Cumberland
MAINE

Request for Proposals for
Solar Photovoltaic Project

Prepared for

Town of Cumberland, Maine

Electronic Copy

April 4, 2018

AMERESCO
Green • Clean • Sustainable

Prepared for

Town of Cumberland, Maine

April 4, 2018

Request for Proposal for

Solar Photovoltaic Project

Presented by
Ameresco Inc.
111 Speen Street, Suite 410
Framingham, MA 01701
T: (508) 661-2200

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April 4, 2018

Mr. Bill Shane, Town Manager
Town of Cumberland
290 Tuttle Road
Cumberland, ME 04021

RE: Request for Proposals: Solar Photovoltaic Project at Town of Cumberland Municipal Landfill on Drowne Road, Cumberland, ME

Dear Mr. Shane,

Ameresco is pleased to provide this proposal to lease land and install, own, operate, and maintain a solar photovoltaic installation on the Town of Cumberland's former municipal landfill located on Drowne Road in Cumberland, Maine. We understand Cumberland's key criteria of realizing the greatest financial value while choosing a firm and project team with the experience and proven financial capability to ensure timely project development and construction. Our proposal demonstrates Ameresco's qualifications to perform the scope of services outlined in the RFP.

Net Metering with Community Solar to Generate Maximum Benefits

We understand the Town's objectives to site a solar energy system that generates electricity savings for the Town through net metering. Our proposed project has the following attributes:

- **Maximum allowed size under net metering**: We have maximized the size of the system within the constraints allowed within the State of Maine for net metering, which is a 660 kW AC system
- **Community Solar Structure**: We propose net metering under a community solar structure. This will allow the Town of Cumberland to maximize use of net metering to offset its bills, with remaining output from the system to be allocated to up to 9 other separate accounts.
- **30 year PPA**: using a 30 year PPA term allows further reduction of the PPA price to allow for savings on net metering
- **Immediate implementation**: Ameresco has the experience and is prepared to act rapidly upon award to start permitting and design

Our Proposal:

855 kW DC (660) kW AC) Solar PV System

- 855 kW-DC ballast mounted solar PV array

- **30-year PPA term**
- **1st Year PPA Rate of $0.094/kWh; 2.5% annual escalation**
- 1.18 million kWh in its first operating year
- 32.8 million kWh over the 30-year PPA term
- 875 metric tons CO2e avoided in year 1 and 24,437 over the 30-year term
- Net metering to the Town of Cumberland and additional entities in ME for all produced energy.
- Assumed $1 Annual lease payment; $0 tax payments
- Optional Buyout Cost after Year 7 – the greater of $1,293,573 or fair market value

The financial benefits to the Town are in the form of electricity savings. The Price Proposal Form is provided in Appendix A.

Pricing Assumptions:

- **System Design**: Final system design, configuration, and equipment selection will be confirmed and approved by the Town during the negotiation of the PPA.
- **Interconnection** – We have assumed $150,000 in utility upgrade costs for the project. Once the actual utility upgrade costs are obtained, the PPA pricing will be adjusted accordingly.

Alternate System – Full use of Site Area

As part of our design analysis, we demonstrated that the site can support up to a 1.8 MW DC solar PV system based on available area that can accommodate a ballasted system. We follow Maine solar PV legislation closely, and it is possible that the State will pass new legislation this year that could expand the possible system size for net metering and community solar. In that event, we would be happy to discuss with the Town the possibility of building a larger project under the new requirements.

Alternate PPA Term – 20 years

We can also offer a 20-year PPA term for the 855 kW DC (660 kW AC) project. This PPA would have a 1st Year rate of $0.114/kWh and a 2.5% annual escalation.

Ameresco Builds Successful Municipal Energy Projects

Ameresco is a leading independent energy services company, and has significant experience in developing, constructing and operating energy projects for municipalities, government agencies, hospitals, universities, and other large, complex organizations.

Our substantial project experience, financial capability, and ability to expedite project development and construction will support the Town of Cumberland in its key objective of maximizing the total lease payments as demonstrated by the following summary of evaluation criteria:

Experience: $5.5 billion in constructed projects; 213MW of solar PV projects.

Ameresco has engineered and constructed more than $5 billion of energy services projects in North America. We have 136 MW of solar PV projects in operation with an additional 76 MW of projects in construction. Our projects are located on landfills, school rooftops, parking canopies, parking garages, airports, highways, and large land areas. Ameresco has extensive experience in building renewable energy projects on landfills across North America completing more than 40 solar PV and landfill gas to energy projects. Twelve of those solar PV projects were built on landfills in MA totaling 23 MW-DC. We know the MADEP permitting staff and have extensive involvement managing their specific requirements. We also have significant experience developing 30+ projects in National Grid service territory and can pre-emptively anticipate their requests.

Financial Capability: Financially secure with immediate access to capital

Ameresco is a financially strong, profitable public company (AMRC) with 2016 revenues of $651 million. We maintain a $87 million credit facility and a $1.4 billion bonding capacity through two corporate providers, both with an AM Best Rating of "A Excellent". Our financial resources funding enables Ameresco to start project permitting and construction promptly without financing delay. The Town of Cumberland can count on Ameresco completing the project, and being in business to operate and maintain the solar PV system throughout its lifetime.

Schedule: 100% construction and operation of contracted projects

Ameresco has built 100% of the solar projects we have been awarded that were not stopped by utility interconnection costs or approvals. We have no barriers to construction financing. Construction for each project can begin as soon as all permits are issued and contracts executed, and we already have financing for our long term solar agreements in place.

We look forward to working with the Town of Cumberland to contributing to the greater environmental benefits of the local community through increasing energy sustainability while generating savings for the Town.

Sincerely,

James J. Walker
Vice President – Solar PV Grid-Tie

PROJECT PROPOSAL FORM
FOR SOLAR PHOTOVOLTAIC PROJECT
AT THE DROWNE ROAD LANDFILL

**** THIS SHEET MUST BE INCLUDED IN YOUR PROPOSAL ****

The undersigned hereby declares that they have read and understand all conditions as outlined in this Request for Proposals, and that the proposal is made in accordance with the same.

