



RETScreen® International

Clean Energy Project Analysis Software

Solar Water Heating Project Model

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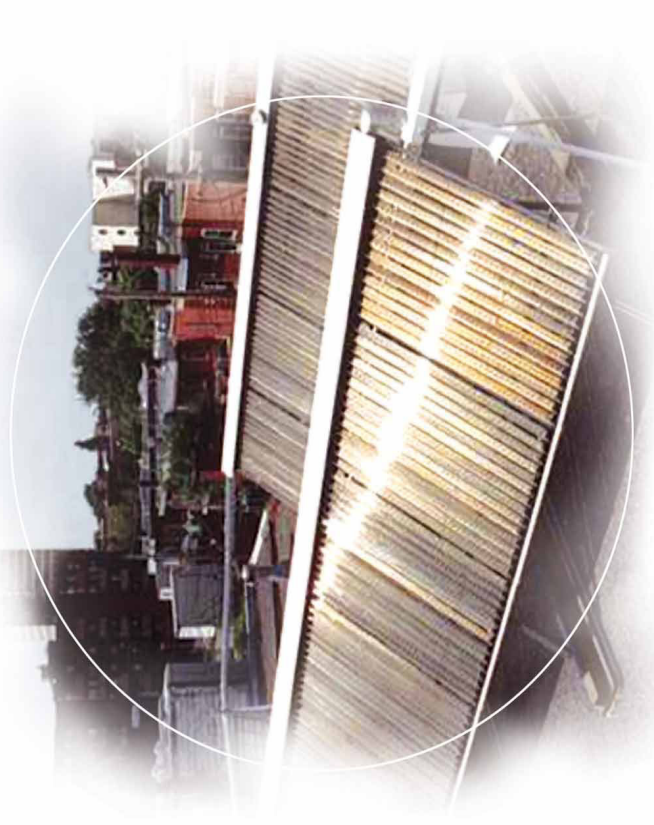
- Description & Flow Chart
- Colour Coding
- Online Manual

Worksheets

- Energy Model
- Solar Resource & Heating Load
- Cost Analysis
- Greenhouse Gas Analysis
- Financial Summary

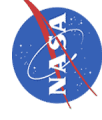
Features

- Product Data
- Weather Data
- Cost Data
- Currency Options
- Sensitivity Analysis



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Site Conditions		Estimate	Notes/Range
Project name		Szkola	See Online Manual
Project location		Tychy, Polska	
Nearest location for weather data		Katowice	→ Complete SR&HL sheet
Annual solar radiation (tilted surface)	MWh/m ²	1,13	
Annual average temperature	°C	7,7	-20.0 to 30.0
Annual average wind speed	m/s	4,6	
Desired load temperature	°C	55	
Hot water use	L/d	4 550	
Number of months analysed	month	9,30	
Energy demand for months analysed	MWh	64,53	

System Characteristics		Estimate	Notes/Range
Application type		Service hot water (with storage)	
Base Case Water Heating System			
Heating fuel type	-	Electricity	
Heating system seasonal efficiency	%	97%	55% to 350%
Solar Collector			
Collector type	-	Glazed	See Technical Note 1
Solar water heating collector manufacturer		Watt	See Product Database
Solar water heating collector model		3000SU	
Area per collector	m ²	2,06	1.00 to 5.00
Fr (tau alpha) coefficient	-	0,79	0.50 to 0.90
Fr UL coefficient	(W/m ²)/°C	3,78	3.50 to 6.00
Suggested number of collectors		37	
Number of collectors		37	
Total collector area	m ²	76,0	
Storage			
Ratio of storage capacity to coll. area	L/m ²	35,0	37.5 to 100.0
Storage capacity	L	2 661	
Balance of System			
Heat exchanger/antifreeze protection	yes/no	Yes	
Heat exchanger effectiveness	%	100%	50% to 85%
Suggested pipe diameter	mm	25	8 to 25 or PVC 35 to 50
Pipe diameter	mm	16	8 to 25 or PVC 35 to 50
Pumping power per collector area	W/m ²	15	3 to 22, or 0
Piping and solar tank losses	%	2%	1% to 10%
Losses due to snow and/or dirt	%	5%	2% to 10%
Horz. dist. from mech. room to collector	m	10	5 to 20
# of floors from mech. room to collector	-	2	0 to 20

