²/A

Church Envelope adjusted to ~PHI - Heating Demand

	Marginal Cost/ kWh/m² of last step to reach 28	From: AS BUILT 28kWh/m²/A Heating Demand 8.9kBTU/sf/A	To: ~PHI 15kWh/m²/A Heating Demand 4.75kBTU/sf/A	Saving kWh/A	Marginal Cost of ~PHIUS+ to ~PHI	Marginal Cost/ kWh/m² of ~PHIUS+ to ~PHI	Marginal Cost/ kWh/m² of Last Increment
Under Slab Insulation	0	4" Type 2 EPS/ R16	16" Type 2 EPS	2167	\$19,260.00	\$4.67*	\$12.28
Below Grade Foundation Walls	\$1.77	4" EPS + R22 Roxul /R35	8" EPS + R28 Roxul / R57		\$5,270.00	\$6.35	\$12.84
Above Grade Walls **	\$4.03	12" Double 2x4 cellulose/ R44	16" Double 2x4 w 2x4 chase/ R72		\$16,564.00	\$16.12	\$14.65
Attic	\$2.12	R80 cellulose	R110 cellulose		\$2,712.00	\$3.05	\$3.46
Windows	~\$5.50	Fibreglass	PHI Certified PVC		\$10,956.52	\$23.29	\$23.29
Air Tightness*	0	0.6 ACH50	0.4 ACH 50		\$1,959.75	\$2.50	\$2.50
HRV*	\$3.96	84%	92%		\$10870.08	\$8.00	\$8.00

PHIUS+ for Edmonton : 9.4KBTU/ft²/A or 29.7kWh/ m²/A

TFA = 522 m² (5624 ft²)
iCFA = 548 m² (5896 ft²)

Townhouse Envelope adjusted to ~PHI - Heating Demand

	Marginal Cost/ kWh/m² of last step to reach <u>AS BUILT</u>	From: 15.9kWh/m²/ A Heating Demand 5.0kBTU/sf/A <u>AS BUILT</u>	To: 15kWh/ m²/A Heating Demand 4.75kBTU/sf/ A (~PHI)	Saving kWh/A	Marginal Cost of AS BUILT to ~PHI	Marginal Cost/ kWh/ m² of AS BUILT	Marginal Cost/ kWh/m² of Last Increment
Under Slab Insulation	0	4" Type 2 EPS/ R16	6" Type 2 EPS	2167	\$6,519.00	\$3.01*	\$3.01
Below Grade Foundation	\$1.77	4" EPS + R22 Roxul /R35	4" EPS + R22 Roxul /R35		0		
Above Grade Walls *	\$4.03	12" Double 2x4 cellulose/ R44	12" Double 2x4 cellulose/ R44		0		
Attic	\$2.12	R80 cellulose	R80 cellulose		0		
Windows	~\$5.50	Fibreglass	Fibreglass		0		
Air Tightness*	0	0.75ACH50	0.6 ACH50	2167	~\$1000	~\$0.50	~\$0.50
HRV*	\$3.96	92%	92%		0		

TFA = 2167 m² (23426 ft²)