COMPANY NAME: Ameresco, Inc.

AUTHORIZED SIGNATURE: James J. Walker

DATE: April 1, 2018

PRINT NAME & TITLE: James J. Walker, PE, Vice President PV Grid Tie

ADDRESS: 111 Speen Street, Suite 410, Framingham, MA 01701

E-MAIL ADDRESS: jawalker@ameresco.com

PHONE NUMBER: 508-598-3030 FAX NUMBER: 508-661-2200

TYPE OF ORGANIZATION (PARTNERSHIP, CORPORATION, INDIVIDUAL, OTHER):

Corportation

STATE OF INCORPORATION, IF APPLICABLE: Delaware

FEDERAL TAX IDENTIFICATION NUMBER (Required): 04-3512838

AUTHORIZED SIGNATURE: James J. Walker

DATE: April 1, 2018

NOTE: Proposals must bear the handwritten signature of a duly authorized member or employee of the organization submitting a proposal.

Section A: Qualifications

A.1: Experience

- *Demonstrated extensive experience in the successful installation and management of multiple, large commercial or public solar electric systems.*
- *Previous work with a public entity on a solar PV program.*

Financing, Regulatory Knowledge, and Skills Deliver 100% Project Success

Ameresco has completed 100% of awarded solar PV projects due to our financial strength, in-depth understanding of energy regulations, and experienced, professional staff. Ameresco finances all construction of solar PV projects its own capital or revolving credit lines, so projects stay on schedule with no delays. Furthermore, our solar PV team has an advanced understanding of regulations and is involved with ongoing rule making at the local, utility, state, and federal levels. We have never missed a regulatory deadline affecting state and utility incentives, enabling our customers to receive their intended economic benefit from the projects.

Significant Experience with Public Entity Projects

Ameresco has engineered and constructed more than $5 billion of energy services projects in North America. We have 136 MW of solar PV projects in operation with an additional 76 MW of projects in construction. The majority of these projects are for local government entities. Ameresco has designed and built 14 solar PV projects on landfills in the Northeast totaling 24.6 MW-DC with others in construction or development. Our team knows the Maine DEP permitting staff and their requirements and can meet them.

The below completed projects represent partnerships with Municipalities and other public organizations in the New England area.

Project	Number of Sites	Size kW DC	Location	Financing
Completed Projects				
Town of Groton, MA	1	2932	Groton, MA	PPA
Providence Water Supply Board, RI	1	667	Providence, RI	EPC
City of Pittsfield, MA	1	2915	Pittsfield, MA	PPA
MassDOT Phase 1a	5	2537	Various in MA	PPA
City of Newton Rumford Landfill	1	2500	Newton, MA	PPA

Town of Weston, MA	1	2347	Weston, MA	PPA
City of Waltham, Phase II	6	1737.5	Waltham, MA	PPA, Grant
Town of Acton, MA	1	1592	Acton, MA	PPA
City of Lowell, MA, Phase II	1	1502	Lowell, MA	PPA
Town of Sudbury, MA	1	1502	Sudbury, MA	PPA
Braintree MA Electric Light Department	1	1300	Braintree, MA	PPA
City of Newton Phase 2 Roof/Canopy	7	1278	Newton, MA	PPA
Town of Ashland, MA	3	1257	Ashland, MA	PPA
City of Newton	4	686	Newton, MA	PPA
Town of Westwood	4	635	Westwood, MA	PPA
City of Fall River	4	575.85	Fall River, MA	PPA
Town of Natick, Phase II	3	521.9	Natick, MA	PPA
City of Newburyport	2	502	Newburyport, MA	PPA
West Newbury, MA	1	440	West Newbury, MA	PPA
City of Hutchinson, MN	1	400	Hutchinson, MN	TELP
Massport - Logan International Airport	2	370	Boston, MA	PPA, Grant
City of Lowell, Phase I	5	348	Lowell, MA	PPA
Town of Natick, Phase III	2	311	Natick, MA	PPA
City of Melrose	1	301	Melrose, MA	PPA
Walnut Hill School	1	235	Natick, MA	PPA
City of Englewood, CO	4	219	Englewood, CO	PPA
Town of Natick, Phase I	1	212.6	Natick, MA	PPA, Grant
City of Waltham, Phase I	1	193.2	Waltham, MA	PPA
Milton Academy	1	192	Milton, MA	PPA
Weston, MA Phase 2	1	167	Weston, MA	PPA
Bridgewater State University	1	103	Bridgewater, MA	PPA, Grant
Mt. Wachusetts Community College	1	97	Gardner, MA	Turnkey
Canton Housing Authority	1	51	Canton, MA	PPA, Grant
City of Revere	1	47	Revere, MA	ESPC
Cambridge Housing Authority	1	46	Cambridge, MA	ESPC
Worcester State University	1	41	Worcester, MA	PPA, Grant
Brockton Transit Authority	1	20	Brockton, MA	Turnkey
Town of Saugus, MA	1	1655	Saugus, MA	PPA
MassDOT Phase 1b	2	1292	Various in MA	PPA
Town of Lenox, MA	1	810	Lenox, MA	PPA

City of Northampton, MA	1	3322	Northampton, MA	PPA
Town of Stockbridge Landfill	1	898	Stockbridge, MA	PPA
MassDOT Phase 2 - Hopkinton	1	541	Hopkinton, MA	PPA
New Castle County	2	127	New Castle County, MD	ESPC
Blue Wave Mendon and Hopedale, MA	5	6,900	Sturbridge, MA	Community Solar
Blue Wave Sturbridge, MA	1	2,300	Sturbridge, MA	Community Solar
Fisher Road Solar I	1	6,000	Dartmouth, MA	PPA

A.3: State of Maine Licenses

- *Possession of all applicable valid and pertinent State of Maine licenses for the installation of commercial solar PV systems in Maine.*

Please find Maine's Authority to Do Business license and a list of professional engineers licensed with the State of Maine in Appendix B

A.4: Local Presence

- *If not a locally-based firm, has established a partnership with a local office or project manager, or will do so if selected. Local is defined to be within a 100-mile radius of Cumberland, Maine.*

Local Presence Assures Seamless Project Delivery and Operations

Ameresco's solar PV engineering team is based out of our Portland, Maine office with development and financing support from our corporate headquarters in Framingham, Massachusetts. Ameresco's location offers the following benefits to project implementation:

- Minimize communication and project delays with local presence and familiarity with the area.
- Eliminate delays to project execution with the ease of scheduling meetings and site visits during engineering, design, and contract negotiation phases of the project.
- Minimize system down time with immediate response to unexpected maintenance with Ameresco service vehicles, service equipment, and operations and maintenance staff located at its Portland location.

