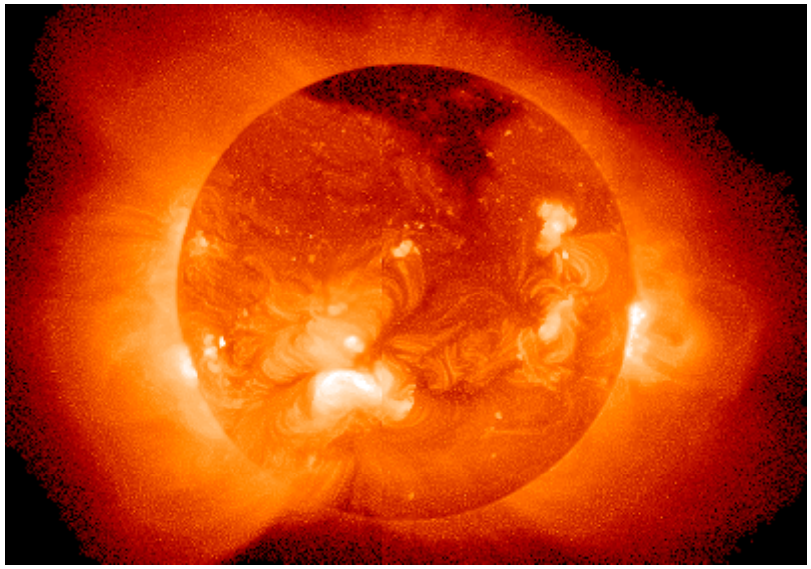
Rendez-vous programme Bâtiments ASHRAE Montréal

Martin Roy, ing. LEED AP

12 décembre 2011

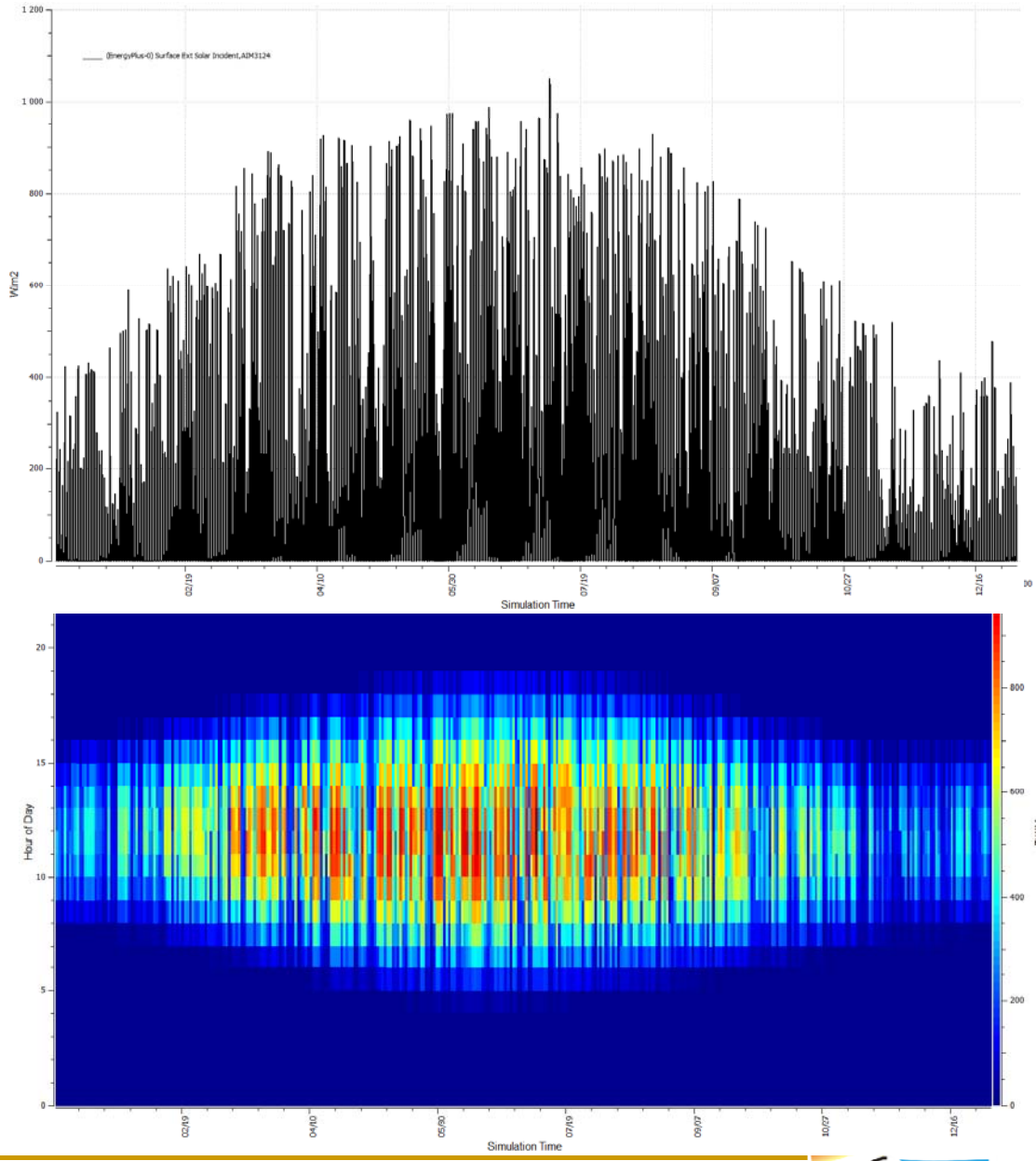
Soleil



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

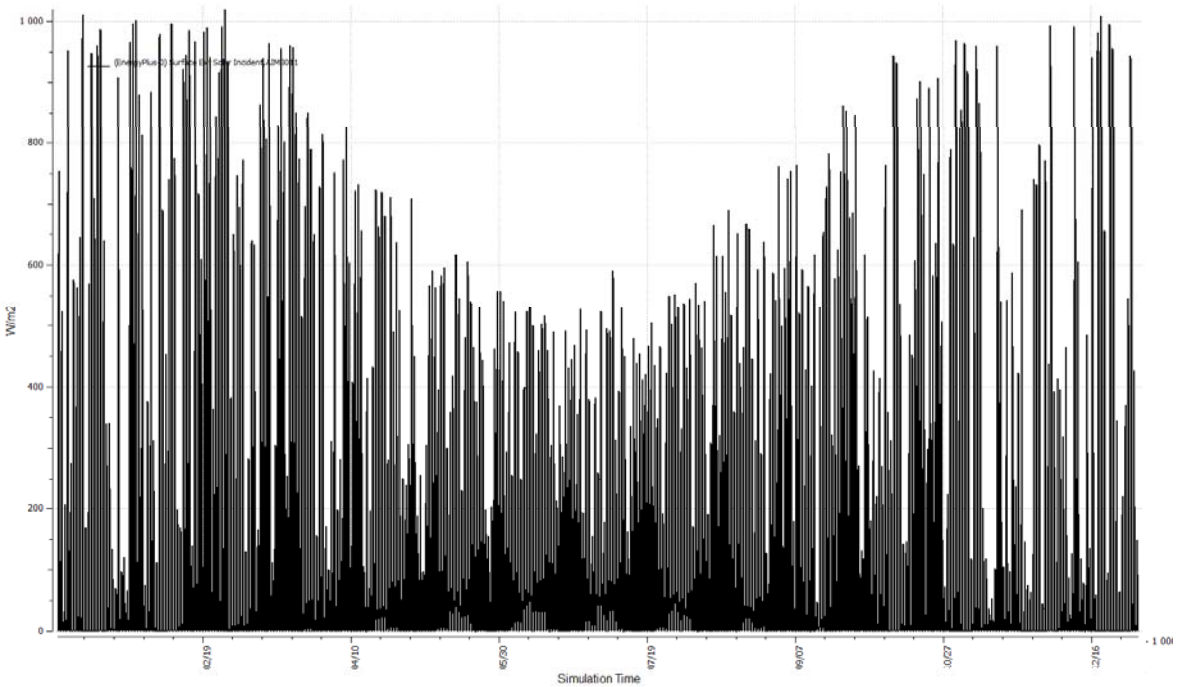
Solaire Passif

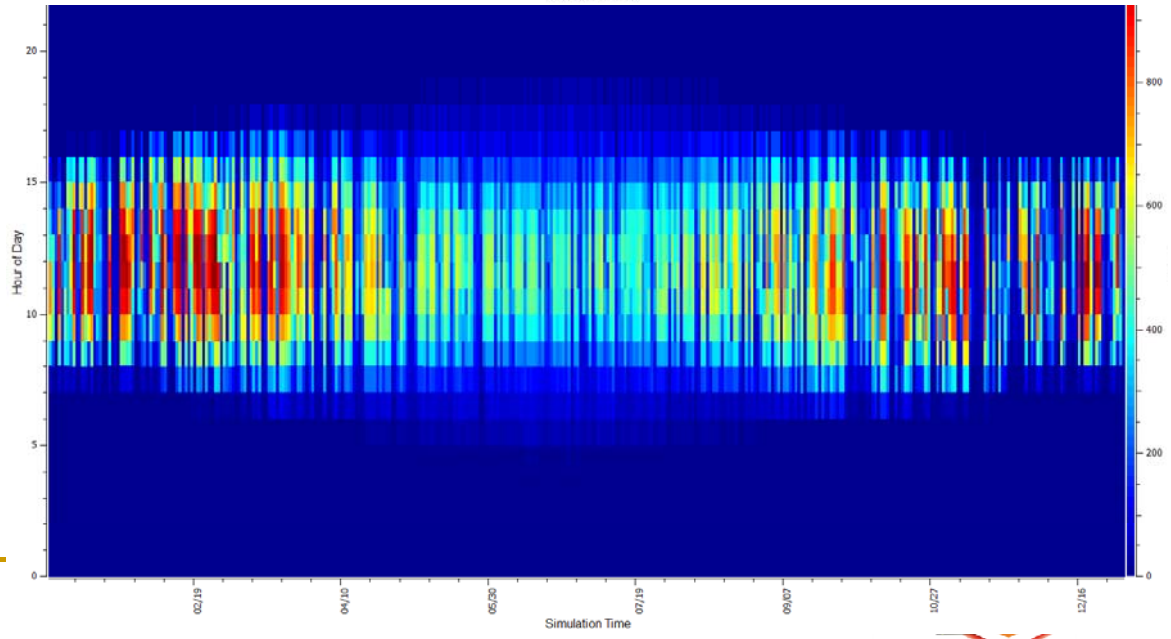
- Énergie solaire sur une surface horizontal
- Energy + weather file Montreal



