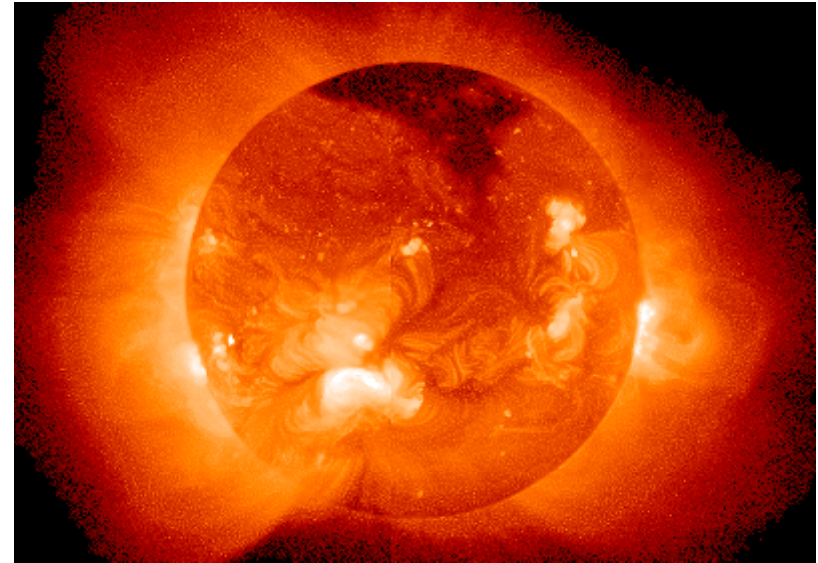

Rendez-vous programme Bâtiments ASHRAE Montréal

Martin Roy, ing. LEED AP
12 décembre 2011



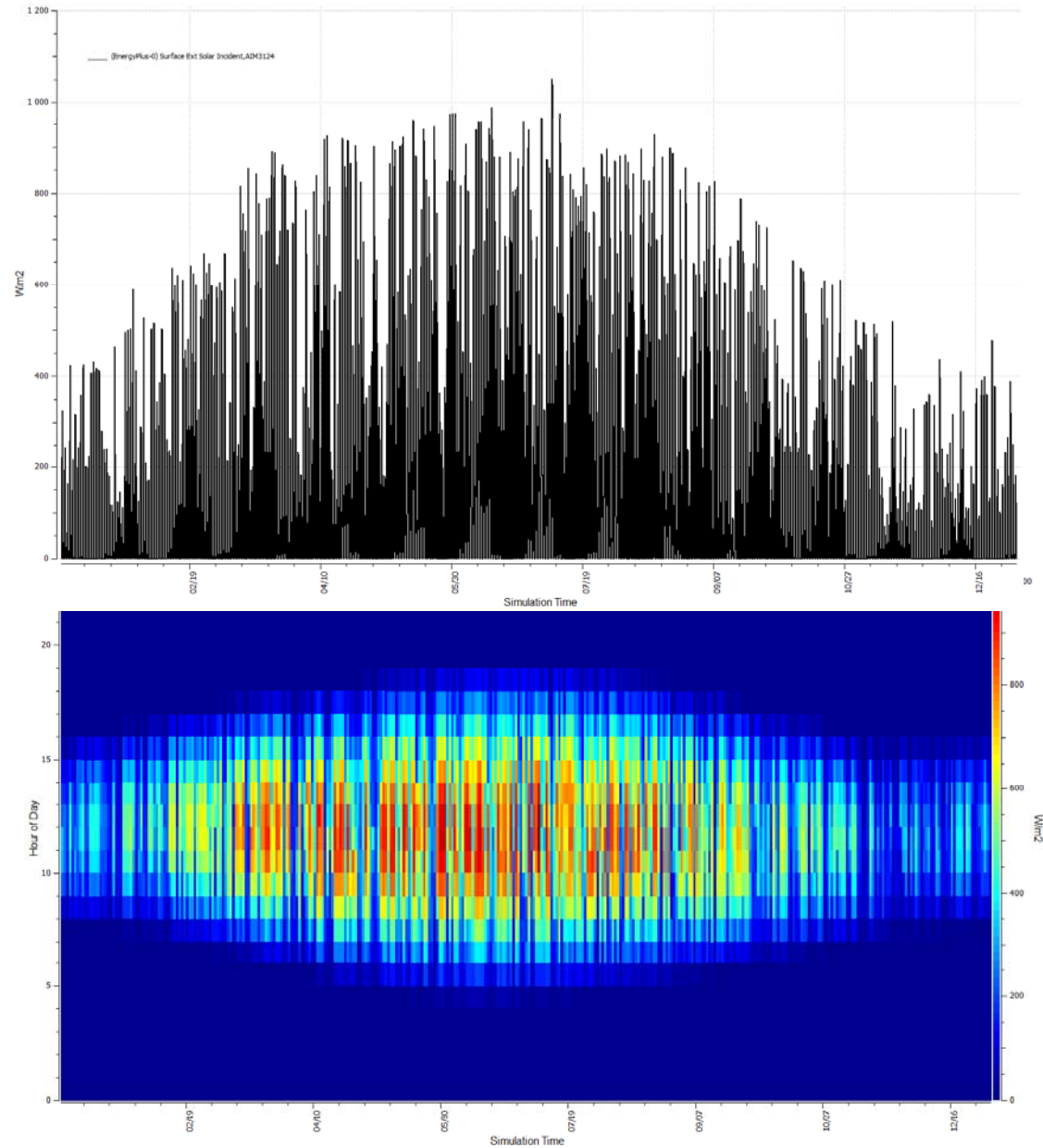
Soleil

- Option Solaire dans le Bâtiment au Québec
 - Solaire Passif
 - Solaire thermique
 - Solaire PV
- Outil de simulation
 - Comfen
 - SolOpt
- Thermopompe assisté de l'énergie solaire



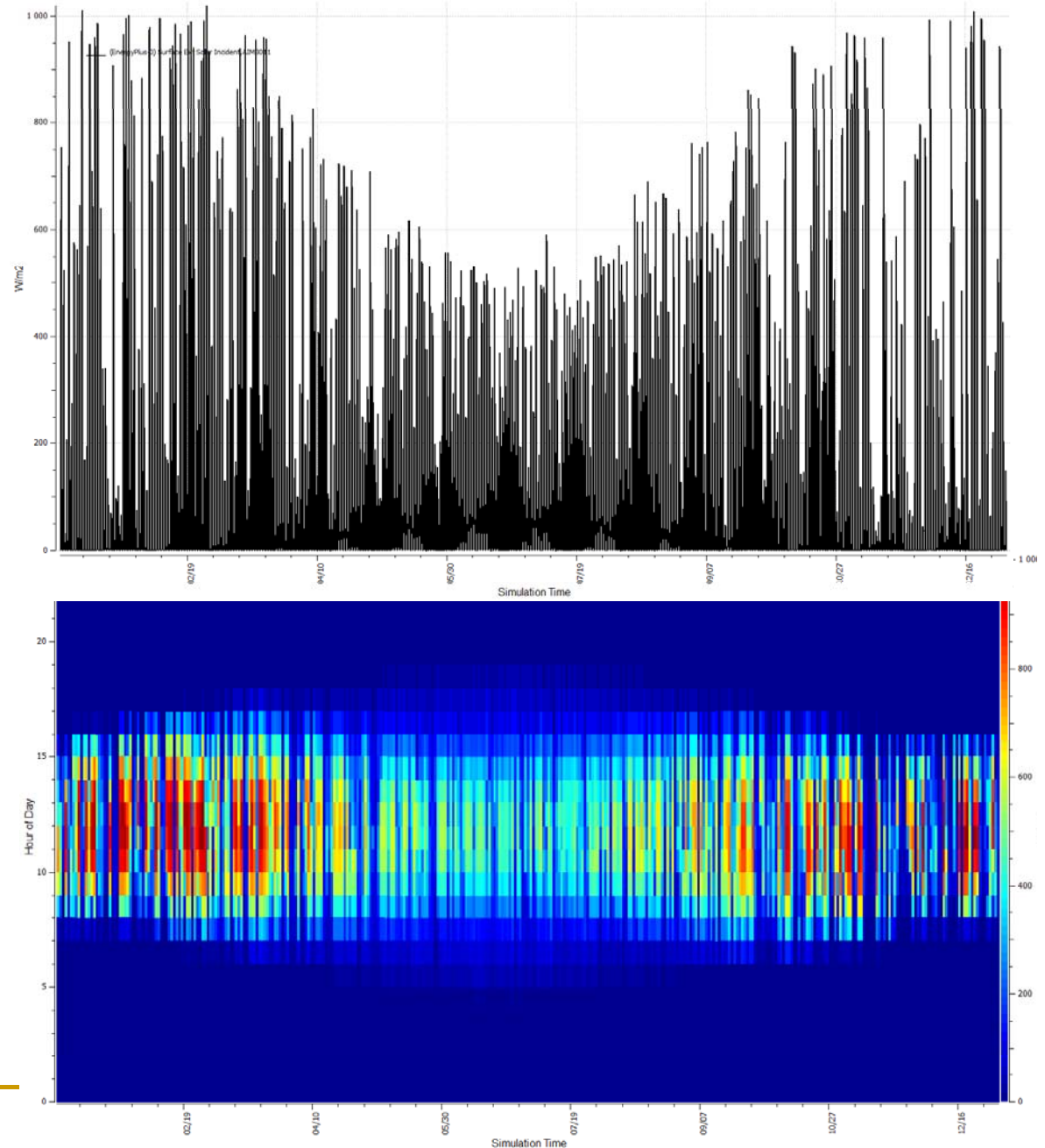
Solaire Passif

- Énergie solaire sur une surface horizontal
- Energy + weather file Montreal



Solaire Passif

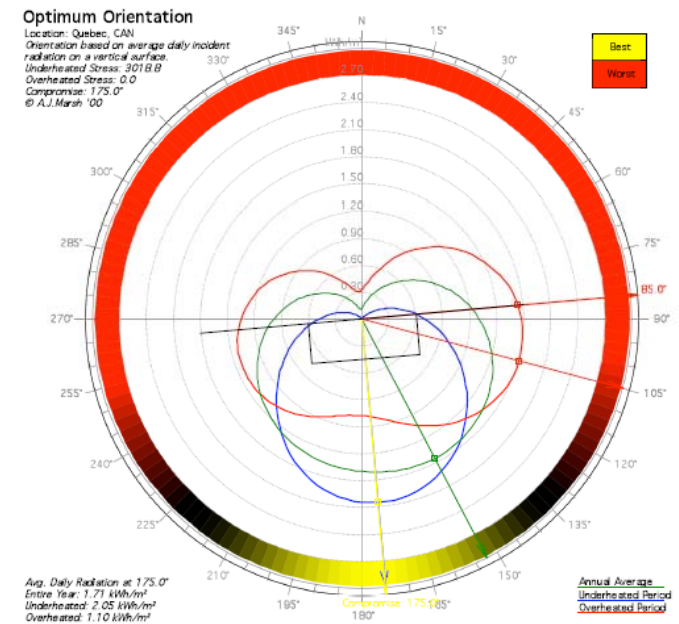
- Radiation sur une surface verticale
- Jusqu'à 1 kW/M2



