Appendix F:
Greenhouse Gas Emissions Modeling

Click on **Calculate** if default values are acceptable, or after selecting your system specifications. Click on **Help** for information about system specifications. To use a DC to AC derate factor other than the default, click on **Derate Factor Help** for information.

Site Location:

Cell ID:	0176346
State*:	California
Latitude*:	38.512
Longitude*:	-121.97

PV System Specifications:

DC Rating (kW):	1000	
DC to AC Derate Factor:	0.77	DERATE FACTOR HELP
Array Type:	1-Axis Tracking	

Fixed Tilt or 1-Axis Tracking System:

Array Tilt (degrees):	38.512	(Default = Latitude)
Array Azimuth (degrees):	180.0	(Default = True South) *What's this?*

Energy Data:

Cost of Electricity (cents/kWh):	12.623

Calculate HELP Reset Form

AC Energy & Cost Savings

Cautions for Interpreting the Results

(Type comments here to appear on printout; maximum 1 row of 90 characters.)

Station Identification

Cell ID:	0176346
State:	California
Latitude:	38.5 ° N
Longitude:	122.0 ° W

PV System Specifications

DC Rating:	1000.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	770.0 kW
Array Type:	1-Axis Tracking
Array Tilt:	38.5 °
Array Azimuth:	180.0 °

Energy Specifications

Cost of Electricity:	12.6 ¢/kWh

Results

Month	Solar Radiation (kWh/m^2/day)	AC Energy (kWh)	Energy Value ($)
1	3.68	84512	10667.95
2	5.40	111136	14028.70
3	6.46	146454	18486.89
4	8.03	173878	21948.62
5	8.73	192230	24265.19
6	9.31	195529	24681.63
7	9.55	204317	25790.94
8	9.27	198230	25022.57
9	8.48	175702	22178.86
10	6.95	151053	19067.42
11	4.75	102206	12901.46
12	3.57	80147	10116.96
Year	7.02	1815394	229157.19

Output Hourly Performance Data

(Gridded data is monthly, hourly output not available.)

Output Results as Text

Saving Text from a Browser

Run PVWATTS v.2 for another location

Run PVWATTS v.1

Please send questions and comments to Webmaster

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RReDC home page (http://rredc.nrel.gov)

Powerplant Emission Calculations

Grasslands Site

Project Information

Number of acres	30
Power production (MW)	5

Solar Energy Calculations

	AC energy (kWh/year/1000 kW)		
PVWatts ID	Fixed Tilt	1 axis tracking	Average
176346	1815394	1815394	1815394

Project's PVWatts ID:	176346
Project's AC energy (kWh/year/1000 kW)	1815394
Project's AC energy (MWh/year)	9077

Sources

- Source of AC Energy (Solar Energy Calculations): National Renewable Energy Laboratory. PVWatts Viewer, Grid Data Calculator (Version 2). http://www.nrel.gov/rredc/pvwatts/ and http://mapserve3.nrel.gov/PVWatts_Viewer/index.html; the estimates are based on the location of the project
- Source of Average Emission Rates: California Climate Action Registry. 2009. General Reporting Protocol. Reporting Entity-Wide Greenhouse Gas Emissions. Version 3.1, January 2009. Website: www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. Table C-2 (for CAMX, WECC California)

Note: Emissions converted from tons per year to metric tons of carbon dioxide equivalents (MTCO2e) per year by using the formula: (tons of gas) x (global warming potential) x (0.9072 metric tons). Global warming potential for methane = 21; nitrous oxide = 310

	NOx	CO2	CO2	Solar Generation	CO2e Reductions	NOx
	pounds/MWh	pounds/MWh	tons/mwh	MWh/year	tons/year	tons/year
Combined Cycle Turbine	0.12	1,100	0.55	9,077	4,992	0.54
Simple Gas Turbine Peaker	0.15	1,100	0.55	9,077		0.68

Represents emission savings compared to use of combined cycle gas turbine or a simple gas turbine peaker plant to generate an equivalent amount of electricity.

