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Using RETScreen for District Energy Projects

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CanmetENERGY, Natural Resources Canada

Natural Resources Canada   Ressources naturelles Canada

Canada

Ouje Bougoumou, Quebec

What’s needed?

- Available fuel
- Fuel cost and availability
- Heat and or power generation technologies
- Distribution system
- Customers energy requirements
- Energy efficiency measures
- Environmental factors
- Financial parameters (IRR, NPV, etc)
- Grants and subsidies
- Building and planning codes
- Legal issues


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THX 615


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	NatGas cost $/MWh	Efficiency	Energy cost $/MWh	Capital cost 10y, 5% ($8,000)	Operating & maintenance cost $100 + water heater rental $350	Energy usage 100 kWh/m², 250 m² = 25 MWh	Total cost
Individual boiler	$28.30	94%	$30.11	$1,036	$450	$753	$2,239
District energy			$88.50		$180	$2,213	$2,393

Natural gas Waterloo 2013 -average

Taxes not included

District energy cost Göteborg Energi - 2013

Cost comparison example

RETScreen Plus

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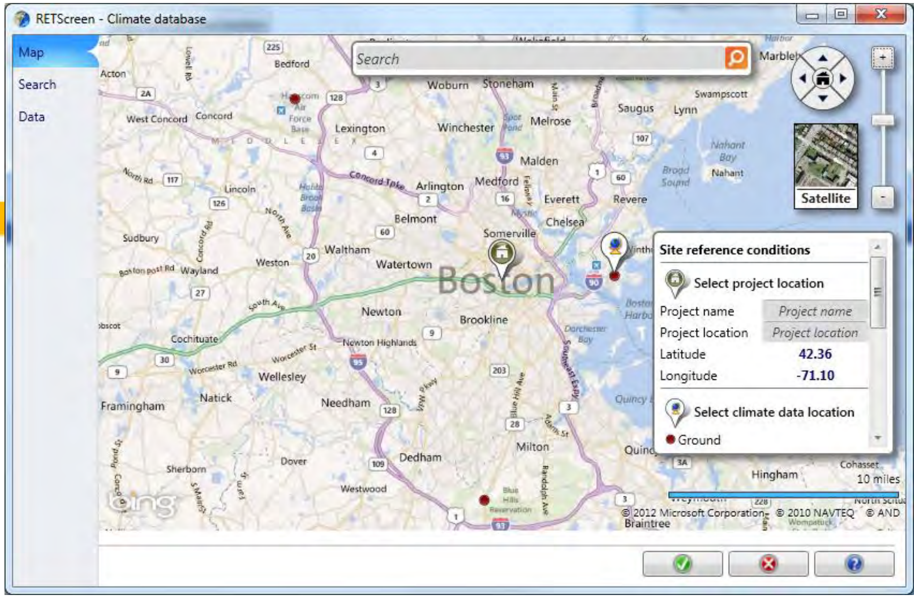
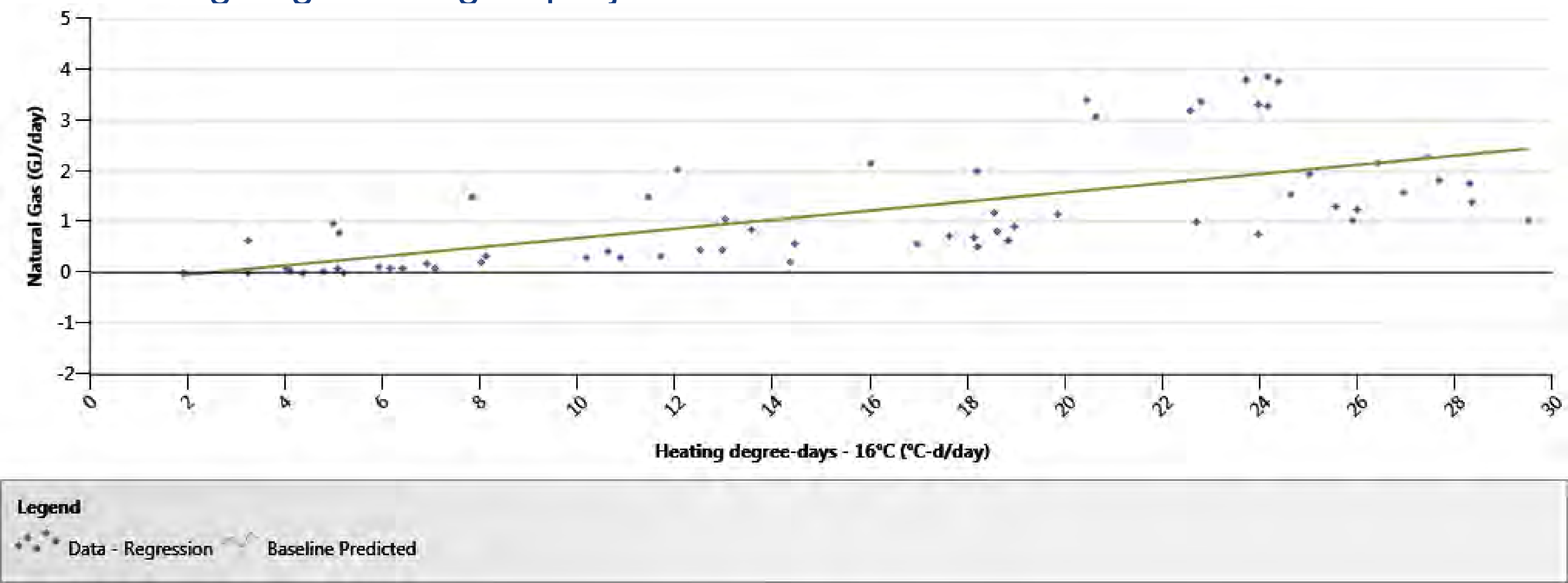
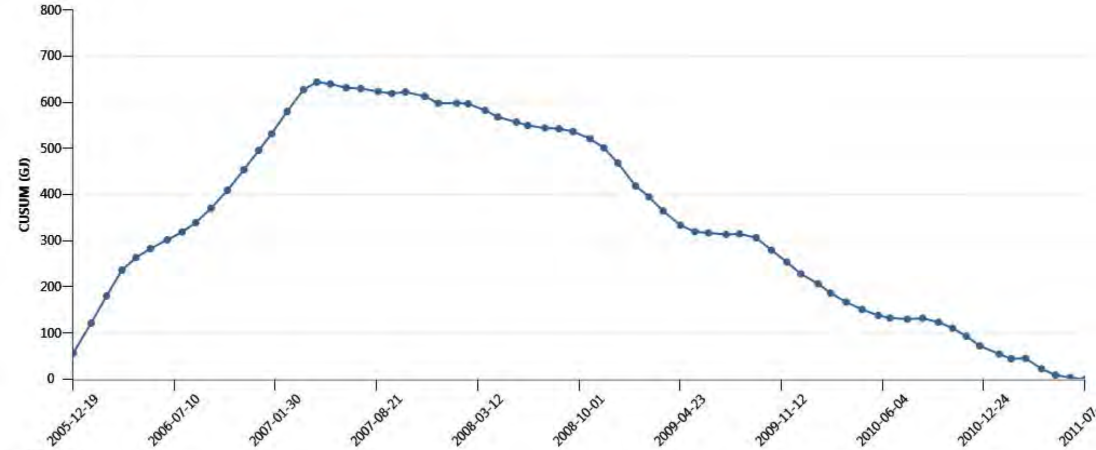
- Performance analysis model
- Import data energy usage or production
- Download weather from NASA
- Analyse performance
- On going tracking of projects