Solaire Passif

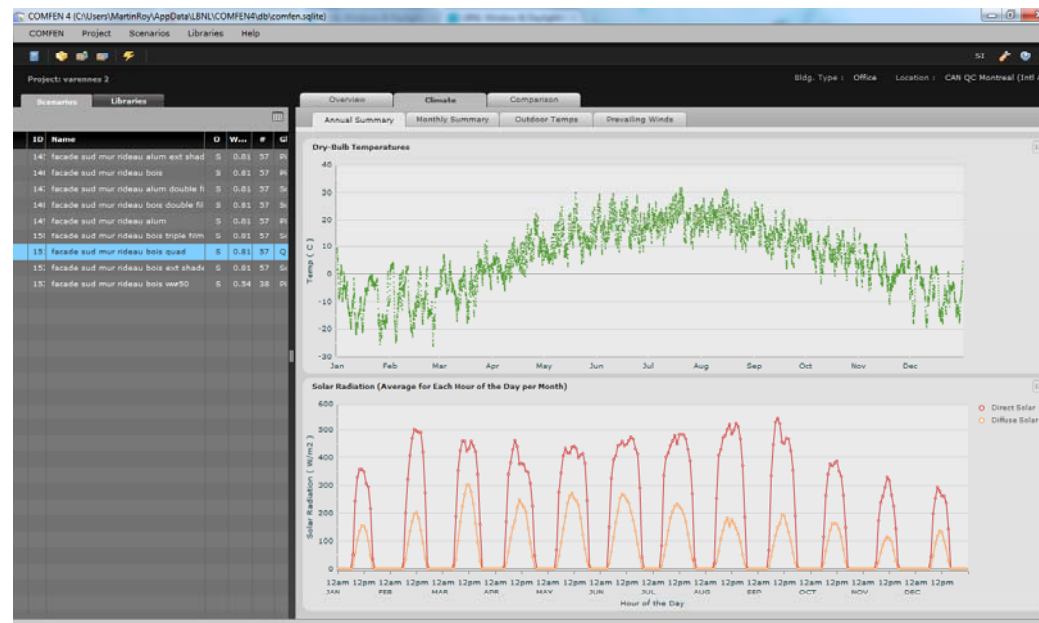


- Favoriser l'orientation pour le captage solaire
- Emmagasiner l'énergie disponible
- Outils disponible
 - Simulation de bâtiment (EE4, DOE2, Equest, Energy +, TRNSYS, etc.)
 - Restscreen
 - Comfen



Comfen 4.0

- Outil de comparaison de façades
- Moteur Energy +
- Inclus Radiance
- Intègre Window 6.0 et Therm 6.0



Comfen 4.0

Project Properties

Project Name: varennes 2

Project Description: test de facade sud

Building type: Office

Vintage: New Construction

Project North: 15 degrees

Location: CAN QC Montreal (Intl AP)

Default Wall: 3. Wood stud wall, R-13 + R-7.5 c.i. (ASHRAE 90.1 - 2007: Zones 6 - 7), 2" x 4," 16" o.c.

Wall R-Value: (ASHRAE 90.1) 21.75 ft²-F-h/Btu

HVAC System: Packaged Single Zone
(COMFEN currently allows only Packaged Single Zone systems.)

Calculation Period: Annual
(COMFEN currently allows only year-long simulations.)

OK Cancel

Geometry and Materials

Width: 33.5 m

Floor Area:

Depth: 6 m

201 m²

Height: 6.25 m

Orient.: South

Wall: Wood stud wall, varennes rsi 8.26

Environment

Lighting Control: Continuous

Glare Control:

HVAC Economizer: Temp. and Enthalpy

Lighting Load: 6 W/m²

Equipment Load: 3 W/m²

people: 1 people

ID: 4 Name: Wood stud wall, varennes rsi 8.26

WALL CONSTRUCTION

First layer is outside layer. (Drag material layers from right)

	ID	Material	Framing	Thickness (mm)	R-value Frame	R-value Cavity
1	86	Film coefficient, moving air, 15...	continuous	0.00	0.03	0.03
2	79	Steel, mild, sheet, 1/16"	continuous	1.59	0.00	0.00
3	71	EPS, R-15.60	continuous	99.06	2.75	2.75
4	36	Plywood (douglas fir), 3/4"	continuous	19.05	0.18	0.18
5	93	Wood stud (southern pine), 2"...	framing	234.95	1.54	--
6	56	Glass fiber-batt, R-30 (2" x 10...	cavity	234.95	--	5.43
7	50	Vapor barrier: seal, plastic film	continuous	0.25	0.00	0.00
8	29	Gypsum, sand agg., 1"	continuous	25.40	0.03	0.03
9	84	Film coefficient, still air, vertica...	continuous	0.00	0.12	0.12

Wall assembly characteristics :

% Framing: 7 %

U-factor: 0.1210 W/m²-°K

R-value: 8.2674 m²-°K/W

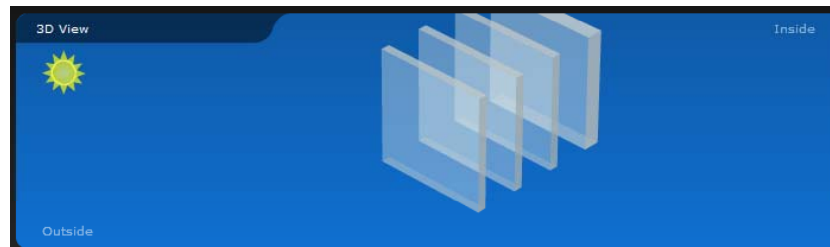
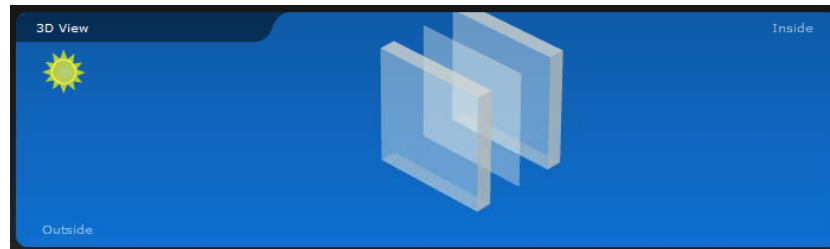
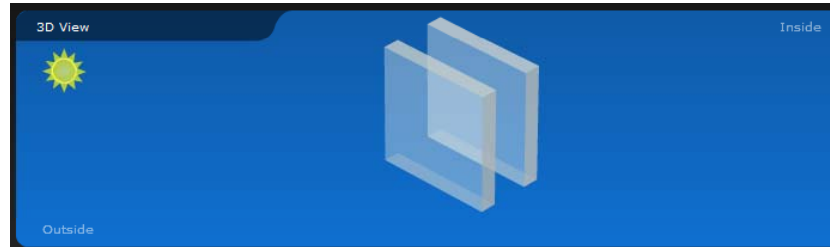
Assembly thickness: 380.3015 mm

- Mur RSI 8.26
- Orientation 15 deg



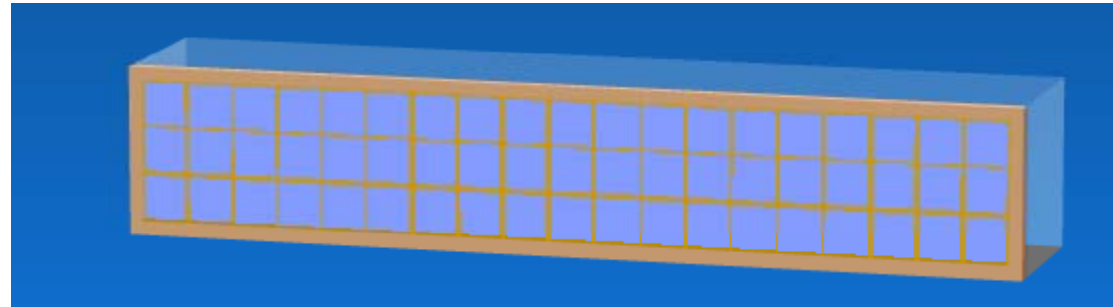
Comfen 4.0

- Pilkington Energy Advantage argon
SHGC=0.62
U=1.624
- Southwall HM TC88,
SHGC 0.467
U=0.818
- Quad Solar LowE
SHGC=0.292
U=0.614
- Mur rideau Alum.
U=5.68
- Mur rideau bois
Raico U=1.0