Local Office
30 Danforth Street, Suite 108
Portland, ME 04101

Corporate Headquarters
111 Speen Street, Suite 410
Framingham, MA 01701

A.5: Financial Strength and Stability of the Solar Provider

- *Sufficient, current information indicating the solar provider's financial strength and the stability of the solar provider in terms of length of service, professional capabilities, construction experience and capabilities over time.*

Founded in 2000, Ameresco (NYSE: AMRC) is a leading publicly-traded energy services company headquartered locally in Framingham, MA specializing in renewable energy systems, including solar PV on landfills, rooftops, carports, and ground-mounts, and energy efficiency solutions. Ameresco became a publicly traded company in 2010, trading on the New York Stock Exchange under the ticker symbol AMRC. There have been no changes in ownership over the past ten years. Ameresco is incorporated in the state of Delaware.

Our in-house staff capabilities include all skills and certifications to complete solar PV projects, including development, design, engineering, financing, major equipment procurement, construction management, commissioning, and operation.

Our skill, integrity, and financial strength to perform faithfully and complete solar PV projects for the Town of Cumberland are evidenced by:

- **39+ MW of solar PV projects for municipal entities in New England; 107+ MW in North America**:. Ameresco has installed solar PV systems on landfills, ground mounts, parking lots and rooftops for municipal entities in New England.

Solar PV Projects Developed by Ameresco's Regions	Completed (kW-DC)	Completed (Number of Installations)	In Construction (kW-DC)
East USA	61,300	114	14,142
West USA	45,652	149	27,712
Federal USA	26,880	12	14,583
Canada	3,992	35	2,532
Ameresco Solar (Off-Grid)	2,543	7	0
Total	**140,367**	**317**	**58,969**
Total Completed/ In Construction (kW-DC)		**199,336**	

- **Profitable, financially strong public company provides assurance of our performance**: Ameresco (NYSE:AMRC) With 2017 revenues of $717.2 million and a construction backlog exceeding $1.77 billion, Ameresco is a leading independent energy services companies in the United States providing

comprehensive energy efficiency and renewable energy solutions for facilities throughout North America and the United Kingdom. Ameresco delivers long-term value through innovative systems, strategies and technologies. For the year 2017, Ameresco had total assets of approximately $984 million, cash in excess of $40 million and an $75 million credit facility. In addition, we maintain a $750 million surety credit facility through two corporate providers, both with an AM Best Rating of "A Excellent". Ameresco has the financial fortitude to be a long-term partner with the Town of Cumberland ensuring a successful development execution, project(s) implementation, and operations.

- **Financing, regulatory knowledge, and skills deliver 100% project success**: Ameresco has completed 100% of awarded solar PV projects due to our financial strength, in-depth understanding of Rhode Island regulations, and experienced, professional staff. Ameresco finances all construction of solar PV projects its own capital or revolving credit lines, so projects stay on schedule with no delays. Furthermore, our solar PV team has an advanced understanding of regulations and is involved with ongoing rule making at the local, utility, state, and federal levels. We have never missed a regulatory deadline affecting state and utility incentives, enabling our customers to receive their intended economic benefit from the projects.
- **Local presence assures seemless project delivery and operations:** Ameresco's solar PV engineering team is based out of our Portland, Maine office with development and corporate financing support from corporate headquarters in Framingham, Massachusetts. Our Ameresco office locations offer the following benefits to project implementation:

    - Minimize communication and project delays with local presence and familiarity with municipalities across Maine
    - Eliminate delays to project execution with the ease of scheduling meetings and site visits during engineering, design, and contract negotiation phases of the project.
    - Minimize system down time with immediate response to unexpected maintenance with Ameresco service vehicles, service equipment, and operations and maintenance staff located at its Portland location.