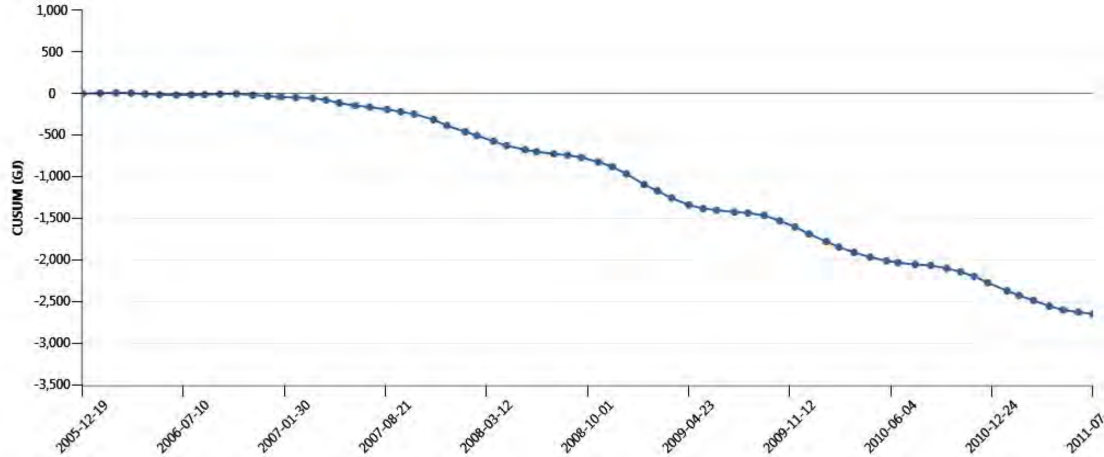




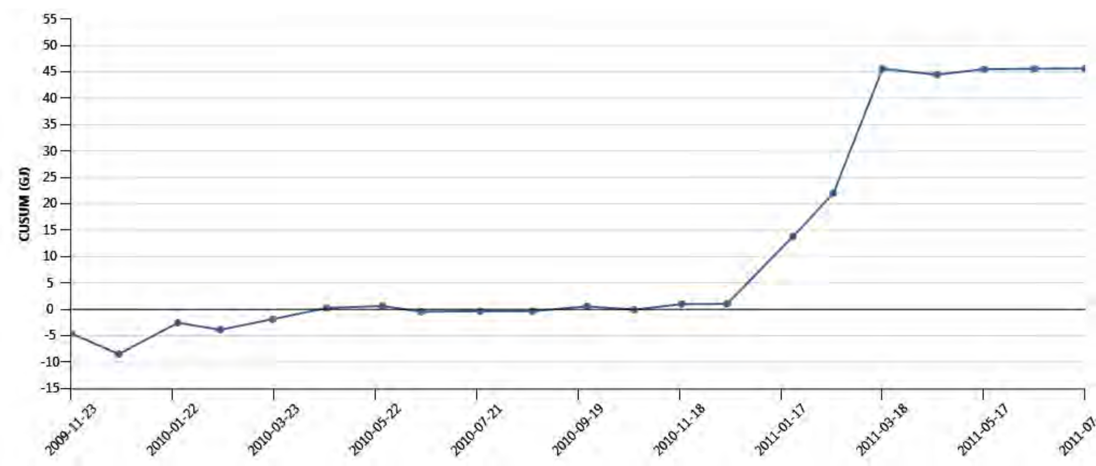
Cumulative sum of the variance



Verify changes



Correcting operational problems



Normal year

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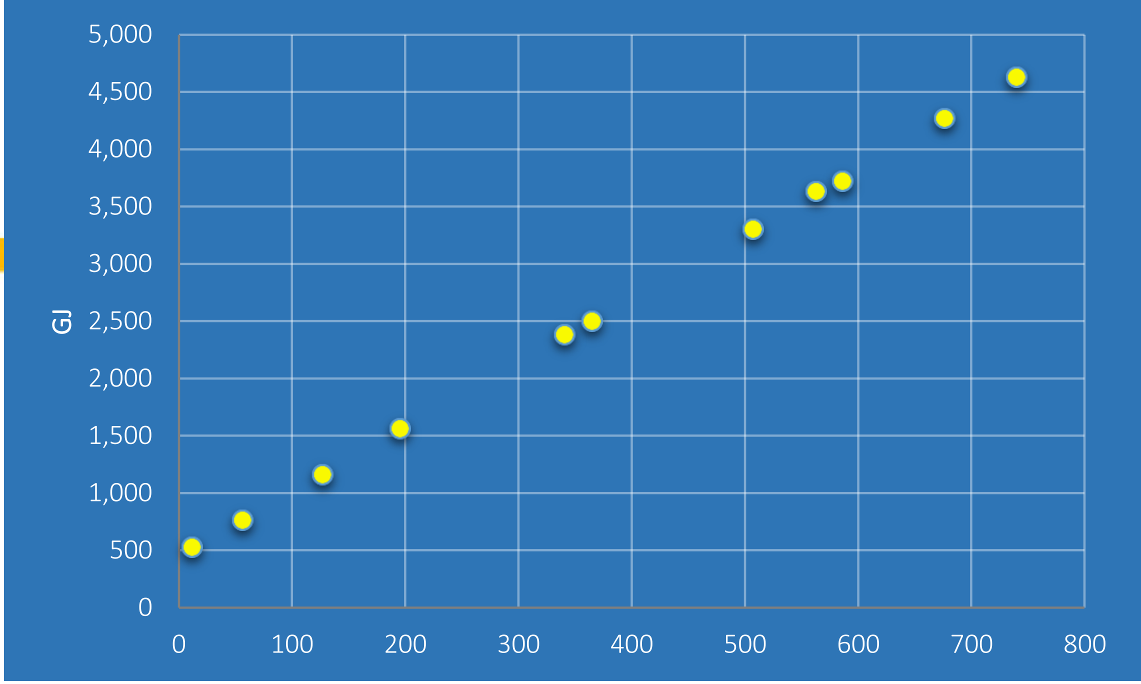
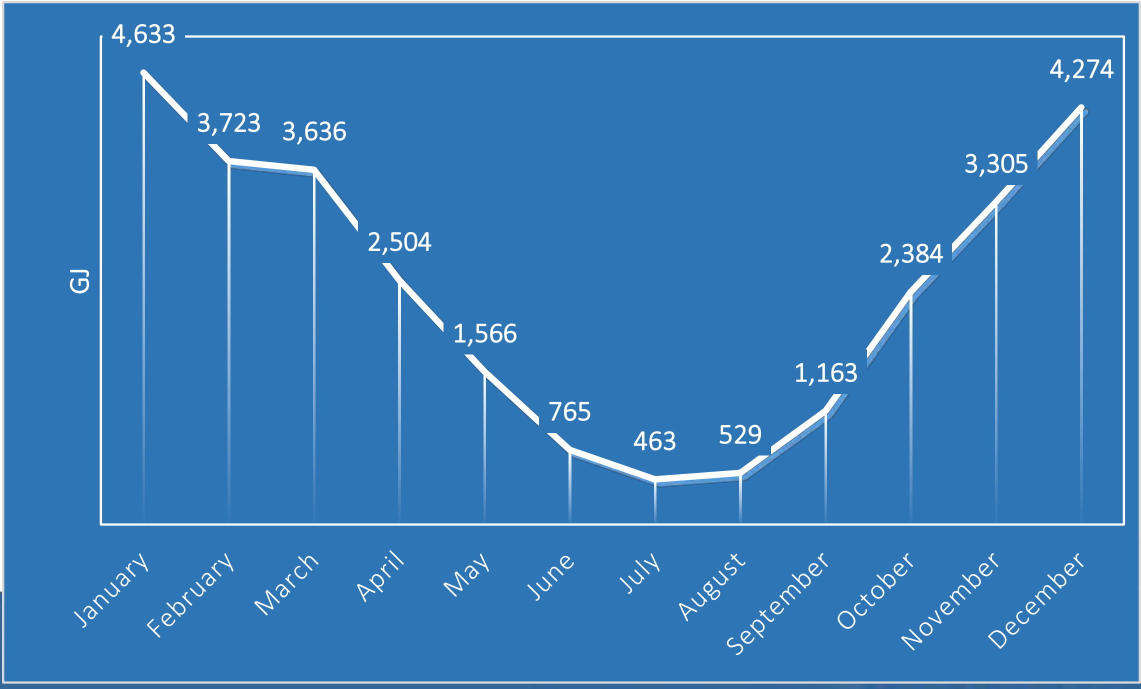
	16 C	Fuel consumption
	HDD -°C-d	GJ
January	740	4,633
February	586	3,723
March	563	3,636
April	364	2,504
May	195	1,566
June	56	765
July	0	463
August	11	529
September	127	1,163
October	341	2,384
November	507	3,305
December	676	4,274
Average	**6,025**	**28,946**
Base load		5,475
y=ax+b		19%
a	5.635	
b	15	