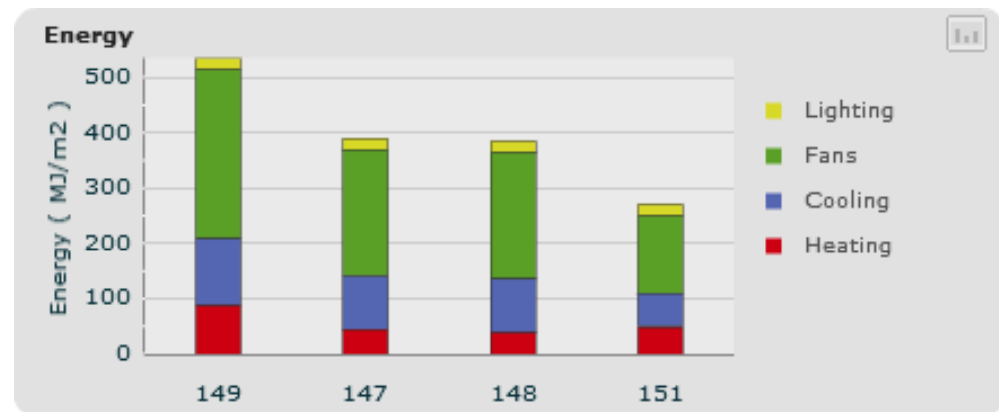


Comfen

Façade sud



- Mur rideau en bois réduction de chauffage de 15%
- Fenestration TC-88 réduction de 55%
- Quad réduction de chauffage de 44%



149 : cadre alu. double vitrage

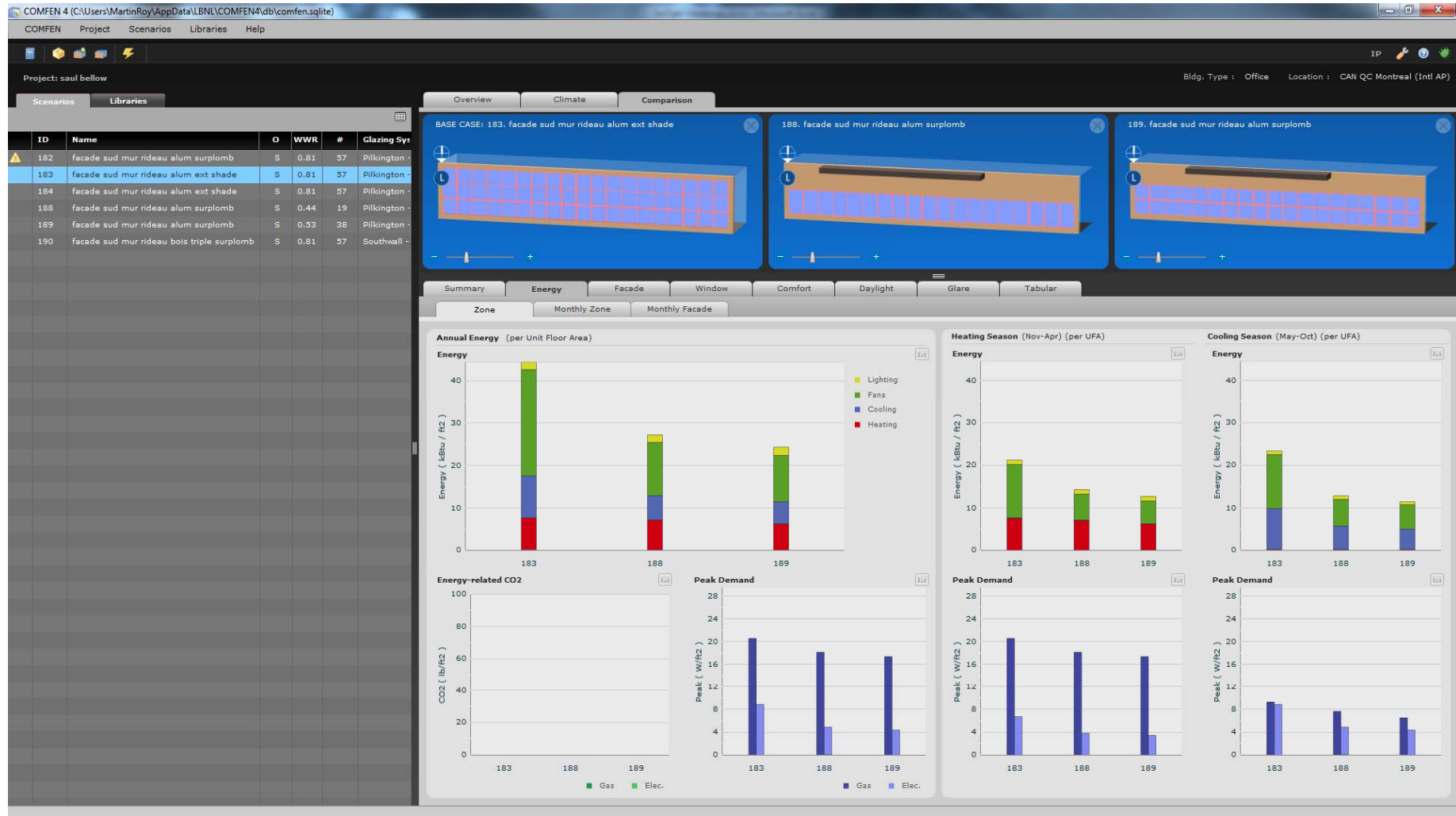
147 : cadre alu. HM TC88

148 : cadre bois HM TC88

151 : cadre bois Quad



Comfen exemple

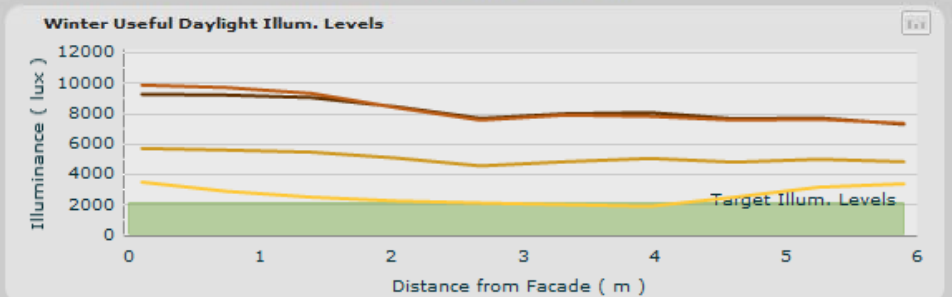
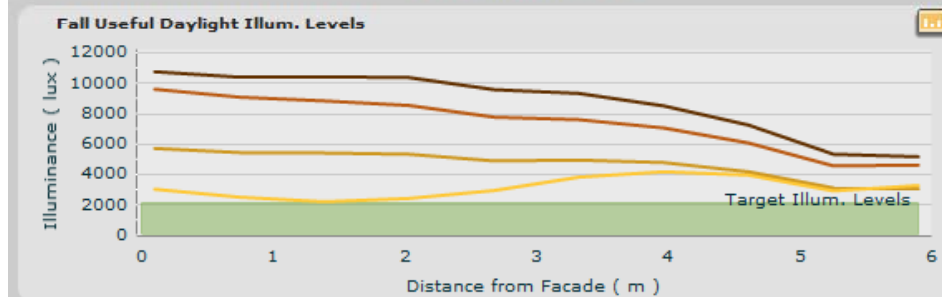
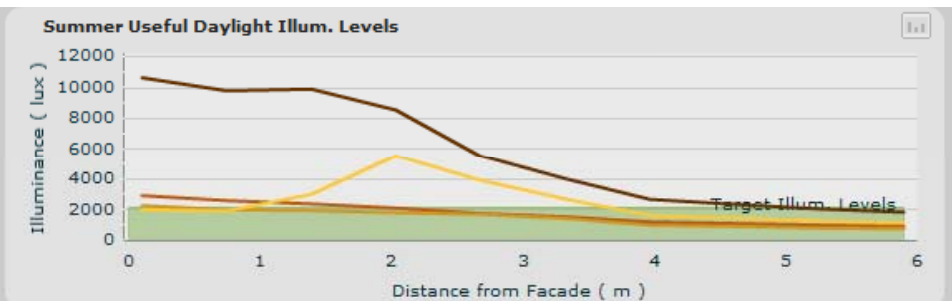
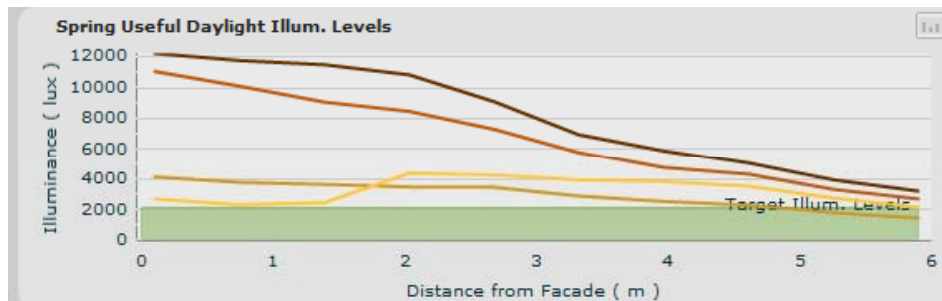
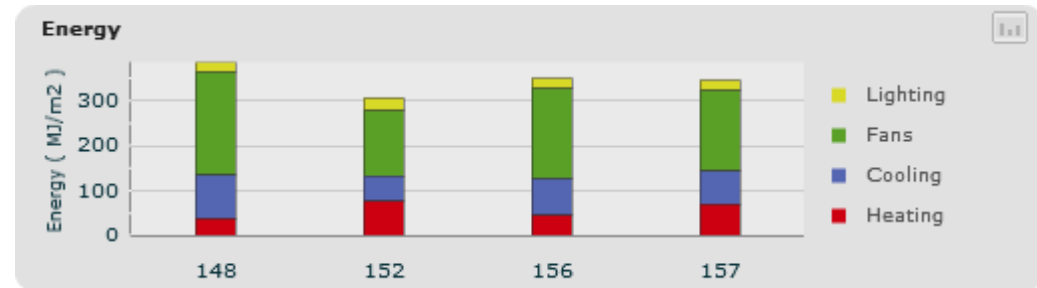