Townhouse Envelope adjusted to ~PHIUS+ Minimum - Heating Demand

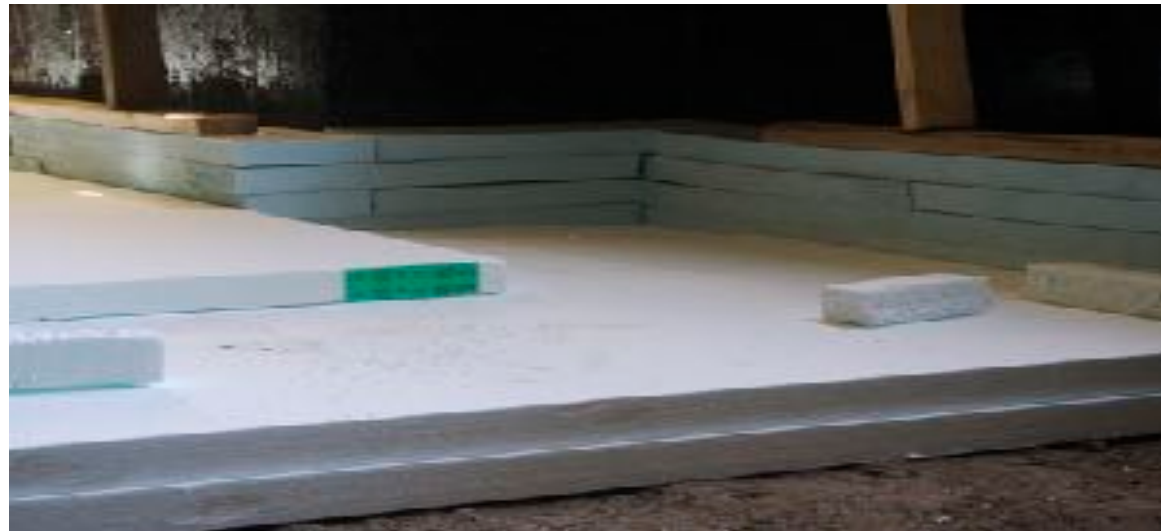
	Marginal Cost/kWh/m² of last step to reach <u>AS BUILT</u>	From: 15.9kWh/m²/A Heating Demand 5.0kBTU/sf/A <u>AS BUILT</u>	To: 27.2kWh/m²/A Heating Demand 8.6kBTU/sf/A PHIUS+ Minimum	Marginal Cost SAVING of AS BUILT to ~PHIUS+	Marginal Cost SAVING per kWh/m² of AS BUILT to min PHIUS+
Under Slab Insulation	0	4" Type 2 EPS/ R16	4" Type 2 EPS/ R16	0	0
Below Grade Foundation Walls	\$1.77	4" EPS + R22 Roxul / R35	2" EPS + R14 Roxul /R20	\$3015	\$0.95
Above Grade Walls *	\$4.03	12" Double 2x4 cellulose/ R44	2x6 Roxul + 2" EPS	\$38938	\$4.38
Attic	\$2.12	R80 cellulose	R60 cellulose	\$3670	\$2.12
Windows	~\$5.50	Fibreglass	Fibreglass	0	0
Air Tightness*	0	0.6 ACH50	0.6 ACH50	0	0
HRV*	\$2.64	92%	75%	\$28,000	\$2.64