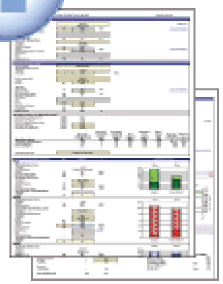




Five Step Standard Analysis

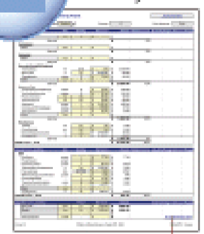
START Settings & Site Conditions

1 Energy Model



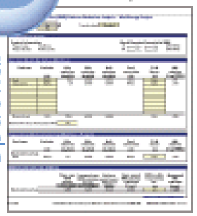
Sub-Worksheet(s)

2 Cost Analysis

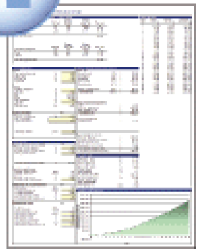


3 Emission Analysis

Optional

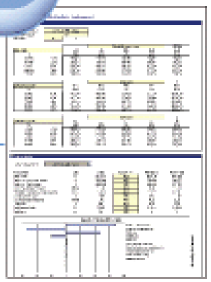


4 Financial Analysis



5 Sensitivity & Risk Analysis

Optional



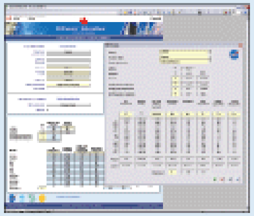
Enter data in shaded cells from top to bottom of each worksheet

Click on blue hyperlinks or floating icon to access integrated features

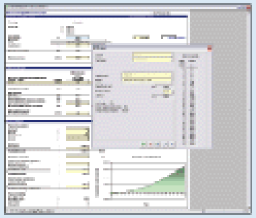
Ready to make **a decision**

Integrated Features

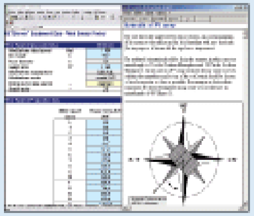
Climate Data



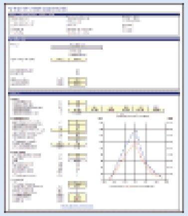
Product Data



Online Manual



Tools



- Distance Learning Course
- Training Material
- Engineering Textbook
- Case Studies
- Marketplace & Maps

Financing Options

- Natural gas 1,000,000 m^3/yr @ \$0.40/m^3
- 25% energy reduction
- Capital cost $300,000
- 2% inflation, 20 year project life

	Cash	Short term 70% debt 10% for 5 yrs	Long term 70% debt 6% for 15 yrs	Leasing 12% for 5 yrs	Energy Performance Contract* 8% for 7 yrs	Savings account, bonds, stocks
Equity	$300,000	$90,000	$90,000	$0	$0	$300,000
Pre-tax IRR - equity	35.90%	61.20%	91.80%			
Pre-tax IRR - assets	35.90%	24.10%	29.10%	19.80%	12.40%	3% - 15%
Simple payback	3	3	3	3	4.5	
Equity payback	2.9	1.9	1.1	Immediate	Immediate	
Cumulative dividend 3 yrs	$312,200	$146,000	$247,300	$62,500	$52,900	$27,000 to $135,000
Cumulative dividend 20 yrs	$2,478,000	$2,201,000	$2,154,000	$2,062,000	$1,873,000	$180,000 to $900,000

* + 20% cost for verification + 30% cost for risk management

RETScreen

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Canada

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Templates | Case studies | User-defined

Project type	Type	Project location	Climate data location	Project name
Heating	Solar water heater	Canada	Comox Airport	Aquaculture
Heating	Solar air heater	Canada	Toronto	Classroom
Heating	Biomass system	Canada	Charlottetown Arpt	District energy
Heating	Solar air heater	Canada	Fort Smith Airport	Gymnasium/exercise area
Heating	Solar water heater	Canada	Quebec A	Hotel/Motel
Heating	Solar water heater	Canada	Vancouver Int'l.	House
Heating	Biomass system	Canada	Ottawa Int'l Airport	Industrial
Heating	Biomass system	Canada	Penticton Airport	Industrial
Heating	Solar air heater	Canada	Montreal Int'l. Airport	Industrial
Heating	Solar air heater	Canada	Cold Lake Airport	Institutional
Heating	Solar air heater	Canada	St-Hubert Airport	Institutional
Heating	Biomass system	Canada	Chibougamau-Chapais	Multiple buildings
Heating	Biomass system	Canada	Kapuskasing Airport	Multiple buildings
Heating	Boiler	Canada	Inuvik Ua	Multiple buildings
Heating	Boiler	Canada	Vancouver Int'l.	Office
Heating	Solar air heater	Canada	Montreal Int'l. Airport	Pig - building
Heating	Boiler	Canada	Vancouver Int'l.	Swimming pool - Indoor

UNEP GEF

RETScreen Suite

Heating - Biomass system - Multiple buildings / Canada (Chibougamau-Chapais)

Case study assignment

You have been hired by a Canadian Aboriginal Community to prepare a pre-feasibility study on their behalf. They wish to construct a new village in northern Quebec, Canada, using renewable energy as the main source of heat. Logging is one of the main economic activities in the area, and local sawmills could provide waste wood for a biomass heating system for the village. Sawmills only utilise a fraction of the harvested log; the wood waste from a sawmill with dry kiln includes bark, sawdust, shavings, and chips from wood that can not be cut to dimensional lumber. The village planners would like to know if a biomass district energy system using this wood waste would be more cost-effective than electric baseboard heaters or oil-fired furnaces sited in each individual building. They are interested in looking at the initial phase of the community with the understanding that if this proves financially viable, then they will invest in a larger design study to provide heat for the entire community as it grows in the future.