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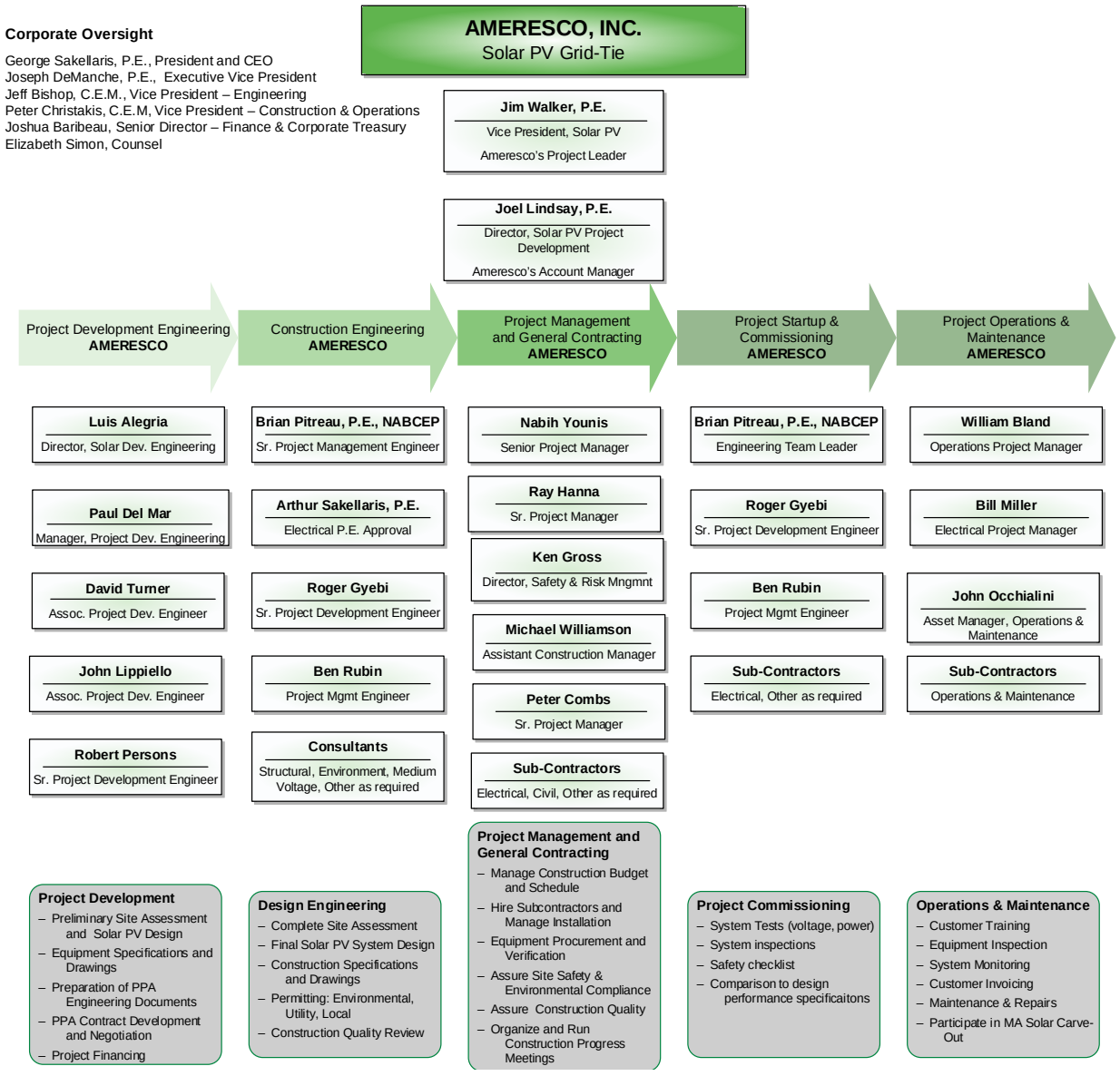
Section B: Project Team Profile

B.1: Resumes

- *Resumes of personnel to be directly involved with the development of the proposed systems.*

Resumes of personnel are presented in Appendix C.



B.2: Team Lead

- *Team leader identification for the entire proposal, including full contact information.*

Ameresco possesses the skills required to complete this project including licensed professional engineers, North American Board of Certified Energy Practitioners (NABCEP), certified solar PV installers, certified and licensed master electricians, and certified energy managers. These resources are all in our Portland, ME and Framingham Headquarters office.

Ameresco's Solar PV Grid-Tie group is led by Jim Walker, P.E. and is comprised of experienced knowledgeable individuals who are responsible for the development, execution and operation of our solar PV systems. The collective technical and economic expertise of the team has been built and demonstrated on multiple rooftop and ground mount PV projects in New England and the Northeast US, including ground mount systems on landfills and rooftop projects on municipal buildings. We also have an in-house financing team, which works directly with our project teams to develop creative financing solutions for our solar projects.

Ameresco's team leader for the proposal and throughout the life of the project is:

Mr. Joel Lindsay, PE, Director, Solar PV Development
111 Speen Street
Suite 410
Framingham, MA 01701

Phone: 508-661-2265
Fax: 508-598-3330
Email: jlindsay@ameresco.com

Mr. Lindsay brings more than 25 years of diverse renewable energy and environmental experience, which has included development, design and construction of large and medium scale solar power projects, as well as management of large scale environmental remediation and restoration projects. He has developed more than 10 MW of solar PV projects across the Northeast. Given his experience in environmental engineering, he is able to provide insights on the development of solar projects for landfills and environmentally-impaired properties as well for greenfield sites.

Mr. Lindsay holds a bachelor's degree from Princeton University and a master's Degree in Environmental Engineering from the University of California – Berkeley, and is a registered Professional Engineer in Massachusetts.

B.3: Each Entities Involvement

- *Identification of each entity, sub-contractor, person or firm involved in the proposal and their role/responsibility (e.g. design, installation, permitting, equipment supply by component, operations, and maintenance), including the relationship between team members.*
- *History of past projects that the team members have worked on together.*
- *A brief description of each team member's firm and their ability to contribute to successful solar PV program implementation (history, performance of similar scope of services, etc.).*

Permitting Requirements

Ameresco has worked extensively with state and local regulatory authorities to develop and construct our landfill projects in the Northeast. To date, we've successfully designed, permitted and constructed fifteen (15) landfill projects in New England. Ameresco successfully completed the application process to receive all required project permits, including local permits of planning boards and conservation commissions, State Departments of Environmental Protection, US Fish and Wildlife permits, Army Corp of Engineers permits, Historical Commission permits, and US EPA permits. Therefore, Ameresco frequently meets and interacts with state and local regulatory authorities to ensure minimum impacts and positive contributions to the communities surrounding the projects. Ameresco's development managers along with their environment consultants ensure that the Town's project will be developed and constructed with minimal environmental impact and in accordance with all applicable authorities having jurisdiction.

The Maine DEP is encouraging the re-use of closed landfills for solar PV deployment, and has established a permitting process for this purpose. Ameresco and its team partner TRC are well versed in the MDEP requirements for solar PV on landfills, and will be able to ensure a smooth, efficient permitting process with both MDEP and the Town of Cumberland.

Ameresco has worked with multiple New England towns to address aesthetic concerns from abutters with regard to solar PV on closed landfills. We have worked with town departments and residents in all cases to provide solutions that address these concerns. This has included screening vegetation and/or fences, and importantly involves pro-active education of town residents of the nature and impacts of solar PV systems during construction and operation.

Ameresco Manages All Aspects of the Project

Ameresco will be fully responsible for all aspects of the development and implementation of the Town of Cumberland's solar project, including the following:

- **Ameresco will develop, design, construct and operate the project**, providing a single point of responsibility for customer satisfaction, and to develop a successful project. This includes the negotiation of the lease and all related contracts.