Solaire Passif

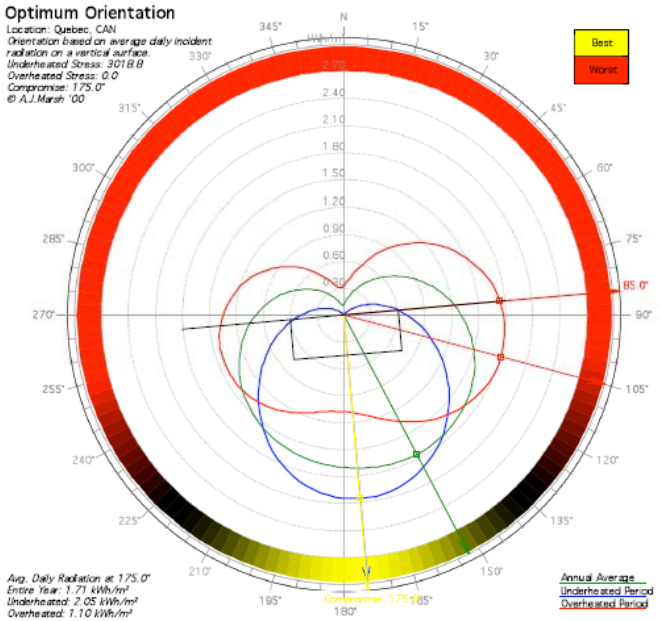
- Radiation sur une surface verticale
- Jusqu'à 1 kW/M2