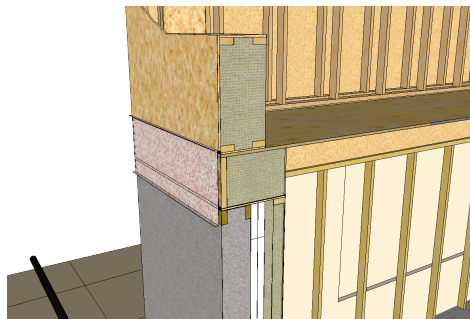
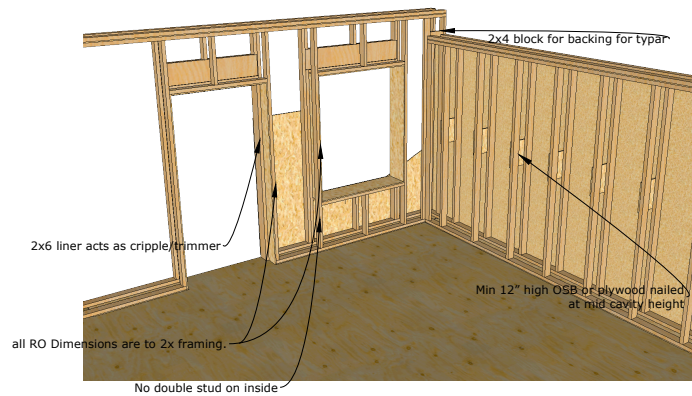
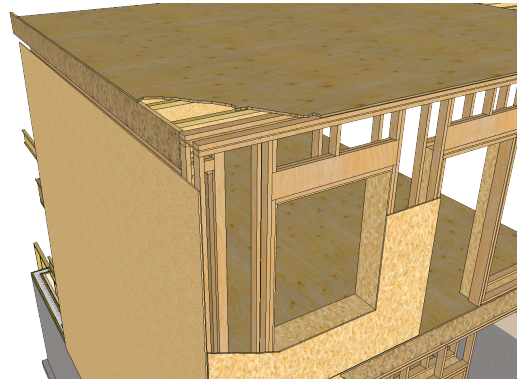
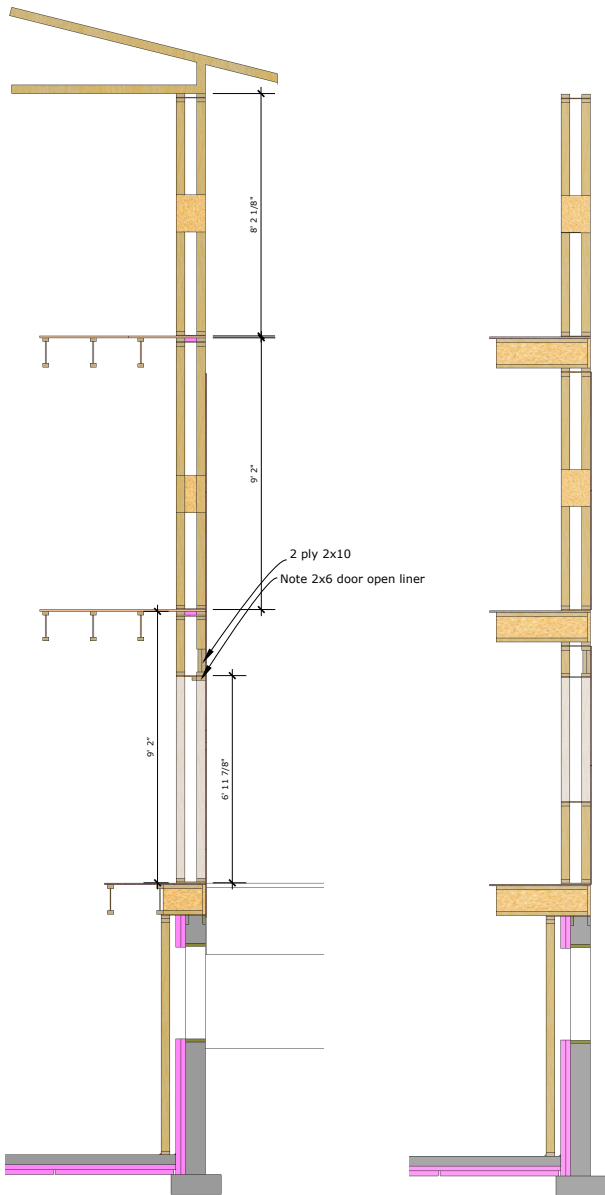
TFA = 2167 m² (23426 ft²)

If it is reasonable to spend \$2.00 to save one kWh/year (year in and year out) anywhere in the system, why wouldn't you do it everywhere no matter what standard you have reached?

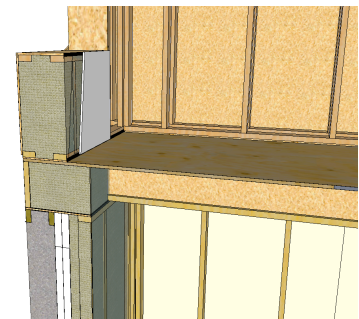
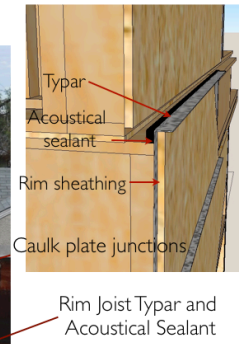
Cost of Church Under Slab Insulation Increments (Vancouver)