- **Ameresco manages and supervises all work by subcontractors**. All subcontractors are required by Ameresco to fully comply with the insurance, bonding, and other requirements of this RFP. Whenever Ameresco employs a subcontractor to perform a service required by the contract or to supply materials and equipment for use on the contract, we require the subcontractor to perform at the same standards that we are required to deliver.
- **Ameresco is fully responsible for the quality and workmanship of its subcontractors**. Each Ameresco subcontract contains the same flow-down clauses and includes the requirements that are in our contract with the Town. Ameresco inspects all goods delivered and services performed to assure compliance with our engineering designs.

Ameresco Maintains All Solar PV Components

To date, Ameresco, as system owner, has maintained nearly all of its solar PV projects under PPA and lease agreements in Massachusetts with in-house personnel. Our Framingham office will be the primary service center for all O&M staff required to maintain the proposed projects. The staff works diligently to ensure that any concerns are addressed quickly to minimize any downtime of the systems. For each project, an Operations Project Manager will be assigned responsibility for all operations and maintenance activities required at that site in order to ensure that the systems continue operating as expected.

Ameresco maintains its own New England based O&M staff and a fleet of vehicles supplied with tools and equipment. We also maintain and stock replacement parts in our warehouse facilities. In addition, we enter into extended warranty programs and we contract with third-party specialty contractors to provide rapid service to our projects. This capability provides our customers long-term, worry-free service – assuring that the solar PV systems continue to operate over the length of its Power Purchase Agreement.

At project completion, Ameresco will present the customer with sets of record drawing for each of the completed installations. Although Ameresco will be responsible for ongoing operations of the equipment, we will train local maintenance personnel and local emergency responders on the equipment that has been installed, where it is located and how it interfaces with the customer owned equipment, if applicable. We will also train staff on the actions to take in the event of an emergency.

Daily Monitoring and Preventative Maintenance

To maintain systems at optimal operation, our team manages the following:

- **Inverter Warranties**: Ameresco enters into extended warranty programs, and contracts, or reserves inverter replacement costs with our bank, whichever option our bank requires. This approach provides our customers with long-term, worry-free service and assurance that the solar PV systems will be in continuous operation.
- **Responsiveness to service alerts and alarms**: For each project, Ameresco's assigned Operations Project Manager receives alerts, alarms, and reports from the data acquisition system (DAS), notifying the manager of any fault(s) or performance problems. When an alert from the DAS occurs, the Operation Project Manager assesses the cause and severity of the alert – dispatching, as required, service technicians or engineers to access the on-site problem and repair or replace equipment.

- **Annual maintenance:** The Operations Project Manager is also responsible for scheduling the annual evaluation and preventative maintenance of the solar PV system(s).

Industry Leading Safety Program

Ameresco has an executive-managed safety program under the leadership of Kenneth Gross, Vice President of Safety and Risk Management. Our safety program requires training of employees and safety audits of job sites. Ameresco's safety record of the past three years is as follows:

Year	Recordable Incident Rate	Experience Modification Rating	Lost Workday Incident Rate	Man-Hours
2015	0.21	0.69	0.21	1,823,094
2016	0.63	0.68	0.21	1,893,884
2017	0.10	0.71	1,895,018	0.00

Ameresco's Significant Contractor and Subcontractor Relationships

Specific subcontractors for the proposed System will be selected after award notification. Through our deep experience building solar projects in Massachusetts, Ameresco has developed significant working relationships with the subcontractors listed below. Ameresco may also solicit bids for portions of the work from other qualified contractors, as part of our process to continuously maintain and improve the quality of the work done on our projects.

1) Medium Voltage Engineering and Utility Interconnections

Consulting Engineers Group (http://cegconsulting.com/). CEG Consulting conducts all of Ameresco's medium voltage and utility interconnections for the 13.8 kV sized interconnections and lower. The firm serves Ameresco and its customers from its Hopedale, MA offices.

Since 1994, CEG has been designing utility substations, distribution & transmission systems (up to 345kV), preparing contract documents, procurement specifications, planning studies, analytical studies, construction standards, and reviewing new and existing electrical equipment.

2) Environmental and Civil Engineering/Permitting

TRC Companies, Inc. (http://trcsolutions.com **)**.TRC is a regional leader in engineering and environmental consulting, with the expertise to speed permit approvals through various federal, state and local agencies. TRC's team offers a breadth of disciplines, along with decades of permitting, planning, design, and construction experience for a wide variety of projects, to develop and execute environmental solutions that meet the changing environmental regulations.

Ameresco teamed with TRC to support Ameresco with civil engineering and permitting as well as its knowledge and history of the site developed in the production of the feasibility study for the site. Services provided by TRC on the solar development on these sites include (as needed):

- **Investigation**
  - *Pre-design investigations* – including site investigation/assessment, wetland investigation/delineation, and utility assessment
- **Engineering**
  - *Civil/environmental engineering* – including storm-water analysis and design, erosion and sediment control plans, access road design, site layout, and site grading to optimize solar array layout.
  - *Geotechnical engineering* – including bearing capacity analysis, settlement analysis, slope stability analysis, sliding and stability analysis of equipment on the landfill surface and foundation design.
  - *Structural engineering* – including concrete pad design for electrical equipment installation on landfills and structural analysis of racking/foundation interface.
- **Land surveying**
  - *Land surveying* – including topographic and boundary surveys, route and right-of-way surveys, surveys for construction layout, and as-built surveys.
- **Permitting (ground mount, rooftop or carport)**
  - *Local Permitting* – Special permits, site plan review, and NOIs as required by local by-laws and overlay district requirements
  - *DEP*—Filing request for clarification or notice of intent for wetlands encroachment.

- **Construction Inspections/ Oversight**
  - Request for Information (RFI) and submittal review of information provided by the contractor during the construction phase.
  - Permit compliance inspections for the owner, developer, contractor, and/or regulators to ensure the cap integrity is maintained.

3) Electrical Subcontractors

a. **Aldon Electrical** (http://www.aldonelectric.com/). Established in 1986, the company has grown to its present size, employing 100 tradesmen and professionals in the electrical contracting business.

Aldon has an agreement with Local 103 of the International Brotherhood of Electrical Workers as well as being a signatory to Local 223, and is able to utilize highly skilled electrical tradesmen.