Annual Energy Production (9,30 months analysed)		Estimate	Notes/Range
Pumping energy (electricity)	MWh	1,30	
Specific yield	kWh/m ²	277	
System efficiency	%	35%	
Solar fraction	%	33%	
Renewable energy delivered	MWh	21,06	
	kWh	21 065	Complete Cost Analysis sheet

RETScreen® Solar Resource and Heating Load Calculation - Solar Water Heating Project

Site Latitude and Collector Orientation		Estimate	Notes/Range
Nearest location for weather data		Katowice	See Weather Database
Latitude of project location	°N	51,1	-90.0 to 90.0
Slope of solar collector	°	45,0	0.0 to 90.0
Azimuth of solar collector	°	0,0	0.0 to 180.0

Monthly Inputs

(Note: 1. Cells in grey are not used for energy calculations; 2. Revisit this table to check that all required inputs are filled if you change system type or solar collector type or pool type or method for calculating cold water temperature).

Month	Fraction of month used (0 - 1)	Monthly average daily radiation on horizontal surface (kWh/m ² /d)	Monthly average temperature (°C)	Monthly average relative humidity (%)	Monthly average wind speed (m/s)	Monthly average daily radiation in plane of solar collector (kWh/m ² /d)
January	1,00	0,79	-2,8	89,0	5,4	1,63
February	1,00	1,45	-1,5	88,0	5,2	2,41
March	1,00	2,37	2,1	82,0	5,2	3,01
April	1,00	3,51	7,5	77,0	4,5	3,69
May	1,00	4,64	12,5	75,0	4,1	4,34
June	0,50	4,72	16,2	71,0	3,9	4,18
July	0,00	4,94	17,4	65,0	3,9	4,48
August	0,00	4,17	16,8	64,0	3,9	4,19
September	0,80	2,75	13,1	71,0	4,3	3,22
October	1,00	1,93	8,4	80,0	4,5	3,07
November	1,00	0,89	3,6	86,0	4,9	1,64
December	1,00	0,61	-0,5	89,0	5,4	1,28
			Annual	Season of Use		
Solar radiation (horizontal)		MWh/m ²	1,00	0,63		
Solar radiation (tilted surface)		MWh/m ²	1,13	0,78		
Average temperature		°C	7,7	5,1		
Average wind speed		m/s	4,6	4,8		

Water Heating Load Calculation		Estimate	Notes/Range
Application type	-	Service hot water	
System configuration	-	With storage	
Building or load type	-	School w/ showers	
Number of units	Student	650	
Rate of occupancy	%	100%	50% to 100%
Estimated hot water use (at ~60 °C)	L/d	4 420	
Hot water use	L/d	4 550	
Desired water temperature	°C	55	
Days per week system is used	d	7	1 to 7
Cold water temperature	-	User-defined	
Minimum	°C	10,0	1.0 to 10.0
Maximum	°C	15,0	5.0 to 15.0
Months SWH system in use	month	9,30	
Energy demand for months analysed	MWh	64,53	
	GJ	232,3	

[Return to Energy Model sheet](#)