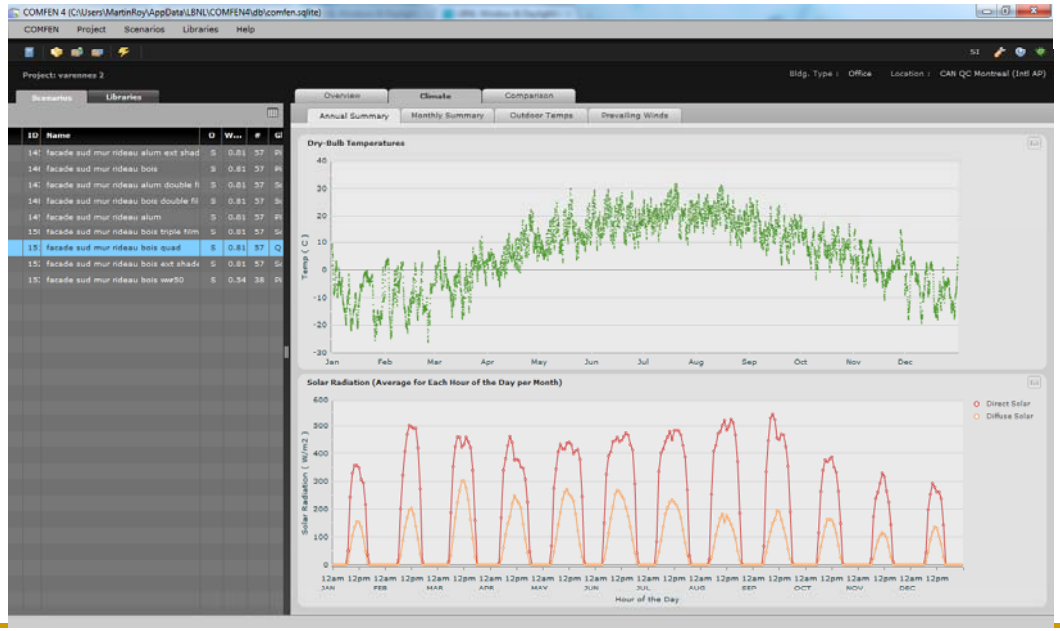
Solaire Passif

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

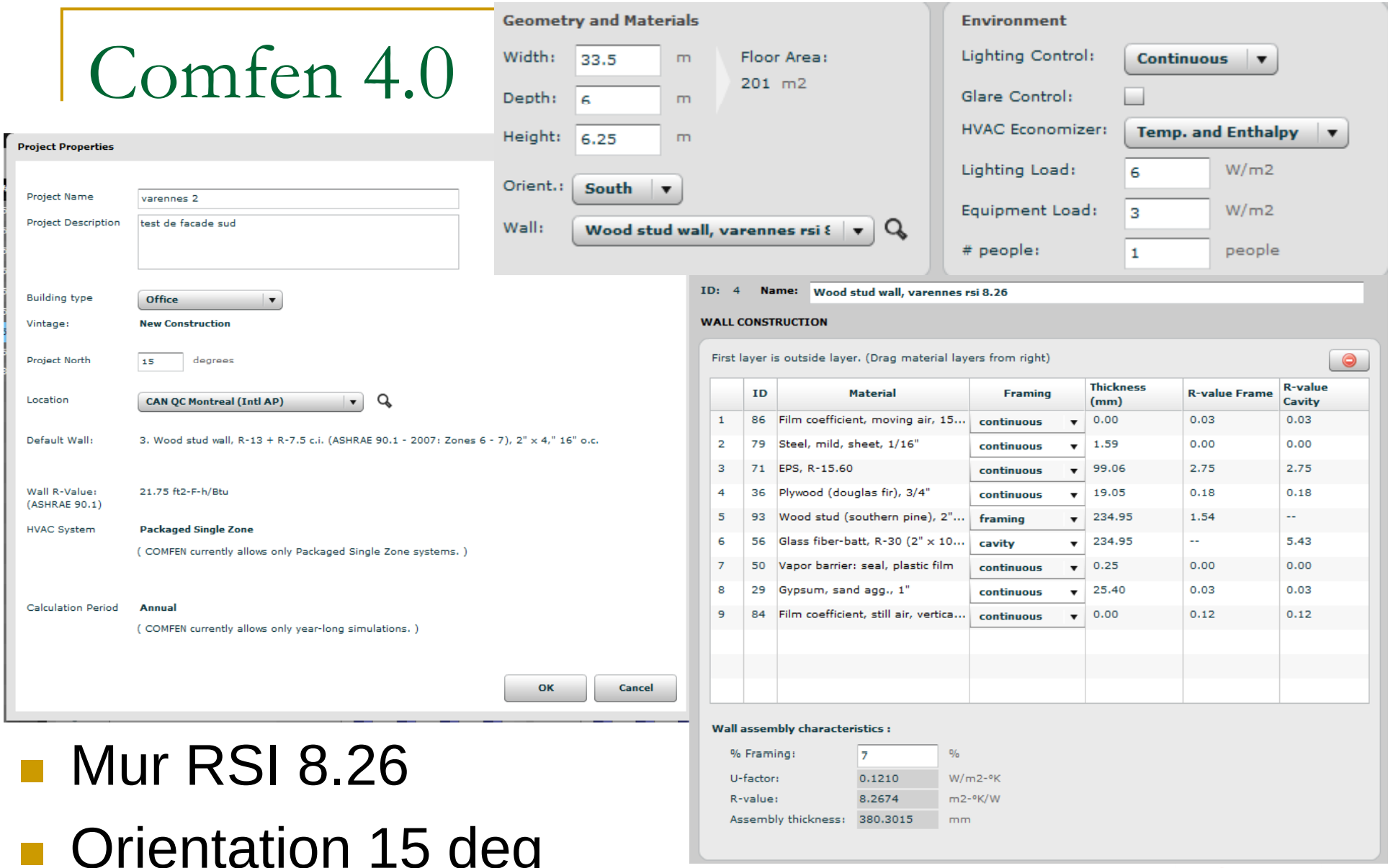


Comfen 4.0

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



Comfen 4.0

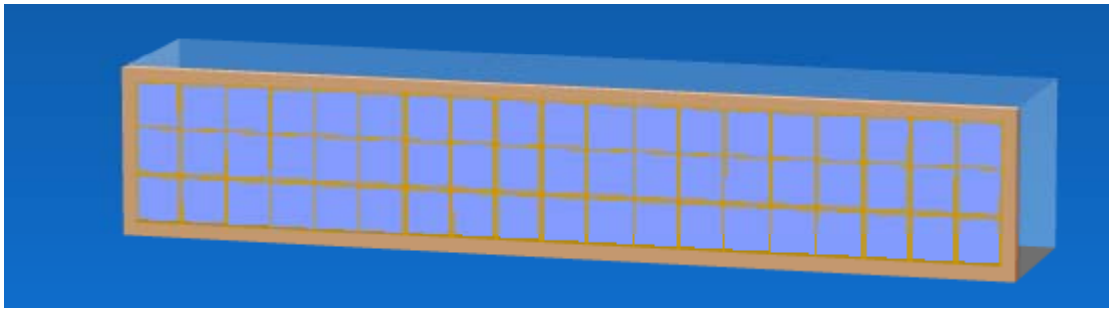


- Mur RSI 8.26
- Orientation 15 deg

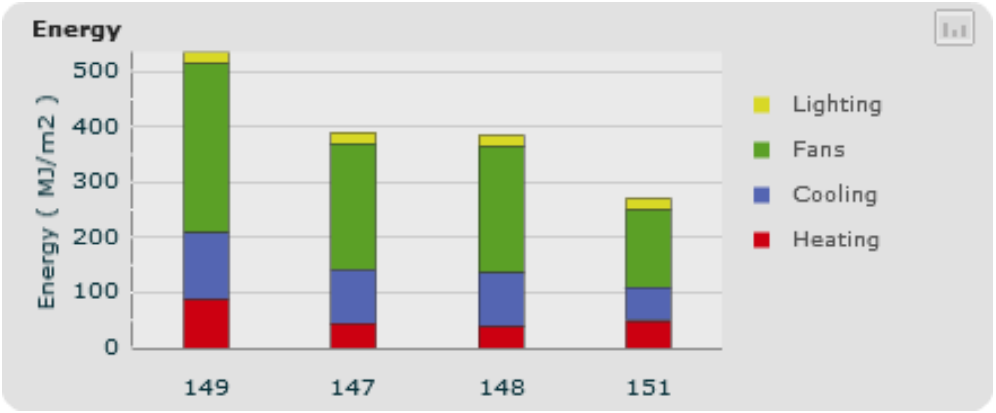
Comfen 4.0

- 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

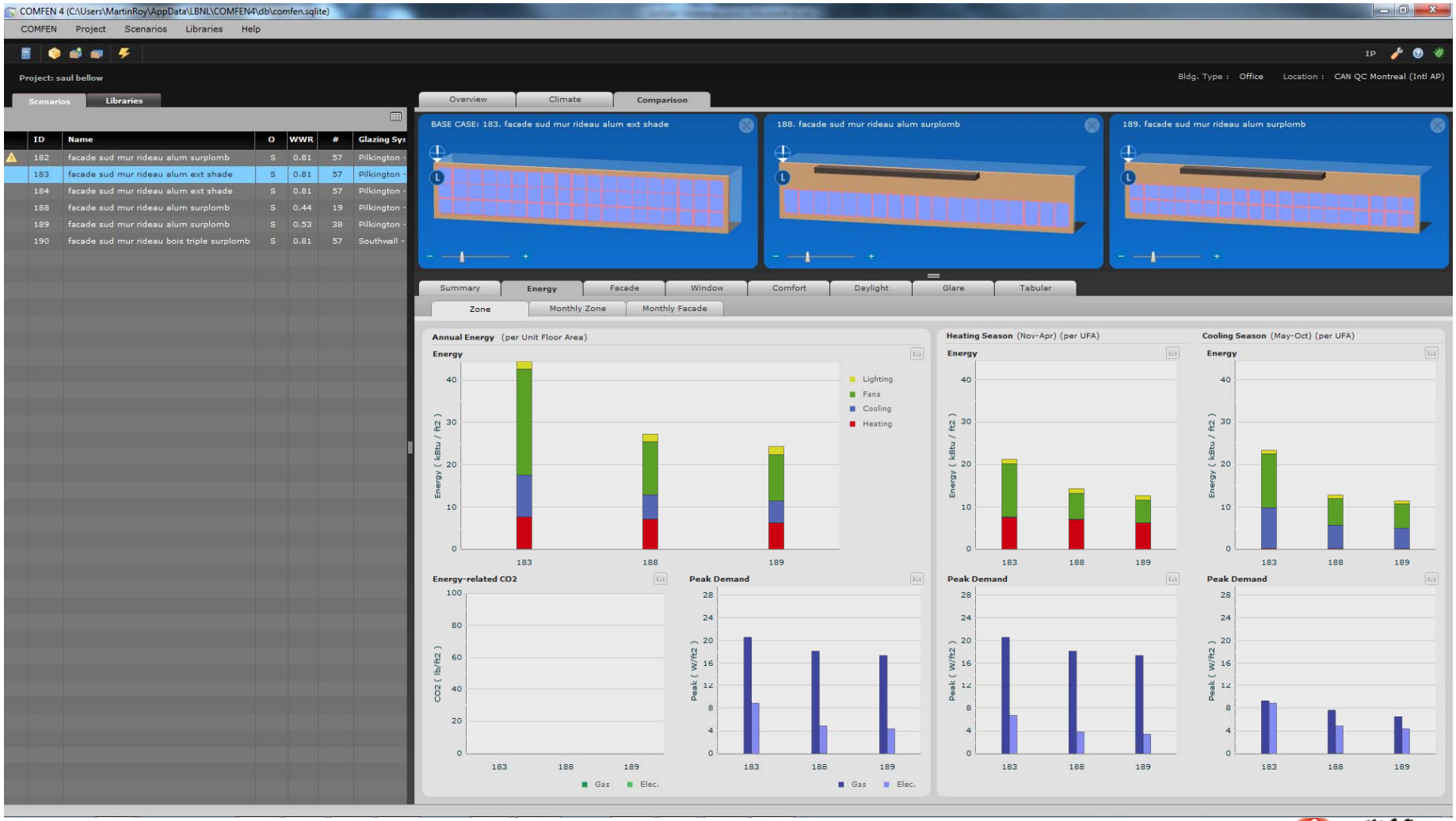


- Mur rideau en bois réduction de chauffage de 15%
- Fenestration TC-88 réduction de 55%
- Quad réduction de chauffage de 44%



149 : cadre alu. double vitrage
147 : cadre alu. HM TC88
148 : cadre bois HM TC88
151 : cadre bois Quad

