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RETScreen® International

Clean Energy Project Analysis Software

Ground-Source Heat Pump Project Model

Click Here to Start

- Description & Flow Chart
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Worksheets

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Features

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Clean Energy Decision Support Centre

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UNEP NASA GEF

RETScreen® Energy Model - Ground-Source Heat Pump Project

Training & Support

Site Conditions		Estimate	Notes/Range
Project name		**Pompa ciepła**	See Online Manual
Project location		**Polska**	
Available land area	m²	1 200	
Soil type	-	Heavy soil - damp	
Design heating load	kW	13,4	→ Complete H&CLC sheet
Design cooling load	kW	0,0	

System Characteristics		Estimate		Notes/Range
Base Case HVAC System				
Building has air-conditioning?	yes/no	No		
Heating fuel type	-	**Natural gas**		
Heating system seasonal efficiency	%	80%		55% to 350%
Ground Heat Exchanger System				
System type	-	Horizontal closed-loop		
Design criteria	-	Heating		
Typical land area required	m²	631		
Ground heat exchanger layout	-	Standard		
Total loop length	m	518		
Total trench length	m	259		
Heat Pump System				
Average heat pump efficiency	-	High		
Standard cooling COP	-	5,50		
Standard heating COP	-	4,00		
Total standard heating capacity	kW	16,4		
	MW	0,016		
Total standard cooling capacity	kW	23,7	Oversized	
	ton (cooling)	6,7		
Supplemental Heating and Heat Rejection System				
Suggested supplemental heating capacity	kW	0,0		
	million Btu/h	0,000		
Suggested supplemental heat rejection	kW	0,0		
	million Btu/h	0,000		

Annual Energy Production		Estimate	Notes/Range
Heating			
Electricity used	MWh	9,0	
Supplemental energy delivered	MWh	0,0	
GSHP heating energy delivered	MWh	**28,7**	
	GJ	103,2	
Seasonal heating COP	-	3,2	2.0 to 5.0
Cooling			
Electricity used	MWh	0,5	
GSHP cooling energy delivered	MWh	**0,0**	
	GJ	0,0	
Seasonal cooling COP	-	0,0	2.0 to 5.5
Seasonal cooling EER	(Btu/h)/W	0,1	7.0 to 19.0
			Complete Cost Analysis sheet

RETScreen® Heating and Cooling Load Calculation - Ground-Source Heat Pump Project

Site Conditions		Estimate	Notes/Range
Nearest location for weather data		Wroclaw-Strachowice	See Weather Database
Heating design temperature	°C	-12,4	-40.0 to 15.0
Cooling design temperature	°C	28,1	10.0 to 40.0
Average summer daily temperature range	°C	9,7	5.0 to 15.0
Cooling humidity level	-	High	
Latitude of project location	°N	51,1	-90.0 to 90.0
Mean earth temperature	°C	9,0	Visit NASA satellite data site
Annual earth temperature amplitude	°C	14,0	5.0 to 20.0
Depth of measurement of earth temperature	m	0,0	0.0 to 3.0

Building Heating and Cooling Load		Estimate	Notes/Range
Type of building	-	Residential	
Available information	-	Energy use data	
Design heating load	kW	13,4	
	MW	0,013	
Annual heating energy demand	MWh	28,5	
	GJ	102,6	
Design cooling load	kW	0,0	
	ton (cooling)	0,0	
Annual cooling energy demand	MWh	0,0	
	million Btu	0,0	Return to Energy Model sheet