RETScreen® Cost Analysis - Solar Water Heating Project

Type of project: **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							
Solar collector	m ²	76,0	PLN 652	PLN 49 609	-	-	-
Solar storage tank	L	2 661	PLN 11,00	PLN 29 273	-	-	-
Solar loop piping materials	m	39	PLN 26,00	PLN 1 005	-	-	-
Circulating pump(s)	W	1 141	PLN 5,00	PLN 5 703	-	-	-
Heat exchanger	kW	45,6	PLN -	PLN -	-	-	-
Transportation	project	1	PLN -	PLN -	-	-	-
Other - Energy equipment	Cost	1	PLN 8 350	PLN 8 350	-	-	-
Sub-total :				PLN 93 940	94,5%	-	-
Balance of System							
Collector support structure	m ²	76,0	PLN 71	PLN 5 435	-	-	-
Plumbing and control	project	1	PLN -	PLN -	-	-	-
Collector installation	m ²	76,0	PLN -	PLN -	-	-	-
Solar loop installation	m	39	PLN -	PLN -	-	-	-
Auxiliary equipment installation	project	1	PLN -	PLN -	-	-	-
Transportation	project	1	PLN -	PLN -	-	-	-
Other - Balance of system	Cost	0	PLN -	PLN -	-	-	-
Sub-total :				PLN 5 435	5,5%	-	-
Miscellaneous							
Training	p-h	4	PLN -	PLN -	-	-	-
Contingencies	%	0%	PLN 99 374	PLN -	-	-	-
Sub-total :				PLN -	0,0%	-	-
Initial Costs - Total				PLN 99 374	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	project	0	PLN -	PLN -	-	-	-
Other - O&M	Cost	0	PLN -	PLN -	-	-	-
Contingencies	%	10%	PLN -	PLN -	-	-	-
Sub-total :				PLN -	0,0%	-	-
Electricity	kWh	1 299	PLN 0,3900	PLN 507	100,0%	-	-
Annual Costs - Total				PLN 507	100,0%	-	-

Periodic Costs (Credits)	Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Valves and fittings	Cost	10 yr	PLN -	-	-
			PLN -	-	-
			PLN -	-	-
End of project life		-	PLN -	-	-

[Go to GHG Analysis sheet](#)

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Solar Water Heating Project

Use GHG analysis sheet? Yes

Type of analysis: Standard

Background Information

Project Information		Global Warming Potential of GHG	
Project name	Szkola	1 tonne CH4 =	21 tonnes CO2 (IPCC 1996)
Project location	Tychy, Polska	1 tonne N2O =	310 tonnes CO2 (IPCC 1996)

Base Case Electricity System (Baseline)

Fuel type	Fuel mix (%)	CO ₂ emission factor (kg/GJ)	CH ₄ emission factor (kg/GJ)	N ₂ O 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%		0,937
Electricity mix	100%	281,1	0,0116	0,0095		11,0%	1,023

Base Case Heating System (Baseline)

Fuel type	Fuel mix (%)	CO ₂ emission factor (kg/GJ)	CH ₄ emission factor (kg/GJ)	N ₂ O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t _{CO2} /MWh)
Heating system						
Electricity	100,0%	281,1	0,0116	0,0095	97,0%	1,055

Proposed Case Heating System (Solar Water Heating Project)

Fuel type	Fuel mix (%)	CO ₂ emission factor (kg/GJ)	CH ₄ emission factor (kg/GJ)	N ₂ O emission factor (kg/GJ)	Fuel conversion efficiency (%)	GHG emission factor (t _{CO2} /MWh)
Heating system						
Electricity	5,8%	281,1	0,0116	0,0095	100,0%	1,023
Solar	94,2%	0,0	0,0000	0,0000	100,0%	0,000
Heating energy mix	100,0%	17,3	0,0007	0,0006		0,063

GHG Emission Reduction Summary

Heating system	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})
	1,055	0,063	21,06	20,89
			Net GHG emission reduction t _{CO2} /yr	20,89

[Complete Financial Summary sheet](#)

RETScreen® Financial Summary - Solar Water Heating Project

Annual Energy Balance			
Project name	Szkola	MWh	MWh
Project location	Tychy, Polska		
Renewable energy delivered	21,06	Net GHG reduction	20,89
Heating fuel displaced	-	Electricity	522,32
		Net GHG emission reduction - 25 yrs	t _{CO2}

Financial Parameters			
Avoided cost of heating energy	PLN/kWh	0,390	Debt ratio
			%
GHG emission reduction credit	PLN/t _{CO2}	-	Income tax analysis?
			yes/no
Retail price of electricity	PLN/kWh	0,390	
Energy cost escalation rate	%	2,0%	
Inflation	%	2,0%	
Discount rate	%	6,0%	
Project life	yr	25	

