RETScreen® International

www.retscreen.net

Clean Energy Project Analysis Software

Project information

See project database

Project name	Tripoli 10MW
Project location	Tripoli, Lebanon
Prepared for	Nadine
Prepared by	Adrian
Project type	Power
Technology	Wind turbine
Grid type	Central-grid
Analysis type	Method 2
Heating value reference	Higher heating value (HHV)
Show settings	☑
Language - Langue	English - Anglais
User manual	English - Anglais
Currency	$
Units	Metric units

Site reference conditions

Select climate data location

Climate data location	Ţarābulus aš-Šām
Show data	☑

	Unit	Climate data location	Project location
Latitude	˚N	34,4	34,4
Longitude	˚E	35,9	35,9
Elevation	m	335	335
Heating design temperature	°C	7,5	
Cooling design temperature	°C	28,6	
Earth temperature amplitude	°C	12,1	

Month	Air temperature	Relative humidity	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days	Cooling degree-days
	°C	%	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January	11,6	64,9%	2,76	97,9	5,1	13,8	198	50
February	11,5	64,4%	3,68	97,7	5,4	13,8	183	41
March	13,1	64,8%	5,03	97,6	5,0	15,4	153	95
April	16,3	62,8%	6,37	97,5	4,5	18,7	51	189
May	19,4	63,5%	7,62	97,4	4,3	22,4	0	292
June	22,8	63,6%	8,31	97,1	4,5	25,9	0	383
July	25,5	61,4%	8,08	96,9	4,8	28,8	0	481
August	26,1	61,7%	7,37	97,0	4,7	29,5	0	499
September	24,4	60,7%	6,32	97,3	4,4	27,8	0	432
October	21,5	61,1%	4,65	97,6	4,0	24,3	0	355
November	17,2	60,6%	3,24	97,8	4,4	19,3	25	215
December	13,3	63,3%	2,49	97,9	4,9	15,4	145	103
Annual	18,6	62,7%	5,50	97,5	4,7	21,3	754	3 136
Measured at	m				10,0	0,0		

Complete Energy Model sheet

☐ Show alternative units

Proposed case power system

Technology		Wind turbine	
Analysis type		○ Method 1	
		◉ Method 2	
		○ Method 3	

Resource assessment

Resource method		Wind speed	☑ **Show data** — *See maps*
			Ţarābulus aš-Šām
Wind speed - annual	m/s	4,7	4,7
Measured at	m	10,0	10,0
Wind shear exponent		0,17	
Air temperature - annual	°C	18,6	18,6
Atmospheric pressure - annual	kPa	97,5	97,5

Wind turbine

Power capacity per turbine	kW	750	*See product database*
Manufacturer		Lagerwey Windturbine	
Model		LAGERWEY 50/750 - 75m	
Number of turbines		12	
Power capacity	kW	9 000	
Hub height	m	75,0	6,6 m/s
Rotor diameter per turbine	m	51	
Swept area per turbine	m²	2 003	
Energy curve data		Standard	
Shape factor		2,0	

☑ **Show data** — *Show figure*

Wind speed m/s	Power curve data kW	Energy curve data MWh
0	0	
1	0	
2	0	
3	0	125,7
4	11	397,7
5	40	841,3
6	85	1 401,8
7	147	1 996,7
8	229	2 564,7
9	334	3 074,7
10	465	3 515,6
11	626	3 884,9
12	730	4 182,9
13	750	4 411,3
14	750	4 573,6
15	750	4 674,9
16	750	
17	750	
18	750	
19	750	
20	750	
21	750	
22	750	
23	750	
24	750	
25 - 30	750	

Array losses	%	5,0%
Airfoil losses	%	3,0%
Miscellaneous losses	%	5,0%
Availability	%	94,0%

☑ **Show data**

		Per turbine
Unadjusted energy production	MWh	1 771
Pressure coefficient		0,962
Temperature coefficient		0,988
Gross energy production	MWh	1 683
Losses coefficient		0,82
Specific yield	kWh/m²	692