RETScreen® Cost Analysis - Ground-Source Heat Pump Project

Type of analysis: Pre-feasibility | Currency: Poland | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study								
Other - Feasibility Study	Cost	0	PLN -	PLN	-		-	-
Sub-total:				**PLN**	**-**	0,0%		
Development								
Other - Development	Cost	0	PLN -	PLN	-		-	-
Sub-total:				**PLN**	**-**	0,0%		
Engineering								
Other - Engineering	Cost	0	PLN -	PLN	-		-	-
Sub-total:				**PLN**	**-**	0,0%		
Energy Equipment								
Heat pumps	kW cooling	23,7	PLN 850	PLN	20 147		-	-
Well pumps	kW	0,0	PLN -	PLN	-		-	-
Circulating pumps	kW	0,4	PLN 500	PLN	201		-	-
Circulating fluid	m³	0,09	PLN 1 500	PLN	137		-	-
Plate heat exchangers	kW	0,0	PLN -	PLN	-		-	-
Trenching and backfilling	m	259	PLN 12,00	PLN	3 106		-	-
Drilling and grouting	m	0	PLN 9,00	PLN	-		-	-
Ground HX loop pipes	m	518	PLN 18,00	PLN	9 317		-	-
Fittings and valves	kW cooling	23,7	PLN 25,00	PLN	593		-	-
Other - Energy Equipment	Cost	0	PLN -	PLN	-		-	-
Electric central heating system	Credit	0		PLN	-		-	-
Sub-total:				**PLN**	**33 502**	100,0%		
Balance of System								
Supplemental heating system	kW	0,0	PLN -	PLN	-		-	-
Supplemental heat rejection	kW	0,0	PLN -	PLN	-		-	-
Internal piping and insulation	kW cooling	23,7	PLN -	PLN	-		-	-
Other - Balance of System	Cost	0	PLN -	PLN	-		-	-
Credit - Balance of System	Credit	0	PLN 1 000	PLN	-		-	-
Sub-total:				**PLN**	**-**	0,0%		
Miscellaneous								
Training	p-h	0	PLN 70	PLN	-		-	-
Contingencies	%	0%	PLN 33 502	PLN	-		-	-
Sub-total:				**PLN**	**-**	0,0%		
Initial Costs - Total				**PLN**	**33 502**	100,0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost		Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M								
Property taxes/Insurance	project	0	PLN -	PLN	-		-	-
O&M labour	m²	0	PLN 2,50	PLN	-		-	-
Travel and accommodation	p-trip	0	PLN -	PLN	-		-	-
Other - O&M	Cost	0	PLN -	PLN	-		-	-
Credit - O&M	Credit	0	PLN 3 500	PLN	-		-	-
Contingencies	%	0%	PLN 33 502	PLN	-		-	-
Sub-total:				**PLN**	**-**	0,0%		
Fuel/Electricity								
Electricity	kWh	**9 755**	**PLN 0,340**	PLN	3 317		-	-
Incremental electricity load	kW	**5,5**	**PLN -**	PLN	-		-	-
Sub-total:				**PLN**	**3 317**	101,9%		
Annual Costs - Total				**PLN**	**3 317**	100,0%		

Periodic Costs (Credits)		Period	Unit Cost		Amount	Interval Range	Unit Cost Range
Heat pump compressor	Cost	10 yr	PLN 800	**PLN**	**800**	-	-
Air-conditioner replacement	Credit	12 yr	PLN -	**PLN**	**-**	-	-
				PLN	**-**	-	-
End of project life	Credit	-	PLN -	**PLN**	**-**		*Go to GHG Analysis sheet*

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Ground-Source Heat Pump Project

Use GHG analysis sheet? Yes Type of analysis: Standard

Background Information

Project Information

Project name	Pompa ciepła
Project location	Polska

Global Warming Potential of GHG

1 tonne CH_4 =	21	tonnes CO_2	(IPCC 1996)
1 tonne N_2O =	310	tonnes CO_2	(IPCC 1996)

Base Case Electricity System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Coal	90,5%	94,6	0,0020	0,0030	35,0%	11,0%	1,105
Biomass	3,8%	0,0	0,0320	0,0040	25,0%	11,0%	0,031
Natural gas	3,7%	56,1	0,0030	0,0010	45,0%	11,0%	0,508
Large hydro	1,6%	0,0	0,0000	0,0000	100,0%	11,0%	0,000
#6 oil	0,4%	77,4	0,0030	0,0020	30,0%	11,0%	1,053
Electricity mix	100%	281,2	0,0116	0,0095		11,0%	1,024