Comfen

Façade sud

- Volets extérieurs fixes
- Volets extérieurs mobiles
- Toiles intérieures

Occultation solaire

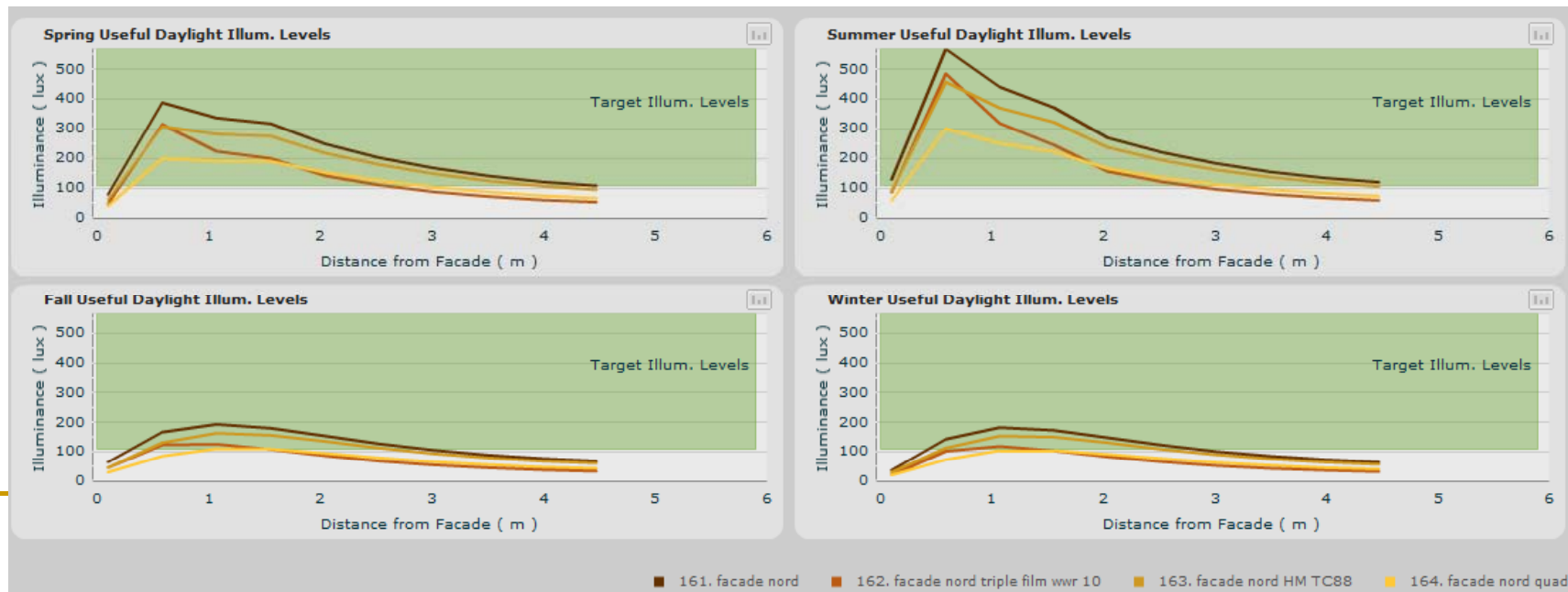
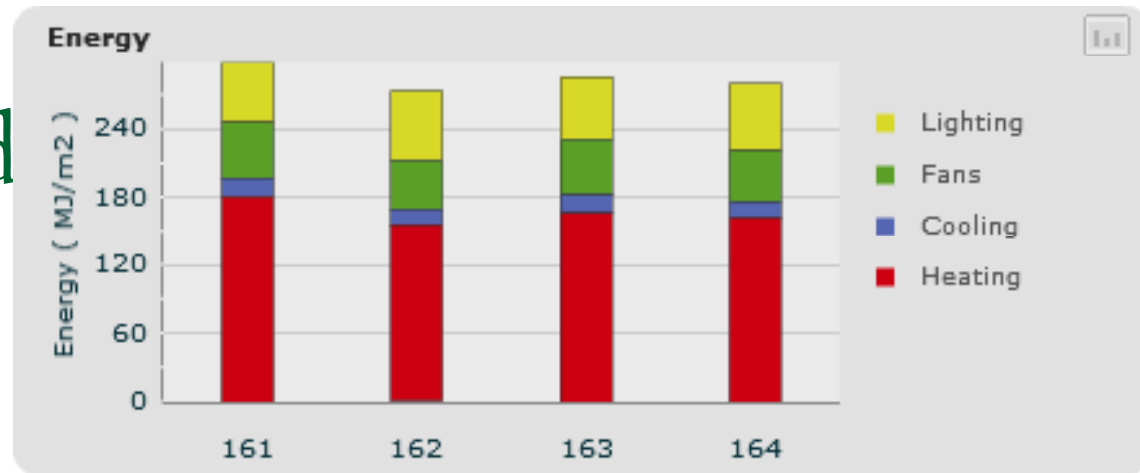


■ 148. facade sud mur rideau bois double film ■ 157. facade sud mur rideau bois ext shade 2/3 ■ 160. facade sud mur rideau bois ext shade fixe ■ 156. facade sud mur rideau bois double film shade 2/3

Comfen

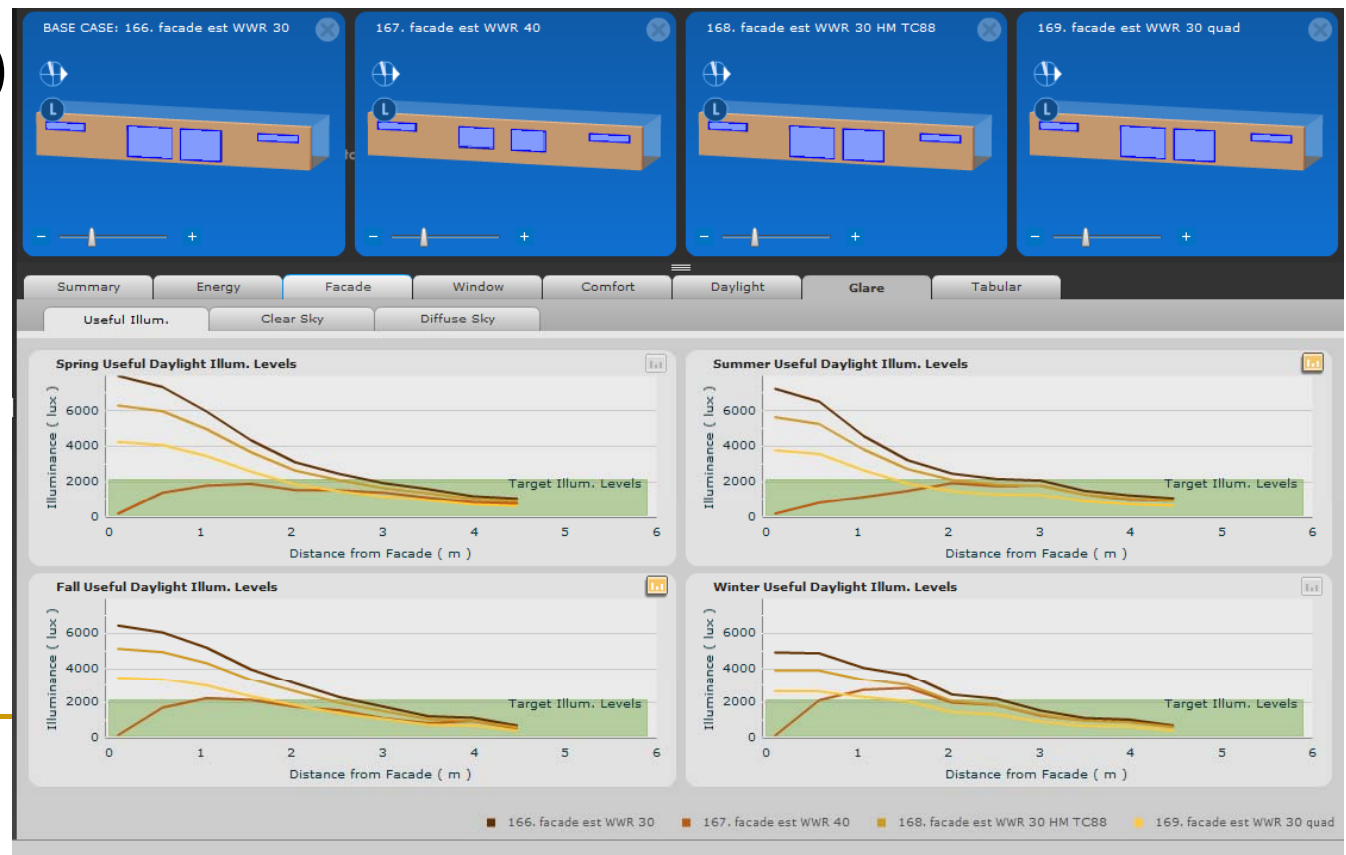
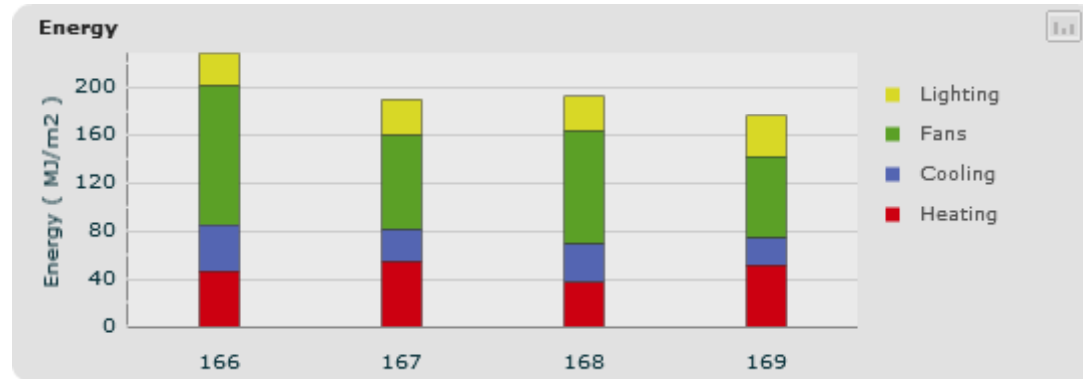
Façades Nord

- PMV 20%
- PMV 10% (-13%)
- HM TC88 (-8%)
- Quad (-10.4%)