Project Costs and Savings			
Initial Costs			
Feasibility study	0,0%	PLN	-
Development	0,0%	PLN	507
Engineering	0,0%	PLN	-
Energy equipment	94,5%	PLN	93 940
Balance of system	5,5%	PLN	5 435
Miscellaneous	0,0%	PLN	-
Initial Costs - Total	100,0%	PLN	99 374
Incentives/Grants		PLN	-
Periodic Costs (Credits)			
Valves and fittings		PLN	-
		PLN	-
		PLN	-
End of project life -		PLN	-
Annual Costs and Debt			
O&M		PLN	-
Electricity		PLN	507
Annual Costs and Debt - Total		PLN	507
Annual Savings or Income			
Heating energy savings/Income		PLN	8 469
Annual Savings - Total		PLN	8 469

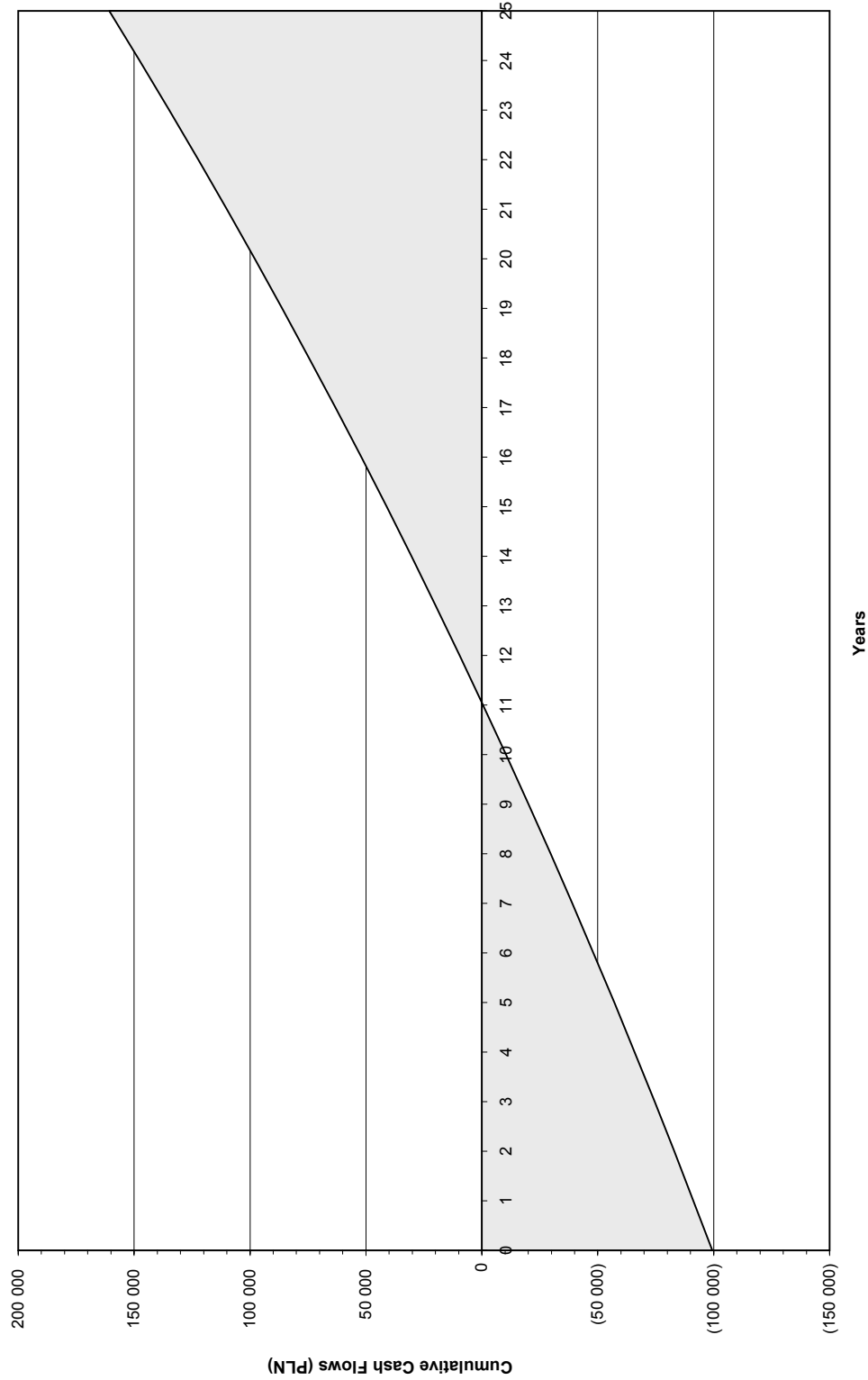
Financial Feasibility			
Pre-tax IRR and ROI	%	8,4%	Calculate GHG reduction cost?
After-tax IRR and ROI	%	8,4%	yes/no
Simple Payback	yr	12,5	Project equity
Year-to-positive cash flow	yr	11,1	PLN
Net Present Value - NPV	PLN	26 057	99 374
Annual Life Cycle Savings	PLN	2 038	
Benefit-Cost (B-C) ratio	-	1,26	

