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Solar Energy Feasibility Study

For a Typical On-Grid Residence in Fairbanks, AK

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Abstract:

Solar Energy Feasibility Study was conducted for a grid-tied photovoltaic system typical of on-grid single-family installations in Fairbanks, AK. This report describes the method by which anticipated annual and monthly solar power produced for the region was obtained. The basis of the cost analysis, including participation in the local utility SNAP program, eligibility for a federal tax credit, and the projected energy costs, is described. A summary of the simple payback period and life cycle cost analyses (LCCA) performed is presented. Assumptions for the study are stated. Results conclude that the LCCA payback period for the described system is 13 years.

Solar Energy Feasibility Study

For a Typical On-Grid Residence in Fairbanks, AK

1. Introduction:

Solar Energy Feasibility Study was conducted for a 2,100 W grid-tied photovoltaic system, typical of on-grid single-family installations in Fairbanks, AK. A 2,100 W system does not generally produce enough energy to completely offset the energy needs of the common household; however such installations are becoming more common in the region. This report summarizes the estimated cost of a commonly-sized solar energy system, anticipated annual solar power produced for the region, anticipated month-by-month power produced, simple payback calculations, and a Life Cycle Cost Analysis (LCCA) for this system. This study is intended to evaluate the overall project's economic viability in its intended location.

2. Site Survey and Considerations:

A site survey is typically conducted to determine the locations on the site property best suited for solar photovoltaic (PV) arrays. Optimal PV array locations maximize the available solar energy and minimize solar obstructions to reduce shading on the PV arrays. A survey may not be absolutely necessary if there is a general understanding that the PV array location clearly has no solar obstructions (for instance, the array may be located on an unobstructed south-facing 10-acre field).

Solar insolation data was estimated for the sample site per reference (1). This software incorporates 30-year historical weather data from the National Renewable Energy Laboratory (NREL) for specific locations in North America and estimates the amount of solar radiation received for a given site and the amount of energy produced for a given system. The calculated energy produced also accounts for estimated system efficiency losses.

Data from the reports generated by reference (1) was used as a basis for estimating the month-by-month solar power generated and the cost analyses described below. The assumption for these data is that no solar obstructions/shading will be present on the PV at any time of the year.

For the Fairbanks, AK region, the array would be manually adjusted twice a year to maximize solar radiation availability. The arrays would be tilted to approximately 52 degrees from horizontal from April through September to maximize the solar radiation from the high summer sun path. The array would be adjusted to 90 degrees from horizontal from October through March to minimize snow accumulation and to maximize solar radiation from the low winter sun path.

The anticipated solar energy produced by the system is summarized in Table 1. The reported results are based upon the 30-year historical weather data from NREL for the site location and estimated system efficiency losses.

Table 1. Anticipated Solar Energy Produced

		Monthly AC Power Generated (kWh)												
System Size	**Description**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual AC Power Generated**
2.1 kW	12- Panel Pole-Mounted Array	42	119	228	290	257	246	243	208	154	104	59	21	1,971 kWh

Notes: (1) Shaded areas in table indicate that the array is to be positioned 90 degrees from horizontal during the indicated months.

3. Cost Analysis Basis:

Projected energy cost savings were estimated based on participation in a region-wide renewable energy program and is discussed at length below. A simple payback analysis and a life cycle cost analysis were performed. The basis for each of the calculations is also described.

Participation in SNAP:

The sample PV system is grid-connected and eligible for participation in the Sustainable Natural Alternative Power (SNAP) program sponsored by the local Fairbanks electrical utility company, Golden Valley Electric Association (GVEA). The SNAP program was first created by Chelan County Public Utility District (PUD) in Washington State and is the model for GVEA's program. Participation in this program is available to GVEA customers with systems generating 25 kilowatts or less. SNAP producers are paid annually for the power they generate from a pool of funds created by voluntary GVEA customer contributions. The amount paid to individual SNAP producers depends on the total funds contributed to the program by GVEA customers and the total power generated by all SNAP producers. The greater the amount contributed by SNAP supporters, the greater the amount that will be distributed among SNAP producers.