Comfen exemple

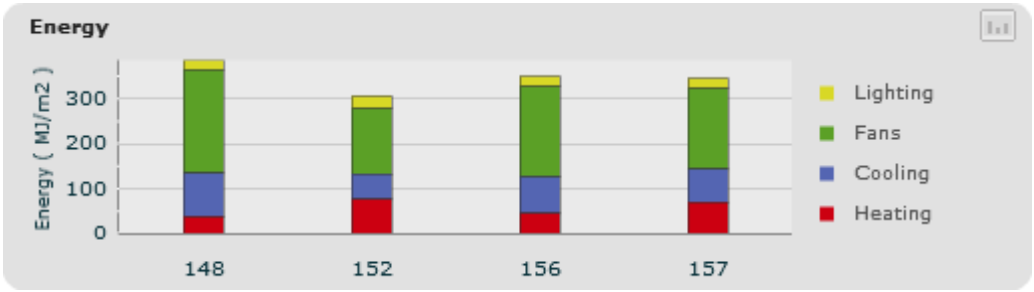


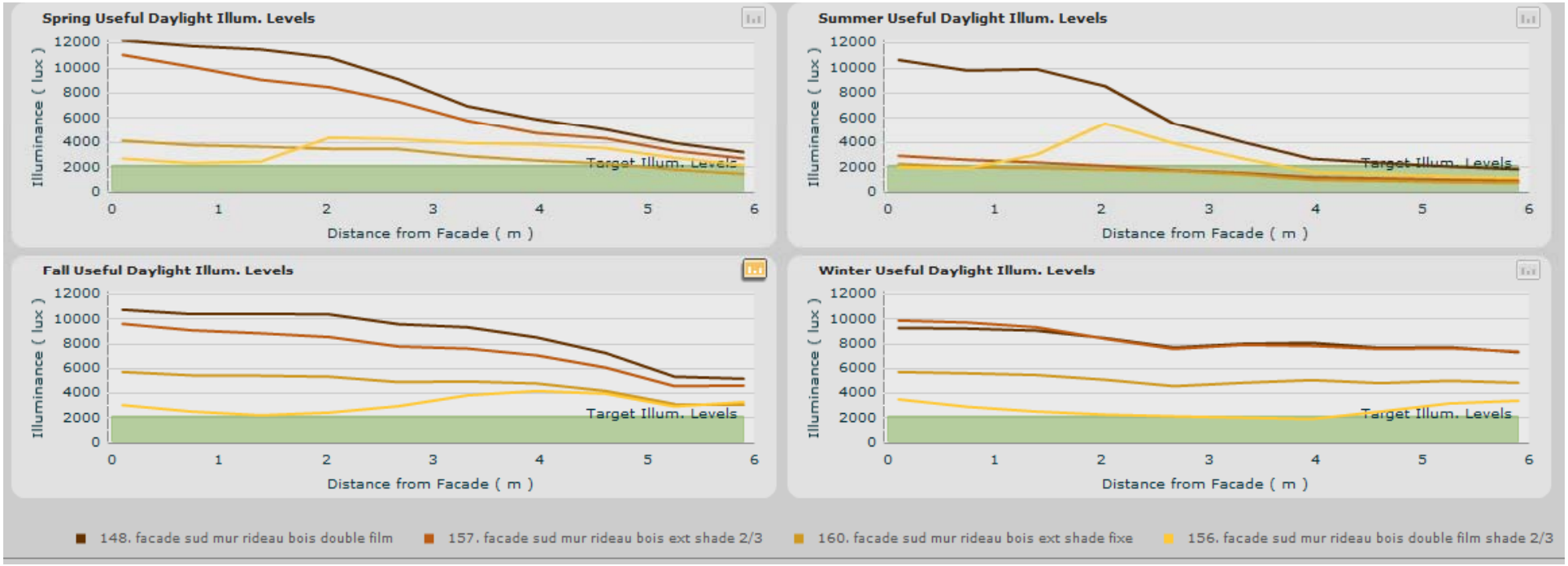
Comfen

Façade sud

- Volets extérieurs fixes
- Volets extérieurs mobiles
- Toiles intérieures

Occultation solaire

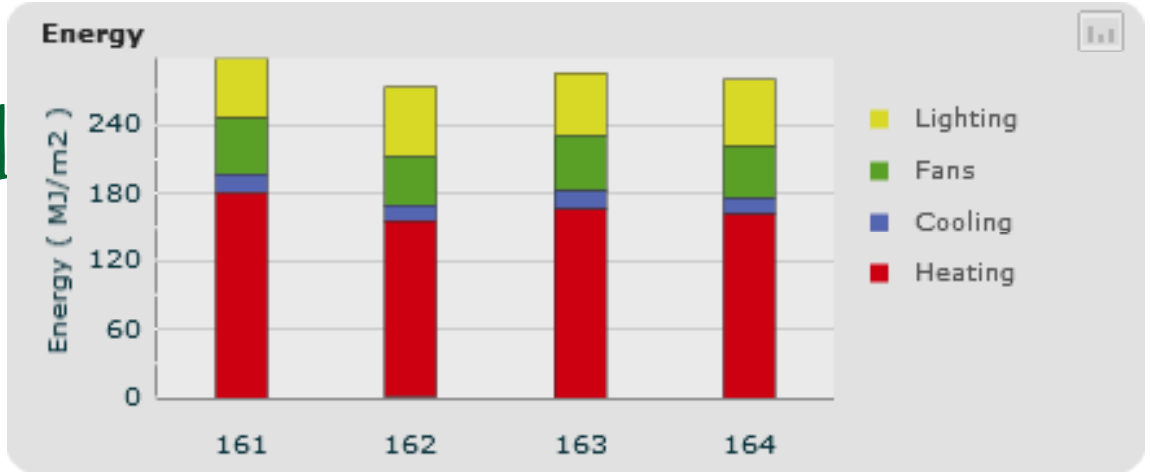


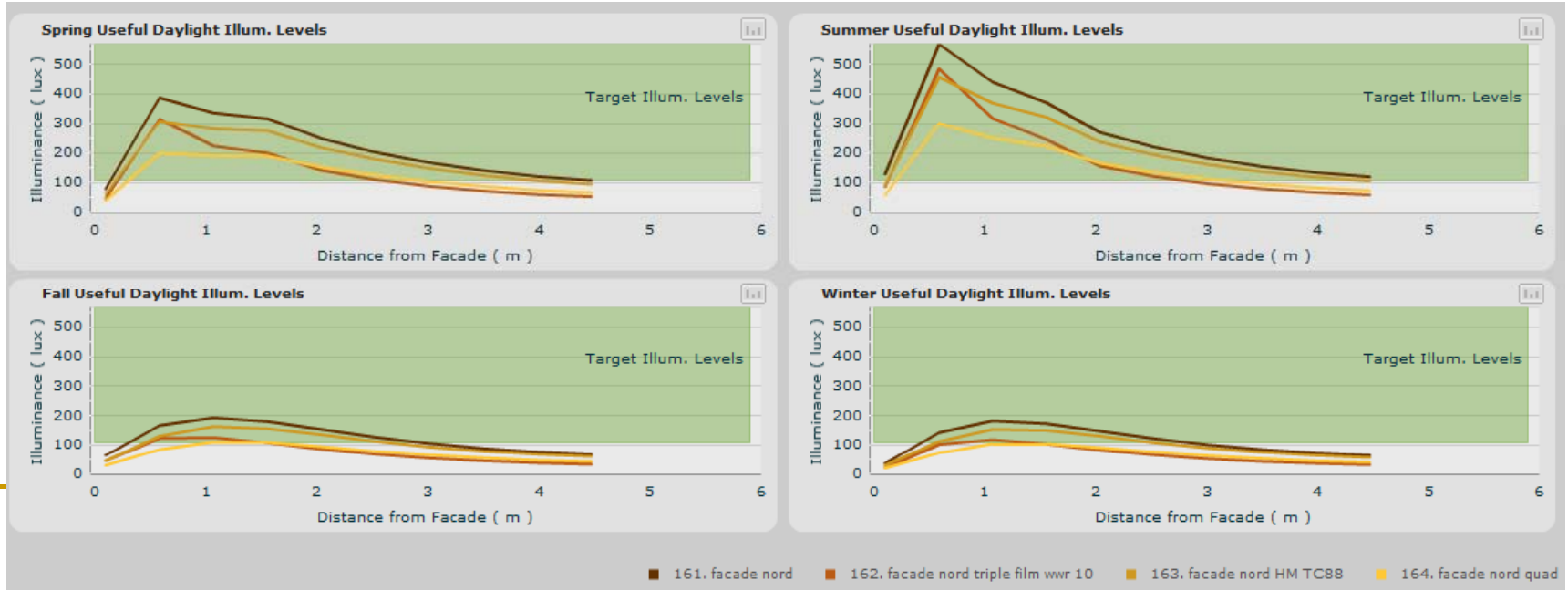


Comfen

Façades Nord

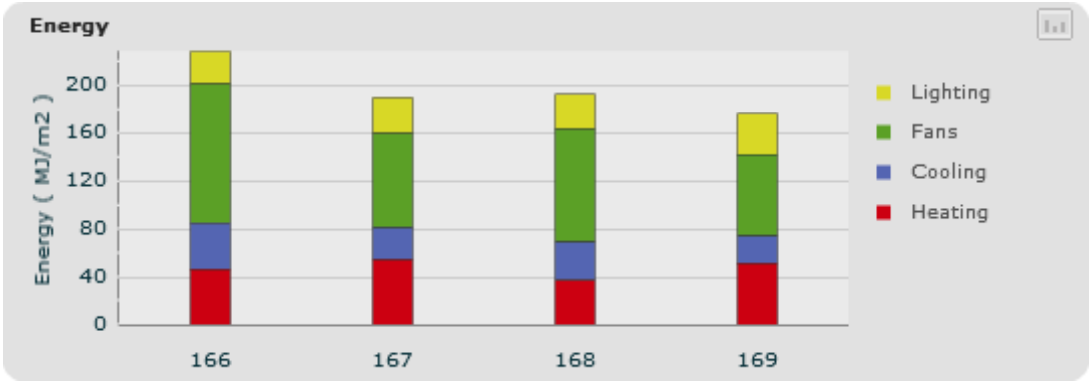
- PMV 20%
- PMV 10% (-13%)
- HM TC88 (-8%)
- Quad (-10.4%)