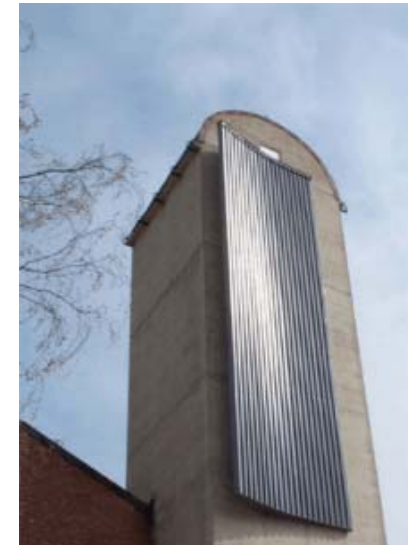
Comfen Façades Est

- PMV 30%
- PMV 20%
(+16%)
- HM TC88 (-20%)
- Quad (+10%)



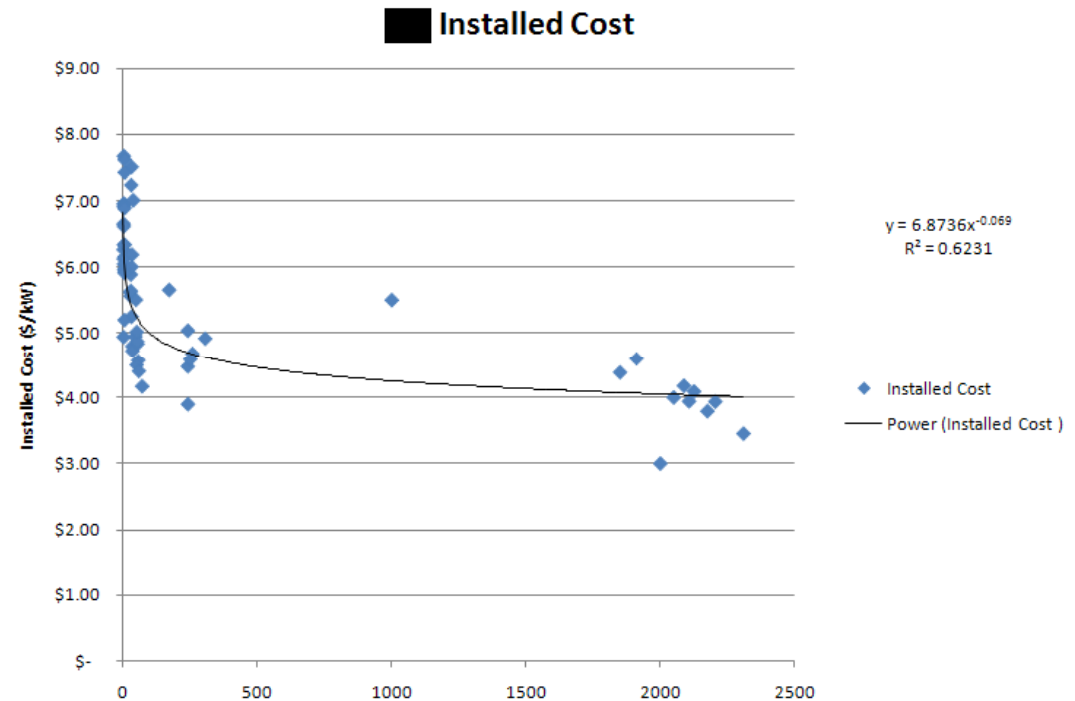
Solaire Thermique

- Technologie éprouvée
- Chauffage de l'air
 - Ventilation
 - Espace
 - Procédés
- Chauffage de l'eau
 - Eau domestique
 - Eau de chauffage
- Besoin limité



Solaire Photovoltaïque

- Réduction des coûts d'installation
- Technologie éprouvée
- Coût du kWh produit élevé
- Besoin illimité (mesurage net)



SolOpt

<http://solaramericacommunities.energy.gov/resources/publications/solopt/>

- Meilleur retour sur investissement
- Analyse du cycle de vie
- Coût normalisé de l'énergie le plus faible

Welcome to SolOpt!

SolOpt is a rooftop optimization and sizing tool for photovoltaic (PV) and solar hot water (SHW) systems. The program uses basic building information such as location, building type, and roof area for an hourly calculation of renewable energy production. It accommodates five optimization criteria based on financial metrics and energy performance.

Instructions:

Step 1: Enable Macros. Click on the sun to the right, if the animation does not play, click "Options" under the formula bar and then click "Enable Content."

Step 2: Select the "Optimization" tab at the bottom of the window.

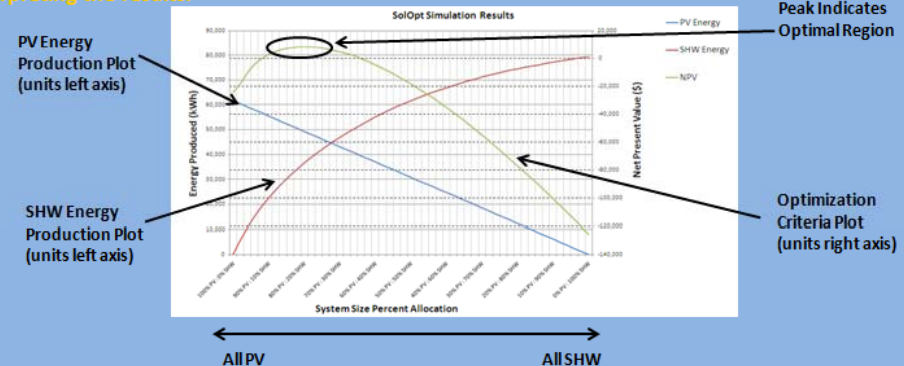
Step 3: In the "Critical Inputs" section, enter general building information and annual utility data (electricity/fuel). It is important that the economic data ("Advanced Inputs" button) and incentives data ("Incentives" tab) are verified due to the significant influence of these inputs on the results.

Step 4: Click "Optimize System" button (sun icon on "Optimization" tab) to run simulation. Internet access is required to read information from weather files.

Step 5: In the "Optimization Results" section, select desired optimization criterion from drop-down menu to view results. By clicking the "Copy Results to Output Table" button results will be saved to the "Output Table" tab. Use this feature to compare different systems and simulations.

Help: The grey cells are inputs and the white cells are calculated or looked-up values. Consult the "Notes" column for technical help. Explore the advanced inputs by clicking the "Show/Hide Advanced Inputs" button at the bottom of the "Optimization" tab.

Interpreting the results:



SolOpt (exemple Net Zero)

- 20,000 pi²
- Toit de 13,000 pi²
- 5 kWh/pi²
- Remplir la surface disponible

Critical Inputs		Units	Value	Notes
State	-	-	New York	  (annual cost) / (annual usage) 1 Mbtu = 1 million btu Conversion Factors
Nearest Weather Station	-	-	WATERTOWN AP	
Roof-top Area	ft ²	-	13 000	
Building Gross Square Feet	ft ²	-	20 000	
Building Tax Status	-	-	Commercial (Tax-paying)	
Building Use	-	-	Office	
Current DHW System Type	-	-	Natural Gas Standard Tank	
Blended Electrical Rate	\$/kWh	-	\$0.10	
Blended Fossil Fuel Rate	\$/Mbtu	-	\$9.00	
Annual Electric Consumption	kWh/year	-	100 000	
Annual Fossil Fuel Consumption	Mbtu/year	-	800	
Simulation Analysis Type	-	-	PV & SHW: Full Entire Roof	Compare EUI to other buildings with the Building Energy Efficiency Indicator graph
Building Energy Use Intensity (EUI)	kBtu/ft ²	-	57.1	
Average Office EUI (CBECS)	kBtu/ft ²	-	92.9	
Latitude	degrees	-	44	
Longitude	degrees	-	-76.017	
Elevation	ft	-	318	

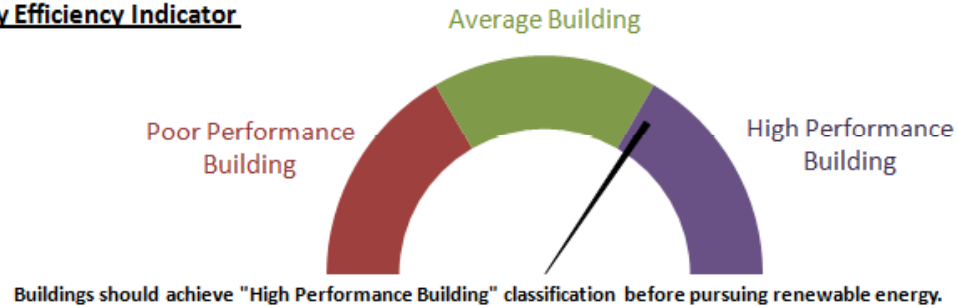
General System Characteristics		Units	Value	Notes
Solar Availability (Shading Derate Factor)	%	-	100%	100% if no shading obstructions
Mounting Surface Material	-	-	White Paint	Typical Roof Angles
Slope of Roof/Ground	degrees	-	44	
Usable Area Derate Factor	%	-	100%	
Total Array Tilt from Horizontal	degrees	-	0	100% if no roof-top obstructions ≥ Roof/Ground Slope
Azimuth (East of South is Positive)	degrees	-	0	Based on annual consumption
Annual System Degradation	%/year	-	0.50%	
Altitude Angle (Winter Equinox)	degrees	-	22.6	
Production Limit	kWh	-	100 000	
Mounting Surface Reflectance	-	-	0.70	
Total Solar Collector Area	A _c (m ²)	-	1207.7	PV and SHW
CO ₂ Emission Factor PV	lb CO ₂ /MWh	-	832.33	EPA eGRID Emissions Factor
CO ₂ Emission Factor SHW	lb CO ₂ /MWh	-	399.01	EPA eGRID Emissions Factor