For example, if a SNAP producer generated 1 percent of the total SNAP power produced, and GVEA purchasers contributed $50,000 to the SNAP fund, then the following year the SNAP producer would receive an annual SNAP payment of $500 ($50,000 times 1 percent).

The Chelan County PUD historical payments to SNAP producers is summarized in Table 2 and serves as a basis for the estimated future SNAP payments under GVEA.

Table 2. Chelan Co. PUD SNAP Payments

Year	Chelan Co. PUD payments to SNAP Producers ($/kWh)
2002	$1.50
2003	$1.20
2004	$0.74
2005	$0.46
2006	$0.35
2007	$0.21
2008	$0.25

Project Life Cycle Cost Analyses:

In order to account for rising energy costs, the life cycle cost analyses take into consideration an anticipated annual energy price increase.

Reference (2) was used as a basis for an estimation of the anticipated annual energy rate. Table 5.22 of this reference was used to analyze past fuel prices since the energy rates in the Fairbanks, AK region are dependent upon fuel prices. Table 5.22 lists the refiner sales prices (excluding taxes) for selected petroleum products from 1991 through 2007. The cold temperatures in the Fairbanks region facilitate the need for fuels such as Naphtha, arctic diesel fuel and/or kerosene-type jet fuel to be considered for use in the local utility generators. The nominal prices for kerosene-type jet fuel excerpted from this table are summarized in Table 3 below. (The historical prices of Naphtha or arctic diesel fuel are not available in reference (2); only the prices of kerosene-type jet fuel are listed.)

Note: The nominal price is the price paid for a product or service at the time of the transaction. Nominal prices are those that have not been adjusted to remove the effect of changes in the purchasing power of the dollar; they reflect buying power in the year in which the transaction occurred.

Table 3. National Average of Refiner Sales Price for Kerosene-Type Jet Fuel (1991-2007)

Year	Nominal Price per Gallon, Excluding Taxes
1991	$0.65
1992	$0.61
1993	$0.58
1994	$0.53
1995	$0.54
1996	$0.65
1997	$0.61
1998	$0.45
1999	$0.54
2000	$0.90
2001	$0.78
2002	$0.72
2003	$0.87
2004	$1.21
2005	$1.74
2006	$2.00
2007	$2.17

Figure 1 plots the national average of refiner sales price for kerosene-type jet fuel from 1991 through 2007. A trendline was created to describe the rate of the overall annual energy cost increase for the recorded time period. From this trendline (which was assumed to be exponential over the recorded period), however, a national annual price increase of 7.83% is evident from 1991 until 2007. Since the utility's energy costs are currently dependent upon these fuel prices, an annual overall energy cost increase of 7.83% was used for this cost analysis.

