



Town of
Barrington, RI

Town of
Bristol, RI



**PUBLIC-PRIVATE PARTNERSHIP FOR
ON-SITE SOLAR PROJECTS**

BID# 850

Presented on November 30, 2016 by:



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- Energy Development Partners
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Executive Summary:

Thank you for allowing Energy Development Partners (EDP), an experienced Rhode Island based renewable energy project developer, the opportunity to present this proposal to the Towns of Bristol and Barrington, Rhode Island. EDP has prepared a plan, described in this proposal that will deliver the towns of Bristol and Barrington a combined savings of over \$10,000,000 throughout the life of the contract. As required by the RFP, our proposal is developed with no up front cost to either town. We estimate first year savings and revenue over \$340,000 to Bristol and over \$200,000 to Barrington.

EDP is a renewable energy developer located in Providence, RI. We have been in business since 2013, but our team has been developing solar projects since 2010 and has installed 4.5 MW's of solar energy here in RI. In addition to our installed base, we have permitted and have under contract an additional 80 MW's with 60 MW's right here in RI. Collectively the management of EDP has over 45 year so experience developing and building solar and wind projects. We are submitting this proposal along with our construction partners, i.b. Vogt, GmbH (IBV). IBV is a world-class renewable energy construction company headquartered in Hamburg, Germany. IBV has been building solar and wind projects throughout Europe for the last ten years. They have successfully built over 530 MW's of solar projects all throughout Europe, Asia and Australia. Our newly developed joint venture provides EDP with a strong financial partner with the capability to construct our existing pipeline of solar projects.

It is EDP's belief that both Bristol and Barrington will be best served in this RFP endeavor through the use of a **Public Entity Net-Metering Financing Arrangement**. In this situation, solar panels are centrally located on one parcel of land and their combined output is used to service the aggregated usage of all of one town's electrical meters. Our proposal is to provide both Bristol and Barrington with the means to offset nearly **100%** of their existing electrical loads with power created from two individual local solar arrays. Although both towns willingly and graciously provided numerous public buildings and school rooftops as potential sites for the solar panels, EDP strongly believes that the most efficient method for installing solar with the lowest possible cost to the towns is to utilize remote net metering. The benefits of remote net metering are captured within the General Laws of Rhode Island (Chapter 39-26.4) and available only to public entities or a multi-municipal collaborative. By following this path both Bristol and Barrington will not incur any additional expenses for roof upgrades, will keep the solar offsite and eliminate the potential for any risk from an on-site installation and they will benefit from the ability of the third party owner/developer to provide the greatest cost benefits through centralization of the construction activities.

EDP proposes to sell the Net Metering Credits from the remote solar arrays at a deep discount to both towns. Our offer is provide the NMC at a guaranteed savings of 22.5% throughout the life of the contract. During the initial Bidders Meeting as well as during the site walks, it was noted that each town was interested in at least one on-site installation that would be visible in town. This visible project would showcase each town's commitment to renewable energy and provide a visual reminder of that commitment to their residents. In our proposal, EDP has allowed for each town to have the option of having just such a visible project. A highly visible array is proposed for the Quinta Gamelin Community Center in Bristol and an equally visible carport array is proposed for the parking lot of the Barrington Town Hall. Unlike the larger remote solar ground mount arrays, both of these projects will be connected behind-the-meter and fed directly into the electrical service for the buildings they will serve. These are not stand-alone projects but are offered as an option to go along with the larger landfill and remote net metering projects offered to each town. It is through the increased purchasing power that EDP can offer these projects at such discounted rates to each town.

Our projects, briefly described above, will provide significant guaranteed savings to both towns for the entirety of the proposed 25-year contracts. The EDP team is highly seasoned and well financed to see each of these

projects quickly through to completion. We are eager and excited to work with both towns on providing the highest quality solar power installations.

The EDP Proposal:

The EDP proposal for both towns is very similar. We would propose utilizing the Remote Net Metering laws of Rhode Island and install one large solar array for each town's total annual electrical load. Additionally, we have provided each town with an option to have an on-site solar array located within their respective town to highlight to their residents the town's commitment to renewable energy. The details for each town's proposals are as follows:

Town of Bristol

PROJECT 1 Minturn Farm Road Landfill: - a Public Entity Net-Metering Financing Arrangement with 100% of the town's electric load offset by solar energy created from an array located on the town's landfill. The landfill at the end of Minturn Farm Road has an adequate amount of land to develop and build a solar energy system that will produce the 4,527,271 kWh's annually that was reported in the RFP as constituting Bristol's annual electric requirement. The system will be a 3,512.88 kW (DC) solar system with over 10,000 solar panels located on top of the landfill. EDP proposes to sell the net metering credits (NMC) to the Town at **22.5%** discount off the Net Metering Credit rate for the full 25-year life of the contract. Additionally, the town of Bristol, as the owners of the landfill, will realize annual revenue of **\$87,500** for leasing the property to EDP. The EDP lease is for \$25,000/MW DC installed with a 1.5% annual escalation. The town will earn an additional tax revenue stream of **\$12,300** for the tangible tax. This calculation is the newly legislated rate (takes affect in 2017) of \$5/kW multiplied by the system's AC size of 2.46. The electricity savings is estimated at **\$148,203** in year one. (Formulation = Proposed production of 4,462,605 x NMC of \$0.14756 x .225 = \$148,203)

Combined annual revenue and savings to the Town of Bristol in year one = \$248,003.

OPTION – PROJECT 2 Quinta Gamelin Community Center On-Site array:

EDP proposes the option of installing a 56.1 kW DC system on the town's Community Center on Asylum Road. This building has three areas that are suitable for solar panels. There are two flat roofs; one on the main building and the other over the separate garage in the back. Both of these roofs would support separate 18.7 kW DC arrays. Additionally, the front of the building has a hip roof that faces due south, directly towards Asylum Road. A third 18.7 kW DC array can be installed here flush to the roof's surface. The orientation of this hip roof would provide an excellent high visibility location for the town to showcase their support for renewable energy. According to Addendum #5 for this RFP, the Quinta Gamelin Community Center consumed 82,480 kWh's for the calendar year of 2015. Our proposed on-site solar project would produce 70,010 kWh's, which is nearly 85% of the building's annual electrical load. This project would be connected behind-the-meter and directly into the control panel of the Community Center. This would reduce the kWh's purchased by the Community Center from the utility by 70,010 kWh's annually. Therefore the savings on this installation would come from the offset of not buying those 70,010 kWh's from National Grid and instead paying for the solar array's production at our proposed PPA rate of \$0.09/kWh. The value of the displaced kWh's would be the standard net metering credit calculation, which includes the supply, distribution, transition and transmission. This Net Metering Credit for a G-02 is currently valued at \$0.10139. Additionally, since this system is hooked directly into the control panel and slowing down the meter, there would be two additional charges that would be reduced as well. The

Renewable Energy Distribution Charge and the Energy Efficiency Programs charges are both calculated according to kWh usage and thus you would save an additional \$0.00344 and \$0.01107 respectively for these charges. All totaled, the per kWh reduction would be \$0.1159 and you would pay EDP for that production the agreed to PPA rate of \$0.09. The year-by-year savings for both of these options are detailed in the following Proposal Summary pages.

The On-Site Option is not mutually exclusive from the larger system at the landfill. It is being offered as an option to go along with the larger landfill project. By selecting the On-Site Option we would of course have to reduce the kW at the landfill by the corresponding kW we install at the Community Center.

Town of Barrington

PROJECT 3 - Wyoming Solar: - a Public Entity Net Metering Financing Arrangement with nearly 100% of the town's electric load offset by solar energy created from an off-site remote net metering facility. The solar array would be located in the village of Wyoming in the town of Richmond, RI. The site is 12 acres and is located on an unused flat parcel of land that is situated between Nooseneck Hill Road (Route 3) and Route 95 North. A system layout and other details are spelled out further on in the Project Details and section of this report. The system has been designed to produce as close to 100% of the annual electrical load for the town Barrington, noted as 3,781,724 kWh's in the RFP. EDP proposes to sell the net metering credits (NMC) to the Town of Barrington at a **22.5%** discount off the Net Metering Credit. The electricity savings is estimated at **\$114,328** in year one. (Formulation = Proposed production of 3,442,581 x NMC of \$0.144756 x .225 = \$114,328)

OPTION – PROJECT 4 Town Hall Parking Area Carport - On-Site array:

As with Bristol, the Town of Barrington also expressed a real interest in having a high visibility solar project in town to highlight the town's commitment to renewable energy. During the site walks there were numerous references made to utilizing the pitched roof at the north end of Town Hall. There were a number of reasons that make this a challenging solar installation including the age and condition of the roof, the steep pitch of the roof and the proximity of several trees that would shade the potential array. For all of these reasons we decided it was not a cost efficient location for a solar array. We did feel that the central location of the Town Hall and the Library/Senior Center make this an ideal location for the town's high visibility project. We therefore decided that a carport erected on the middle island in the shared parking area behind Town Hall would be the best location for this featured solar array. We have designed a dual incline carport totaling 134.64 kW DC. The dual incline design provides the simplest method for handling snow and rain. While this is an option for the Town of Barrington it is not on its own an individual offering. As with Bristol's On-Site Option, the carport option is not mutually exclusive of the larger offsite project. We would only propose to install and provide this carport as part of a combined offering with the offsite remote system described above.

The carport is projected to produce 164,700 kWh's in year one and will offset either the Town Hall usage or the Library. The Library was not included on the site walk and we'd like to examine both the Town Hall and the Library service hook up areas before deciding which system to connect in to. Both sites are stated as having G-02 meters and the production from the carport will not exceed the annual usage for either meter.

Proposal Summary

Solar Facility Summary

Size DC (kW)	3,512.88	56.1
Size AC (kW)	2,460	42
DC/AC Ratio	1.43	1.34
Warranty & Agreement Term (yrs)	25	25
Year 1 Production (kWh)	4,479,027	70,010
% Total Municipal Load	99%	2%
Total Production Warranty Term (kWh)	105,257,144	1,680,936

Off- Take Agreements

Net Metering Credit (%)	22.50%	
Assumed Utility Escalator	0.60%	
Power Purchase Agreement Yr 1 (\$/kWh)		\$0.09
PPA Annual Escalator Contracted		0.60%

Financial Summary

EST Savings Electricity*	\$3,762,322	\$51,352
Lease	\$2,558,732	\$40,862
Tangible PPT Paid (\$5/kW AC annually)	\$307,500	\$5,250
Commerce RI Rebate (EST)		\$65,795
Est. REC Revenue		\$38,662

Total

Bristol	
Remote Town Landfill	Roof
Size DC (kW)	56.1
Size AC (kW)	42
DC/AC Ratio	1.34
Warranty & Agreement Term (yrs)	25
Year 1 Production (kWh)	70,010
% Total Municipal Load	2%
Total Production Warranty Term (kWh)	1,680,936
Net Metering Credit (%)	22.50%
Assumed Utility Escalator	0.60%
Power Purchase Agreement Yr 1 (\$/kWh)	\$0.09
PPA Annual Escalator Contracted	0.60%
EST Savings Electricity*	\$51,352
Lease	\$40,862
Tangible PPT Paid (\$5/kW AC annually)	\$5,250
Commerce RI Rebate (EST)	\$65,795
Est. REC Revenue	\$38,662
Total	\$201,921

\$6,830,476

Barrington	
Remote Wyoming, RI	Carport
Size DC (kW)	134.64
Size AC (kW)	112
DC/AC Ratio	1.20
Warranty & Agreement Term (yrs)	25
Year 1 Production (kWh)	164,550
% Total Municipal Load	4%
Total Production Warranty Term (kWh)	4,034,246
Net Metering Credit (%)	22.50%
Assumed Utility Escalator	0.60%
Power Purchase Agreement Yr 1 (\$/kWh)	\$0.09
PPA Annual Escalator Contracted	0.60%
EST Savings Electricity*	\$134,520
Lease	\$98,070
Tangible PPT Paid (\$5/kW AC annually)	\$14,000
Commerce RI Rebate (EST)	\$135,212
Est. REC Revenue	\$92,788
Total	\$474,590

\$3,366,311

* For term based on escalator



Town of Bristol - Landfill

Calculator Inputs	
System Output Yr 1	4,479,027
Utility Annual Avg Rate Increase*	0.600%
Annual De-Rate	0.50%
Net Metering Credit Yr 1 \$/kWh**	\$ 0.1476
Net Metering Credit Discount	22.50%

Notes:
 * NEMA RI C-00 10mm Net Metering Credit history 2011-2016 AACP - 0.24%
 ** Current credit as of October 2016

Output & Utility Assumptions for RI Remote Net Metering			Net Meter Rate & Annual Credit Savings		
Year	Electricity Output	Utility NMC Credit Issued on Bill	NMA rate Paid to EDP	Savings per kWh	Period Savings
1	4,479,027	\$0.14760	\$0.11439	\$0.03321	\$148,748.50
2	4,456,632	\$0.14849	\$0.11508	\$0.03341	\$148,892.79
3	4,434,349	\$0.14938	\$0.11577	\$0.03361	\$149,037.21
4	4,412,177	\$0.15027	\$0.11646	\$0.03381	\$149,181.78
5	4,390,116	\$0.15117	\$0.11716	\$0.03401	\$149,326.48
6	4,368,166	\$0.15208	\$0.11786	\$0.03422	\$149,471.33
7	4,346,325	\$0.15299	\$0.11857	\$0.03442	\$149,616.32
8	4,324,593	\$0.15391	\$0.11928	\$0.03463	\$149,761.45
9	4,302,970	\$0.15484	\$0.12000	\$0.03484	\$149,906.71
10	4,281,456	\$0.15576	\$0.12072	\$0.03505	\$150,052.12
11	4,260,048	\$0.15670	\$0.12144	\$0.03526	\$150,197.67
12	4,238,748	\$0.15764	\$0.12217	\$0.03547	\$150,343.37
13	4,217,554	\$0.15859	\$0.12290	\$0.03568	\$150,489.20
14	4,196,467	\$0.15954	\$0.12364	\$0.03590	\$150,635.17
15	4,175,484	\$0.16049	\$0.12438	\$0.03611	\$150,781.29
16	4,154,607	\$0.16146	\$0.12513	\$0.03633	\$150,927.55
17	4,133,834	\$0.16243	\$0.12588	\$0.03655	\$151,073.95
18	4,113,165	\$0.16340	\$0.12663	\$0.03676	\$151,220.49
19	4,092,599	\$0.16438	\$0.12739	\$0.03699	\$151,367.17
20	4,072,136	\$0.16537	\$0.12816	\$0.03721	\$151,514.00
21	4,051,775	\$0.16636	\$0.12893	\$0.03743	\$151,660.97
22	4,031,516	\$0.16736	\$0.12970	\$0.03766	\$151,808.08
23	4,011,359	\$0.16836	\$0.13048	\$0.03788	\$151,955.33
24	3,991,302	\$0.16937	\$0.13126	\$0.03811	\$152,102.73
25	3,971,345	\$0.17039	\$0.13205	\$0.03834	\$152,250.27

Total Savings
Average Annual Savings 25 years

NMC
\$3,762,322
\$150,493

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Town of Bristol - Roof

Calculator Inputs	
System Output Yr 1	70,010
Annual De-Rate	0.50%
Utility Rate	\$ 0.1190
Utility Annual Avg Rate Increase*	0.600%
PPA Rate Yr 1	\$0.09
PPA Annula Esulator	0.60%

Output & Utility Assumptions for PPA			PPA & Annual Savings		
Year	Electricity Output	Utility Rate Billed (\$/kWh)	PPA Rate Paid to EDP	Savings per kWh	Period Savings
1	70,010	\$0.11900	\$0.09000	\$0.02900	\$2,030.29
2	69,660	\$0.11971	\$0.09054	\$0.02917	\$2,032.26
3	69,312	\$0.12043	\$0.09108	\$0.02935	\$2,034.23
4	68,965	\$0.12115	\$0.09163	\$0.02953	\$2,036.20
5	68,620	\$0.12188	\$0.09218	\$0.02970	\$2,038.18
6	68,277	\$0.12261	\$0.09273	\$0.02988	\$2,040.16
7	67,936	\$0.12335	\$0.09329	\$0.03006	\$2,042.13
8	67,596	\$0.12409	\$0.09385	\$0.03024	\$2,044.12
9	67,258	\$0.12483	\$0.09441	\$0.03042	\$2,046.10
10	66,922	\$0.12558	\$0.09498	\$0.03060	\$2,048.08
11	66,587	\$0.12634	\$0.09555	\$0.03079	\$2,050.07
12	66,254	\$0.12709	\$0.09612	\$0.03097	\$2,052.06
13	65,923	\$0.12786	\$0.09670	\$0.03116	\$2,054.05
14	65,593	\$0.12862	\$0.09728	\$0.03135	\$2,056.04
15	65,265	\$0.12940	\$0.09786	\$0.03153	\$2,058.04
16	64,939	\$0.13017	\$0.09845	\$0.03172	\$2,060.03
17	64,614	\$0.13095	\$0.09904	\$0.03191	\$2,062.03
18	64,291	\$0.13174	\$0.09963	\$0.03210	\$2,064.03
19	63,970	\$0.13253	\$0.10023	\$0.03230	\$2,066.03
20	63,650	\$0.13332	\$0.10083	\$0.03249	\$2,068.04
21	63,332	\$0.13412	\$0.10144	\$0.03269	\$2,070.04
22	63,015	\$0.13493	\$0.10205	\$0.03288	\$2,072.05
23	62,700	\$0.13574	\$0.10266	\$0.03308	\$2,074.06
24	62,387	\$0.13655	\$0.10328	\$0.03328	\$2,076.07
25	62,075	\$0.13737	\$0.10389	\$0.03348	\$2,078.09

Total Savings
Average Annual Savings 25 years

\$51,352
\$2,054

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Town of Barrington - Remote Wyoming RI

Calculator Inputs (as modeled)	
System Output Yr 1	3,442,581
Utility Annual Avg Rate Increase*	0.600%
Annual De-Rate	0.50%
Net Metering Credit Yr 1 \$/kWh**	\$ 0.1476
Net Metering Credit Discount	22.50%

Notes:
 * NGRID RI C-00 10mm Net Metering Credit history 2011-2016 AACP - 0.24%
 ** Current credit as of October 2016

Output & Utility Assumptions for RI Remote Net Metering			Net Meter Rate & Annual Credit Savings		
Year	Electricity Output	Utility NMC Credit Issued on Bill	NMA rate Paid to EDP	Savings per kWh	Period Savings
1	3,442,581	\$0.14760	\$0.11439	\$0.03321	\$114,328.12
2	3,425,368	\$0.14849	\$0.11508	\$0.03341	\$114,439.01
3	3,408,241	\$0.14938	\$0.11577	\$0.03361	\$114,550.02
4	3,391,200	\$0.15027	\$0.11646	\$0.03381	\$114,661.13
5	3,374,244	\$0.15117	\$0.11716	\$0.03401	\$114,772.35
6	3,357,373	\$0.15208	\$0.11786	\$0.03422	\$114,883.68
7	3,340,586	\$0.15299	\$0.11857	\$0.03442	\$114,995.12
8	3,323,883	\$0.15391	\$0.11928	\$0.03463	\$115,106.67
9	3,307,264	\$0.15484	\$0.12000	\$0.03484	\$115,218.32
10	3,290,727	\$0.15576	\$0.12072	\$0.03505	\$115,330.08
11	3,274,274	\$0.15670	\$0.12144	\$0.03526	\$115,441.95
12	3,257,902	\$0.15764	\$0.12217	\$0.03547	\$115,553.93
13	3,241,613	\$0.15859	\$0.12290	\$0.03568	\$115,666.02
14	3,225,405	\$0.15954	\$0.12364	\$0.03590	\$115,778.21
15	3,209,278	\$0.16049	\$0.12438	\$0.03611	\$115,890.52
16	3,193,231	\$0.16146	\$0.12513	\$0.03633	\$116,002.93
17	3,177,265	\$0.16243	\$0.12588	\$0.03655	\$116,115.45
18	3,161,379	\$0.16340	\$0.12663	\$0.03676	\$116,228.09
19	3,145,572	\$0.16438	\$0.12739	\$0.03699	\$116,340.83
20	3,129,844	\$0.16537	\$0.12816	\$0.03721	\$116,453.68
21	3,114,195	\$0.16636	\$0.12893	\$0.03743	\$116,566.64
22	3,098,624	\$0.16736	\$0.12970	\$0.03766	\$116,679.71
23	3,083,131	\$0.16836	\$0.13048	\$0.03788	\$116,792.89
24	3,067,715	\$0.16937	\$0.13126	\$0.03811	\$116,906.18
25	3,052,377	\$0.17039	\$0.13205	\$0.03834	\$117,019.58

NMC

Total Savings
Average Annual Savings 25 years

\$2,891,721
\$115,669

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Town of Barrington - Carport

Calculator Inputs	
System Output Yr 1	164,550
Annual De-Rate	0.50%
Utility Rate	\$ 0.1190
Utility Annual Avg Rate Increase*	0.600%
PPA Rate Yr 1	\$0.01
PPA Annula Esulator	0.60%

Output & Utility Assumptions for PPA			PPA & Annual Savings		
Year	Electricity Output	Utility Rate Billed (\$/kWh)	PPA Rate Paid to EDP	Savings per kWh	Period Savings
1	164,550	\$0.11900	\$0.00600	\$0.11300	\$18,594.18
2	163,728	\$0.11971	\$0.09054	\$0.02917	\$4,776.59
3	162,909	\$0.12043	\$0.09108	\$0.02935	\$4,781.22
4	162,094	\$0.12115	\$0.09163	\$0.02953	\$4,785.86
5	161,284	\$0.12188	\$0.09218	\$0.02970	\$4,790.50
6	160,477	\$0.12261	\$0.09273	\$0.02988	\$4,795.15
7	159,675	\$0.12335	\$0.09329	\$0.03006	\$4,799.80
8	158,877	\$0.12409	\$0.09385	\$0.03024	\$4,804.45
9	158,082	\$0.12483	\$0.09441	\$0.03042	\$4,809.11
10	157,292	\$0.12558	\$0.09498	\$0.03060	\$4,813.78
11	156,505	\$0.12634	\$0.09555	\$0.03079	\$4,818.45
12	155,723	\$0.12709	\$0.09612	\$0.03097	\$4,823.12
13	154,944	\$0.12786	\$0.09670	\$0.03116	\$4,827.80
14	154,170	\$0.12862	\$0.09728	\$0.03135	\$4,832.48
15	153,399	\$0.12940	\$0.09786	\$0.03153	\$4,837.17
16	152,632	\$0.13017	\$0.09845	\$0.03172	\$4,841.86
17	151,869	\$0.13095	\$0.09904	\$0.03191	\$4,846.56
18	151,109	\$0.13174	\$0.09963	\$0.03210	\$4,851.26
19	150,354	\$0.13253	\$0.10023	\$0.03230	\$4,855.97
20	149,602	\$0.13332	\$0.10083	\$0.03249	\$4,860.68
21	148,854	\$0.13412	\$0.10144	\$0.03269	\$4,865.39
22	148,110	\$0.13493	\$0.10205	\$0.03288	\$4,870.11
23	147,369	\$0.13574	\$0.10266	\$0.03308	\$4,874.84
24	146,632	\$0.13655	\$0.10328	\$0.03328	\$4,879.56
25	145,899	\$0.13737	\$0.10389	\$0.03348	\$4,884.30

Total Savings
Average Annual Savings 25 years

\$134,520
\$5,381

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On-site versus Off-site Solar Arrays

This RFP was entitled *Public-Private Partnership For On-Site Solar Projects* and it clearly demonstrated both towns' desire to site solar projects on the rooftops of numerous public buildings. While this appears at first glance to be a good option for interconnecting solar arrays there are numerous issues and risks with rooftop solar installations that need to be addressed and pointed out to the towns' officials reviewing the RFP proposal submissions. The following list summarizes our main concerns with siting solar arrays on some of the public buildings offered up in this RFP.

- **Roof condition** – the first consideration for any potential rooftop solar project is always the age and condition of the roofing material. Solar arrays are designed and expected to last 25+ years. Many public solar contracts are entered through a PPA that is typically owned by a third-party financial institution. This third-party will typically require that any roof over 5-7 years old be considered for replacement prior to entering into a PPA. The additional cost of the roof replacement can and often does kill the economics of the deal thus ending the potential project. Of the 13 buildings offered by Bristol and the 10 offered by Barrington only 4 of Bristol's buildings had newer (acceptable) roofs and 2 for Barrington. Furthermore, three of the four offered by Bristol had other limiting factors such as size and/or roof field orientation that made them ineligible candidates to house an efficient solar array. That left the Quinta Gamelin Community Center for Bristol and the Primrose and Nayatt Elementary Schools for Barrington.
- **Load considerations** – flat rooftop solar arrays are typically installed utilizing a tray system that keeps the solar panels in place by weighing down the racking system with ballast blocks. These ballast blocks are very similar to large concrete patio blocks. The weight and amount of the ballast is an engineering equation that is different for every solar project dependent upon the racking design, the solar array design, the proximity of the location to the ocean and the building's roofing structure. While there is a high degree of certainty in the calculations derived by the engineers performing the design of these systems, there is always the risk that at sometime during the 20 to 25 year contract period there will be extenuating circumstance that will test the system's design limits. Heavy snow in New England can often build up on rooftops and stress a building's structure. Additionally, our area has been affected by numerous hurricanes and high wind events that can also create havoc to rooftop solar systems and roof coatings in general. EDP does not repudiate rooftop solar in general but we do have a serious concern with their placement on public school facilities. Admittedly it is a rare chance that a roof collapse would occur or panels would blow off a rooftop, however we don't believe it is a risk worth taking on publically owned facilities where young children spend most of their day.
- **Economic benefits** – Many cities, towns and states in the US are enacting remote net metering laws similar to the Rhode Island Public Net Metering Financing Arrangement due to the numerous benefits they provide. One of the most pertinent benefits is the cost savings realized through bulk purchasing and centralized construction location. Without getting too far into the details, it is widely accepted that a single centralized array can be much more efficiently constructed than numerous smaller arrays that need to be built on numerous rooftops. These savings are then obviously passed onto the municipality in the form of a lower PPA rate or Met Metering Discount.

Rhode Island Commerce Corporation Rebate

The Rhode Island Commerce Corporation (Commerce RI) through their Renewable Energy Fund offers Commercial Scale projects (> 10 kW) in RI a one-time rebate to help alleviate some of the higher cost of solar installations. The rebate is calculated based upon total kW DC installed and is on a declining tiered scale. The table below summarizes the rebate calculation.

Funding Levels	
\$1.10/W	For the first 0-50kW
\$0.95/W	For the 2nd 50kW (up to 100kW)
\$0.80/W	For the 3rd 50kW (up to 150 kW)
\$0.65/W	For the 4th 50kW (up to 200 kW)
\$0.50/W	For the 5th 50kW (up to 250 kW)
\$0.35/W	For all installed capacity over the first 250 kW
Incentives are capped at \$300,000 for a single project .	

The rebate is only available for behind the meter and remote net-metered projects. Projects opting to go into the R.I. Renewable Energy Growth program are not eligible for the rebate. Both of the larger projects in our proposal are available for the maximum rebate amount of \$300,000 per project. EDP proposes to utilize these awards to help reduce the interconnection and construction cost resulting in the lower discount rate in our overall offer. For the two smaller on-site solar projects (Quinta Gamelin Community Center in Bristol and the Town Hall carport in Barrington) we would propose signing over these rebates to each of the respective towns. These awards would be \$65,795 to Bristol for the Community Center and \$135,212 to Barrington for the carport.

It needs to be noted that the Funding Levels in the table above are the current levels at the time of the writing of this report. The RI Commerce Corporation reserves the right to change these funding levels depending upon activity of the fund and funding levels from the state. It is therefore noted that EDP cannot be held responsible for the exact amount of the Commerce RI REF rebate(s) that would ultimately be awarded for these projects. However, we stand by our offer in this proposal regardless of the Commerce Corp. award levels and will sign over whatever amount is granted on the two smaller projects.

We anticipate the following awards from the Commerce Corp. regarding the aforementioned projects:

- Project 1 – Minturn Farm Road Landfill Solar \$300,000
- Project 2 – Quinta Gamelin Community Center \$65,795 (to be signed over the Bristol)
- Project 3 – Wyoming Solar, llc. \$300,000
- Project 4 – Barrington Town Hall Carport \$135,212 (to be signed over to Barrington)

Net Metering Credit Purchase Agreements (NMA's)

In general, NMAs are structured as a fixed discount from the utility rate of electricity over a fixed period of time in which the public entity receives 100% of the value of net-metering credits on their utility bill and pays the project owner a fixed percentage of that value, in this case 77.5%, for a guaranteed savings of 22.5%. NMAs may include a floor price for utility rates, below which the owner will not guarantee savings to the public entity. This offer does not include a utility rate floor; the savings are a guaranteed 22.5% over the life of the contract.

The payments made to the project are directly related to the utility's net metering credit rate. The net metering credit in Rhode Island is specifically defined in the R.I.G.L. Section 39-26.4-2 as a Renewable Net Metering Credit and is calculated by adding the per kWh charges for Standard Offer Service (the actual supply), distribution, transmission and transition.

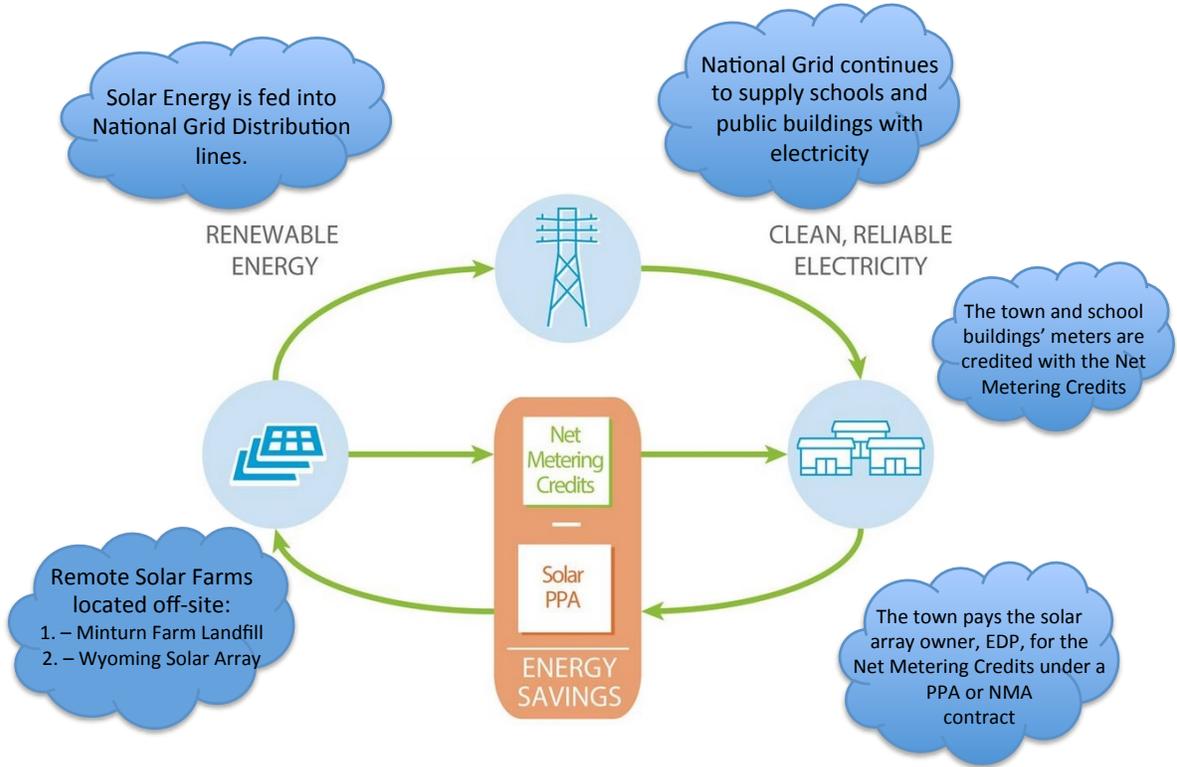
From the perspective of the public entity, in this case the Towns of Bristol and Barrington, NMA's require no upfront costs, provide long-term cost savings, mitigates the risk of regulatory actions that will fluctuate future electricity rates and supports renewable energy in the State of Rhode Island. As a side note, recently the

Governor of Rhode Island signed an executive order instructing all state’s agencies and offices to procure 100% of their power from renewable resources by 2025. Many other RI towns, municipalities, school departments and other state agencies are entering into these types of NMA contracts.

The Project and its owners receive all of the direct benefits associated with financing and construction of the project including federal tax incentives, construction incentives, and all renewable energy attributes, also known as REC’s. Through the collection of these financial incentives the owner is able to pass along the savings to the host town in the form of a lower PPA or NMA arrangements.

A NMA is designed to reduce electricity costs for the public entity. Solar renewable energy facilities developed as part of this NMA are owned and operated by EDP. In an NMA, EDP enters into a contract with the public entity that agrees to the long-term purchase of some or all of the net metering credits. The public entity realizes a monetary credit on its monthly utility bill and pays EDP an amount less than that monetary credit. The public entity may allocate some or all of their credits to one or more accounts associated with the public entity and/or other public entities. This is known as a Schedule B in Rhode Island. The public entity may change credit allocations up to two times per year by updating their Schedule B ‘Allocation of Net Metering Credits’ with National Grid.

Remote Net Metering Concept



Calculating Your Savings with a Net Metered Credit Agreement

It is important to understand how the utility calculates net metering credits and why a Net Metering Credit Purchase Agreement protects the Towns of Bristol and Barrington in the near and long term.

As stated above, the renewable net metering credit (NMC) for off-site or virtual net-metered sites is calculated on certain charges of the C-06 rate class published by National Grid. These charges include supply (also known as Standard Offer Service), plus the distribution, transmission and transition charges. These charges, and thus the value of the net meter credits, will fluctuate with the utility rates over the term of our agreement.

Your 22.5% discount will never change, however. Unlike a fixed PPA rate or escalating rate agreement, the Towns of Bristol and Barrington never need to be concerned that the NMC credit will be less than the rate being paid to the solar facility as utility rates fluctuate. Utility rates will continue to fluctuate over time and they will more than likely rise and fall. The risk of entering into a stated PPA rate agreement is that if the rate falls below the stated rate of the contract then the town will be paying more for the solar energy than the utility is charging for its supply. With a NMA based upon a discount there is no risk of this happening. If the utility rates rise or fall Bristol and Barrington will always be earning a 22.5% discount, guaranteed.

As of this writing, the C-06 NMC is valued at \$0.14756 per kWhr. Bristol and Barrington's savings will be 22.5% of this value per kWhr, or \$0.033201 per kWhr.

Laws & Regulatory Issues in Rhode Island

General Laws of R.I. (Chapter 39-26.4)

The net metering credits from the electricity generated by the proposed solar park(s) are being offered to the Towns of Bristol and Barrington as the members qualify as "Public Entities" under General Laws of RI 39-26.4.

Special regulations in the General Laws of RI 39-26.4 allow public entities the ability to have an arrangement with a third party that owns or finances the solar park and places the solar generator on a site which the Public Entity owns or controls, but that does not have onsite electric load. The electricity created by the renewable energy generator is fed directly into the utility grid.

By Law, the utility assigns a monetary net metering credit based on a commercial meter class of supply, distribution, transmission and transition billing line items for every kilowatt-hour of electricity it receives from the project to the public entity's off-site meters. There is no limit as to the number of public entity meters in which credits can be assigned. This is commonly referred to as Virtual or Remote Net Metering

The public entity enters into a long-term net metering credit purchase agreement to buy the net metering credits from the Project.

The public entity acquires site control thru either a sub-lease or an easement to the project site. EDP provides the sub-lease or easement agreement. These agreements are structured so that the public entity has no liability whatsoever for the lease or operations of the solar facility.

ENERGY DEVELOPMENT PARTNERS – Background and Qualifications

EDP's Principals are experienced renewable energy developers each having over 10 years of experience in the field. Both principals are active locally in RI, are involved and testify on regulatory issues with the RI-PUC and have participated in working groups that helped create Rhode Island's current legislations and laws concerning renewable energy. EDP has over 10MW's of solar energy projects located within Rhode Island that are either operating or under construction.

EDP's management has been awarded an aggregate of 60 MW's DC of PPA's with either National Grid or local municipal off-takers. We have successfully commissioned four (4) solar facilities with long-term PPA contracts with National Grid under the 2011-2014 Standard Contracts Act. Additionally, EDP has been awarded three (3) Certificates of Eligibility for solar facilities under the latest 2015 Renewable Energy Growth Program with those projects being built in 2016-17 timeframe.

In 2015 EDP was selected as the provider for long-term Net Metering Credit Purchase Agreements to offset 100% of the electrical load for the Quonset Development Corporation and the Town of North Smithfield, each entering into agreements to purchase net metering credits from EDP solar facilities. In February 2016, EDP was awarded the Off-Site Net Metering Credit Purchase Agreement for up to 50 MWs to the South Kingston Solar Consortium consisting of the Towns of South Kingston, Narragansett and the University of Rhode Island. That PPA agreement is nearing the end of the negotiation phase and we expect to be in construction on the 240-acre site in West Greenwich during the spring of 2017. In March 2016, EDP was awarded the Off-Site Net Metering Credit Purchase Agreement for up to 3.7MWs to City of Central Falls, Rhode Island.

EDP has finalized a land lease with Balfour Beatty Communities, the management company for the Newport Naval Station housing division. Three sites totaling over 5.5MW's will be interconnected within the next 6 months. At the time of this writing, power off-take agreements are being negotiated with the Town of Middletown and the City of Newport for the power created from these projects.

In June 2016, EDP and ib-vogt signed a joint venture agreement to develop and build utility scale ground mounted solar arrays in the United States. Ib-vogt is an engineering, procurement and construction firm with its roots in Germany that in the last 7 years has built over 530 MW's of solar PV worldwide. The combination of the two companies, EDP and ib-vogt, will provide the necessary development and construction efforts needed for the successful completion of Bristol and Barrington's solar energy projects. Additionally, ib-vogt will be working locally with AMEC Foster Wheeler on the construction management phase. AMEC Foster Wheeler is one of the largest construction services companies to the energy and utility markets. They have project experience across the key renewables sectors including wind, solar, hydropower, geothermal, biomass, biofuels, and energy from waste, hydrogen, fuel cells, carbon capture and storage and clean coal. AMEC Foster Wheeler recently completed two solar PV plants for Duke Energy totaling 21.5 MW's, they are providing operations and maintenance for these two projects as well. Rounding out the team is our local civil engineering team of Woodard & Curran. Woodard & Curran has been the lead civil engineering team on all of EDP's solar projects to date. Statements of Qualifications for all four entities are included as Attachments to this proposal.

With multiple sites under control, having approved or favorable local permitting, coupled with interconnection approvals and demonstrated success in navigating the regulatory and tariff issues surrounding virtual net metering credits, we offer the towns of Bristol and Barrington the ability to mitigate risks and reduce the time when savings can be recognized by acquiring net metered credits. The EDP/ib-vogt team brings the knowledge and experience of local permitting and development coupled with a world-class construction and procurement firm to the Towns of Bristol and Barrington. We are confident that we can successfully deliver on this RFP's proposal highlights.

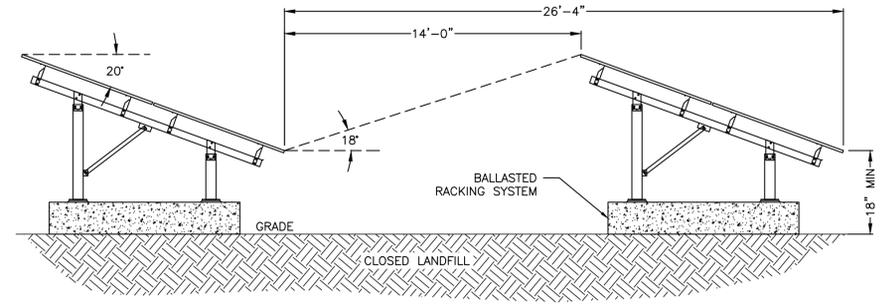
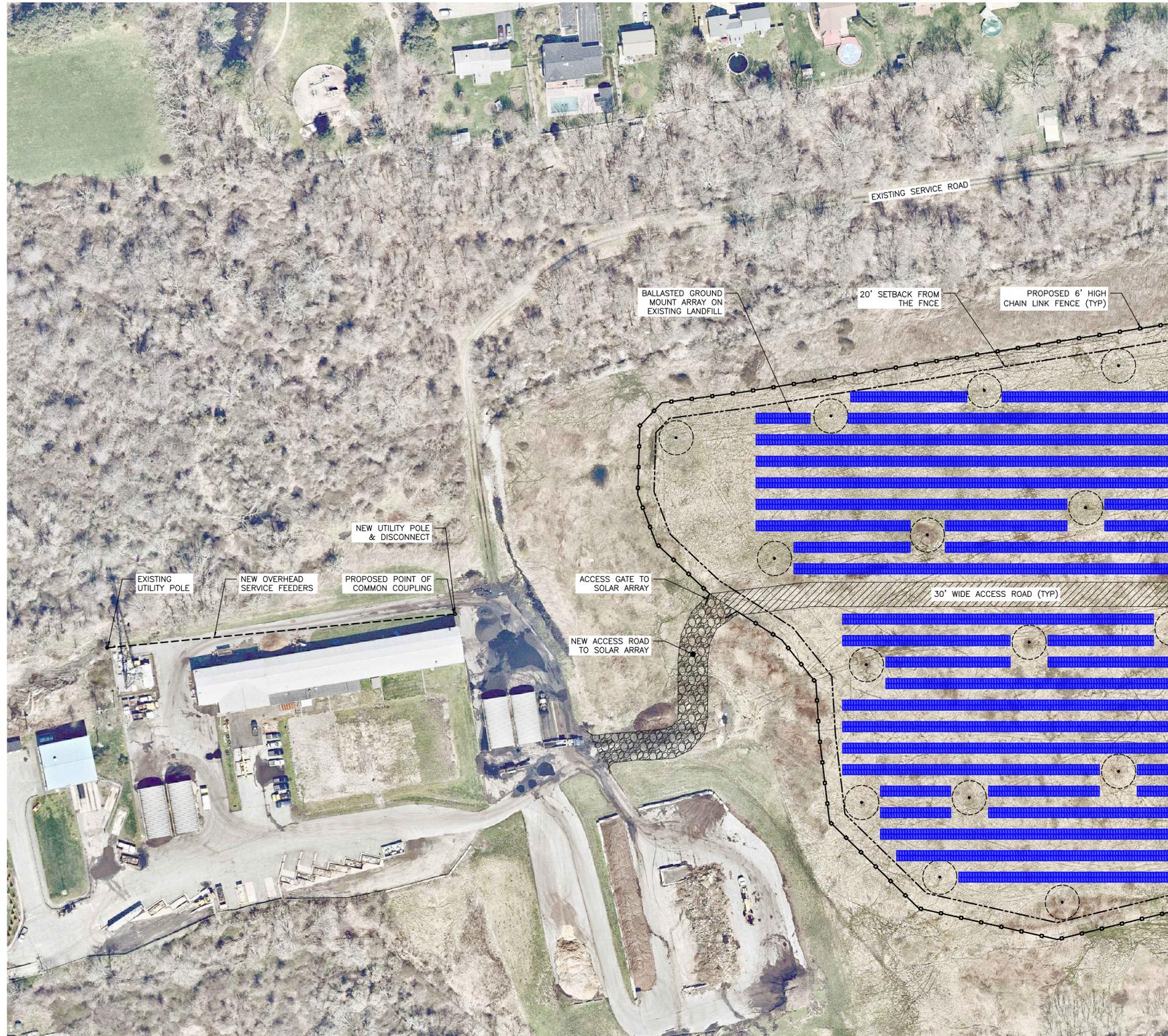
Project Details and Specifications

Project 1. – Minturn Farm Road Landfill

The project to be located at the landfill at the end of Minturn Farm Road in Bristol will be a ballasted ground mount array. The power created will be fed back up onto National Grid's distribution lines through a newly installed revenue grade meter. A new overhead line and service will be fed from the exiting pole located near the west end of the composting building. The off take agreement will be with the Town of Bristol in a Public Net Metering Finance Arrangement. The following table highlights some of the specifics regarding this installation.

Project DC System Size	3,512.88 kW
Project AC System Size	2460.0 kW
Solar Module Type	SolarWorld Sunmodule 340 watt XL mono
Number of modules	10,332
Panel tilt angle	20°
Azimuth	180°
Inverter type	String level
Inverter supplier	Solectria Renewables
Inverter model	PVI 60Tl
Inverter qty	41
Racking	Ballasted
Year 1 production	4,566,000 kWh

An engineering layout and design of this ground mount system is on the next page followed by a 5 page PVSyst production report.



2 BALLASTED RACKING DETAIL
PV01 SCALE: N.T.S.

1 SOLAR ARRAY PLAN
PV01 SCALE: 1" = 70'-0" 

NOTE: THIS LAYOUT IS FOR ESTIMATE PURPOSES ONLY. LAND SURVEYING, SHADING ANALYSIS AND STRUCTURAL ANALYSIS WILL BE REQUIRED PRIOR TO FINALIZING THE DESIGN OF THE SOLAR PV SYSTEM AT THIS LOCATION.

