From:	Louie Azzolini
To:	Jim Sparling
Cc:	Ken Baigent; Nick Walker
Subject:	FW: Ekati info
Date:	Friday, June 12, 2015 12:59:17 PM
Attachments:	image001.png Ekati 50 kW Solar - Project Information.pdf Ekati 50 kW Solar - Energy Model.pdf Ekati 50 kW Solar - Emission Analysis.pdf Ekati 50 kW Solar - Financial Analysis.pdf Ekati 50 kW Solar - Risk Analysis.pdf Ekati 1.jpg Ekati 2.jpg

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Mr. Sparling, in response to your June 8th request for assistance (email appended) the Arctic Energy Alliance (AEA) completed a RETScreen analysis of installing 50 kW of solar at the Ekati mine. Based on the Rae Lakes weather data, this 50 kW system should:

1. Produce about 48,050 kWh annually,
2. Offset about 34 tCO2 annually,
3. Generates solar electricity @ $0.20847/kWh (about 25% less than the current assumed cost of diesel power @ $0.28), and have an
4. Equity payback of about 16.3 years.

PDF's of the RETScreen data sheets are attached, as are the photos used in the analysis.

Assumptions

1. From AEA's Commercial Fuel Cost Library, the highest cost of oil in the NWT was $1.90/litre in Wekweeti (a winter road community), and the lowest cost of oil was $1.06 in Hay River (a road access community in the far south of the NWT).
2. From all of the NTPC generator data efficiency data that AEA has, the best efficiency of all of them is about 35.2%, and the Ekati will have newer generators. Using 35.2%, these generators will produce 3.755 kWh/litre of oil.
3. At $1.90/litre oil, the equivalent cost of electricity is $0.506/kWh
4. At $1.06/litre oil, the equivalent cost of electricity is $0.280/kWh
5. Assuming that Ekati has a cost of oil equivalent to the lowest commercial rate in the NWT, and has generator efficiency equal to the highest that NTPC has in the NWT AEA has used $0.280/kWh as the current cost of electricity for Ekati.
6. AEA prepared the RETScreen to include the above data, and used the Rae Lakes weather station as this is the closet data set in NRCan's database, in latitude, to Ekati.
7. NTPC has a general guideline that distributed renewable energy generation should not exceed 20% of the average load of their generation facility. A 50 kW system is 20% of 250 kW. AEA assumes the baseload of Ekati is much higher than 250 kW, so integrating a 50 kW solar PV system should be easy to achieve.

The RETScreen analysis produced the following results

1. GHG offsets are 34.4 tCO2 annually (860 over 25 years)
2. Annual solar electricity generation is calculated as 48,050 kWh (1.2 MWH over 25 years)
3. Cost of solar electricity generation is $0.20847/kWh
4. Based on a 25 year life expectancy of the system (most panels are warrantied

for 25 years):

- 16.3 year equity payback
- 4.4% IRR
- $97,786 Net Present Value (NPV)

5. For the sensitivity analysis, AEA used a +/- 30% swing in system cost (base case = $6.00/watt) and in the current cost of electricity (base case = $0.28/kWh). Another way to look at this is "as long as the renewable option has a NPV of no less than $0.00, and there are associated GHG savings, going solar for a portion of their generation requirements demonstrates corporates social responsibility.

Site specific considerations regarding the placement of the PV

There is a large building (lower left side of Ekati 2 picture) that has a perfectly south facing roof that is 150 meters wide x 50 meters of south facing roof. Filling the whole roof would accommodate 30 rows of 150 panels = 4,500 panels or (at 250 watts per panel) 1.125 MW of solar. Of course, some roof set-backs and system access would be required, so you would probably lose about 208 panels or 52 kW. You could probably open up 8 or 9 vertical access rows, and still have plenty of room for 4,000 panels = 1MW of solar.