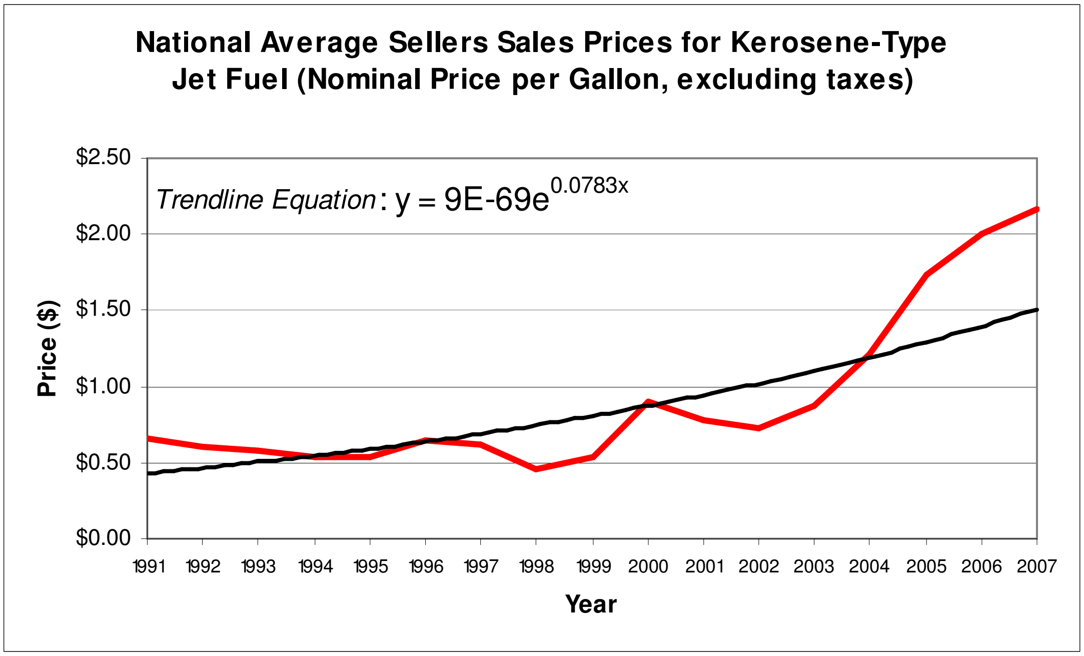

Figure 1. National Average of All Sellers Sales Price for No. 2 Diesel Fuel (1991-2007) with Trendline

Overall Energy Costs:

SNAP producers who generated power in 2007 received payments of $1.50 from GVEA in 2008. Using past Chelan County PUD SNAP payments (shown in Table 2) as a basis for future GVEA SNAP payments, an estimated payment schedule was created for future payments to GVEA SNAP producers, and is presented in the "SNAP Payments" column of Table 4. For the analysis, an assumption was made that the SNAP payments to GVEA customers would be the same as payments to Chelan County PUD SNAP customers and would remain constant ($0.25/kWh) after the last year documented.

SNAP producers also receive from the GVEA the utility's *avoided cost* of producing electricity. At the time of this writing, the avoided cost paid to SNAP customers by GVEA is 11.389¢ per kilowatt hour. As described in the preceding section, the average anticipated annual energy rate increase for this report will be 7.83%. The projected energy costs (fuel-adjusted energy rate) were calculated for this analysis based on the 7.83% annual energy rate increase and are summarized in the column labeled "Avoided Cost w/7.83% increase/year" of Table 4.

The total anticipated avoided cost paid to GVEA SNAP producers is presented in the "Total Avoided Cost" column of Table 4. This column is a sum of the preceding two columns, thereby summarizing the total projected energy cost savings of producing power for GVEA SNAP producers.

Table 4. Tabulated Projected Energy Cost Savings

		SNAP Payments ($/kWh)	Avoided Cost w/ 7.83% increase/year	Total Avoided Cost ($/kWh)
Year 1	2008	$1.50	$0.11	$1.61
Year 2	2009	$1.20	$0.12	$1.32
Year 3	2010	$0.74	$0.13	$0.87
Year 4	2011	$0.46	$0.14	$0.60
Year 5	2012	$0.35	$0.15	$0.50
Year 6	2013	$0.21	$0.17	$0.38
Year 7	2014	$0.25	$0.18	$0.43
Year 8	2015	$0.25	$0.19	$0.44
Year 9	2016	$0.25	$0.21	$0.46
Year 10	2017	$0.25	$0.22	$0.47
Year 11	2018	$0.25	$0.24	$0.49
Year 12	2019	$0.25	$0.26	$0.51
Year 13	2020	$0.25	$0.28	$0.53
Year 14	2021	$0.25	$0.30	$0.55
Year 15	2022	$0.25	$0.33	$0.58
Year 16	2023	$0.25	$0.35	$0.60
Year 17	2024	$0.25	$0.38	$0.63
Year 18	2025	$0.25	$0.41	$0.66
Year 19	2026	$0.25	$0.44	$0.69
Year 20	2027	$0.25	$0.48	$0.73
Year 21	2028	$0.25	$0.51	$0.76
Year 22	2029	$0.25	$0.55	$0.80
Year 23	2030	$0.25	$0.60	$0.85
Year 24	2031	$0.25	$0.64	$0.89
Year 25	2032	$0.25	$0.70	$0.95
Year 26	2033	$0.25	$0.75	$1.00
Year 27	2034	$0.25	$0.81	$1.06
Year 28	2035	$0.25	$0.87	$1.12
Year 29	2036	$0.25	$0.94	$1.19
Year 30	2037	$0.25	$1.01	$1.26