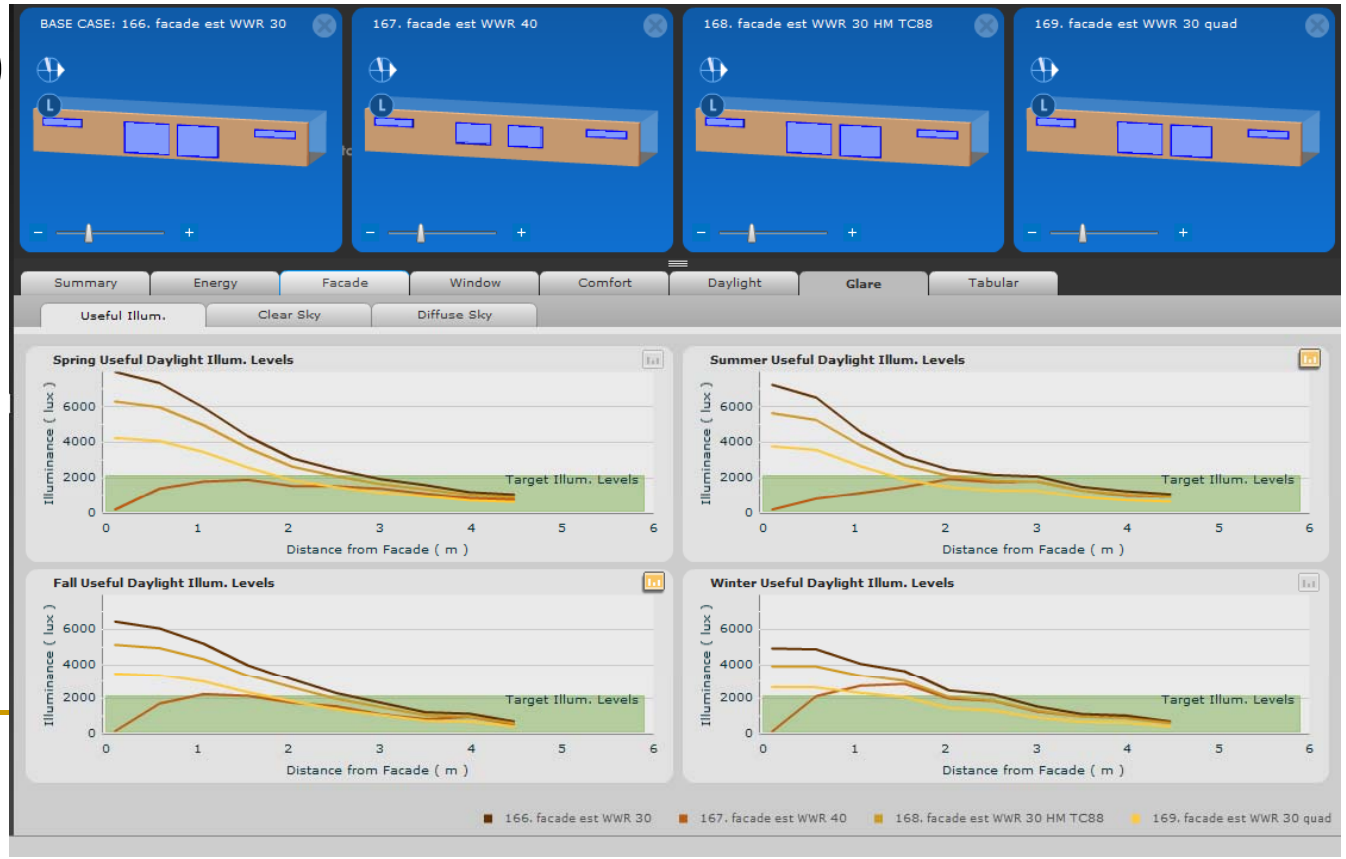




Comfen Façades Est

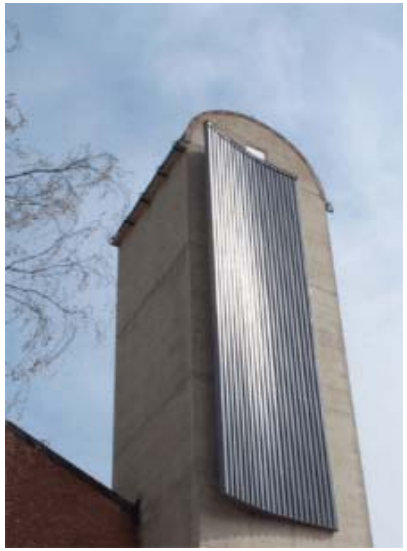
- PMV 30%
- PMV 20% (+16%)
- HM TC88 (-20%)
- Quad (+10%)





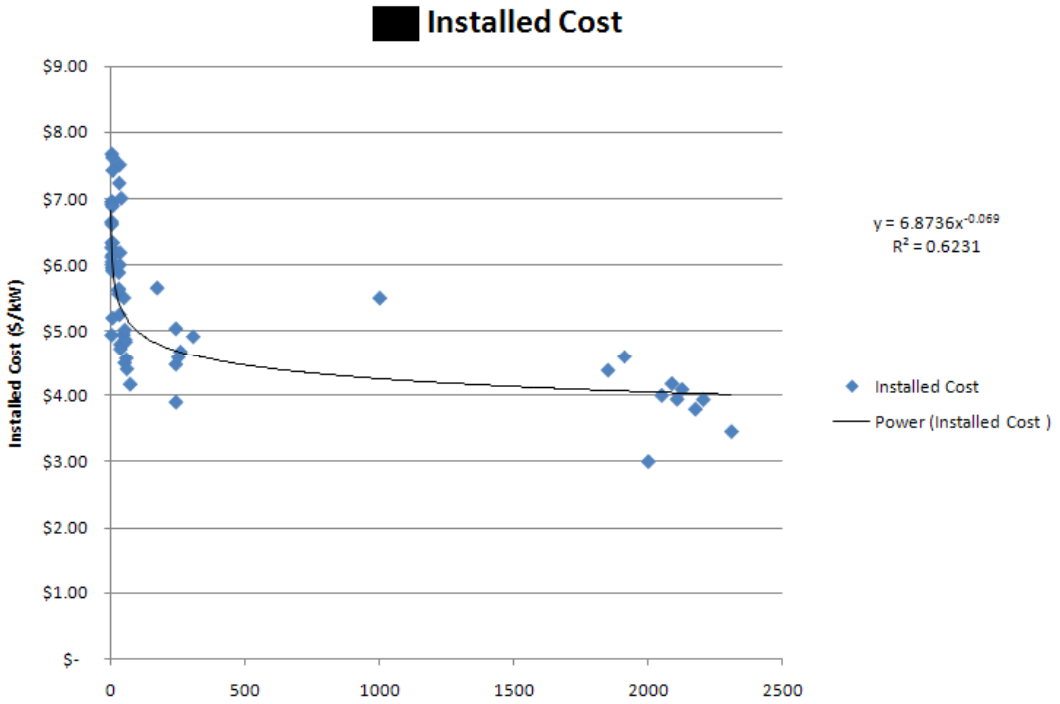
Solaire Thermique

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



Solaire Photovoltaïque

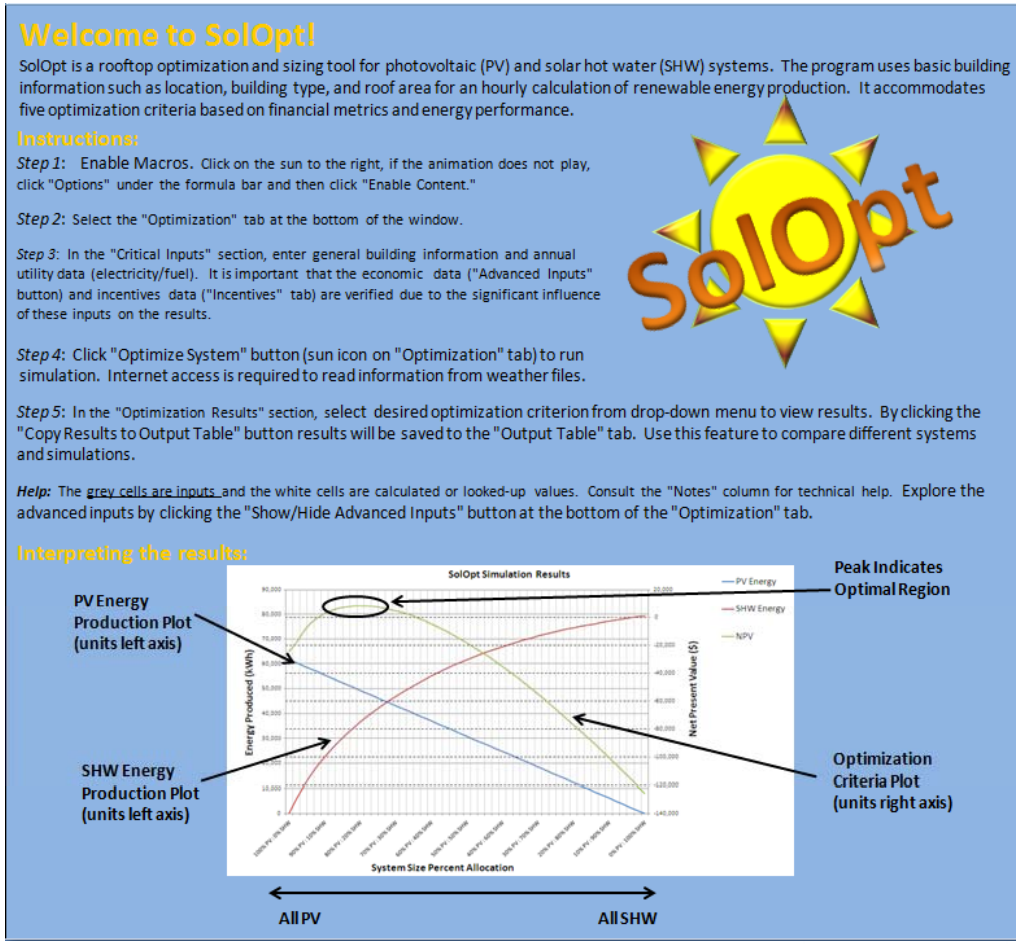
- Réduction des coûts d'installation
- Technologie éprouvée
- Coût du kWh produit élevé
- Besoin illimité (mesurage net)



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



SolOpt (exemple Net Zero)