Aldon supports Ameresco and its customers from its Weymouth, MA offices.

b. **G&B Electrical Services** (http://www.gandbelectrical.com/). G&B Electrical is a full service electrical contracting firm with over 40 years of experience, servicing Massachusetts, New Hampshire, Maine and Vermont. The firm specializes in utility and commercial solar installations.

G&B Serves Ameresco and its customers from its Amesbury, MA offices.

c. **Fischbach and Moore Electrical Group** (http://fbmpower.com/). Since 2008, Fischbach and Moore has performed solar installations throughout Massachusetts ranging in size from 240 kw on the roof of the Boston Water & Sewer Commission to 6 MW at the Hyannis airport on Cape Cod. The firm understands the intricacies of a solar project and have knowledgeable staff that have experience with designing and executing a solar installation.

Fischbach and Moore was founded in 1918 and is a member of International Brotherhood of Electrical Workers Local 103. The firm serves Ameresco and its customers from its Boston, MA offices.

d. **Senecal Electric Services**. Senecal provides roof-mounted solar PV installations for Ameresco and its customers from its Worcester, MA offices. Senecal provides fast and efficient installations on schools and municipal buildings for Ameresco.

4) Civil Subcontractors

a. **T-Ford** (http://tford.com/about_us/index.html). T-Ford is a general civil contractor with specific expertise in civil construction, specifically environmental remediation and restoration, waterside construction, site work, utilities, concrete foundations and industrial buildings.

Founded in 1983 by Thomas Ford, the firm has grown by providing its clients with thoughtful execution of their construction projects, delivered on time and to the complete satisfaction of their quality and operational requirements. Craftsmanship, professionalism and teamwork are integral to our project delivery system.

T-Ford's clients include public agencies, civil/environmental engineers and private industrial/utility organizations. The preponderance of our work is within eastern New England and we own our own heavy excavation and support equipment.

T-Ford is Massachusetts DCAM, DCR and Mass Highway certified and has excellent bonding, insurance, banking and vendor relationships.

T-Ford's offices are in Amesbury, MA.

b. **J Derenzo Company** (http://www.jderenzo.com/). J. Derenzo Co. prepares sites for new construction – clearing and grading the land, performing excavation, installing earth retention and foundation systems. The firm also provides ground completing landscaping, installing curbing and finalizing utility hook ups.

J. Derenzo Co. has been one of New England's premier site work contractors for more than 65 years. The team's experience ranges from large scale rural site clearing to some of the most complex, tight-site, deep hole excavations in downtown Boston.

J. Direnzo is headquartered in Brockton, MA.

c. **Ricciardi Bros**. (http://ricciardibrosinc.com/). Founded in 1979, Ricciardi Bros., Inc. is a general civil contractor, specializing in utilities and excavation, located in Worcester, MA. Project work includes: Comprehensive Site Work Packages and Excavation' Underground

Utilities, Project Management, and Demolition and Site Remediation.

The firm's employees hold a 10-Hour OSHA safety card and most are 40-Hour HazMat certified along with maintaining their individual licenses to operate heavy equipment.

d. **J. Bates and Son Construction** (http://jbatesandson.com/). J.Bates and Son has partnered with solar firms in the development of ballasted and post driven solar fields. From survey and layout to concrete equipment pad construction; the firm provides all the civil services needed for the completion of solar projects.

   J. Bates and Son also has a full range of civil construction capabilities. From bridge, culvert and concrete construction to site development and utilities construction; we have the experience, equipment and personnel to complete projects on time and on budget.

   The firm is headquartered in Clinton, MA.

Past Landfill Solar PV Experience

The Ameresco team has extensive experience in building renewable energy projects on landfills across North America completing more than 40 solar PV and landfill gas to energy projects. In New England, completed solar PV projects on landfills total **23 MW-DC,** with others in construction or development, or in other states:

- Town of Acton Landfill: 1.6 MW
- Town of Sudbury Landfill: 1.5 MW
- City of Lowell Landfill: 1.5 MW
- City of Braintree Landfill: 1.1 MW
- Town of Weston Landfill: 2.3 MW
- Town of Saugus Landfill: 1.7 MW
- City of Pittsfield Landfill: 2.9 MW
- Town of Lenox Landfill: 1.0 MW
- Town of Groton Landfill: 2.9 MW
- Town of Stockbridge Landfill: 900 kW
- City of Northampton Landfill: 3.2 MW
- City of Newton Landfill: 2.2 MW

We are also currently under award to design, construct, own and operate a project for the Towns of Hamilton, Hampden, and Westport, Massachusetts on their municipal solid waste landfills.

Outside of Massachusetts, we built a 440 kW landfill project at a site in MN, and have a 1 MW project for the Town of Bethel, CT which was completed in January, 2018.

Section C: Project Experience

C.1: Commercial Grid-Connected PV Experience

- *Provide an overview of the firm'(s) commercial grid-connected PV experience (do not include residential PV experience).*

Ameresco has engineered and constructed more than $5 billion of energy services projects in North America. We have 145 MW of solar PV projects in operation with an additional 35 MW of projects in construction. Our projects are located on school rooftops, parking canopies, parking garages, airports, highways, municipal landfills, and large land areas. We financed and currently own and operate more than 110MW of these solar PV projects across all Ameresco Divisions. We have installed over 25MW on 15 Municipal Landfill in New England, and currently own and operate all but 3 of these projects. They are all financed under traditional PPA's with Town which owns the site.