Yearly Cash Flows			
Year #	Pre-tax PLN	After-tax PLN	Cumulative PLN
0	(99 374)	(99 374)	(99 374)
1	8 122	8 122	(91 253)
2	8 284	8 284	(82 968)
3	8 450	8 450	(74 518)
4	8 619	8 619	(65 899)
5	8 791	8 791	(57 108)
6	8 967	8 967	(48 140)
7	9 147	9 147	(38 994)
8	9 330	9 330	(29 664)
9	9 516	9 516	(20 148)
10	9 706	9 706	(10 442)
11	9 901	9 901	(541)
12	10 099	10 099	9 558
13	10 301	10 301	19 858
14	10 507	10 507	30 365
15	10 717	10 717	41 081
16	10 931	10 931	52 012
17	11 150	11 150	63 162
18	11 373	11 373	74 535
19	11 600	11 600	86 135
20	11 832	11 832	97 967
21	12 069	12 069	110 036
22	12 310	12 310	122 346
23	12 556	12 556	134 902
24	12 807	12 807	147 710
25	13 064	13 064	160 773

Cumulative Cash Flows Graph

SWH Project Cumulative Cash Flows Szkoła, Tychy, Polska

Renewable energy delivered (MWh/yr): 21,06 Total Initial Costs: PLN 99 374 Net average GHG reduction (t_{CO2}/yr): 20,89



IRR and ROI: 8.4% Year-to-positive cash flow: 11,1 yr Net Present Value: PLN 26 057

RETScreen® Sensitivity and Risk Analysis - Solar Water Heating Project

Use sensitivity analysis sheet? Yes
 Perform risk analysis too? No
 Project name Szkoła
 Project location Tychy, Polska

Perform analysis on Net Present Value - NPV
 Sensitivity range 25%
 Threshold 0 PLN

Sensitivity Analysis for Net Present Value - NPV

		Avoided cost of heating energy (PLN/kWh)				
		0,2925 -25%	0,3413 -13%	0,3900 0%	0,4388 13%	0,4875 25%
RE delivered (MWh)						
15,80	-25%	-32 311	-19 804	-7 296	5 211	17 718
18,43	-13%	-19 804	-5 212	9 380	23 972	38 564
21,06	0%	-7 296	9 380	26 057	42 733	59 410
23,70	13%	5 211	23 972	42 733	61 494	80 255
26,33	25%	17 718	38 564	59 410	80 255	101 101

		Avoided cost of heating energy (PLN/kWh)				
		0,2925 -25%	0,3413 -13%	0,3900 0%	0,4388 13%	0,4875 25%
Initial costs (PLN)						
74 531	-25%	17 547	34 224	50 900	67 577	84 253
86 953	-13%	5 125	21 802	38 479	55 155	71 832
99 374	0%	-7 296	9 380	26 057	42 733	59 410
111 796	13%	-19 718	-3 042	13 635	30 311	46 988
124 218	25%	-32 140	-15 463	1 213	17 890	34 566

		Avoided cost of heating energy (PLN/kWh)				
		0,2925 -25%	0,3413 -13%	0,3900 0%	0,4388 13%	0,4875 25%
Annual costs (PLN)						
380	-25%	-5 301	11 375	28 052	44 729	61 405
443	-13%	-6 299	10 378	27 054	43 731	60 407
507	0%	-7 296	9 380	26 057	42 733	59 410
570	13%	-8 294	8 383	25 059	41 736	58 412
633	25%	-9 292	7 385	24 061	40 738	57 415