Economic Characteristics		Units	Value	Notes
Net Metering Production Limit	%	-	100%	Percent of annual electric load
Net Metering PV Capacity Limit	kW	-		Leave Blank if Not Applicable
Excess Sell Back Rate	\$/kWh	-	\$0.00	DHW Fuel Escalation
Project Lifetime	years	-	25	
Real DHW Fuel Escalation Rate		-	1.083%	
Real Discount Rate	%	-	3.000%	Federal Default: 3%
Real Electricity Escalation Rate	%	-	0.542%	Federal Default: 0.541667%
Inflation Rate	%	-	0.300%	Federal Default: 0.3%
First Equipment Replacement Cost	\$	-	\$0.00	Solar Incentives
First Equipment Replacement Year	year	-	20	
Second Equipment Replacement Cost	\$	-	\$0.00	
Second Equipment Replacement Year	year	-	40	
PV Federal Tax Incentive	%	-	0%	
PV State Tax Incentive	%	-	0%	Incentives can be updated from the "Incentives" Tab
PV State Production Credit	\$/kWh	-	\$0.00	
PV State (Rebate) Buydown	\$/kW	-	\$0	
SHW Federal Tax Incentive	%	-	25%	
SHW State Tax Incentive	%	-	25%	
SHW State Production Credit	\$/kWh	-	\$0.00	
SHW State (Rebate) Buydown	\$/kW	-	\$0	

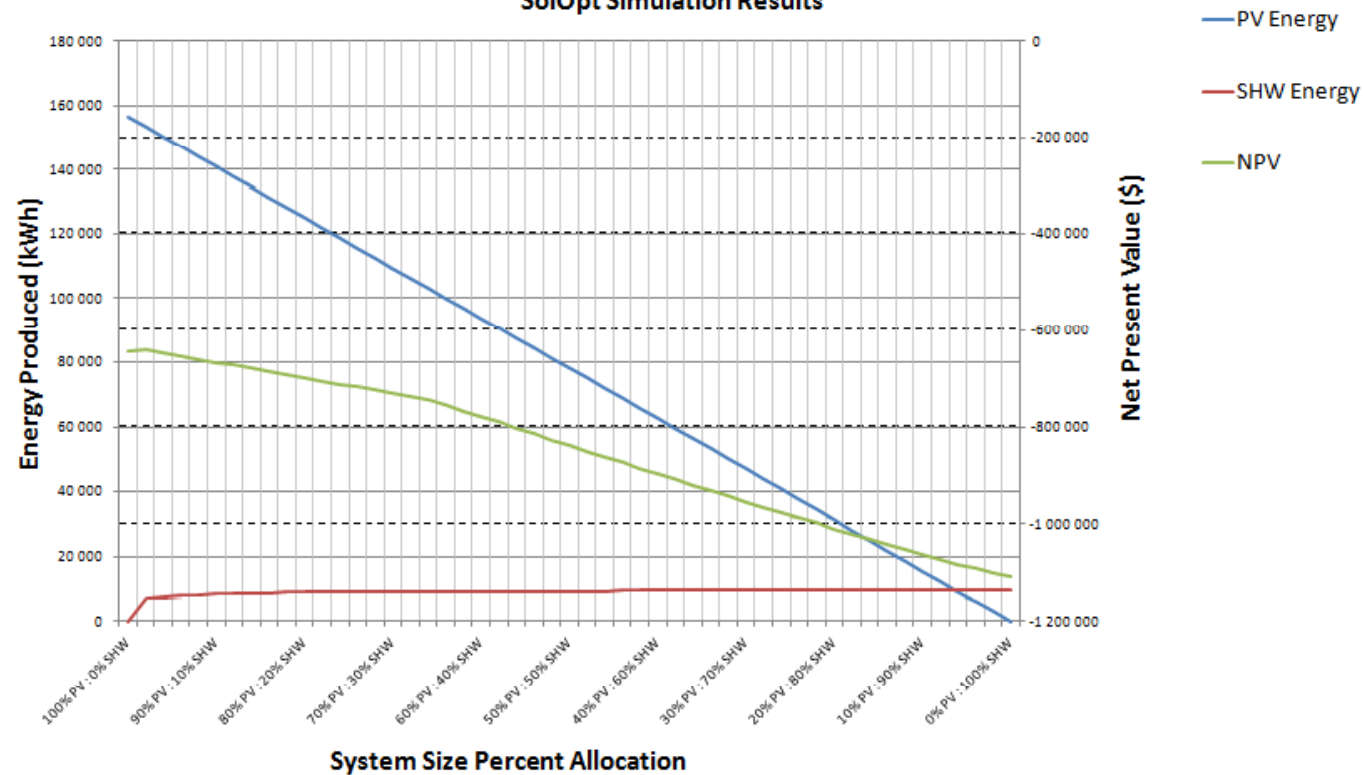


SolOpt (example Net Zero)

Building Energy Efficiency Indicator



SolOpt Simulation Results



SolOpt (exemple Net Zero)

<u>Optimization Results</u>		Units	Value	Notes
Optimization Criterion	-		Maximize Net Present Value (NPV)	Select from 5 different optimal systems
Optimal PV System Size	ft ²		12 740	
Optimal PV System Capacity	kW		158,6	
PV Capacity Factor	%		11,0%	
Number of PV Panels	-		910,4	
Installed Cost PV	\$/W		\$4,85	
Optimal SHW System Size	ft ²		260	
Optimal SHW System Capacity	kW		11	
SHW Solar Fraction	%		50,4%	
SHW Capacity Factor	%		7,3%	
Installed Cost SHW	\$/ft ²		\$90,00	
Number of SHW Panels	-		8,1	
Annual System Production	kWh/yr		160 153	
Cost Savings	\$/yr		\$10 232	
Total Incentives	\$		\$10 850	
System Cost with Incentives	\$		\$800 249	Based on Utility Bills Only
Simple Payback Period (SPP)	years		87,1	
Discounted Payback Period (DPP)	years		100,0	
Net Present Value (NPV)	\$		-\$641 200	
Life Cycle Cost (LCC)	\$		\$833 331	
Cost of Business as Usual (NPV)	\$		\$192 131	
Savings to Investment Ratio (SIR)	-		0,2	
Internal Rate of Return (IRR)	%		0,0%	
Levelized Cost of Energy (LCOE)	\$/kWh		\$0,311	
Greenhouse Gas Reduction (GHG)	tonnes CO ₂ e		59	LCOE does not include accelerated depreciation or salvage value

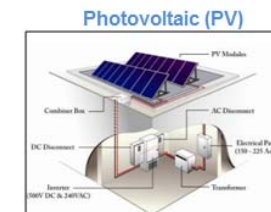
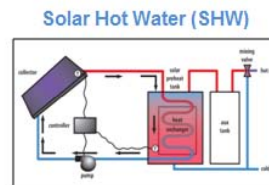
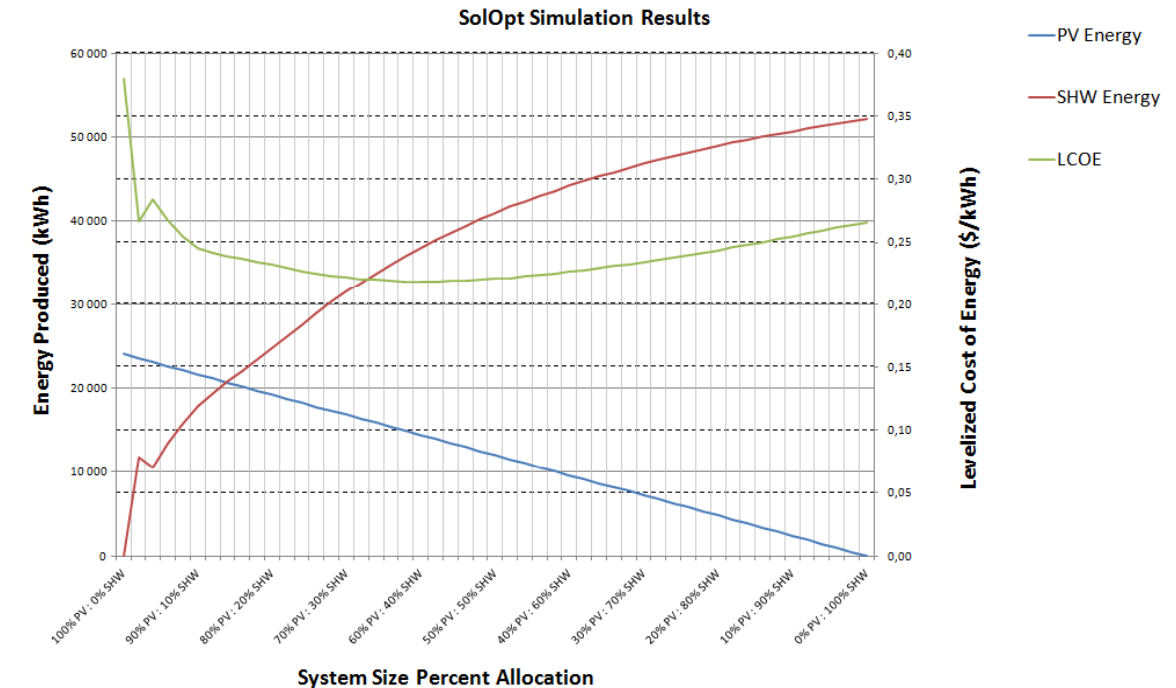
Show/Hide Advanced Inputs

Copy Results to Output Table



SolOpt (exemple Résidence)

- Multi-résidentiel 10 logements 3 étages
- Chauffe-eau électrique
- Calcul selon 3 options
 - ❑ Toit complet NPV
 - ❑ Surface utilisée non définie
 - ❑ Toit complet coûts minimum de l'énergie