4. Simple Payback and Life Cycle Cost Analyses:

Reference (3) was used as a reference for the LCCA. An excerpt from page 1 of the document reads:

"This report provides tables of present-value factors for use in the life-cycle cost analysis of capital investment projects for federal facilities. It also provides energy price indices based on Department of Energy (DOE) forecasts from 2008 to 2038. The factors and indices presented in this report are useful for determining the present value of future project-related costs, especially those related to operational energy costs. Discount factors included in this report are based on two different federal sources: (1) the DOE discount rate for projects related to energy conservation, renewable energy resources, and water conservation; and (2) Office of Management and Budget (OMB) discount rates from Circular A-94 for use with most other capital investment projects in federal facilities.

The DOE discount and inflation rates for 2008 are as follows:
Real rate (excluding general price inflation): 3.0 %
Nominal rate (including general price inflation): 4.9 %
Implied long-term average rate of inflation: 1.8 %"

Based on the federal requirements for life cycle cost analyses applied to government projects as cited above, a discount rate of 3% was applied to the LCCA performed herein. The simple payback periods calculated are based solely on the overall estimated project cost and the cost savings during the first year. A simple payback period calculation does not factor changing energy costs. The LCCA payback periods, however, are calculated by taking into consideration the changing costs of energy. For the sample case, the savings-to-investment ratio, net present value, internal rate of return, and adjusted rate of return were calculated.

Also factored into the calculations are the following assumptions:

1. The initial investment cost is based on an installed system cost $23,000.

2. The yearly PV cell performance degradation is 0.5% per year. Reference (4) describes "the loss of Energy Life production [of a PV cell] as a function of annual degradation rates. Reports have placed this rate between 0.2% and 0.7% per annum." Based on these rates, cell performance degradation of 0.5% per year was selected for this study as a moderate factor used to determine the amount of energy produced per year, thus the energy cost savings for the corresponding year.

3. Three study periods were considered for the LCCA calculations: 10 years, 20 years, and 30 years. 10- and 20-year study periods were assumed to be periods of interest to homeowners. The 30-year study period was assumed to be of additional interest for businesses. For each of these study periods, the savings-to-investment ratio, net present value, internal rate of return, and adjusted rate of return were calculated.

4. Reference (5) provides an opportunity for businesses and residents to be eligible for 30% tax credits for qualified photovoltaic systems placed in service between January 1, 2006 and December 31, 2016. This report assumes that individuals installing the solar electric system are eligible for this tax credit.

5. The inverter life is 20 years, at which point the inverter (assumed to be $2,300) would be replaced.

6. After 30 years, 5% of the solar panels would be replaced ($1,050, which is 5% of the total installed system cost).

Table 5 summarizes the outcome of the simple payback analysis and LCCA for the sample case. A summary of the cost analysis and period of study is included as Appendix A.

Table 5. Cost Analysis Results Summary

Study Period	Estimated Net Project Cost (w/tax credit)	Annual kWh Production	Discount Rate	Present Value (of Savings over Study Period)	Annual Cost Savings(1)	Simple Payback Period(2)	LCCA Payback Period(3)	Savings-to-Investment Ratio (SIR)(4)	Net Present Value (NPV)(5)	Internal Rate of Return (IRR)(6)	Adjusted Internal Rate of Return (AIRR)(7)
10 Years	$16,100	1,971 kWh	3.0%	$12,175	$3,181	5.1 years	13 Years	0.76	($3,925)	7%	-3%
20 Years				$17,734	$3,181	5.1 years	13 Years	1.10	$1,634	7%	2%
30 Years				$25,184	$3,181	5.1 years	13 Years	1.56	$9,084	7%	3%

Notes:
1. The annual cost savings is based on first-year cost factor of $1.61/kWh times the annual savings of 1971 kWh.
2. Simple Payback Period = Annual kWh Production ÷ Annual Cost Savings
3. LCCA Payback Period is the period of time it takes for the cumulative cash flow to be positive. In other words, the break-even point.
4. SIR = Present Value ÷ Estimated Net Project Cost
5. NPV = Present Value - Estimated Net Project Cost
6. The IRR is the annualized effective compounded return rate which can be earned on the invested capital, i.e., the yield on the investment.
7. AIRR = {[1+Discount Rate]*[(SIR)^(1/Life)]}- 1. AIRR assumes interim proceeds can be invested at the discount rate.