- *Breakdown by application (roof mounted, vs. ground mounted) installed by your company.*

Project	COD (mmm-yy)	Installation Type	Project Cost $
Completed Projects			
Town of Groton, MA	Jun-16	Landfill	$ 6,000,000
City of Pittsfield, MA	Jan-17	Landfill	$ 6,800,000
MassDOT Phase 1a	Sep-15	Ground Mounted	$ 5,800,000
City of Newton Rumford Landfill	Jun-17	Landfill	$ 4,000,000
Town of Weston, MA	Mar-16	Landfill	$ 5,700,000
City of Waltham, Phase II	Dec-11	Roof Mounted	$ 6,272,390
Town of Acton, MA	Dec-13	Landfill	$ 6,000,000
City of Lowell, MA, Phase II	Dec-13	Landfill	$ 5,800,000
Town of Sudbury, MA	Dec-13	Landfill	$ 4,900,000
Braintree MA Electric Light Department	Dec-14	Landfill	$ 4,600,000
City of Newton Phase 2 Roof/Canopy	Jan-17	Roof and Parking Canopy	$ 4,300,000
Town of Ashland, MA	Feb-17	Canopy and Landfill	$ 3,500,000
Town of Wayland, MA	Jan-17	Roof and Parking Canopy	$ 5,300,000
Town of Lexington, MA	Dec-14	Roof Mounted	$ 3,750,000
Town of Natick Phase IV	Jun-17	Roof Mounted	$ 2,100,000
Town of Arlington, MA	Oct-15	Roof Mounted	$ 2,100,000
Town of Easton, MA	Feb-17	Roof Mounted	$ 2,300,000
City of Newton	Dec-13	Roof Mounted	$ 2,500,000

Braintree Electric Light Department Phase 2 - Braintree High School	Jan-16	Rooftop	$	1,500,000
Town of Westwood	Apr-17	Roof	$	1,873,250
City of Fall River	Dec-11	Roof Mounted	$	2,370,110
Town of Natick, Phase II	Dec-11	Roof Mounted	$	2,172,675
City of Newburyport	Sep-09	Roof Mounted	$	3,415,000
West Newbury, MA	Nov-15	Ground Mounted	$	1,400,000
City of Hutchinson, MN	Dec-15	Landfill	$	1,500,000
Massport - Logan International Airport	Dec-11	Roof Mounted	$	2,506,190
City of Lowell, Phase I	Nov-10	Roof Mounted	$	2,036,400
Town of Natick, Phase III	Dec-12	Roof Mounted	$	1,400,000
City of Melrose	Dec-13	Roof Mounted	$	875,000
Walnut Hill School	Feb-16	Roof and Carport	$	1,175,000
City of Englewood, CO	Dec-10	Roof Mounted	$	991,000
Town of Natick, Phase I	Dec-11	Roof Mounted	$	843,425
City of Waltham, Phase I	Dec-11	Roof Mounted	$	1,150,000
Milton Academy	Aug-12	Roof Mounted	$	816,400
Weston, MA Phase 2	Jul-17	Rooftop	$	440,880
Bridgewater State University	May-11	Roof Mounted	$	745,000
Mt. Wachusetts Community College	Dec-09	Roof Mounted		
Canton Housing Authority	Dec-11	Roof Mounted	$	400,000
City of Revere	Dec-09	Roof Mounted		
Cambridge Housing Authority	Dec-11	Roof Mounted		
Worcester State University	Oct-11	Roof Mounted	$	300,000
Brockton Transit Authority	Dec-09	Roof Mounted		
Town of Saugus, MA	Sep-17	Landfill	$	3,900,000
MassDOT Phase 1b	Aug-17	Ground Mounted	$	7,400,000
Mathworks	May-17	Rooftop		TBD
Town of Lenox, MA	Dec-17	Landfill	$	2,600,000
MS Walker Solar	Dec-17	Roof Mounted	$	1,450,000
City of Northampton, MA	Nov-17	Landfill	$	7,200,000
Town of Stockbridge Landfill	Feb-18	Landfill	$	2,400,000
MassDOT Phase 2 - Hopkinton	Feb-18	Parking Canopy, Rooftop	$	3,675,000
Town of Bethel, CT	Dec-17	Landfill	$	2,700,000
Providence Water Company	Dec-17	Rooftop	$	1,398,930
Total			**$**	**142,356,650**

In Construction				
Readington NJ	Jan-18	Rooftop and Ground Mounted	$	3,000,000
Abington, MA	Mar-18	Rooftop	$	989,920
Portland Intl Jetport	Jun-18	Rooftop	$	1,230,250
Northbridge Companies	May-18	Rooftop	$	1,230,250
Total			**$**	**6,450,420**

Awarded				
Zervas School Solar PV	Jul-17	Rooftop	$	422,280
New Milford, CT	Dec-18	Ground Mounted	$	40,500,000
Hampden, Town of Solar PV	Jun-18	Ground Mounted	$	11,026,080
Lanesborough, Town of Solar PV	Jun-18	Ground Mounted	$	2,312,500
Town of Hamilton, MA	Sep-18	Landfill	$	2,101,540
Town of Westport, MA- Solar PV	Jun-18	Ground Mounted	$	1,856,400
Natick - Senior Center Canopies	Jun-18	Canopy	$	2,101,540
North Kingstown Solar PV	Jun-18	Ground Mounted	$	3,915,000
Wayland Solar PV Resiliency		Energy Storage/Microgrid	$	224,250
PSEG Solar4All Extension	TBD	Landfill	$	10,000,000
NY OGS Solar RFI	TBD	?	$	4,500,000
Total			**$**	**78,959,590**

C.2: Average Commercial Grid-Connected PV System Size

- *Average commercial grid-connected PV system size installed by your company during the last five years.*

Over the past five (5) years Ameresco has installed 172 PV systems at an Average size of 592kW. Our landfill projects average over 1.5 MW in size.

C.3: Total Commercial MWp of Grid-Connected PV Systems

- *Total commercial MWp of grid-connected PV systems installed under straight sales and Power Purchase Agreements.*

Ameresco has installed a total of 145.964MW of Solar PV projects, a combination of Design-Build projects and Power Purchase Agreements in which Ameresco owns the project for the lifetime of the contract.

C.4: Experience with Local Government Projects

- *Experience with local government projects.*

Ameresco has design, permitted, and installed over **25 MW-DC** of solar PV systems on capped landfills in New England for municipal customers. We are currently in the development process on several other awarded landfill projects. Ameresco's understands municipalities and their desire to maximize the beneficial use of their landfill sites, while minimizing project risk and expenditures.

State and Local Permitting Experience for Landfills

Ameresco has worked with the Central, Northeast, Western, and Southeast regions of the MassDEP, and Connecticut DEEP on the permitting of these projects.