Siting 50 kW of solar

50 kW of solar = 200 solar panels, which can be laid out as 2 rows of 100 panels across the top edge of the south-facing roof.

Assumptions used in the RETScreen analyses include:

1. $0.28 cost of diesel generation @ Ekati
2. Coordinates for Ekati are 64.7 Lat & -110.6 Long
3. Pitch of the host roof is 4/12
4. Roof orientation is perfectly solar south
5. Existing diesel grid has a generator efficiency of 35.2%
6. Inverter Efficiency = 95% (very common for new inverters)
7. Miscellaneous Loss = 15% (snow, dirt coverage & any down time)
8. Other Miscellaneous Losses = 2% (line losses should be very low as the system will be installed near the diesel generators)
9. Cost = $6.00 watt
10. No assumption for service & maintenance as anything required should be offset by less maintenance (run time) of one of the Ekati generators.
11. 25 year life of the Solar System
12. $15,000 AETP rebate

If you have any questions regarding this submission please contact either Ken Baigent of Nick Walker.

Respectfully on behalf of Ken Baigent and Nick Walker,

Louie Azzolini
Executive Director, Arctic Energy Alliance
C: 867-765-8550 P: 867-920-3384 www.aea.nt.ca

Sent: Monday, June 8, 2015 1:22 PM
To: Louie Azzolini
Subject: solar for diamond mines

Louie,

The Jay Pipe expansion at DDEC's Ekati mine will result in an estimated increase of greenhouse gas emissions of over 200 kilotonnes. In the first round of Information Requests ENR along with others asked them about using alternative energy at the site to limit the increase in emissions. DDEC's answer was they did not think any other source of energy would meet their needs and when I asked them about solar, they stated they would not seek any information about viability or cost at their site.

Could the Arctic Energy Alliance help me answer the following information request submitted in round two? Could you prepare a RETScreen type analysis for a moderately sized PV system at the site to provide an indication of the cost, payback and emission reductions from something in the range of a 50 kW system to illustrate what might be possible?

Jim Sparling
Manager, Climate Change Programs
Environment Division
NWT Dept of Environment and Natural Resources
NEW (867) 920-8649

☐ Show alternative units

Proposed case power system

Analysis type ○ Method 1 ◉ Method 2

Resource assessment

Solar tracking mode		Fixed
Slope	°	18.4
Azimuth	°	0.0

☑ Show data

Month	Daily solar radiation - horizontal kWh/m²/d	Daily solar radiation - tilted kWh/m²/d	Electricity export rate $/MWh	Electricity exported to grid MWh
January	0.14	0.46	280.0	0.669
February	0.76	1.44	280.0	1.836
March	2.12	3.04	280.0	4.150
April	4.01	4.82	280.0	6.019
May	5.74	6.17	280.0	7.608
June	6.30	6.50	280.0	7.453
July	5.85	6.13	280.0	7.176
August	4.17	4.69	280.0	5.617
September	2.46	3.15	280.0	3.780
October	1.07	1.81	280.0	2.362
November	0.29	0.81	280.0	1.076
December	0.04	0.21	280.0	0.304
Annual	**2.76**	**3.28**	**280.00**	**48.051**

Annual solar radiation - horizontal	MWh/m²	1.01
Annual solar radiation - tilted	MWh/m²	1.20

Photovoltaic

Type		poly-Si	
Power capacity	kW	50.00	See product database
Manufacturer		Conergy	
Model		poly-Si - ON-250P-60	200 unit(s)
Efficiency	%	15.1%	
Nominal operating cell temperature	°C	45	
Temperature coefficient	% / °C	0.40%	
Solar collector area	m²	331	
Miscellaneous losses	%	15.0%	

Inverter

Efficiency	%	95.0%
Capacity	kW	50.0
Miscellaneous losses	%	2.0%

Summary

Capacity factor	%	11.0%
Electricity exported to grid	MWh	48.051

RETScreen Emission Reduction Analysis - Power project

☑ Emission Analysis

○ Method 1
◉ Method 2
○ Method 3

Global warming potential of GHG

25 tonnes CO2 = 1 tonne CH4 (IPCC 2007)
298 tonnes CO2 = 1 tonne N2O (IPCC 2007)