DEVELOPER

ENERGY DEVELOPMENT PARTNERS
 260 WEST EXCHANGE ST, SUITE 102A
 PROVIDENCE, RHODE ISLAND 02903
 WWW.EDP-ENERGY.COM

SYSTEM INFO		
DC SYSTEM SIZE:	3,512.88 kW(DC)	SOLECTRIA RENEWABLES
AC SYSTEM SIZE:	2,480.00 kW(AC)	PVI 60TL
MODULE TYPE:	SOLARWORLD	41
MODULE MODEL:	SW 340 XL MONO	99.0%
NUMBER OF MODULES:	10,332	480VAC, 3-PHASE
NUMBER OF STRINGS:	574	RACKING SYSTEM:
MODULES PER STRING:	18	BALLASTED
TILT & AZIMUTH:	20° & 180°	ANNUAL PRODUCTION:
		4566 MWh

PROJECT
3,512.88 KW SOLAR PV SYSTEM AT
BRISTOL CLOSED LANDFILL
MINTURN FARM ROAD
BRISTOL, RHODE ISLAND 02809

DATE	PROJECT REVISION DESCRIPTION	REV BY
11-20-16	PRESALE LANDFILL ARRAY LAYOUT	RK

DRAWING TITLE
SOLAR ARRAY PLAN

DRAWING SIZE: ARCH_D 36"x24"

DESIGNER: RK
 PROJECT #16.010
 1 OF 1
 DRAWING # PV-01

Grid-Connected System: Simulation parameters

Project :	Bristol Closed Landfill			
Geographical Site	Providence T F Green State Ar	Country	United States	
Situation	Latitude	41.7°N	Longitude	71.4°W
Time defined as	Legal Time	Time zone UT-5	Altitude	16 m
	Albedo	0.20		
Meteo data:	Providence T F Green State Ar	NREL NSRD : TMY3 - TMY		

Simulation variant : **Initial Run**

Simulation date 20/11/16 15h08

Simulation parameters

Collector Plane Orientation	Tilt	20°	Azimuth	0°	
15 Sheds	Pitch	8.00 m	Collector width	3.94 m	
Inactive band	Top	0.02 m	Bottom	0.02 m	
Shading limit angle	Gamma	17.56 °	Occupation Ratio	49.3 %	
Shadings electrical effect	Cell size	15.6cm	Strings in width	1	
Models used	Transposition	Perez	Diffuse	Imported	
Horizon	Average Height	10.0°			
Near Shadings	Mutual shadings of sheds	Electrical effect			
PV Array Characteristics					
PV module	Si-mono	Model	Sunmodule XL SW 340 mono		
Original PVsyst database		Manufacturer	SolarWorld		
Number of PV modules		In series	18 modules	In parallel	574 strings
Total number of PV modules		Nb. modules	10332	Unit Nom. Power	340 Wp
Array global power		Nominal (STC)	3513 kWp	At operating cond.	3137 kWp (50°C)
Array operating characteristics (50°C)		U mpp	604 V	I mpp	5198 A
Total area		Module area	20612 m²		
Inverter					
Custom parameters definition		Model	PVI 60TL Preliminary 5-20-16		
		Manufacturer	Solectria Renewables		
Characteristics		Operating Voltage	300-850 V	Unit Nom. Power	60 kWac
Inverter pack		Nb. of inverters	41 units	Total Power	2460 kWac
PV Array loss factors					
Array Soiling Losses			Loss Fraction	3.0 %	
Thermal Loss factor	Uc (const)	29.0 W/m ² K	Uv (wind)	0.0 W/m ² K / m/s	
Wiring Ohmic Loss	Global array res.	1.3 mOhm	Loss Fraction	1.0 % at STC	
LID - Light Induced Degradation			Loss Fraction	1.0 %	
Module Quality Loss			Loss Fraction	-0.4 %	
Module Mismatch Losses			Loss Fraction	0.5 % at MPP	
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05	
System loss factors					
AC wire loss inverter to transfo	Inverter voltage	480 Vac tri			
	Wires: 3x2500.0 mm ²	2 m	Loss Fraction	0.0 % at STC	
External transformer	Iron loss (24H connexion)	5189 W	Loss Fraction	0.2 % at STC	
	Resistive/Inductive losses	0.8 mOhm	Loss Fraction	0.9 % at STC	

Grid-Connected System: Simulation parameters (continued)

User's needs :

Unlimited load (grid)

Grid-Connected System: Horizon definition

Project : Bristol Closed Landfill

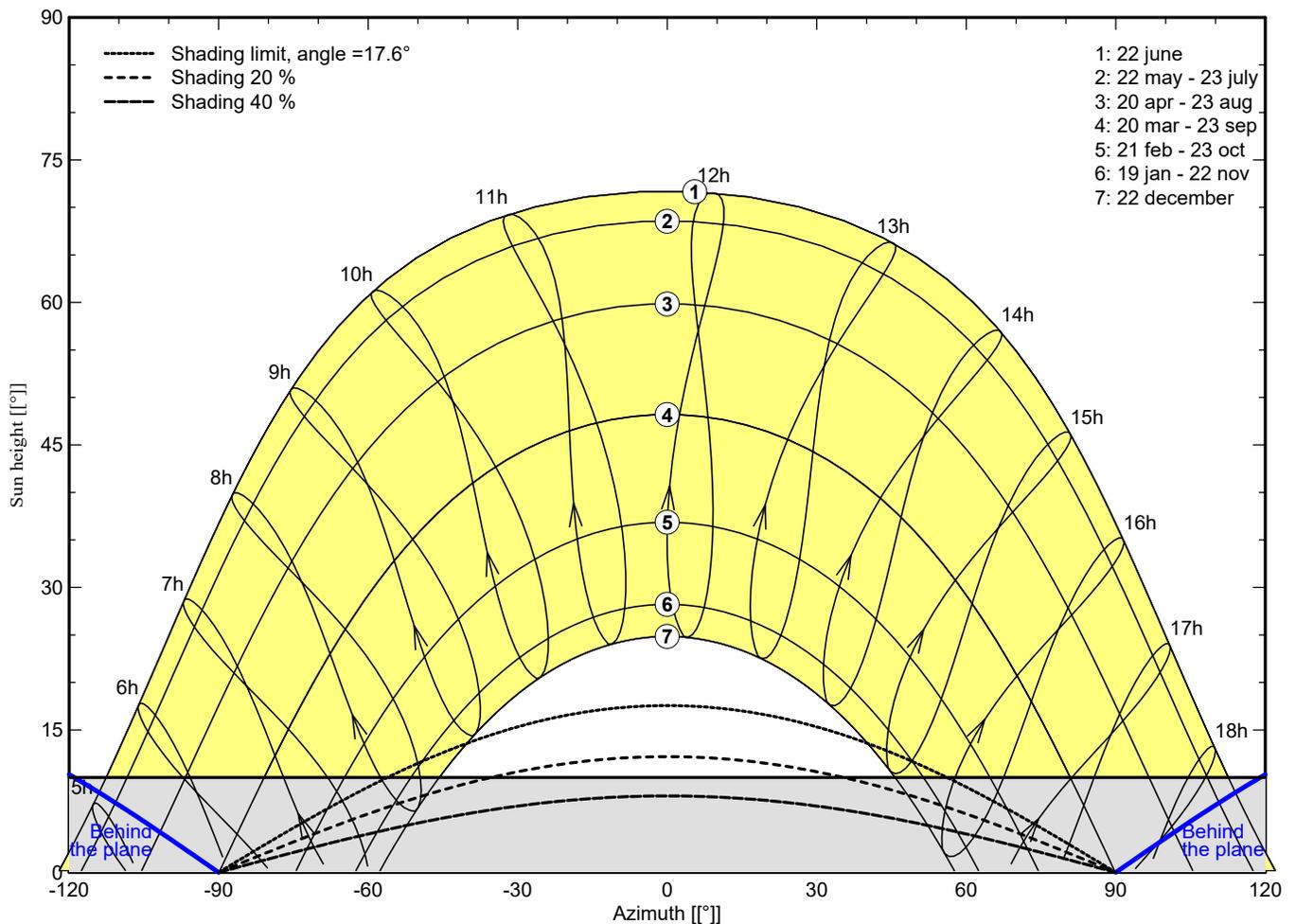
Simulation variant : Initial Run

Main system parameters	System type	Grid-Connected		
Horizon	Average Height	10.0°		
PV Field Orientation	Sheds disposition, tilt	20°	azimuth	0°
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp	
PV Array	Nb. of modules	10332	Pnom total	3513 kWp
Inverter	Model	PVI 60TL Preliminary 5-20-16	60.0 kW ac	
Inverter pack	Nb. of units	41.0	Pnom total	2460 kW ac
User's needs	Unlimited load (grid)			

Horizon	Average Height	10.0°	Diffuse Factor	0.95
	Albedo Factor	100 %	Albedo Fraction	0.50

Height [°]	10.0	10.0	10.0	10.0
Azimuth [°]	-120	-40	40	120

Horizon line at Providence T F GreeLegal Time



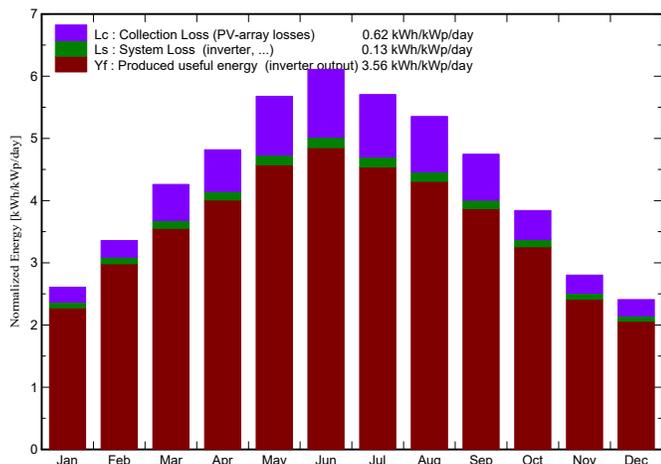
Grid-Connected System: Main results

Project : Bristol Closed Landfill
Simulation variant : Initial Run

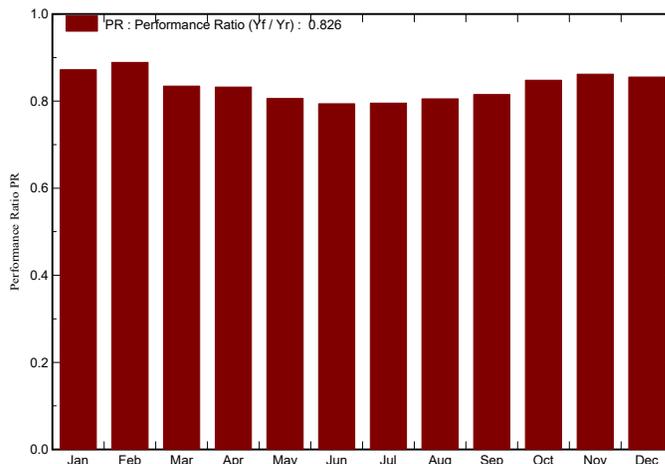
Main system parameters	System type	Grid-Connected	
Horizon	Average Height	10.0°	
PV Field Orientation	Sheds disposition, tilt	20°	azimuth 0°
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp
PV Array	Nb. of modules	10332	Pnom total 3513 kWp
Inverter	Model	PVI 60TL Preliminary 5-20-16	60.0 kW ac
Inverter pack	Nb. of units	41.0	Pnom total 2460 kW ac
User's needs	Unlimited load (grid)		

Main simulation results
 System Production **Produced Energy 4566 MWh/year** Specific prod. 1300 kWh/kWp/year
 Performance Ratio PR **82.6 %**

Normalized productions (per installed kWp): Nominal power 3513 kWp



Performance Ratio PR



Initial Run

Balances and main results

	GlobHor kWh/m ²	T Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	57.8	-1.59	80.9	71.0	257.9	247.8	15.47	14.86
February	73.1	0.15	94.0	84.6	304.2	293.6	15.70	15.15
March	111.0	3.81	132.0	120.7	400.7	387.1	14.72	14.22
April	132.7	8.47	144.5	132.2	437.1	422.6	14.67	14.19
May	172.1	15.12	176.0	160.9	515.3	498.4	14.20	13.74
June	182.6	19.21	183.3	168.3	528.7	511.3	13.99	13.53
July	174.5	23.27	176.9	162.0	511.8	494.3	14.04	13.56
August	157.7	21.57	165.9	151.6	485.7	469.2	14.20	13.72
September	124.1	18.30	142.4	130.1	422.4	407.7	14.39	13.89
October	93.4	11.90	119.1	107.9	367.7	354.8	14.98	14.45
November	61.2	5.85	84.1	74.9	264.6	254.7	15.26	14.69
December	49.8	-0.50	74.7	64.7	233.7	224.4	15.18	14.57
Year	1390.0	10.52	1573.9	1428.9	4729.7	4565.7	14.58	14.07

Legends: GlobHor Horizontal global irradiation EArray Effective energy at the output of the array
 T Amb Ambient Temperature E_Grid Energy injected into grid
 GlobInc Global incident in coll. plane EffArrR Effic. Eout array / rough area
 GlobEff Effective Global, corr. for IAM and shadings EffSysR Effic. Eout system / rough area

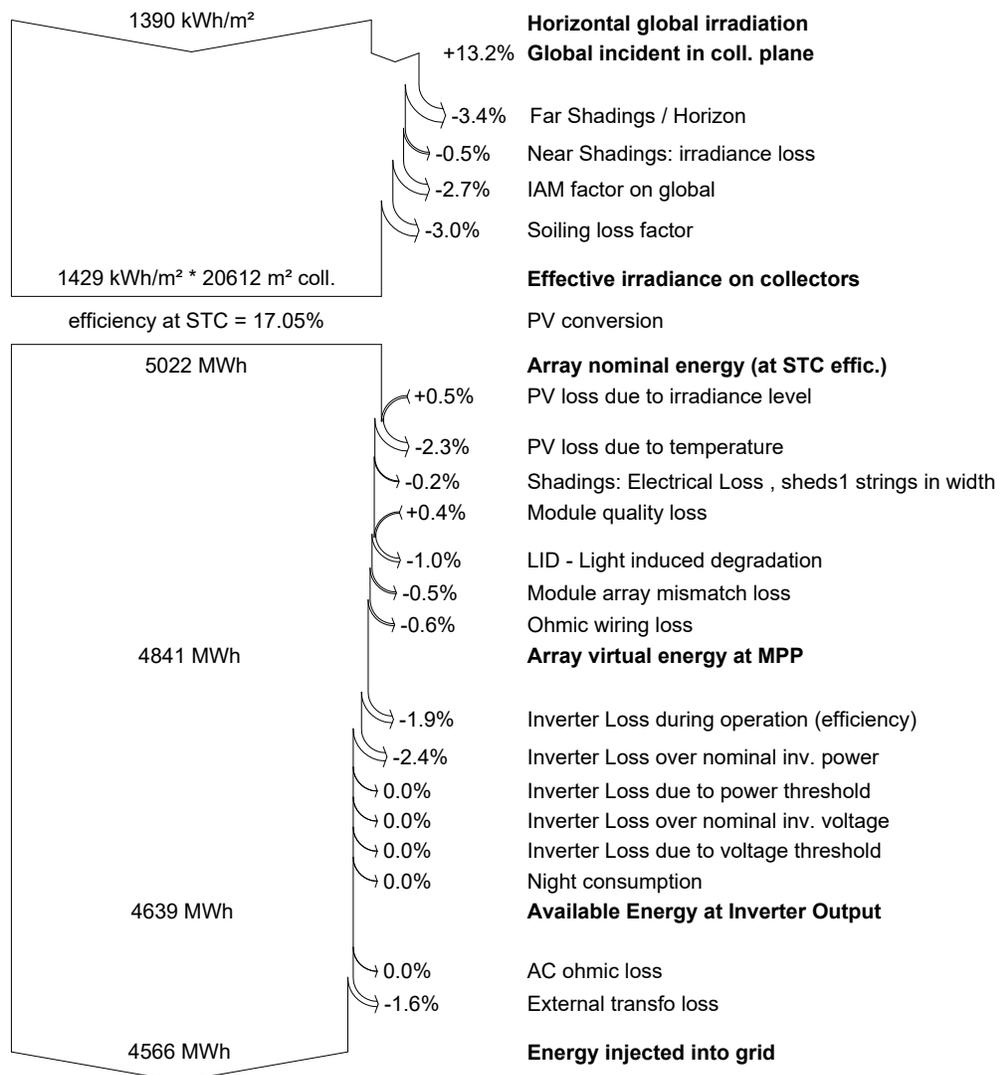
Grid-Connected System: Loss diagram

Project : Bristol Closed Landfill

Simulation variant : Initial Run

Main system parameters	System type	Grid-Connected		
Horizon	Average Height	10.0°		
PV Field Orientation	Sheds disposition, tilt	20°	azimuth	0°
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp	
PV Array	Nb. of modules	10332	Pnom total	3513 kWp
Inverter	Model	PVI 60TL Preliminary 5-20-16	60.0 kW ac	
Inverter pack	Nb. of units	41.0	Pnom total	2460 kW ac
User's needs	Unlimited load (grid)			

Loss diagram over the whole year



Project 2. – Quinta Gamelin Community Center

The on-site project proposed for Bristol will be located at Quinta Gamelin Community Center on Asylum Road. This project will consist of three arrays equally sized at 18.7 kW. Two of the arrays will be located on the flat roofs over the Community Center and the garage, while the third array will be flush mounted to the south facing hip roof in the front of the building. The power created will be fed directly back into the control panel on site creating a behind-the-meter system. A new bidirectional meter will be installed as part of the project. The town of Bristol will purchase the power under a separate PPA agreement starting at \$0.09/kWh in year one and escalating at 0.6% annually throughout the term of the 25-year contract.

The following table highlights some of the specifics regarding this rooftop installation.

Project DC System Size	56.1 kW (three separate 18.7 kW arrays)
Project AC System Size	42.0 kW
Solar Module Type	SolarWorld Sunmodule 340 watt XL mono
Number of modules	165
Panel tilt angle	5° rooftop and 20° hip roof
Azimuth	182° (all three)
Inverter type	String level
Inverter supplier	Solectria Renewables
Inverter model	PVI 14Tl
Inverter qty	3
Racking	Ballasted rooftops – flush mount on hip roof
Year 1 production	70,010 kWh

An engineering layout and design of this rooftop system is on the next page followed two separate PVSyst production reports, a 5 page report for the two flat rooftop arrays and another 4 page PVSyst report for the hip roof array.



1 SOLAR ARRAY PLAN
PV01 SCALE: 1/16" = 1'-0" 

NOTE: THIS LAYOUT IS FOR ESTIMATE PURPOSES ONLY. ROOF SURVEYING, SHADING ANALYSIS AND STRUCTURAL ANALYSIS WILL BE REQUIRED PRIOR TO FINALIZING THE DESIGN OF THE SOLAR PV SYSTEM AT THIS LOCATION.

DEVELOPER

ENERGY DEVELOPMENT PARTNERS
 260 WEST EXCHANGE ST, SUITE 102A
 PROVIDENCE, RHODE ISLAND 02903
 WWW.EDP-ENERGY.COM

SYSTEM INFO		
DC SYSTEM SIZE:	56.10 kW(DC)	INVERTER:
AC SYSTEM SIZE:	42.00 kW(AC)	INVERTER MODEL 1:
MODULE TYPE:	SOLARWORLD	INVERTER QUANTITY:
MODULE MODEL:	SW 340 XL MONO	INVERTER EFFICIENCY:
NUMBER OF MODULES:	165	INVERTER VOLTAGE:
NUMBER OF STRINGS:	15	RACKING SYSTEM:
MODULES PER STRING:	11	ANNUAL PRODUCTION:
TILT & AZIMUTH:	5°, 20° & 182°	

PROJECT
56.10 KW SOLAR PV SYSTEM AT BRISTOL COMMUNITY CENTER
 101 ASYLUM ROAD
 BRISTOL, RHODE ISLAND 02809

DATE	PROJECT REVISION DESCRIPTION	REV BY
11-19-16	PRESALE ROOFTOP ARRAY LAYOUT	RK

DRAWING TITLE	DESIGNER: RK
SOLAR ARRAY PLAN	PROJECT #16.011
DRAWING SIZE: ARCH_D 36"x24"	1 OF 1
	DRAWING # PV-01

Grid-Connected System: Simulation parameters

Project :	Bristol Community Center			
Geographical Site	Providence T F Green State Ar	Country	United States	
Situation	Latitude	41.7°N	Longitude	71.4°W
Time defined as	Legal Time	Time zone UT-5	Altitude	16 m
	Albedo	0.20		
Meteo data:	Providence T F Green State Ar	NREL NSRD : TMY3 - TMY		

Simulation variant : **Array #1 & #2 - Ballasted System**

Simulation date 20/11/16 15h23

Simulation parameters

Collector Plane Orientation	Tilt	5°	Azimuth	2°
15 Sheds	Pitch	1.27 m	Collector width	0.96 m
Inactive band	Top	0.02 m	Bottom	0.02 m
Shading limit angle	Gamma	16.21 °	Occupation Ratio	75.6 %
Shadings electrical effect	Cell size	15.6cm	Strings in width	3
Models used	Transposition	Perez	Diffuse	Imported
Horizon	Average Height	5.0°		
Near Shadings	Mutual shadings of sheds	Electrical effect		

PV Arrays Characteristics (2 kinds of array defined)

PV module	Si-mono	Model	Sunmodule XL SW 340 mono		
Original PVsyst database		Manufacturer	SolarWorld		
Sub-array "PV Array #1"					
Number of PV modules	In series	11 modules	In parallel	5 strings	
Total number of PV modules	Nb. modules	55	Unit Nom. Power	340 Wp	
Array global power	Nominal (STC)	18.70 kWp	At operating cond.	16.70 kWp (50°C)	
Array operating characteristics (50°C)	U mpp	369 V	I mpp	45 A	
Sub-array "PV Array #2"					
Number of PV modules	In series	11 modules	In parallel	5 strings	
Total number of PV modules	Nb. modules	55	Unit Nom. Power	340 Wp	
Array global power	Nominal (STC)	18.70 kWp	At operating cond.	16.70 kWp (50°C)	
Array operating characteristics (50°C)	U mpp	369 V	I mpp	45 A	
Total	Arrays global power	Nominal (STC)	37 kWp	Total	110 modules
		Module area	219 m²		

Inverter

Custom parameters definition	Model	PVI 14TL 208V		
	Manufacturer	Solectria Renewables		
Characteristics	Operating Voltage	260-550 V	Unit Nom. Power	14.0 kWac
Sub-array "PV Array #1"	Nb. of inverters	1 units	Total Power	14.0 kWac
Sub-array "PV Array #2"	Nb. of inverters	1 units	Total Power	14.0 kWac
Total	Nb. of inverters	2	Total Power	28 kWac

PV Array loss factors

Grid-Connected System: Simulation parameters (continued)

Array Soiling Losses			Loss Fraction	3.0 %
Thermal Loss factor	Uc (const)	20.0 W/m ² K	Uv (wind)	0.0 W/m ² K / m/s
Wiring Ohmic Loss	Array#1	92 mOhm	Loss Fraction	1.0 % at STC
	Array#2	92 mOhm	Loss Fraction	1.0 % at STC
	Global		Loss Fraction	1.0 % at STC
LID - Light Induced Degradation			Loss Fraction	1.0 %
Module Quality Loss			Loss Fraction	-0.4 %
Module Mismatch Losses			Loss Fraction	0.5 % at MPP
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05
System loss factors				
	Wires: 3x10.0 mm ²	10 m	Loss Fraction	1.5 % at STC
User's needs :	Unlimited load (grid)			

Grid-Connected System: Horizon definition

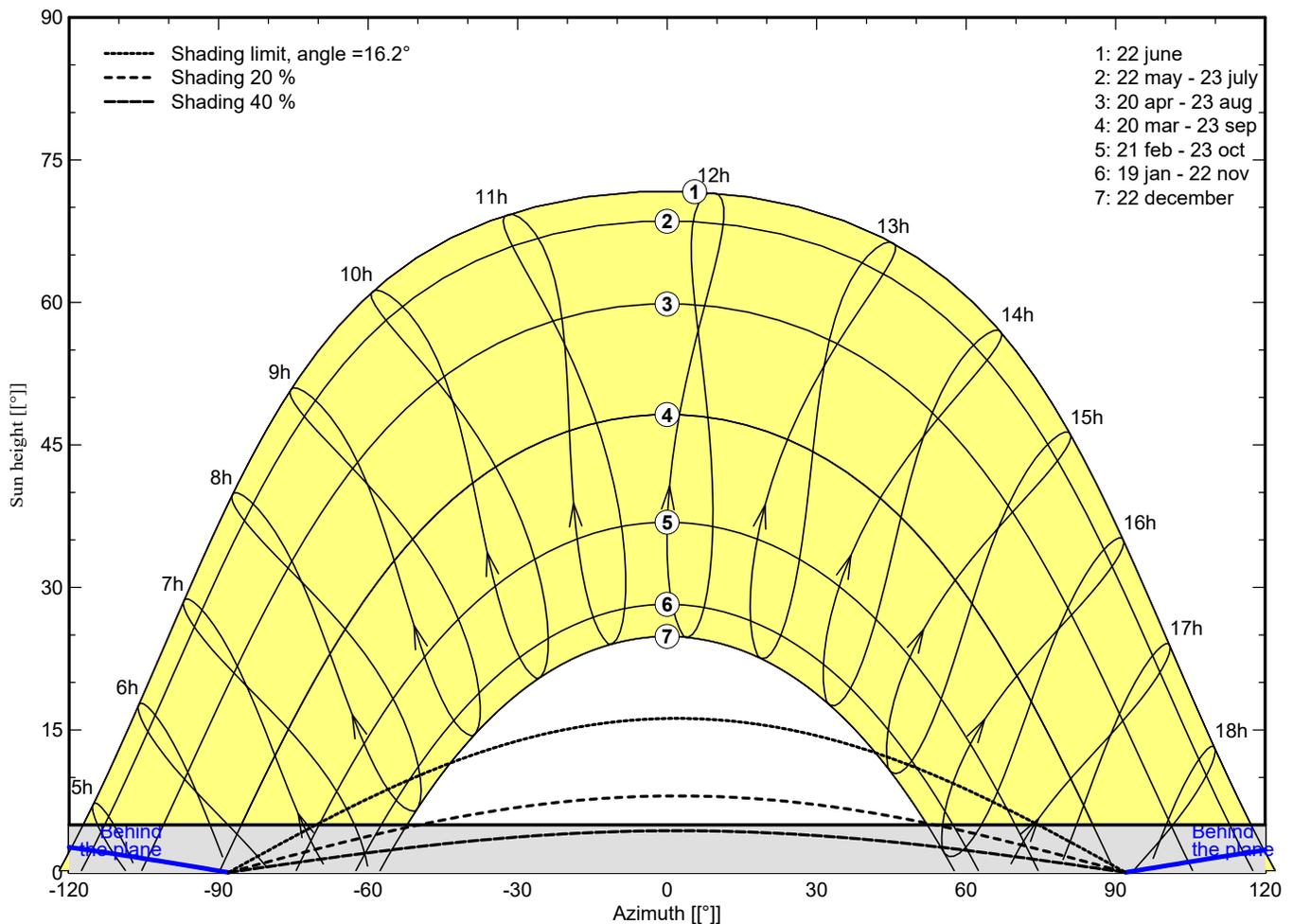
Project : Bristol Community Center
Simulation variant : Array #1 & #2 - Ballasted System

Main system parameters	System type	Grid-Connected	
Horizon	Average Height	5.0°	
PV Field Orientation	Sheds disposition, tilt	5°	azimuth 2°
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp
PV Array	Nb. of modules	110	Pnom total 37.4 kWp
Inverter	Model	PVI 14TL 208V	Pnom 14.00 kW ac
Inverter pack	Nb. of units	2.0	Pnom total 28.00 kW ac
User's needs	Unlimited load (grid)		

Horizon	Average Height	5.0°	Diffuse Factor	0.99
	Albedo Factor	100 %	Albedo Fraction	0.75

Height [°]	5.0	5.0	5.0	5.0
Azimuth [°]	-120	-40	40	120

Horizon line at Providence T F GreeLegal Time



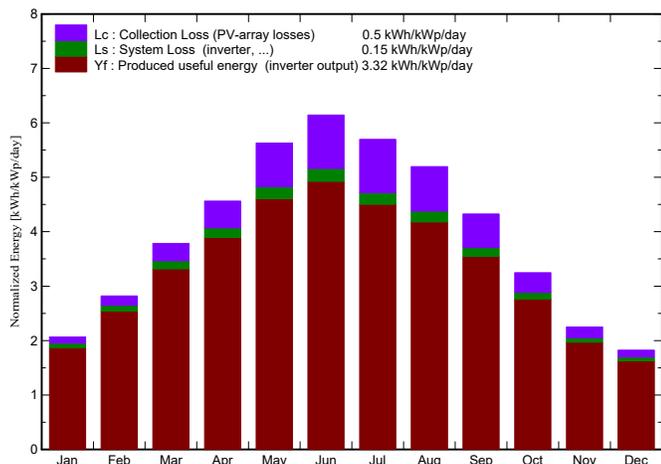
Grid-Connected System: Main results

Project : Bristol Community Center
Simulation variant : Array #1 & #2 - Ballasted System

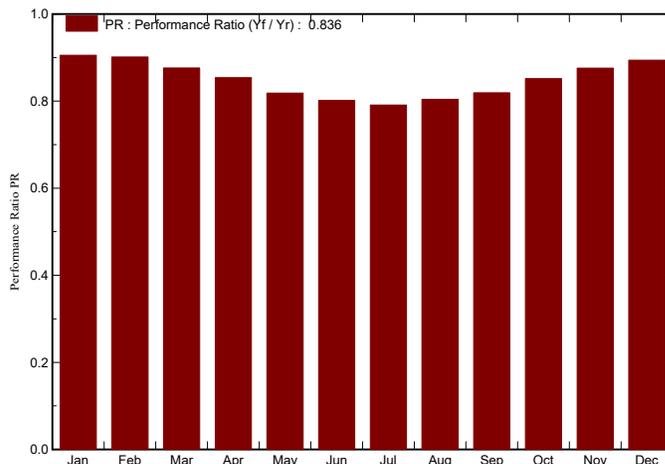
Main system parameters	System type	Grid-Connected	
Horizon	Average Height	5.0°	
PV Field Orientation	Sheds disposition, tilt	5°	azimuth 2°
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp
PV Array	Nb. of modules	110	Pnom total 37.4 kWp
Inverter	Model	PVI 14TL 208V	Pnom 14.00 kW ac
Inverter pack	Nb. of units	2.0	Pnom total 28.00 kW ac
User's needs	Unlimited load (grid)		

Main simulation results
 System Production **Produced Energy 45.27 MWh/year** Specific prod. 1210 kWh/kWp/year
 Performance Ratio PR **83.6 %**

Normalized productions (per installed kWp): Nominal power 37.4 kWp



Performance Ratio PR



Array #1 & #2 - Ballasted System
Balances and main results

	GlobHor kWh/m ²	T Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	57.8	-1.59	64.1	57.9	2.265	2.169	16.11	15.43
February	73.1	0.15	79.0	72.2	2.773	2.663	16.00	15.36
March	111.0	3.81	117.3	108.7	4.018	3.845	15.60	14.93
April	132.7	8.47	136.8	127.4	4.568	4.369	15.21	14.55
May	172.1	15.12	174.5	162.8	5.597	5.342	14.61	13.95
June	182.6	19.21	184.3	172.6	5.790	5.526	14.31	13.66
July	174.5	23.27	176.6	165.0	5.469	5.224	14.11	13.48
August	157.7	21.57	161.1	150.1	5.075	4.846	14.35	13.70
September	124.1	18.30	129.8	120.5	4.162	3.976	14.61	13.96
October	93.4	11.90	100.7	92.5	3.346	3.207	15.14	14.51
November	61.2	5.85	67.5	61.3	2.303	2.211	15.54	14.92
December	49.8	-0.50	56.5	50.4	1.969	1.889	15.88	15.23
Year	1390.0	10.52	1448.3	1341.4	47.334	45.266	14.89	14.24

Legends:

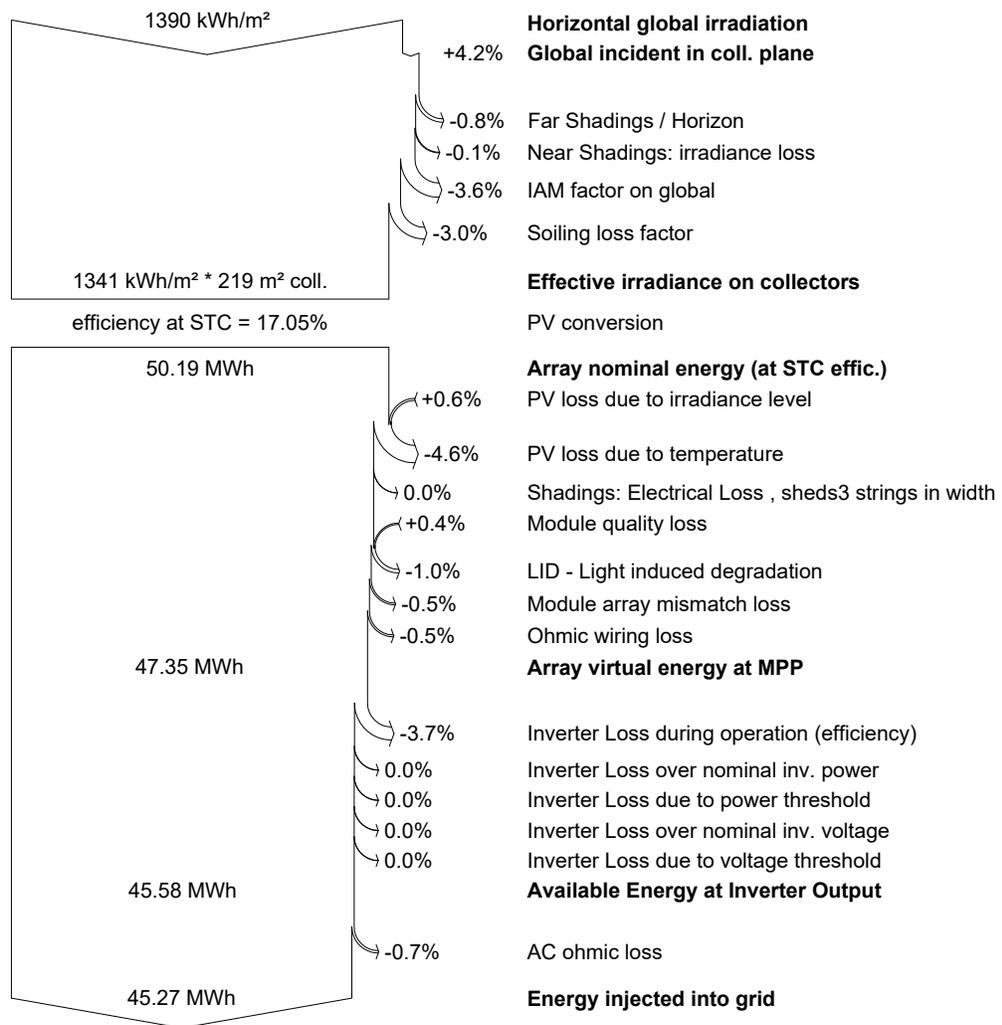
GlobHor	Horizontal global irradiation	EArray	Effective energy at the output of the array
T Amb	Ambient Temperature	E_Grid	Energy injected into grid
GlobInc	Global incident in coll. plane	EffArrR	Effic. Eout array / rough area
GlobEff	Effective Global, corr. for IAM and shadings	EffSysR	Effic. Eout system / rough area

Grid-Connected System: Loss diagram

Project : Bristol Community Center
Simulation variant : Array #1 & #2 - Ballasted System

Main system parameters	System type	Grid-Connected		
Horizon	Average Height	5.0°		
PV Field Orientation	Sheds disposition, tilt	5°	azimuth	2°
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp	
PV Array	Nb. of modules	110	Pnom total	37.4 kWp
Inverter	Model	PVI 14TL 208V	Pnom	14.00 kW ac
Inverter pack	Nb. of units	2.0	Pnom total	28.00 kW ac
User's needs	Unlimited load (grid)			

Loss diagram over the whole year



Grid-Connected System: Simulation parameters

Project :	Bristol Community Center			
Geographical Site	Providence T F Green State Ar	Country	United States	
Situation	Latitude	41.7°N	Longitude	71.4°W
Time defined as	Legal Time	Time zone UT-5	Altitude	16 m
	Albedo	0.20		
Meteo data:	Providence T F Green State Ar	NREL NSRD : TMY3 - TMY		

Simulation variant :	Array #3 - Flush Mount
	Simulation date 19/11/16 21h30

Simulation parameters

Collector Plane Orientation	Tilt	20°	Azimuth	2°
Models used	Transposition	Perez	Diffuse	Imported
Horizon	Average Height	5.0°		
Near Shadings	No Shadings			

PV Array Characteristics

PV module	Si-mono	Model	Sunmodule XL SW 340 mono	
<small>Original PVSyst database</small>		Manufacturer	SolarWorld	
Number of PV modules		In series	11 modules	In parallel 5 strings
Total number of PV modules		Nb. modules	55	Unit Nom. Power 340 Wp
Array global power		Nominal (STC)	18.70 kWp	At operating cond. 16.70 kWp (50°C)
Array operating characteristics (50°C)		U mpp	369 V	I mpp 45 A
Total area		Module area	110 m²	

Inverter

<small>Custom parameters definition</small>	Model	PVI 14TL 208V		
	Manufacturer	Solectria Renewables		
Characteristics	Operating Voltage	260-550 V	Unit Nom. Power	14.0 kWac
Inverter pack	Nb. of inverters	1 units	Total Power	14.0 kWac

PV Array loss factors

Array Soiling Losses		Loss Fraction	3.0 %
Thermal Loss factor	Uc (const)	20.0 W/m ² K	Uv (wind) 1.0 W/m ² K / m/s
Wiring Ohmic Loss	Global array res.	92 mOhm	Loss Fraction 1.0 % at STC
LID - Light Induced Degradation			Loss Fraction 1.0 %
Module Quality Loss			Loss Fraction -0.4 %
Module Mismatch Losses			Loss Fraction 0.5 % at MPP
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param. 0.05

System loss factors

Wiring Ohmic Loss	Wires: 3x10.0 mm ²	19 m	Loss Fraction	1.5 % at STC
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User's needs : Unlimited load (grid)

Grid-Connected System: Horizon definition

Project : Bristol Community Center

Simulation variant : Array #3 - Flush Mount

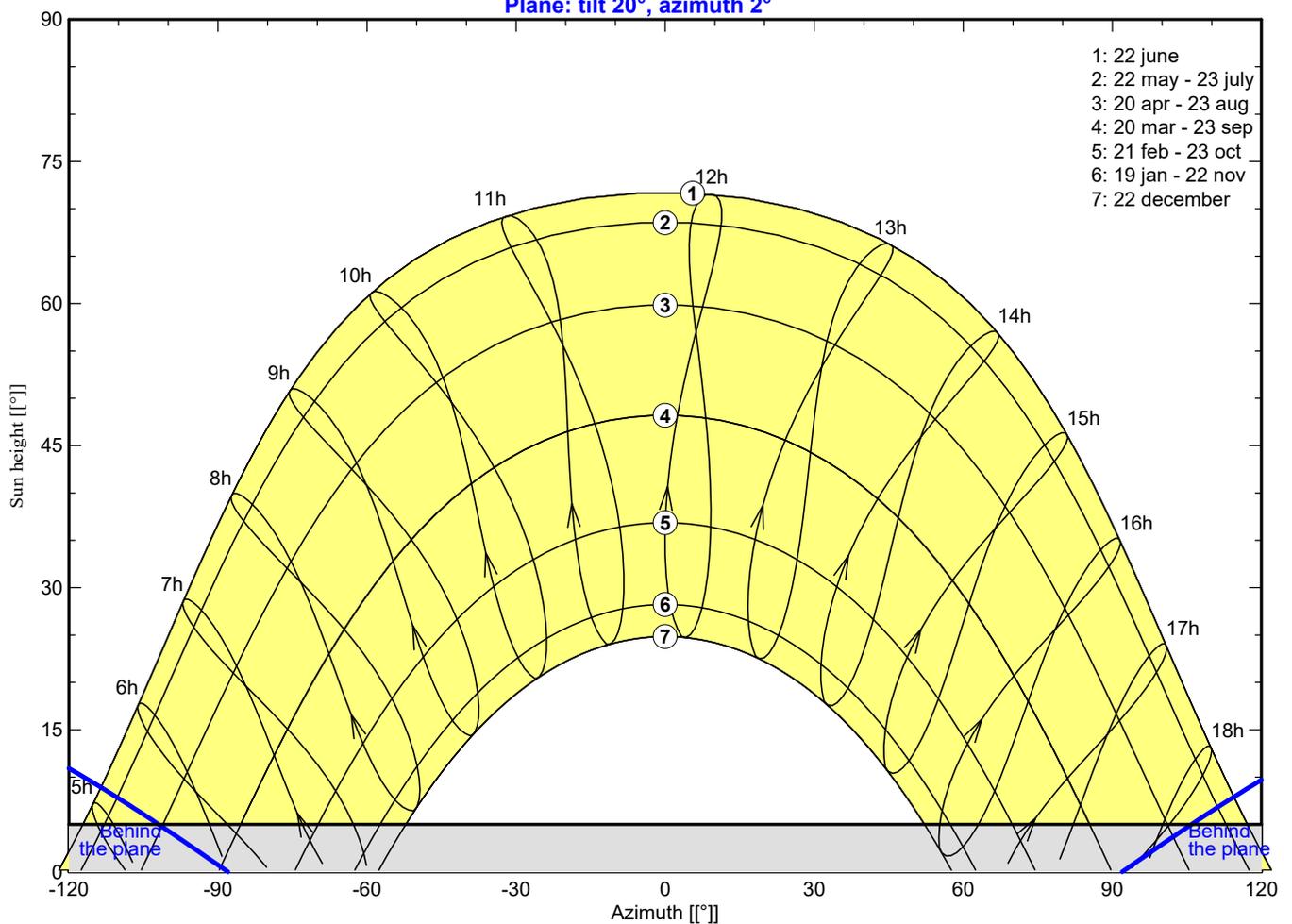
Main system parameters	System type	Grid-Connected		
Horizon	Average Height	5.0°		
PV Field Orientation	tilt	20°	azimuth	2°
PV modules	Model	Sunmodule XL SW 340 mono		340 Wp
PV Array	Nb. of modules	55	Pnom total	18.70 kWp
Inverter	Model	PVI 14TL 208V	Pnom	14.00 kW ac
User's needs	Unlimited load (grid)			

Horizon	Average Height	5.0°	Diffuse Factor	0.97
	Albedo Factor	100 %	Albedo Fraction	0.75

Height [°]	5.0	5.0	5.0	5.0
Azimuth [°]	-120	-40	40	120

Horizon line at Providence T F GreeLegal Time

Plane: tilt 20°, azimuth 2°



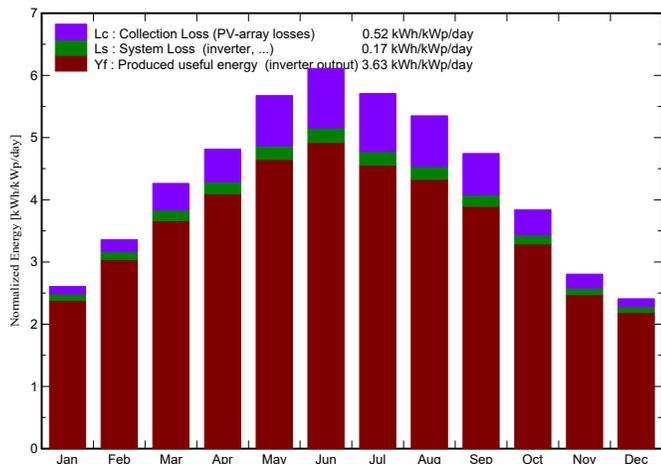
Grid-Connected System: Main results

Project : Bristol Community Center
Simulation variant : Array #3 - Flush Mount

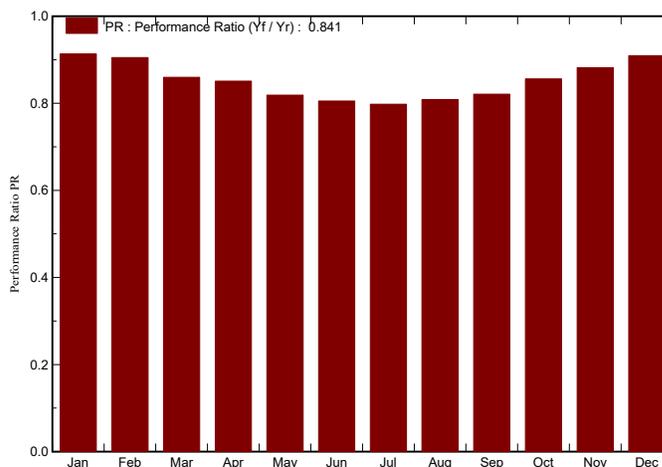
Main system parameters	System type	Grid-Connected	
Horizon	Average Height	5.0°	
PV Field Orientation	tilt	20°	azimuth 2°
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp
PV Array	Nb. of modules	55	Pnom total 18.70 kWp
Inverter	Model	PVI 14TL 208V	Pnom 14.00 kW ac
User's needs	Unlimited load (grid)		

Main simulation results
 System Production **Produced Energy 24.74 MWh/year** Specific prod. 1323 kWh/kWp/year
 Performance Ratio PR **84.1 %**

Normalized productions (per installed kWp): Nominal power 18.70 kWp



Performance Ratio PR



Array #3 - Flush Mount Balances and main results

	GlobHor kWh/m ²	T Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	57.8	-1.59	80.8	73.8	1.442	1.380	16.26	15.57
February	73.1	0.15	94.0	86.5	1.661	1.591	16.10	15.42
March	111.0	3.81	132.1	122.7	2.223	2.124	15.33	14.65
April	132.7	8.47	144.4	134.2	2.407	2.298	15.19	14.50
May	172.1	15.12	175.9	163.2	2.822	2.694	14.62	13.95
June	182.6	19.21	183.3	170.6	2.892	2.760	14.38	13.72
July	174.5	23.27	176.9	164.3	2.767	2.640	14.25	13.60
August	157.7	21.57	165.8	153.8	2.629	2.508	14.45	13.78
September	124.1	18.30	142.3	132.2	2.290	2.185	14.66	13.99
October	93.4	11.90	119.1	110.1	1.992	1.906	15.25	14.59
November	61.2	5.85	84.1	77.2	1.447	1.387	15.68	15.02
December	49.8	-0.50	74.7	67.7	1.323	1.270	16.15	15.50
Year	1390.0	10.52	1573.6	1456.3	25.896	24.743	15.00	14.33

Legends: GlobHor Horizontal global irradiation EArray Effective energy at the output of the array
 T Amb Ambient Temperature E_Grid Energy injected into grid
 GlobInc Global incident in coll. plane EffArrR Effic. Eout array / rough area
 GlobEff Effective Global, corr. for IAM and shadings EffSysR Effic. Eout system / rough area

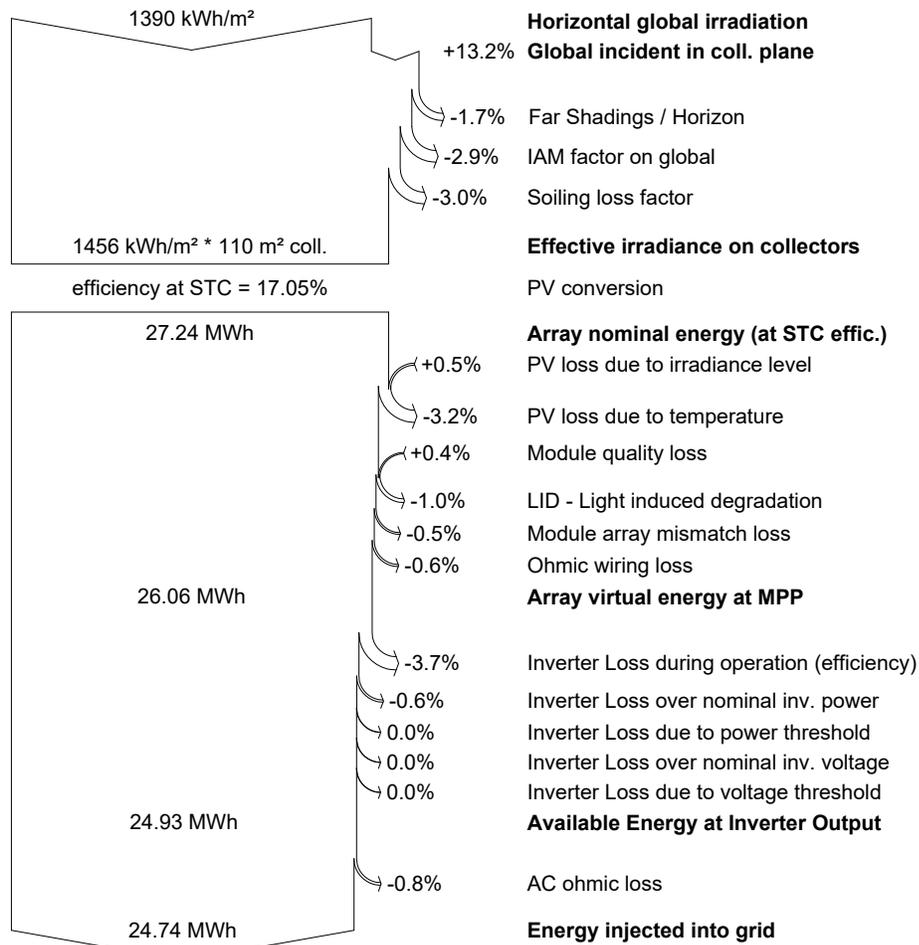
Grid-Connected System: Loss diagram

Project : Bristol Community Center

Simulation variant : Array #3 - Flush Mount

Main system parameters	System type	Grid-Connected		
Horizon	Average Height	5.0°		
PV Field Orientation	tilt	20°	azimuth	2°
PV modules	Model	Sunmodule XL SW 340 mono		340 Wp
PV Array	Nb. of modules	55	Pnom total	18.70 kWp
Inverter	Model	PVI 14TL 208V	Pnom	14.00 kW ac
User's needs	Unlimited load (grid)			

Loss diagram over the whole year



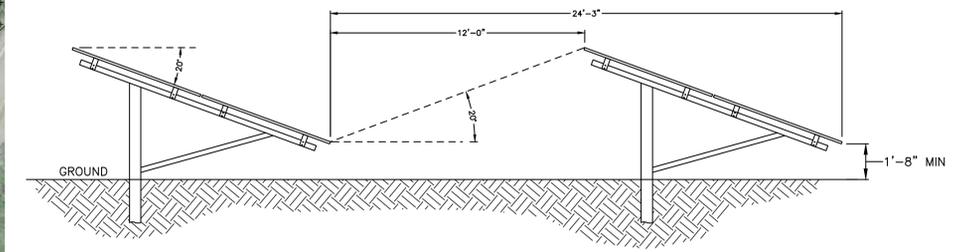
Project 3. – Wyoming Solar

The remote project that will supply most of Barrington’s annual electricity load will be located in the village of Wyoming in the town of Richmond, RI on Nooseneck Hill Road. This is a flat unused wooded piece of property running between Nooseneck Hill Road and Route 95 North. The racking for this system will be a post driven beam, typical for most ground mount solar projects. The power created will be fed back up onto National Grid’s distribution lines through a newly installed revenue grade meter. A new overhead line and service will be fed from the existing pole on Nooseneck Hill Road back to the solar array. The off take agreement will be with the Town of Barrington in a Public Net Metering Finance Arrangement.