Summary

Capacity factor	%	21,1%
Electricity exported to grid	MWh	16 621
Electricity export rate	$/MWh	150,00

RETScreen Cost Analysis - Power project

Settings

◉ Method 1	◉ Notes/Range		
○ Method 2	○ Second currency	Notes/Range	None
	○ Cost allocation		

Initial costs (credits)	Unit	Quantity	Unit cost	Amount	Relative costs
Feasibility study					
Feasibility study	cost	1	$ 150 000	$ 150 000	
Sub-total:				**$ 150 000**	0,7%
Development					
Development	cost	1	$ 400 000	$ 400 000	
Sub-total:				**$ 400 000**	2,0%
Engineering					
Engineering	cost	1	$ 400 000	$ 400 000	
Sub-total:				**$ 400 000**	2,0%
Power system					
Wind turbine	kW	9 000,00	$ 1 300	$ 11 700 000	
Road construction	km	5	$ 30 000	$ 150 000	
Transmission line	km	15	$ 40 000	$ 600 000	
Substation	project	1	$ 2 000 000	$ 2 000 000	
Energy efficiency measures	project			$ -	
User-defined	cost			$ -	
				$ -	
Sub-total:				**$ 14 450 000**	71,6%
Balance of system & miscellaneous					
Spare parts	%	2,0%	$ 11 700 000	$ 234 000	
Transportation	project	12	$ 30 000	$ 360 000	
Training & commissioning	p-d			$ -	
Installation	cost	1	$ 2 000 000	$ 2 000 000	
Contingencies	%	10,0%	$ 17 994 000	$ 1 799 400	
Interest during construction	8,00%	6 month(s)	$ 19 793 400	$ 395 868	
Sub-total:				**$ 4 789 268**	23,7%
Total initial costs				**$ 20 189 268**	100,0%

Annual costs (credits)	Unit	Quantity	Unit cost	Amount
O&M				
Parts & labour	project			$ -
Operation cost	cost	1	$ 200 000	$ 200 000
Contingencies	%	10,0%	$ 200 000	$ 20 000
Sub-total:				**$ 220 000**

Periodic costs (credits)	Unit	Year	Unit cost	Amount
Major replacements (blades, etc.)	cost	10	$ 2 500 000	$ 2 500 000
				$ -
End of project life	cost			$ -

RETScreen Emission Reduction Analysis - Power project

Emission Analysis

- (•) Method 1
- ( ) Method 2
- ( ) Method 3

Base case electricity system (Baseline)

Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
Lebanon	Oil (#6)	0,776	5,0%	0,817

☐ Baseline changes during project life

Base case system GHG summary (Baseline)

Fuel type	Fuel mix %	Fuel consumption MWh	GHG emission factor tCO2/MWh	GHG emission tCO2
Electricity	100,0%	16 621	0,817	13 577
Total	100,0%	16 621	0,817	13 577

Proposed case system GHG summary (Power project)

Fuel type	Fuel mix %				Fuel consumption MWh	GHG emission factor tCO2/MWh	GHG emission tCO2
Wind	100,0%				16 621	0,000	0
Total	100,0%				16 621	0,000	0
			T&D losses				
Electricity exported to grid	MWh	16 621	2,0%		332	0,817	272
						Total	272

GHG emission reduction summary

	Base case GHG emission tCO2	Proposed case GHG emission tCO2	Gross annual GHG emission reduction tCO2	GHG credits transaction fee %	Net annual GHG emission reduction tCO2
Power project	13 577	272	13 305		13 305

Net annual GHG emission reduction	13 305	tCO2	is equivalent to	2 705	Cars & light trucks not used