<u>SLAB INSULATION</u>	R16	R16 - R24	R24 - R40	R40 - R56	R56 - R64	R16 - R64
Heat loss -kWh/m ² /A *	28	24.8	22.1	20.6	20.1	20.1
Energy Saving of Increment (Edmonton)	0*	1672.32	1411.02	783.9	261.3	4128
Energy Saving of Increment (Vancouver)		1003.392	846.612	470.34	156.78	2477.124
Cost of Increment		\$3,210.00	\$6,420.00	\$6,420.00	\$3,210.00	\$19260
Cost-/kWh/m ² /A of Increment (Edmonton)		\$1.92	\$4.55	\$8.19	\$12.28	\$4.67
Cost-/kWh/m ² /A of Increment (Vancouver)		\$3.20	\$7.58	\$13.65	\$20.47	\$7.78





Rim Joist Seal Application



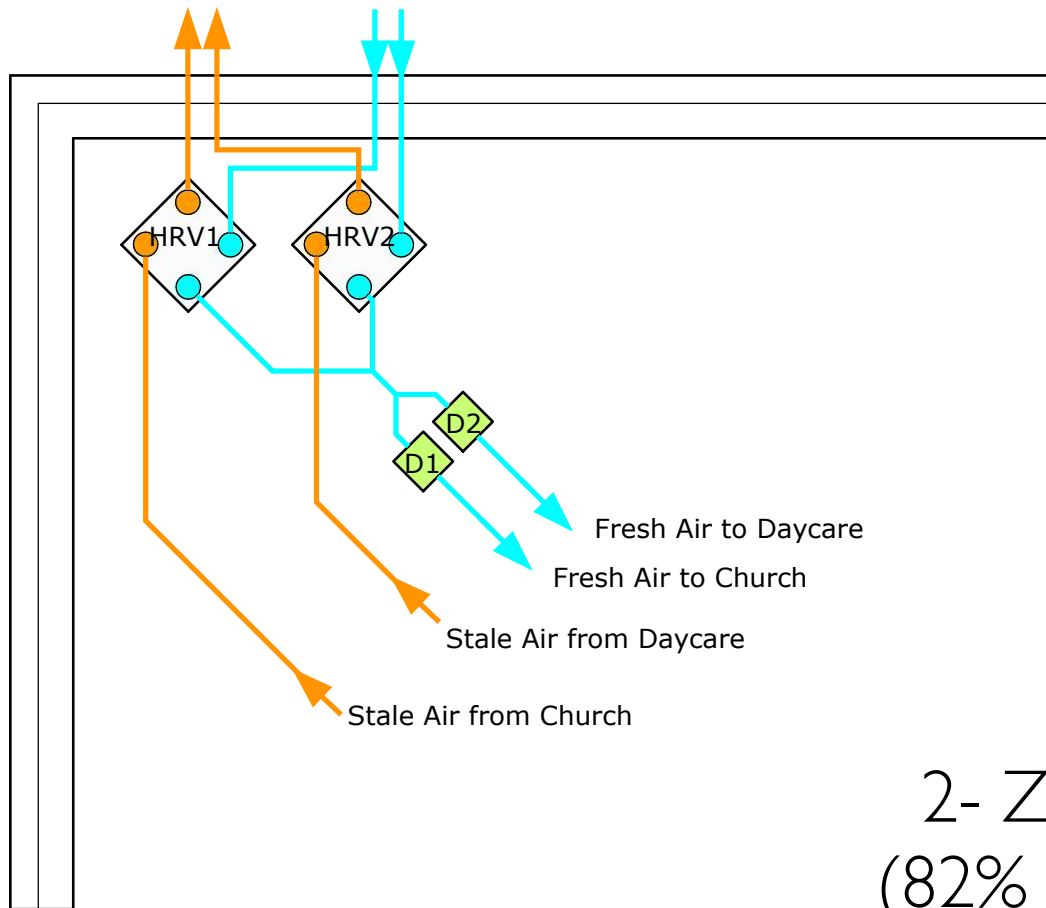
Air Tightness

Townhouses- .075ACH 50 (.08 cfm/ft²) : @#%#&*@#\$

Church - ??