The following table highlights some of the specifics regarding this installation.

Project DC System Size	2,746.80 kW
Project AC System Size	2,040.0 kW
Solar Module Type	SolarWorld Sunmodule 350 watt XL mono
Number of modules	7,848
Panel tilt angle	20°
Azimuth	198°
Inverter type	String level
Inverter supplier	Solectria Renewables
Inverter model	PVI 60T1
Inverter qty	34
Racking	Post driven ground mount
Year 1 production	3,511,000 kWh

An engineering layout and design of the ground mount system is on the next page followed by a 5 page PVSyst production report.



2 GROUND MOUNT RACKING DETAIL
 PV01 SCALE: N.T.S.

1 SOLAR ARRAY PLAN
 PV01 SCALE: 1" = 80'-0"

NOTE: THIS LAYOUT IS FOR ESTIMATE PURPOSES ONLY. LAND SURVEYING, SHADING ANALYSIS, STRUCTURAL AND GEOTECH ANALYSIS WILL BE REQUIRED PRIOR TO FINALIZING THE DESIGN OF THE SOLAR PV SYSTEM AT THIS LOCATION.

DEVELOPER

ENERGY
Development Partners

ENERGY DEVELOPMENT PARTNERS
 260 WEST EXCHANGE ST, SUITE 102A
 PROVIDENCE, RHODE ISLAND 02903
 WWW.EDP-ENERGY.COM

SYSTEM INFO		
DC SYSTEM SIZE:	2,746.80 kW(DC)	SOLECTRIA RENEWABLES
AC SYSTEM SIZE:	2,040.00 kW(AC)	PVI 60TL
MODULE TYPE:	SOLARWORLD	34
MODULE MODEL:	SW 350 XL MONO	99.0%
NUMBER OF MODULES:	7848	INVERTER EFFICIENCY:
NUMBER OF STRINGS:	436	INVERTER VOLTAGE:
MODULES PER STRING:	18	RACKING SYSTEM:
TILT & AZIMUTH:	20° & 198°	ANNUAL PRODUCTION:
		3511 MWh

PROJECT

2,746.80 KW SOLAR PV SYSTEM AT
 NOOSENECK HILL RD SOLAR
 301 NOOSENECK HILL RD
 RICHMOND, RI 02898

DATE	PROJECT REVISION DESCRIPTION	REV BY
11-27-16	PRESALE GROUND MOUNT ARRAY LAYOUT	KR

DRAWING TITLE	DESIGNER: KR
SOLAR ARRAY PLAN	PROJECT #NH16.013
	1 OF 1
DRAWING SIZE: ARCH_D 36"x24"	DRAWING # PV-01

Grid-Connected System: Simulation parameters

Project :	Nooseneck Hill Rd Solar Farm			
Geographical Site	Providence T F Green State Ar	Country	United States	
Situation	Latitude	41.7°N	Longitude	71.4°W
Time defined as	Legal Time	Time zone UT-5	Altitude	16 m
	Albedo	0.20		
Meteo data:	Providence T F Green State Ar	NREL NSRD : TMY3 - TMY		

Simulation variant : Simulation

Simulation date 27/11/16 15h45

Simulation parameters

Collector Plane Orientation	Tilt	20°	Azimuth	18°
15 Sheds	Pitch	7.39 m	Collector width	3.94 m
Inactive band	Top	0.02 m	Bottom	0.02 m
Shading limit angle	Gamma	20.26 °	Occupation Ratio	53.3 %
Shadings electrical effect	Cell size	15.6cm	Strings in width	1
Models used	Transposition	Perez	Diffuse	Imported
Horizon	Average Height	10.0°		
Near Shadings	Mutual shadings of sheds	Electrical effect		
PV Array Characteristics				
PV module	Si-mono	Model	Sunmodule XL SW 350 mono	
Original PVsyst database	Manufacturer	SolarWorld		
Number of PV modules	In series	18 modules	In parallel	436 strings
Total number of PV modules	Nb. modules	7848	Unit Nom. Power	350 Wp
Array global power	Nominal (STC)	2747 kWp	At operating cond.	2452 kWp (50°C)
Array operating characteristics (50°C)	U mpp	611 V	I mpp	4011 A
Total area	Module area	15657 m²		
Inverter				
Custom parameters definition	Model	PVI 60TL Preliminary 5-20-16		
Characteristics	Manufacturer	Solectria Renewables		
	Operating Voltage	300-850 V	Unit Nom. Power	60 kWac
Inverter pack	Nb. of inverters	34 units	Total Power	2040 kWac
PV Array loss factors				
Array Soiling Losses			Loss Fraction	3.0 %
Thermal Loss factor	Uc (const)	25.0 W/m ² K	Uv (wind)	0.0 W/m ² K / m/s
Wiring Ohmic Loss	Global array res.	1.8 mOhm	Loss Fraction	1.0 % at STC
LID - Light Induced Degradation			Loss Fraction	1.0 %
Module Quality Loss			Loss Fraction	-0.6 %
Module Mismatch Losses			Loss Fraction	0.5 % at MPP
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05
System loss factors				
AC wire loss inverter to transfo	Inverter voltage	480 Vac tri		
	Wires: 3x1500.0 mm ²	105 m	Loss Fraction	1.2 % at STC
External transformer	Iron loss (24H connexion)	4216 W	Loss Fraction	0.2 % at STC
	Resistive/Inductive losses	0.5 mOhm	Loss Fraction	0.5 % at STC

Grid-Connected System: Simulation parameters (continued)

User's needs :

Unlimited load (grid)

Grid-Connected System: Horizon definition

Project : Nooseneck Hill Rd Solar Farm

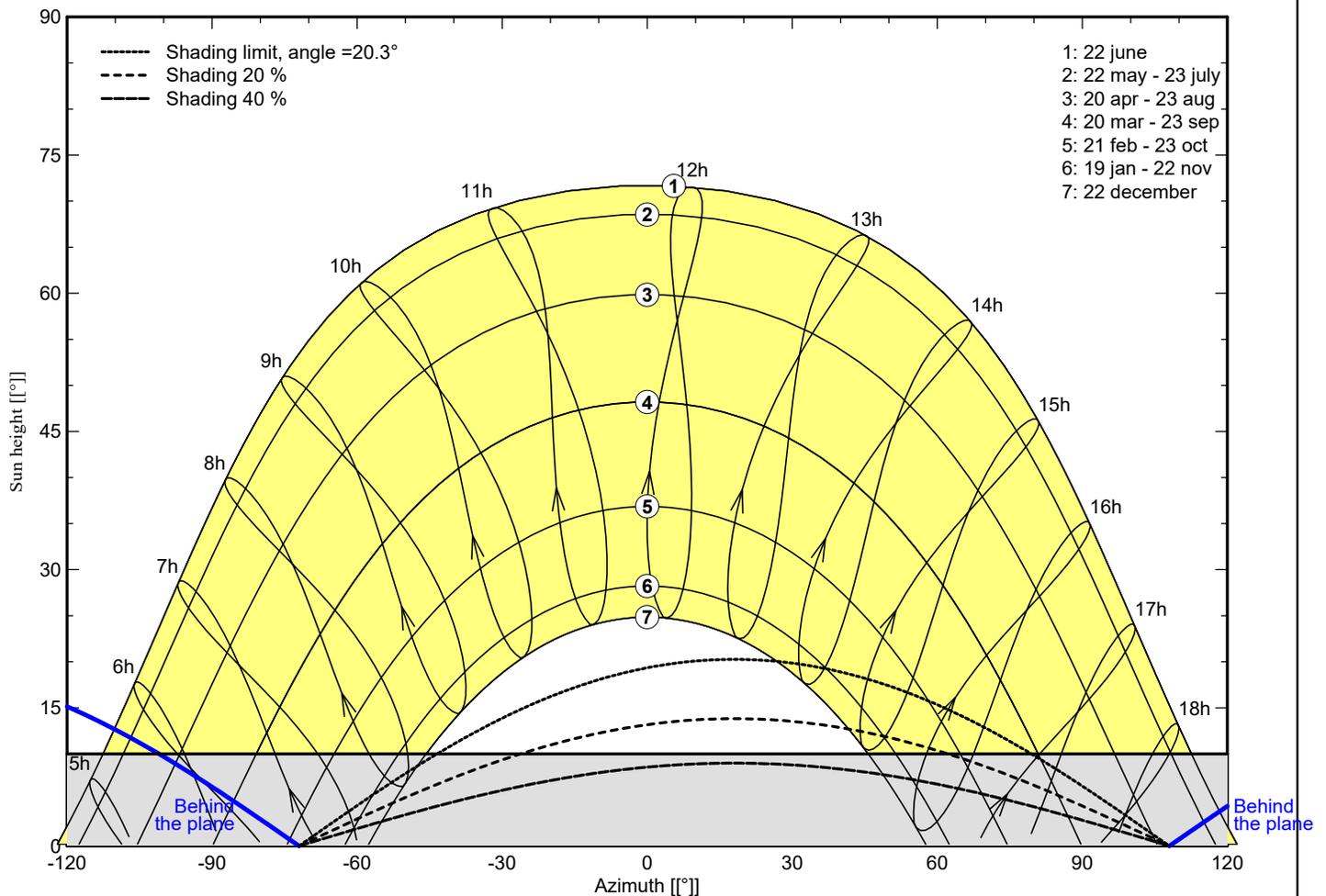
Simulation variant : Simulation

Main system parameters		System type	Grid-Connected	
Horizon		Average Height	10.0°	
PV Field Orientation		Sheds disposition, tilt	20°	azimuth 18°
PV modules		Model	Sunmodule XL SW 350 mono	350 Wp
PV Array		Nb. of modules	7848	Pnom total 2747 kWp
Inverter		Model	PVI 60TL Preliminary 5-20-16	60.0 kW ac
Inverter pack		Nb. of units	34.0	Pnom total 2040 kW ac
User's needs		Unlimited load (grid)		

Horizon	Average Height	10.0°	Diffuse Factor	0.95
	Albedo Factor	100 %	Albedo Fraction	0.50

Height [°]	10.0	10.0	10.0	10.0
Azimuth [°]	-120	-40	40	120

Horizon line at Providence T F GreeLegal Time



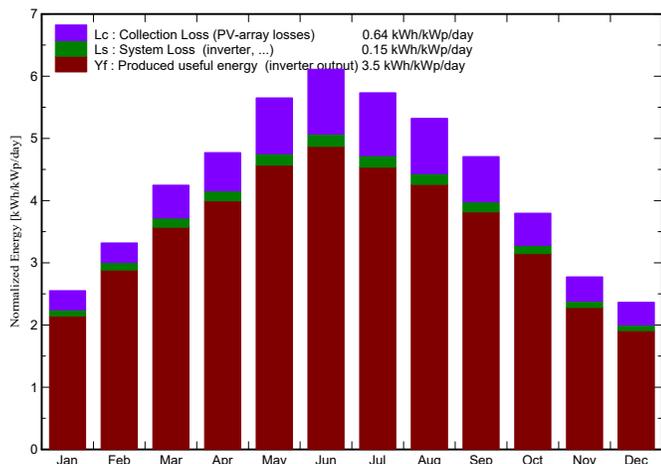
Grid-Connected System: Main results

Project : Nooseneck Hill Rd Solar Farm
Simulation variant : Simulation

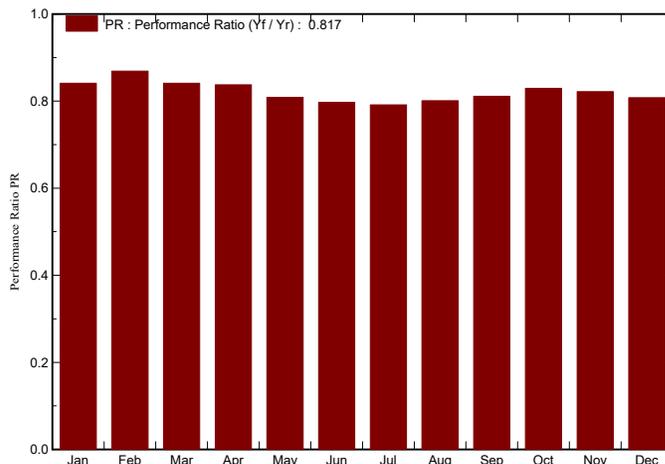
Main system parameters	System type	Grid-Connected	
Horizon	Average Height	10.0°	
PV Field Orientation	Sheds disposition, tilt	20°	azimuth 18°
PV modules	Model	Sunmodule XL SW 350 mono	350 Wp
PV Array	Nb. of modules	7848	Pnom total 2747 kWp
Inverter	Model	PVI 60TL Preliminary 5-20-16	60.0 kW ac
Inverter pack	Nb. of units	34.0	Pnom total 2040 kW ac
User's needs	Unlimited load (grid)		

Main simulation results
 System Production **Produced Energy 3511 MWh/year** Specific prod. 1278 kWh/kWp/year
 Performance Ratio PR **81.7 %**

Normalized productions (per installed kWp): Nominal power 2747 kWp



Performance Ratio PR



Simulation

Balances and main results

	GlobHor kWh/m ²	T Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray MWh	E_Grid MWh	EffArrR %	EffSysR %
January	57.8	-1.59	79.1	69.0	191.2	182.7	15.44	14.75
February	73.1	0.15	93.0	83.3	231.2	221.9	15.89	15.25
March	111.0	3.81	131.7	120.0	316.8	304.1	15.37	14.75
April	132.7	8.47	143.1	130.6	342.5	329.2	15.28	14.69
May	172.1	15.12	175.2	160.0	404.8	389.2	14.75	14.19
June	182.6	19.21	183.4	168.1	417.7	401.5	14.55	13.99
July	174.5	23.27	177.8	162.5	402.3	386.4	14.45	13.88
August	157.7	21.57	165.0	150.4	377.7	362.9	14.62	14.05
September	124.1	18.30	141.2	128.7	327.9	314.6	14.83	14.23
October	93.4	11.90	117.7	106.2	279.4	268.1	15.16	14.55
November	61.2	5.85	83.3	73.6	196.4	187.9	15.06	14.41
December	49.8	-0.50	73.3	62.8	170.4	162.6	14.84	14.17
Year	1390.0	10.52	1563.7	1415.3	3658.2	3511.2	14.94	14.34

Legends: GlobHor Horizontal global irradiation EArray Effective energy at the output of the array
 T Amb Ambient Temperature E_Grid Energy injected into grid
 GlobInc Global incident in coll. plane EffArrR Effic. Eout array / rough area
 GlobEff Effective Global, corr. for IAM and shadings EffSysR Effic. Eout system / rough area

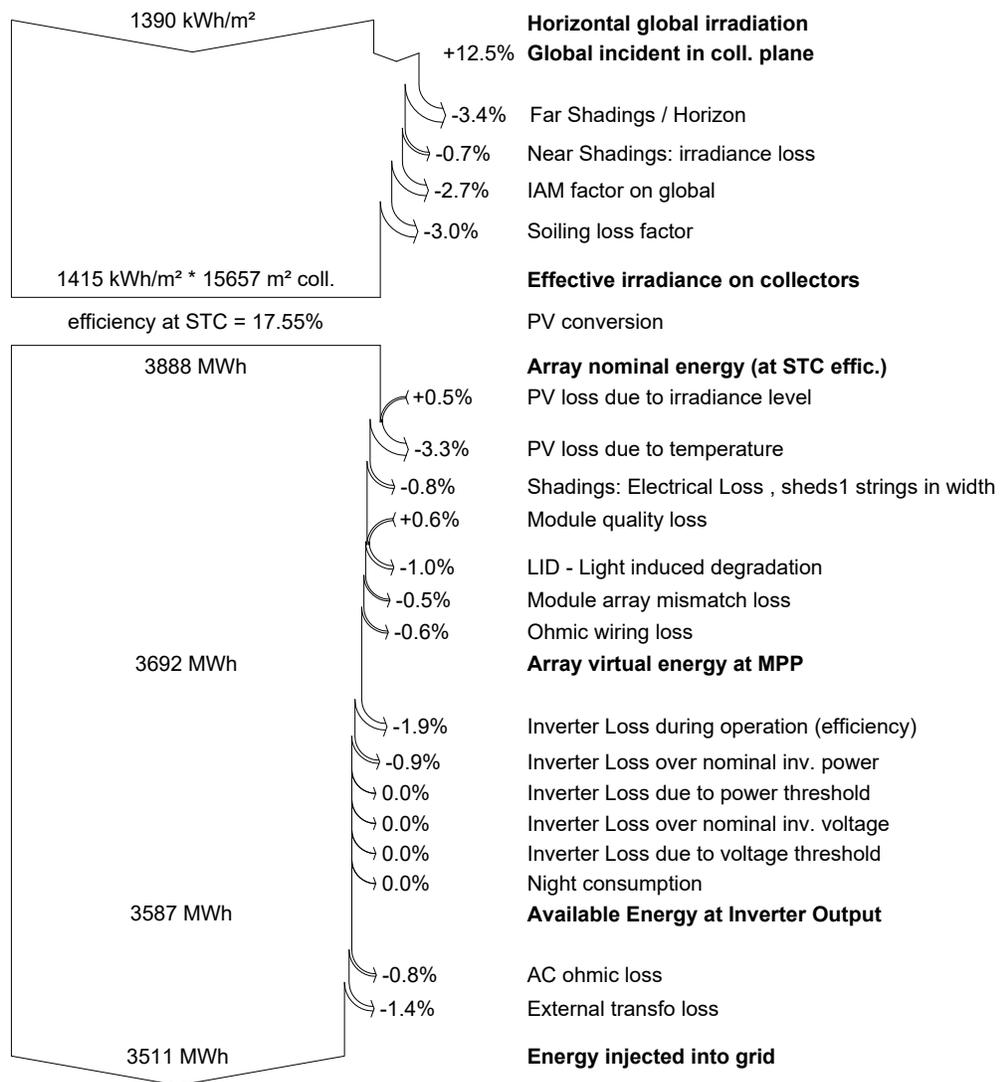
Grid-Connected System: Loss diagram

Project : Nooseneck Hill Rd Solar Farm

Simulation variant : Simulation

Main system parameters	System type	Grid-Connected		
Horizon	Average Height	10.0°		
PV Field Orientation	Sheds disposition, tilt	20°	azimuth	18°
PV modules	Model	Sunmodule XL SW 350 mono	350 Wp	
PV Array	Nb. of modules	7848	Pnom total	2747 kWp
Inverter	Model	PVI 60TL Preliminary 5-20-16	60.0 kW ac	
Inverter pack	Nb. of units	34.0	Pnom total	2040 kW ac
User's needs	Unlimited load (grid)			

Loss diagram over the whole year

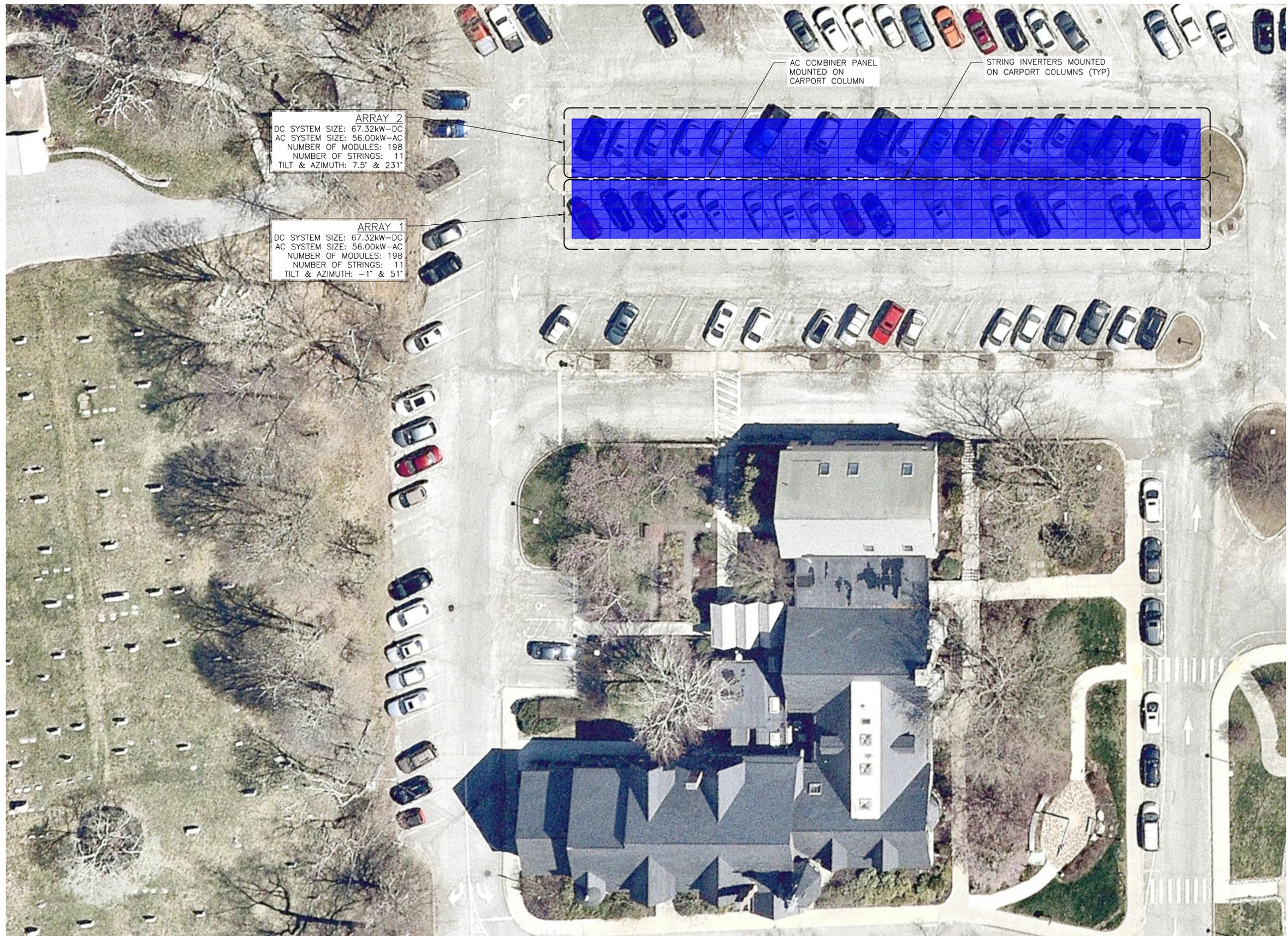


Project 4. – Barrington Town Hall Carport

The carport project is targeted for the middle island in the rear parking area of the Barrington Town Hall. The structure has a dual incline design resembling the letter “Y”. This design allows both rain and snow to divert towards the middle of the carport area preventing rain runoff and snow melt from affecting cars and previously treated paved surfaces. The project can be connected into the Town Hall or Library meters. Either way, this will be a behind-the-meter net metering setup with the production staying 100% on-site. A new bidirectional meter will be installed with this project. The following table highlights some of the specifics regarding this installation.

Project DC System Size	134.64 kW
Project AC System Size ¹¹	112.0 kW
Solar Module Type	SolarWorld Sunmodule 340 watt XL mono
Number of modules	396
Panel tilt angle	-1.5° and 7.5°
Azimuth	231°
Inverter type	String level
Inverter supplier	Solectria Renewables
Inverter model	PVI 28TI
Inverter qty	4
Racking	Dual incline Y Carport structure
Year 1 production	164,600 kWh

An engineering layout and design of the system and a 3D rendering follow on the next 2 pages. They are followed by a 5 page PVSyst production report.



ARRAY 2
 DC SYSTEM SIZE: 67.32kW-DC
 AC SYSTEM SIZE: 56.00kW-AC
 NUMBER OF MODULES: 198
 NUMBER OF STRINGS: 11
 TILT & AZIMUTH: 7.5° & 231°

ARRAY 1
 DC SYSTEM SIZE: 67.32kW-DC
 AC SYSTEM SIZE: 56.00kW-AC
 NUMBER OF MODULES: 198
 NUMBER OF STRINGS: 11
 TILT & AZIMUTH: -1° & 51°

AC COMBINER PANEL MOUNTED ON CARPORT COLUMN

STRING INVERTERS MOUNTED ON CARPORT COLUMNS (TYP)

1 SOLAR ARRAY PLAN

PV01 SCALE: 1/16" = 1'-0"



NOTE: THIS LAYOUT IS FOR ESTIMATE PURPOSES ONLY. GEOTECHNICAL ANALYSIS, SHADING ANALYSIS AND STRUCTURAL ANALYSIS WILL BE REQUIRED PRIOR TO FINALIZING THE DESIGN OF THE SOLAR PV SYSTEM AT THIS LOCATION.

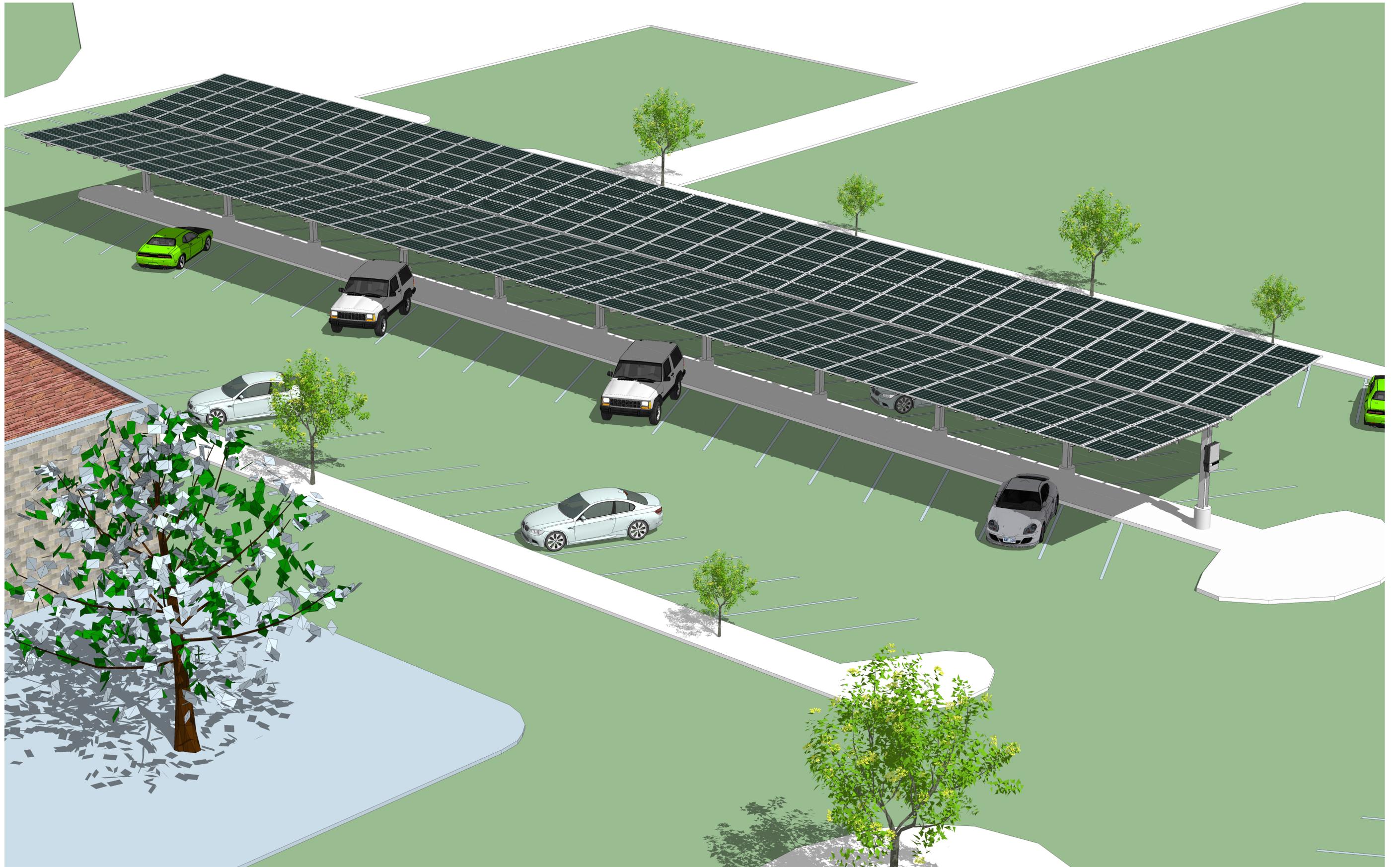
DEVELOPER
ENERGY DEVELOPMENT PARTNERS
 Development Partners
 260 WEST EXCHANGE ST, SUITE 102A
 PROVIDENCE, RHODE ISLAND 02903
 WWW.EDP-ENERGY.COM

SYSTEM INFO			
DC SYSTEM SIZE:	134.64 kW(DC)	INVERTER:	SOLECTRIA RENEWABLES
AC SYSTEM SIZE:	112.00 kW(AC)	INVERTER MODEL 1:	PVI 28TL
MODULE TYPE:	SOLARWORLD	INVERTER QUANTITY:	44
MODULE MODEL:	SW 340 XL MONO	INVERTER EFFICIENCY:	98.6%
NUMBER OF MODULES:	396	INVERTER VOLTAGE:	480VAC, 3-PHASE
NUMBER OF STRINGS:	22	CARPORT SYSTEM:	SOLAIRE OR EQUAL
MODULES PER STRING:	18	ANNUAL PRODUCTION:	164.6 MWH
TILT & AZIMUTH:	-1&7.5°, 51°&231°		

PROJECT
134.64KW SOLAR CARPORT SYSTEM AT BARRINGTON TOWN HALL
 283 COUNTRY ROAD
 BARRINGTON, RHODE ISLAND 02806

DATE	PROJECT REVISION DESCRIPTION	REV BY
11-20-16	PRESALE CARPORT ARRAY LAYOUT	RK

DRAWING TITLE	DESIGNER: RK
SOLAR ARRAY PLAN	PROJECT #16.012
	1 OF 1
DRAWING SIZE: ARCH_D 36"x24"	DRAWING # PV-01



Developer



ENERGY DEVELOPMENT PARTNERS
260 WEST EXCHANGE ST, SUITE 102A
PROVIDENCE, RHODE ISLAND 02903

Barrington Town Hall - Carport 3D Rendering

Designer: RK

November 19, 2016

283 Country Road, Barrington, Rhode Island 02806

Grid-Connected System: Simulation parameters

Project : **Barrington Town Hall**

Geographical Site **Providence T F Green State Ar** Country **United States**

Situation Latitude 41.7°N Longitude 71.4°W
 Time defined as Legal Time Time zone UT-5 Altitude 16 m
 Albedo 0.20

Meteo data: **Providence T F Green State Ar** NREL NSRD : TMY3 - TMY

Simulation variant : **Initial Run**

Simulation date 20/11/16 15h11

Simulation parameters

2 orientations Tilts/Azimuths 1°/-141° and 8°/51°

Models used Transposition Perez Diffuse Imported

Horizon Average Height 10.0°

Near Shadings No Shadings

PV Arrays Characteristics (2 kinds of array defined)

PV module <small>Original PVSyst database</small>	Si-mono	Model	Sunmodule XL SW 340 mono	
		Manufacturer	SolarWorld	
Sub-array "PV Array #1"		Orientation	#1	Tilt/Azimuth 1°/-141°
Number of PV modules		In series	18 modules	In parallel 11 strings
Total number of PV modules		Nb. modules	198	Unit Nom. Power 340 Wp
Array global power		Nominal (STC)	67.3 kWp	At operating cond. 60.1 kWp (50°C)
Array operating characteristics (50°C)		U mpp	604 V	I mpp 100 A
Sub-array "PV Array #2"		Orientation	#2	Tilt/Azimuth 8°/51°
Number of PV modules		In series	18 modules	In parallel 11 strings
Total number of PV modules		Nb. modules	198	Unit Nom. Power 340 Wp
Array global power		Nominal (STC)	67.3 kWp	At operating cond. 60.1 kWp (50°C)
Array operating characteristics (50°C)		U mpp	604 V	I mpp 100 A
Total Arrays global power		Nominal (STC)	135 kWp	Total 396 modules
		Module area	790 m²	

Inverter

Custom parameters definition

	Model	PVI 28TL 480V	
	Manufacturer	Solectria Renewables	
Characteristics	Operating Voltage	500-800 V	Unit Nom. Power 28.0 kWac
Sub-array "PV Array #1"	Nb. of inverters	2 units	Total Power 56 kWac
Sub-array "PV Array #2"	Nb. of inverters	2 units	Total Power 56 kWac
Total	Nb. of inverters	4	Total Power 112 kWac

PV Array loss factors

Array Soiling Losses		Loss Fraction	3.0 %
Thermal Loss factor	Uc (const)	29.0 W/m ² K	Uv (wind) 0.0 W/m ² K / m/s
Wiring Ohmic Loss	Array#1	68 mOhm	Loss Fraction 1.0 % at STC
	Array#2	68 mOhm	Loss Fraction 1.0 % at STC
	Global		Loss Fraction 1.0 % at STC

Grid-Connected System: Simulation parameters (continued)

LID - Light Induced Degradation		Loss Fraction	1.0 %
Module Quality Loss		Loss Fraction	-0.4 %
Module Mismatch Losses		Loss Fraction	0.5 % at MPP
Incidence effect, ASHRAE parametrization	IAM = $1 - b_o (1/\cos i - 1)$	b_o Param.	0.05

System loss factors

Wiring Ohmic Loss	Wires: 3x70.0 mm ² 97 m	Loss Fraction	1.5 % at STC
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User's needs : Unlimited load (grid)

Grid-Connected System: Horizon definition

Project : Barrington Town Hall

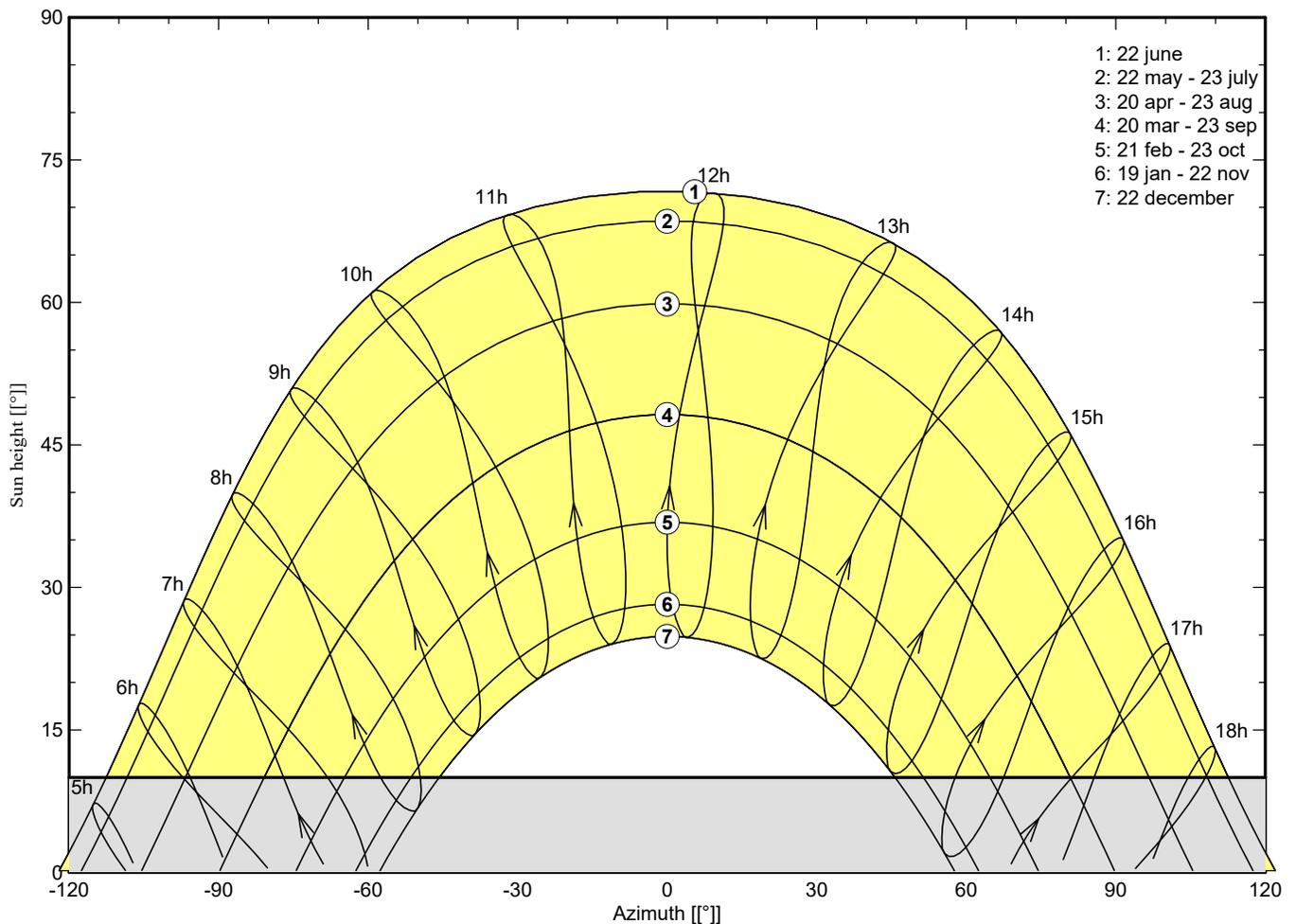
Simulation variant : Initial Run

Main system parameters	System type	Grid-Connected	
Horizon	Average Height	10.0°	
PV Field Orientation	2 orientations	Tilt/Azimuth = 1°/-141° and 8°/51°	
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp
PV Array	Nb. of modules	396	Pnom total 135 kWp
Inverter	Model	PVI 28TL 480V	Pnom 28.00 kW ac
Inverter pack	Nb. of units	4.0	Pnom total 112 kW ac
User's needs	Unlimited load (grid)		

Horizon	Average Height	10.0°	Diffuse Factor	0.97
	Albedo Factor	100 %	Albedo Fraction	0.50

Height [°]	10.0	10.0	10.0	10.0
Azimuth [°]	-120	-40	40	120

Horizon line at Providence T F GreeLegal Time



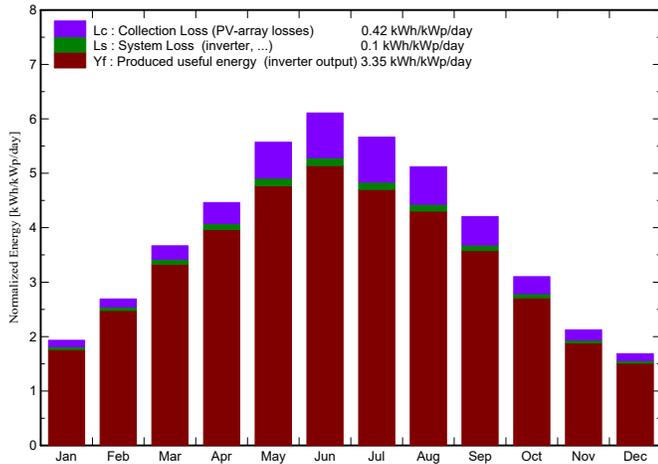
Grid-Connected System: Main results

Project : Barrington Town Hall
Simulation variant : Initial Run

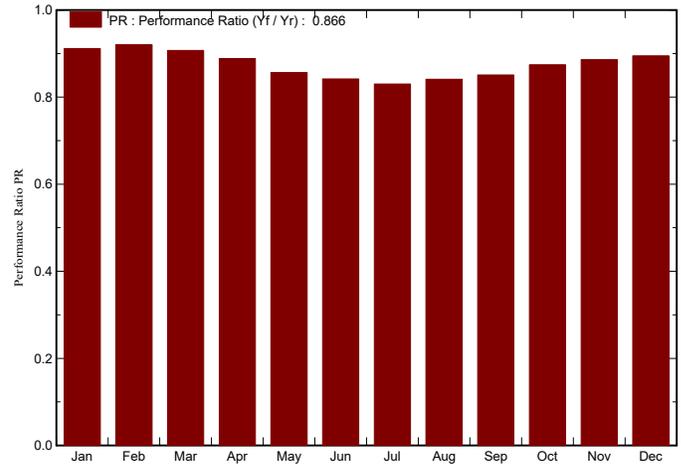
Main system parameters	System type	Grid-Connected	
Horizon	Average Height	10.0°	
PV Field Orientation	2 orientations	Tilt/Azimuth = 1°/-141° and 8°/51°	
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp
PV Array	Nb. of modules	396	Pnom total 135 kWp
Inverter	Model	PVI 28TL 480V	Pnom 28.00 kW ac
Inverter pack	Nb. of units	4.0	Pnom total 112 kW ac
User's needs	Unlimited load (grid)		

Main simulation results
 System Production **Produced Energy 164.6 MWh/year** Specific prod. 1222 kWh/kWp/year
Performance Ratio PR 86.6 %

Normalized productions (per installed kWp): Nominal power 135 kWp



Performance Ratio PR



Initial Run

Balances and main results

	GlobHor	T Amb	GlobInc	GlobEff	EArray	E_Grid	EffArrR	EffSysR
	kWh/m ²	°C	kWh/m ²	kWh/m ²	MWh	MWh	%	%
January	57.8	-1.59	59.9	53.0	7.58	7.35	16.01	15.53
February	73.1	0.15	75.4	68.1	9.59	9.34	16.11	15.69
March	111.0	3.81	113.7	104.5	14.28	13.89	15.89	15.46
April	132.7	8.47	133.9	124.0	16.47	16.02	15.57	15.14
May	172.1	15.12	172.7	160.4	20.49	19.91	15.02	14.59
June	182.6	19.21	183.2	170.8	21.36	20.76	14.75	14.34
July	174.5	23.27	175.6	163.4	20.19	19.63	14.55	14.15
August	157.7	21.57	158.7	147.1	18.50	17.97	14.75	14.33
September	124.1	18.30	126.2	116.2	14.88	14.46	14.93	14.50
October	93.4	11.90	96.1	87.3	11.63	11.31	15.32	14.90
November	61.2	5.85	63.7	56.8	7.82	7.61	15.53	15.10
December	49.8	-0.50	52.3	45.6	6.50	6.30	15.72	15.25
Year	1390.0	10.52	1411.5	1297.3	169.29	164.55	15.18	14.76

Legends:

GlobHor	Horizontal global irradiation	EArray	Effective energy at the output of the array
T Amb	Ambient Temperature	E_Grid	Energy injected into grid
GlobInc	Global incident in coll. plane	EffArrR	Effic. Eout array / rough area
GlobEff	Effective Global, corr. for IAM and shadings	EffSysR	Effic. Eout system / rough area

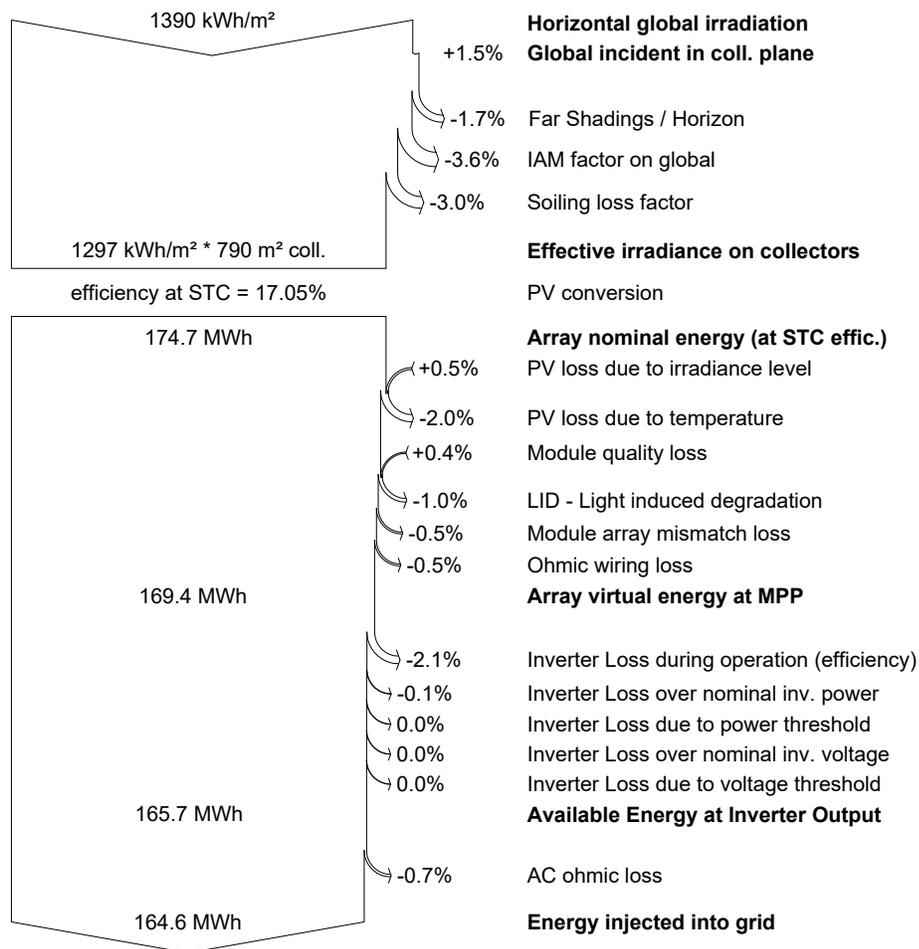
Grid-Connected System: Loss diagram

Project : Barrington Town Hall

Simulation variant : Initial Run

Main system parameters	System type	Grid-Connected		
Horizon	Average Height	10.0°		
PV Field Orientation	2 orientations	Tilt/Azimuth = 1°/-141° and 8°/51°		
PV modules	Model	Sunmodule XL SW 340 mono	340 Wp	
PV Array	Nb. of modules	396	Pnom total	135 kWp
Inverter	Model	PVI 28TL 480V	Pnom	28.00 kW ac
Inverter pack	Nb. of units	4.0	Pnom total	112 kW ac
User's needs	Unlimited load (grid)			

Loss diagram over the whole year



Facility Monitoring, Operations and Maintenance

All solar facilities are monitored 24/7 with certain remote SCADA control capabilities. This Internet based monitoring system alerts us of any issues or faults that might arise. Both broadband and cellular Internet Protocol communications paths are installed along with a weather station and an Internet based camera.