5. Conclusions and Commentary:

The calculated economic payback period for a grid-tied photovoltaic system, typical of on-grid single-family installations in Fairbanks, AK is 13 years. Any financial incentives lowering the initial investment costs would be the primary consideration in reducing the payback period for such a system, thereby increasing the potential for residents and businesses in the Fairbanks, AK region to invest in photovoltaic system technologies. Businesses may be able to claim accelerated depreciation against the cost of their system. This could result in a substantial reduction of both the Simple and LCCA Payback Periods for a solar investment.

Any business considering an investment in a solar energy system should contact a tax professional before any purchase takes place.

6. References:

1. "PVWATTS v. 1: A Performance Calculator for Grid-Connected PV Systems," retrieved 03 November, from the National Renewable Energy Laboratory.
   Web Source: http://rredc.nrel.gov/solar/codes_algs/PVWATTS/version1/

2. Department of Energy publication DOE/EIA-0384(2007),"Annual Energy Review 2007" published June 2008
   Web Source: http://www.eia.doe.gov/overview_hd.html

3. Department of Energy publication NISTIR 85-3273-23, "Energy Price Indices and Discount Factors for Life-Cycle Cost Analysis – April 2008", Rev. 5/08
   Web Source: http://www1.eere.energy.gov/femp/pdfs/ashb08.pdf

4. Dunlop, Ewan D. "Lifetime Performance of Crystalline Silicon PV Modules." Dunlop European Commission, Joint Research Centre, Institute for Environment and Sustainability, Renewable Energies Unit TP 450, via E. Fermi 1, I-21020 Ispra (Va), Italy

5. H.R. 1424 bill, "The Emergency Economic Stabilization Act of 2008," Passed into law October 3, 2008.

Appendix A

Simple Payback and Life Cycle Cost Analysis Worksheets

LIFE CYCLE COST ANALYSIS	Solar Energy System Evaluation		ENERGY CONSERVATION PROJECT	
Location:	Energy Conservation Measures (ECM):	ECM Cost: $23,000	Annual cost savings:	$3,181
General Site, Fairbanks, AK	2,100 Watt System, consisting of an adjustable 12 -panel pole-mounted array situated on a property with no shading. The array utilizes one inverters to provide 120 VAC power.		(electricity) in U.S. Dollars Based on cost factor of $1.61389/KHW.	

ECM Life:	10	years	Saved as:	COMPs1.XLS		Savings to Investment Ratio, **SIR:**		0.53
Initial Annual KWH Savings:	1,971	KWH	(Year 1) KWH Rate:	$1.61	/KWH	(PV Savings/PV Investment)		
Energy Escalation Rate:	8%	/ year	Annual Panel Degradation	0.5%		**Simple Pay Back Period**		
Recurring Maint. Cost:	$0	first year	Yr 1 $ Svgs:	$3,181		($16,100)	=	**5.06 Years**
Discount Rate:	3%		Maint. Escalation Rate:	2%	/ year	3181		

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
ECM cost	($23,000)										
Federal Rebate, as applic	$6,900										
Projected KWH Rate: (see tab entitled "Projected AK Payments")		$1.61	$1.32	$0.87	$0.60	$0.50	$0.38	$0.43	$0.44	$0.46	$0.47
Power Output		99.5%	99.0%	98.5%	98.0%	97.5%	97.0%	96.5%	96.0%	95.5%	95.0%
Energy Cost Savings:		$3,165	$2,581	$1,694	$1,164	$968	$719	$816	$838	$862	$888
Less O & M Costs:											
Misc. Benefits/Costs:											
Net Cash Flow:	($16,100)	$3,165	$2,581	$1,694	$1,164	$968	$719	$816	$838	$862	$888
Cum.Cash Flow:	($16,100)	($12,935)	($10,354)	($8,660)	($7,496)	($6,527)	($5,808)	($4,992)	($4,154)	($3,291)	($2,403)

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Projected KWH Rate: (see tab entitled "Projected AK Payments")										
Power Output										
Energy Cost Savings:										
Less O & M Costs:										
Misc. Benefits/Costs:										
Net Cash Flow:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cum.Cash Flow:	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)