Site information

The community will construct 30 single family homes, each 125 m^2, built to specifications exceeding the Canadian R-2000 building standard. The houses are offset 12 m from the centre of the road and each property is 20 metres wide. The community will also construct a school (700 m^2), band office (500 m^2) and a clinic (200 m^2). A new cultural centre (600 m^2) is planned for the next few years. The public buildings are offset 30 m from the centre of the road. The planned layout of the village is such that any further expansion of housing for the village will be directly to the north of the heating plant. The plan of the community is provided here.

The area planned for development has sandy soil, without rock. A sawmill is located approximately 26 km from the proposed site. The nearest meteorological station is at Roberval Airport, Quebec, Canada.

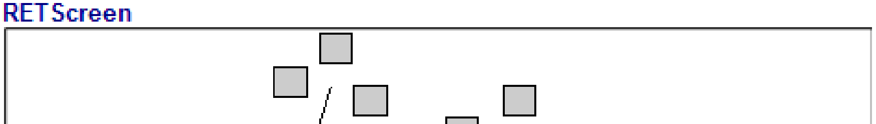
Financial information

Typical financial figures for the analysis are provided by the community: debt ratio of 90%, debt interest rate of 8%, discount rate of 12%, and a debt term of 20 years, and inflation rate of 2.5%. The community will not pay income tax. The system is assumed to last 25 years.

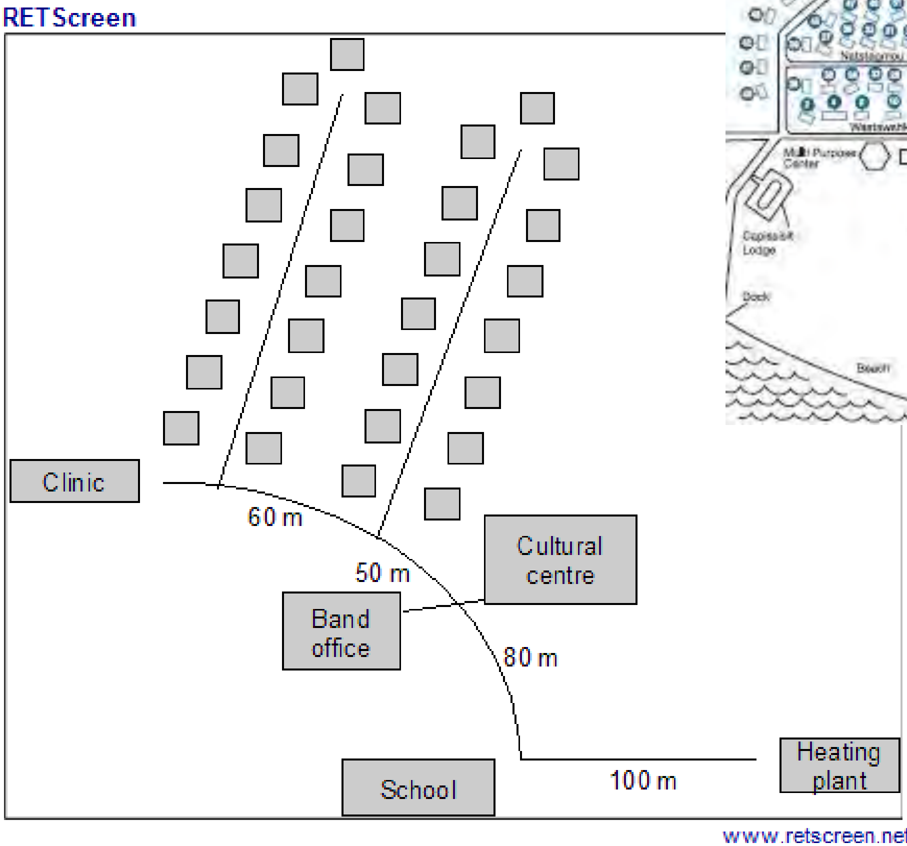
Wood waste is available free of charge from the sawmill, but transporting it will cost about $7/tonne. The average price of electricity is $0.15/kWh and oil is delivered to the community at $0.45/litre. Fuel costs are expected to escalate at the same rate as inflation. The cost of conventional oil-fired boiler heating systems will average about $2,500 per building. The community is somewhat remote and labour costs are relatively high.