EDP manages all operations and maintenance (O&M) contracts for our RI facilities and guarantees a 98% availability of the system's performance.

EDP maintains a local spare parts inventory of critical or customized parts.

Detailed criteria for the O&M procedures for preventive maintenance and fault repair response time are detailed in our procedures manual.

System Monitoring for Public Information and Educational Opportunities

EDP will provide, as part of this proposal and at no additional cost to the Towns, access to our web-based monitoring system to provide the Towns with information on the performance of the solar arrays. The monitoring system will have several locations to display this information for the public to view and as part of a potential educational program for each town's school systems. EDP proposes installing LCD screens in the Town Hall for both Bristol and Barrington and in the high schools within both towns. Those sites are as follows:

- Bristol Town Hall – 10 Court Street, Bristol, RI
- Mt. Hope High School – 199 Chestnut Street, Bristol, RI
- Barrington High School – 220 Lincoln Avenue, Barrington, RI
- Barrington Town Hall – 283 County Road, Barrington, RI

The monitoring system will provide basic information on the system's performance for the day, month and year. A variety of screens can be provided and designed to explain how the solar array generates electricity and how it benefits the Town, the community and our environment overall. The final design of the screens and the display of the information can be finalized with the Town and the School Department once the RFP has been awarded. The Town and School locations will need to provide Internet WiFi access at their cost.

Exhibit- History of Net Metering Credits

NGRID Rhode Island C-06 Tariff Net Metering Credit History 2011-2016 - \$/kWh

Month/YR	Supply	Delivery	Total	Month/YR	Supply	Delivery	Total
Sep-16	\$0.08555	\$0.0563	\$0.1419	Dec-13	\$0.09184	\$0.0537	\$0.1455
Aug-16	\$0.08555	\$0.0563	\$0.1419	Nov-13	\$0.07468	\$0.0537	\$0.1283
Jul-16	\$0.08555	\$0.0563	\$0.1419	Oct-13	\$0.06826	\$0.0537	\$0.1219
Jun-16	\$0.08555	\$0.0563	\$0.1419	Sep-13	\$0.06614	\$0.0537	\$0.1198
May-16	\$0.08555	\$0.0563	\$0.1419	Aug-13	\$0.07305	\$0.0537	\$0.1267
Apr-16	\$0.08555	\$0.0563	\$0.1419	Jul-13	\$0.07496	\$0.0537	\$0.1286
Mar-16	\$0.08327	\$0.0563	\$0.1396	Jun-13	\$0.06925	\$0.0537	\$0.1229
Feb-16	\$0.08327	\$0.0563	\$0.1396	May-13	\$0.06063	\$0.0537	\$0.1143
Jan-16	\$0.08327	\$0.0563	\$0.1396	Apr-13	\$0.06454	\$0.0537	\$0.1182
Dec-15	\$0.08327	\$0.05447	\$0.1377	Mar-13	\$0.06626	\$0.0537	\$0.1199
Nov-15	\$0.08327	\$0.05447	\$0.1377	Feb-13	\$0.08402	\$0.0537	\$0.1377
Oct-15	\$0.08327	\$0.05447	\$0.1377	Jan-13	\$0.08835	\$0.0537	\$0.1420
Sep-15	\$0.08327	\$0.05447	\$0.1377	Dec-12	\$0.07099	\$0.0536	\$0.1246
Aug-15	\$0.08327	\$0.05447	\$0.1377	Nov-12	\$0.06119	\$0.0536	\$0.1148
Jul-15	\$0.08327	\$0.05447	\$0.1377	Oct-12	\$0.05899	\$0.0536	\$0.1126
Jun-15	\$0.11862	\$0.05447	\$0.1731	Sep-12	\$0.05843	\$0.0536	\$0.1121
May-15	\$0.11862	\$0.05447	\$0.1731	Aug-12	\$0.06212	\$0.0536	\$0.1158
Apr-15	\$0.11862	\$0.05447	\$0.1731	Jul-12	\$0.06246	\$0.0536	\$0.1161
Mar-15	\$0.12139	\$0.05527	\$0.1767	Jun-12	\$0.06969	\$0.0536	\$0.1233
Feb-15	\$0.12139	\$0.05527	\$0.1767	May-12	\$0.07109	\$0.0536	\$0.1247
Jan-15	\$0.12139	\$0.05527	\$0.1767	Apr-12	\$0.07195	\$0.0536	\$0.1256
Dec-14	\$0.09281	\$0.0554	\$0.1482	Mar-12	\$0.06991	\$0.0536	\$0.1235
Nov-14	\$0.09281	\$0.0554	\$0.1482	Feb-12	\$0.08403	\$0.0536	\$0.1377
Oct-14	\$0.09281	\$0.0554	\$0.1482	Jan-12	\$0.08673	\$0.0536	\$0.1404
Sep-14	\$0.09281	\$0.0554	\$0.1482	Dec-11	\$0.07312	\$0.0536	\$0.1268
Aug-14	\$0.09281	\$0.0554	\$0.1482	Nov-11	\$0.06978	\$0.0536	\$0.1234
Jul-14	\$0.09281	\$0.0578	\$0.1506	Oct-11	\$0.06878	\$0.0536	\$0.1224
Jun-14	\$0.09381	\$0.0578	\$0.1516	Sep-11	\$0.06757	\$0.0536	\$0.1212
May-14	\$0.09381	\$0.0578	\$0.1516	Aug-11	\$0.07143	\$0.0536	\$0.1251
Apr-14	\$0.09381	\$0.0578	\$0.1516	Jul-11	\$0.07089	\$0.0536	\$0.1245
Mar-14	\$0.09076	\$0.0578	\$0.1485	Jun-11	\$0.06700	\$0.0536	\$0.1206
Feb-14	\$0.09076	\$0.0578	\$0.1485	May-11	\$0.06980	\$0.0536	\$0.1234
Jan-14	\$0.09076	\$0.0578	\$0.1485	Apr-11	\$0.07144	\$0.0536	\$0.1251

Supply = Fixed Standard Offering Rate published by National Grid for stated Month/YR.

Delivery = Aggregate value of distribution, transmission and transition charges published by National Grid for stated Month/YR.

Total = Net Metering Credit (NMC) value for stated Moth/YR.

Contact Information:

Russ Maymon, Director Project Development
russ@edp-energy.com
(401)644-7869 cell

Frank A. Epps, Managing Director – Principal
frank@edp-energy.com

Elle Noordzy, Land Specialist
elle@edp-energy.com

Energy Development Partners, LLC
220 West Exchange Street
Suite 105
Providence, Rhode Island 02903

Office: 401-349-1229
Fax: 888-907-1603



Attachments:

1. Required Bid Forms

2. Statement of Qualifications

- **Energy Development Partners**
- **i.b.Vogt GmbH**
- **Woodard & Curran**
- **AMEC/Foster Wheeler**

3. Equipment Specification Sheets

TOWN OF BRISTOL and TOWN OF BARRINGTON, RI

INVITATION FOR RFQ/RFP
BID #850
PUBLIC-PRIVATE PARTNERSHIP FOR ON-SITE SOLAR PROJECTS

Attachment A
Town of Bristol

BID FORM

NAME AND ADDRESS OF BIDDING FIRM:

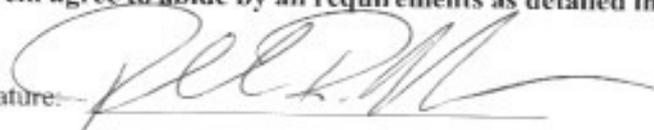
ENERGY Development Partners
260 West Exchange St., Suite 102A
Providence, RI 02903

I herein agree to abide by all requirements as detailed in the "Invitation for Bid #850".

Signature:

Printed Name & Title:

Date:


Russell R. Maynard, Director
11/30/2016

TOWN OF BRISTOL and TOWN OF BARRINGTON, RI

INVITATION FOR RFQ/RFP
BID #850
PUBLIC-PRIVATE PARTNERSHIP FOR ON-SITE SOLAR PROJECTS

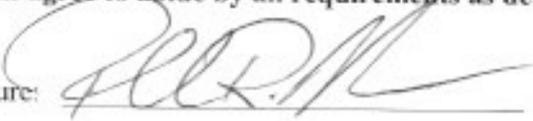
Attachment A
Town of Barrington

BID FORM

NAME AND ADDRESS OF BIDDING FIRM:

ENERGY Development PARTNERS
260 W. Exchange St, Suite 102A
Providence, RI 02903

I herein agree to abide by all requirements as detailed in the "Invitation for Bid #850".

Signature: 

Printed Name & Title:

Russell R. Maynard, Director

Date:

11/30/2016

TOWN OF BRISTOL and TOWN OF BARRINGTON, RI

INVITATION FOR RFQ/RFP
BID #850
PUBLIC-PRIVATE PARTNERSHIP FOR ON-SITE SOLAR PROJECTS

ATTACHMENT B
Non-COLLUSION AFFIDAVIT
To Be Completed, Notarized, and Submitted With Bid

State of Rhode Island
County of Bristol

" FRANK A. EPPS, Bidder, being first duly sworn, deposes and says that he or she is Owner of the party making the foregoing bid that the bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the bid is genuine and not collusive or sham; that the Bidder has not directly or indirectly induced or solicited any other Bidder to put in a false or sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any Bidder or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the Bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the Bidder or any other Bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other Bidder, or to secure any advantage against the public body awarding the contract of anyone interested in the proposed contract; that all statements contained in the bid are true; and further, that the Bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid."

11/30/2016
Date

Energy Development Partners
Bidder name
(Person, Firm, Corp.)

260 W. Exchange St., Ste 102A
Address

Providence, RI 02903
City, State, Zip

260 W. Exchange St., Prov, RI
(Signed at)

[Signature]
Authorized Representative

Russell R. Maymon
Representative's Name

Director
Representative's Title

TOWN OF BRISTOL and TOWN OF BARRINGTON, RI

INVITATION FOR RFQ/RFP
BID #850
PUBLIC-PRIVATE PARTNERSHIP FOR ON-SITE SOLAR PROJECTS

ATTACHMENT C

**BIDDER'S STATEMENT
REGARDING INSURANCE COVERAGE**

BIDDER HEREBY CERTIFIES that the Bidder has reviewed and understands the insurance coverage requirements specified in the Invitation for Bid No. 850, Public – Private Partnership for On-Site Solar Projects. Should the Bidder be awarded the contract for the work, Bidder further certifies that the Bidder can meet the specified requirements for insurance and agrees to provide the Town with a certificate of insurance which names the Town of Bristol and the Town of Barrington as an Additional Insured for the work specified.

Insurance Required:

- Workman's Compensation in compliance with statutory limits
- Comprehensive General Liability Insurance of at least \$1,000,000.

Energy Development Partners
Name of Bidder (Person, Firm, or Corporation)

[Signature]
Signature of Bidder's Authorized Representative

Russell R. Maymon Director
Name & Title of Authorized Representative

11/30/2016
Date of Signing

TOWN OF BRISTOL and TOWN OF BARRINGTON, RI

INVITATION FOR RFQ/RFP
 BID #850
 PUBLIC-PRIVATE PARTNERSHIP FOR ON-SITE SOLAR PROJECTS

ATTACHMENT D

BIDDER STATEMENT OF RELEVANT EXPERIENCE

List three (3) references for which your firm provided service within the last five years.

I hereby certify that I have performed the work listed below.


 Signature of Bidder

DESCRIPTION	DATES	CONTRACT AMOUNT	CUSTOMER CONTACT	CUSTOMER TELEPHONE
1.5 MW SOLAR GROUND MOUNT JOHNSTON, RI	START NOV. 2013 C.O.D. JULY 2015	\$3.75 m	William FETTERLEY HALFMOON VENTURES	(414) 429-3258
500 KW R.I. DG GROUND MOUNT MIDDLETOWN, RI	START JAN. 2012 C.O.D. JULY 2013	\$1.65 m	Gene Golobstein Golobstein Assoc. Prod., RI	(401) 453-0038
UNIVERSITY SOLAR (URI, SK + NARR.) 40MW GROUND MOUNT W. GREENWICH, RI	START FEB. 2016 Est. C.O.D. DEC. 2018	\$70.0 m	ZAC BLOOM C.E. S.	(617) 237-6497

Energy Development Partners, LLC

Statement of Qualifications

Energy Development Partners, LLC (EDP) www.edp-energy.com, develops, constructs and operates distributed generation renewable energy solutions for utilities, businesses, property owners, investors, state and federal agencies and communities. The EDP team consists of seasoned renewable energy industry experts dedicated to delivering expertise in all stages of development and integration including site analysis & acquisition, financial modeling, power purchase agreements, project finance, and asset management – ensuring that renewable energy projects are completed on time, on budget, and providing years of financial performance and clean energy output.

USA

260 West Exchange Street, Suite 102A
Providence, RI 02903 USA
401-349-1229 - Office
888-907-1603 - Fax

Primary Contact:
Frank A. Epps – Principal
Managing Director – USA
frank@edp-energy.com

Germany

Mittelweg 144
20148 Hamburg,
Germany

Primary Contact:
Maarten Reidel – Principal
maarten@edp-energy.com



Company Overview

Established in 2013, Energy Development Partners, LLC is a privately held company with offices in Providence, Rhode Island, USA and Hamburg, Germany. Founded by experienced renewable energy executives and developers, Maarten Reidel and Frank Epps, EDP has quickly developed a reputation for high quality analysis, honesty, and integrity. Our depth of knowledge, strong relationships with leading financial institutions, utilities and construction partners along with our knowledge to work

successfully with local, state, and federal governments worldwide, has given Energy Development Partners the insights needed to forge the correct path and arrive at the right decisions - resulting in the most expedient and highest performing results for our project partners and investors.

The “Partners” Business Strategy in Energy Development

Partnerships are key to EDP’s development strategy. Together we provide ‘turn-key’ execution optimization of the critical elements of a renewable energy’s project early stages: planning, permitting, finance, technology, and construction. This strategy has led to the establishment of a high-quality pipeline with significant potential for expansion. We target utility scale, commercial and municipal/community renewable distributed and transmission generation projects ranging in size from 500 kilowatts to 200 megawatts. EDP does not develop residential solar systems.

EDP funds all development activities and provides investment opportunities for our asset owners who invest in our projects at various project development stages depending on their risk mitigation profile. Entry points for our partners looking to invest and own projects include;

- Upon the project receiving *Notice to Proceed* by obtaining all local and state permits and approvals, power purchase and interconnection agreements,
- At *Commencement of Construction* when the project construction contracts and construction financing have been obtained, or
- When the project achieves *Commercial Operations* and has proven output capacity.

Our development strategy is to partner with *Best in Class* providers for expert project services. Certain of these partnership relationships include;



The EDP and Woodard & Curran partnership has resulted in the successful civil permitting of eight (8) solar photovoltaic facilities.

Woodard & Curran (W&C) is an 800-person, integrated engineering, science, and operations company. Privately held and steadily growing, W&C serves public and private clients locally and nationwide. From environmental roots to the range of consulting, engineering, and operations expertise W&C provide today, we work for a diverse clientele—including municipalities, industry, colleges and universities, the real estate community, and food and beverage manufacturers.

Energy Development Partners - Key Personnel

Maarten Reidel

Principal – Managing Director

Maarten is a seasoned renewable energy developer with 80MW solar and 120MW of wind energy projects to his credit. Maarten oversees the strategic positioning of the company and the creation of our development partnerships. Maarten also oversees our company's and our project's financial structuring and new business development internationally. Before co-founding Energy Development Partners in 2014, Maarten was a principal of 67rockwell Energy, a German renewable energy developer and the CFO of Mercer International. Maarten earned a Bachelors degree in Accounting from Babson College.

Frank A. Epps

Principal – Managing Director

Frank heads our Company's operations and oversees project management and leads new business development in the United States. Before cofounding Energy Development Partners in 2014, Frank served as President & CEO of rTerra, LLC, a Rhode Island based renewable energy developer from 2010 to 2013. From 2007 thru 2010 he served as the President of EWT Americas, Inc., the US subsidiary of Emergya Wind Technologies, a global wind turbine design and manufacturing company.

Frank is an advisory member to the Rhode Island Distributed Energy Board, has testified at the RI-PUC and serves as an advisor to many state and local offices on renewable energy. Frank held ownership and senior positions in sales, business development and executive management with manufacturing, technology and newspaper publishing companies from 1978 thru 2007, including Narragansett Imaging, Scientific Atlanta, Optigain, The Hartford Courant and The Want Ad Press Publications. Frank earned an MBA from Rensselaer Polytechnic Institute and a BS in Business Administration from Bryant University.

Russ Maymon

Director, Project Development

Russ leads all of the Project Development activities for EDP. Russ works with the entire team coordinating project development including site control, permitting, negotiations with potential off takers, business development and project specific financial analysis. Russ has over 12 years of business development experience in renewable energy working with solar, wind, fuel cells, waste-to-energy, anaerobic digestion and other cutting edge technologies. For the past 6 years, Russ has been

in business development for several well-known solar energy EPC's. Focusing primarily in the Northeast, he has developed over 20MW's of solar projects for both private and public institutions. Russ holds a BS in Business Administration from Bryant University with a concentration in Finance.

Stephen Theran

Technical Development

Stephen provides leadership with the execution and management of projects for EDP. In addition to delivering recent solar and wind projects in Massachusetts, Stephen has led project developments, including entitlements, design and construction in the hospitality, retail and office sectors. Recent work includes Owner Representation for the delivery of private and municipal school and public safety projects totaling \$200M+.

Stephen is a LEED Accredited Professional and holds a Massachusetts Construction Supervisor's License Unlimited. Steve earned a Bachelor of Science Mechanical Engineering and a Master of City Planning, both from Boston University.

Justin Moran

Business Development

Justin is a professional salesman and entrepreneur with nearly ten years of experience in the renewable energy field. During his career, he has marketed and sold nearly one million tons of wood pellets throughout North America. As the business development manager for EDP, he is tasked with leading each aspect of the sales process with select clients. His duties include uncovering new opportunities, leading the discovery process to determine customer needs, and matching their needs with EDP's solutions. Justin earned a degree from Syracuse University with a BS in Finance/Economics

Ellen Noordzy

Project Development & Administration

Elle is responsible for preliminary site evaluation, working closely with EDP's civil engineering partners. A graduate of Castleton State College with a bachelor's degree in Natural Sciences, Elle's course studies included Environmental Geology, Environmental Harm & Mitigation Strategies, Physics, Statistics, Geochemistry, Environmental Ethics and Environmental Problems in Geography, Hydrogeology, Organic Chemistry, and Field Techniques. She is also an experienced administrator, drawing from her experiences in the hospitality industry.

Selected Distributed Generation Wind Projects

Below is a list of projects that our Managing Director – USA, Frank Epps, worked on during his tenure as President, EWT-Americas, Inc.



Source: Rural Electric Convenience Cooperative - IL

City / State	Country	Type	No.	Power	
Alaska	USA	DW 54 – 900	1	900	kW
Colorado	USA	DW 54 – 900	1	900	kW
Illinois	USA	DW 54 – 900	2	900	kW
Iowa	USA	DW 54 – 900	3	900	kW
Minnesota	USA	DW 52 – 750	1	750	kW
Nova Scotia	Canada	DW 54 – 900	2	1,800	kW
<i>Total installed</i>			10	8,850	kW

Solar Projects



Plain Lane Power I – 2MW



Plain Lane Power I – 2MW DC under construction, Feb. 2013



Jacome Way Power – 500kW



In 2011, while at rTerra, EDP's Managing Director, Frank Epps, was contracted to develop a 500kW ground mount solar PV system in a corporate park in the Town of Middletown, RI. This project was bid to then newly established Rhode Island Distributed Generation program and awarded a 15-year Standard Contract with National Grid. Frank led the team to conducted feasibility studies, submitted an interconnection application, an NGRID impact study, secured equipment and contracts to fulfill the Treasury Grant 1603a Safe Harbor provision, and obtained state and local permits. Woodard & Curran acted as the civil engineering firm and was awarded the construction contract. The system came on-line in July 2013 under budget and on-time.

Jacome Way Power – 500 kW ground mount solar PV array

Middletown, RI

Construction Start Date: February 2013

Commercial Operations Date: July 2013

Project Contact: Project Owner, Gene Goldstein, genegoldstein@gmail.com



During his tenure at rTerra, our Managing Director, Frank Epps, along with partners, ConEdison Development and Woodard & Curran, jointly developed, permitted and constructed a 2MW solar array constructed on a privately-owned tree farm in West Greenwich, RI.

The project was bid to the then newly established Rhode Island Distributed Generation program and awarded a 15-year Standard Contract with National Grid in December 2011. The project was commissioned in July 2013 and today is owned and operated by ConEdison Development.

Plain Lane Power I – 2.0MW ground mount solar PV array

West Greenwich, RI

Construction Start Date: November 2012

Commercial Operations Date: April 2013

Project contact: Tim Leyden, Landowner, tim.leyden@yahoo.com

Matt Leyden, Landowner, matt.leyden@gmail.com, (401) 524-8395



In partnership with Half Moon Ventures, Inc., Woodard & Curran and New England Construction, EDP developed this new 500 kW solar array in the Quonset Industrial Park. The project was awarded a 15 year PPA by National Grid and is currently operating.

North Kingstown Power, LLC - 500 kW ground mount solar PV array

North Kingstown, RI

Construction Start Date: March 2015

Commercial Operations Date: July 2015

Project Contact: Will Fetterley – Half Moon Ventures - wfetterley@hm-ventures.com



Selected International Solar Projects

Saxony Annex – Germany, 5.4 MW ground mounted solar project, completed in May, 2014. Feed-in tariff under the German EEG law.

Imola - Italy , 1 MW ground mounted solar project, completed in April, 2012. Feed-in tariff under the Conto Energia Italian law.

Lower-Saxony – Germany 3,4 MW roof-top solar project, completed in January, 2012. Feed-in tariff under the German EEG law.



In partnership with Half Moon Ventures, Inc., Woodard & Curran and New England Construction, EDP developed this new 1.53 MW solar array adjacent to a EPA - superfund site in Johnston RI. The project was awarded a 15 year PPA by National Grid and is currently operating.

Johnston Solar, LLC – 1.53MW ground mount solar PV array

Johnston, RI

Construction Start Date: February 2015

Commercial Operations Date: July 2015

Project Contact: Will Fetterley – Half Moon Ventures - wfetterley@hm-ventures.com

Rhode Island Public Entity Net Metering Awards 2015 -2016

Town of North Smithfield * Quonset Development Corporation* City of Central Falls *
South Kingston Solar Consortium – S. Kingston, University of Rhode Island, Narragansett

Rhode Island Renewable Energy Growth Program Awards 2015 – 2016

Exeter Solar * North Smithfield Soar * Richmond Solar

Rhode Island Permitted & Approved Solar Projects - 2016

- **Exeter Solar - 1 MW**
 - Awarded Eligibility Contract with National Grid - September 2015
 - COD Q3 2016
- **North Smithfield Solar - 2.5MW**
 - 1.6MW RI Public Entity Net Metered Collaborative - Power Purchase Agreement with Town of North Smithfield approved November 2015
 - 900kW Awarded Eligibility Contract with National Grid - November 2015
 - COD Q4 2016
- **Compass Circle Solar & NK Solar II - 2.7MW**
 - Public Entity Net Metered Collaborative - Power Purchase Agreement with:
 - Quonset Development Corporation approved July 2015
 - City of Central Falls
 - COD Q4 2016
- **Richmond Solar 1 - 8.75MW**
 - 750kW Awarded Eligibility Contract with National Grid - November 2015
 - COD Q4 2016
 - Available 8.0 MW. Reserved - Pending RFP Town of Westerly
- **Naval Station Newport – Balfour Beatty Communities – 5.5MW**
 - 5.3 MW on Naval Station Newport – Public Entity Net Metered Collaborative - Power Purchase Agreements with:
 - Town of Middletown – LOI signed
 - City of Newport – LOI signed
 - COD Q2 2017

- **Wyoming Solar - 1,25MW**
 - Public Entity Net Metered Facility - Power Purchase Agreement with:
 - City of Central Falls
 - COD Q2 2017

- **University Solar - 40MW**
 - Public Entity Net Metered Collaborative - Power Purchase Agreement in final legal review with:
 - University of Rhode Island
 - South Kingstown
 - Narragansett
 - COD Q4 2017

An aerial photograph of a vast solar farm. The solar panels are arranged in neat, parallel rows that follow the contours of a rolling green valley. The landscape is lush with green grass and scattered trees. In the distance, more hills and a few utility poles are visible under a clear sky.

Company Presentation

ib vogt GmbH 2016

Disclaimer

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This document is not intended to form the basis of a decision to invest in the Company or any other investment decision and does not constitute an offer, invitation or recommendation for the sale or purchase of securities. Neither the information contained in this document nor any further information made available in connection with the Company will form the basis of any contract. This document does not purport to be comprehensive or to contain all the information that a prospective investor may need. No representation, warranty or undertaking, express or implied, is or will be made or given and no responsibility or liability is or will be accepted by the Company or by any of their respective directors, officers, employees, agents or advisers, in relation to the accuracy or completeness of this memorandum or any other written or oral information made available in connection with the Company. Any responsibility or liability for any such information is expressly disclaimed.

In addition, the information contains projections and forward-looking statements that may reflect the Company's current views with respect to future events. These views are based on current assumptions which are subject to various factors and which may change over time. No assurance can be given that future events will occur, that projections will be achieved, or that the Company's assumptions are correct.

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Company profile

Established in 2002, ib vogt GmbH is specialised on the development, design & engineering, financing, EPC and operations & maintenance of solar power plants. The company provides high quality turnkey solar power plant solutions, designed and engineered in Germany, to end investors internationally.

As a manufacturer-independent integrated developer, the company focuses on tailor made solar power plant solutions that maximise lifecycle performance and returns for their investors.

Since 2009 ib vogt has realised plants with a total rated capacity of > 570 MWp. All projects have been commissioned on time, quality and budget.

ib vogt employs over 90 experts in all areas of the solar power plant value chain. The company operates internationally from offices in Germany, United Kingdom, USA, Panama, Eastern Europe, India and South East Asia and several Joint Ventures across Africa.



ibvogt®
expertise in solar power plants

Key facts and figures

ib vogt - a rapidly expanding global solar power plant expert with an excellent track record.

- **> 570 MWp** Solar power plants built and under construction
- **> 900 MWp** Pipeline of solar power projects
- **> 425 MWp** Operations & maintenance
- **> 50 MWp** Ownership in operating solar power plants (IPP)
- **> EUR 200m** Group turnover 2015

ib vogt - short profile

- Tailor made turnkey solutions to end investors
- First class “blue chip” reference list
- Internationally active, working with local partners
- Fully integrated in-house approach from site identification to operation
- EPC-partner for large-scale high-performing solar power plants
- Excellent track record of in-house project development

History

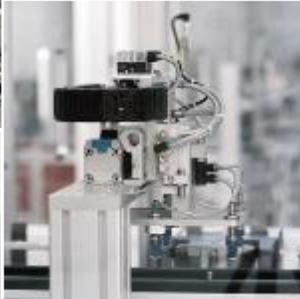
1991

Environmental Engineering



2002

Establishment of ib vogt GmbH



2010

First project in Germany



2012

Foundation of nv vogt Singapore

First project in Slovenia

2014

Building UK's largest solar plant in 8 weeks



2016

0,5 GWp realised in Just 6 years

Pipeline: > 900 MWp



1998

Focus on PV Industry

Over 20 PV factories constructed worldwide

All mainstream technologies

First factory build in record-breaking time 2001

2009

Focus on Solar Power Plants

Foundation of vogt solar Ltd. UK



2011

First project In UK



2013

ib vogt GmbH strengthened its organisation for future growth



2015

Foundation of vogt solar Panamá S.A.

Foundation of IBVBF Holding LLC

First project in Philippines

Our solar solutions



Ground-mounted Solar Power Plants

High performing, utility-grade, grid-connected power plants



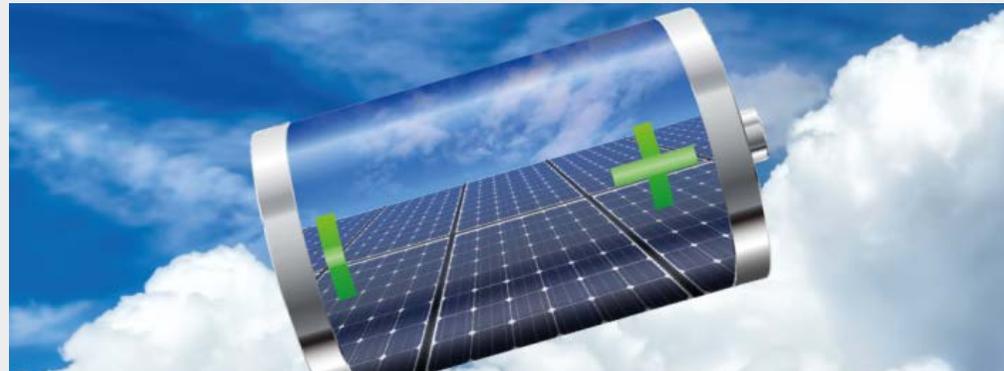
PV Diesel Hybrid Systems

Fuel saving integrated PV diesel hybrid systems



Commercial PV Rooftop

Customised commercial rooftop installations > 1 MWp



Energy Storage Integration

Advanced energy storage solutions

Our approach

“Our solar farms are highly optimised, incorporating state-of-the-art technology and top quality engineering made in Germany. The farms are engineered, built and operated by our dedicated, professional teams.



Anton Milner
Managing Director

The standards we apply consistently result in high over-performance of our solar farms in both electricity generation and technical operating parameters, such as performance ratio and availability.

We use flexible situational oriented financing from development through to turnkey, often providing the development, construction and bridge equity financing in collaboration with our partners and as required arranging exit financing facilities.”

Our services - from project planning to handover

Project Development

- Property Rights
- Wayleaves
- Feasibility Study
- Grid Connection Service
- Systems Engineering & Design
- Environmental Statement
- Planning Application Approval Processes

Financing

- Due Diligence
- Financial Structuring
- Construction & Bridge Financing
- Project Finance

Engineering, Procurement and Construction

- Energy Yield Assessments
- Economic Optimization
- Procurement
- Construction Management
- Grid Connection
- Turnkey Handover

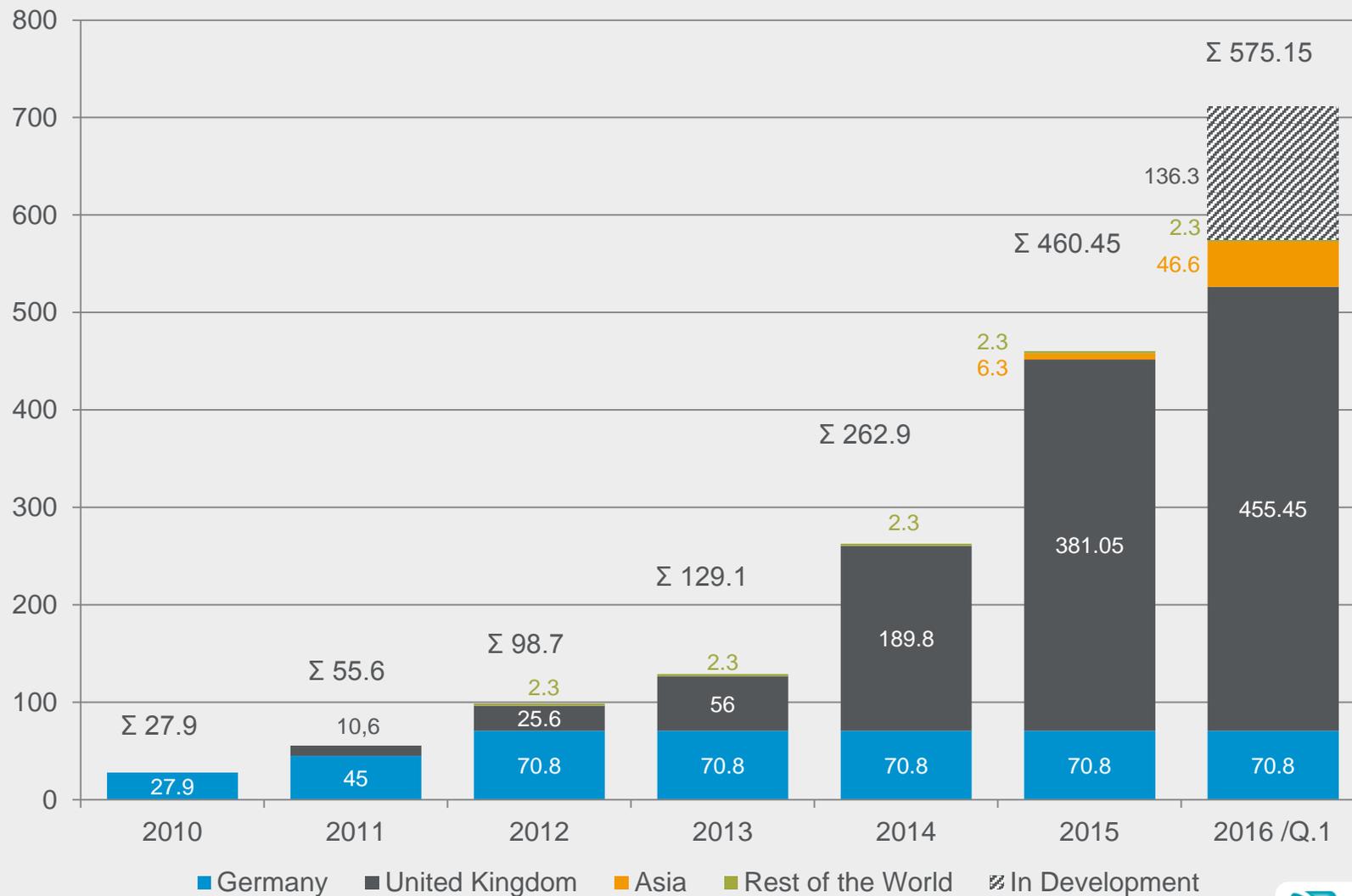
Operations and Maintenance

- Ensuring Operative Readiness & Yield
- Troubleshooting
- Monitoring & Reporting
- Maintenance

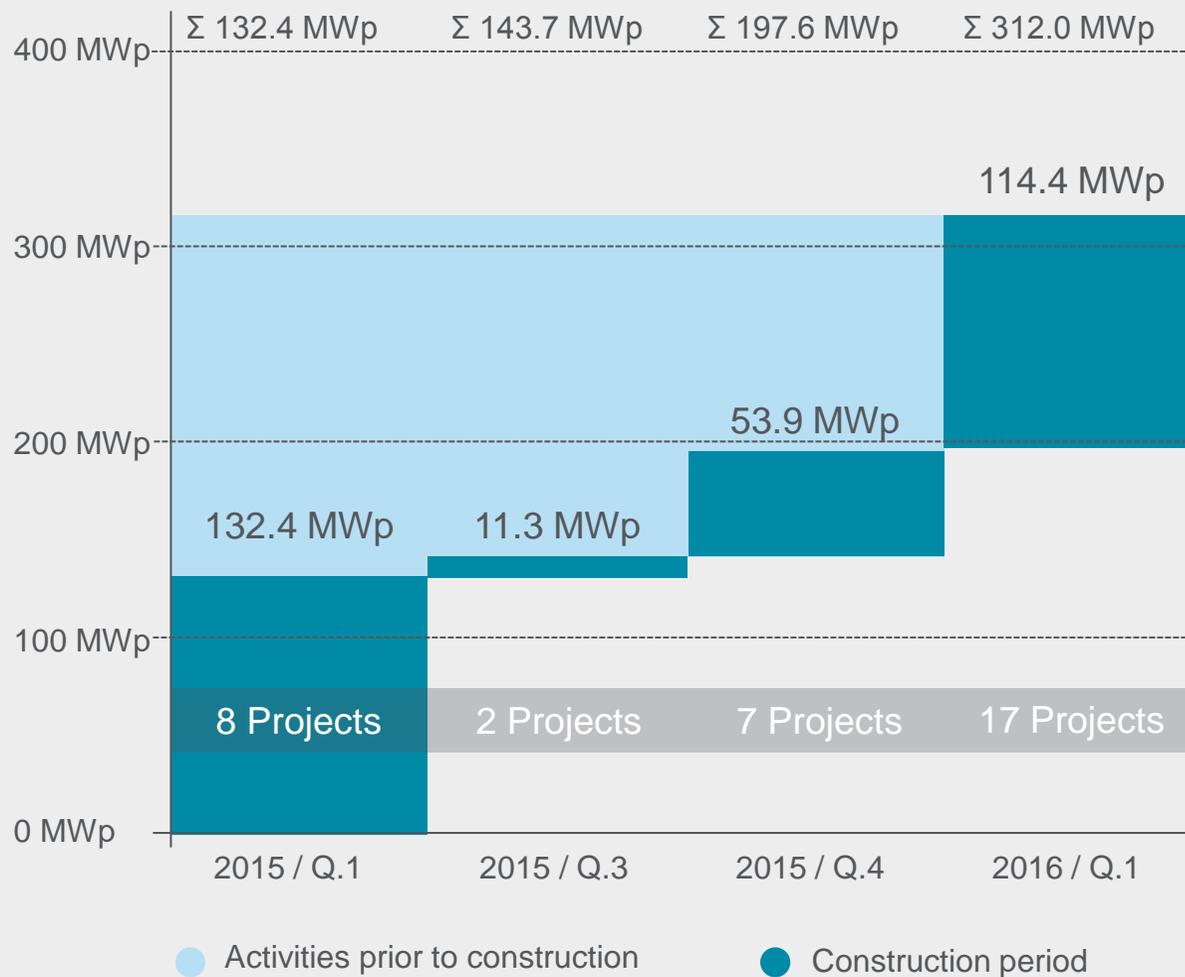
Independent Power Producer

- PV Park Ownership
- IPP & Asset Management

Total capacity of solar power plants built and in construction in MWp



Parallel execution of 312 MWp – across 3 continents



Engineering, Procurement and Construction overview of annual EPC services

Year	EPC	No. of projects p.a.
2016, Q.1	79.4 MWp	14
2015	197.6 MWp	16
2014	133.8 MWp	8
2013	30.4 MWp	4
2012	28.8 MWp	9
2011	11.8 MWp	4

Operations & Maintenance

overview of sites/volume of O&M services under management

Year	O&M	No. of projects p.a.
2016, Q.1	412,2 MWp	43
2015	381,0 MWp	37
2014	189,8 MWp	21
2013	56,0 MWp	13
2012	49.3 MWp	12
2011	24.3 MWp	7
2010	13.0 MWp	3

Benefits - ib vogt as your partner

Bankability

Proven ability to realise and structure complex, large projects

Proven track of projects delivered on time and on budget

PV design

Plant size, IRR and system economics - maximised to situational constraints

Proven engineering and project management strength of ib vogt guarantees that our partners get the most out of their site and out of the system installed:

**Secure your
Internal Rate of Return.**

Realisation

High quality component and supplier selection – OEM independent

Fast track realisation

Integrated approach – from design to turnkey to O&M

Performance

High expected operational system over-performance ($PR_{op} > PR_{design}$)

Strong executional performance and reliability backed up by first class supplier relationships



Our customers

Since 2014 ib vogt has sold 300 MWp to institutional investors. Our customer portfolio covers exclusively first class "blue chip" companies, including some of the world's largest renewable energy development companies and investment firms.

All ib vogt clients benefit from comprehensive specialist knowledge and more than 15 years of solar industry experience.

International approach

ib vogt is committed to long term growth in the international markets and continues to expand its global activities.

Local challenges and global solutions. The success of our solar power projects stems from the partnerships we cultivate – both with local and international stakeholders. Our regional relationships allow us to understand the regulatory and technical challenges specific to each individual market. And our international focus permits greater flexibility as we develop cutting-edge engineering solutions to overcome those local challenges. In addition, this global reach allows us to source some of the highest quality solar components from leading manufacturers in the industry. Consequently, the results we produce consistently exceed our clients' expectations.

International markets



Our Business Development Team



Martin A. Hausmann
Executive Director Intern.
Business Development
& General Counsel



Joachim Altpeter
Executive Director Intern.
Business Development



Franz Ziering
Director Intern. Business
Development



Francesca Rossani
Head of Business
Development UK



Goncalo Aleixo
Business Development
Manager



Faried Muscati
Business Development
Manager



Sebastian Hack
Business Development
Manager



Ulrike Hartwig
Team Assistant

The team behind your success

ib vogt's experienced business development team combine detailed knowledge of solar project development with established relationships with utilities, IPPs, and local developers for the major markets: utilities, government and commercial. Our world class team acting on the highest level of professionalism to customers, suppliers, and investors in a mix of direct development and partnering projects in various geographic and vertical markets.

Our leadership is composed of pioneers within the solar industry.

Board



Dagmar Vogt
Managing Director



Anton Milner
Managing Director



Carl von Braun
Managing Director (CFO)

Executive Team



Martin A. Hausmann
Executive Director Intern.
Business Development
& General Counsel



Joachim Altpeter
Executive Director Intern.
Business Development



Alexander Hanke
Head of Finance
& Administration



Olaf Salzwedel
Director of Solar Power
Plants



Lars Bageritz
Director Operations

Short profiles

Dagmar Vogt - Managing Director and owner of ib vogt GmbH

Dagmar Vogt is a trained chemical engineer, and has been active in plant construction since 1991. Her introduction into the solar industry in 1998 laid the groundwork for the foundation of ib vogt GmbH in 2002. With her excellent personal network and entrepreneurial courage, Ms. Vogt is also a strong supporter of the photovoltaics branch in addition to her position as Managing Director, and is a member of numerous committees and associations.

Anton Milner - Managing Director (Corporate Development)

English-born Anton Milner is one of the pioneers in the solar industry. As one of the co-founders of the cell manufacturer Q CELLS SE, he helped the "Solarvalley Mitteldeutschland" industry cluster become the top German production location. He was a member of the board at Q CELLS until 2009. Since 2011, Anton Milner has been responsible for solar power plants at ib vogt GmbH and has successfully launched the company on the British solar energy market. He became Managing Director in 2012.

Carl von Braun - Managing Director (CFO)

After gaining a Business Administration degree Carl von Braun joined the Deutsche Babcock Group of Companies during which time he held a series of management positions in Germany and India. Subsequently, he held various Finance Director and CFO positions in the telecoms sector. His career in Solar began in 2006 when he joined CSG Solar. Before joining ib vogt Carl was responsible for business development and project finance at Suntech Power International Ltd.

Short profiles

Alexander Hanke - Head of Finance & Administration

After his professional training at BMW AG the trained accountant and controller, Alexander Hanke has already been responsible for internal and external accounting in a range of different employment positions e.g. Südchemie AG. He was Vice President of Finance & Controlling in the USA for Willy Bogner, before taking on the leading position in the Finance department at ib vogt in 2008. He joined the senior management team in 2010.

Olaf Salzwedel - Director of Solar Power Plants

Olaf Salzwedel is a trained supply and power engineer and has been active in plant construction since 1990, after which he has managed building construction projects of all shapes and sizes. He started working at ib vogt in 2005, where he was initially project manager for numerous factory construction projects within Germany. Since 2009, his key tasks have been in the development and implementation of international solar power plants, which he has been responsible for as Director since 2010.

Lars Bageritz - Director Operations

After several years of project management for solar power plants and thin film production facilities Lars Bageritz became the Director of Operations for solar power plant projects at ib vogt in 2013. He is an expert for international EPC projects and is conversant with project development, layout design and optimisation, approval processes, procurement, construction management, claim management and O&M. At ib vogt Lars already successfully managed solar power plant projects with more than 500 MWp in Europe and Asia.

Short profiles

Joachim Altpeter - Executive Director Business Development

Over 10 years P&L responsibility and leadership in the Renewable Energy industry. Deep understanding of global solar energy markets. PV solar project development and execution experience across Europe, Asia, Middle East, Africa and US. Wide PV solar network regarding project development, suppliers, EPC and financing institutions. Profound technical and financial understanding.

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Overview of Consulting Services

QUALIFICATIONS





Contents

- SECTION 1 Firm Profile**
- SECTION 2 Energy & Solar Services and Experience**
- SECTION 3 Corrective Action & Ecological Services and Experience**
- SECTION 4 Solid Waste Services and Experience**
- SECTION 5 Superfund Site Services and Experience**
- SECTION 6 Key Staff**



Woodard & Curran is an integrated engineering, science, and operations company. Privately held and steadily growing, we serve public and private clients locally and nationwide.

From our environmental roots to the range of consulting, engineering, and operations expertise we provide today, we work for a diverse clientele — including energy developers, manufacturers, industrial clients, municipalities, colleges and universities, the real estate community, food and beverage manufacturers, and industry.

Talented people are at the heart of our firm. Our company was founded in 1979 on a simple business concept: provide an enjoyable place to work with opportunity, integrity, and commitment, and we will attract talented people. It happened. At the heart of our company are people who are experts in their field and passionate about what they do, showing a level of commitment and integrity that drive results for our clients. You experience this power every day in our actions, our solutions, and our promises kept.

Commitment evident in personal approach

Our commitment to each project is reflected in our remarkable personal attention and collaborative, results-oriented culture. We assign the right people with the right expertise to the job, and provide clients with easy accessibility to senior experts.

Our results-oriented approach is evident in our energy, responsiveness, resourcefulness, and willingness to do what it takes to get the job done properly. Examples range from helping communities garner state and federal funding for wastewater treatment system improvement to managing a multi-vendor manufacturing project through a major snowstorm and getting production lines up and running. We are expert at navigating the complexities of environmental regulations and have been involved in transforming many brownfields sites into marketable properties. In defining moments like these, it is commitment that brings our clients results.

Operating with integrity

Our integrity impacts our decision-making at all junctures of our work — from the openness of our communication to the fairness of our prices to placing your interests above our pocketbook. We hire people who share our values of honesty, respect, and fairness and who want to do the right thing. They, in turn, treat everyone — our people, our clients, regulators, and stakeholders — respectfully and honestly.