RETScreen Financial Analysis - Power project

Financial parameters

General		
Fuel cost escalation rate	%	2,0%
Inflation rate	%	2,0%
Discount rate	%	12,0%
Project life	yr	20
Finance		
Incentives and grants	$	
Debt ratio	%	70,0%
Debt	$	14 132 488
Equity	$	6 056 780
Debt interest rate	%	8,00%
Debt term	yr	15
Debt payments	$/yr	1 651 092
Income tax analysis		☑
Effective income tax rate	%	10,0%
Loss carryforward?		Yes
Depreciation method		Declining balance
Half-year rule - year 1	yes/no	Yes
Depreciation tax basis	%	
Depreciation rate	%	
Tax holiday available?	yes/no	No

Annual income

Electricity export income		
Electricity exported to grid	MWh	16 621
Electricity export rate	$/MWh	150,00
Electricity export income	$	2 493 115
Electricity export escalation rate	%	2,0%
GHG reduction income		☑
Net GHG reduction	tCO2/yr	13 305
Net GHG reduction - 20 yrs	tCO2	266 100
GHG reduction credit rate	$/tCO2	4,00
GHG reduction income	$	53 220
GHG reduction credit duration	yr	20
Net GHG reduction - 20 yrs	tCO2	266 100
GHG reduction credit escalation rate	%	
Customer premium income (rebate)		☐
Other income (cost)		☐
Clean Energy (CE) production income		☑
CE production	MWh	16 621
CE production credit rate	$/kWh	0,010
CE production income	$	**166 208**
CE production credit duration	yr	
CE production credit escalation rate	%	

Fuel type	Energy delivered (MWh)	Clean energy
Wind	16 621	Yes

Project costs and savings/income summary

Initial costs			
Feasibility study	0,7%	$	150 000
Development	2,0%	$	400 000
Engineering	2,0%	$	400 000
Power system	71,6%	$	14 450 000
Balance of system & misc.	23,7%	$	4 789 268
Total initial costs	**100,0%**	**$**	**20 189 268**
Annual costs and debt payments			
O&M		$	220 000
Fuel cost - proposed case		$	0
Debt payments - 15 yrs		$	1 651 092
Total annual costs		**$**	**1 871 092**
Periodic costs (credits)			
Major replacements (blades, etc.) - 10 yrs		$	2 500 000
Annual savings and income			
Fuel cost - base case		$	0
Electricity export income		$	2 493 115
GHG reduction income - 20 yrs		$	53 220
CE production income - yrs		$	166 208
Total annual savings and income		**$**	**2 712 543**

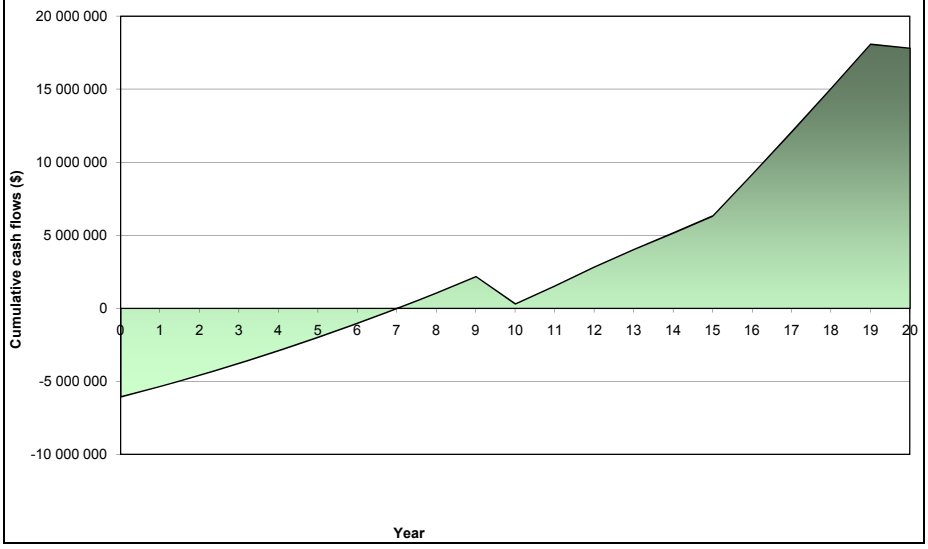
Financial viability

Pre-tax IRR - equity	%	14,7%
Pre-tax IRR - assets	%	2,0%
After-tax IRR - equity	%	14,1%
After-tax IRR - assets	%	1,3%
Simple payback	yr	8,1
Equity payback	yr	7,0
Net Present Value (NPV)	$	1 022 192
Annual life cycle savings	$/yr	136 850
Benefit-Cost (B-C) ratio		1,17
Debt service coverage		1,44
Energy production cost	$/MWh	142,47
GHG reduction cost	$/tCO2	(10)