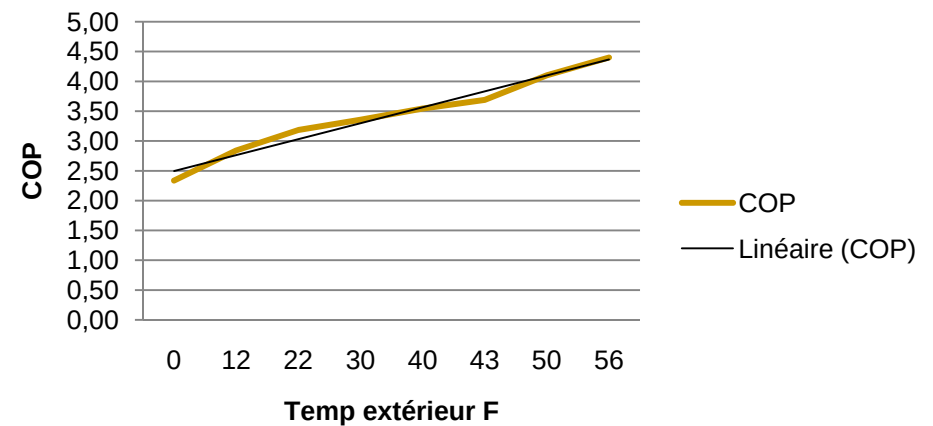
Output Table	residence1	residence2	residence3
Optimization Criteria	Maximize Net Present Value (NPV)	Maximize Net Present Value (NPV)	Minimize Levelized Cost of Energy
Optimal PV System Size	1 505	0	1 254
Optimal PV System Capacity	18,7	0,0	15,6
PV Capacity Factor	10,5%	0,0%	10,5%
Number of PV Panels	107,5	0,0	89,6
Installed Cost PV	\$5,62	\$0,00	\$5,69
Optimal SHW System Size	585	42	836
Optimal SHW System Capacity	24	2	35
SHW Solar Fraction	37,1%	14,5%	45,2%
SHW Capacity Factor	14,3%	78,0%	12,2%
Installed Cost SHW	\$90,00	\$151,07	\$90,00
Number of SHW Panels	18,3	1,3	26,1
Annual System Production	47 544	11 812	51 262
Cost Savings	\$4 754	\$1 181	\$5 126
Total Incentives	\$0	\$0	\$0
System Cost with Incentives	\$158 662	\$6 315	\$164 557
Simple Payback Period (SPP)	40,6	5,7	40,5
Discounted Payback Period (DPP)	61,4	6,1	60,5
Net Present Value (NPV)	-\$77 716	\$16 491	-\$80 089
Life Cycle Cost (LCC)	\$461 507	\$367 299	\$463 879
Cost of Business as Usual (LCC)	\$383 790	\$383 790	\$383 790
Savings to Investment Ratio (SIR)	0,5	3,6	0,5
Internal Rate of Return (IRR)	0,0%	15,3%	0,0%
Levelized Cost of Energy (LCOE)	\$0,223	\$0,039	\$0,219
Greenhouse Gas Reduction (GHG)	18	4	19



Thermopompe assistée par l'énergie solaire

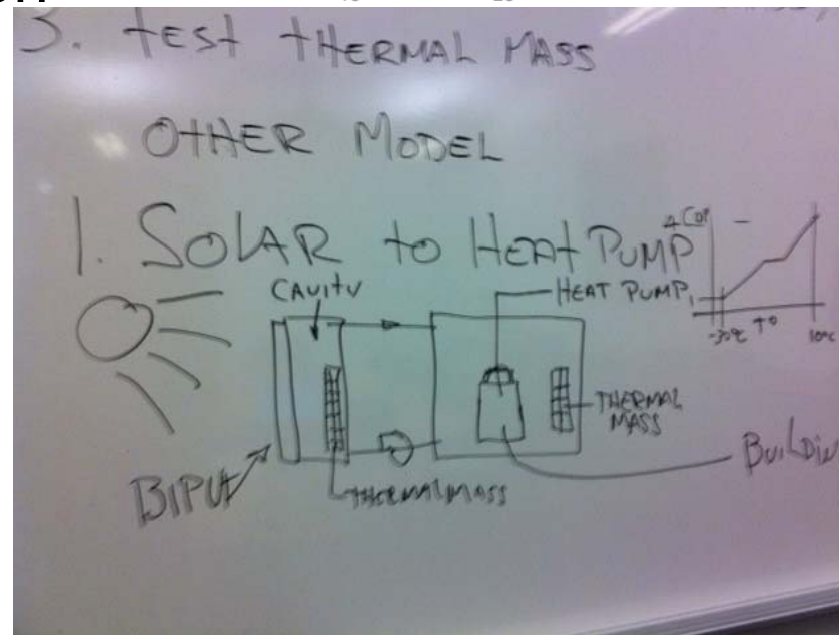
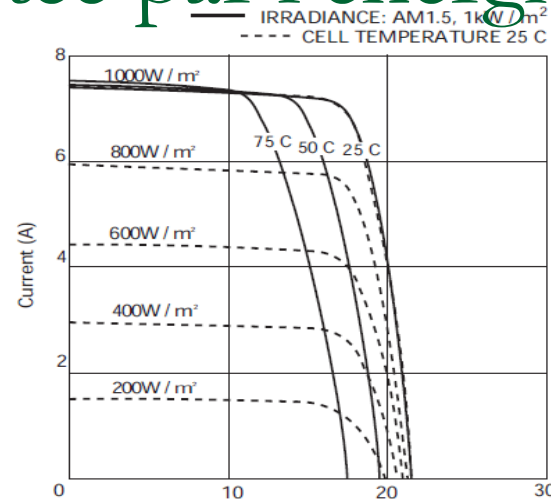
- Technologie des thermopompe permet 75% de capacité à -20 deg C
- Grande flexibilité grâce à la technologie du réfrigérant à débit variable
- Possibilité d' un coût plus faible que la géothermie

COP en fonction de la température extérieure

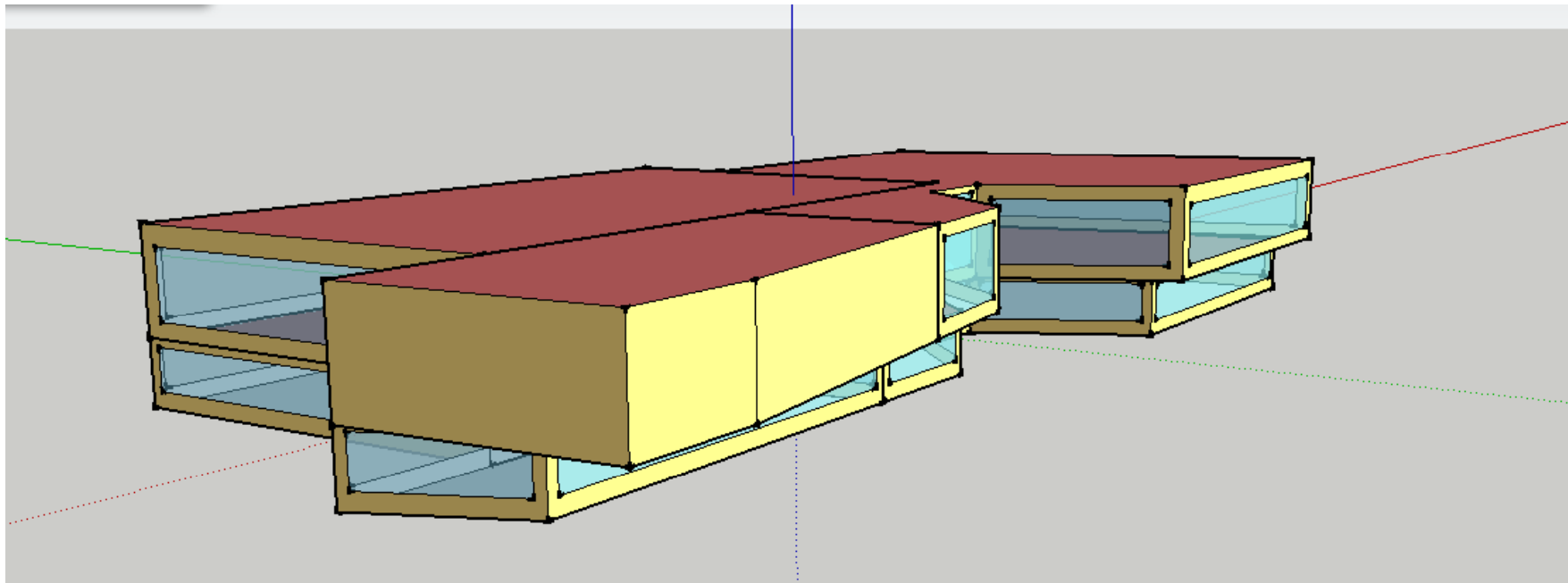


Thermopompe assistée par l'énergie solaire

- Circuit ouvert (mur solaire, BIPV)
- Circuit fermé (mur trombe, accumulation thermique)