Woodard & Curran serves clients locally and nationwide from offices throughout the U.S. The firm operates offices in the locations noted above, as well as treatment facilities in the states that appear in orange.



Full-service firm with multidisciplinary staff

Our integrity and commitment are matched only by the depth of our expertise. Our staff are specialists in their fields, offering in-depth understanding of cutting-edge technology, astute problem-solving, multidisciplinary engineering, and expert regulatory guidance. The firm has received numerous honors and awards, and we have ranked among *Engineering News-Record's* top 100 engineering firms, top 200 environmental firms, and top 500 design firms over the past decade.

Services to the private sector

Woodard & Curran provides a range of environmental engineering, science, and operations support to companies in the energy development and operation, bottled water, pulp & paper, biosolids, automotive, food processing, pharmaceuticals, electronics, and metals forging industries, as well as to hospitals, colleges and universities, and law firms.

While the range of clients we serve has grown, our work has always been characterized by long-term relationships. Typical projects include compliance and permitting; process and infrastructure improvements; corrective and remedial action; expert witness/litigation support; air quality; environmental information management; and various engineering services. Our private-sector clients also benefit from our services in health, safety, and security, and environmental sustainability.

Services to the public sector

We have been serving cities, towns, and state governments for over 36 years. Today, we offer services beginning with studies, concept, and design on through construction and operations to address our clients' solid waste, wastewater, water, stormwater, and civil engineering needs.

These projects often incorporate hydrogeology, Geographic Information Services (GIS), and instrumentation and controls. We also offer strong capabilities in health, safety, and security, including vulnerability assessments of public water supplies, emergency planning, and environmental sustainability.

Operations and Management (O&M)

Woodard & Curran operates nearly 50 water, wastewater, and groundwater treatment facilities across the U.S. Our O&M specialists focus on contract operations and other O&M assignments for water, wastewater, groundwater, and solid waste facilities.

We design flexible, expandable solutions that keep operations efficient, maximize existing assets, and conserve costs. Our projects have ranged from quick, hard-hitting operational and training assignments to comprehensive plant evaluations and process control improvements to full contract operations.



SERVICES OFFERED

Civil and environmental engineering

- wastewater engineering
- civil engineering
- water supply and treatment
- solid waste management
- design-build contracting

Operations and management

- contract operations
- utility and asset management
- organizational development
- water & wastewater treatment
- water reclamation
- groundwater remediation
- training services
- health and safety

Corrective action and real estate services

- due diligence
- site investigation and remediation
- risk assessment
- real estate development
- environmental ecology
- civil/site engineering and permitting
- natural gas services

Industrial engineering

- food and beverage manufacturing and source infrastructure
- electrical instrumentation and controls
- industrial wastewater
- process engineering
- power engineering

Environmental management consulting

- hazard mitigation planning
- climate change
- emergency preparedness
- expert witness
- environmental information systems
- compliance
- health, safety, and security
- sustainability



Energy & Solar

SERVICES AND EXPERIENCE

Woodard & Curran and its staff have been serving the energy industry for more than 20 years with a broad scope of regulatory, environmental, and litigation services. Our clients range from small municipal utilities to governmental and regulatory agencies, as well as regional producers, distributors, and transporters of electricity, natural gas, petroleum products, nuclear energy, combined heat and power, and renewable energy. With services including site selection and feasibility studies, planning and permitting, engineering and instrumentation, industrial design, and federal agency relations, Woodard & Curran has extensive and varied experience helping clients achieve their objectives.

Site selection & feasibility services

Woodard & Curran staff have significant experience with site selection and feasibility studies. Key services include:

- site evaluations;
- environmental and economic assessments;
- linear project routing;
- mapping;
- visual simulation modeling;
- project scheduling;
- wind studies;
- property acquisition and risk assessment support;
- decommissioning of fuel pipelines and site remediation services;
- Phase I and II environmental site investigations;
- remedial design and oversight;
- voluntary remedial action plans and other regulatory negotiations; and
- layout of large-scale Solar Photovoltaic (PV) systems installed on rooftops, greenfields, and brownfield/landfill sites based on evaluation of technical, regulatory, and financial constraints.

Permitting & compliance

Woodard & Curran's team of compliance specialists have in-depth knowledge and experience with specific local, state, and federal regulatory requirements applicable to energy industry clients. Key services include:

- development of permit-level design drawings;
- local land use permitting including zoning and planning board;
- ecological services/wetlands permitting;
- state brownfields and solid waste permitting including landfill post closure use;
- National Pollutant Discharge Elimination System (NPDES) permitting including



Services

- site selection & feasibility studies
- permitting & compliance
- electrical engineering & instrumentation
- gas engineering
- civil engineering
- industrial design
- corrective action
- federal agency relations
- power engineering
- landfill engineering
- solar PV design



Construction General Permits;

- natural gas and electric transmission linear project permitting;
- large scale solar array permitting;
- compliance with the National Environmental Policy Act (NEPA) for FERC and USCG;
- air emissions and New Source Review (NSR) permitting and performance standards;
- ecological services/wetlands permitting;
- emergency response planning, including oil and chemical spill prevention, containment, and countermeasure plans;
- Emergency Management System (EMS) design;
- control technology requirements (MACT, BACT, RACT, LAER, BPT, etc.);
- Title V permit modifications;
- air quality dispersion modeling;
- noise monitoring and modeling;
- periodic monitoring and compliance assurance monitoring;
- periodic reporting requirements;
- air emissions inventories;
- environmental, health and safety audits, planning, report, training, and compliance services;
- solid waste handling and residual use support;
- LNG siting;
- Article VII (NY State) filing; and
- SEQRA filing.



Electrical, instrumentation and controls systems (EICS)

Our electrical, instrumentation, controls, and information management team has extensive experience designing and implementing Supervisory Control and Data Acquisition (SCADA) systems for energy industry clients ranging from nuclear power plants to gas transmission and LNG storage facilities. Key services include:

- remote controls of pressure vaults for gas delivery;
- screens and alarm handling for quick panel operator interface terminals;
- integrated cooling systems that use the latest Programmable Logic Controller (PLC) and Distributed Control System (DCS) technology;
- Monitoring and remote control of medium-voltage switch gears for electric utilities;
- Geographic Information Systems (GIS) and data management software to evaluate environmental conditions;
- electric utility distribution system design including aerial and underground systems;
- electric utility 35KV - 12.5KV switchyards/interconnect design; and
- spent fuel pool alarm monitoring systems for nuclear power plants;
- solar system DC and AC design;
- EICS support of co-gen systems; and
- EICS design of biomass systems.

Gas engineering

Woodard & Curran staff have provided services to the natural gas industry for the engineering and design of their distribution systems, gate and regulator stations, transmission lines, routing studies and engineering and environmental services for various gas projects. Our personnel have assisted clients with all aspects of

Woodard & Curran staff has years of experience with gas main design, installation, and relocation.



these projects from the initial planning, through design and construction oversight. Woodard & Curran can offer our energy clients a one stop source for all their environmental and engineering requirements, such as:

- base mapping and GIS;
- routing and facility siting;
- health and safety plans;
- horizontal directional drill design services;
- geotechnical services;
- pipeline design / upgrade;
- regulator / gate station design;
- site relocation coordination;
- site investigation and remediation;
- instrumentation; and
- master meter system.

Industrial design

Our engineers, scientists, and operations specialists have worldwide experience designing:

- distribution lines and steam piping infrastructure;
- combustion air hydro systems;
- fuel oil, natural gas, inert gas, bulk chemical storage tanks, and distribution systems;
- loading and unloading systems;
- cooling towers;
- water treatment systems;
- air quality control systems;
- low- and high-pressure steam systems; and
- utility infrastructure.

Corrective action

Woodard & Curran is recognized nationally for its corrective action capabilities. Key capabilities and services include:

- manufactured gas plant assessment and remediation;
- pipeline remediation;
- air monitoring and testing;
- sediment assessment;
- human health and ecological risk assessment;
- natural resource damage assessment; and
- voluntary remedial action plans and other regulatory negotiations.

Federal agency relations

As technical experts, we bring years of experience as practicing professionals on projects such as:

- National Environmental Policy Act (NEPA) environmental impact statements;
- expert testimony for rate disputes before the Federal Energy Regulatory Commission (FERC);
- forensic engineering;

Woodard & Curran has been serving the energy industry for more than 20 years with a broad scope of regulatory, environmental, and litigation services.



- dispute resolution;
- corporate responsibility;
- auditing;
- compliance;
- training;
- site remediation;
- corrective action;
- Procurement services and purchasing support;
- Budgeting, scheduling, and document control;
- Documentation services;
- Design/build projects; and
- Engineering, procurement, and construction management (EPCM) projects.

Design Engineering

- Environmental
 - Permitting – air, noise, water
 - Planning
 - Remediation
 - Emissions modeling
- Civil
 - Site planning and selection
 - Site design and layout
 - Local Zoning and Planning Board Permitting
 - Wetlands Permitting
 - NPDES Construction General Permit
 - Ground- and stormwater planning and design
 - Drainage and erosion control
 - Subsurface utility design
 - Structural building design
- Landfill Engineering
 - Landfill Post Closure Use Permitting
 - Solar PV Design
 - Stability/Settlement Evaluations
 - Landfill cap evaluation
 - Landfill gas evaluation
- Mechanical
 - Equipment selection and size
 - Flow and water balance
 - Mechanical and piping system specifications
 - P&ID, piping, and arrangement drawings
 - Equipment lists

- Pipe stress analysis
- Efficiency and performance studies
- Electrical
 - Equipment selection and size
 - Electrical one-line, interconnection, point-to-point, termination diagrams
 - Equipment list and loading schedules
 - Cable and conduit schedule
 - Grounding systems
 - ArcFlash audits and remediation
 - Distribution and sub-station design
 - Switchgear, MCC, and metering systems
- Instrumentation & Controls
 - Instrumentation size and selection
 - Instrument hookup and connection drawings
 - Instrumentation specifications
 - Instrument lists
 - Control system planning and selection
 - Control system specifications
 - Control system equipment and I/O lists
 - Control strategies, SAMA logic, and control write ups
 - Supplier and integrator supervision
 - Point-to-point and connection diagrams
 - Programmable logic controller and control system programming
 - Alarm management

Field Engineering

- Construction management and supervision
- Overall or single discipline
- Safety supervision and administration
- QA/QC supervision and administration

Installation Services

- Electrical
 - Instrumentation and controls
 - Control system integration and programming
 - Startup and commissioning programs and services

- Commissioning management
- Commissioning plans and procedures
- Turnover package development
- Equipment test and checkout sheets
- Mechanical, electrical, and I&C staffing
- Performance testing

Aftermarket and Plant Engineering Services

- SCADAServ – PLC and control system programming and 24-hour field service support
- Remote access SCADA systems
- Plant upgrades and retrofits
- Plant engineering and staff augmentation
- Procedure writing
- O&M manuals
- Training manuals and programs
- DCS and control system programming and field services

Areas of expertise for the group are industrial and aeroderivative gas turbine generators (simple and combined cycle), biomass fuel handling and combustion systems, control systems (Bailey, ABB, Emerson, and Allen Bradley), air pollution control, process wastewater treatment and handling, and 316B Clean Water Act plans and remediation.

Woodard & Curran's power engineering team is uniquely qualified and has the experience to perform the full life-cycle of a project from conception, execution, to turnover to the client. With the added capabilities of post project field engineering and plant engineering support services to meet your needs.

SOLAR PV SYSTEMS

Woodard & Curran understands the critical technical and regulatory issues associated with solar PV developments, and have successfully delivered on a wide variety of solar PV projects, including those constructed on brownfields/landfill sites, sites with topographic challenges, and rooftop systems. Our engineers have provided the geotechnical, civil, structural, electrical, PV design, PV array renderings, permitting services and construction management for solar energy projects, and are well-positioned to provide these technical services to ensure our clients' interests are well represented for each project. Key services include:

- **Civil and Solid Waste Design Engineering:** Woodard & Curran's engineering team provides a full range of design services, from initial site selection through preparation of bid-ready construction drawings and contract documents. We understand that responsiveness and timeliness of these design services are essential to the success of the project, and have the qualified staff necessary to quickly and effectively complete the design. Our civil engineers provide upfront due-diligence services to assist our clients in assessing the technical, regulatory, and financial viability of a potential solar site. Once the project is go, that team will develop permit level design drawings suitable for local, state and federal permitting. We provide design of civil site components, including roadways, equipment pads, grading and stormwater management. For solar arrays proposed on closed landfill, our team of experienced solid waste engineers will can work with racking manufacturers to develop a design that will maximize the use of the landfill side-slope areas to maximize system output. Once the local and state permits are issued, our team will develop construction drawings and technical specifications suitable for project bidding and contractor selection.
- **Electrical Design Engineering:** Our team can provide feasibility studies, including preliminary panel layouts and one-line diagrams suitable for interconnection applications and assessments of local regulatory constraints. Our design services include full AC and DC design. We work closely with racking manufacturers to provide design of the structural and mechanical aspects of the panel system and can conduct structural review of roof-mounted systems. Having these design services under one roof, means that all aspects of the design are fully coordinated.
- **Financial Analysis and Project Funding:** Woodard & Curran has a successful track record of interfacing with its clients on project funding and financing opportunities. Our funding team provides a wide range of leveraging opportunities with regard to defraying the local share cost of solar projects. Woodard & Curran's funding team helps our clients decipher and negotiate federal and state funding program eligibility criteria and identify the hot-button issues which define the success or failure of public entities in securing federal and state project funding. We provide cost estimating services and project financial analysis, with consideration of various payback methodologies. We can also provide Tax Energy Flow Calculations to possibly reduce taxes payable to utilities.
- **Land Use Permitting:** Today's changing regulatory landscape places nearly every client in a position of uncertainty. Woodard & Curran's clients receive guidance from specialists, whose experience and knowledge of solar PV systems,



understanding of opportunities to streamline the permit process, and timely communications with key regulators keep projects on track and on schedule, saving time and money. Our land-use and environmental permitting experience includes an array of local, state and federal reviews and permits – from straight-forward local board approvals to complex state and federal environmental and natural resource permits. Our team has extensive experience preparing permit applications for solar projects and representing our clients at public hearings held by planning, zoning, and wetland regulatory boards.

- **Solid Waste and Brownfield Management:** Woodard & Curran’s team of solid waste professionals have been providing design, assessment, permitting, and construction services relating to landfill, brownfield and solid waste management for over three decades. As a specific area of focus, Woodard & Curran provides solid waste engineering and permitting services associated with the development of utility-scale solar PV systems on landfills. We understand the regulatory constraints, the health and safety considerations, and the technical design components of developments on landfills. Our team has extensive experience successfully permitting post closure uses on capped landfills.
- **Construction Administration and Management:** Woodard & Curran can tailor construction administration and management services to meet the need of the solar developer, from straight forward “on-call” construction administration support services through full Procurement and Construction Services, including onsite supervision, scheduling, cost control, purchasing & expediting of equipment, management of sub-contractors, development and implementation of health and safety plans, and coordination with utilities, facility owners, and stakeholders.
- **Testing & Commissioning:** Woodard & Curran provides testing of solar PV and interconnection equipment, including utility witness testing for relay protection and coordination.
- **Service of Installed Systems:** Once designed, Woodard & Curran’s electrical team can provide diagnostic and routine service on installed systems and can install remote system monitoring to any location.

SERVICES

- Site selection & feasibility studies
- Shading analysis
- Permitting & compliance
- Electrical engineering & instrumentation
- Electrical interconnect application
- Civil engineering
- Landfill engineering
- Solar PV design
- PV system service
- Aesthetics/renderings
- Funding
- Financial analysis
- Construction administration and management
- Testing & commissioning
- Service of installed systems
- Remote monitoring



Experience

0.5 MW Solar PV Permitting and Design-Build of Solar Photovoltaic System, Energy Development Partners, Middletown, Rhode Island

Property owner ACP Land, LLC and project developer EDC were developing a 495 kW solar photovoltaic (PV) system for sale of electricity to National Grid's 13.8 KV distribution network in Middletown. They hired Woodard & Curran as the Design-Builder to work as the project lead performing project management, project controls, equipment procurement, planning, zoning, and wetlands permitting, and site/civil and electrical solar PV design services to address critical path permitting and interconnection requirements. In addition, Woodard & Curran also provided final engineering, commissioning, and construction services for the installation.

1.1 MW Landfill Solar PV Design, Permitting Services and Construction Support Services East Road Landfill, Tecta Solar, Adams, Massachusetts

Woodard & Curran, was hired by a Tecta Solar working in partnership with the Town of Adams for the Adams Landfill Solar Farm Project. The project involved the installation of a 1.1-MW solar array and electrical interconnection upon the closed Adams Landfill. Woodard & Curran successfully obtained local planning, zoning and wetlands permits. Woodard & Curran also assisted the solar developer in securing a Post Closure Use Permit for the capped landfill, provided site and electrical engineering design, followed by construction monitoring services. The solar developer, through a lease arrangement with the Town of Adams, constructed a ground-mounted solar array of approximately 4,000 polycrystalline PV modules mounted on ballasted Panda Bear® racking in strings of 11 modules each. The Town entered into a long-term Power Purchase Agreement and lease of land which generates revenue for the town and saves on power costs.

1.7 MW Landfill Solar PV Design, Permitting Services and Construction Support Services Concord Landfill, Kearsarge Energy, Concord, Massachusetts

Woodard & Curran, in partnership with Tecta Solar, was hired by the Town of Concord to provide engineering and permitting services for the Concord Landfill PV Installation Project. The project includes the installation of a 1.75-MW ground-mounted solar array on the closed municipal solid waste landfill, adjacent to a sensitive tree protection zone. The project will provide the Town with a source of clean solar electric power, such that the utility can increase its electricity supply from renewable sources and reduce its exposure to market price volatility and rising transmission costs. Woodard & Curran represented the solar developer during the local and state permitting process, successfully obtaining Site Plan approval from the Town and Post-Closure Use Permit approvals from the Massachusetts Department of Environmental Protection (MassDEP). Woodard & Curran provided AC and DC design and interconnection coordination with the utility, and is currently providing construction administration support and preparation of certification documentation.

1.2 MW Landfill/Brownfields Solar PV Design and Construction Support Services Hartford Landfill, Tecta Solar, Hartford, Connecticut

Woodard & Curran was selected by a Tecta Solar to perform the electrical design and provide the construction administration services for the 1.2MW DC Landfill solar PV System on a capped landfill. This included selection and design of a racking system that could be installed on a unique ClosureTurf capping system, AC/DC design services, overhead pole line interconnection final design and coordination with the local utility.



*Solar PV Permitting and Design-Build
Town of Middletown, RI*

During the permitting process, Woodard & Curran was able to successfully work with the Natural Heritage and Endangered Species Program (NHESP) to evaluate and subsequently modify a designated priority habitat area boundary line associated with the Adams Landfill. The coordination resulted in NHESP modifying the line location.

Solar PV System Technical Advisor, Hartford, Connecticut

Under a 5-year on-call consulting contract, Woodard & Curran was the City's technical consultant for evaluating solar PV development on their closed municipal landfill. These services include evaluating the proposed system layouts prepared by solar developers regarding feasibility and optimization, conducting detailed technical reviews of the proposed PV/landfill design, assisting the City with negotiation of a Lease Agreement and with negotiation of an execution of a Power Purchase Agreement.

1.0 MW Landfill Solar PV Design, Permitting Services and Construction Support Services, Brownfield Redevelopment, Chemtura/Nexamp, Naugatuck, Connecticut

Woodard & Curran was selected to provide civil site design, brownfield remediation, and permitting services associated with the development of a 1.0 MW solar development on an industrial site in Connecticut. By utilizing the solar panels as part of the cap over contaminated soils, the project has dual benefits of remediating an impacted site, while at the same time, generating energy for industrial uses onsite. Woodard & Curran represented the solar developer and the site owner in obtaining permit approvals from the Inland Wetlands Commission, Zoning Commission, and Planning Commission. Woodard & Curran also provided environmental permitting of the remediation through the Connecticut Department of Energy and Environmental Protection (CTDEEP), and successfully obtained approvals for an Engineered Control Variance from the state.

2.0 WM Solar PV Design, Permitting Services and Construction Support Services, Energy Development Partners, West Greenwich, Rhode Island

Woodard & Curran was selected by a private solar developer to provide site civil design and land-use permitting services for a 2.0 MW ground mounted solar development in West Greenwich. Approvals were obtained for wetlands protection permitting through the Rhode Island Department of Environmental Management (RIDEM), as well as local site plan and zoning approvals from the Town of West Greenwich. Upon receipt of the permits, Woodard & Curran was selected by the utility and contractor to provide construction administration services.

1.0 MW Solar PV Design and Permitting Services, Energy Development Partners, Westerly, Rhode Island

Woodard & Curran was selected by EDC to provide site civil design and land-use permitting assistance for a 1-MW ground-mounted solar PV project on Town owned land in Westerly. The design included consideration of wetlands, stormwater management and erosion control.

1.7 MW Solar PV Design, Permitting and Construction Support Services, Superfund Site, Energy Development Partners, Johnston, Rhode Island

Woodard & Curran was selected by EDC to provide site civil design and local land use permitting services for the development of a 1.7 MW Solar PV project in on a Superfund Site in Johnston. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. Woodard & Curran successfully obtained local planning, zoning and wetlands/NPDES permits and provided construction support services. Because his project was located on an EPA Superfund Site, it required conducting a Phase I and Phase 2 Environmental Site Assessments and obtaining approvals from RIDEM Waste Management Group.



Landfill/Brownfields Solar PV Design and Construction Support, City of Hartford, CT



Solar PV Design Permitting Services and Construction Support, West Greenwich, RI



Solar PV Design, Permitting and Construction, Johnston, RI

2.5 MW Solar PV Design, Permitting and Construction Support Services, L&RR Landfill Superfund Site, Energy Development Partners, North Smithfield, Rhode Island

Woodard & Curran was selected by EDC to provide site civil design and local land use permitting services for the development of a 1.7 MW Solar PV project in on a Superfund Landfill Site in Johnston. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. Woodard & Curran successfully obtained local planning, zoning and wetlands/NPDES. Because this project was located on an EPA Superfund Site, it also required obtaining EPA and RIDEM approval of a modification to an existing Environmental Land Use Restriction.

1.0 MW Solar PV Design Services, Coddington Cove Solar Development, Balfour Beatty Communities, Energy Development Partners, Middletown, Rhode Island

Woodard & Curran was selected by EDC to provide site civil design of the development of a 1.0 MW Solar PV project in on a Navy Housing Site in Middletown. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. The project is ongoing.

3.2 MW Solar PV Design Services, Melville Solar Development, Balfour Beatty Communities, Energy Development Partners, Portsmouth, Rhode Island

Woodard & Curran was selected by EDC to provide site civil design of the development of a 3.2 MW Solar PV project in on a Navy Housing Site in Middletown. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. The project is ongoing.

1.1 MW Solar PV Design Services, Greene Lane Solar Development Balfour Beatty Communities, Energy Development Partners, Middletown, Rhode Island

Woodard & Curran was selected by EDC to provide site civil design of the development of a 3.2 MW Solar PV project in on a Navy Housing Site in Middletown. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. The project is ongoing.

1.0 MW Solar PV Design, Permitting and Construction Support Services, Nexamp, Richmond, Rhode Island

Woodard & Curran was selected by Nexamp to provide site civil design and local land use permitting services for the development of a 1.0 MW Solar PV project in on site in Richmond. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. Woodard & Curran successfully obtained local planning, zoning and wetlands/NPDES permits and provided construction support services.

1.4 MW Solar PV Design and Permitting Services, Energy Development Partners, Exeter, Rhode Island

Woodard & Curran was selected by EDC to provide site civil design and local land use permitting services for the development of a 1.4 MW Solar PV project in Exeter. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. Woodard & Curran successfully obtained local planning, zoning and wetlands/NPDES permits and provided construction support services. This project also required obtaining a Physical Alternation Permit from the Rhode Island Department of Transportation.



1.0 MW Solar PV, Richmond, RI

0.5 MW Solar PV Design and Permitting Services, Energy Development Partners, Phase 1, North Kingstown, Rhode Island

Woodard & Curran was selected by EDC to provide site civil design, electrical design, and local land use permitting services for the development of a 0.5 MW Solar PV project in Exeter. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. Woodard & Curran provided AC and DC design and interconnection coordination with the utility, Woodard & Curran successfully obtained approval from the Quonset Economic Development Corporation and State Building Commissioner.

0.5 MW Solar PV Design and Permitting Services, Energy Development Partners, Phase 2, North Kingstown, Rhode Island

Woodard & Curran was selected by EDC to provide site civil design, electrical design, and local land use permitting services for the development of a 0.5 MW Solar PV project in Exeter. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. Woodard & Curran is in the process of obtaining approval from the Quonset Economic Development Corporation and State Building Commissioner.

1.0 MW Solar PV Design, Permitting and Construction Support Services, Nexamp, Webster, Massachusetts

Woodard & Curran was selected by Nexamp to provide site civil design and local land use permitting services for the development of a 1.0 MW Solar PV project in on site in Webster. The project includes consideration of shading impacts, stormwater management, grading, and erosion control. Woodard & Curran obtained local planning, zoning and wetlands/NPDES permits and provided construction support services.

1.3 MW Landfill Solar PV Design, Permitting Services and Construction Support Services Ecology Road Landfill, True Green Capital Management, East Hartford, Connecticut

Woodard & Curran, was hired by a True Green Capital Management working in partnership with the Town of East Hartford for the Ecology Road Landfill Solar Farm Project. The project involved the installation of a 1.3-MW solar array and electrical interconnection upon the closed Town Landfill. Woodard & Curran is in the process of obtaining local planning, zoning and wetlands permits. Woodard & Curran is also assisting the solar developer in securing a Post Closure Use Permit for the capped landfill from the CTDEEP. Woodard & Curran also prepared a Virtual Net Metering Application, which was one of the first three approved in the State of Connecticut.

70 MVA Substation Renovation and Design Services Concord Municipal Light Plant, Concord, Massachusetts

Woodard & Curran provided project management, engineering management, and electrical engineering services to upgrade (2) two 50 MVA fully redundant primary transformers and substation equipment to (2) two 70 MVA transformers to allow for predicted future peak loads. Project included the addition of a blast wall to separate the redundant transformers and improvements to the lightning protection system adding reliability to their grid. Project included a detailed computerized model of the system for electrical analysis including load flow, short circuit and relay protection coordination. Project plans and specifications were developed to obtain equipment and contractor pricing to execute the project in a traditional design bid build contract method. The project was followed up by the client with requests for additional electrical analysis on another of the light plant's substations.



70 MVA Substation Renovation and Design Services at Concord Municipal Light Plant

12 MW Solar PV Preliminary Design Services, East Brookfield, Massachusetts

Woodard & Curran prepared preliminary layouts, including one-line diagrams for a 12MW ground mounted solar development, to be constructed in two 6-MW phases. Woodard & Curran prepared and received approval of the interconnect applications. We also prepared tax energy flow calculations and supported our client in negotiation of a \$800,000 tax saving from the utility.

0.6 MW Water Treatment Plant Solar PV Design, Permitting & Construction Support Services, Lowell, Massachusetts

Woodard & Curran and the City of Lowell, MA have been working together for over 15 years to minimize costs and improve operational efficiency. Most recently, as part of a \$10.5 million capital improvement project for the City, Woodard & Curran identified, evaluated, designed and oversaw construction of an innovative alternative to that will not only reduce the City's energy costs, but also generate revenue for the Water Utility's enterprise fund. The project was the first solar installation in Massachusetts, owned by a public entity and bid under MGL Chapter 149.

The project included the installation of a 609 kilowatt solar PV array on the roof and grounds of the water treatment facility. While only one component of a larger project, including the solar panel installation helped the Water Utility address both financial pressures due to increasing energy costs and the political need to keep water rates unchanged.

The energy generated from the Solar PV installation will help offset energy use at the plant and will generate additional revenue for the City through the sale of Solar Renewable Energy Credits (SRECs). The net result is anticipated to be over \$100,000 per year in additional revenue and cost savings for the City. This effort also aligns Lowell with Massachusetts' goal for energy-neutral water facilities, stabilizes Lowell's energy costs, strengthen Lowell's Green Community status, and demonstrates energy and financial leadership.

0.9 MW Solar PV Design and Construction Support Services The Shops LLC, Whitinsville, Massachusetts

The Shops LLC selected Tecta Solar to design and build a new 900-kilowatt (kW) solar power generation system on the rooftops of five buildings at the existing 1 Main Street. Woodard & Curran was selected to design the DC electrical distribution system, design existing system upgrades as necessary, and coordinate utility system interconnection for the exporting of generated power.

4.0 MW Solar PV Preliminary Design Services AMW Adesa Boston, Framingham, Massachusetts

Con-Edison Solutions selected Tecta Solar and Woodard & Curran to develop a conceptual design for a 4-megawatt (MW) solar power generation system on the rooftops at the Adesa Facility. The facility currently consumes 7 million kW/hr a year. The new generation system is capable of producing 4.4 million kW/hr per year, which will drastically reduce the facilities dependence on the local electric utility. Woodard & Curran designed the DC electrical distribution system, reviewed the existing distribution infrastructure, and determined the most effective means of interconnecting the generation facility into the existing electrical distribution system.



Water Treatment Plant Solar PV Feasibility Evaluation, City of Lowell, MA

1.0 MW Landfill Solar PV Design Services Church Street Landfill, Northbridge Redevelopment Corporation, Town of Northbridge, Massachusetts

The Northbridge Redevelopment Corporation (NRC), which owns the Northbridge Landfill on Church Street extension, is developing a 1-megawatt (MW) solar power electrical generation facility on the landfill site. Woodard & Curran was selected to develop a cost-effective, technically feasible, and regulatory acceptable approach for installing the solar racks on the landfill. Woodard & Curran identified site-specific requirements needed to support the post-closure use permit application. Woodard & Curran developed permit-level drawings and supporting documentation suitable for local and MassDEP permitting.

7.6 MW Solar PV Preliminary Design Services Dartmouth, Massachusetts

Woodard & Curran was selected by the solar developer to provide full AC and DC electrical design of this 7.6 MW, ground-mounted solar PV system. As part of this work, Woodard & Curran also prepared and received approval of the interconnection application.

0.6 MW Palmer Technology Center Solar PV Design Services Palmer, Massachusetts

Woodard & Curran provided full AC and DC electrical design of this 0.6 MW, roof-mounted solar PV system, and provided construction administration services.

2.5 MW Hubbardston Solar PV Design and Construction Support Services, Hubbardston, Massachusetts

Woodard & Curran was selected by the solar developer to provide full AC and DC electrical design of this 2.5 MW, ground-mounted solar PV system. Services included construction administration, testing and commissioning. As part of the project, Woodard & Curran was contracted to provide engineering, procurement, and construction of the systems communication system.

2.5 MW Palmer Solar PV Design and Construction Support Services Palmer, Massachusetts

Woodard & Curran was selected by the solar developer to provide full AC and DC electrical design of this 2.5 MW, ground-mounted solar PV system. Services included construction administration, testing and commissioning. As part of the project, Woodard & Curran was contracted to provide engineering, procurement, and construction of the systems communication system.

1.7 MW Diamond Properties, Feasibility Support Services Mt. Kisco, New York

Woodard & Curran was selected by the solar developer to provide feasibility studies, interconnection agreement services, and full AC and DC electrical design of a 1.7 MW roof-mounted solar PV development in Mt. Kisco.



*2.5 MW Hubbardston Solar PV Design,
Hubbardston, MA*



Corrective Action & ECOLOGICAL SERVICES AND EXPERIENCE

Supporting both remediation and redevelopment projects

Our services encompass a broad array of distinct but related ecological fields. Our ecological risk assessment team supports hazardous waste site remediation as well as site redevelopment with ecological and toxicological expertise in fresh water, estuarine, and marine aquatic systems, in addition to a variety of terrestrial ecosystems.

Our capabilities also include wetland mitigation and restoration, stream biomonitoring and assessment, habitat evaluation, vernal pool identification, and related skills. Our Ecological Services Group works closely with our Permitting Group, supporting state wetland and National Environmental Policy Act (NEPA) permits and providing supporting biological studies for a variety of projects.

Technical expertise combined with big-picture vision

Because we work within the larger context of remediation or redevelopment projects, they understand how to address ecological issues in a way that supports overall project schedule and budget. We combine big-picture vision with the detailed knowledge of the technical specialist, providing clients with a seamless approach to addressing the most complex of ecological issues. Our specific services include the following:

Site Remediation:

- EPA screening and baseline risk assessments;
- MCP Stage I and II ecological risk characterizations;
- bioaccumulation studies;
- habitat assessments;
- benthic and wetland macroinvertebrate community assessments;
- Natural Resource Damage Assessment (NRDA) evaluations;
- sediment testing and evaluation;
- contaminant fate and transport studies; and
- toxicity evaluations.

Development and Permitting:

- wetland mitigation and restoration;
- vernal pool identification;
- endangered species reviews;
- biomonitoring and stream surveys;
- environmental impact statements (EISs);
- benthic surveys using EPA's rapid bioassessment protocol;
- water quality criteria development;
- water effect ratio development; and
- NPDES permit assistance.



Woodard & Curran's in-house range of ecological services, combined with our scientists' working knowledge of the "big picture" in engineering and project direction, help ensure smooth and effective project implementation.

Meeting clients' business objectives

Woodard & Curran has a highly experienced team of professionals to meet our clients' site assessment and remediation needs. Whether we are providing property due diligence, facilitating Brownfields re-development, or completing regulatory driven site investigation and remediation programs, we pride ourselves on our ability to understand our clients' business objective and leverage our technical and regulatory expertise to develop cost-effective, strategic project approaches that are tailored to our clients' business and risk management objectives.

Customized risk-based solutions

Our senior staff has over 30 years of direct experience with federal and state programs and providing creative solutions to complicated environmental problems. We have a wide range of capabilities on the cutting edge of technology and risk evaluation, anchored in solid traditional design engineering services. Over the past decade, more and more remediation projects and associated regulatory programs have evolved from a regulatory-standard-based, cleanup approach to risk-based, redevelopment-focused efforts. Woodard & Curran have been leaders in this area and continually strive to align project objectives with realistic risk drivers. Our relationships with state and federal regulators help us to effectively navigate the regulations on behalf of our clients. We are committed to being a strategic partner for our clients from the remedial investigation phase of a project through to project completion.

The remediation of contaminated properties is a complex challenge that requires a full understanding of the interplay between environmental and health risks, the desired current and future uses of the property, and regulatory requirements. Woodard & Curran approaches each remediation project differently, customizing solutions to the demands of the site and integrating current and future site use into all considerations. We address contamination in a risk-based framework and develop approaches that take advantage of all available techniques, from conventional soil excavation and capping to innovative in-situ soil and groundwater treatment programs. We strive to implement cost-effective remedial solutions that minimize risks and maximize future use, while meeting our clients' schedule, budget, and vision.

We fit the solution to the problem, focusing on the development outcome to provide you with the right level of risk assessment, as well as pre-characterization and management of impacted soil, during construction and development of earthwork. By using innovative sampling techniques and developing field programs that gather only enough data to gain a solid understanding of site conditions, we maintain control of both schedule and expense. Our use of innovative approaches, low-impact design, stakeholder outreach, and development-phased implementation has won awards for brownfields reuse.

Hands-on project approach

At Woodard & Curran, we are large enough to take on the toughest assignments, but small enough to provide great service and responsive project teams. Our senior staff are hands on project managers that work closely with clients and project staff every day. Our project teams are comprised of a dedicated team of professionals from a variety of disciplines including geologists, hydrogeologists, environmental scientists, human and ecological risk assessors, civil, chemical and environmental engineers, and construction and treatment system operations experts. The commitment and integrity of our teams drive results for our clients every day.



DUE DILIGENCE

Supplying the information is essential to successfully close the deal

Woodard & Curran provides focused due diligence services that collect and evaluate the information our clients need to successfully “close the deal” in a timely and efficient manner. Our team has completed hundreds of real estate due diligence and business liability assessments for an extensive list of real estate, banking, legal, commercial, municipal, manufacturing, health care, and educational clients. We know the United States Environmental Protection Agency All Appropriate Inquiry (AAI) standard and the ASTM International Standard Practices for Environmental Site Assessments (ESAs) and routinely conduct assessments following these protocols.

We understand the big picture

The environmental assessment is just one component of our client’s due diligence process. But, a property’s environmental liabilities commonly are not easily seen and may present a significant challenge to the transaction. To provide our clients the “big picture” they need for their business evaluation, we strive to identify environmental liabilities and risks associated with the property and present our findings, opinions, and recommendations in a clear manner. We seek to understand our client’s concerns and risk tolerances to facilitate a rapid, comprehensive environmental site assessment. In addition to evaluating the pollution and hazardous waste potential on the property, we have the capability and experience to project estimated future costs associated with assessment and remediation of the property.

Significant experience across a wide geography

Our due diligence team consists of a specially trained staff of scientists and engineers who also implement assessment and clean-up solutions on a wide variety of corrective action projects. Our team not only has significant knowledge conducting assessments in the local communities surrounding our offices but also successful experience carrying out multi-site, multi-state due diligence assignments. Our due diligence team understands how a wide range of current and historical commercial and industrial practices may have resulted in potential environmental issues. With the team’s broad experience evaluating environmental liabilities and implementing corrective action solutions, we have the knowledge that assists our clients with their business decision making needs.



We know the AAI standard

Our environmental professionals ask the right questions, research a comprehensive list of historical sources, and document the assessment’s findings as specified by AAI.

SITE INVESTIGATION

FOCUS ON SOLUTIONS

Woodard & Curran undertakes site investigation activities with the project specific end game strategy in mind. We initiate a project by developing a preliminary site conceptual model and construct a site investigation approach based on this conceptual model and the overall project goal. By implementing this approach, we have met our clients' objectives at a wide range of sites, including Superfund and RCRA Corrective Action sites, military installations, municipal facilities, landfills, educational and health care sites, and hundreds of commercial and industrial properties.

Our field scientists and engineers employ the right tools and procedures to complete the investigation project. The site investigation team has completed hands-on training lead by Woodard & Curran experts and industry specialists to ensure we use procedures capable of achieving project data quality objectives. All work is subject to rigorous technical review and oversight by our Technical Advisory Team, Woodard & Curran's comprehensive internal Quality Assurance/Quality Control program. All personnel working on site and in the field have 40-hour health and safety training and medical monitoring to ensure that all activities are completed safely and in compliance with the law. Prior to initiating fieldwork, the project team jointly prepares a project-specific Health & Safety Plan and a Project Work Plan.

We are experts at collecting a wide range of environmental media samples, including soil, sediment, rock, surface water, groundwater, soil vapor, and air. To implement the appropriate technology to meet the project's objectives, we oversee an extensive selection of subsurface assessment technologies, such as geoprobe sampling, hollow stem auger drilling, air rotary drilling, and sonic drilling. Our site investigation team is skilled at collecting specialty samples, including tissue samples from marine, freshwater, and/or terrestrial environments to support human health and ecological risk assessments, waste materials to support waste characterization and disposal efforts, and building materials to support demolition and redevelopment projects.

We use sample analytical tools ranging from on-site field screening instruments to off-site specialty analytical laboratories. Our team often implements field procedures to quickly and cost-effectively analyze samples and target investigation activities to areas of concern. We have relationships with a wide range of analytical laboratories and often consult with our laboratory colleagues to develop specialized sample analytical procedures specific to a project or sample matrix. Our team is adept at reviewing laboratory data, analyzing quality assurance/quality control information, and interpreting the validity, representativeness, and precision of the data.

Throughout the site investigation process, we use our observations and data to modify and update the preliminary site conceptual model developed at the beginning of the project. We complete the site investigation project by preparing a concise, straight-forward report that summarizes our findings, interprets the data, and provides our professional opinion for our clients to use for their business decisions.



Our site investigation services include:

- environmental sampling
- remedial investigation
- human health and ecological risk assessment
- technology screening and selection
- corrective action under state and federal programs
- site closure
- redevelopment and reuse



GROUNDWATER HYDROGEOLOGY & MODELING

Woodard & Curran has extensive experience performing hydrogeologic characterization and developing groundwater flow and chemical transport models to assist in the selection and implementation cost effective groundwater remedies. Since groundwater flow and chemical transport is a key mechanism for the spread of chemicals of concern at many sites, we focus on understanding the sources of groundwater degradation and associated migration pathways. This allows the development of effective remedial actions to solve problems in a cost-effective manner.

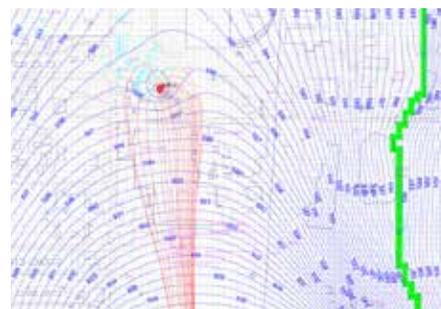
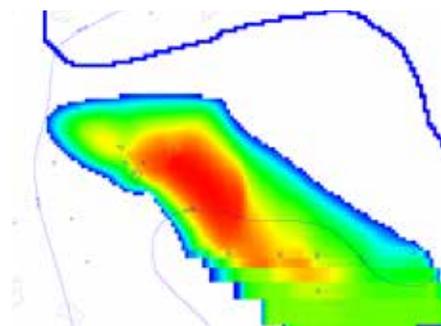
Engineering and science to protect public health

Woodard & Curran's hydrogeologists, water resources engineers, and geologists have developed successful strategies that evaluate the hydrogeological regime and select effective remedial actions. Our staff has the expertise and in-depth knowledge of regulatory issues to offer in-house capabilities to complete all aspects of water resource evaluations, from hydrogeologic investigation through complex modeling assessments. Our hydrogeologists work closely with our remediation engineers to assess, select and implement remedial solutions based on a sound scientific and engineering basis. Our team offers a full range of groundwater services, including:

- Remedial investigations and feasibility studies
- Groundwater pumping tests
- Groundwater Infiltration tests
- Conceptual site model development
- Modeling fractured bedrock systems
- LNAPL & DNAPL assessments
- Groundwater flow and chemical fate and transport modeling
- GIS/hydraulic models
- Monitored natural attenuation evaluations
- Regulatory assistance
- Design of in-situ extraction, delivery and recirculation systems
- Design of groundwater containment systems
- Design of groundwater dewatering systems
- Design of hydraulic and or reactive barriers
- Design of monitored natural attenuation systems
- Remedial performance assessments
- Groundwater and surface water discharge permitting

Quantify source and potential risks

Groundwater modeling programs quantify the hydrologic system associated with a contaminant source. We are experienced with a variety of analytical and numerical modeling approaches; we don't take a one size fits all approach. We match the level of effort in model development to the potential benefit of model application at each site that we work on. Utilizing these tools, we can quickly mimic a hydrologic system, predicting chemical migration pathways which can be presented in a variety of outputs, allowing us to quickly assess potential human health and/or ecological risks. The end result enables our clients to quickly and effectively respond to questions from agencies or the public regarding the delineation and potential impacts of site-related chemicals and to reliably assess and select the applicable remedy.



REMEDIATION ENGINEERING

Woodard & Curran's engineers have experience with a wide variety of remediation approaches and technologies, from conventional soil excavation and capping, to innovative in-situ soil and groundwater treatment programs. In those instances where risk considerations conclude that corrective action is required, we develop and implement cost-effective remediation programs that are consistent with and integrated into site use and or development.

Our engineering teams have experience under both state and USEPA programs in a wide range of remediation planning, engineering and implementation for:

- Soil and Groundwater Contamination
- Landfill Closure
- Facility Decontamination and Demolition
- Indoor Air Mitigation
- Underground Storage Tank Management

Our in-house staff routinely provides the following services:

- Remedial investigations
- Feasibility studies
- Treatability studies and pilot testing
- Remedial strategy development
- Conceptual planning and cost estimating
- Remediation system design
- Bid document preparation
- Permitting
- Construction oversight
- System operation and monitoring
- Environmental data management

Technical expertise

We have a deep bench of senior people who understand the technical issues and apply this knowledge to complicated problem solving.

- Soil removal and disposal
- Capping and barrier systems
- Dewatering programs
- Product recovery programs
- Monitored natural attenuation
- Hydraulic containment and groundwater treatment systems
- PCB and other hazardous building material decontamination
- Sub-slab ventilation systems
- UST management
- In-situ physical, chemical and biological treatment programs including:
 - Soil vapor extraction and air sparging
 - Multi-phase extraction
 - Soil stabilization
 - Thermal treatment
 - Chemical oxidation
 - Bioaugmentation and bioenhancement



RISK ASSESSMENT & MANAGEMENT

Determining risk also determines feasibility

Risk assessments play a vital role in the evaluation and restoration of contaminated sites, from determining human health and ecological risks to establishing property use limitations for expedited site reuse.

Whatever the goal, Woodard & Curran makes the client's objectives a top priority. We know that a focused risk assessment can mean the difference between a successful exit strategy or an endless series of evaluations and study. We focus our efforts on answering the important questions about risk and exposure to facilitate rapid, cost-effective, and protective cleanup, not prolonged site investigation.

We have assisted lawyers, industry, public agencies, and even other consultants with their risk assessment needs on more than 200 projects throughout New England. These projects were performed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Resource Conservation and Recovery Act (RCRA); the Toxic Substances Control Act (TSCA); and state regulatory programs. This has positioned us as one of the premier providers of risk assessment services in the Northeast.

Clients benefit from team of seasoned experts

Our team of risk assessors, database managers, air modelers, toxicologists, chemists, biologists, and public health specialists are some of the best in the field. They bring to each project significant practical experience in assessing the effects of contaminants in both aquatic and terrestrial settings.

Since Woodard & Curran is a full-service consulting firm, we can blend our assessment capabilities with other service centers. This enables us to provide our clients with a united front, bringing them integrated project teams that include top-notch risk assessors and environmental data management, as well as design engineering experts.

Our risk assessment and risk management services include:

- CERCLA and RCRA baseline human health and ecological risk assessments;
- New England and other State regulatory agencies;
- sampling program design;
- derivation of cleanup goals;
- fate and transport modeling;
- habitat and ecological evaluations;
- product safety analysis;
- indoor and ambient air evaluations;
- epidemiology studies/biostatistics;
- regulatory negotiations;
- toxicology studies;
- litigation support for toxic torts;
- risk communication and public outreach; and
- due diligence assessments.



We craft inventive approaches that emphasize site outcomes and eliminate unnecessary process steps — all while meeting some of the most complex and stringent regulations.



From litigation support to property transfers

Woodard & Curran's risk assessment experts also provide expert opinions and litigation support on issues ranging from regulatory closure to toxic tort cases.

We can apply risk assessment analysis techniques to help clients determine if risks were evaluated appropriately in a property transfer, and assess and manage liabilities at a site for prospective buyers.

Many times, those risk assessment conclusions are used to help negotiate the price of a property, establish indemnification for environmental issues, allocate costs for liability management, or procure environmental insurance.

Expert negotiators work as client's advocate with regulators

Whether it's meeting RCRA or CERCLA requirements or pioneering new uses for risk assessments, we have extensive experience with state and federal environmental regulations and the compliance process. We are expert at negotiating favorable outcomes that meet client objectives and regulator approval.