Church Ventilation



2- Zehnder ComfoAir 550's
(82% recovery) installed so that
they supply either the church or
the daycare or both

Site Net Zero Balance

	HOT 2000	PHPP	IES
Housing		kWh/A	
Annual Heating Demand	37542	42327	35635
Annual Cooling Demand	5100	10033	5540
Annual DHW	48278	26267	42773
Lighting, Appliances, and Misc Electrical	81048	50813	81048
Housing Total Annual Energy w/o COP	171968	129440	164996
Housing Total Annual Energy w/ COP	112520	75090	109736
Saving from Geo system	59448	54350	55261
Church			
Annual Heating Demand	12690	14616	20763
Annual Cooling Demand	6560	8954	3814
Annual DHW	5500	9233	5347
Lighting, Appliances, and Misc Electrical .	10240	12009	10240
Church Total Annual Energy w/o COP	34990	44812	40164
Church Total Annual Energy w/ COP	17233	21500	19025
Saving from Geothermal Sytem	17757	23312	21138
Total site energy	129753	96590	128761
Predicted Output from 118,000 Watts of installed PW		135000	

Geothermal system

- System cost increment ~\$225,000
- Annual energy saving 76,000 kWh/A
- Cost per Kilowatt / hour/ year- \$2.96



Geothermal Efficacy

	Annual Demand per IES	C.O.P. (annual)	Demand after Geo	Geo Saving
Housing	kWh/A		kWh/A	kWh/A
Annual Heating Demand	35635	3.5	10181	25454
Annual Cooling Demand	5540	6.1	908	4632
Annual DHW	42773	2	17822	24951
Lighting, Appliances, and Misc Electrical	81048	1	81048	0
Housing Total Annual Energy w/o Geo COP	164996			
Housing Total Annual Energy w Geo COP			109960	
Saving from Geo system				55036
Church				
Annual Heating Demand	20763	3.5	5932	14831
Annual Cooling Demand	3814	6.1	625	3189
Annual DHW	5347	2	2228	3119
Lighting, Appliances, and Misc Electrical .	10240	1	10240	0
Church Total Annual Energy w/o COP	40164			
Church Total Annual Energy w/ COP	19025		19025	
Saving from Geothermal System	21138			21138
Total site energy	205160		128985	
Total Savings from Geo				76175
Predicted Output from 118,000 Watts of installed PW	135000			