Base case electricity system (Baseline)

Fuel type	Fuel mix %	CO2 emission factor kg/GJ	CH4 emission factor kg/GJ	N2O emission factor kg/GJ	Electricity generation efficiency %	T&D losses %	GHG emission factor tCO2/MWh
Diesel (#2 oil)	100.0%	69.3	0.0019	0.0019	35.2%		0.715
Electricity mix	100.0%	197.0	0.0054	0.0054		0.0%	0.715

☐ Baseline changes during project life

Base case system GHG summary (Baseline)

Fuel type	Fuel mix %	CO2 emission factor kg/GJ	CH4 emission factor kg/GJ	N2O emission factor kg/GJ	Fuel consumption MWh	GHG emission factor tCO2/MWh	GHG emission tCO2
Electricity	100.0%	197.0	0.0054	0.0054	48	0.715	34.4
Total	100.0%	197.0	0.0054	0.0054	48	0.715	34.4

Proposed case system GHG summary (Power project)

Fuel type	Fuel mix %	CO2 emission factor kg/GJ	CH4 emission factor kg/GJ	N2O emission factor kg/GJ	Fuel consumption MWh	GHG emission factor tCO2/MWh	GHG emission tCO2
Solar	100.0%	0.0	0.0000	0.0000	48	0.000	0.0
Total	100.0%	0.0	0.0000	0.0000	48	0.000	0.0
				T&D losses			
Electricity exported to grid	MWh	48			0	0.715	0.0
						Total	0.0

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	34.4	0.0	34.4		34.4

Net annual GHG emission reduction	34.4	tCO2	is equivalent to	6.3	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	%	2.0%
Project life	yr	25

Finance

Incentives and grants	$	15,000
Debt ratio	%	0.0%

Income tax analysis ☐

Annual income

Electricity export income

Electricity exported to grid	MWh	48
Electricity export rate	$/MWh	280.00
Electricity export income	$	13,454
Electricity export escalation rate	%	3.0%

GHG reduction income ☐

Net GHG reduction	tCO2/yr	34
Net GHG reduction - 25 yrs	tCO2	859

Customer premium income (rebate) ☐

Other income (cost) ☐

Clean Energy (CE) production income ☐

Project costs and savings/income summary

Initial costs

Power system	100.0%	$	300,000
Balance of system & misc.	0.0%	$	0
Total initial costs	**100.0%**	**$**	**300,000**
Incentives and grants		$	15,000

Annual costs and debt payments

O&M	$	0
Fuel cost - proposed case	$	0
Total annual costs	**$**	**0**

Periodic costs (credits)

Annual savings and income

Fuel cost - base case	$	0
Electricity export income	$	13,454
Total annual savings and income	**$**	**13,454**