	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Projected KWH Rate: (see tab entitled "Projected AK Payments")										
Power Output										
Energy Cost Savings:										
Less O & M Costs:										
Misc. Benefits/Costs:										
Net Cash Flow:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cum.Cash Flow:	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)	($2,403)

Discount Rate:	3%
Present Value Savings:	$12,175
Net Present Value (NPV):	($3,925)
Internal Rate of Return (IRR): IRR assumes interim proceeds can be invested at the IRR rate.	7%
Adjusted Internal Rate of Return (AIRR): where AIRR = {[1+Discount Rate]*[(SIR)^(1/Life)]}- 1 AIRR assumes interim proceeds can be invested at the discount rate.	-3%

LIFE CYCLE COST ANALYSIS	Solar Energy System Evaluation		ENERGY CONSERVATION PROJECT	
Location:	Energy Conservation Measures (ECM):	ECM Cost: $23,000	Annual cost savings:	$3,181
General Site, Fairbanks, AK	2,100 Watt System, consisting of an adjustable 12 -panel pole-mounted array situated on a property with no shading. The array utilizes one inverters to provide 120 VAC power.		(electricity) in U.S. Dollars Based on cost factor of $1.61389/KHW.	

ECM Life:	20 years	Saved as:	COMPs1.XLS	Savings to Investment Ratio, **SIR:**	0.77
Initial Annual KWH Savings:	1,971 KWH	(Year 1) KWH Rate:	$1.61 /KWH	(PV Savings/PV Investment)	
Energy Escalation Rate:	8% / year	Annual Panel Degradation	0.5%	**Simple Pay Back Period**	
Recurring Maint. Cost:	$0 first year	Yr 1 $ Svgs:	$3,181	($16,100) =	5.06 **Years**
Discount Rate:	3%	Maint. Escalation Rate:	2% / year	3181	

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
ECM cost	($23,000)										
Federal Rebate, as applic	$6,900										
Projected KWH Rate: (see tab entitled "Projected AK Payments")		$1.61	$1.32	$0.87	$0.60	$0.50	$0.38	$0.43	$0.44	$0.46	$0.47
Power Output		99.5%	99.0%	98.5%	98.0%	97.5%	97.0%	96.5%	96.0%	95.5%	95.0%
Energy Cost Savings:		$3,165	$2,581	$1,694	$1,164	$968	$719	$816	$838	$862	$888
Less O & M Costs:											
Misc. Benefits/Costs:											
Net Cash Flow:	($16,100)	$3,165	$2,581	$1,694	$1,164	$968	$719	$816	$838	$862	$888
Cum.Cash Flow:	($16,100)	($12,935)	($10,354)	($8,660)	($7,496)	($6,527)	($5,808)	($4,992)	($4,154)	($3,291)	($2,403)

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Projected KWH Rate: (see tab entitled "Projected AK Payments")	$0.49	$0.51	$0.53	$0.55	$0.58	$0.60	$0.63	$0.66	$0.69	$0.73
Power Output	94.5%	94.0%	93.5%	93.0%	92.5%	92.0%	91.5%	91.0%	90.5%	90.0%
Energy Cost Savings:	$916	$947	$979	$1,015	$1,052	$1,093	$1,137	$1,184	$1,235	$1,290
Less O & M Costs:										($2,300)
Misc. Benefits/Costs:										
Net Cash Flow:	$918	$948	$981	$1,016	$1,054	$1,095	$1,139	$1,186	$1,237	($1,009)
Cum.Cash Flow:	($1,485)	($537)	$444	$1,460	$2,514	$3,608	$4,747	$5,933	$7,169	$6,161

	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Projected KWH Rate: (see tab entitled "Projected AK Payments")										
Power Output										
Energy Cost Savings:										
Less O & M Costs:										
Misc. Benefits/Costs:										
Net Cash Flow:	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Cum.Cash Flow:	$6,161	$6,161	$6,161	$6,161	$6,161	$6,161	$6,161	$6,161	$6,161	$6,161

Discount Rate:	3%
Present Value Savings:	$17,734
Net Present Value (NPV):	$1,634
Internal Rate of Return (IRR):	7%
IRR assumes interim proceeds can be invested at the IRR rate.	
Adjusted Internal Rate of Return (AIRR):	2%
where AIRR = {[1+Discount Rate]*[(SIR)^(1/Life)]}- 1	
AIRR assumes interim proceeds can be invested at the discount rate.	