Net Zero

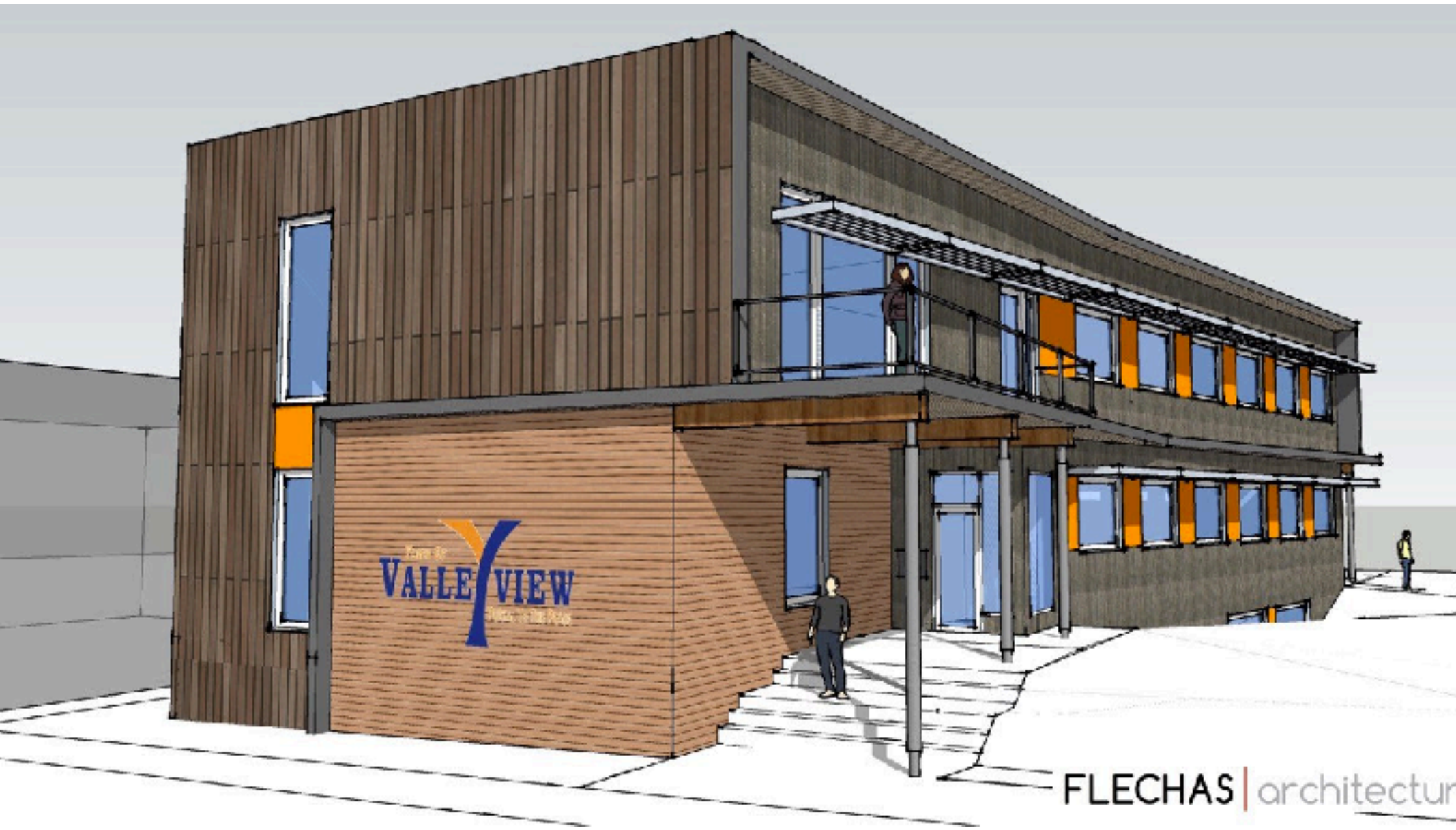
Cooling

- Driving annual heating down demand increases cooling demand
- The church exceeds the PHIUS+ cooling demand limit
- Mini district energy system



Cooling Demand

	Annual Demand per IES	Area Based	Demand after Geo	Area Based
Housing	kWh/A	kWh/m ² /A	kWh/A	kWh/m ² /A
Annual Heating Demand	35635		10181	
Annual Cooling Demand	5540	2.45	908	0.40
Annual DHW	42773		17922	
Lighting, Appliances, and Misc Electrical	81048		81048	
Housing Total Annual Energy w/o Geo CC	0.8 kBTU/ft²			
Housing Total Annual Energy w Geo COP			110059	
Saving from Geo system				
Church				
Annual Heating Demand	20763		5932	
Annual Cooling Demand	3814	7.31	625	1.20
Annual DHW	5347		2228	
Lighting, Appliances, and Misc Electrical .	10240		10240	
Church Total Annual Energy w/o COP	2.3 kBTU/ft²			
Church Total Annual Energy w/ COP			129084	
Saving from Geothermal Sytem	21138			
Total site energy	205160		129084	
Total Savings from Geo				
Predicted Output from 118,000 Watts of installed PW	135000			



Center for
VALLE VIEW
Center for the Arts

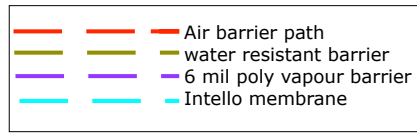
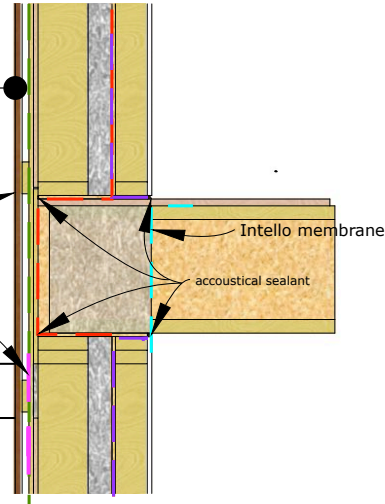
FLECHAS | architecture

vertical siding
 rainscreen cavity
 vapour open, water resistant barrier
 12mm plywood
 2x6 600mm OC bearing wall
 800mm cellulose
 10mm OSB
 6Mil poly vapour barrier
 2x4 service cavity with R14 Roxul