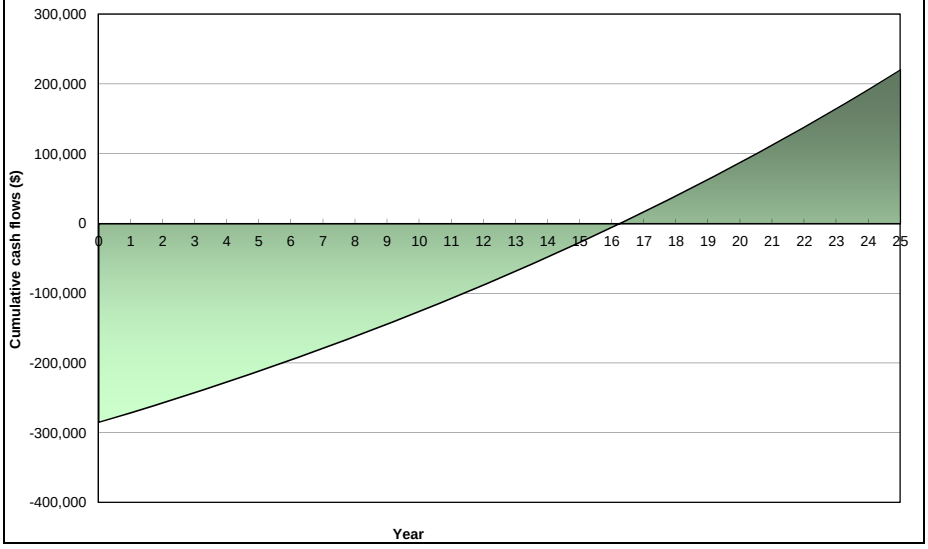
Financial viability

Pre-tax IRR - equity	%	4.4%
Pre-tax IRR - assets	%	4.4%
After-tax IRR - equity	%	4.4%
After-tax IRR - assets	%	4.4%
Simple payback	yr	21.2
Equity payback	yr	16.3
Net Present Value (NPV)	$	97,786
Annual life cycle savings	$/yr	5,009
Benefit-Cost (B-C) ratio		1.33
Energy production cost	$/MWh	208.47
GHG reduction cost	$/tCO2	(146)

Yearly cash flows

Year	Pre-tax	After-tax	Cumulative
#	$	$	$
0	-285,000	-285,000	-285,000
1	13,858	13,858	-271,142
2	14,274	14,274	-256,869
3	14,702	14,702	-242,167
4	15,143	15,143	-227,024
5	15,597	15,597	-211,427
6	16,065	16,065	-195,362
7	16,547	16,547	-178,815
8	17,043	17,043	-161,771
9	17,555	17,555	-144,216
10	18,081	18,081	-126,135
11	18,624	18,624	-107,511
12	19,183	19,183	-88,329
13	19,758	19,758	-68,571
14	20,351	20,351	-48,220
15	20,961	20,961	-27,258
16	21,590	21,590	-5,668
17	22,238	22,238	16,569
18	22,905	22,905	39,474
19	23,592	23,592	63,067
20	24,300	24,300	87,366
21	25,029	25,029	112,395
22	25,780	25,780	138,175
23	26,553	26,553	164,728
24	27,350	27,350	192,078
25	28,170	28,170	220,248

Cumulative cash flows graph



Project information

See project database

Project name	50 kW Solar in conjunction with Jay Pipe Development
Project location	Ekati Mine Site - Lac de Gras
Prepared for	GNWT - Environment & Natural Resources
Prepared by	Arctic Energy Alliance
Project type	Power
Technology	Photovoltaic
Grid type	Isolated-grid
Analysis type	Method 2
Heating value reference	Higher heating value (HHV)
Show settings	☐

Site reference conditions

Select climate data location

Climate data location	Rae Lakes
Show data	☑

	Unit	Climate data location	Project location
Latitude	˚N	64.1	64.1
Longitude	˚E	-117.3	-117.3
Elevation	m	223	223
Heating design temperature	°C	-40.9	
Cooling design temperature	°C	24.3	
Earth temperature amplitude	°C	27.5	

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	-27.7	70.8%	0.14	98.0	1.9	-27.6	1,417	0
February	-23.0	73.5%	0.76	98.1	2.1	-25.2	1,148	0
March	-18.3	68.5%	2.12	98.1	2.9	-19.6	1,125	0
April	-5.9	63.9%	4.01	98.1	2.8	-9.1	717	0
May	3.6	62.8%	5.74	98.0	3.3	1.8	446	0
June	13.4	56.3%	6.30	97.8	3.3	12.0	138	102
July	16.8	56.9%	5.85	97.7	3.3	15.1	37	211
August	13.3	72.9%	4.17	97.6	3.5	11.3	146	102
September	7.2	79.6%	2.46	97.6	3.8	3.5	324	0
October	-2.6	83.5%	1.07	97.6	3.7	-7.9	639	0
November	-13.9	83.8%	0.29	97.7	2.6	-19.9	957	0
December	-21.7	79.5%	0.04	97.8	2.3	-24.7	1,231	0
Annual	-4.8	71.0%	2.76	97.8	3.0	-7.4	8,325	415
Measured at	m				10.0	0.0		