Base Case Heating and Cooling System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t_{CO2}/MWh)
Heating system						
Natural gas	100,0%	56,1	0,0030	0,0010	80,0%	0,254

Proposed Case Heating and Cooling System (Ground-Source Heat Pump Project)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t_{CO2}/MWh)
Heating system						
Electricity	100,0%	281,2	0,0116	0,0095	317,5%	0,322
Cooling system						
Electricity	100,0%	281,2	0,0116	0,0095	1,8%	58,137

GHG Emission Reduction Summary

	Base case GHG emission factor (t_{CO2}/MWh)	Proposed case GHG emission factor (t_{CO2}/MWh)	End-use annual energy delivered (MWh)	Annual GHG emission reduction (t_{CO2})
Heating system	0,254	0,322	28,7	-1,96
Cooling system	0,000	58,137	0,0	-0,56
			Net GHG emission reduction t_{CO2}/yr	**-2,52**

Complete Financial Summary sheet

RETScreen® Financial Summary - Ground-Source Heat Pump Project

Annual Energy Balance

Project name		Pompa ciepła	Electricity required	MWh	9,6
Project location		Polska	Incremental electricity load	kW	5,5
			Net GHG reduction	t_{CO2}/yr	(2,70)
Heating energy delivered	MWh	28,7			
Cooling energy delivered	MWh	0,0			
Heating fuel displaced	-	Natural gas	Net GHG emission reduction - 25 yrs	t_{CO2}	(67,59)

Financial Parameters

Avoided cost of heating energy	PLN/m³	1,600	Debt ratio	%	80,0%
			Debt interest rate	%	6,9%
			Debt term	yr	10
GHG emission reduction credit	PLN/t_{CO2}	-	Income tax analysis?	yes/no	No
Retail price of electricity	PLN/kWh	0,340			
Demand charge	PLN/kW	-			
Energy cost escalation rate	%	2,0%			
Inflation	%	1,8%			
Discount rate	%	5,0%			
Project life	yr	25			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	0,0%	PLN	-	O&M	PLN	-
Development	0,0%	PLN	-	Fuel/Electricity	PLN	3 317
Engineering	0,0%	PLN	-	Debt payments - 10 yrs	PLN	3 798
Energy equipment	100,0%	PLN	33 502	**Annual Costs and Debt - Total**	**PLN**	**7 115**
Balance of system	0,0%	PLN	-			
Miscellaneous	0,0%	PLN	-	**Annual Savings or Income**		
Initial Costs - Total	100,0%	**PLN**	**33 502**	Heating energy savings/income	PLN	5 551
				Cooling energy savings/income	PLN	-
Incentives/Grants		PLN	6 700			
				Annual Savings - Total	**PLN**	**5 551**
Periodic Costs (Credits)						
Heat pump compressor		PLN	800	Schedule yr # 10,20		
Air-conditioner replacement		PLN	-			
		PLN	-			
End of project life - Credit		PLN	-			

Financial Feasibility

Pre-tax IRR and ROI	%	11,0%	Calculate GHG reduction cost?	yes/no	No
After-tax IRR and ROI	%	11,0%			
Simple Payback	yr	12,0	Project equity	PLN	6 700
Year-to-positive cash flow	yr	immediate	Project debt	PLN	26 801
Net Present Value - NPV	PLN	9 897	Debt payments	PLN/yr	3 798
Annual Life Cycle Savings	PLN	702	Debt service coverage	-	0,49
Benefit-Cost (B-C) ratio	-	2,48			