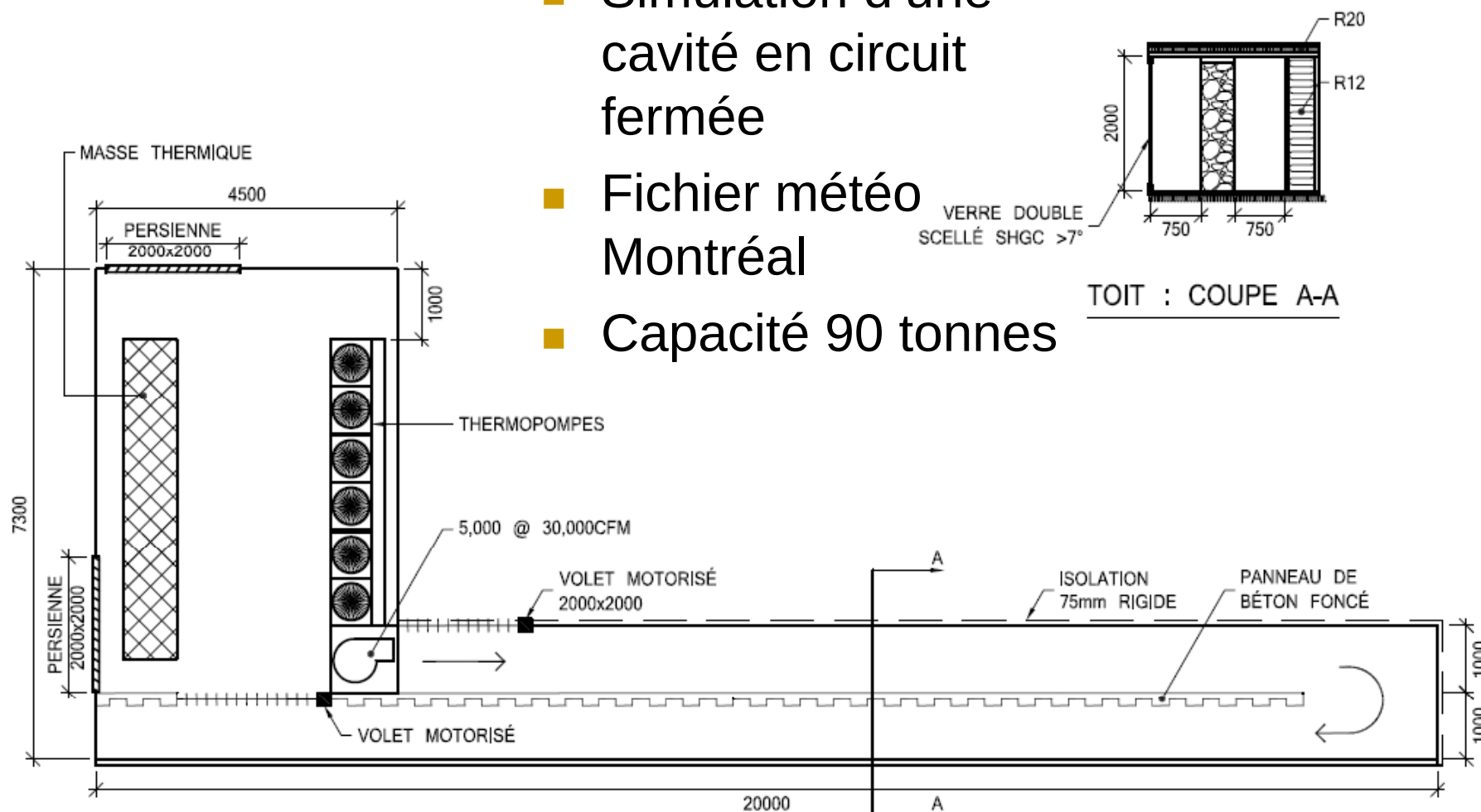


Thermopompe assistée par l'énergie solaire

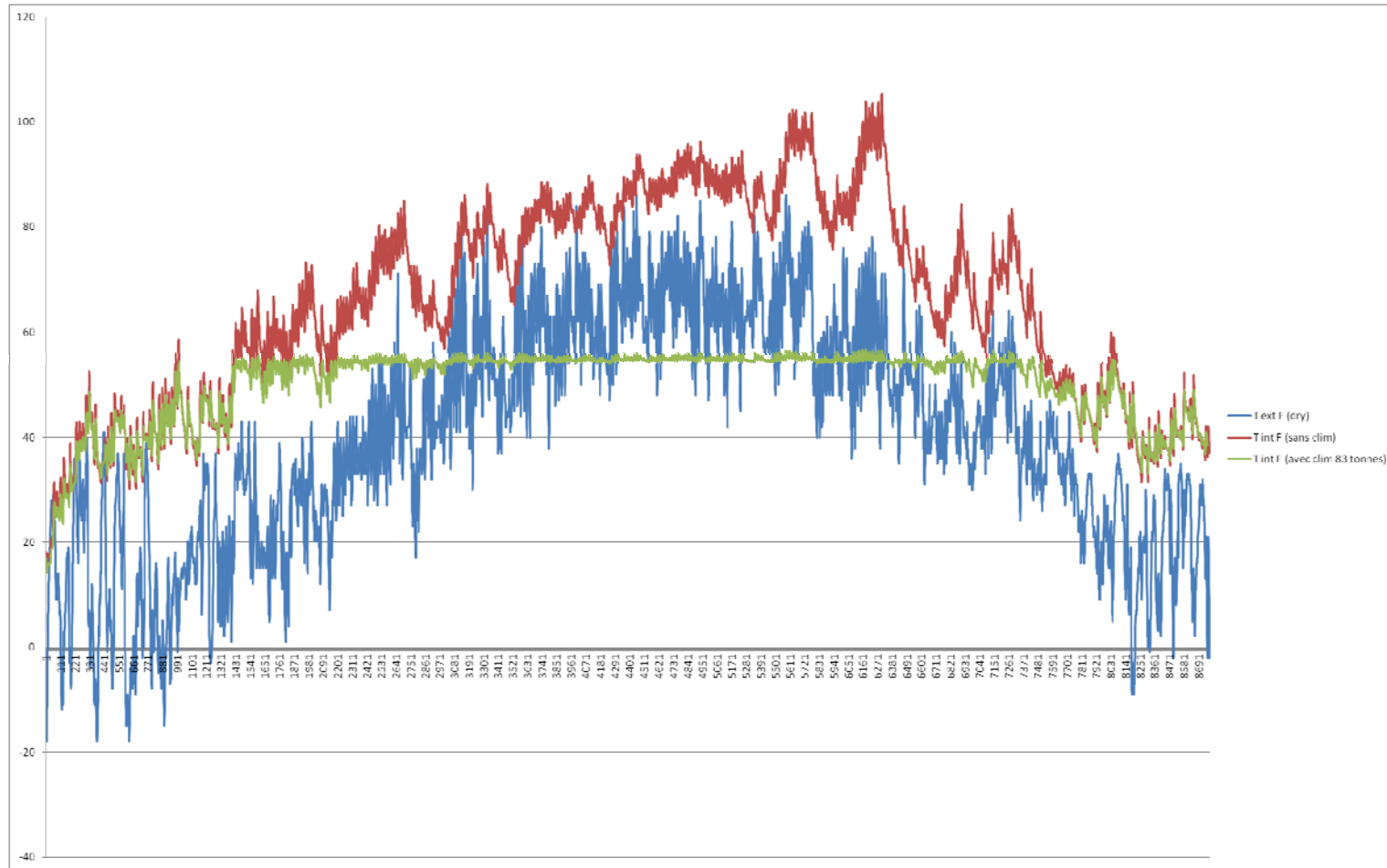


Thermopompe assistée par l'énergie solaire

- Simulation d'une cavité en circuit fermé
- Fichier météo Montréal
- Capacité 90 tonnes



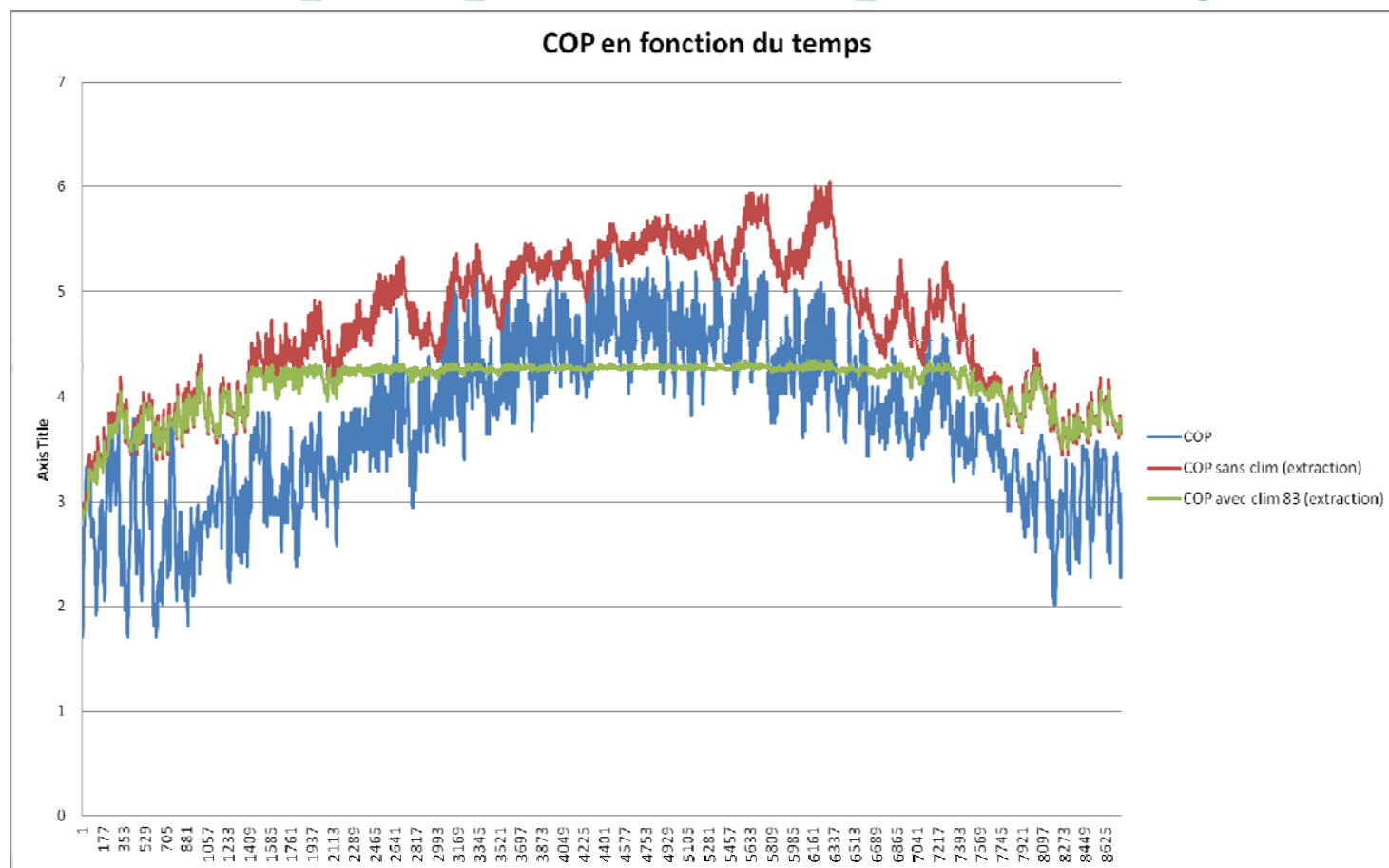
Thermopompe assistée par l'énergie solaire



Température à l'intérieure de la salle de mécanique



Thermopompe assistée par l'énergie solaire



- COP moyen en période de chauffage: 4,04
- Coût des puits de géothermie 250,000 \$





Misty winter afternoon by Bert Kaufmann