1x4 for vertical siding

Fibreglass mesh for air escape
 and density inspection

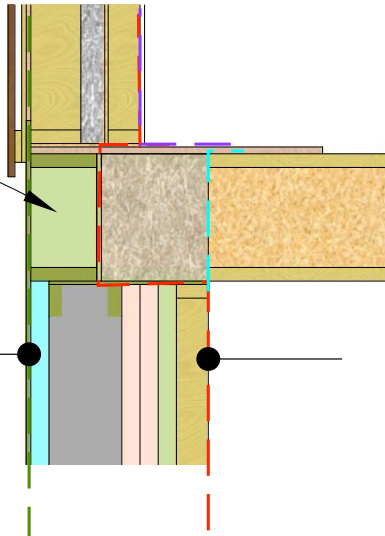
6"



1' 0"

2x8 treated pony wall with R28 Roxul
 (to accommodate varying grade level)

12 mmPWF
 200mm concrete wall
 150mm of XPS or Neopore
 R22 Roxul
 2x4 600mm OC with R14 roxul
 6 Mil poly VB
 12mm GWB

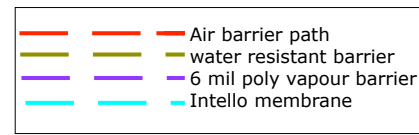
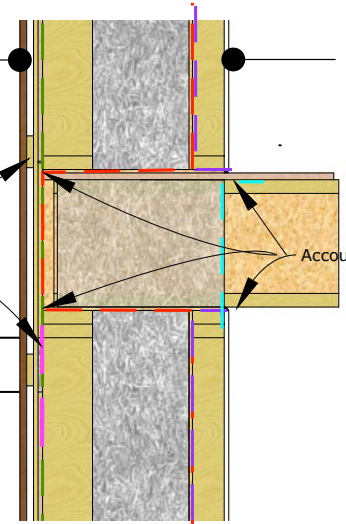


vertical siding
 rainscreen
 vapour open, water resistant barrier
 12mm plywood
 2x6 600mm OC bearing wall
 400mm cellulose
 10mm OSB
 6Mil poly vapour barrier
 2x4 service cavity with R14 roxul

1x4 for vertical siding

Fibreglass mesh for air escape
 and density inspection

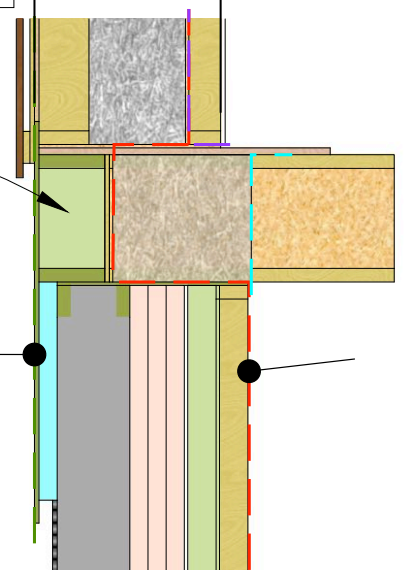
6"



1' 8 1/2"

2x8 treated pony wall with R28 Roxul
 (to accommodate varying grade level)

12 mmPWF
 200mm concrete wall
 150mm of XPS or Neopore
 2x4 600mm OC with R28 roxul
 6 Mil poly VB
 12mm GWB



Valleyview Townhall PHIUS+ Wall Section

Valleyview Townhall PHI Wall Section

Things that might move the sweet spot

- Greened up grid
- Serious carbon pricing
- Cheap abundant zero carbon energy
- High C.O.P heat pumps
- Cheap energy storage

“It's tough to make predictions, especially about the future.”

- Yogi Berra