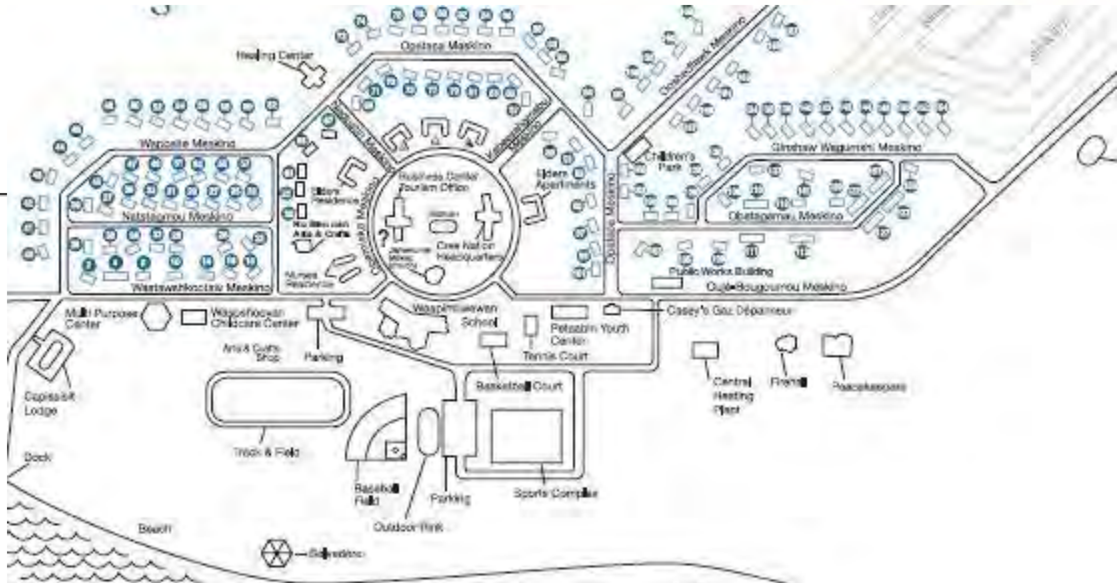
Prepare a RETScreen study, documenting any assumptions that you are required to make, and report on the significant conclusions from this analysis.

RETScreen



Community layout





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Building clusters

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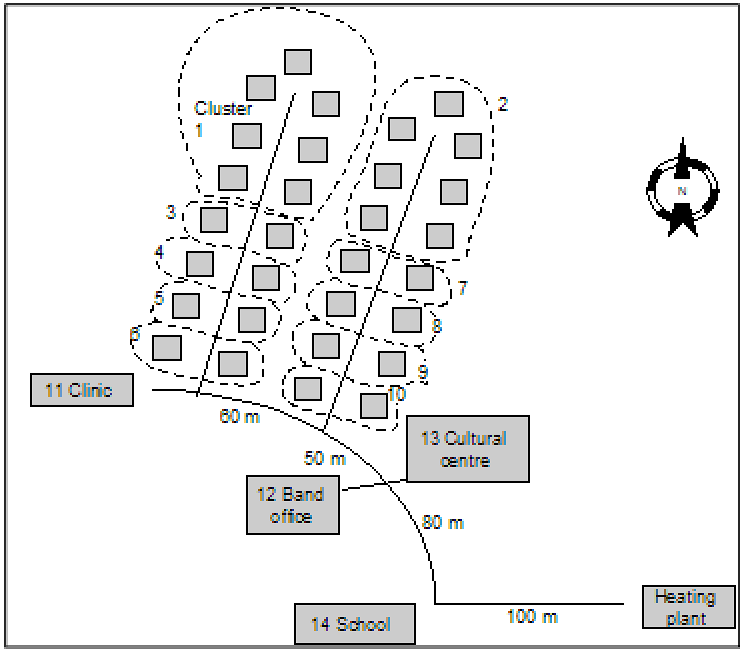

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District energy evaluation

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Clean Energy Project Analysis Software

Project information *See project database*

Project name	Ouje Bougoumou, Quebec
Project location	Canada
Prepared for	
Prepared by	
Project type	Heating
Technology	Biomass system
Analysis type	Method 2
Heating value reference	Higher heating value (HHV)
Show settings	☐

Site reference conditions *Select climate data location*

Climate data location	Chibougamau-Chapais
Show data	☐

NASA UNEP GEF reeep

Complete Load & Network sheet

RETScreen Load & Network Design - Heating project

Heating project	Unit						
Base case heating system	Multiple buildings - space heating						
See technical note on heating network design				**Building clusters**			
				1	**2**	**3**	**4**
Heated floor area per building cluster	m²	5,750		875	875	250	250
Number of buildings in building cluster	building	34		7	7	2	2
Fuel type				Diesel (#2 oil) - L	Diesel (#2 oil) - L	Diesel (#2 oil) - L	Diesel (#2 oil) - L
Seasonal efficiency	%	-		60%	60%	60%	60%
Heating load calculation							
Heating load for building cluster	W/m²	-		70	70	70	70
Domestic hot water heating base demand	%	10%					
Total heating	MWh	1,028		156	156	45	45
Total peak heating load	kW	403		61	61	18	18
Fuel consumption - unit		-		L	L	L	L
Fuel consumption - annual		-		24,454	24,454	6,987	6,987
Fuel rate - unit		-		$/L	$/L	$/L	$/L
Fuel rate		-		0.450	0.450	0.450	0.450
Fuel cost		$	72,314	$ 11,004	$ 11,004	$ 3,144	$ 3,144
Proposed case energy efficiency measures							
End-use energy efficiency measures	%	0%		0%	0%	0%	0%
Net peak heating load	kW	403		61	61	18	18
Net heating	MWh	1,028		156	156	45	45

Proposed case district heating network		**Estimate/Total**					
Heating pipe design criteria							
Design supply temperature	°C	95					
Design return temperature	°C	65					
Differential temperature	°C	30					
Main heating distribution line							
Main pipe network oversizing	%	0%					
Pipe sections	**Load**	**Length**	**Pipe size**	**Is the building cluster supplied by this pipe section? (yes/no)**			
	kW	**m**	**mm**	**1**	**2**	**3**	**4**
Section 1	78.8	20	DN 40	Yes		Yes	
Section 2	96.3	20	DN 50	Yes		Yes	Yes
Section 3	113.8	20	DN 50	Yes		Yes	Yes
Section 4	131.3	20	DN 50	Yes		Yes	Yes
Section 5	78.8	20	DN 40		Yes		
Section 6	96.3	20	DN 50		Yes		
Section 7	113.8	20	DN 50		Yes		
Section 8	131.3	20	DN 50		Yes		
Section 9	145.3	60	DN 50	Yes		Yes	Yes
Section 10	276.5	50	DN 65	Yes	Yes	Yes	Yes
Section 11	353.5	80	DN 65	Yes	Yes	Yes	Yes
Section 12	402.5	100	DN 65	Yes	Yes	Yes	Yes
Section 13							
Total pipe length for main distribution line	m	450					
Secondary heating distribution lines							
Secondary pipe network oversizing	%	0%		**Secondary distribution pipes length per building cluster**			