Yearly Cash Flows

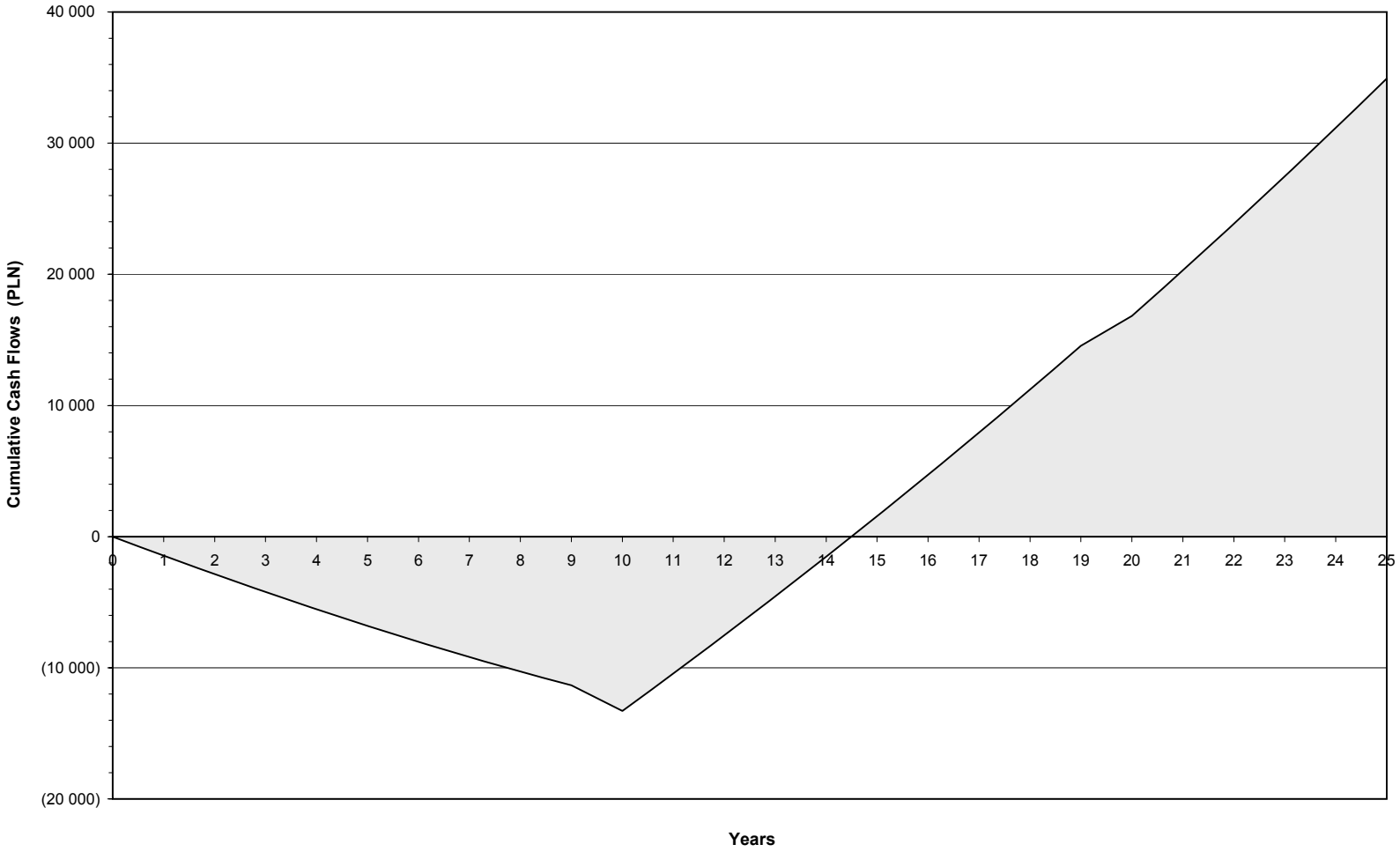
Year #	Pre-tax PLN	After-tax PLN	Cumulative PLN
0	-	-	-
1	(1 456)	(1 456)	(1 456)
2	(1 409)	(1 409)	(2 866)
3	(1 362)	(1 362)	(4 228)
4	(1 313)	(1 313)	(5 540)
5	(1 263)	(1 263)	(6 804)
6	(1 213)	(1 213)	(8 016)
7	(1 161)	(1 161)	(9 177)
8	(1 108)	(1 108)	(10 285)
9	(1 054)	(1 054)	(11 340)
10	(1 956)	(1 956)	(13 295)
11	2 855	2 855	(10 440)
12	2 912	2 912	(7 528)
13	2 970	2 970	(4 558)
14	3 030	3 030	(1 529)
15	3 090	3 090	1 561
16	3 152	3 152	4 713
17	3 215	3 215	7 928
18	3 279	3 279	11 208
19	3 345	3 345	14 553
20	2 269	2 269	16 821
21	3 480	3 480	20 301
22	3 550	3 550	23 851
23	3 621	3 621	27 472
24	3 693	3 693	31 165
25	3 767	3 767	34 932

