Natural Resources Canada | Ressources naturelles Canada

Canada

RETScreen® International

www.retscreen.net

Clean Energy Project Analysis Software

Project information

See project database

Project name	Molino Arco Thirty
Project location	Molino de Los Arcos
Prepared for	Lonny Grafman
Prepared by	Meghan Heintz Jessica Lamb Matt Allan Rachel Rivera
Project type	Power
Technology	Hydro turbine
Grid type	Isolated-grid
Analysis type	Method 1
Heating value reference	Higher heating value (HHV)

Show settings

Site reference conditions

Select climate data location

Climate data location: San Cristóbal de las Casas

Show data

	Unit	Climate data location	Project location
Latitude	°N	16.8	16.8
Longitude	°E	-92.6	-92.6
Elevation	m	828	828
Heating design temperature	°C	13.8	
Cooling design temperature	°C	29.1	
Earth temperature amplitude	°C	10.9	

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	19.1	71.0%	4.67	92.4	3.1	19.9	0	281
February	20.5	65.6%	5.42	92.3	2.9	21.8	0	294
March	22.0	61.5%	6.20	92.2	2.7	23.8	0	371
April	23.4	62.6%	6.41	92.1	2.2	25.4	0	402
May	23.5	70.3%	6.05	92.0	2.0	25.1	0	419
June	23.0	78.2%	5.55	92.1	2.0	24.0	0	390
July	22.6	76.6%	5.89	92.2	2.4	23.4	0	390
August	22.8	75.0%	5.70	92.2	2.2	23.8	0	398
September	22.4	79.3%	4.99	92.1	2.0	23.2	0	371
October	21.3	79.3%	4.68	92.1	2.5	22.1	0	351
November	20.4	76.0%	4.67	92.2	2.8	21.1	0	311
December	19.3	74.3%	4.46	92.3	3.2	19.9	0	287
Annual	21.7	72.5%	5.39	92.2	2.5	22.8	0	4,264
Measured at	ft				10.0	0.0		

Complete Energy Model sheet

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RETScreen Energy Model - Power project

Show alternative units

Proposed case power system

				Incremental initial costs	
Technology		Hydro turbine			
Analysis type		Method 1 Method 2			
Hydro turbine					
Power capacity	kW	8		$ 157,292	See product database
Manufacturer		Canyon Hydro			
Model		Cross-flow			
Capacity factor	%	90.0%			
Electricity exported to grid	MWh	66			
Electricity export rate	$/MWh	489.00			

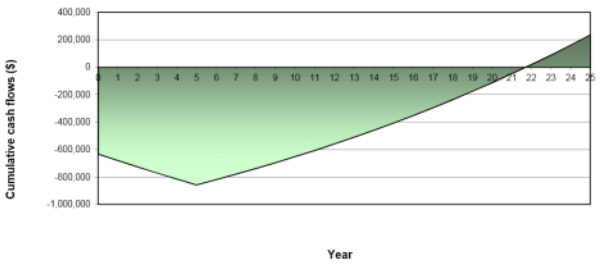
Emission Analysis

Base case electricity system (Baseline)		GHG emission factor (excl. T&D)	T&D losses	GHG emission factor	
Country - region	Fuel type	tCO2/MWh	%	tCO2/MWh	
Mexico	All types	0.500		0.500	
Electricity exported to grid	MWh	66	T&D losses	8.0%	
GHG emission					
Base case	tCO2	32.9			
Proposed case	tCO2	2.6			
Gross annual GHG emission reduction	tCO2	30.3			
GHG credits transaction fee	%	0.0%			
Net annual GHG emission reduction	tCO2	30.3	is equivalent to	13,015	Litres of gasoline not consumed
GHG reduction income					
GHG reduction credit rate	$/tCO2	152.00			
GHG reduction credit duration	yr	5			
GHG reduction credit escalation rate	%	3.0%			

Financial Analysis

Financial parameters			
Inflation rate	%	3.6%	
Project life	yr	25	
Debt ratio	%	37%	
Debt interest rate	%	4.50%	
Debt term	yr	5	
Initial costs			
Power system	$	157,292	15.7%
See Costs Appendix	$	845,638	84.3%
Total initial costs	$	1,002,930	100.0%
Incentives and grants	$	0	0.0%
Annual costs and debt payments			
O&M (savings) costs	$	1,176	
Fuel cost - proposed case	$	0	
Debt payments - 5 yrs	$	84,530	
	$	0	
Total annual costs	$	85,706	
Annual savings and income			
Fuel cost - base case	$	0	
Electricity export income	$	32,182	
GHG reduction income - 5 yrs	$	4,604	
	$	0	
Total annual savings and income	$	36,786	
Financial viability			
Pre-tax IRR - equity	%	1.6%	
Pre-tax IRR - assets	%	-0.7%	
Simple payback	yr	28.2	
Equity payback	yr	21.7	