Financial viability

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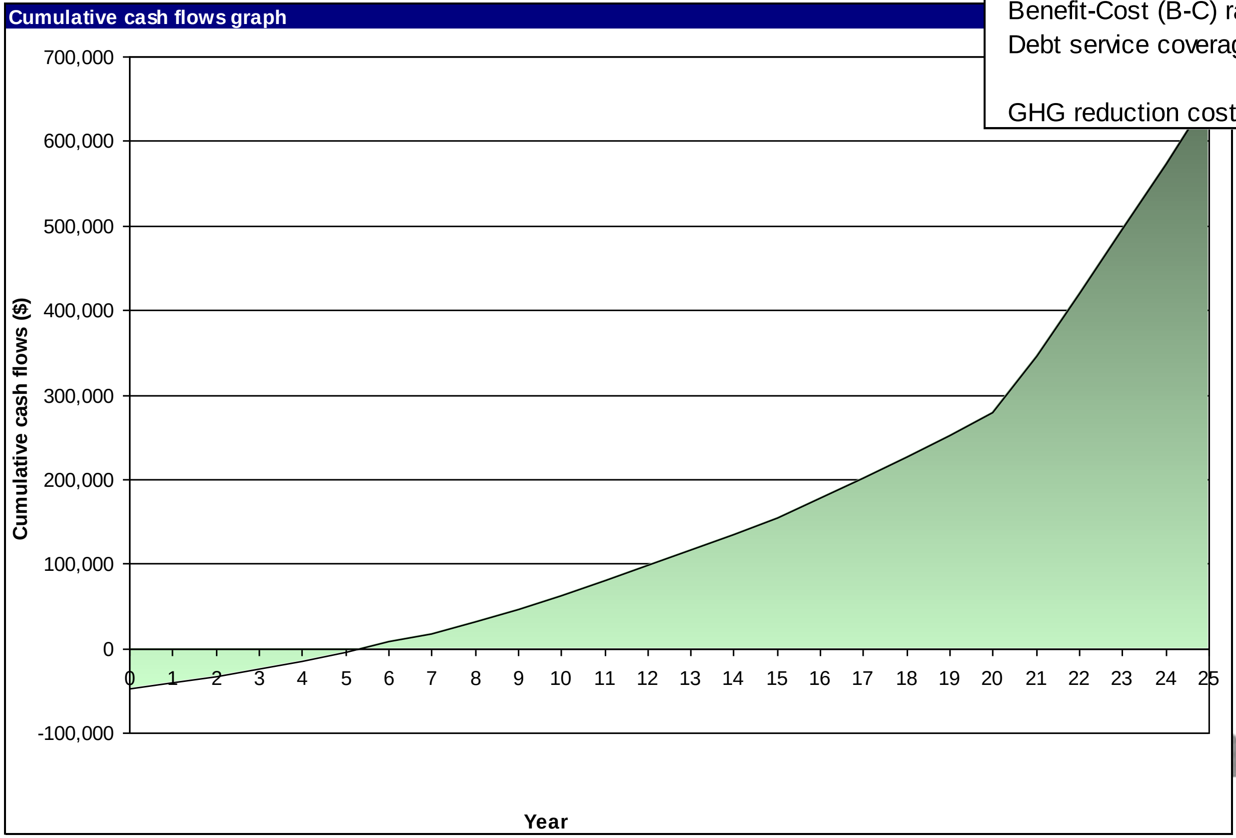
Financial viability		
Pre-tax IRR - equity	%	32.3%
Pre-tax IRR - assets	%	4.4%
After-tax IRR - equity	%	23.5%
After-tax IRR - assets	%	2.2%
Simple payback	yr	8.9
Equity payback	yr	5.3
Net Present Value (NPV)	$	74,953
Annual life cycle savings	$/yr	9,556
Benefit-Cost (B-C) ratio		2.57
Debt service coverage		1.25
GHG reduction cost	$/tCO2	(23)



Sensitivity analysis

RETScreen Sensitivity and Risk Analysis - Heating project

☑ Sensitivity analysis

Perform analysis on	After-tax IRR - equity
Sensitivity range	30%
Threshold	10 %

Fuel cost - base case		Initial costs				$
		334,583	406,280	477,976	549,673	621,369
$		-30%	-15%	0%	15%	30%
50,620	-30%	13.6%	6.0%	1.3%	-2.1%	-4.8%
61,467	-15%	34.0%	19.1%	10.9%	5.8%	2.2%
72,314	0%	58.8%	37.1%	**23.5%**	15.0%	9.5%
83,161	15%	84.7%	57.6%	39.4%	26.9%	18.5%
94,008	30%	110.8%	78.9%	56.8%	41.0%	29.6%

Fuel cost - proposed case		Initial costs				$
		334,583	406,280	477,976	549,673	621,369
$		-30%	-15%	0%	15%	30%
3,363	-30%	62.2%	39.8%	25.4%	16.4%	10.6%
4,084	-15%	60.5%	38.4%	24.4%	15.7%	10.0%
4,805	0%	58.8%	37.1%	**23.5%**	15.0%	9.5%
5,525	15%	57.1%	35.8%	22.5%	14.3%	9.0%
6,246	30%	55.4%	34.5%	21.6%	13.6%	8.5%