Assumes inverter will be replaced in Year 20.

LIFE CYCLE COST ANALYSIS	Solar Energy System Evaluation		ENERGY CONSERVATION PROJECT	
Location:	Energy Conservation Measures (ECM):	ECM Cost: $23,000	Annual cost savings:	$3,181
General Site, Fairbanks, AK	2,100 Watt System, consisting of an adjustable 12 -panel pole-mounted array situated on a property with no shading. The array utilizes one inverters to provide 120 VAC power.		(electricity) in U.S. Dollars Based on cost factor of $1.61389/KHW.	

ECM Life:	30	years	Saved as:	COMPs1.XLS		Savings to Investment Ratio, **SIR:** (PV Savings/PV Investment)	1.09
Initial Annual KWH Savings:	1,971	KWH	(Year 1) KWH Rate:	$1.61	/KWH		
Energy Escalation Rate:	8%	/ year	Annual Panel Degradation	0.5%		**Simple Pay Back Period**	
Recurring Maint. Cost:	$0	first year	Yr 1 $ Svgs:	$3,181		($16,100) / 3181 =	5.06 **Years**
Discount Rate:	3%		Maint. Escalation Rate:	2%	/ year		

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
ECM cost	($23,000)										
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Cum. Cash Flow:	($16,100)	($12,935)	($10,354)	($8,660)	($7,496)	($6,527)	($5,808)	($4,992)	($4,154)	($3,291)	($2,403)

	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Projected KWH Rate: (see tab entitled "Projected AK Payments")	$0.49	$0.51	$0.53	$0.55	$0.58	$0.60	$0.63	$0.66	$0.69	$0.73
Power Output	94.5%	94.0%	93.5%	93.0%	92.5%	92.0%	91.5%	91.0%	90.5%	90.0%
Energy Cost Savings:	$916	$947	$979	$1,015	$1,052	$1,093	$1,137	$1,184	$1,235	$1,290
Less O & M Costs:										($2,300)
Misc. Benefits/Costs:										
Net Cash Flow:	$918	$948	$981	$1,016	$1,054	$1,095	$1,139	$1,186	$1,237	($1,009)
Cum. Cash Flow:	($1,485)	($537)	$444	$1,460	$2,514	$3,608	$4,747	$5,933	$7,169	$6,161

	Year 21	Year 22	Year 23	Year 24	Year 25	Year 26	Year 27	Year 28	Year 29	Year 30
Projected KWH Rate: (see tab entitled "Projected AK Payments")	$0.76	$0.80	$0.85	$0.89	$0.95	$1.00	$1.06	$1.12	$1.19	$1.26
Power Output	90.0%	89.5%	89.0%	88.5%	88.0%	87.5%	87.0%	86.5%	86.0%	85.5%
Energy Cost Savings:	$1,348	$1,412	$1,479	$1,552	$1,630	$1,715	$1,805	$1,902	$2,006	$2,117
Less O & M Costs:										($1,150)
Misc. Benefits/Costs:										
Net Cash Flow:	$1,350	$1,413	$1,481	$1,554	$1,632	$1,716	$1,807	$1,904	$2,008	$969
Cum. Cash Flow:	$7,511	$8,924	$10,405	$11,959	$13,591	$15,308	$17,114	$19,018	$21,026	$21,995

Discount Rate:	3%
Present Value Savings:	$25,184
Net Present Value (NPV):	$9,084
Internal Rate of Return (IRR): IRR assumes interim proceeds can be invested at the IRR rate.	7%
Adjusted Internal Rate of Return (AIRR): where AIRR = {[1+Discount Rate]*[(SIR)^(1/Life)]}- 1 AIRR assumes interim proceeds can be invested at the discount rate.	3%

Assumes inverter will be replaced in Year 20 and 5% of PV panels will be replaced in Year 30.