Cumulative Cash Flows Graph

GSHP Project Cumulative Cash Flows
Pompa ciepła, Polska

Total Initial Costs: PLN 33 502

Net average GHG reduction (t_{CO2}/yr): -2,70



IRR and ROI: 11%

Year-to-positive cash flow: Nil

Net Present Value: PLN 9 897

RETScreen® Sensitivity and Risk Analysis - Ground-Source Heat Pump Project

Use sensitivity analysis sheet?	Yes	Perform analysis on	Net Present Value - NPV	
Perform risk analysis too?	No	Sensitivity range	30%	
Project name	Pompa ciepła	Threshold	0	PLN
Project location	Polska			

Click here to Calculate Sensitivity Analysis

Sensitivity Analysis for Net Present Value - NPV

Initial costs (PLN)		Avoided cost of heating energy (PLN/m³) 1,1200 -30%	1,3600 -15%	**1,6000 0%**	1,8400 15%	2,0800 30%
23 451	-30%	-10 494	3 024	18 696	32 215	47 887
28 476	-15%	-15 970	-298	13 220	28 892	42 411
33 502	0%	-19 293	-5 774	**9 897**	23 416	39 088
38 527	15%	-24 769	-9 097	4 421	20 093	33 612
43 552	30%	-28 092	-14 573	1 099	14 617	30 289

Annual costs (PLN)		Avoided cost of heating energy (PLN/m³) 1,1200 -30%	1,3600 -15%	**1,6000 0%**	1,8400 15%	2,0800 30%
2 322	-30%	-2 176	11 666	27 015	40 856	56 205
2 819	-15%	-11 650	3 861	17 541	33 051	46 731
3 317	0%	-19 293	-5 774	**9 897**	23 416	39 088
3 814	15%	-29 090	-13 256	101	15 934	29 291
4 312	30%	-36 410	-23 215	-7 220	5 976	21 971

Debt interest rate (%)		Debt ratio (%) 56,0% -30%	68,0% -15%	**80,0% 0%**	92,0% 15%	N/A 30%
4,8%	-30%	11 503	12 613	11 570	12 679	
5,9%	-15%	11 629	10 382	11 288	10 041	
6,9%	0%	9 579	10 277	**8 821**	9 518	
7,9%	15%	9 660	7 991	8 475	6 806	
9,0%	30%	7 566	7 832	5 945	6 211	

Debt interest rate (%)		Debt term (yr) 7,0 -30%	8,5 -15%	**10,0 0%**	11,5 15%	13,0 30%
4,8%	-30%	11 514	13 897	11 570	13 544	11 622
5,9%	-15%	11 579	11 691	11 288	10 993	11 012
6,9%	0%	9 474	11 614	**8 821**	10 555	8 197
7,9%	15%	9 506	9 362	8 475	7 924	7 487
9,0%	30%	7 368	9 241	5 945	7 410	4 577