Debt interest rate		Initial costs				$
		334,583	406,280	477,976	549,673	621,369
%		-30%	-15%	0%	15%	30%
5.60%	-30%	69.5%	47.2%	32.3%	22.3%	15.5%
6.80%	-15%	64.3%	42.2%	27.8%	18.5%	12.3%
8.00%	0%	58.8%	37.1%	**23.5%**	15.0%	9.5%
9.20%	15%	53.1%	32.1%	19.4%	11.8%	7.0%
10.40%	30%	47.4%	27.1%	15.7%	9.1%	4.7%

Risk Analysis

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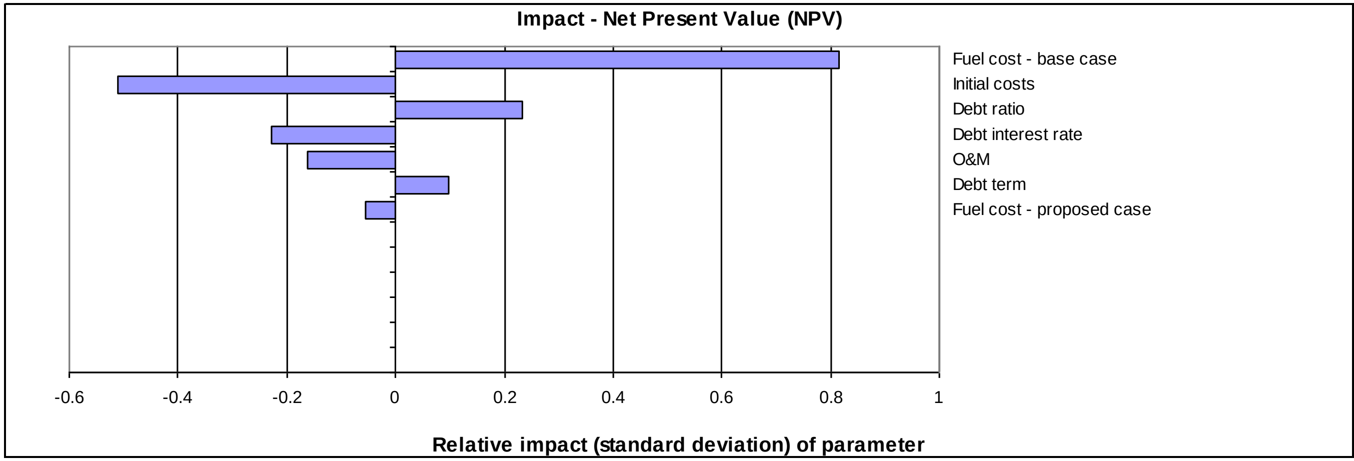
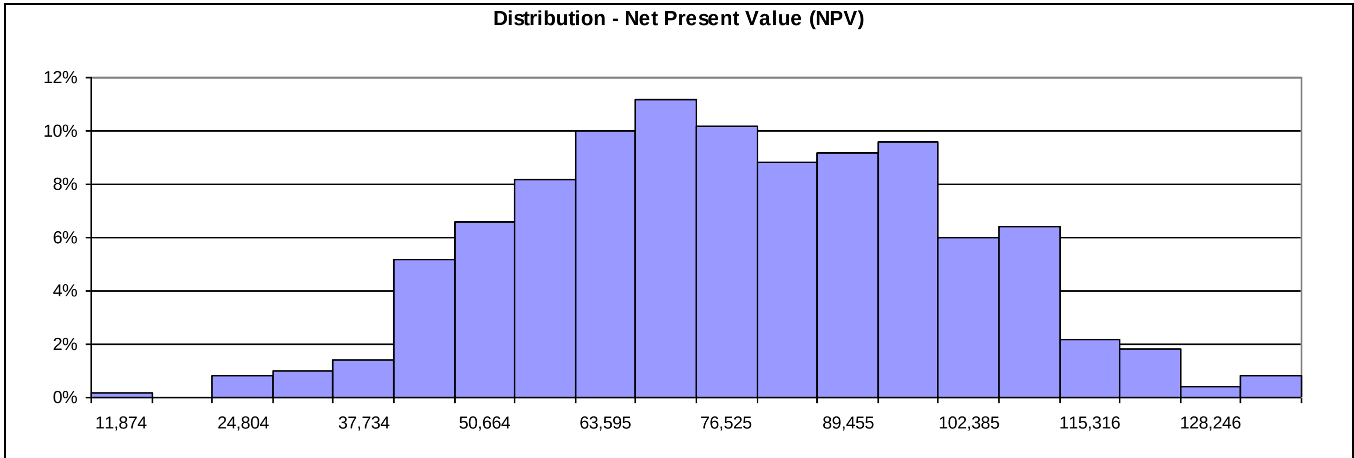
☑ Risk analysis

Perform analysis on: Net Present Value (NPV)

Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Initial costs	$	477,976	10%	430,179	525,774
O&M	$	14,037	10%	12,634	15,441
Fuel cost - proposed case	$	4,805	10%	4,324	5,285
Fuel cost - base case	$	72,314	10%	65,083	79,546
Debt ratio	%	90%	10%	81%	99%
Debt interest rate	%	8.00%	10%	7.20%	8.80%
Debt term	yr	20	10%	18	22



Median	$	76,512
Level of risk	%	
Minimum within level of confidence	$	8,641
Maximum within level of confidence	$	137,944



Check calculations! Questions?