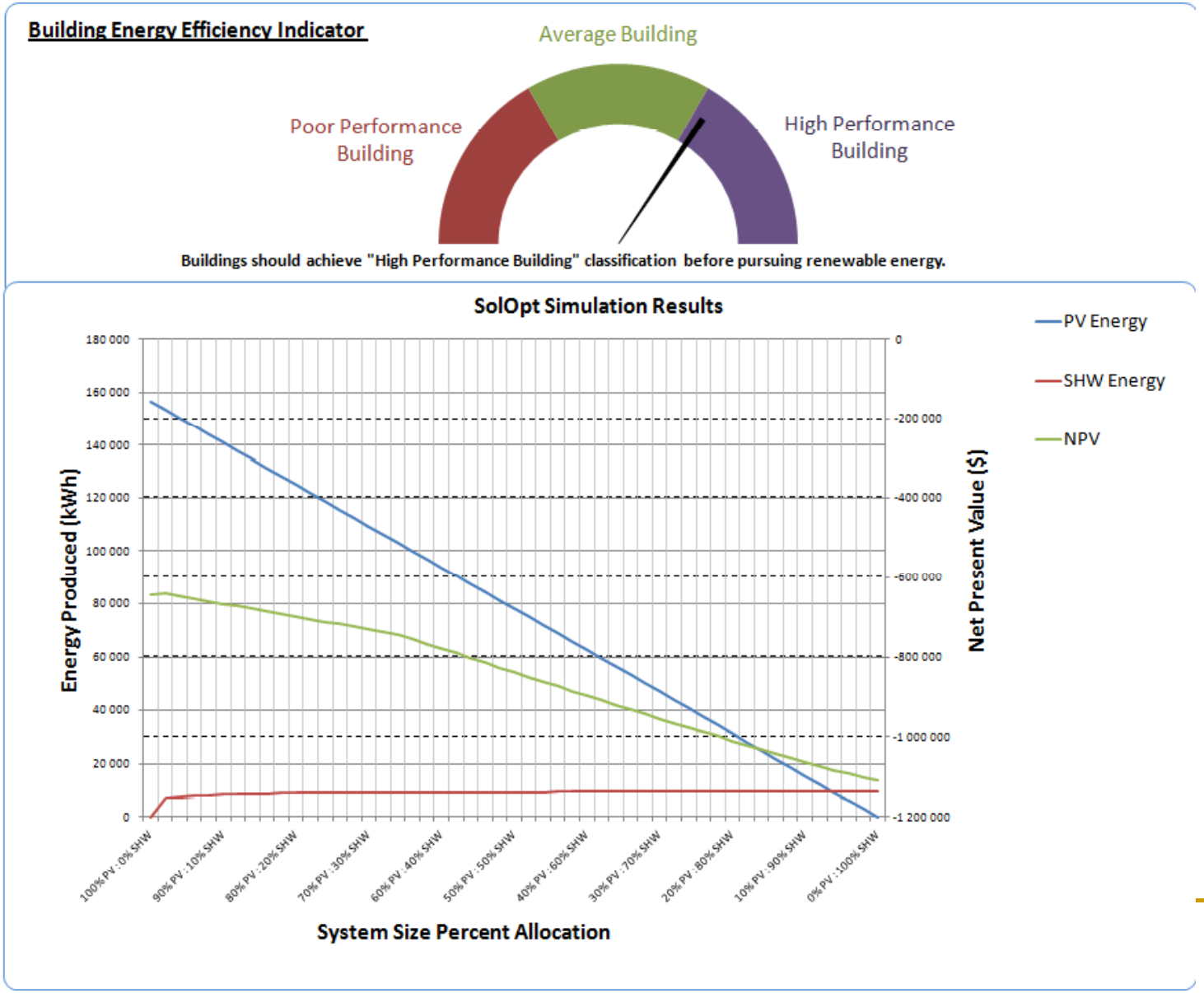
- 20,000 pi2
- Toit de 13,000 pi2
- 5 kWh/pi2
- Remplir la surface disponible

Critical Inputs	Units	Value	Notes
State	-	New York	
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	(annual cost) / (annual usage)
Blended Fossil Fuel Rate	$/Mbtu	$9,00	1 Mbtu = 1 million btu
Annual Electric Consumption	kWh/year	100 000	
Annual Fossil Fuel Consumption	Mbtu/year	800	Conversion Factors
Simulation Analysis Type	-	PV & SHW: Fill Entire Roof	
Building Energy Use Intensity (EUI)	$kBtu/ft^2$	57,1	Compare EUI to other buildings with the
Average Office EUI (CBECS)	$kBtu/ft^3$	92,9	Building Energy Efficiency Indicator gragh
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	
Slope of Roof/Ground	degrees	44	Typical Roof Angles
Usable Area Derate Factor	%	100%	100% if no roof-top obstructions
Total Array Tilt from Horizontal	degrees	0	≥ Roof/Ground Slope
Azimuth (East of South is Positive)	degrees	0	
Annual System Degradation	%/year	0,50%	
Altitude Angle (Winter Equinox)	degrees	22,6	
Production Limit	kWh	100 000	Based on annual consumption
Mounting Surface Reflectance	-	0,70	
Total Solar Collector Area	Ac (m^2)	1207,7	PV and SHW
CO2 Emission Factor PV	lb CO_2/ MWh	832,33	EPA eGRID Emissions Factor
CO2 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	
Project Lifetime	years	25	
Real DHW Fuel Escalation Rate		1,083%	DHW Fuel Escalation
Real Discount Rate	%	3,000%	Federal Default: 3%
Real Electricity Escalation Rate	%	0,542%	Federal Default: 0.541667%
Inflation Rate	%	0,900%	Federal Default: 0.9%
First Equipment Replacement Cost	$	$0,00	
First Equipment Replacement Year	year	20	
Second Equipment Replacement Cost	$	$0,00	
Second Equipment Replacement Year	year	40	
PV Federal Tax Incentive	%	0%	Solar Incentives
PV State Tax Incentive	%	0%	Incentives can be updated from the
PV State Production Credit	$/kWh	$0,00	"Incentives" Tab
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 (exemple Net Zero)



SolOpt (exemple Net Zero)

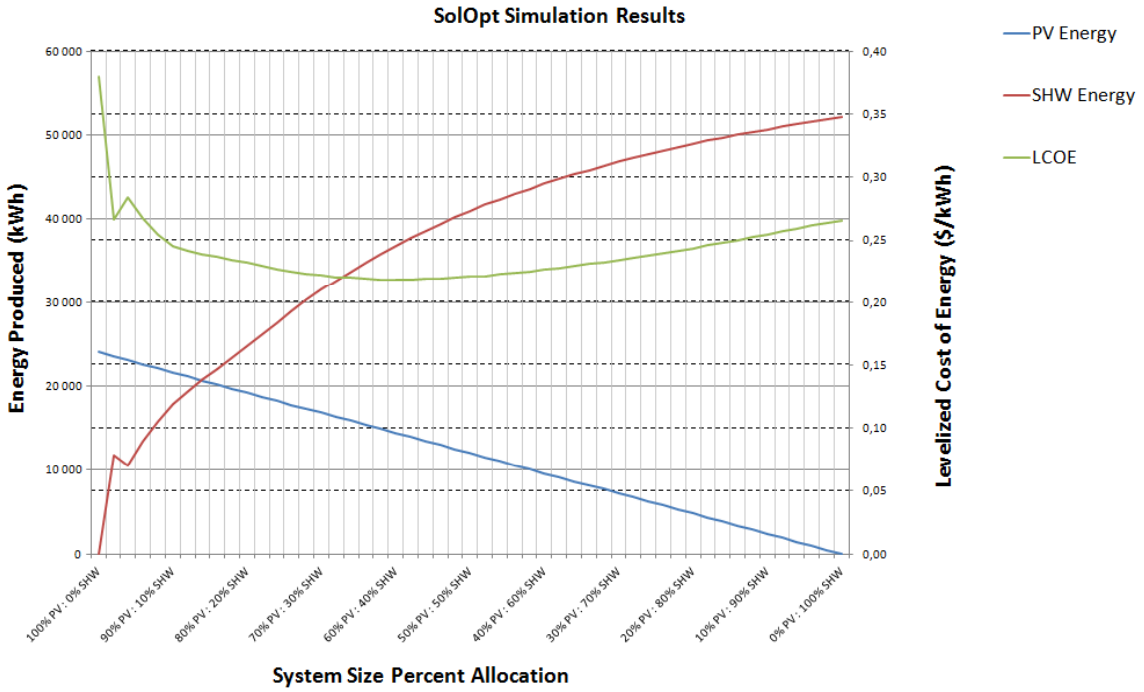
Optimization Results	Units	Value	Notes
Optimization Criterion	-	Maximize Net Present Value (NPV)	Select from 5 different optimal systems
Optimal PV System Size	ft^2	12 740	
Optimal PV System Capacity	kW	158,6	
PV Capacity Factor	%	11,0%	
Number of PV Panels	-	910,4	
Installed Cost PV	$/W	$4,85	
Optimal SHW System Size	ft^2	260	
Optimal SHW System Capacity	kW	11	SHW Capacity Rating
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	
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	Based on Utility Bills Only
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_2e	59	LCOE does not include accelerated depreciation or salvage value

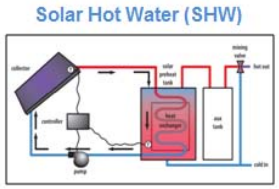
Show/Hide Advanced Inputs

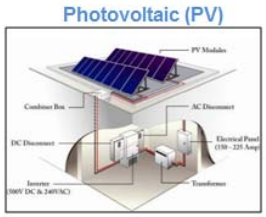
Copy Results to Output Table

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



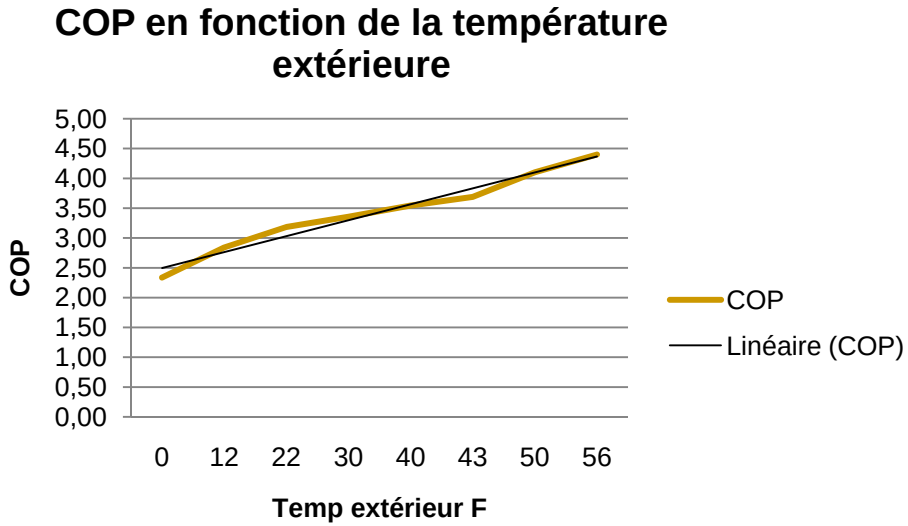




Output Table	residence1	residence2	residence3
Optimization Criteria	Maximize Net Present Value (NPV)	Maximize Net Present Value (NPV)	Minimize Levelized Cost of Energy
Optimal PV System Size	1 505	0	1 254
Optimal PV System Capacity	18,7	0,0	15,6
PV Capacity Factor	10,5%	0,0%	10,5%
Number of PV Panels	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