Since RCRA and CERCLA were instituted in 1980, we have forged cooperative relationships with EPA Region I regulators and state departments of environmental protection, earning their trust and respect. In this way, we are able to craft inventive approaches that emphasize site outcomes and eliminate unnecessary process steps — all while meeting some of the most complex and stringent regulations.

Communication key to stakeholder buy-in

Property owners, future developers, and public agencies sometimes face adverse public perception associated with the contamination of a site.

We use our risk assessments to demonstrate the feasibility of remedial action plans to the community, stakeholders, and regulators. Clear communication, along with community outreach and involvement, are essential to a successful project.

Our integrated risk and remedial action team are experts at conveying complex technical information in terms anyone can understand. We do what it takes to get the message across, often using in-house geographical information system tools and 3-D conceptual models to illustrate ideas.

Finding new ways to use risk assessment tools

Woodard & Curran is using risk assessment analysis techniques in new ways to meet client objectives. We are employing our risk analysis techniques to demonstrate to regulators and attorney generals that a product is safe and effective for consumer use when it is used as instructed. This approach can be applied to a wide array of products, ranging from household cleaners to pesticides.



VAPOR INTRUSION

There has been a shift in focus from the regulators and scientific community from drinking water issues to impacts from the subsurface on indoor air quality. This is due to both the high potential for exposure to indoor air (time spent indoors and lack of alternate air sources) and because science suggests the way we previously evaluated indoor air concerns is flawed and that the transport and toxicity of some solvents are even higher than previously thought.

The result: a spotlight on the potential for contamination to move from soil and groundwater beneath buildings to indoor air – termed vapor intrusion - potentially placing occupants at risk. In the wake of these changes, new sampling methods, new phases of assessment, new agency scrutiny, and new litigation by tenants and owners follow.

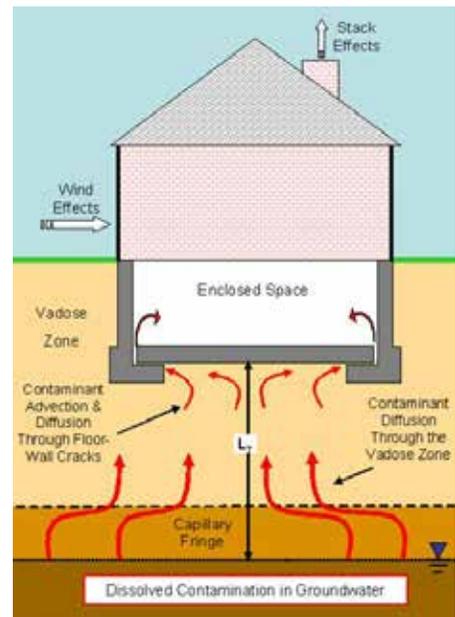
Our experts make the difference

Our in-house experts offer a full scope of services, providing clients with one-stop solutions. We focus this expertise on clients' needs to conduct each project with the end in mind, saving clients time and money. We are always at the forefront of innovation and practical problem solutions for our Clients. For example, many of our experts are LSPs under the Massachusetts Contingency Plan (MCP), which has required assessment of the vapor intrusion pathway since the program's privatization in 1993. We have been solving vapor intrusion matters for our clients for decades.

Woodard & Curran has nearly 20 licensed professionals (LSPs, LEPs, & LSRPs) who practice site investigation, remediation and risk management. Our team boasts dozens of highly trained engineers, scientists, risk assessors and technical staff to bring you quality, experience, and the assurance that your assets and liabilities will be managed safely and securely. One phone call provides you with the expertise of over 200 engineers and scientists, of which nearly 150 have advanced degrees and over 100 professional engineers. Few firms can offer this depth of experience and education to clients.

Our site remediation experts conduct vapor intrusion projects for commercial and industrial clients, real estate developers, architects and engineers, municipalities, hospitals, colleges and universities, and utilities.

Woodard & Curran is sought after by industrial, commercial and municipal clients for our expertise, comprehensive service, client advocacy, and solutions-oriented approach to site remediation. Knowing the laws is not enough in a rapidly changing regulatory environment. Our professionals work with regulators by bringing our technical expertise to bear on the development of new policies and changes to the law. In this way, Woodard & Curran stays current with changes affecting businesses and industry and helps ensure that these changes are based on real technical and economic considerations.



Woodard & Curran understands Vapor Intrusion pathway assessment from beginning to end.

Streamlining compliance

Our in-house expertise helps clients streamline the compliance process, thus reducing costs and the time required to meet legal obligations. We have extensive experience in the design and implementation of vapor intrusion assessment and mitigation systems, with systems being installed throughout the Northeast. We implement real-time design modifications to account for unknown field conditions encountered at the time of construction and working with our in-house team of risk assessors and air quality experts to evaluate sub slab and indoor air vapor data and help craft the right solution for your site.

Innovative approach results in cost-effective solutions

At Woodard & Curran, we begin with the end in mind. We examine the big-picture goals of a project and develop a strategy that blends the right mix of services to meet a client's business needs. We understand the critical factors with all vapor intrusion sites. The potential for exposure is real. The concerns of occupants, regulators, and stakeholders often lead to emotional rather than sound technical responses to perceived issues.

Woodard & Curran's commitment to research, policy development, and continuous practice improvement makes us a leading provider of high-value site closure services. In the vapor intrusion area, Woodard & Curran has developed innovative techniques for field measurement of volatile organic compounds beneath foundations to ensure what we measure is actually from a discharge of contamination. We advocate using a site conceptual model approach that first examines then tests pathways along with source identification and potential receptor exposure. We have consistently developed new approaches or explored alternatives to solving hazardous and industrial waste problems that result in cost-effective and timely site closure.

We're here for you

Technical expertise may not be the only thing a project needs. Managing legal liabilities, property transfers, and public relations as well as accessing negotiations can all be part of a successful project completion. The law recognizes that some properties, particularly industrial and commercial sites in urbanized areas, do not warrant the same high degree of cleanup as other sites where there exists exposure to sensitive populations or the environment. We focus our efforts on both client and site-specific considerations

Woodard & Curran recognizes the importance of client advocacy and places top priority on translating a client's needs into skillful, professional representation. In this way, we leverage our expertise to create success for clients on all levels of a project.

For over a quarter century, Woodard & Curran has helped manage built environment needs for our clients with a suite of civil-environmental engineering and consulting services. Whether you are performing site selection for a new development, constructing the site, managing an already built environment, or managing liabilities at a remnant site, we have the services to assist you in all stages of the asset life cycle.



Technical vapor intrusion specialties we handle include:

- vapor intrusion applicability assessment
- soil vapor study design and implementation
- HVAC assessment
- vapor intrusion/indoor air modeling and exposure pathway analysis
- indoor air testing study design and management
- quantitative exposure analysis/risk assessment
- tenant and occupant risk communication
- SSDS pilot test and turn-key design, build, permit, and operation
- solvent and petroleum contaminated groundwater/plume remediation
- soil vapor extraction and sparging

BROWNFIELDS REDEVELOPMENT

In 1998, the U.S. Environmental Protection Agency launched its Resource Conservation and Recovery Act (RCRA) Brownfields Prevention Initiative to encourage cities, industries, and developers to clean up and redevelop old industrial or commercial properties that are contaminated.

At Woodard & Curran, we know that strategic redevelopment of brownfields can produce favorable outcomes for property owners, regulators, and the surrounding community. We help achieve these outcomes by eliminating barriers to site cleanup and redevelopment, thereby increasing the marketability and use-ability of selected sites.

We have completed dozens of projects involving investigation and cleanup of industrial and municipal sites. This work has been done in accordance with some of the most complex regulatory guidelines in the nation.

Our corrective and remedial action team has a proven track record of successfully turning under-utilized, contaminated properties into retail sites, light industrial facilities, office parks, market-rate housing, and waterfront promenades.

Outreach programs help envision new life for brownfields

Brownfields redevelopment projects are complicated by contamination, regulatory interpretation and oversight, public perception, and marketability of the property's future use. That's why we approach each project with the end in mind in order to help our clients, as well as developers, public officials, and regulators, envision the redevelopment of a site and its future possibilities.

Agreement among stakeholders is essential for an effective remediation plan. We know that clear communication, along with community outreach and public involvement, is the cornerstone to every successful project. In fact, we often hold public meetings to hear stakeholder concerns, discuss project milestones and issues, and address neighborhood concerns.

Our corrective and remedial action team members are experts at presenting complex technical information in terms anyone can understand. We do what it takes to get the message across, often using in-house geographical information system tools and 3-D conceptual models to illustrate the site and potential solutions. In some cases, we have successfully reversed adverse public opinion and launched new remedial approaches in tandem with regulators.



The American Council of Engineering Companies of Connecticut (ACEC/CT) honored Woodard & Curran with a 2006 Engineering Excellence Award for its work on a confidential client's Brownfields redevelopment and wetlands restoration project. The award is given each year to recognize consulting engineers whose projects demonstrate merit and ingenuity and which provide a contribution to technical, economic, and social advancement.

Strategic approach streamlines process, keeps goals in focus

Our approach consists of a series of steps or phases that focus on client goals within regulatory frameworks. Our approach includes:

- **Phase I** - Based on visual observation and document review, we identify Areas of Concern (AOC) that may have significant environmental liabilities. This may include a first look at the future use of the site.
- **Phase II** - Investigation and assessment of the AOCs identified in Phase I. Using limited sampling, we verify the presence or absence of contamination and define the extent of areas that need to be remediated for redevelopment. We develop conceptual and risk management plans and use results to estimate cost of remediation. We can develop risk-based Remedial Objectives (ROs) that are protective of current and anticipated future site uses and activities.
- **Phase III** - Includes a Remedial Action Plan (RAP) that identifies and characterizes the areas of a site requiring remediation and provides remediation options and costs. The RAP acts as a design model and provides guidance during the design, construction, and regulatory sign-off phases of development. We also incorporate remedial action activities with the site's future use by blending our remedial activities with the redevelopment plan.

Focused remediation

The successful redevelopment of an impacted site requires a tailored approach that keeps costs contained and achieves a client's goals. By using innovative sampling techniques and developing field programs that gather only enough data to gain a solid understanding of site conditions, substantial benefits can be realized in both schedule and expense.

We focus our remediation efforts on the site's future needs. Our tailored solutions are marked by ingenuity, characterized by cost-effectiveness, and include:

- use of Voluntary Cleanup Programs to streamline regulatory processes;
- remediation that focuses only on areas that need to be remediated in order to meet the goals of the proposed site use;
- application of the appropriate technology; and
- risk management plan that helps clients manage future risks and obtain environmental cost-cap insurance.

HAZARDOUS MATERIALS ABATEMENT

The historic use of lead, asbestos, PCBs, and other hazardous chemicals in schools, residential housing units, and commercial and industrial buildings is a growing concern. These substances can be found in paints, coatings, insulation and caulking/sealants, and at locations where commercial and industrial operations occurred, chemicals can be present in typical building materials, like wood, concrete, and drywall.

Many of these adjacent materials are important to the structural integrity of the building and their remediation is not a straightforward process. If not addressed properly, the presence of these hazardous chemicals causes significant impacts to building renovation and demolition projects, and poses considerable human health concerns.

PCBs

PCBs (Polychlorinated Biphenyls) are a class of organic compounds favored by industry from the 1930s to the 1970s. PCB oil in electrical transformers, hydraulic equipment, or waste oils is a common use, but high concentrations of PCBs have also been found in paint and caulk. As the health risks posed by these chemicals came to light, PCBs went from one of the most widely used chemicals to one of the most tightly controlled in just a few decades.

Woodard & Curran personnel use their experience and working relationships with EPA to guide our clients through the complicated PCB remediation process with extensive knowledge on the Federal Toxic Substance Control Act (TSCA) and Federal Disposal regulations.

Manage risk and minimize the unexpected

Knowledge of hazardous materials in advance of property transfer or acquisition, or any construction or demolition projects, allows for the proper incorporation of remedial activities into project schedules and budgets. Looking for chemical contamination in building materials as part of the due diligence process is time- and cost-effective when compared to the potential impacts that late discovery can cause to a redevelopment/renovation project's schedule and budget. Woodard & Curran's team of experts understands the importance of finding issues in front and is expert in evaluating the presence of hazardous chemicals in building materials

Why choose Woodard & Curran

The remediation of contaminated properties is a complex challenge that requires a full understanding of the interplay between environmental and health risks, the desired current and future uses of the property, and regulatory requirements. Woodard & Curran approaches each remediation project differently, customizing solutions to the demands of the site and integrating current and future site use into all considerations. We address contamination in a risk-based framework and develop approaches that take advantage of all available techniques. We strive to implement cost-effective remedial solutions that minimize risks and maximize future use, while meeting our clients' schedule, budget, and vision.



WETLAND SERVICES

Wetland protection is an increasingly important component of site development and remediation projects, since the presence of these protected areas can impact both the design and schedule of proposed construction.

In-house wetlands specialists provide quick response

Because the efficient resolution of these issues is so important to the overall success of a project, Woodard & Curran maintains key wetlands-related capabilities in-house, with trained wetland scientists, soil scientists, and aquatic biologists experienced in solving complex problems associated with resource protection.

Our scientists work primarily within the larger context of our development and engineering projects, and so understand how to address ecological issues in a way that efficiently supports overall project budget and schedule.

Experts in wetlands permitting and regulations

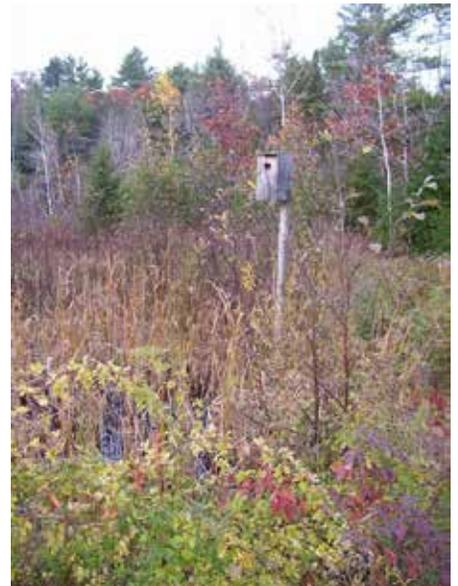
Our wetland capabilities are diverse, ranging from resource delineation to wetland restoration. We also know the intricate permitting and regulatory pathways that trigger these requirements in each state, so we are able to anticipate issues and apply our skills in a way that helps keep the project moving smoothly.

Our services include the following:

- wetland delineation review (freshwater and estuarine);
- wetland functional assessment;
- stream wetland mitigation/restoration design and construction oversight;
- wetland/ecological enhancement; and
- state/federal permitting.

Comprehensive ecological services complete the package

Our wetland services comprise only a subset of our total range of ecological capabilities. In addition to wetland work, our Ecological Services Group has expertise in key related areas, such as risk assessment, toxicity studies, and resource identification providing a comprehensive approach to achieving project goals.



Our wetlands experience ranges from resource delineation to wetland restoration to enhancement and mitigation.

OPERATIONS & MANAGEMENT

When industrial, commercial, and municipal enterprises are faced with contaminated sites, they seek rapid and effective remedial action to help them get back to business.

We help clients achieve this by taking our comprehensive corrective and remedial action services an important step further with our operations and maintenance capabilities. We minimize environmental liabilities and maximize existing operations by developing practical, effective exit strategies that achieve compliance.

Broad experience helps clients meet specific goals

Whether it's taking over operations at a Superfund groundwater treatment facility, setting up remote operating systems, or training treatment facility staff, Woodard & Curran has a proven track record for completing projects on time with practical approaches, solid technical solutions, and regulator buy-in.

Our operations and management specialists have in-depth experience contract operating numerous Super-fund and Resource Conservation and Recovery Act (RCRA) facilities and remediation systems, including:

- groundwater pump and treat systems;
- soil vapor extraction systems
- air sparging systems;
- vacuum-enhanced extraction systems;
- metals removal, air stripping, and vapor treatment systems;
- sludge dewatering system;
- effluent disposal operations; and
- natural biodegradation and attenuation techniques.

Integrated firm offers clients balanced, targeted solutions

Since Woodard & Curran operates without divisions, we can make the right people, both junior- and senior-level staff, available for a client's project. Our senior managers are practicing professionals, so our clients get the best we have to offer. Our O&M capabilities include:

- facility evaluations and optimization;
- troubleshooting and training programs;
- development of operation plans;
- operations and process control;
- hands-on operations assistance;
- drafting of O&M manuals;
- short-term operator support;
- part- and full-time operations management;
- preventive and predictive maintenance; and
- full contract operations.



Woodard & Curran has a proven track record for completing projects on time with practical approaches, solid technical solutions, and regulator buy-in.



Our compliance record speaks for itself

Woodard & Curran has a high compliance record on all reportable parameters at the facilities we operate and maintain. We have never faced litigation for any aspect of operation, and most importantly, our clients have never paid a fine or faced litigation while we have been responsible for operating their facilities.

We achieve this by working actively on the client's behalf to operate and maintain facilities at optimal levels and recommend improvements or modifications to keep the facilities in compliance.

Maintaining facilities to optimize operations

Often, our staff performs ongoing benchmark studies and plant and hydrogeologic evaluations to determine the best ways to optimize existing systems. Our philosophy is to:

- protect facilities through exceptional maintenance;
- equip staff with the appropriate training, tools, and technical support;
- set high standards for staff and overall plant performance;
- invest in needed capital improvements; and
- always hold compliance as the number one priority.

Keeping facilities staffed with experienced professionals

Our pool of highly skilled, professional operations and management personnel work closely with clients to train existing staff whenever possible. Our high-level O&M training programs provide employees with the tools to advance their certification levels and develop their skills to the fullest, while making health and safety our top priority. This has lowered our turnover rate and improved employee transition and retention rates.

We also pull from our own crew of professional facility operators and managers to assist clients with either short-term operator support or full contract operations.

REGULATORY EXPERTISE & STRATEGIES

Advocacy through experience

Navigating federal and state regulatory programs for site remediation can be a difficult task, particularly when the success of your project is dependent on meeting regulatory compliance standards that often seem like moving targets. Woodard & Curran has the experienced staff to lead you through the maze of site remediation programs at both the state and federal level. Our experience, reputation for good work, and relationships with state and federal regulators, allow us to effectively advocate for our clients in a manner that moves projects forward while maintaining strict regulatory compliance for short and long term liability protection.



State programs

State regulatory programs vary widely from prescriptive command and control programs in some states to the privatized systems in Massachusetts, Connecticut and New Jersey. Our staff is consistently involved in working with the local state agencies to develop and improve regulatory guidance, educate stakeholders, and improve the efficiency of the regulatory process. Regardless of the state program, Woodard & Curran's staff takes a consistent approach of understanding the regulations inside and out while establishing credibility with the agencies. Working closely with our clients to understand their business objectives, we develop regulatory approaches and identify key business decision points that allow our clients to make informed decisions on how best to move their projects forward as cost-effectively and expeditiously as possible.



Federal programs

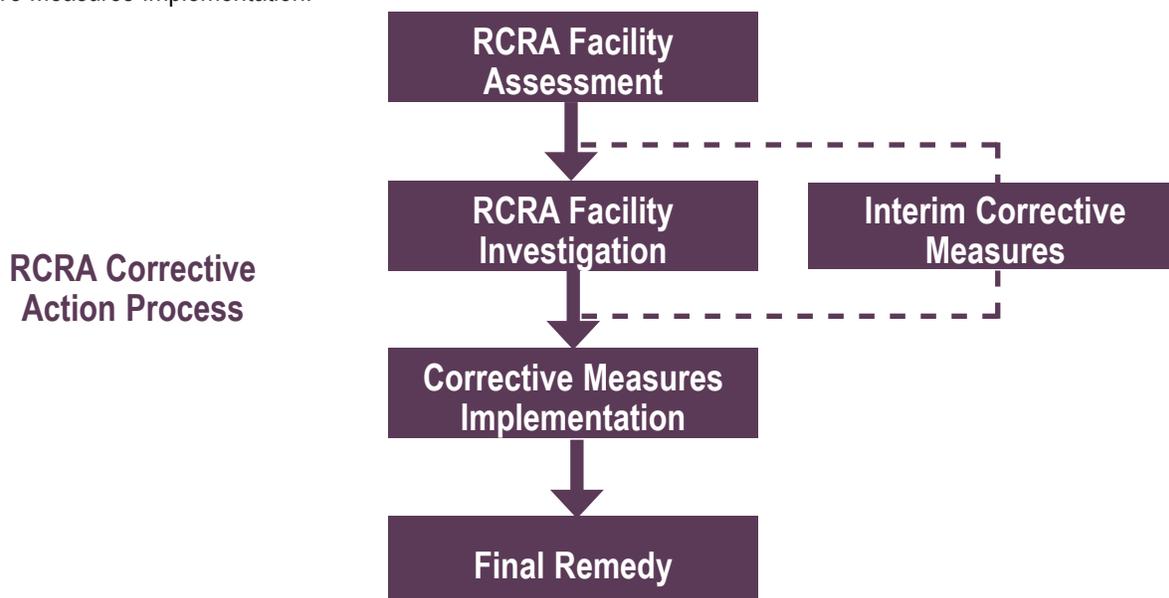
Certain sites or types of chemicals warrant regulation under federal programs rather than local state programs. These sites or issues are often larger and or more complex than sites that are regulated through the state program. Woodard & Curran takes the same strong approach at sites falling under federal regulatory programs as we do state program sites to build credibility and client advocacy. We have developed particular expertise in the following federal programs.

CERCLA/Superfund

Woodard & Curran staff have been working with Potential Responsible Parties (PRPs) in the Superfund program for over 20 years. We have extensive experience at dozens of sites representing PRPs in virtually all facets of the Superfund process. Our experience includes strategic support in liability defense, cost share allocation and Consent Decree negotiations along with complete Removal Actions, Remedial Investigation, Remedial Design and Remedial Action activities. We are well known in the regulatory, legal and PRP community and understand the unique perspectives that must be considered for all stake holders to effectively move projects through the extensive Superfund process. Our experience allows us to produce cost effective deliverables and implement remedies that stand the scrutiny of extensive regulatory oversight.

RCRA Corrective Action

The Resource Conservation and Recovery Act, (RCRA) is a federal regulation for the management of solid waste, hazardous waste, and underground storage tanks holding petroleum products or certain chemicals. The U.S. EPA enforces corrective action through statutory authorities established by the 1984 Hazardous and Solid Waste Amendments (HSWA). Through HSWA, Congress expanded USEPA's corrective action authority increasing enforcement focusing on waste minimization and phasing out land disposal of hazardous waste. HSWA also created more stringent hazardous waste management standards and a comprehensive underground storage tank program. Woodard & Curran has extensive experience working with clients and USEPA under the RCRA Corrective Action Program and are currently working on numerous facilities where the primary regulatory driver is RCRA. We take a consistent approach in balancing our clients' regulatory compliance needs with their business objectives in the development and implementation of cost effective RCRA Facility Assessments, Facility Investigations, Corrective Measures Studies and Corrective Measures Implementation.



TSCA

The Toxic Substances and Control Act (TSCA) establishes specific requirements for the management and disposal of polychlorinated biphenyls (PCBs), a class of organic compounds that were widely used by industry from the 1930s to 1970s. PCBs were commonly used for oils in electrical transformers and hydraulic equipment and often present in waste oils. PCBs have more recently been found in high concentrations in building materials such as paint and caulk, where they were used as a plasticizer. 40 CFR 761, commonly referred to as the "Mega Rule" establishes the prohibitions of and requirements for the manufacture, handling, cleanup, disposal, etc. of PCB containing materials. Woodard & Curran staff have extensive experience dealing with PCB in soils, sediment and building materials. We are familiar with the nuances of the sampling and analytical procedures, mitigation, and remediation measures that are effective for PCBs. We have extensive experience working the EPA's TSCA staff in the development of cost-effective investigation, mitigation and remediation programs that can be integrated into our clients building renovation or site remediation program needs.

ENVIRONMENTAL STUDIES & PERMITTING

Today's changing regulatory landscape places nearly every client in a position of uncertainty relative to the regulations that could impact their project or operations.

Woodard & Curran's clients receive guidance from specialists whose experience and knowledge of the technical issues at hand, understanding of opportunities to streamline the permit process, and timely communications with key regulators keep projects on track and on schedule, saving time and money.

Address your regulatory requirements with the guidance of proven experts

Our regulatory specialists play an essential guiding role in the majority of our engineering and design projects; these services are also a major component of more complex projects that require regulatory management expertise to guide a client through the regulatory maze.

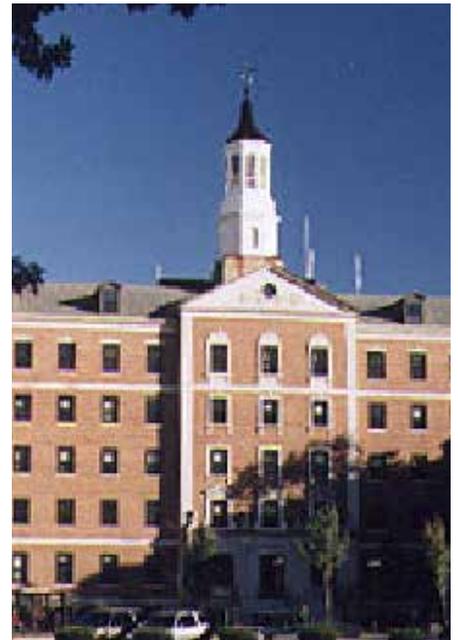
In some complex projects involving multiple agency reviews and permit approvals, a regulatory strategy that includes ways to consolidate agency reviews or obtain agreements to meet pre-determined review timelines is essential. This can mean the difference between reacting to agency delays rather than managing the permit process to achieve timely approval.

Understand the local, state, and federal implications

Our environmental permitting experience includes an array of local, state, and federal reviews and permits — from straight-forward local board approvals to complex state and federal environmental and natural resource permits involving air emissions, traffic and land use, water supply, wetlands, riverfront and shoreline, habitat or endangered species protection that require extensive negotiation and mitigation measures to gain full compliance.

Benefit from our comprehensive package of services

- Air Emissions Major and Minor Source License and Source Registration
- Title V Air Permit
- Sewer Extension/Connection Permits
- Wastewater Discharge/NPDES Permits
- Stormwater NPDES Permits
- Water Quality Certification
- Environmental Site Assessments and Compliance Audits
- Federal & State EIS/EIR Reports
- U.S. Army Corps of Engineers Wetlands and River Permits
- Site Feasibility Analyses
- Coastal and Freshwater Wetlands Permits and Mapping
- Natural Resource Inventories and Mapping
- Local Conservation Commission Approvals
- Natural Resources Protection Permits (Wetlands, Habitat, Shoreline)
- Environmental Mitigation Plans/Compliance Monitoring
- Public Participation and Public Hearings



Woodard & Curran assisted the U.S. Veterans Administration at several of its hospital locations with local, State and Federal air and environmental permits associated with cogeneration energy systems modernization.

Learn how you'll benefit from our design expertise

Our expertise in environmental engineering and design for wastewater, industrial process, and water supply projects affords us the basis for maintaining our strong role as regulatory specialists able to manage the permitting process. We provide our clients with services that lead to solutions that are technically sound, environmentally safe, and acceptable to regulators and the public at large.

CONSTRUCTION SERVICES

At Woodard & Curran construction activity services begins during design. We review each project during the design to consider the constructability and economical options for equipment and materials. In the instance of work at an existing facility, each project is considered in relationship with ongoing operations and staged, future projects. Once the design is completed and approvals are in place, Woodard & Curran will provide traditional construction administration services to support you and your staff. A brief synopsis of each of these services follows.

Bidding

Woodard & Curran solicits competitive bids from contractors through several avenues. First working with you, dates are established for a pre-bid meeting and the bid opening. The project is advertised with sufficient coverage to attract interest in the project. We also provide complimentary copies of the contract documents to industry plan rooms to be considered for advertisement in industry publications. The printing and distribution of contract documents to interested contractors and suppliers is a part of bidding. We have done this in both paper form and electronically depending upon the location and complexity of the project. Acting as your representative, we conduct a Pre-Bid Conference, respond to all questions during bidding, issue information addenda as necessary, and receive bids. Once the bids have been received, we will prepare a tabulation of the bids and make a recommendation for award based upon our review.

Construction field administration

Woodard & Curran staffs the construction site with trained and experienced engineers to monitor the construction progress. These professionals maintain records of the daily activities at the site; advise the contractor on work quality and detail as it relates to the requirements of the construction documents; provide clarifications to construction documents if necessary; provide recommendations on change orders, payment requests, and completion; and generally act as your representative during construction. We provide our field staff with OSHA standards safety training. Many have gone beyond and obtained their OSHA 10-Hour and OSHA 30-Hour Safety Training Certificates. A number of our field staff have 40-Hour HAZWOPER training and the 8-Hour HAZWOPER Supervisor Certificate for construction sites with contamination issues.

Construction office administration

Our field personnel are supported in the office by members of the design team. The design team assists with construction document clarifications, evaluates change order request pricing, creates record drawings in AutoCAD, and reviews shop drawings. Our office staff also provides assistance in the monitoring of specialized construction when requested by the field personnel.



Shop drawing (or submittal) review

On your behalf, Woodard & Curran will review all shop drawings and submittals offered by the contractor as required by the construction documents. These items are required of the contractor to confirm his understanding of the equipment and material requirements for the project. Woodard & Curran will provide review comments to the contractor, return copies to the contractor, and maintain a complete set of shop drawings for your files once the project is complete.

Change order negotiation

During the project, if any changes from the construction documents become necessary due to unforeseen conditions, Woodard & Curran will negotiate with the contractor on a price for this work and make a recommendation to you once we believe the change is reasonable. We will prepare all required documentation for execution. If regulatory agencies are involved, we will coordinate these changes for their approval prior to making our recommendation to you.

Project start-up

Working with the Construction Administration team, we provide staff to work with the contractor to start up and performance test individual pieces of equipment and systems. If the project involves biological and/or chemical processes, we will develop a project start-up plan to facilitate a timely and controlled system development and startup. For renovation and facility expansion projects, implementation plans are developed to minimize impact on the existing facilities.

Project closeout

Once construction has been completed and the project has started up and is operating as designed, Woodard & Curran ends the project by assembling and turning over all construction documentation including record drawings, shop drawings, and O&M Manuals to you. Project closeout also includes any assistance to you during the warranty period to address problems that may arise.

The effectiveness of any construction project is dependent upon communications and anticipation. It has been the experience of Woodard & Curran that understanding the sequence and mechanics of construction by thinking ahead of the daily activities minimizes construction issues. Regular meetings plus daily discussions let each party contribute to a project being constructed to the expectations of you with fewer claims and in a professional, non-adversarial environment.

Our experience

Woodard & Curran's experience in construction dates back to our founding, which has provided us with a knowledge base that includes a complete library of forms, guidelines, procedures, and materials to assist in providing the efficient and effective delivery of services from the design to a completed project.



Experience

LNG Terminal and Linear Permitting, Confidential Client, Northeastern U.S.

Woodard & Curran served as project manager for all environmental permitting for a Liquefied Natural Gas (LNG) receiving, storage, and vaporization facility that would connect to the Maritimes and Northeast pipeline. Tasks included: wetland and vernal pool identification and delineation; marine, cultural, and geologic resources investigations; photo simulations; and all permit and license applications. Woodard & Curran managed the complex permitting schedule, coordinating with several federal and state agencies to meet their requirements on more than a dozen reports and applications. As an indication of the thoroughness of our approach to permitting this project, our 15-volume draft FERC application was approved for final submission after only one round of comments.



As part of the site-selection process for this LNG project in the Northeast, preliminary studies determined that visual aesthetics could be an issue. The image above is a visual simulation developed by Woodard & Curran's graphic designers to illustrate the project aesthetics.

Woodard & Curran also identified pipeline routing alternatives, selected a preferred route, and provided all environmental studies and permitting services for 20 miles of pipeline. To meet all federal and state requirements, Woodard & Curran managed the ecological, cultural resource, and other investigations and prepared all necessary permit applications. The pipeline route was carefully selected to avoid a wildlife refuge and take advantage of existing rights-of-way wherever possible, minimizing the visual impact and effect on animal habitat and ecological resources.

B. L. England Upgrade Series, PEPCO Holdings, Inc. (Conectiv), New Jersey

A Woodard & Curran staff member oversaw several phases of work that were necessary to reinforce an existing electric transmission system (both 115kv and 230kv) to allow for the retirement or sale and upgrade of B.L. England generating stations in New Jersey. Tasks included: feasibility and route assessments, wetlands delineation, threatened and endangered species habitat assessments, and Phase 1A and 1B cultural resource surveys; regulatory agency coordination; and environmental, permitting, and construction details in GIS base maps.

There was extensive coordination with regulatory agencies to assure that the project's strict construction schedule, which was developed in consideration of the various endangered species (including pine berrans treefrog, numerous plant species, coopers hawk, northern pine snake, timber rattle snake, red shouldered hawk, and barred owl) along the route, was achieved. Permitting applications included FAA, ACOE, Coastal Area Facility Review Act (CAFRA), Soil Erosion and Sediment Control, New Jersey Tidelands, and State Pinelands.

600-MW HVDC Undersea Cable Project, Northeast Utilities, Connecticut/New York

A Woodard & Curran staff member served as Principal-in-Charge for work on a 600-MW project for Northeast Utilities that sought to extend a 25-mile route from a Norwalk, CT terrestrial substation into Hempstead Harbor in Long Island, NY. The project involved assessing routing options and extensive geophysical and geotechnical surveys of seabed conditions within Long Island Sound to evaluate several potential submarine cable routes. The project included extensive ecological and environmental impact evaluations associated with selected cable routes and landfall locations. These evaluations included impact assessments of shellfish and finfish resources, water quality protection, prevailing tides and currents, and areas of navigational and marine sensitivity. Final draft applications were prepared and submitted to Northeast Utilities for municipal filings and submittal to the Connecticut Siting Council.

Wind Turbine Installation Varian Semiconductor, Gloucester, Massachusetts

Woodard & Curran installed two wind turbines at Varian's facility to reduce their noticeable burden on local electricity resources. The project called for placing one turbine in a resource buffer zone and another directly in a delineated wetland. Woodard & Curran produced a detailed plan for restoring the wetland resource following turbine installation, with a focus on minimizing the final impact on the wetland resources as well as improvement of other areas of the resource to offset the minimal long-term impact of the turbines. Though the plan was opposed by a local avian specialist, requiring a superseding order in support of the project, Woodard & Curran was successful in helping Varian move off-grid some of its equipment in compliance with an order from the utility. The process of obtaining both the local and superseding orders included three hearings, a site walk, and a public meeting required by the State of Massachusetts.

Ecological Services for Natural Gas Pipeline, South Jersey Gas, Upper Township, New Jersey

Woodard & Curran designed and provided full environmental and gas engineering services for the installation of a new 24" diameter steel pipeline to supply natural gas for the re-powering of the existing Beesley's Point coal-fired electric generating plant owned by South Jersey Gas. Services included route analysis studies, environmental permitting, HDD design, threatened and endangered species surveys, cultural resources studies, agency coordination, wetland and waterway delineations, soil erosion & sediment control planning and implementation, and construction oversight.

Woodard & Curran's preliminary task was to study three potential routes using GIS mapping and field investigations to prepare a detailed route analysis study. The preferred route included approximately 21.7 miles of new pipeline, contained within existing road and power line right-of-ways and passing through three counties on land regulated by the ACOE, NJ Pinelands Commission, and state-regulated coastal zone across southern New Jersey.

Woodard & Curran biologists then conducted detailed wetland delineations surrounding the proposed pipeline placement, and identified all rivers, streams, and channels that would be considered in accordance with federal, state, and Pineland jurisdictional regulations. Additionally, we provided management and guidance over extensive surveying services and detailed sub-consultant studies to identify potential state and federal protected wildlife species and cultural resources along the project corridor.

The end result was a design that minimized environmental impacts, avoided time-consuming permit processes, and met the aggressive schedule required to address the needs of South Jersey Gas and the repowering of the B.L. England Generating Station.

Ellijay to Blue Ridge Gas Pipeline Environmental Support, Atlanta Gas Light, Georgia

Atlanta Gas Light retained Woodard & Curran to provide environmental support services for the design and construction of a 27-mile natural gas pipeline from Ellijay to Blue Ridge, located primarily along road rights-of-way. The project consists of initial environmental route reconnaissance; detailed ecological survey and field delineation; historic and cultural resources survey (Phase I); environmental permitting; erosion, sedimentation, and pollution prevention designs; and construction oversight. Studies consisted of ecological, cultural, and environmental investigations using GPS survey equipment to delineate and identify potential issues and outline all required permits for construction of the pipeline. Threatened and endangered species habitats were identified and were avoided through alternative construction methods.

Data obtained during ecological delineation surveys were mapped using GIS database software to support stream and wetland permitting by the ACOE, a stream buffer variance by the Georgia Environmental Protection Division, and a NPDES Notice of Intent to discharge stormwater.

Central Region Gas Pipeline Environmental Support, Atlanta Gas Light, Georgia

Woodard & Curran worked seamlessly with Atlanta Gas Light's engineering design team to assess routing options for environmental issues and provide input into the routes that had the least impacts for AGL's 26-mile Central Region natural gas pipeline project, which spans three counties and is placed in a newly acquired easement. Woodard & Curran provided comprehensive environmental services for the project, including initial route investigations; detailed ecological surveys; stream and wetland delineation with GPS survey equipment and field flagging; historic and cultural resources survey (Phase I); environmental permitting; erosion, sedimentation and pollution prevention designs; and construction oversight.

During the Phase I cultural/historic resources survey, two sites were found to be potentially eligible for listing on the National Registry of Historic Places. A limited Phase II cultural/historic resources survey was conducted for both locations and the route was realigned to avoid impacts to the resources.

Stream and wetland resources identified were mapped using GIS database software to support the permit applications for ACOE, a stream-buffer variance by the Georgia EPD, and a NPDES NOI to discharge stormwater. Construction oversight services included full-time environmental inspection to ensure compliance with all environmental permits. Compliance reporting, including rainfall monitoring and rainfall event sampling as required by the NPDES permit, was also provided by Woodard & Curran.

Cherokee-Forsyth Gas Pipeline Environmental Support, Atlanta Gas Light, Georgia

Woodard & Curran was retained by Atlanta Gas Light to provide full environmental services for preliminary studies; permitting; erosion, sedimentation, and pollution prevention designs; and construction oversight/inspection for the Cherokee-Forsyth



Woodard & Curran has performed a number of ecological and engineering projects for Atlanta Gas Light – the eighth largest natural gas distribution utility in the U.S. and the largest in the Southeast.

gas pipeline project to facilitate growing demands for natural gas service in the metropolitan Atlanta area as well as to maintain reliable gas service. The project consists of over 14 miles of new 24" natural gas pipeline to Cherokee and Forsyth Counties, and preliminary studies consisted of ecological, cultural, and environmental investigations to identify any potential issues and outline all required permits for construction of the pipeline.

During ecological studies of the project corridor, it was determined that seven streams crossed by the pipeline alignment are habitat for the federally threatened Cherokee darter (*Etheostoma scotti*). As a result of environmental studies, it was determined that the project would require coordination and a Biological Opinion from the United States Fish and Wildlife Service (USFWS) in addition to stream and wetland permitting by the ACOE, a stream buffer variance by the Georgia EPD, and a NPDES permit.

Woodard & Curran completed all permitting and coordination with the various agencies prior to project construction. During construction, Woodard & Curran had a registered professional wetland scientist trained in protected species studies, agency coordination, and erosion and sedimentation control overseeing each crossing of a darter stream and all pipeline construction along the project, ensuring compliance with USACE, USFWS, Georgia EPD, and NPDES permits. After construction, each darter stream and wetland was restored using bio-engineering techniques and natural channel design principles. Stream restoration activities were designed and inspected in the field by a Rosgen IV-trained environmental engineer.

Namakan River Hydroelectric Development, Ontario, Canada

A member of Woodard & Curran's staff was the primary reviewer on a proposed hydro-electric development project in Ontario, which included the installation of three separate generation facilities along a large free-flowing river. The project was partnered 50/50 between a private company and the Lac La Croix First Nation. Our staff member participated with the First Nations community throughout the process of evaluating the project, collecting additional ecological data, reviewing ecological and social impacts. The member of our staff established a positive professional relationship with the First Nation community and was invited by their elders to join them within their round-house for their annual water ceremony where they blessed the river and our work.

The firm also served as a liaison between the OMNR and Canadian Department of Fisheries and Oceans (DFO) and coordinated site visits with the DFO to the project area to provide them with local knowledge of critical resources. The local river is home to Lake Sturgeon, a protected species, which required an Endangered Species Act Permit to Take that enabled active research on the sturgeon, particularly the juvenile fish, which would be most impacted during larval drift downstream and as juveniles they would pass downstream through the turbines. The proposed project also included the development of approximately 50km of new transmission line to connect to the power grid.



In addition to careful timing and restoration of stream crossings as part of the Cherokee-Forsyth Gas Pipeline project, Woodard & Curran negotiated a purchase of conservation credits to offset temporary project impacts to the darters.

License and Permit Applications, Numerous Uranium In-Situ Recovery, Mining Operations, Wyoming

The firm served as the prime contractor to support the field characterization and environmental evaluations required for In-Situ Recovery (ISR) mining applications to the Nuclear Regulatory Commission (NRC) for a Radioactive Source Materials License, and the Wyoming State Department of Environmental Quality – Land Quality Division (WDEQ-LQD) permit.

Our services included a comprehensive site characterization for all resource areas and an assessment of proposed facilities, equipment, procedures, and the potential impacts of the proposed operations on the health and safety of the public and environment. Resources that were characterized for over 20,000 acres of project area included: land use, transportation, geology, water resources, ecological, wetlands, soils, air, noise, historic and cultural, visual and scenic, socioeconomic, public health, and more. We also coordinated various subcontractor field studies and associated reports for the applications.

In addition, we assisted the client in coordinating completion of field activities, as well as developing draft and final environmental baseline reports in support of the client's licensing and permit application documents. Once data evaluation was complete, multiple state and federal permits were filed to fulfill regulatory agency requirements for future uranium ISR mining purposes. We also developed an innovative means for electronic submittal of the applications, thus reducing submittal costs.

Thompson Creek Mine, Environmental Impact Statement, Idaho

Woodard & Curran completed a 900-acre wetland delineation and waters of the U.S. survey in central Idaho to provide baseline conditions for a potential land exchange Environmental Impact Statement (EIS). The work took place within 5,000-acre of Bureau of Land Management and U.S. Forest Service lands for the potential land exchange EIS.

Within the same area, we completed a 900-acre vegetation survey on rangeland to provide baseline conditions for a potential land exchange EIS. Additional tasks included a 5,000-acre survey on BLM and USFS lands for the distribution, identification and relative extent of major plant communities on rangeland, forest lands, and grasslands. In 2011, the firm completed the analysis of the mining impact effects on proposed expansion lands.

Environmental Impact Statement/Environmental Assessment for Proposed Coal Mine Access Railroad, Montana

Woodard & Curran managed a multi-disciplinary group of experts to prepare an environmental assessment (state) and a supplemental environmental impact statement (federal) for the proposed 130-mile-long Tongue River Railroad (TRRR) to be constructed in southeast Montana. Our staff organized and conducted public hearings, reviewed public comments and reviewed information submitted by the proponent for state permit requirements.

The environmental assessment work included review and evaluation of all past EISs for the entire alignment, the EIS prepared by the MDNRC for the Tongue River Basin, and the EA prepared by the State for the Miles City to Ashland portion of the TRRR. The work included review of all available documentation and data for 14 resources (e.g., air quality, vegetation, wildlife, soils, etc.) to confirm applicability for meeting Montana environmental policy act and secondary permitting requirements for the State of Montana. The work has also included evaluation of impacts of the



Uranium project drilling to collect geological, hydrogeologic and groundwater quality baseline data.

railroad to the Miles City Fish Hatchery and assisting the Montana Department of Transportation and Montana Department of Natural Resources and Conservation (MDNRC) with evaluations for encroachment permits and easements. The final document included a description of the project and alternatives evaluated to date, a description of existing environment, an evaluation of impacted resources, and the identification of mitigation measures.

The firm prepared the SEIS for the TRRR extension from Ashland to Decker (42 miles) with particular emphasis on the proposed 17-mile Western Alignment. This work included, again, review and evaluation of all past EISs for the entire alignment, the EIS prepared by the MDNRC for the Tongue River Basin, and the EA prepared by the State for the Miles City to Ashland portion of the TRRR. The work included review of all available documentation and data for 14 resources (i.e., air quality, vegetation, wildlife, soils, etc.), determining if changed circumstances have occurred for the first 21 miles of the Ashland to Decker EIS, and an evaluation of comments on the NOI for re-opening the EIS for the entire alignment. The work has also included a description of the project and alternatives evaluated to date, a description of the existing environment, an evaluation of impacted resources, and the identification of mitigation measures.

Ecological Permitting and Plan Implementation Atlantic Cape Community College, Cape May, New Jersey

After the siting process was complete for this significant expansion project, Woodard & Curran staff worked closely with College and County staff to implement their plan. The project was complicated by the identification of numerous protected species in the area, coastal regulations, and Green Acres restrictions. A series of multi-season surveys were conducted in coordination with the State to identify an alternative layout, including mitigation and monitoring that allowed the first community college in Cape May County to be constructed.

Environmental Assessment, Engineering, and Permitting National Cold Water Marine Aquaculture Center, Franklin, Maine

The National Cold Water Marine Aquaculture Center provides research facilities for scientists studying cold water marine aquaculture, in conjunction with the U.S. Department of Agriculture's Agricultural Research Service (ARS). Woodard & Curran prepared an Ecological and Environmental Assessment for the project, which resulted in a Finding of No Significant Impact issued by ARS, allowing the project to proceed without further analysis or consultation. Woodard & Curran prepared and submitted an application for a NPDES waste discharge license, developed a series of bedrock supply wells to supply the aquaculture center, and assisted with the design of a new pump station and water storage tank system.

Woodard & Curran also worked with the project's lead architect to engineer the water supply system, provide civil and site engineering, and prepare all required permit applications. This project required ACOE wetland alteration permits for a new outfall in Taunton Bay, a local Shoreland zoning review, and permitting under Maine's Site Location of Development Law.



In the final design phase for the Franklin Cold Water Aquaculture Center facility, Woodard & Curran worked with the project's lead architect to engineer the water supply system, provided civil and site engineering, and prepared all required permit applications.

Ecological Services, Fortune 100 Client, American Cyanamid Superfund Site, Bound Brook, New Jersey

Woodard & Curran was hired by a confidential Fortune 100 industrial firm to manage the remedial activities at its 435-acre site in Bound Brook, NJ. Services include operation and maintenance of the groundwater extraction system, an on-site RCRA Subtitle C landfill, stormwater pumping systems, a wastewater pre-treatment system, and flood-control berms, in addition to the development of a stormwater pollution prevention plan (SWPPP) and the provision of ecological services. The site is challenging due to its location in a natural floodplain of the Raritan River with multiple wetlands, a perennial tributary to the Raritan, and onsite protected species habitat; as a result, the client needed a partner who could maintain the existing facilities in the floodplain and work with stakeholders and agencies to continue remedial activities while complying with state and federal environmental regulations.

As part of the ongoing management of the site, Woodard & Curran has completed state and federal wetland and stream evaluations and determinations as well as protected species habitat evaluations in support of a number of state and federal permits. Woodard & Curran coordinated the permit by rule for NJ Department of Environmental Protection permits, including a Flood Hazard Area permit, Individual Open Water permit, and Wetlands General permit. In addition, Woodard & Curran has been tasked with long-term wetlands monitoring activities on the site.