Cumulative cash flows graph



Settings

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

Hydro formula costing method

Country		Mexico	
Local vs. Canadian equipment cost ratio		0.55	
Local vs. Canadian fuel cost ratio		0.55	
Local vs. Canadian labour cost ratio		0.56	
Equipment manufacture cost coefficient		1.50	
Exchange rate	$/CAD	12.26	
Cold climate	yes/no	Yes	
Frost days at site	day	0	
Design flow	ft³/s	6.717447	0
Gross head	ft	30	0
Number of turbines	turbine	1	0
Type		Pelton	Kaplan
Flow per turbine	m³/s	0.19	
Turbine runner diameter per unit	m	0.23	
Facility type		Micro	Micro
Existing dam	yes/no	Yes	
New dam crest length	ft	8	
Maximum hydraulic losses	%	10.0%	0.0%
Miscellaneous losses	%	5.0%	
Road construction			
Canal			
Penstock			
Transmission line			
Grid type		Isolated-grid	Isolated-grid
Length	km	1.0	
Difficulty of terrain		3.0	
Voltage	kV	12.0	

See maps

Initial costs (credits)	Amount $	Adjustment factor	Amount $	Relative costs
Feasibility study	0	1.00	0	0.0%
Development	0	1.00	0	0.0%
Engineering	51,000	1.00	51,000	3.4%
Power system				
Hydro turbine	988,000	1.00	988,000	65.6%
Road construction	0	1.00	0	0.0%
Transmission line	461,000	1.00	461,000	30.6%
Substation	6,000	1.00	6,000	0.4%
Balance of system & miscellaneous				
Penstock	0	1.00	0	0.0%
Canal	0	1.00	0	0.0%
Tunnel	0	1.00	0	0.0%
Other	0	1.00	0	0.0%
Sub-total:	0		0	
Total initial costs	**1,506,000**		**1,506,000**	**100.0%**

Additonal Initial Costs
Permits for using federal water
Permits for contructing 10 km from federal water

Material	Amount		Cost (in Pesos
Rebar 1/2" 2 meter poles	4,000 1/2" poles		$400,000.00
Cemento		151178.1818	$347,709.82
Cable Electrico			
12 Gague	100m		$520.00
Transmission Line/Acometeda	per km		$1,500.00
Power Pole/Mofa			$2,000.00
Initial Labor			$90,000.00
Total Cost			$845,637.82

Pesos (MXN)
2,745.00
1,163.00

)

Canal Construction Prices	**(MXN)**
Based on Price Quotes in S.C.	
Pay for Construction Boss	$250.00
Pay for Workers	$100.00
Cement 50 kg Bag	$115.00
Rebar 1/2" 2 meter Poles	$100.00

Assumptions on Cement/Concrete

Concrete contains 15% Cement
Cement weights 52 lb/ft^3
1 kg is 2.2 lbs

Labor Assumptions

Two workers with one boss can build 5 m a day

1000	meters of canal
5	meters per day
200	days to build

Pay

Boss	$50,000.00
2 Workers	$40,000.00
Total	$90,000.00

Canal Dimensions & Cost Assu

Wall Width
Wall Height
Wall Length
Floor Width
Floor Depth
Wall Length

Total Concrete
Total Cement

Conversion to Kg of cement
No. of 50 kg Bags of Cement
Cost of Cement in (MXN)

Rebar Assumptions

1/2" 2 meter pole
Canal Walls
Poles for canal walls
Price per Pole
Total Rebar Price

ıмptions

$1.00	ft	0.3048	m
5	ft	1.524	m
3280	ft	999.744	m
3	ft	0.9144	m
1	ft	0.3048	m
3280	ft	999.744	m
42640	ft^3	1207.43	m^3
6396	ft^3	181.1146	m^3
		151178.2	Kg
		3024	Bags
		347709.8	Pesos

0.5	m of canal
2000	m
4000	poles
100	(MXN)
400000	(MXN)

Hydrological Data from Rio Grijalva for Peje de Oro in Mm^3

Adjustment factor based on only known flow for July

1.61E-16

	Rio Grijalva		Rio Peje de Oro	
Jan	2550 Mm^3	409672.13 m^3	2508.77 GPM	
Feb	2277 Mm^3	365813.11 m^3	2240.18 GPM	
March	2050 Mm^3	329344.26 m^3	2016.85 GPM	
April	1800 Mm^3	289180.33 m^3	1770.90 GPM	
May	2050 Mm^3	329344.26 m^3	2016.85 GPM	
June	2880 Mm^3	462688.52 m^3	2833.43 GPM	
July	3050 Mm^3	490000.00 m^3	3000.69 GPM	
August	3050 Mm^3	490000.00 m^3	3000.69 GPM	
Sept	5050 Mm^3	811311.48 m^3	4968.35 GPM	
Oct	5550 Mm^3	891639.34 m^3	5460.26 GPM	
Nov	3550 Mm^3	570327.87 m^3	3492.60 GPM	
Dec	2550 Mm^3	409672.13 m^3	2508.77 GPM	

Kilowatts Produced Each Month with 50% Take		**Average**
Jan	7.02 KWH	8.347497 KWH
Feb	6.26 KWH	
Mar	5.64 KWH	
Apr	4.95 KWH	
May	5.64 KWH	
Jun	7.92 KWH	
Jul	8.39 KWH	
Aug	8.39 KWH	
Sep	13.89 KWH	
Oct	15.27 KWH	
Nov	9.77 KWH	
Dec	7.02 KWH	

GHG Emissions Credits	http://www.3degreesinc.com/	Price (MXN) per Ton of CO2	$152
Feed in Tariffs based on CFE	http://www.cfe.gob.mx/Paginas/Home.aspx		
Cross Flow Turbine	www.greenpelton.org	Price (MXN)	$157,292.06