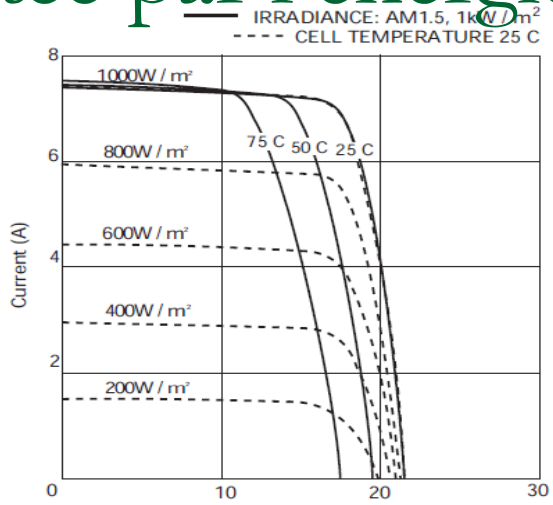
Thermopompe assistée par l'énergie solaire

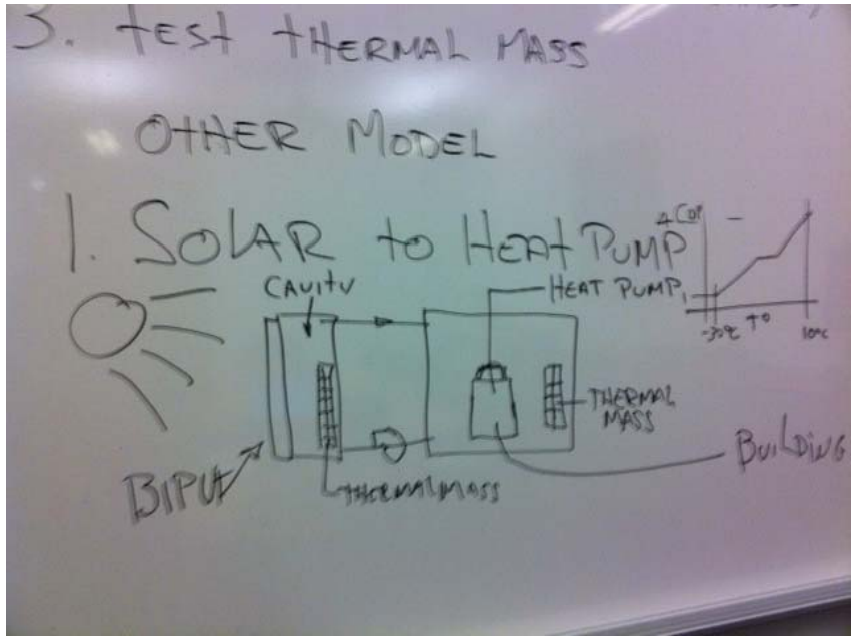
- Technologie des thermopompe permet 75% de capacité à -20 deg C
- Grande flexibilité grâce à la technologie du réfrigérant à débit variable
- Possibilité d' un coût plus faible que la géothermie



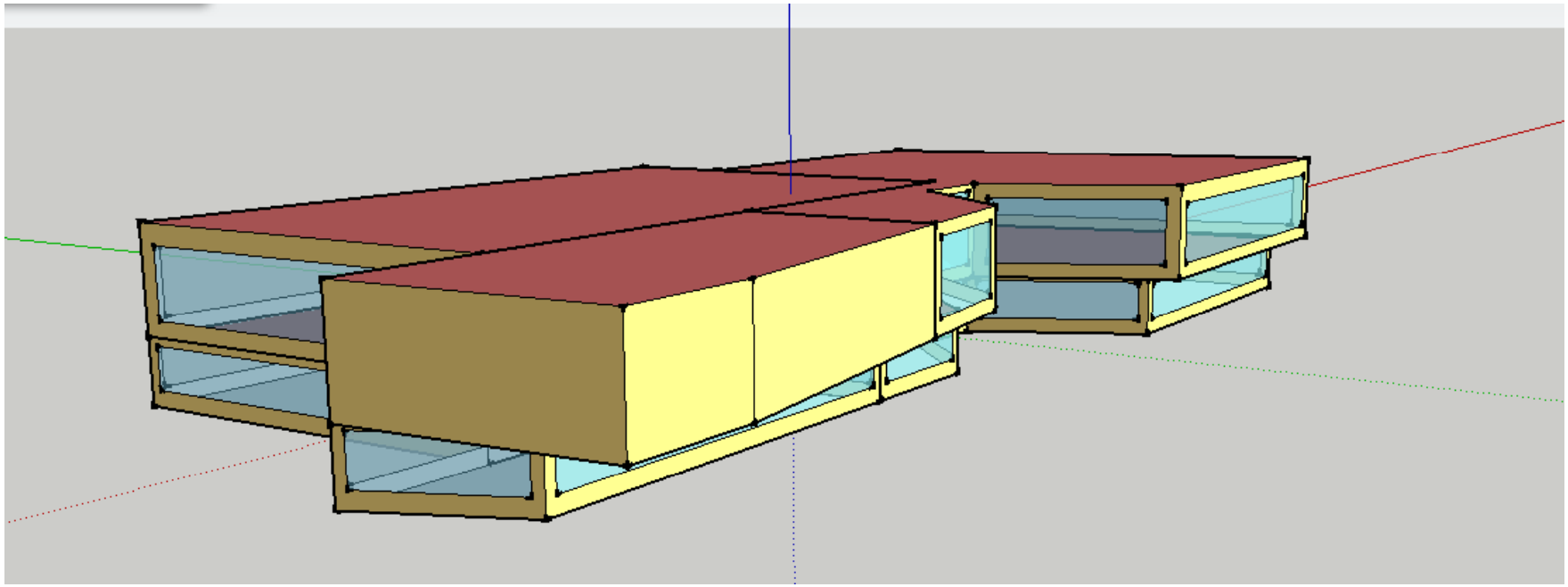
Thermopompe assistée par l'énergie solaire