Municipal Review and Environmental Monitoring Town of Pound Ridge, New York

The Town of Pound Ridge turned to Woodard & Curran when a local businessman and golf course developer proposed the expansion of an old 9-hole golf course into a premier 18-hole destination course. The 173-acre site, located within a highly sensitive wetland environment, warranted a detailed review under the State Environmental Quality Review Act (SEQRA) to ensure that the development plan incorporated proper site and stormwater engineering and that the local residents who rely on groundwater for drinking water supply and sensitive habitats would not be impacted.

Woodard & Curran reviewed the groundwater-based irrigation systems, stormwater management plan, integrated turf grass and pest management plan, and the formulation of a groundwater and surface water monitoring plan to detect and eliminate any impacts to the quality or quantity of the area's water resources. The SEQRA review process was completed after extensive input from Woodard & Curran.

Woodard & Curran also served as Environmental Monitor and Third-Party Auditor, performing weekly site inspections, establishing the baseline data for surface water quality and groundwater quantity and quality in accordance with the approved Long-Term Environmental Monitoring Plan. The Pound Ridge Golf Club opened for operation in July 2008, and Woodard & Curran completes monthly/quarterly sampling of surface water and groundwater to determine whether or not the golf course operation is having a measurable impact on the quality of the water resources.

Manursing Lake Aquatic Habitat Restoration, Rye, New York

Woodard & Curran was selected for the planning and design of a self-regulating tide-gate at the existing southern outlet of Manursing Lake, as well as the planning and design of tidal wetland and coastal upland habitats restoration and establishment in anticipation of the installation of the self-regulating tide-gate. Located within the 179-

acre Edith G. Read Natural Park and Wildlife Sanctuary, Manursing Lake originally existed as vegetated tidal wetlands (salt marsh and tidal creeks) associated with the Long Island Sound, but the lake was dredged and impounded in the 1920s as part of the development for Playland Amusement Park. The lake connects to the Long Island Sound at the southern outlet through two manually controlled tide-gates, which are only periodically opened or monitored. In the past, Manursing Lake has provided refuge and spawning/nesting sites for various fish and migrating avian species; however, without tidal flow, negative ecological consequences, such as: hypoxia and anoxia, reduced fish access and breeding habitat, increased sedimentation, loss of intertidal areas and native vegetation, and expansion of invasive common reed have resulted.

The self-regulating tide-gates will assist in the restoration and establishment of coastal wetlands and estuarine functions by reintroducing tidal flow. The resulting fluctuation in surface water elevations will lead to an overall increase in the biological diversity and primary productivity in the system through the expansion of intertidal habitat. Increasing the daily tidal fluctuations will also create a semi-diurnal cycling of nutrients and oxygen, control and reduce stands of invasives, create colonization for native low- and high-marsh vegetation, improve areas for fish inhabitation, and maintain and enhance feeding habitat for diving and migratory waterfowl.

Ecological Permitting, Harbor Dredging, Risk Assessment Former Chadwick Lead Mills, Salem and Marblehead, Massachusetts

This site, on the path to becoming a multi-unit residential development, straddles the waterfront of two municipalities in Massachusetts and is a historical source of lead contamination present in harbor sediments and beaches. To address the ecological issues delaying any remediation or redevelopment of the site, Woodard & Curran dredged and tested harbor sediment contamination levels and established opinions on impact to coastal ecology.

This project required wetlands permitting; an ACOE permit premised upon mandated harbor dredging, water quality analysis, and archaeological analysis; ecological risk assessment for animal and plant populations; completion of the Massachusetts Environmental Policy Act (MEPA) process; a MassDEP 401 Water Quality Certification; two local conditions permits from Salem and Marblehead; compliance with the National Heritage and Endangered Species Act; a permit under the 1894 Rivers Harbors Act Permit; and a permit under Chapter 91.

Environmental Assessment and Evaluation DR Horton Grand at Crystal Lake, New Jersey

The Grand at Crystal Lake is a residential development project of 300 units adjacent to Route 130 and the New Jersey Turnpike, near the Delaware River. Woodard & Curran worked with DR Horton in the preliminary evaluation of the project site providing constraint analysis, a preliminary assessment, and site investigation through remedial action report, which identified and addressed arsenic and buried ash, allowing the project to move forward.

After an initial feasibility evaluation and years of design and permitting, the NJDEP identified a nesting site for a pair of bald eagles on a 400-acre uninhabited island in the Delaware River within a half mile of the development location. Woodard & Curran staff began a lengthy process of negotiations with Federal and State Fish and Wildlife, demonstrating how the project could be constructed while minimizing potential impacts to the bald eagles. The project layout was revised, 14 units were



The Chadwick Lead Mill project included:

- human health and ecological risk assessments
- remedial planning and feasibility analyses
- state funding assistance
- public involvement plan
- local, state, and federal permitting
- wetlands restoration design
- environmental mitigation plan

eliminated, construction restrictions were required, and an educational element was included for the residential community to involve the residents in the protection of the bald eagles. These efforts allowed the project to proceed with development.

Wetlands Restoration, Former Manufacturing Facility, Stamford, Connecticut

Woodard & Curran was the prime contractor on a major waterfront redevelopment project that had significant contamination throughout a salt marsh as the result of historical manufacturing operations. Woodard & Curran completed extensive site investigations, and then conducted a comprehensive ecological risk assessment of the salt marsh to identify cleanup levels for marsh sediments. Working with a developer and contractor, we then designed a wetland restoration program that enhanced the reuse potential of the property while creating a high-value wetland with both recreational and wildlife opportunities. As part of the restoration, contaminated sediment and invasive Phragmites within the marsh were removed and replaced by clean, locally obtained, wetland-enhancing soils. The site was graded to increase the size of the marsh and prevent the re-establishment of Phragmites stands, and replanted with locally grown Spartina species to reproduce natural marsh zonation. As part of the site redevelopment, elevated boardwalks were constructed over the salt marsh to increase the recreational value of the marsh and the value of the property in general.

Ecological Impact Assessment of Arsenic in Freshwater Stream, Municipal Landfill, and Wetland Construction, Saco, Maine

On behalf of several potentially responsible parties (PRPs) at a former landfill site, Woodard & Curran conducted an in-depth ecological risk assessment of the potential effects of arsenic-laden groundwater discharging to a small freshwater stream. Subsurface conditions at the landfill mobilized natural bedrock arsenic, iron, and manganese, which entered a small brook adjacent to the site and precipitated in stream sediments. In order to quantify actual effects, Woodard & Curran conducted a three-pronged study consisting of a benthic macroinvertebrate community assessment, a 42-day bioassay of the sensitive amphipod *Hyalella azteca*, and a detailed sediment sampling at 25-foot intervals along the length of 1,500-foot stream.

The results of the three studies were combined to support the conclusion that arsenic concentrations in the sediment potentially had a minor effect on stream ecology in approximately 15 percent of the affected area. Based on the quality of this assessment, the EPA decided that groundwater treatment was unnecessary, saving the PRP group several million dollars.

In addition to these studies, Woodard & Curran designed a multiple-use wetland for this area that included habitat enhancements for amphibians and reptiles, nesting boxes for wood ducks and other waterfowl, and a diverse planting regime to attract and support a variety of wildlife while limiting cattail growth. In addition, the wetland was configured to allow the placement of boardwalks and interpretive stations, to support its use as an educational facility by the City. The site is now a thriving natural habitat that enhances the recreational value of the closed landfill.



The results of an ecological risk assessment that used a 42-day bioassay of a sensitive amphipod at a former landfill in Saco saved a PRP group several million dollars when the U.S. EPA deemed a groundwater pump-treat-system as unnecessary. The agency also praised the technical soundness of the work and considered it to be a model study for the ecological assessment of aquatic systems.



Solid Waste

SERVICES AND EXPERIENCE

SOLID WASTE MANAGEMENT

As population density in the United States increases and the amount of available open space decreases, the landfill process is increasingly driven by development. Proper solid waste management both protects public health and makes way for the redevelopment of large tracts of valuable land. We have a long history of success providing design engineering and planning services for solid waste projects. Whether closing a landfill classified as a Superfund site or designing phased closures for municipal facilities using recycled cover materials, our approach is rooted in client specific programs integrating environmental and solid waste engineering, hydrogeology, and strong communications with regulators.

Services include:

- Landfill design
- Landfill closure and post closure planning, permitting, design, and construction
- Waste characterization and waste stream composition studies
- Recycling evaluations and final disposal alternative evaluations
- Transfer station design
- Site research and prioritization studies
- Feasibility and site selection
- Leachate management and treatment systems
- Groundwater and surface water monitoring programs
- Hydrogeologic investigations and evaluations
- Environmental monitoring
- Permit applications
- Facility site planning and design
- Redevelopment of closed landfills
- Quality assurance plans
- Operator training and assistance



Vast range of experience, including design firsts

Our accomplishments range from an innovative landfill closure demonstration project in Springfield, MA using recycled materials for closure—an approach copied at over a dozen other landfills in the state; to designing Maine’s first solid waste landfill in 1978.

LANDFILL DEVELOPMENT

OVER 36 YEARS OF EXPERIENCE

Woodard & Curran's team of solid waste professionals have been providing design, assessment, permitting, and construction services relating to the development of new landfills and the horizontal and vertical expansion of existing landfills for over 36 years. Our approach is founded in the experiences of our team members and the firm, which includes many vertical expansions and post-closure redevelopment projects across the east coast and beyond. This approach is focused on the application of sound landfill engineering principles with appropriate performance monitoring to meet the goals of our clients.

Deep and broad experience

Our team brings extensive expertise in all aspects of landfill development including, but not limited to, the following areas:

- hydrogeologic/site assessments;
- geotechnical investigations, design, and modeling;
- slope stability modeling;
- settlement/subsidence modeling;
- drainage design and modeling;
- civil/site design;
- landfill gas collection and treatment system design;
- solid waste, environmental, and land development permitting;
- public procurement of construction services;
- construction administration and management;
- construction inspection; and
- peer review services

Horizontal and vertical expansions

Our team has experience with challenging horizontal and vertical expansion projects, with the most significant design challenges focused around geotechnical issues associated with the construction of a double composite liner system above existing waste; that is, the manner in which the existing liner, final cap, and environmental controls (gas and leachate systems) are protected and connected to the new systems installed as part of the expansion. Our team brings the necessary experience to successfully address these critical design challenges during the project development stage, thus avoiding expensive post-development costs associated with unanticipated existing system upgrades and/or repairs.

LANDFILL CLOSURE

STARTING WITH THE END IN MIND

Proper landfill closure is important for long-term environmental protection, and paves the way for potential post-closure development. Efficiently using a landfill site following closure requires long-range planning. The best strategy is to start with the end in mind, planning a closure project for the eventual site use before the landfill is constructed and operated.

No matter the size or location of your landfill, a large regional site or an urban fill environment, our experts can develop a cost-effective closure for you.

Alternative cap designs cut costs significantly

Our experts can develop a cost-effective closure for you, if possible utilizing alternative cap designs with recycled materials that can result in significant project savings.

Efficiently managing risks and liabilities

Protecting public health and meeting regulatory requirements are key when closing a landfill. Our extensive experience ensures that your risks and liabilities are managed properly and efficiently. Our experts have experience monitoring numerous landfills, conducting routine monitoring and evaluation of groundwater and surface water, assessing leachate migration, and maintaining compliance with all applicable regulations.

Post-closure monitoring

We are responsible for implementing the environmental post-closure monitoring programs for over a dozen closed landfill sites, providing groundwater, surface water gas emission and migration monitoring and settlement monitoring.

Using state-of-the-art data management and analytical software tools, our specialists can compile your data, analyze, present and interpret groundwater, surface water and landfill gas monitoring results for accurate annual monitoring and hydrogeology reports.



Innovative closure uses recycled materials

The Bondi Island landfill closure and demonstration project in Springfield, MA, included the design and permitting of a 5-acre engineered cap, consisting of recycled products such as crushed glass, boiler aggregate, paper fiber soil and bio-soils.

Post-closure Monitoring: a 30-year commitment

Once a landfill is closed, the owner/operator is responsible for the following 30 years to maintain the landfill; make repairs as needed to the final cover; monitor water quality; monitor settling; maintain and monitor the gas control system; manage the leachate collection system; maintain the post-closure groundwater monitoring and surface water management systems; provide financial assurance for the cost of post-closure care; and file annual reports to regulatory agencies. We conduct long-term post-closure development programs for many communities, a few of which include:

- Waterbury, CT
- Leominster, MA
- Canton, MA
- Blackstone, MA
- Boylston, MA
- Methuen, MA

LANDFILL GAS MANAGEMENT

PROTECTING THE PUBLIC, ENVIRONMENT

Landfill gas is generated during the natural decomposition process. Unmanaged, it can raise public health, safety, and environmental concerns such as subsurface migration, surface emissions and air pollution, and odor nuisances. We work closely with our clients and regulators to assess landfill gas issues and develop custom solutions.

Assessments and post-closure monitoring

Our experts regularly conduct gas assessments, monitoring for gas migration, and gas monitoring programs.

Gas collection and treatment—from design through construction management and O&M

We design gas collection and treatment systems and provide construction oversight and operations and maintenance for them.

Landfill gas models

We develop landfill gas models to assess contaminant migration that accurately determine the necessary gas extraction well layout, zones of influence, production rates, collection pipe sizing, condensate generation, system head loss, and flare and blowing sizing appropriate for your site.

Tailor-made solutions

We work closely with clients to meet their specific needs, whatever they may be. For example:

- **High-tech communications.** To meet the requirements of an Administrative Consent Order for to eliminate a gas migration issue at a rural site, an innovative, technically advanced telemetry/communications system was developed allowing an operator to remotely download operating information from the landfill site for to prepare the regulatory annual reports.

Unmanaged, landfill gas can raise public health, safety, and environmental concerns. We work closely with our clients to assess issues and develop custom solutions.



POST-CLOSURE DEVELOPMENT

REDEVELOPING FORMER LANDFILL SITES

Redevelopment presents communities and developers with prime real estate that was previously unavailable. While regulatory requirements and grant and financing opportunities vary from state to state, all states in New England and the mid-Atlantic areas are actively encouraging the redevelopment of these formerly unattractive, unused sites.

According to the U.S. Census Bureau, New England and the mid-Atlantic states have some of the densest populations in the United States. This population density, coupled with limited available land, make the redeveloping former landfill sites, large tracts of land previously considered unpalatable by developers, a strong trend today.

Woodard & Curran is remediating and revitalizing former landfill sites to make room for everything from residential and commercial developments to sports and recreation arenas.

Start with the end in mind

We approach remediating a former landfill site with the end in mind. The end point isn't closing the site, it is the development. We know how to properly and safely close the landfill up front, and our goal is to design a closure project that will transition seamlessly into a redevelopment project, when one is proposed.

Taking the first step

The first step toward investigating redevelopment is conducting a feasibility study to characterize what is at the site, determine if it is a candidate for remediation, and establish the best remediation process. For example, Woodard & Curran is currently conducting a feasibility study at a waterfront site in Peekskill, New York. The site could potentially be developed into a high-rise hotel and residential apartments. The feasibility study will be a key part of the decision-making process.



New Uses for Old Landfills

“These are large sites that can include 10 to 15 acres of open space in a densely populated area. We’re working with clients who want to build everything from housing developments to a major league ballpark on former landfill sites.”

*Alan Benevides, PE,
Senior Vice President,
Solid Waste Services*

WASTE HANDLING & PROCESSING FACILITIES

Municipal officials face developing a clear vision of how to manage solid waste and recyclables for the long-term, choosing from many viable options. Landfill capacity is scarce in the Northeast, and waste handling and processing facilities such as transfer stations, recycling centers, and construction and demolition transfer stations often can help reduce waste hauling costs and increase efficiency.

Collaborating to meet your needs

Whether you are planning and designing a new or expanded transfer station or need assistance with monitoring the compliance of a privatized system, Woodard & Curran has the valuable professional experience that leads to success. We have designed and permitted numerous transfer stations and work closely with our clients to ensure the type, size, and layout of the facility suits the unique needs of each community.

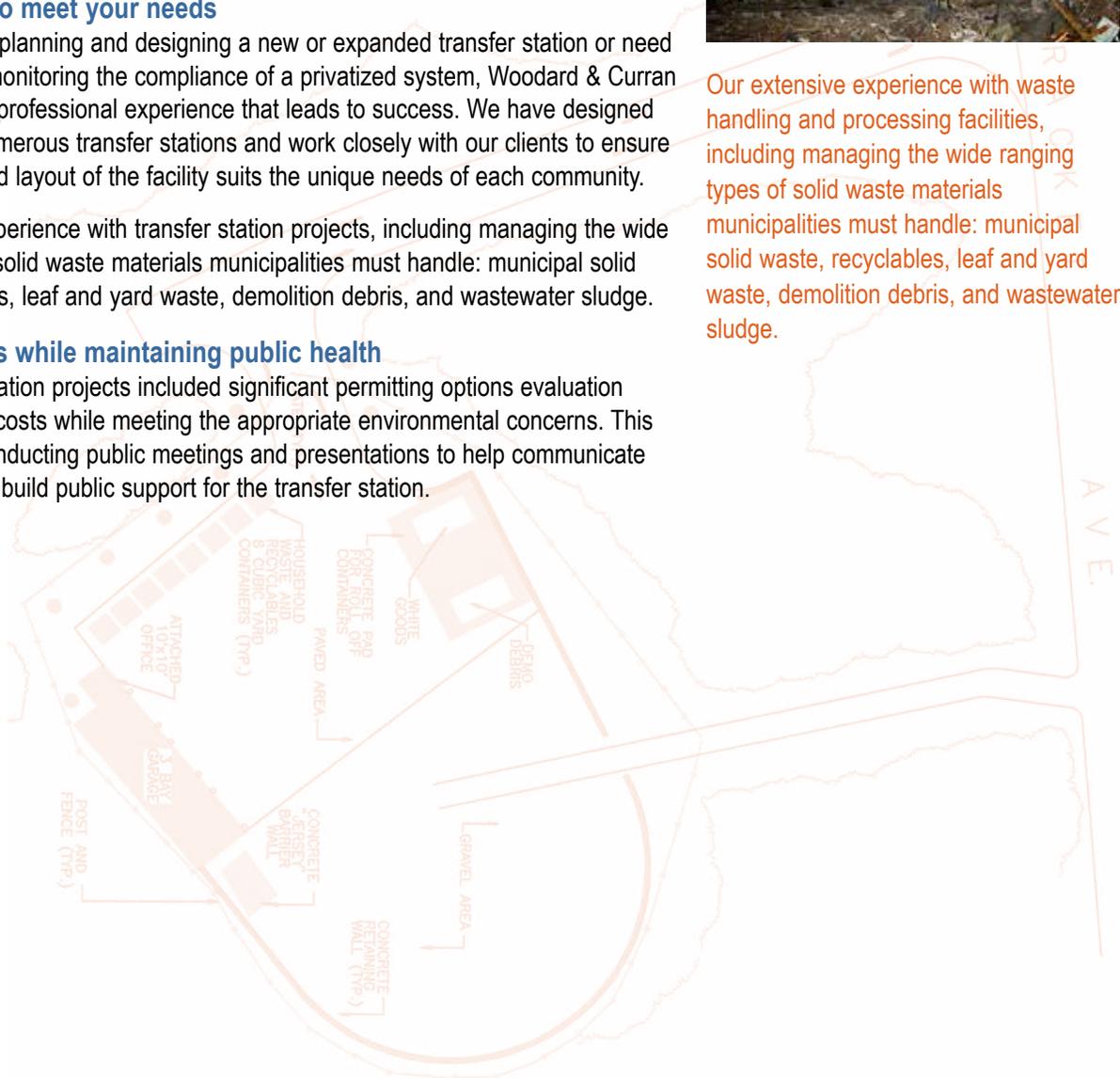
Our extensive experience with transfer station projects, including managing the wide ranging types of solid waste materials municipalities must handle: municipal solid waste, recyclables, leaf and yard waste, demolition debris, and wastewater sludge.

Reducing costs while maintaining public health

All our transfer station projects included significant permitting options evaluation efforts to reduce costs while meeting the appropriate environmental concerns. This often includes conducting public meetings and presentations to help communicate these issues and build public support for the transfer station.



Our extensive experience with waste handling and processing facilities, including managing the wide ranging types of solid waste materials municipalities must handle: municipal solid waste, recyclables, leaf and yard waste, demolition debris, and wastewater sludge.



Experience

Project and Location	Client	Site Assessment	Alternative Analysis	Corrective Action/Closure Design	Leachate Management & Treatment	Gas Collection & Treatment or Migration Control	Re-Use of Alternative Materials	Environmental Monitoring	Construction Services	Permitting	Post-Closure Landfill Re-Use/ Redevelopment
Adams Landfill Solar Farm Adams, MA	Tecta Solar	♦							♦	♦	♦
UMass - Lot 12 Landfill Amherst, MA	University of Massachusetts, Amherst	♦	♦	♦			♦	♦	♦	♦	♦
Brimbal Avenue Landfill Beverly, MA	Beverly, City of							♦			
Iron Horse Park Landfill Billerica, MA	Wilmer Hale/BNZ Materials	♦	♦	♦				♦		♦	♦
Farm Street Landfill Blackstone, MA	The Rosenfeld Company	♦	♦	♦		♦	♦	♦	♦	♦	♦
Canton Landfill Canton, MA	Canton, Town of	♦		♦		♦		♦		♦	♦
M.T. Sullivan Landfill Chicopee, MA	Waste Management Disposal Services	♦	♦	♦		♦	♦	♦	♦	♦	
Concord Landfill Solar Farm Concord, MA	Concord Municipal Light Plant	♦							♦	♦	♦
Crane Paper Landfill Dalton, MA	Crane & Company, Inc.	♦	♦	♦			♦	♦	♦	♦	
Dedham Landfill Dedham, MA	Dedham, Town of										♦
Wayside Landfill Framingham, MA	Wayside Youth & Family Support Services	♦	♦	♦						♦	♦
Howland Road Landfill Freetown, MA	Freetown, Town of	♦	♦	♦		♦		♦	♦	♦	
Mechanic Street Landfill Leominster, MA	Leominster, City of	♦	♦	♦		♦		♦	♦	♦	♦
156 Pine Street Landfill Manchester-by-the-Sea, MA	Manchester-by-the-Sea, Town of	♦	♦	♦				♦	♦	♦	
Asher's Path Landfill/Transfer Station Mashpee, MA	Mashpee, Town of							♦		♦	
Huntington Avenue Landfill Methuen, MA	Methuen, Town of	♦	♦	♦		♦	♦	♦	♦	♦	

Project and Location	Client	Site Assessment	Alternative Analysis	Corrective Action/Closure Design	Leachate Management & Treatment	Gas Collection & Treatment or Migration Control	Re-Use of Alternative Materials	Environmental Monitoring	Construction Services	Permitting	Post-Closure Landfill Re-Use/ Redevelopment
Nantucket C&D Facility Nantucket, MA	Toscana Corporation									♦	
Northbridge Landfill Solar Farm Northbridge, MA	Northbridge Redevelopment Corporation	♦	♦	♦		♦	♦	♦	♦	♦	♦
Former Industrial Landfill Salem, MA	Salem State University	♦	♦	♦					♦	♦	♦
Armory Street Landfill Springfield, MA	Springfield, City of	♦	♦	♦		♦		♦	♦	♦	♦
Mercy Medical Center Landfill Springfield, MA	Mercy Medical Center	♦	♦	♦		♦		♦	♦	♦	♦
Townsend Landfill Townsend, MA	Townsend, Town of	♦	♦	♦	♦				♦	♦	
Sutton Brook Landfill Tyngsboro, MA	Sutton Brook PRP Group	♦	♦					♦		♦	
Upton Landfill Upton, MA	Upton Development Group	♦	♦	♦		♦	♦	♦	♦	♦	♦
East Hartford Landfill Solar Farm East Hartford, CT	True Green Capital			♦					♦	♦	♦
Hartford Landfill Solar Farm Hartford, CT	Hartford, City of			♦					♦	♦	♦
North/South End Disposal Area Waterbury, CT	Waterbury, City of		♦	♦			♦	♦	♦	♦	
Coventry Landfill Coventry, RI	Coventry, Town of	♦						♦			
Cranston Sanitary Landfill Cranston, RI	Cranston, City of	♦	♦	♦		♦	♦	♦	♦	♦	
L&RR Landfill North Smithfield, RI	L&RR PRP Group	♦	♦	♦	♦	♦	♦	♦	♦	♦	
West Kingston Town Dump/URI Disposal Area, South Kingstown, RI	South Kingstown and Narragansett, Towns of; University of RI	♦	♦	♦			♦	♦	♦	♦	

Project and Location	Client	Site Assessment	Alternative Analysis	Corrective Action/Closure Design	Leachate Management & Treatment	Gas Collection & Treatment or Migration Control	Re-Use of Alternative Materials	Environmental Monitoring	Construction Services	Permitting	Post-Closure Landfill Re-Use/ Redevelopment
Anson-Madison Sanitary Landfill Anson-Madison, ME	Anson-Madison Sanitary District			♦	♦			♦	♦	♦	
Hatch Hill Landfill Augusta, ME	Augusta, City of	♦		♦	♦			♦	♦	♦	
Graham Road Landfill Brunswick, ME	Brunswick, Town of	♦	♦	♦	♦		♦	♦	♦	♦	
Lewiston Secure Landfill Lewiston, ME	Lewiston, City of			♦	♦					♦	
Carpenter Ridge Landfill Lincoln, ME	Maine State Planning Office	♦	♦		♦					♦	
Georgia-Pacific Landfill Old Town, ME	Maine DEP	♦								♦	
MCSWC Solid Waste Facility Rockport, ME	Rockport, Town of	♦	♦	♦	♦			♦		♦	
Saco Superfund Landfill Saco, ME	Saco, City of	♦	♦	♦				♦	♦	♦	♦

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Woodard & Curran is committed to serving our clients in the Superfund and related markets. We have worked on and continue to work on numerous Superfund and large RCRA Corrective Action sites in Region 1 and nationally. We have a highly experienced, deep and stable team of technical professionals that specialize in the areas that are key to the successful closure and long term management of Superfund projects. Woodard & Curran has provided technical services as the consultant of record or design engineer on over 50 Superfund sites, ranging from RI/FS to RD/RA. The names and locations of the sites where we have provided this support are provided on the figure and table on the following pages of this proposal.

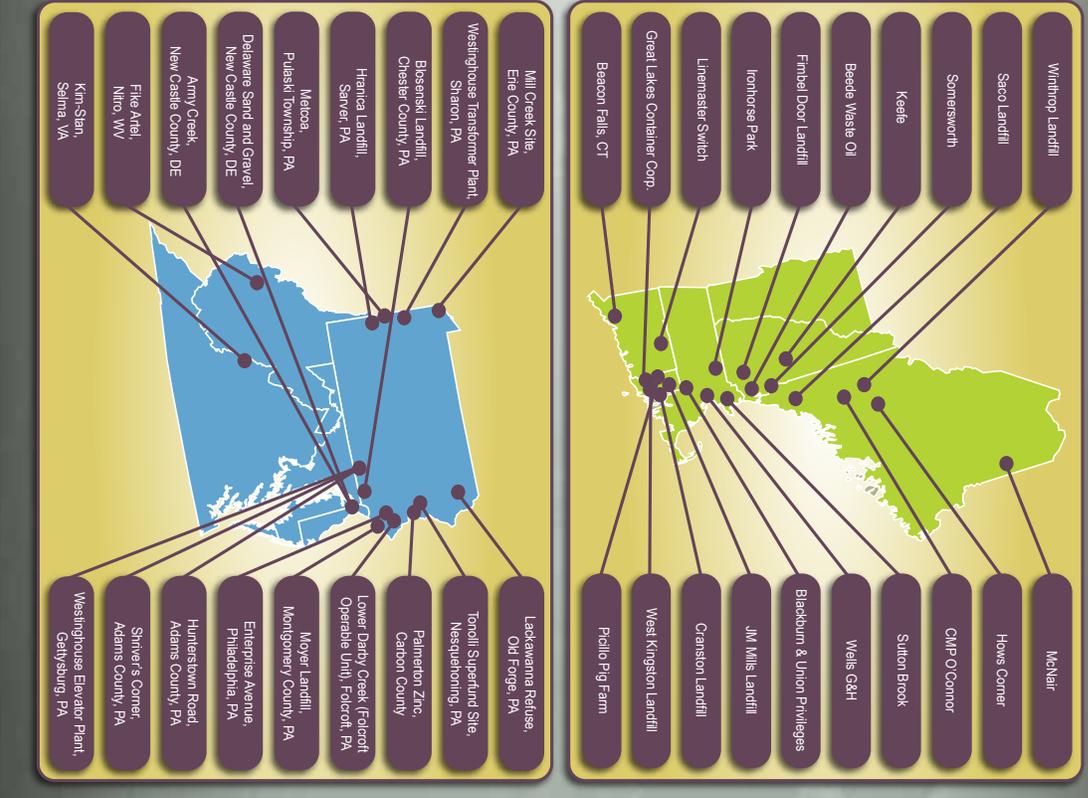
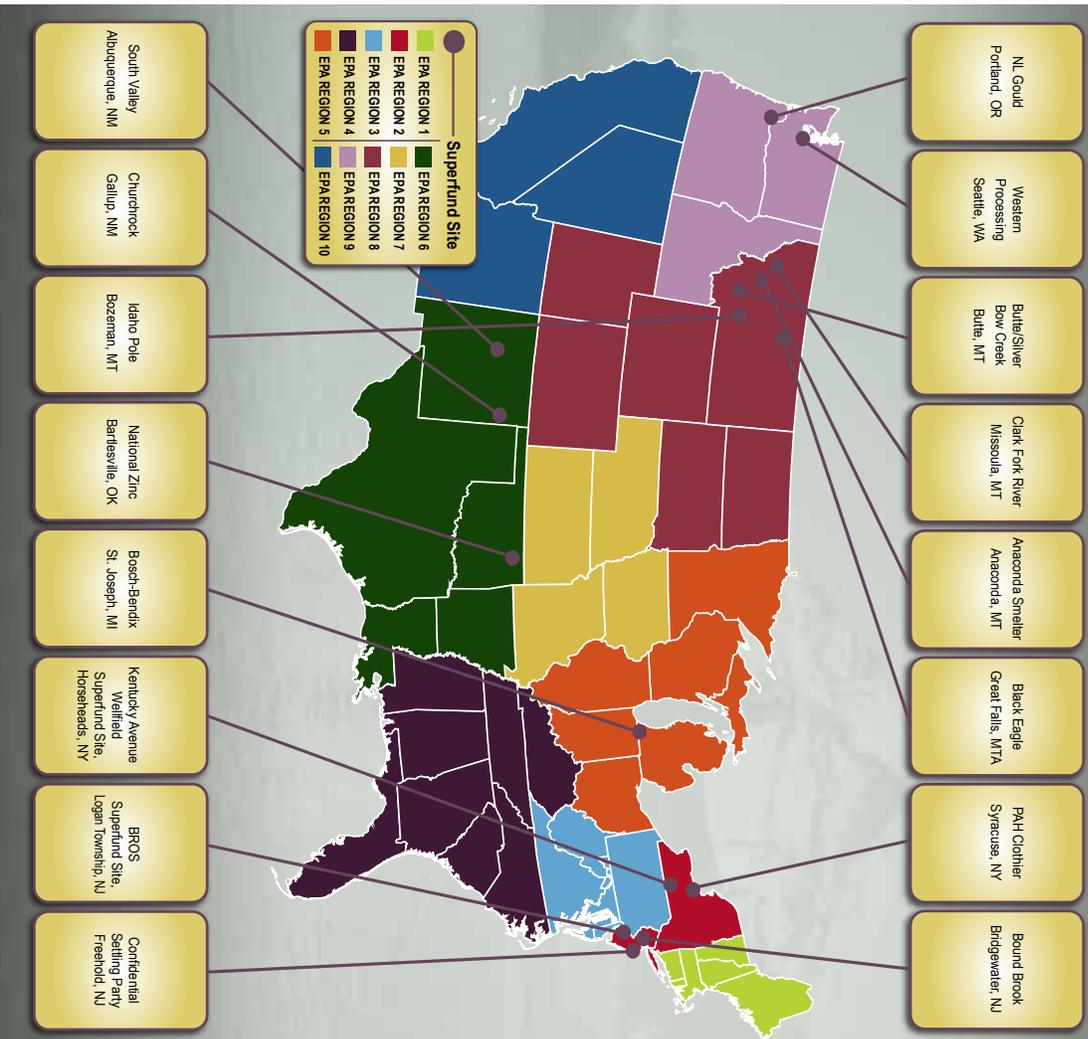
We work closely with our clients and regulatory agencies to develop project goals and deliverables that cost-effectively meet U.S. EPA guidelines and apply innovative, alternative approaches to cut costs. For example, our work on the Saco (Maine) Landfill Superfund Site established a collaborative model among state, regulatory, and legal partners, all working to a common solution. The International City and County Managers Association acknowledged the success of this effort by awarding it first place for intergovernmental cooperation in its annual awards competition.

Experience

Our experience includes projects (on the following pages) with aggressive scheduling and accelerated field programs to keep projects moving and on schedule.



Woodard & Curran SUPERFUND SITES



Client	State	Regulatory Program	EPA-NE Negotiations and Work Plans	Field Investigations/Bench & Pilot Testing	Design & Operations of Groundwater Remediation	Remedy Design	Construction	Risk Assessment/Asbestos	Wetland Assessment, Mitigation, Restoration	Long-term Monitoring Programs/Optimization
Picillo Pig Farm, Coventry, Town of	RI	Superfund/RIDEM	♦	♦	♦	♦			♦	♦
Cranston Sanitary Landfill, Cranston, City of	RI	Superfund		♦		♦				
Electric Boat - Quonset Point Naval Base, North Kingstown, Town of	RI	RCRA/RIDEM	♦	♦	♦	♦	♦			
L&RR Landfill, North Smithfield, Town of	RI	Superfund/RIDEM	♦	♦	♦	♦			♦	
URI/West Kingston Town Dump, West Kingston, Town of	RI	Superfund/RIDEM	♦	♦	♦	♦	♦		♦	
Iron Horse Park, Billerica, Town of	MA	Superfund	♦	♦		♦	♦	♦	♦	
Confidential Industrial Client, Concord, Town of	MA	MassDEP		♦		♦	♦	♦	♦	
South River Flood Impact, Salem, City of	MA	NPDES, USACOE		♦		♦	♦		♦	♦
Confidential Client, Salem, City of & Marblehead, Town of	MA	MassDEP		♦		♦	♦	♦	♦	
Sutton Brook Landfill, Tewksbury, Town of	MA	Superfund	♦	♦	♦		♦	♦	♦	♦
Jackstraw Brook, Westborough, Town of	MA	USACOE, MassDEP		♦		♦	♦		♦	♦
Confidential Client, Wilmington, Town of	MA	EPA/MassDEP	♦	♦	♦	♦	♦	♦	♦	♦
Beede Waste Oil, Plaistow, Town of	NH	Superfund	♦	♦	♦	♦	♦	♦	♦	
Keefe Environmental Services	NH	Superfund		♦	♦					♦
Electric Boat, Groton, Town of	CT	RCRA/CTDEEP	♦	♦	♦	♦	♦	♦		♦
Linemaster Switch, Woodstock, Town of	CT	Superfund			♦		♦		♦	♦
General Dynamics (Saco Defense)	ME	RCRA	♦	♦	♦	♦	♦	♦	♦	♦
Hows Corner	ME	Superfund	♦	♦	♦	♦	♦	♦	♦	♦
McNair Superfund Site	ME	Superfund	♦	♦	♦	♦	♦			
O'Connor Superfund Site	ME	Superfund	♦		♦	♦	♦	♦	♦	
Saco Municipal Landfill, Saco, City of	ME	Superfund	♦	♦	♦	♦	♦	♦	♦	♦
Bosch Braking Systems	MI	Superfund	♦	♦	♦	♦	♦	♦	♦	♦
Pond Restoration, SUNY Albany	NY	NPDES, USACOE		♦		♦	♦		♦	♦

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Key Staff



Glenn Almquist
Senior Vice President

Glenn has over 30 years of experience working on multidisciplinary projects ranging from research and development investigations to managing assignments for industrial, municipal, energy, and development clients.

Recently, he has served as Principal-in-Charge of energy and land development and commercial/industrial permitting projects, often involving preparation of air permit applications for a variety of minor and major sources.

He has managed projects requiring air quality, water quality, wetlands, visual, and soil impact assessments, often addressing impacts to aquatic and terrestrial flora, fauna, and human health.



Alan Benevides, PE
Senior Vice President

Alan has over 30 years of professional experience in the civil engineering, land-use permitting, hazardous, and solid waste markets. He specializes in the areas of hazardous and solid waste assessment and remediation, civil/site development and design, solar array design and permitting, and regulatory compliance for municipal, industrial, and commercial clients.

Alan specializes in land-use permitting and site civil design engineering for large utility scale solar PV developments, including re-purposing landfill sites for solar energy production. He has successfully designed and permitted over a dozen solar arrays located on greenfield, brownfield, and landfill sites. His solid waste experience includes the design, permitting, and construction certification of landfill caps at numerous closed sites.



Denise Cameron, PE
Project Manager

Denise is a licensed Civil Engineer with 15 years' experience in civil engineering and construction management. Denise is responsible for quality assurance, coordination, communications, project management and execution. With a background in construction, Denise provides unique insights and pragmatic approaches to her projects. She specializes in the areas of civil/site development design, stormwater management design, land-use permitting, and construction administration services.

Denise has provided engineering services to municipal, industrial, and commercial clients for a variety of projects, including both ground mounted and landfill utility-scale solar projects.



Daniel Kelley
Vice President

As Woodard & Curran's Power Engineering Service Line Leader, Dan is responsible for the development and implementation of business strategies, as well as the execution of consulting and engineering services, to meet the power generation needs of clients across all markets. He has nearly two decades of engineering and process control systems experience in simple-cycle, cogeneration, biomass, coal-fired, and oil-fired plants, from preliminary and detailed design to construction and start-up to operations and maintenance. Dan has provided project management for full Engineering, Procurement and Construction (EPC) projects including ground mounted solar PV development.



Miles Walker, LEED AP
Project Manager

As leader of Woodard & Curran's Energy and Power Strategic Business Unit, Miles is responsible for implementation of business strategies and for the overall performance of the consulting team. Miles is a Project Manager, MBA and Chemical Engineer with over 18 years of experience, and has supported renewable energy projects for clients throughout New England. He applies his business knowledge and technical expertise to help clients develop their assets and potential projects in a cost efficient and sustainable manner. Prior to joining Woodard & Curran, Miles worked at Harvard University where he held positions in Utilities Operations, managing environmental programs and developing economic models to determine internal utility costs. Miles has held various roles in project development for solar, biomass, wind, anaerobic digestion, and emerging fields such as algae-based biofuels. He is a PMI Credentialed Project Management Professional and LEED AP.



Andrew Fitzpatrick, PE
Project Engineer

Andy is a professional engineering with over 10 years of experience designing and implementing photovoltaic, electrical power, SCADA, and lighting systems projects. He has also worked on the analysis of existing and new electrical systems including power quality, short circuit, load flow, and arc flash studies. His work has been in the water, wastewater, food and beverage, and energy industries.



amec
foster
wheeler

Statement of Qualifications Solar Array Services



Statement of Qualifications

Solar Array Services

Submitted to

ib-Vogt

Submitted by

Amec Foster Wheeler Environment & Infrastructure, Inc.

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Why Amec Foster Wheeler?

Hands-On Solar Experience

Since entering the solar market, Amec Foster Wheeler has been involved in the design, permitting, and/or installation of more than 100 MW of solar photovoltaic power. We are a life-of-asset, single-source service provider for distributed and utility scale photovoltaic projects, from site assessment through operations and maintenance. Amec Foster Wheeler's New England team of experts has provided engineering and consulting services to renewable energy developers for development of solar PV systems on several closed municipal landfills, ground-mounted sites, and carport systems. Our involvement begins with site identification and assessment and proceeds through environmental planning and permitting, site layout and design, construction, and long-term asset support.

Landfill PV Solar System Planning and Design Support

Amec Foster Wheeler capitalizes on experience with landfill design and closure, geotechnical evaluation, environmental assessment, and site remediation to address the unique engineering requirements for installation of solar projects on closed landfills. Recent local experience includes ten solar PV systems in Massachusetts (Acton Landfill, Westford Street Landfill in Lowell, Scituate Landfill, Braintree Landfill, Ashland Landfill, Saugus Landfill, Weston Landfill, Pittsfield Landfill, Groton Landfill, and Sudbury Sand Hill Landfill), as well as one in New Jersey (Bernards Township).



We understand the technical challenges and solutions for successfully developing PV solar systems at closed landfill sites:

- ▶ Non-penetrating ballasted footing/foundation designs
- ▶ Bias towards fixed tilt systems which are less sensitive to output reduction due to settlement tilting and require far less substantial foundations than tracking systems
- ▶ Flexible and adjustable panel racking system designs to accommodate settlement and maintain system performance (for rigid poly or mono crystalline panels)
- ▶ Use of flexible conduit systems or adjustable conduit supports to accommodate settlement
- ▶ Rack and wiring design details to facilitate cost-effective panel removal/replacement in the event intrusive activities must be performed at current panel location
- ▶ Conduct all aspects of facility design, operations, construction, operation and maintenance, and eventual deconstruction in ways that ensure no adverse impacts on the site's ongoing post closure operations (active remediation systems, landfill gas venting or flare systems, leachate recovery systems, landfill settlement surveys, landfill gas surveys, erosion inspections, routine cap maintenance, areas of potential future intrusive remedial measures, etc.)

- ▶ Careful planning of onsite construction traffic for system installation – use of temporary roadways to minimize localized compaction and soil disturbance
- ▶ Planning of permanent access roads for system operations and maintenance – making full use of existing roads

Based on our experience and understanding of the solar industry, Amec Foster Wheeler has been able to streamline the permitting process to save our clients both time and money.

Ground-Mounted Solar Photovoltaic System Planning and Design Support



Amec Foster Wheeler has worked on a range of solar photovoltaic array designs, including ground-mounted arrays and carport systems. We have performed civil engineering design and environmental permitting for ground-mounted solar arrays for five sites across Massachusetts on highway medians, on highway embankments, and on land within highway interchanges. We have also performed civil engineering design and

environmental permitting for a ground-mounted system in West Newbury, MA, and a carport system in Natick, MA. These installations have created energy outputs ranging from 183 kW to 650 kW per site.

Familiarity with Rhode Island Regulations and Procedures

Amec Foster Wheeler has over twenty years of experience working in Rhode Island on a variety of projects. Some projects include site investigation and remediation in Lincoln, Rhode Island and Fort Greene, Narragansett, Rhode Island for the U.S. Army Reserves Center; brownfield site investigations, modeling, and redevelopment in Charlestown, Pascoag, Providence, and other cities in Rhode Island for the Rhode Island Department of Environmental Management (RIDEM); soil capping projects in Portsmouth and Providence, Rhode Island; Superfund site treatment system in Cumberland, Rhode Island; stormwater permitting for Amtrak in Providence, Rhode Island; and many others. Because of these experiences, we are confident in our ability to follow all required permitting procedures and to work within applicable Rhode Island regulations.

Project Experience

Amec Foster Wheeler Environment & Infrastructure Solar PV Experience

Amec Foster Wheeler has supported numerous projects for the repurposing of closed landfills, open spaces, parking areas, and hazardous waste sites for solar PV system installations. Our solar PV experience includes the following projects:

[Pittsfield, Groton, Saugus, Northampton, Lenox, and Newton Landfill Solar Redevelopment, Ameresco, Inc., Massachusetts](#)

Amec Foster Wheeler has worked on the redevelopment of closed landfills ranging from 1.0 to over 3 megawatt solar photovoltaic generating systems. The projects are in various stages of permitting and include engineering and permitting in order to require a Post-Closure Use Permit through MassDEP. Engineering evaluation includes geotechnical analysis of bearing capacity, slope and sliding stability, and settlement; access road design; structural design of cast-in-place concrete inverter/transformer pads and conduit support blocks; and stormwater analysis to assess the potential increase in stormwater runoff volume and rate due to the proposed development. In addition to the Post-Closure Use Permit, additional permitting requirements include local wetlands and planning board approval; state historic commission and endangered species protection agency permitting, and federal coverage under EPA's NPDES construction general permit.

[Weston Landfill Solar Redevelopment, Ameresco, Inc., Weston, Massachusetts](#)

Amec Foster Wheeler has worked on the redevelopment of a closed landfill as a 2.27 megawatt solar photovoltaic generating system. The project included engineering and permitting in order to require a Post-Closure Use Permit through MassDEP. Engineering evaluation included geotechnical analysis of bearing capacity, slope and sliding stability, and settlement; access road design; structural design of cast-in-place concrete inverter/transformer pads and conduit support blocks; and stormwater analysis to assess the potential increase in stormwater runoff volume and rate due to the proposed development. In addition to the Post-Closure Use Permit, additional permitting requirements included local wetlands and planning board permit approval. Construction oversight of earthwork activities on the landfill cap was also provided.



[MassDOT Solar PV Development, Ameresco, Inc., Massachusetts](#)

Amec Foster Wheeler managed the civil engineering and environmental permitting of 10 sites within the MassDOT right-of-way including sites within the highway median, on highway embankments, and on land within highway interchanges. Civil engineering and surveying tasks included the development of proposed site plans, erosion & sedimentation control plans, traffic management plans, highway alteration plans, and structural design of concrete equipment pads. Permitting included wetlands permitting, local site plan review, and development of Stormwater Pollution Prevention Plans as required by the USEPA's construction general permit. Construction inspections were performed for equipment pad installations and for compliance with wetlands permit conditions.

Braintree Landfill Solar Redevelopment, Ameresco, Inc., Braintree, Massachusetts

Amec Foster Wheeler managed the redevelopment of a closed landfill as a 1.263 megawatt solar photovoltaic generating system. The project included engineering and permitting in order to require a Post-Closure Use Permit through MassDEP. Engineering evaluation included geotechnical analysis of bearing capacity, slope and sliding stability, and settlement; access road design; structural design of cast-in-place concrete inverter/transformer pads and conduit support blocks; and stormwater analysis to assess the potential increase in stormwater runoff volume and rate due to the proposed development. In addition to the Post-Closure Use Permit.



Construction oversight of earthwork activities on the landfill cap was also provided. Post-construction inspections and reporting to MassDEP continue to be conducted monthly.

Landfill Solar Project, Environmental Engineering Design and Permitting Support, Town of Acton, Massachusetts

Amec Foster Wheeler, under contract to Ameresco, Inc., provided engineering and permitting support for a 1.59 MW photovoltaic system on the 17.5-acre closed municipal landfill in Acton, MA. The project included engineering and permitting in order to require a Post-Closure Use Permit through MassDEP. Engineering evaluation included grading/earthwork design to accommodate maximum allowable slopes for solar PV development; geotechnical analysis of bearing capacity, slope and sliding stability, and settlement; stormwater analysis to assess the potential increase in stormwater runoff volume and rate due to the proposed development; and structural cast-in-place concrete design for equipment pads. MassDEP issued the permit in 2012. Amec Foster Wheeler began providing construction inspection services in Spring 2013. Amec Foster Wheeler also provided construction inspection services.