Yearly cash flows

Year #	Pre-tax $	After-tax $	Cumulative $
0	-6 056 780	-6 056 780	-6 056 780
1	720 706	720 706	-5 336 075
2	767 077	767 077	-4 568 998
3	814 376	814 376	-3 754 621
4	862 621	862 621	-2 892 000
5	911 831	911 831	-1 980 169
6	962 025	962 025	-1 018 144
7	1 013 223	1 013 223	-4 921
8	1 065 445	1 065 445	1 060 524
9	1 118 711	1 118 711	2 179 235
10	-1 874 443	-1 874 443	304 792
11	1 228 461	1 228 461	1 533 253
12	1 284 988	1 284 988	2 818 241
13	1 342 645	1 220 990	4 039 231
14	1 401 455	1 119 755	5 158 987
15	1 461 442	1 162 419	6 321 405
16	3 173 720	2 856 348	9 177 754
17	3 236 130	2 912 517	12 090 271
18	3 299 789	2 969 810	15 060 081
19	3 364 720	3 028 248	18 088 329
20	-283 919	-283 919	17 804 410

Cumulative cash flows graph



RETScreen Sensitivity and Risk Analysis - Power project

Sensitivity analysis

Perform analysis on	Net Present Value (NPV)
Sensitivity range	15%
Threshold	$

Electricity export rate		Initial costs				$
		17 160 878	18 675 073	20 189 268	21 703 463	23 217 658
$/MWh		-15%	-8%	0%	8%	15%
127,50	-15%	461 751	-788 169	-2 043 063	-3 302 178	-4 564 814
138,75	-8%	1 985 298	741 972	-506 684	-1 759 947	-3 017 131
150,00	0%	3 501 658	2 264 698	**1 022 192**	-225 199	-1 476 830
161,25	8%	5 007 422	3 780 767	2 544 097	1 302 413	56 286
172,50	15%	6 501 804	5 285 767	4 057 058	2 820 679	1 579 816

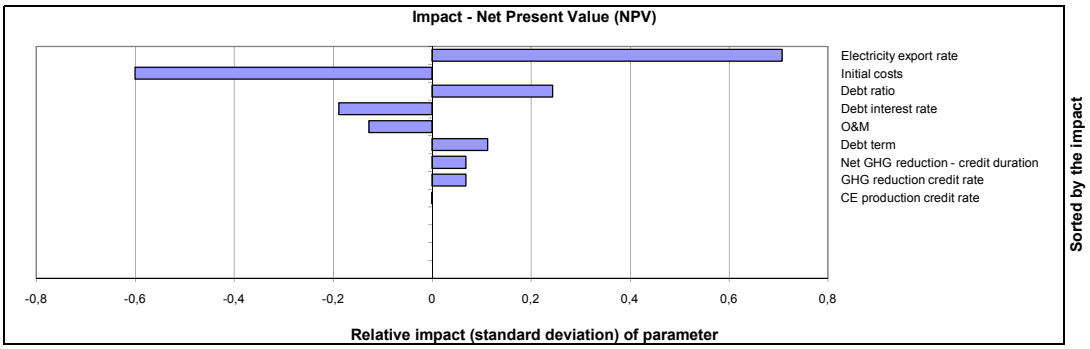
Debt ratio		Initial costs				$
		17 160 878	18 675 073	20 189 268	21 703 463	23 217 658
%		-15%	-8%	0%	8%	15%
60%	-15%	3 095 410	1 826 664	552 593	-727 236	-2 011 094
65%	-8%	3 298 534	2 045 681	787 466	-475 495	-1 743 336
70%	0%	3 501 658	2 264 698	**1 022 192**	-225 199	-1 476 830
75%	8%	3 704 511	2 483 715	1 256 918	25 097	-1 211 059
81%	15%	3 905 770	2 701 203	1 490 846	275 393	-945 289