Complete Energy Model sheet

RETScreen Sensitivity and Risk Analysis - Power project

☑ Sensitivity analysis

Perform analysis on	Net Present Value (NPV)	
Sensitivity range	30%	
Threshold	0	$

		Initial costs				$
Electricity export rate		210,000	255,000	300,000	345,000	390,000
$/MWh		-30%	-15%	0%	15%	30%
196.00	-30%	72,950	27,950	-17,050	-62,050	-107,050
238.00	-15%	130,368	85,368	40,368	-4,632	-49,632
280.00	0%	187,786	142,786	**97,786**	52,786	7,786
322.00	15%	245,203	200,203	155,203	110,203	65,203
364.00	30%	302,621	257,621	212,621	167,621	122,621

		Initial costs				$
Electricity export rate		210,000	255,000	300,000	345,000	390,000
$/MWh		-30%	-15%	0%	15%	30%
196.00	-30%	72,950	27,950	-17,050	-62,050	-107,050
238.00	-15%	130,368	85,368	40,368	-4,632	-49,632
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		Initial costs				$
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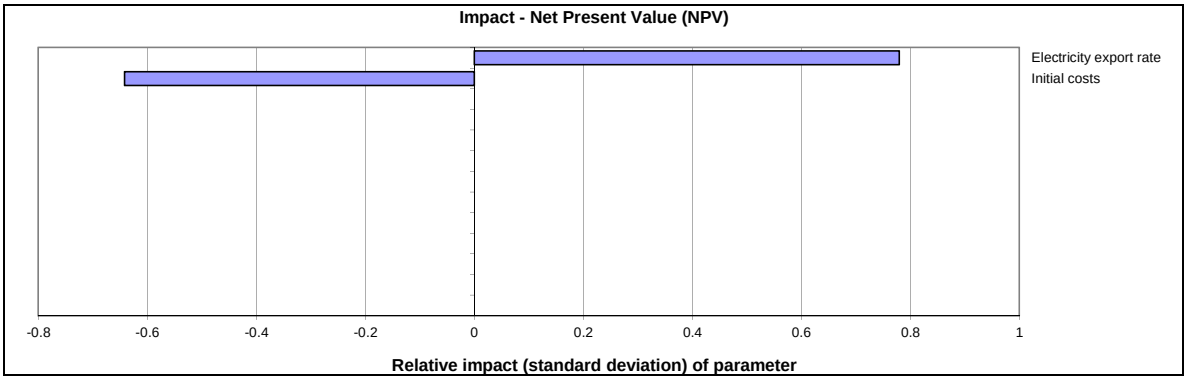
$/MWh		-30%	-15%	0%	15%	30%
196.00	-30%	72,950	27,950	-17,050	-62,050	-107,050
238.00	-15%	130,368	85,368	40,368	-4,632	-49,632
280.00	0%	187,786	142,786	**97,786**	52,786	7,786
322.00	15%	245,203	200,203	155,203	110,203	65,203
364.00	30%	302,621	257,621	212,621	167,621	122,621

☑ Risk analysis

Perform analysis on	Net Present Value (NPV)

Parameter	Unit	Value	Range (+/-)	Minimum	Maximum
Initial costs	$	300,000	30%	210,000	390,000
Electricity export rate	$/MWh	280.00	30%	196.00	364.00



Median	$	97,629
Level of risk	%	0.0%
Minimum within level of confidence	$	-39,303
Maximum within level of confidence	$	241,736