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



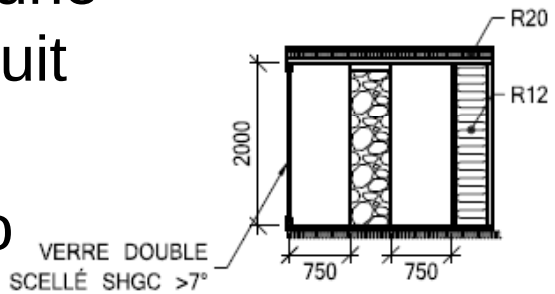


Thermopompe assistée par l'énergie solaire

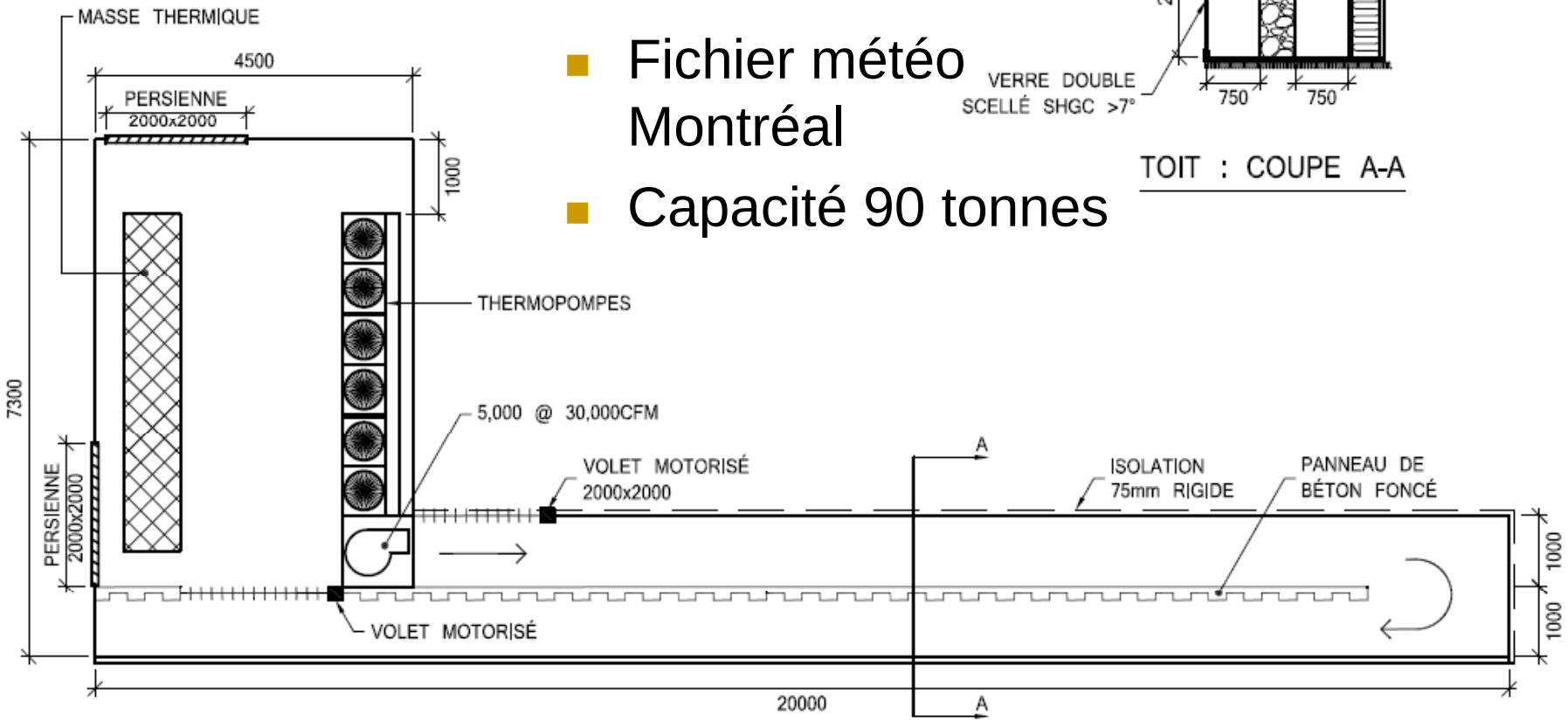


Thermopompe assistée par l'énergie solaire

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



TOIT : COUPE A-A



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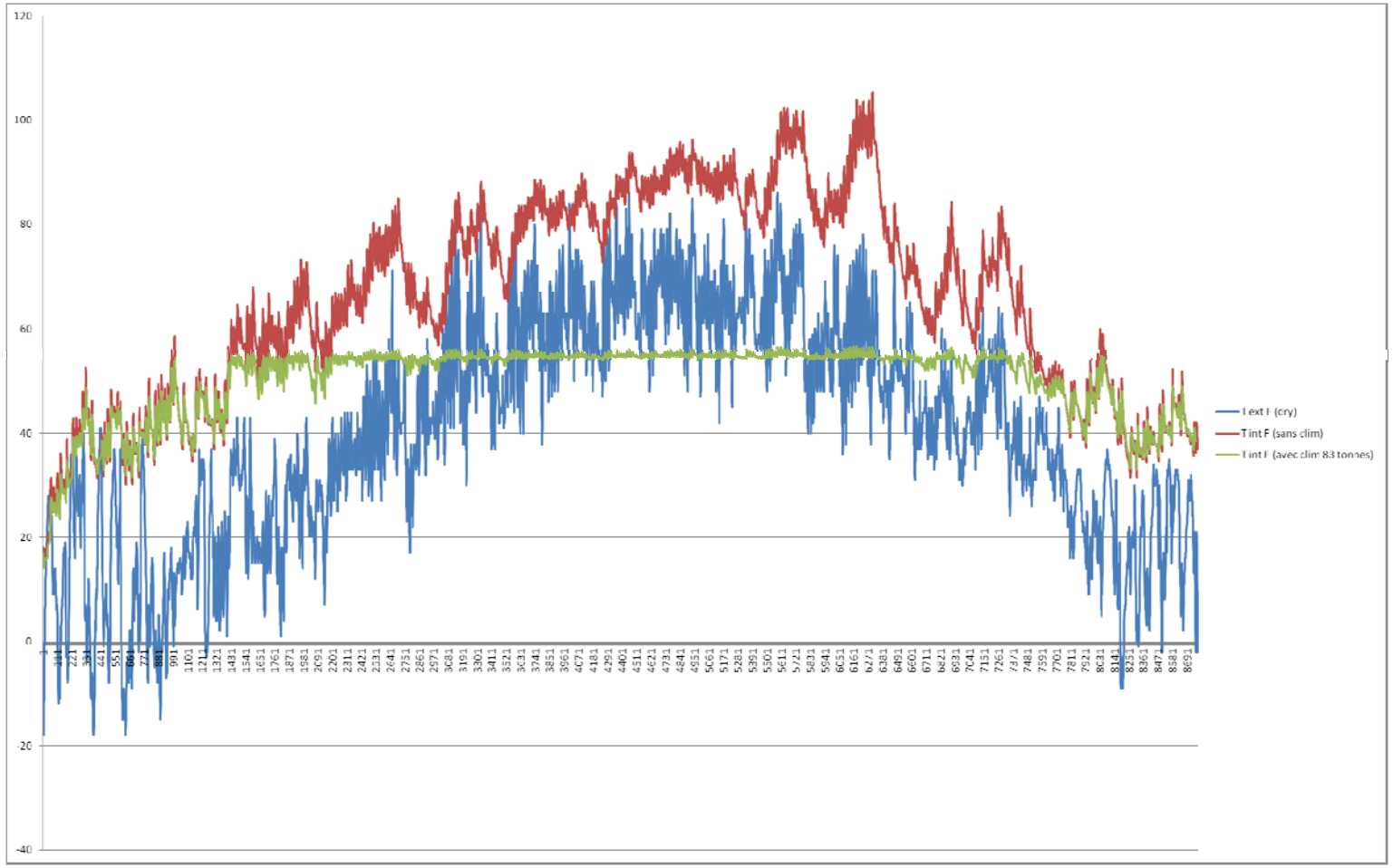
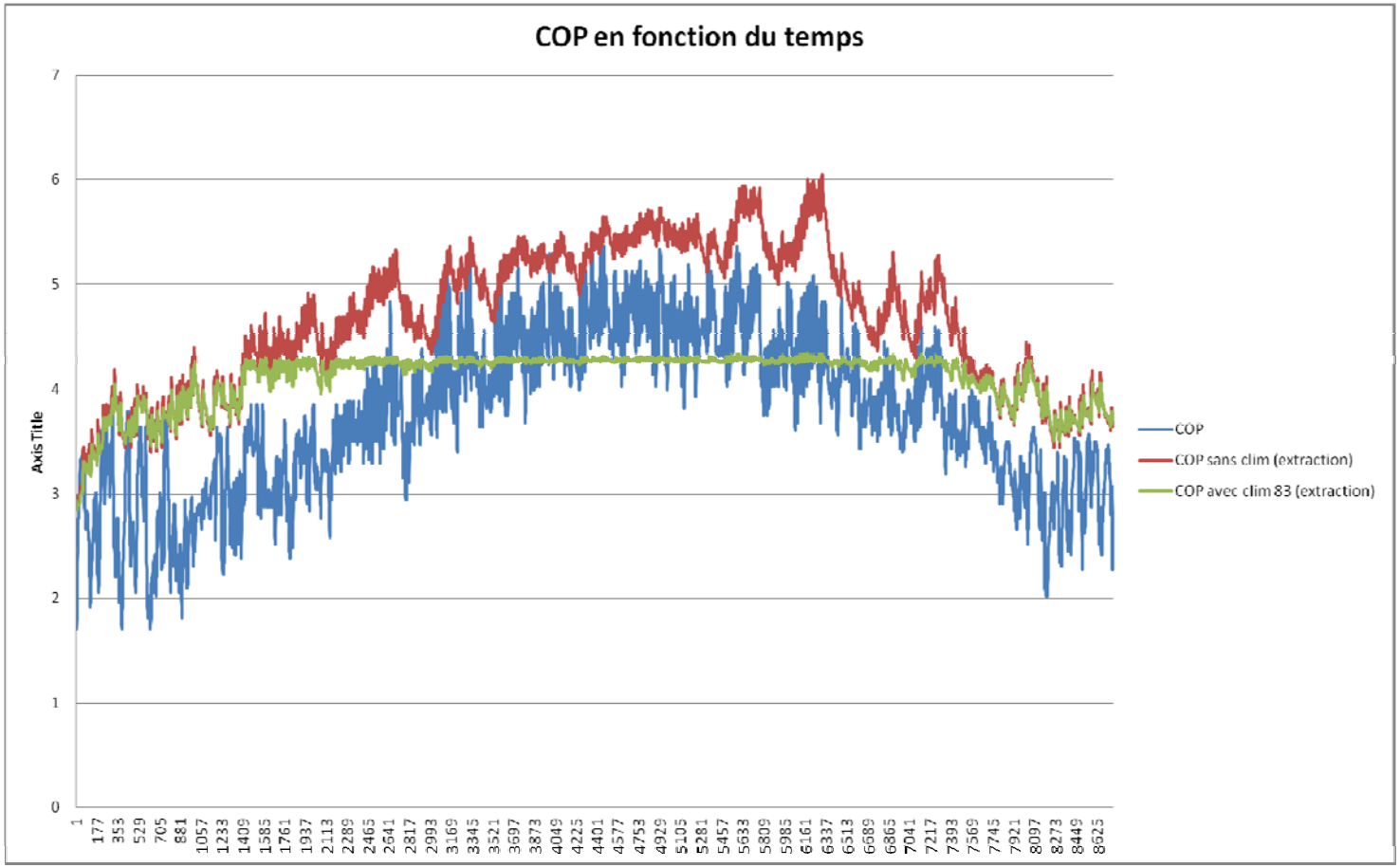


Température à l'intérieure de la salle de mécanique

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