

Clean Energy Project Analysis Software

Project information [See project database](#)

Project name: Molino Arco Ten
 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:
 Language - Langue: English - Anglais
 User manual: English - Anglais
 Currency: Mexico
 Units: Metric units

Site reference conditions [Select climate data location](#)

Climate data location: San Cristóbal de las Casas
 Show data:

	Climate data		Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days	Cooling degree-days
	Unit	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						

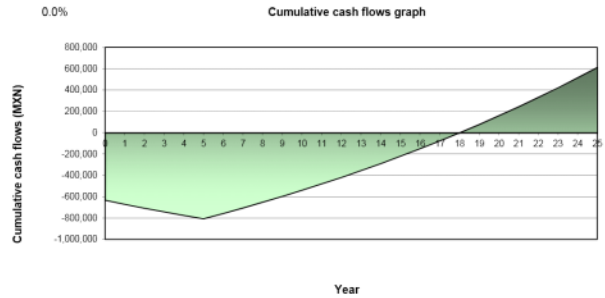
Month	Air temperature	Relative humidity	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days	Cooling degree-days
	°C	%	kWh/m ² /d	kPa	m/s	°C	°C-d	°C-d
January	19.1	71.0%	4.67	92.4	3.1	19.9	0	281
February	20.5	65.6%	5.42	92.3	2.9	21.8	0	294
March	22.0	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

Proposed case power system		Incremental initial costs	
Technology	Hydro turbine		
Analysis type	Method 1 Method 2		
Hydro turbine			
Power capacity	kW	8	MXN 157,292
Manufacturer	Canyon Hydro		
Model	Cross-flow		
Capacity factor	%	90.0%	See product database
Electricity exported to grid	MWh	66	
Electricity export rate	MXN/MWh	629.10	

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	MXN/tCO2	152.00		
GHG reduction credit rate	yr	5		
GHG reduction credit duration	%	3.0%		
GHG reduction credit escalation rate				

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	MXN	157,292	15.7%	
See Costs Appendix	MXN	645,638	84.3%	
Total initial costs	MXN	1,002,930	100.0%	
Incentives and grants	MXN	0	0.0%	
Annual costs and debt payments				
OBM (savings) costs	MXN	1,176		
Fuel cost - proposed case	MXN	0		
Debt payments - 5 yrs	MXN	84,530		
Total annual costs	MXN	85,706		
Annual savings and income				
Fuel cost - base case	MXN	0		
Electricity export income	MXN	41,402		
GHG reduction income - 5 yrs	MXN	4,604		
Total annual savings and income	MXN	46,006		
Financial viability				
Pre-tax IRR - equity	%	3.7%		
Pre-tax IRR - assets	%	1.2%		
Simple payback	yr	22.4		
Equity payback	yr	18.0		



RETScreen Tools - Power project

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	MXN/CAD	12.26		
Cold climate	yes/no	Yes		
Frost days at site	day	0		
Design flow	ft ³ /s	6.717447	0	
Gross head	ft	30	0	
Number of turbines	turbine	1	0	
Type		Pelton	Kaplan	
Flow per turbine	m ³ /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		
Initial costs (credits)	Amount MXN	Adjustment factor	Amount MXN	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%

[See maps](#)

Additional Initial Costs

	Pesos (MXN)
Permits for using federal water	2,745.00
Permits for constructing 10 km from federal water	1,163.00

Material	Amount	Cost (in Pesos)
Rebar 1/2" 2 meter poles	4,000 1/2" poles	\$400,000.00
Cemento in 50 kg bags	3024	\$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

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/ft³
 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 Assumptions

Wall Width	\$1.00 ft	0.3048 m
Wall Height	5 ft	1.524 m
Wall Length	3280 ft	999.744 m
Floor Width	3 ft	0.9144 m
Floor Depth	1 ft	0.3048 m
Wall Length	3280 ft	999.744 m

Total Concrete	42640 ft ³	1207.43034 m ³
Total Cement	6396 ft ³	181.114551 m ³

Conversion to Kg of cement	151178.182 Kg
No. of 50 kg Bags of Cement	3024 Bags
Cost of Cement in (MXN)	347709.818 Pesos

Rebar Assumptions

1/2" 2 meter pole	0.5 m of canal
Canal Walls	2000 m
Poles for canal walls	4000 poles
Price per Pole	100 (MXN)
Total Rebar Price	400000 (MXN)

Hydrological Data from Rio Grijalva for Peje de Oro in Mm³

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.com	Price (MXN)	\$157,292.06