Sources: 1) California Air Resources Board. Guidance for the Permtting of Electrical Generation Technologies as approved by the Air Resources Board on November 15, 2001. 2) California Energy Commission. Implementation of SB 1368 Emission Performance Standard. November 2006 CEC-700-2006-011

Western US Average Emission Rates	Pounds/MWh	CO2e tons/MWh	MWh/year	CO2e Reductions Tons/Year	tons CO2e Reductions in 25 years
Emission Rate CO2	724.12	0.3621	9,077	3,286	82,160
Emission Rate Methane	0.0302	0.0003	9,077	3	72
Emission Rate N2O	0.0081	0.0013	9,077	11	285
		0.3636		3,301	82,517

Assumptions:

CO2 reductions from 1 mwh (tons)	0.55	**Sources:** Guidance for the Permitting of Electrical Generation Technologies, ARB, November 15, 2001
CO2 emissions from 1 mwh from CC Turbine	1100	CEC Emission Performance Standards (EPS)

lb/MW-hr = (emission rate [lb/MMBtu]) x (3.413 [MMBtu/MWh]) / (efficiency)

	Project's Electricity Generation MWh/year	Compared to CC Nat Gas CO2 (tons/year)	Compared to Western US CO2e (tons/year)	Average Western US CO2e (Mtons/year)
Year 1	9,077	4,992	3,301	2,994
Year 2	9,032	4,967	3,285	2,980
Year 3	8,986	4,943	3,268	2,965
Year 4	8,941	4,918	3,252	2,950
Year 5	8,897	4,893	3,236	2,935
Year 6	8,852	4,869	3,219	2,921
Year 7	8,808	4,844	3,203	2,906
Year 8	8,764	4,820	3,187	2,891
Year 9	8,720	4,796	3,171	2,877
Year 10	8,677	4,772	3,155	2,863
Year 11	8,633	4,748	3,140	2,848
Year 12	8,590	4,725	3,124	2,834
Year 13	8,547	4,701	3,108	2,820
Year 14	8,504	4,677	3,093	2,806
Year 15	8,462	4,654	3,077	2,792
Year 16	8,420	4,631	3,062	2,778
Year 17	8,377	4,608	3,047	2,764
Year 18	8,336	4,585	3,031	2,750
Year 19	8,294	4,562	3,016	2,736
Year 20	8,252	4,539	3,001	2,723
Year 21	8,211	4,516	2,986	2,709
Year 22	8,170	4,494	2,971	2,696
Year 23	8,129	4,471	2,956	2,682

Year 24	8,089	4,449	2,942	2,669
Year 25	8,048	4,426	2,927	2,655
Year 26	8,008	4,404	2,912	2,642
Year 27	7,968	4,382	2,898	2,629
Year 28	7,928	4,360	2,883	2,616
Year 29	7,888	4,339	2,869	2,603
Year 30	7,849	4,317	2,854	2,590
Year 31	7,810	4,295	2,840	2,577
Year 32	7,771	4,274	2,826	2,564
Year 33	7,732	4,252	2,812	2,551
Year 34	7,693	4,231	2,798	2,538
Year 35	7,655	4,210	2,784	2,525
Total	292,118	160,665	106,235	96,376
Power generation assuming an output decline of .5% per year			Avg Savings/year	3,855

Click on **Calculate** if default values are acceptable, or after selecting your system specifications. Click on **Help** for information about system specifications. To use a DC to AC derate factor other than the default, click on **Derate Factor Help** for information.

Site Location:

Cell ID:	0177346
State*:	California
Latitude*:	38.761
Longitude*:	-121.614

PV System Specifications:

DC Rating (kW):	1000
DC to AC Derate Factor:	0.77
Array Type:	1-Axis Tracking

Fixed Tilt or 1-Axis Tracking System:

Array Tilt (degrees):	38.761 (Default = Latitude)
Array Azimuth (degrees):	180.0 (Default = True South) *What's this?*

Energy Data:

Cost of Electricity (cents/kWh):	11.274

Calculate HELP Reset Form

AC Energy & Cost Savings

Cautions for Interpreting the Results

(Type comments here to appear on printout; maximum 1 row of 90 characters.)

Station Identification

Cell ID:	0177346
State:	California
Latitude:	38.8 ° N
Longitude:	121.6 ° W

PV System Specifications

DC Rating:	1000.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	770.0 kW
Array Type:	1-Axis Tracking
Array Tilt:	38.8 °
Array Azimuth:	180.0 °

Energy Specifications

Cost of Electricity:	11.3 ¢/kWh

Results

Month	Solar Radiation (kWh/m^2/day)	AC Energy (kWh)	Energy Value ($)
1	3.61	83144	9373.65
2	5.52	113803	12830.15
3	6.57	148930	16790.37
4	8.12	175646	19802.33
5	8.88	195019	21986.44
6	9.38	196172	22116.43
7	9.66	205619	23181.49
8	9.53	202885	22873.26
9	8.73	180437	20342.47
10	7.14	155232	17500.86
11	4.85	104526	11784.26
12	3.34	75100	8466.77
Year	7.12	1836514	207048.59

Output Hourly Performance Data

(Gridded data is monthly, hourly output not available.)