Landfill Solar Project, Environmental Engineering Design and Permitting Support, City of Lowell, Massachusetts



Amec Foster Wheeler, under contract to Ameresco, Inc., provided engineering and permitting support for a 1.502 MW photovoltaic system on the 56-acre closed Westford Street Landfill in Lowell, MA. The project included engineering and permitting in order to require a Post-Closure Use Permit through MassDEP. Engineering evaluation included geotechnical analysis of bearing capacity, slope and sliding stability, and settlement; and stormwater analysis to assess the potential increase in stormwater runoff volume and rate due to the proposed development; and structural design of cast-in-place concrete equipment pads. Amec Foster Wheeler also provided construction inspection services.

[Landfill Solar Project, Environmental Engineering Design and Permitting Support, Town of Sudbury, Massachusetts](#)

Amec Foster Wheeler, under contract to Ameresco, Inc., provided engineering and permitting support for a 1.512 MW photovoltaic system at the 23-acre closed Sudbury Sand Hill Landfill in Sudbury, MA. The project included engineering and permitting in order to require a Post-Closure Use Permit through MassDEP. Engineering evaluation included geotechnical analysis of bearing capacity, slope and sliding stability, and settlement; stormwater analysis to assess the potential increase in stormwater runoff volume and rate due to the proposed development; and structural design of cast-in-place concrete equipment pads. In addition to the Post-Closure Use Permit, additional permitting requirements included submittal of NHESP clearance, as well as local permit applications, including an ANRAD, Site Plan Review, and local Stormwater Permit. Amec Foster Wheeler also provided construction inspection services, as-built plan preparation, and construction certification.

[Landfill Solar Project, Environmental Engineering Design and Permitting Support, Town of Scituate, Massachusetts](#)

Amec Foster Wheeler provided engineering and permitting support for a 3.0 MW photovoltaic system on a closed municipal landfill in Scituate, MA. The project site was challenging due to constantly changing slopes, subterranean drainage and gas piping, and landfill loading and settlement constraints. Amec Foster Wheeler was able to increase the available landfill area by closely examining the constraints for ballast stability and increased the capacity of the project by 25 percent. Amec Foster Wheeler design included dead and transient loading calculations, ballasts, racks, 500kVa inverter pads, and identification of locations suitable for PV arrays. Central to the design was the requirement not to negatively affect landfill storm water features, avoid excess differential settlement, and protect the integrity of landfill maintenance and monitoring operations.

[Hamilton Ontario Solar PV Landfill Feasibility Study, City of Hamilton, ON, Canada](#)

Amec Foster Wheeler worked on the feasibility study of solar PV at several landfill sites in the City of Hamilton. We developed criteria for feasibility screening including site features, environmental receptors, and potential interconnection. The screening process evaluated over a dozen sites and criteria evaluation narrowed it down to two sites for further evaluation to include conceptual solar PV array design and detailed permitting evaluation.

[Wind and Solar Energy Study, Confidential Client, Active Chemical Plant, Newark, New Jersey](#)

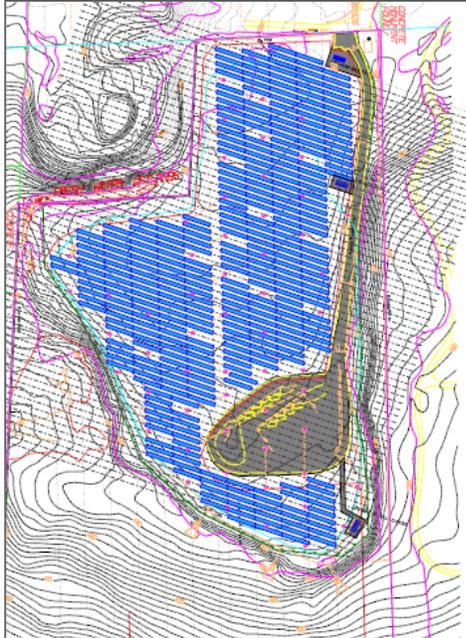
This ongoing project seeks to quantify the wind and solar energy potential, as well as economic viability for constructing a maximum capacity wind and solar energy system at this industrial facility located adjacent to Newark Bay. Wind speed and direction along with other weather data are being continuously collected for a period of 12 months and will be utilized to determine the actual available energy of the wind resource, type of turbine design most suitable for the wind speed distribution present, and wind turbine layout options which will optimize energy yield of various system sizes. A variety of PV solar array layouts, along with a solar shading analysis and PV-Watts data is being used to assess the PV solar energy potential, as well, including a review of a hybrid wind/solar renewable energy system. An economic evaluation incorporating available state and utility incentives is also being prepared as required to assist the customer in developing the business case for proceeding with implementing this project.

[City Redevelopment Project, PV Solar Concept Evaluation, Northern New Jersey](#)

Amec Foster Wheeler was retained by the developer/landowner of an undeveloped 100-acre parcel (with an approved re-development plan) to investigate generating revenue from the undeveloped portions of the site throughout the 2015 to 2052 build-out cycle via large-scale PV Solar. The 25MW PV Solar concept developed, which will be compared to other interim development approaches,

includes a combination of a ground mount, rooftop, and a “transitional” system which is engineered to be cost-effectively relocated from a ground mounted configuration to a rooftop configuration as open land diminishes and rooftop space becomes available.

Landfill Solar Project, Bernards Township, New Jersey



Amec Foster Wheeler provided engineering, land use permitting and site plan design to allow the installation of a 3-MW solar installation on this closed municipal landfill. Working in collaboration with the solar array designer, Amec Foster Wheeler has developed solar array layouts compatible with the site topography, wetlands buffers, and site geotechnical characteristics. Engineering analyses were performed to develop foundation recommendations for ballasted solar arrays to assure landfill cap and closure system integrity. Surface water analyses were performed to assess the potential for incremental surface runoff, and engineering application necessary to comply with NJDEP stormwater management regulations. A wetlands survey was completed to update wetland and habitat boundaries affecting the extent of developable area on the site. Amec Foster Wheeler worked with NJDEP's Office of Permit Coordination and Review to expedite project permitting and development. A site plan was developed and reviewed by the township engineer and planning board for consistency with local codes and regulations.

Solar Plant Siting and Feasibility Study, Joint Base McGuire-Dix-Lakehurst, Burlington and Ocean Counties, New Jersey

Amec Foster Wheeler provided environmental and engineering services to evaluate candidate land areas and rooftop locations for installation of solar arrays to meet federal renewable energy goals at this military complex. Siting criteria included compatibility with base missions, relative age and size of available or future roof top areas, compatibility with environmentally sensitive habitats, and hazardous waste site avoidance. Five candidate sites were identified. Preliminary cost benefit analyses were developed to rank these sites for subsequent detailed evaluation and project implementation.

9 MW Solar Development, Mountain Creek Project, Vernon, New Jersey

Amec Foster Wheeler is providing a wide range of engineering and permitting services to the Solar Developer, including site constraints mapping; wetlands delineation and permitting; local planning and permitting support; geotechnical investigation; site civil and stormwater design; solar shading evaluations; solar array layout and power production estimates; meter consolidation plan; detailed A.C. electrical distribution design; utility interconnection agreements; detailed design of parking canopy structures; and development of RFPs for solar facility construction, A.C. power distribution, site civil, and structural steel contractors. This project consists of developing seven total solar facilities (4 ground mount and 3 parking canopy systems), as well as power distribution to off-takers which currently are served by over 80 electric meters and 2 electric utilities. The developer will enter into a long-term power purchase agreement with several off-takers on properties contiguous with the Solar Facility sites.

Amec Foster Wheeler Power & Process Solar PV Experience

In addition to the above projects performed by Amec Foster Wheeler Environment & Infrastructure, the following projects were performed by our Power & Process division, lending additional experience and support to our team of experts.

2 MW Solar Field, Renewable Ventures, Colorado State University, Colorado

Amec Foster Wheeler executed the EPC contract for Renewable Ventures (FRV), a Fotowatio company, to install a 2 MW solar power plant at Colorado State University. Work on the \$12 million project completed in the winter of 2009. Amec Foster Wheeler provided the engineering, procurement and construction services, including operation and maintenance services and SCADA design, for Colorado State University's 2 MW solar field generating facility. This ground-breaking project sets the standard for clean and renewable energy solutions. This 2 MW solar field generating facility that will supply enough solar power to meet more than 10 percent of the site hosts electric energy needs. In this collaborative approach between Amec Foster Wheeler and FRV, Amec Foster Wheeler evaluated multiple technologies for the system and performed a site analysis to achieve effective land use and a cost-effective installation.

26 MW Photovoltaic Solar Power Plants, Sunpower (Florida Power & Light), Florida

Amec Foster Wheeler's scope of work includes development of a plant-wide SCADA system, specification of hardware & software, configuration, checkout and startup services.

Solar Cell Array Integration, Research Triangle Park, Virginia

Amec Foster Wheeler provided design and construction specifications for reroofing of a 17,800-square-foot office building for the Environmental Protection Agency in Research Triangle Park, VA that integrated a 90 KW amorphous silicon solar cell array into the new roofing system. The project included insulating the roof with tapered rigid insulation and installation of a mechanically attached white TPO membrane roofing system and associated flashing details, and connection of the new integrated solar array to an existing electrical panel.

50 MW net Concentrated Solar Power, Nevada Solar One, Acciona (formerly Solargenix), Boulder City, Nevada

Amec Foster Wheeler conducted preliminary engineering, basic engineering, and the EPC capital cost estimate for Solargenix's Concentrating Solar Power (CSP) plant in Boulder City, Nevada. The plant is a Thermal Solar Power plant using trough technology to collect solar energy from the sun to heat and produce steam that is sent to a steam turbine generator. The steam turbine generator is capable of generating 70 MW of electric power. The plant utilizes a unique low temperature reheat design and was the first solar thermal power plant built in the United States in 15 years. Amec Foster Wheeler worked with the Owner to develop the site layout of the solar field and power plant, process design of the heat transfer fluid (HTF) system, steam generating system, power generating island, and major equipment specifications for 50 MW net Concentrated Solar Power (CSP) using parabolic trough solar collectors. Amec Foster Wheeler also worked with the Owner to procure major equipment, including the steam turbine generator, power block heat exchangers, condenser, parabolic mirrors and frames. We worked with the Owner and major vendors for mirrors, collector tubes, frames, control systems, heat exchangers and HTF. Amec Foster Wheeler also worked with the turbine generator supplier on the reheat cycle, substantially increasing the steam turbine efficiency.

Fixed Array Photovoltaic Solar Power Plants, Confidential Client, Ontario, Canada

Amec Foster Wheeler provided preliminary engineering, including solar project layouts, solar energy assessments, and EPC cost estimates for multiple solar PV projects in Ontario.

20 MW Fixed Array Photovoltaic Solar Power Plant, Phase 1, First Solar, Sarnia, Ontario, Canada

Amec Foster Wheeler provided electrical and civil support for the development and construction of the 20 MW PV power plant. Amec Foster Wheeler reviewed client designs for compliance with local codes and standards, provided on-site electrical engineering support during construction, and provided permitting support.

60 MW Fixed Array Photovoltaic Solar Power Plant, Phase 2, First Solar, Sarnia, Ontario, Canada

Amec Foster Wheeler provided environmental assessment and permitting support, and produced environmental reports to meet federal requirements for the project.

20 MW Tracking Array Photovoltaic Solar Power Plant, Confidential Client, Canada

Amec Foster Wheeler is providing civil, electrical, and structural engineering support, as well as permitting support. Amec Foster Wheeler designed a variety of foundations for tracker based arrays, road cross sections, foundations for inverter buildings and transformer, and ground grids. Soil resistivity tests were also conducted for the ground grid design. Amec Foster Wheeler also reviewed client electrical designs for compliance with local codes and standards and provided permitting support. Amec Foster Wheeler also witnessed field tests for helical pile foundations.

10 MW Fixed Array Photovoltaic Solar Power Plant, Confidential Client, Canada

Amec Foster Wheeler provided a layout for the solar farm, including arrays, collector system, inverter building locations, transformer locations, roads and drainage system, and grid connection. Amec Foster Wheeler also provided a single line diagram for the solar farm and BOP cost estimate.

Qualified Staff

A benefit to selecting Amec Foster Wheeler is our ability to manage our projects using local resources, as well as drawing from our expertise of over 3,500 Environment & Infrastructure engineers and scientists throughout the US, thereby ensuring our clients seamless access to the full depth of our technical services. This approach provides our clients with staff located close to the project site and knowledgeable in the state's environmental regulations, senior staff with experience relevant to the project conditions, and national practice leaders and nationally recognized experts who can cost-effectively add value to the overall project.

Robert J. Bukowski, PE, Project Leader

Mr. Bukowski has over 22 years of experience in management, design, permitting and construction of civil and environmental engineering projects. He is experienced in civil/site design, stormwater design/management, remediation design, landfill closure/redevelopment, and environmental compliance. He has extensive experience in the design of site development projects (including erosion and sedimentation control design, stormwater management system design, and utility design); remediation design (including implementation of in-situ remediation technologies and soil excavation plans); landfill closure/redevelopment (including capping system design, landfill gas collection system design, leachate collection system design, and landfill redevelopment design); and environmental compliance (including SWPPP preparation, SPCC preparation, and local permit compliance). Mr. Bukowski also has extensive experience in performing construction oversight and construction inspections. During Mr. Bukowski's tenure with Amec Foster Wheeler, he has served as Project Manager and Engineer of Record for federal, commercial, and industrial civil engineering and permitting projects, as well as soil and groundwater remediation projects. Most recently, Mr. Bukowski's experience has focused on the redevelopment of closed municipal landfills and greenfield sites as solar PV facilities. He has been involved in various phases of implementing these projects, including permitting, design, and construction of over 15 MW of solar PV in the northeast US.

David E. Heislein, EIT

Mr. Heislein provides expertise in project management, technical leadership and engineering in environmental/civil design, permitting and construction. This experience includes investigation and remediation of chemical, explosives and radiological contaminated sites, regulatory compliance and environmental permitting, feasibility studies, engineering design, and construction for federal, state, and municipal agencies, and the private sector. Mr. Heislein has been responsible for environmental projects under CERCLA, RCRA, BRAC and USEPA Brownfields Program. His expertise includes the assessment and remediation of small-arms ranges, unexploded ordnance, and explosive residue at active and closed military ranges. Mr. Heislein has also worked on projects with the Rhode Island Department of Environmental Management (RIDEM), is a member of the Society of Military Engineers, and is the Corporate Representative for the Rhode Island Society of Professional Engineers.

Danielle A. Ahern, PE

Ms. Ahern is a professional engineer with 13 years of experience in civil and environmental engineering including remediation, solid waste, utility, stormwater, roadway, building, site design and marine planning. She supports projects from the planning and site assessment stages through permitting, conceptual and final design, implementation and project close out. She has been actively involved with the permitting, design, construction administration, and project management for both the

federal, municipal and private sectors. Ms. Ahern has been actively involved in renewable energy projects for solar photovoltaic development on brownfields sites including solid waste landfills. These redevelopment plans have included site civil and stormwater design to support the installation of photovoltaic systems on otherwise unusable land. She regularly interfaces with federal, state, and local agencies in support of these projects.

David M. Pettit, PE

Mr. Pettit has over 11 years of progressive experience in environmental engineering and consulting. He has provided service to public and private-sector clientele, including municipalities, commercial retailers and developers, government agencies, and public school systems. His responsibilities consist of managing projects and leading feasibility analyses, engineering design documents, permit applications, contractor procurement, construction oversight, and remedial system evaluation. Mr. Pettit brings a multi-disciplinary background, which allows him to approach engineering and consulting projects from different perspectives and generate effective solutions. He is well versed in professional engineering design standards, as well as state and federal regulations relating to environmental cleanups.

About Amec Foster Wheeler

In a constantly changing industry, Amec Foster Wheeler remains at the forefront, providing dynamic and innovative approaches and solutions to environmental and engineering challenges.

Amec Foster Wheeler plc is ranked among the top global design firms providing engineering, consulting, and project management services worldwide. Globally, Amec Foster Wheeler plc's engineering and environmental consulting business includes more than 36,000 employees.

Amec Foster Wheeler Environment & Infrastructure

Amec Foster Wheeler Environment & Infrastructure (Amec Foster Wheeler) is a division of Amec Foster Wheeler plc with a staff of approximately 6,400 professionals in North America, located in over 170 offices. Global office locations can be found on our website at <http://www.amecfw.com>. We provide multi-disciplinary solutions covering all aspects of environmental services, geotechnical engineering, infrastructure, materials testing, architecture and engineering design, and water resources.

Whether supporting site planning, acquisition, design and development, on-going facility operations, or facility renovation/closure, Amec Foster Wheeler's professionals provide timely and cost-effective solutions so our clients can focus on their core business concerns. Our specialists serve public and private sector clients locally or globally, and often in long-term relationships. We draw on our experienced local managers and geographical reach to support the needs of clients, regardless of project size and complexity.

With over 100 years of experience in the industry, we have an excellent understanding of the regulatory, technical, and financial constraints facing our clients. Amec Foster Wheeler has a solid track record of controlling costs, meeting aggressive schedules, protecting workers and public health, and designing and implementing innovative solutions to meet each company's unique challenges.

Sustainable Development

Previous to the merger of AMEC plc and Foster Wheeler, AMEC plc was made industry leader for oil equipment and services by the Dow Jones Sustainability Index. As the newly formed Amec Foster Wheeler, plc, we remain 100 percent committed to integrating social, environmental and economic concerns into our values and operations in a transparent and accountable manner. In fact, we view this as **a new opportunity for us to be even better than we were before.**

Contacts

If you would like more information about Amec Foster Wheeler's services, please contact any of the individuals below:

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Tel (401) 486-6583
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Sunmodule®

SW 340-350 XL MONO



TUV Power controlled:
Lowest measuring tolerance in industry



Every component is tested to meet
3 times IEC requirements



Designed to withstand heavy
accumulations of snow and ice



Available with either 1000 V or 1500 V
maximum voltage rating



25-year linear performance warranty
and 10-year product warranty



Glass with anti-reflective coating



World-class quality

Fully-automated production lines and seamless monitoring of the process and material ensure the quality that the company sets as its benchmark for its sites worldwide.

SolarWorld Plus-Sorting

Plus-Sorting guarantees highest system efficiency. SolarWorld only delivers modules that have greater than or equal to the nameplate rated power.

25-year linear performance guarantee and extension of product warranty to 10 years

SolarWorld guarantees a maximum performance digression of 0.7% p.a. in the course of 25 years, a significant added value compared to the two-phase warranties common in the industry, along with our industry-first 10-year product warranty.*

*in accordance with the applicable SolarWorld Limited Warranty at purchase.
www.solarworld.com/warranty



- Qualified, IEC 61215
- Safety tested, IEC 61730
- Blowing sand resistance, IEC 60068-2-68
- Ammonia resistance, IEC 62716
- Salt mist corrosion, IEC 61701
- Periodic inspection



- Periodic inspection
- Power controlled



Sunmodule®

SW 340-350 XL MONO



PERFORMANCE UNDER STANDARD TEST CONDITIONS (STC)*

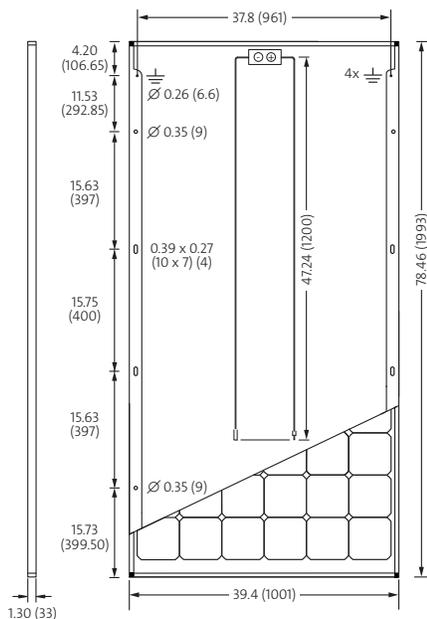
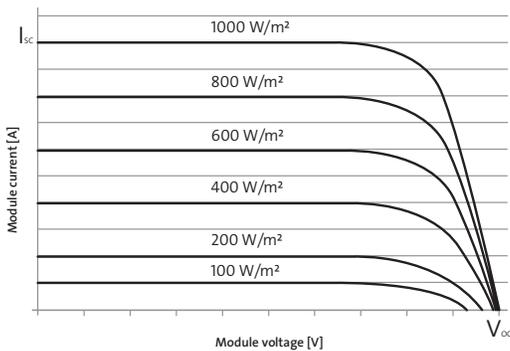
		SW 340	SW 345	SW 350
Maximum power	P_{max}	340 Wp	345 Wp	350 Wp
Open circuit voltage	V_{oc}	47.6 V	47.8 V	48.0 V
Maximum power point voltage	V_{mpp}	38.0 V	38.2 V	38.4 V
Short circuit current	I_{sc}	9.69 A	9.75 A	9.82 A
Maximum power point current	I_{mpp}	9.01 A	9.10 A	9.17 A
Module efficiency	η_m	17.04 %	17.29 %	17.54 %

*STC: 1000W/m², 25°C, AM 1.5

PERFORMANCE AT 800 W/M², NOCT, AM 1.5

		SW 340	SW 345	SW 350
Maximum power	P_{max}	259.3 Wp	263.8 Wp	267.2 Wp
Open circuit voltage	V_{oc}	41.5 V	41.8 V	42.0 V
Maximum power point voltage	V_{mpp}	34.9 V	35.2 V	35.4 V
Short circuit current	I_{sc}	8.05 A	8.10 A	8.16 A
Maximum power point current	I_{mpp}	7.42 A	7.50 A	7.56 A

Minor reduction in efficiency under partial load conditions at 25° C: at 200 W/m², 100% of the STC efficiency (1000 W/m²) is achieved.



All units provided are imperial. SI units provided in parentheses.
SolarWorld AG reserves the right to make specification changes without notice.

COMPONENT MATERIALS

Cells per module	72	Front	Low-iron tempered glass with ARC (EN 12150)
Cell type	Monocrystalline	Frame	Clear anodized aluminum
Cell dimensions	6.17 in x 6.17 in (156.75 x 156.75 mm)	Weight	47.6 lbs (21.6 kg)

THERMAL CHARACTERISTICS

NOCT	46 °C
TCI_{sc}	0.042 % / °C
TCV_{oc}	-0.304 % / °C
TCP_{mpp}	-0.43 % / °C
Operating temp	-40 to +85 °C

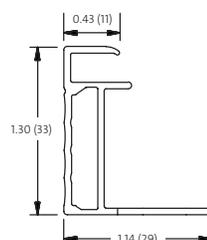
ADDITIONAL DATA

Power sorting	-0 Wp/+5 Wp
J-Box	IP65
Connector	PV wire per UL4703 with H4/UTX connectors
Module fire performance	(UL 1703) Type 1

PARAMETERS FOR OPTIMAL SYSTEM INTEGRATION

Maximum system voltage NEC	1000 V or 1500 V - Specify when ordering
Maximum system voltage SC II	1000 V
Maximum reverse current	25 A
Number of bypass diodes	3
Design loads*	Two rail system 113 psf downward, 64 psf upward
Design loads*	Edge mounting 178 psf downward, 23 psf upward

* Please refer to the Sunmodule installation instructions for the details associated with these load cases.



- Compatible with both "Top-Down" and "Bottom" mounting methods
- ⚡ Grounding Locations:
 - 4 locations along the length of the module in the extended flange.

SW-01-7540US-I 1500V 160419



Solar Mounting Systems

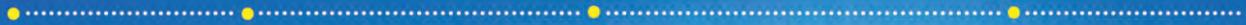
SOLAR CARPORTS

DESIGN

ENGINEERING

MANUFACTURING

INSTALLATION

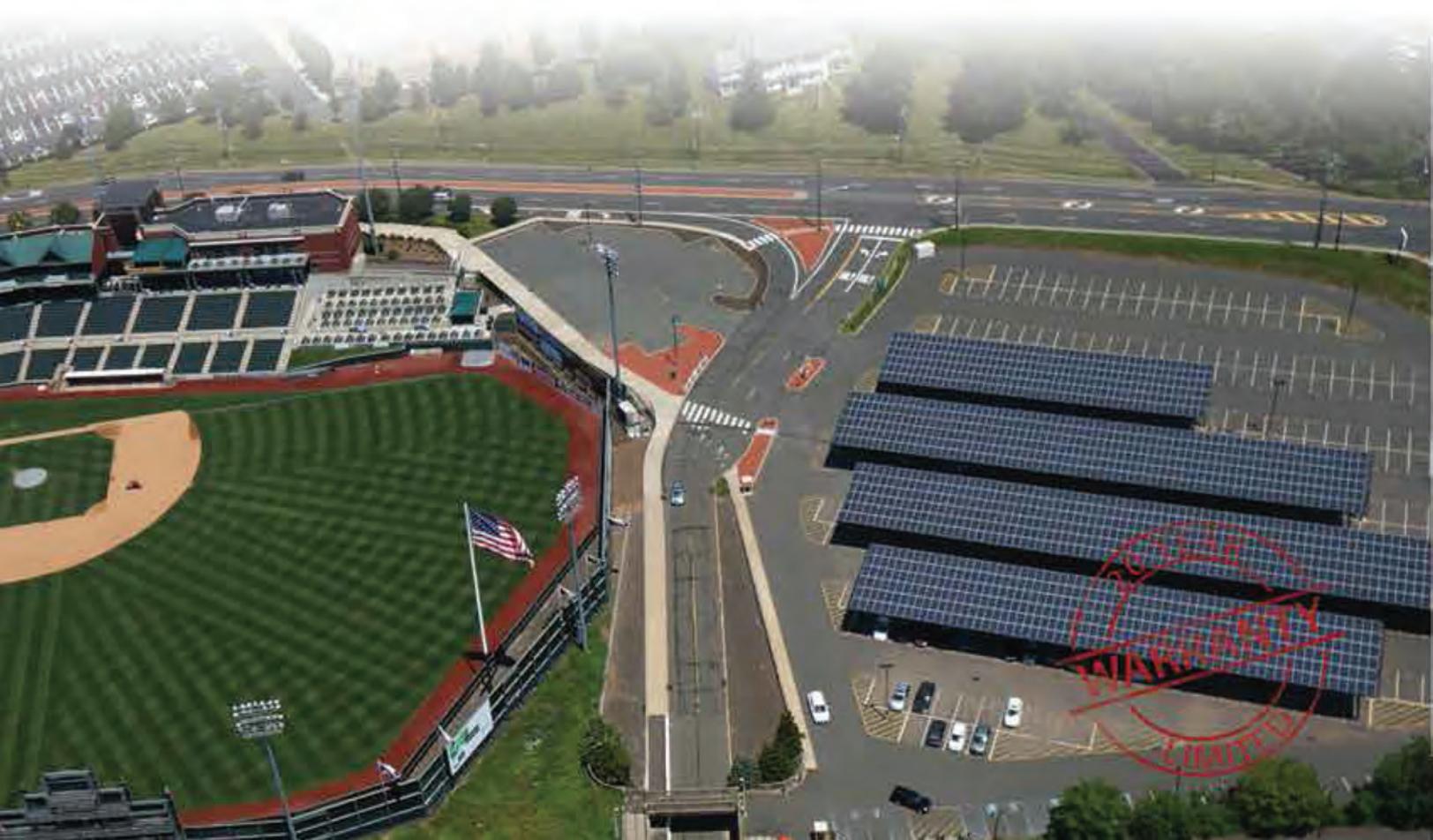


www.rbisolar.com

RBI Solar designs, engineers, manufactures and installs solar mounting systems. This single-source responsibility is focused on delivering value throughout the solar value chain.

Features & Benefits

- Standard installations maintain 8'-6" minimum clearance, higher elevations available
- Optimized span between posts
- Custom design available
- Designed with applicable codes and loading considerations
- Foundation and installation options available
- Readily tailored to fit different modules and parking lots
- Custom colors and optional raised concrete piers are available
- Industry-leading 20-year warranty on all of our carport installations
- Water control with decking available
- No field welding, drilling or other on-site fabrication needed
- Multiple coatings options:
 - Hot dipped galvanized
 - Epoxy coated



RBI Solar Background

Family owned and operated, we pride ourselves in 80+ years of experience in commercial design-build specialty structures. RBI Solar's unique design capabilities and multiple manufacturing facilities help us develop the most economical, reliable and robust solutions for any structural solar mounting challenge. We are committed to taking single-point responsibility for the entire project starting from the initial design to complete installation of solar modules.

Solar Carport Structure Types

Single Slope

Single slope structures are installed sloping toward the southern exposure to optimize solar production.

Double Slope

Gable, double-sloping structures are typically installed in a north/south orientation with panels sloping 5° east and west.

Inverted Design

The inverted design provides increased clearance at the eaves while promoting snow to shed toward the center column of the structure.

Full Coverage

The full coverage design is utilized to cover whole parking area including the drive aisles between the parking rows. Typical applications are parking garages, drive-throughs and bus loading and unloading zones.



RBI Solar Installs Solar Canopies

At RBI Solar, we understand that solar carport project development can stretch out over a number of years, which is why our commitment to customers extends from project conception to completion. We take single-source responsibility to complete your solar racking installation project including foundations. With in-house project management and installation crews, this approach reduces duplication of efforts throughout the enterprise, and focuses on delivering projects on time and within budget.



SINGLE SOURCE PROVIDER



DESIGN

RBI Solar provides complete structural and foundation design. Our focus is to deliver the most effective and efficient racking solution based upon the array layout and site conditions.

ENGINEERING

Our in-house engineers incorporate and analyze data from available certified geotechnical reports, on-site pile testing, all applicable codes and loading considerations when designing the most cost-effective structures.

MANUFACTURING

Multiple state-of-the-art manufacturing facilities, along with a vertically integrated procurement and manufacturing protocol, ensure overall quality of product with reduced lead times for material.

INSTALLATION

Single source responsibility, with in-house project management and installation crews. This approach reduces duplication of efforts throughout the enterprise, focused on delivering projects on time and within budget.

GROUND MOUNT • ROOF MOUNT • CARPORTS • LANDFILL

**Racking questions? We are here to answer.
Contact us at info@rbisolar.com or call (513)242-2051**



Solar Mounting Systems

GROUND MOUNT

DESIGN

ENGINEERING

MANUFACTURING

INSTALLATION



www.rbisolar.com

RBI Solar designs, engineers, manufactures and installs solar mounting systems. This single-source responsibility is focused on delivering value throughout the solar value chain.

Features & Benefits

- Custom engineered to specific site conditions
- High strength steel with corrosion protection
- Designed to minimize field installation labor
 - Reduced number of posts compared to traditional racking
 - Follows contours to mitigate civil/site work
 - Same hardware throughout
 - Optional pre-assembly
- Design and engineering at every step of the way
 - In-house engineers
 - Stamped drawings including foundation
- Pile driving test available
- Flexible to mount any module type
- Nationwide installation
- Various foundation options
- UL 2703 classification available
- Procurement and manufacturing:
 - Leverage with national and international facilities
 - Material certification available
 - ARRA compliant; "Made in the USA" certification available





RBI Solar Background

Family owned and operated, we pride ourselves in 80+ years of experience in commercial design-build specialty structures. RBI Solar's unique design capabilities and multiple manufacturing facilities help us develop the most economical, reliable and robust solutions for any structural solar mounting challenge. We are committed to taking single point responsibility for the entire project starting from the initial design to complete installation of solar modules.

Engineered Foundation Options

Our engineers consider many factors when determining the most reliable and cost-effective foundation solution for our projects. Incorporating and analyzing data from available certified geotechnical reports, on-site pile testing, wind tunnel testing, and all applicable codes and loading considerations, our team can provide various foundation options:

- Driven post
- Concrete pier
- Dual post
- Screw piles
- Pre-cast or cast-in-place concrete ballast
- Spread footings

Installation Services

With experience of completing multiple solar racking jobs for commercial, institutional and utility customers, RBI Solar is the most trusted name when it comes to solar racking installation. Our highly trained project managers and installation crews work with your on-site engineers to install custom engineered solar racking systems. Racking installation is essential for meeting project time and budget goals. Advantages of using RBI Solar for installation include:

- Company owned post driving equipment
- Highly skilled construction crews that specialize in solar racking
- Dedicated project managers

Technical Specifications

Description of product	Fixed tilt racking
Efficient designs	GM-I, GM-T and GM-B
Module configuration	Landscape or portrait ; designed to accommodate any module type
Tilt angle	0° to 45°
Array height	Project specific design
Ground cover ratio	Project specific design
Installation options	Posts, racking and module mounting
Geographical range	Nationwide
Grounding	Continuously bonded racking; tested by ETL to UL2703 standards (GM-I & GM-T)
Wire management	Built-in wire management options
Design criteria	Engineered to meet applicable structural codes
Warranty	20-year limited warranty



SINGLE SOURCE PROVIDER



DESIGN

System classified to UL 2703, with in-house designers and engineers. Our focus is to deliver the most effective and efficient racking solution based upon the array layout and site conditions.

ENGINEERING

Our in-house engineers, licensed and registered in all states, provide structural calculations applying RBI proprietary wind tunnel analysis and focus on delivering appropriate racking and foundation design based on existing soil conditions.

MANUFACTURING

Multiple state-of-the-art manufacturing facilities, along with a vertically integrated procurement and manufacturing protocol, ensures overall quality of product with reduced lead times for material.

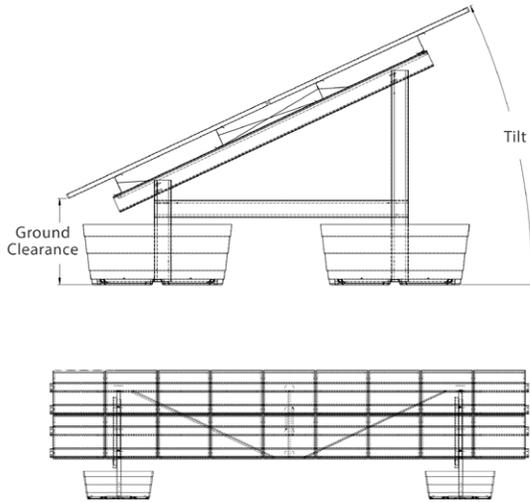
INSTALLATION

Single source responsibility, with in-house project management and installation crews. This approach reduces duplication of efforts throughout the enterprise, focused on delivering projects on time and within budget.

GROUND MOUNT • ROOF MOUNT • SPECIALTY STRUCTURES • LANDFILL

**Racking questions? We are here to answer.
Contact us at info@rbisolar.com or call (513)242-2051**

Technical Data Sheet



Patent pending protected system with self-leveling technology: 68% faster install than precast

Substantial labor savings by eliminating moving and shimming heavy, precast blocks

Articulating purlin connections to navigate up to 15% terrain slopes

Supports all poly, glass and thin film modules

Integrated grounding and wire management

Available in both 1 and 2up in portrait panels

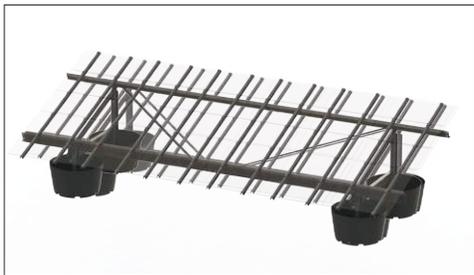
Landfill solar racking leader



Technical Data Sheet



Pour-in-Place™ Ballasted Ground System:
faster install, steeper slopes



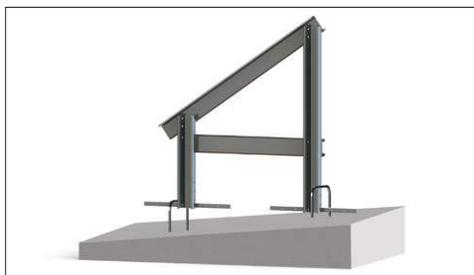
Pour-in-Place™ thin film panel clamps
mount using rivets, T bolts or socket bolts



Slots combine with rail support self-leveling
technology enables up to 7" vertical adjustability



Available with galvanized purlins with
large wire management tray



Large hoop-shaped brackets slide to enable over
7" of vertical adjustment of facilitate install on
ground sloping in all directions

Features

Pour-in-Place™ Ballasted Ground System: less concrete, faster install, steeper slopes

Substantial adjustability allows for slopes up to 15%

Self-leveling technology enables up to 7" total vertical adjustability including use of slots

No gravel beds or other expensive ground preparations required for leveling as needed for precast - save up to \$.05/watt

Up to 4 ft. high ground clearance to allow for snow and vegetation

5 to 35° tilt with multiple inter-row spacing options

Full layout and engineering analysis for every project

51% overall lower cost than competitors

Integrated grounding and wire management

Test & Certification

- Wind tunnel tested by industry leader CPP & rated for 150 mph wind speed
- Independent assessment by Black & Veatch
- Rated up to 90 psf snow load
- ETL / UL 2703 tested
- Meets IBC and ASME standards for structural loading
- Warranty 20 years

Calculations

- 100% code compliant designs for any locality
- Structural PE stamped drawings and calculations
- Individual system structural calculations
- Individual system design calculations based on regional load values
- Design loads according to IBC 2006 or 2009

Material

- Rail support structure components: G90+ galvanized steel
- Panel mounting rails: G90+ galvanized steel (aluminum also available)
- Recycled HMWPE forms
- 3/8" magnacoat bolts and serrated flange nuts
- Panel mounting hardware: top mount - panel mounting clips: stainless steel FTL / UL 467 teathed clips 1/4" - 20 x 1.5" to 2.5" T bolts, 1/4" - 20 serrated flange nuts: stainless steel bottom mount: 1/4" - 20 x 3/4" T bolts, 1/4" - 20 serrated flange nuts, star washers: stainless steel

Grounding

- Integrated grounding with star washers or teathed module clamps included - both approved under ETL / UL 2703
- Grounding must be done by electrician at row ends



PVI 50TL PVI 60TL

FEATURES

- NEC 2014 compliant (arc fault and rapid shutdown)
- 3 MPPTs with 5 inputs each
- Integrated DC and AC disconnects
- AC terminals compatible with copper and aluminum conductors
- Modbus communications
- Internal data logger
- 0 - 90° installation orientation
- Remote firmware upgrades
- Remote diagnostics

OPTIONS

- H4 wiring box
- Shade cover
- DC combiners bypass
- Web-based monitoring

3-PH TRANSFORMERLESS STRING INVERTERS

Yaskawa - Solectria Solar's PVI 50TL and PVI 60TL are grid-tied, transformerless three-phase inverters designed for ground mount, rooftop and carport arrays and can be installed from 0 - 90 degrees. The PVI 50/60TL inverters are NEC 2014 compliant and are the most reliable, efficient and cost effective in their class. They come standard with AC and DC disconnects, three MPPTs, a 15-position string combiner, remote diagnostics, remote firmware upgrades and various protection features. Options include H4 wiring box, shade cover, DC combiner fuse bypass, and web-based monitoring.



SPECIFICATIONS	PVI 50TL	PVI 60TL
DC Input		
Absolute Maximum Open Circuit Voltage	1000 VDC	
Operating Voltage Range	200-950 VDC	
Max Power Input Voltage Range (MPPT)	480-850 VDC	540-850 VDC
MPP Trackers	3	
Maximum Operating Input Current	36 A per MPPT (108 A)	38 A per MPPT (114 A)
Maximum Available PV Current (Isc x 1.25)	60 A per MPPT (180 A)	
Maximum PV Power	75 kW (25 kW per MPPT)	90 kW (30 kW per MPPT)
Start Voltage	330 V	
AC Output		
Nominal Output Voltage	480 VAC, 3Ø+/PE/N	
AC Voltage Range (Standard)	-12%/+10%	
Continuous Output Power	50 kW	60 kW
Maximum Output Current	61 A	73 A
Maximum Backfeed Current	0 A	
Nominal Output Frequency	60 Hz	
Output Frequency Range	57-63 Hz	
Power Factor	Unity, >0.99 (adjustable 0.8 leading / 0.8 lagging)	
Fault Current Contribution (1 Cycle RMS)	55 A	
Total Harmonic Distortion (THD) @ Rated Load	< 3%	
Performance		
Peak Efficiency	99.0%	
CEC Efficiency	98.5%	
Tare Loss	< 2 W	
Ambient Temperature Range	-22°F to +140°F (-30°C to +60°C) Derating occurs over +122°F (+50°C)	
Storage Temperature Range	-40°F to +158°F (-40°C to +70°C)	
Relative Humidity (non-condensing)	0-95%	
Audible Noise	< 55 dBA @ 1 m at room temperature	
Operating Altitude	13,123 ft (4,000 m) Derating from 9,842.5 ft (3,000 m)	
Safety Listings & Certifications	UL 1741:2010, UL 1699B, CSA-C22.2 #107.1-01, IEEE1547; FCC PART15	
Testing Agency	CSA	
Mechanical		
15 Fused Positions (5 positions per MPPT)	15 A standard (20, 25, 30 A accepted*)	
AC/DC Disconnect	Standard, fully-integrated	
Enclosure Rating	Type 4X	
Enclosure Finish	Polyester powder coated aluminum	
Mounting Method	0-90° from horizontal (vertical, angled, flat)	
Dimensions (H x W x D)	39.4 x 23.6 x 10.24 in. (1,000 x 600 x 260 mm)	
Weight	Inverter: 123.5 lbs (56 kg); Wiring Box: 33 lbs (15 kg)	
Communications		
Data Logger Hardware	Standard, Internal	
SolrenView Monitoring Service	Optional	
Revenue Grade Meter/Monitoring	Optional, External	
Communication Interface	RS-485 Modbus RTU	
Remote Firmware Upgrades	Standard	
Remote Diagnostics	Standard	
Features & Protections		
Arc-Fault Detection	Standard	
Smart Grid Features	L/HVRT, L/HFRT, Soft Start, Volt-Var, Frequency-Watt and Volt-Watt	
Warranty		
Standard	10 year	
Optional	15, 20 year; extended service agreement	

*Yaskawa - Solectria Solar does not supply the optional fuses



PVI 14TL
PVI 20TL
PVI 23TL
PVI 28TL
PVI 36TL

FEATURES

- 600 or 1000 VDC
- Best in class efficiency
- Touch-safe fuses
- Dual & wide MPP tracking zones
- Modbus communications
- Integrated DC fused string combiner
- DC arc-fault protection
- PVI 36TL - HECO and Rule 21 compliant

OPTIONS

- Web-based monitoring
- Shade cover
- DC/AC disconnect covers
- Roof mount array brackets
- DC combiners bypass

3-PH TRANSFORMERLESS STRING INVERTERS

Yaskawa - Solectria Solar's PVI 14TL, PVI 20TL, PVI 23TL, PVI 28TL, and PVI 36TL are compact, transformerless three-phase inverters with a dual MPP tracker. These inverters come standard with AC and DC disconnects, user-interactive LCD, and an integrated fused string combiner. Its small, lightweight design makes for quick and easy installation and maintenance. These inverters include an enhanced DSP control, comprehensive protection functions, and advanced thermal design enabling highest reliability and uptime. They also come with a standard 10 year warranty with options for 15 and 20 years. Options include web-based monitoring, shade cover, DC/AC disconnect covers, DC combiners bypass, and roof mount array bracket.



SPECIFICATIONS	PVI 14TL	PVI 20TL	PVI 23TL	PVI 28TL	PVI 36TL
DC Input					
Absolute Maximum Open Circuit Voltage	600 VDC		1000 VDC		
Operating Voltage Range	180-580 VDC	260-580 VDC	300-900 VDC		240-950 VDC
Max Power Input Voltage Range (MPPT)	300-540 VDC	300-550 VDC	500-800 VDC		540-800 VDC
MPP Trackers	2 with 4-fused inputs per tracker				2 with 5-fused inputs per tracker
Maximum Operating Input Current	25 A per MPPT (50 A)	35 A per MPPT (70 A)	25 A per MPPT (50 A)	29 A per MPPT (58 A)	35 A per MPPT (70 A)
Maximum Available PV Current (Isc x 1.25)	45 A per MPPT (90 A)	45.5 A per MPPT (91 A)	41 A per MPPT (82 A)	48 A per MPPT (96 A)	62.5 A per MPPT (125 A)
Maximum PV Power (per MPPT)	9.5 kW	13.5 kW	15.5 kW	19 kW	27 kW
Strike Voltage	300 V		330 V		
AC Output					
Nominal Output Voltage	208 VAC, 3-Ph		480 VAC, 3-Ph		
AC Voltage Range (Standard)	-12%/+10%				
Continuous Output Power	14 kW	20 kW	23 kW	28 kW	36 kW
Maximum Output Current	39 A	25.5 A	27.7 A	33.7 A	43.5 A
Maximum Backfeed Current	0 A				
Nominal Output Frequency	60 Hz				
Output Frequency Range	59.3-60.5 Hz (adjustable 55-65 Hz)				57-63 Hz
Power Factor	Unity, >0.99 (±0.8 adjustable)	Unity, >0.99 (±0.9 adjustable)	Unity, >0.99 (±0.8 adjustable)		
Fault Current Contribution (1 Cycle RMS)	70.4 A	43.3 A	69.6 A		73.2 A
Total Harmonic Distortion (THD) @ Rated Load	< 3%				
Grid Connection Type	3Ø+N/GND (4-wire)				
Efficiency					
Peak Efficiency	96.6%	97.4%	98.6%		98.5%
CEC Efficiency	96.0%	97.0%	98.0%		
Tare Loss	4 W		2 W		
Integrated String Combiner					
Fused Positions	8 fused positions (4 positions per MPPT) 15 A (fuse by-pass available)				10 fused positions (5 positions per MPPT) 15 or 30 A (30A only for combined inputs)
Temperature					
Ambient Temperature Range	-13°F to +140°F (-25°C to +60°C) Derating occurs over +50°C		-22°F to +140°F (-30°C to +60°C) Derating occurs over +45°C		
Storage Temperature Range	-22°F to +158°F (-30°C to +70°C)				-40°F to +158°F (-40°C to +70°C)
Relative Humidity (non-condensing)	0-95%				
Operating Altitude	13,123 ft/4,000 m (derating from 6,562 ft/2,000 m)				
Data Monitoring					
Optional SolrenView Web-based Monitoring	Integrated				
Optional Revenue Grade Monitoring	External				
External Communication Interface	RS-485 Modbus RTU				
Testing & Certifications					
Safety Listings & Certifications	UL 1741/IEEE 1547, CSA C22.2#107.1, FCC part 15 B				
Testing Agency	ETL		CSA		
Warranty					
Standard	10 year				
Optional	15, 20 year; extended service agreement				
Enclosure					
dB(A) (Decibel) Rating	< 50 dB(A) @ 3 m				
AC/DC Disconnect	Standard, fully-integrated				
Dimensions (H x W x D)	41.6 in. x 21.4 in. x 8.5 in. (1057 mm x 544 mm x 216 mm)		39.4 in. x 23.6 in. x 9.1 in. (1001 mm x 600 mm x 232 mm)		
Weight	141 lbs (64 kg)	132 lbs (60 kg)	104 lbs (47.2 kg)		121 lbs (55kg)
Enclosure Rating	Type 4				Type 4X
Enclosure Finish	Polyester powder coated aluminum				

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