Debt interest rate		Initial costs				$
		17 160 878	18 675 073	20 189 268	21 703 463	23 217 658
%		-15%	-8%	0%	8%	15%
6,80%	-15%	4 147 860	2 972 375	1 791 200	604 729	-585 716
7,40%	-8%	3 827 525	2 621 561	1 410 272	194 266	-1 026 847
8,00%	0%	3 501 658	2 264 698	**1 022 192**	-225 199	-1 476 830
8,60%	8%	3 169 909	1 901 942	627 710	-651 581	-1 935 233
9,20%	15%	2 831 299	1 531 406	225 650	-1 085 180	-2 400 869

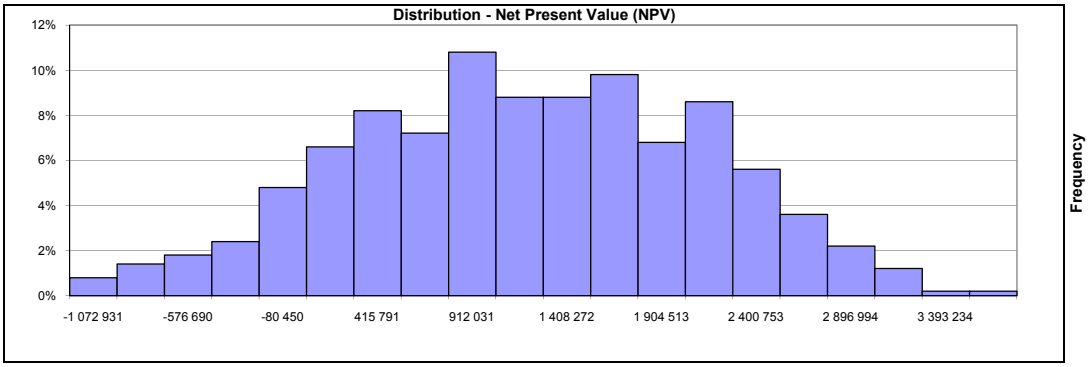
Risk analysis

Perform analysis on	Net Present Value (NPV)

Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Initial costs	$	20 189 268	10%	18 170 341	22 208 195
O&M	$	220 000	20%	176 000	264 000
Electricity export rate	$/MWh	150,00	10%	135,00	165,00
GHG reduction credit rate	$/tCO2	4,00	50%	2,00	6,00
Net GHG reduction - credit duration	tCO2	266 100	50%	133 050	399 150
CE production credit rate	$/kWh	0,01	50%	0,01	0,02
Debt ratio	%	70%	20%	56%	84%
Debt interest rate	%	8,00%	10%	7,20%	8,80%
Debt term	yr	15	20%	12	18



Median	$	1 192 978
Level of risk	%	
Minimum within level of confidence	$	-1 196 991
Maximum within level of confidence	$	3 765 415



Settings

- ☐ As fired fuel
- ☐ Biogas
- ☐ Building envelope properties
- ☐ Appliances & equipment
- ☐ Electricity rate - monthly
- ☐ Electricity rate - time of use
- ☐ GHG equivalence
- ☐ Ground heat exchanger
- ☐ Heat rate
- ☐ Heating value & fuel rate
- ☐ Hydro formula costing method
- ☐ Landfill gas
- ☐ Unit conversion
- ☐ User-defined fuel
- ☐ User-defined fuel - gas
- ☐ User-defined fuel - solid
- ☐ Water & steam
- ☐ Water pumping
- ☐ Window properties
- ☐ Custom 1
- ☐ Custom 2