Output Results as Text

Saving Text from a Browser

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Run PVWATTS v.1

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RReDC home page (http://rredc.nrel.gov)

Powerplant Emission Calculations

Beamer/Cottonwood Site

Project Information

Number of acres	2
Power production (MW)	0.8

Solar Energy Calculations

	AC energy (kWh/year/1000 kW)		
PVWatts ID	Fixed Tilt	1 axis tracking	Average
177346	1836514	1836514	1836514

Project's PVWatts ID:	177346
Project's AC energy (kWh/year/1000 kW)	1836514
Project's AC energy (MWh/year)	1469

Sources

- Source of AC Energy (Solar Energy Calculations): National Renewable Energy Laboratory. PVWatts Viewer, Grid Data Calculator (Version 2). http://www.nrel.gov/rredc/pvwatts/ and http://mapserve3.nrel.gov/PVWatts_Viewer/index.html; the estimates are based on the location of the project
- Source of Average Emission Rates: California Climate Action Registry. 2009. General Reporting Protocol. Reporting Entity-Wide Greenhouse Gas Emissions. Version 3.1, January 2009. Website: www.climateregistry.org/resources/docs/protocols/grp/GRP_3.1_January2009.pdf. Table C-2 (for CAMX, WECC California)

Note: Emissions converted from tons per year to metric tons of carbon dioxide equivalents (MTCO2e) per year by using the formula: (tons of gas) x (global warming potential) x (0.9072 metric tons). Global warming potential for methane = 21; nitrous oxide = 310

	NOx	CO2	CO2	Solar Generation	CO2e Reductions	NOx
	pounds/MWh	pounds/MWh	tons/mwh	MWh/year	tons/year	tons/year
Combined Cycle Turbine	0.12	1,100	0.55	1,469	808	0.09
Simple Gas Turbine Peaker	0.15	1,100	0.55	1,469		0.11

Represents emission savings compared to use of combined cycle gas turbine or a simple gas turbine peaker plant to generate an equivalent amount of electricity.

Sources: 1) California Air Resources Board. Guidance for the Permtting of Electrical Generation Technologies as approved by the Air Resources Board on November 15, 2001. 2) California Energy Commission. Implementation of SB 1368 Emission Performance Standard. November 2006 CEC-700-2006-011

Western US Average Emission Rates	Pounds/MWh	CO2e tons/MWh	MWh/year	CO2e Reductions Tons/Year	tons CO2e Reductions in 25 years
Emission Rate CO2	724.12	0.3621	1,469	532	13,299
Emission Rate Methane	0.0302	0.0003	1,469	0	12
Emission Rate N2O	0.0081	0.0013	1,469	2	46
		0.3636		534	13,356

Assumptions:

		Sources:
CO2 reductions from 1 mwh (tons)	0.55	Guidance for the Permitting of Electrical Generation Technologies, ARB, November 15, 2001
CO2 emissions from 1 mwh from CC Turbine	1100	CEC Emission Performance Standards (EPS)

lb/MW-hr = (emission rate [lb/MMBtu]) x (3.413 [MMBtu/MWh]) / (efficiency)

	Project's Electricity Generation MWh/year	Compared to CC Nat Gas CO2 (tons/year)	Compared to Western US CO2e (tons/year)	Average Western US CO2e (Mtons/year)
Year 1	1,469	808	534	485
Year 2	1,462	804	532	482
Year 3	1,455	800	529	480
Year 4	1,447	796	526	477
Year 5	1,440	792	524	475
Year 6	1,433	788	521	473
Year 7	1,426	784	518	470
Year 8	1,419	780	516	468
Year 9	1,411	776	513	466
Year 10	1,404	772	511	463
Year 11	1,397	769	508	461
Year 12	1,390	765	506	459
Year 13	1,383	761	503	456
Year 14	1,377	757	501	454
Year 15	1,370	753	498	452
Year 16	1,363	750	496	450
Year 17	1,356	746	493	447
Year 18	1,349	742	491	445
Year 19	1,342	738	488	443
Year 20	1,336	735	486	441
Year 21	1,329	731	483	438
Year 22	1,322	727	481	436
Year 23	1,316	724	479	434

Year 24	1,309	720	476	432
Year 25	1,303	716	474	430
Year 26	1,296	713	471	428
Year 27	1,290	709	469	425
Year 28	1,283	706	467	423
Year 29	1,277	702	464	421
Year 30	1,270	699	462	419
Year 31	1,264	695	460	417
Year 32	1,258	692	457	415
Year 33	1,251	688	455	413
Year 34	1,245	685	453	411
Year 35	1,239	681	451	409
Total	47,283	26,005	17,195	15,600
Power generation assuming an output decline of .5% per year			Avg Savings/year	624