The Ameresco team also has engaged with City and Town boards and departments to address siting, wetlands aesthetics and other concerns under local jurisdiction for all of our solar PV projects. Landfills in MA are often located adjacent to wetlands and/or rivers (in fact, they have often been sited in wetlands in the past), and so particular attention must be paid to wetlands permitting requirements. In addition, there are often concerns on the part of local residents and abutters in terms of aesthetics and other environmental issues. We address these concerns through direct engagement via Site Plan review and other meetings to hear concerns and provide education and practical solutions.

Of note is that we are currently moving forward with design, permitting and construction of a solar PV system at Portland, ME International Jetport. We expect to complete this system in Summer of 2018.

Section D: References

List three (3) or more references for power purchase agreements for solar PV projects or developments within the past five (5) years. Include for each project:

- *Project name & location*
- *Project size (total cost and project capacity in kW)*
- *Project type – turnkey or third party energy sales*
- *Cumulative kWh produced since system installation*
- *Year completed*
- *Name of project manager*
- *Name of client contact*
- *Physical description of the project (equipment manufacturer, model, etc.)*
- *A brief discussion of any specific challenges and how they were overcome*

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Groton Electric Light Department – Groton Landfill

Project Name and Location	**GELD - Town of Groton Landfill** **600 Cow Pond Brook Rd, Groton, MA 01450**
Project Size **(total cost and project capacity kW)**	$6,000,000 2900 kW
Project Type **(turnkey or third-party energy sale)**	PPA – Groton Electric & Light Department
Cumulative kWh **(produced since system installation)**	5,880,000
Year Completed	2016
Name of Project Manager	Geri Kantor
Name of Client Contact	Kevin Kelly Manager, GELD 23 Station Avenue, Groton, MA kpkelly@grotonelectric.org 978-448-1150
Physical Description of the Project **(equipment manufacturer, model, etc.)**	Landfill – Ballasted Solar 4x5 Ground mount Array
Challenges Met	During construction, this project required special fencing to keep Blandings turtles out of the work site, as required by the Massachusetts Natural Heritage and Endangered Species program. Another construction challenge included a storm at sea which resulted in the loss of several pallets of solar modules during shipping, however close coordination with our module manufacturer enabled the replacement of the lost modules with ultimately no delay to the project completion date.

This 2.9 MW landfill and ground mount project was built on the Town of Groton capped landfill for the local municipal utility, GELD. The solar installation will supply the more than 10,000 residents of the Town with renewable energy for the next 25 years. During construction, this project required special fencing to keep Blandings turtles out of the work site, as required by the Massachusetts Natural Heritage and Endangered Species program. Another construction challenge included a storm at sea which resulted in the loss of several pallets of solar modules during shipping, however close coordination with our module manufacturer enabled the replacement of the lost modules with ultimately no delay to the project completion date. The solar PV system began commercial operation in June 2016.

City of Pittsfield – Pittsfield Landfill

Project Name and Location	**City of Pittsfield** **6 Downing IV Parkway, Pittsfield, MA**
Project Size **(total cost and project capacity kW)**	$6,800,000 2910 kW
Project Type **(turnkey or third-party energy sale)**	PPA – City of Pittsfield
Cumulative kWh **(produced since system installation)**	3,456,000
Year Completed	2017
Name of Project Manager	Joel Lindsay
Name of Client Contact	James McGrath Director – Parks and Open Space 110 North Rd, Pittsfield, MA jmcgrath@pittsfieldch.com 413-499-9330
Physical Description of the Project **(equipment manufacturer, model, etc.)**	Landfill – Ballasted Solar 4x5 Ground mount Array
Challenges Met:	The main access to the site is through a Town owned animal shelter. Ameresco worked closely with the City of Pittsfield and animal shelter management to create an accessway that allowed efficient access to the site while protecting the animals and animal shelter employees.

The City of Pittsfield, Massachusetts selected Ameresco to use the City of Pittsfield landfill for a solar PV project. The 2.91 MW DC facility is a ballasted solar PV system that sits on top of the landfill cap to protect landfill's cap integrity. The facility employs 9,538 solar panels and went into commercial operation in January 2017.

City of Northampton – Northampton Landfill

Project Name and Location	**City of Northampton** **Glendale Road, Florence, MA 01062**
Project Size **(total cost and project capacity kW)**	$7,200,000 3170 MW
Project Type **(turnkey or third-party energy sale)**	PPA – City of Northampton
Cumulative kWh **(produced since system installation)**	796,646
Year Completed	2017
Name of Project Manager	Joel Lindsay
Name of Client Contact	Chris Mason 210 Main Street Northampton, MA 01060 cmason@northamptonma.gov
Physical Description of the Project **(equipment manufacturer, model, etc.)**	Ballasted and Ground Mounted Solar PV
Challenges Met:	Ameresco designed the solar PV system for minimum interference with the active landfill gas collection system while maximizing system size in the usable area. This required detailed analysis of piping locations and coordination with City engineering staff.

The City of Northampton, Massachusetts selected Ameresco to use the City of Northampton landfill for a solar PV project. The 3.17 MW DC facility is a combination of a ballasted solar PV system that sits on top of the landfill cap, and a ground mounted system to the southern portion of the array. The facility employs 9,920 solar panels and went into commercial operation in November 2017.

Massachusetts Department of Transportation

Project Name and Location	**MA DOT Highway Solar – Phase 1A** **Multiple locations - MA**
Project Size **(total cost and project capacity kW)**	$5,800,000 2450 kW
Project Type **(turnkey or third-party energy sale)**	PPA – Massachusetts Department of Transportation
Cumulative kWh **(produced since system installation)**	7,364,010
Year Completed	2015
Name of Project Manager	Joel Lindsay
Name of Client Contact	Hongyan (Lily) Oliver Massachusetts Department of Transportation 10 Park Plaza, Suite 4150 Hongyan.oliver@state.ma.us 857-368-9025
Physical Description of the Project **(equipment manufacturer, model, etc.)**	Various ground mount projects
Challenges Met:	Ameresco was able to efficiently and safely construct these systems adjacent to major highways by strict adherence to MADOT safety and access protocols, and rigorous management of daily activities and access needs for equipment delivery and assembly.

The Massachusetts Department of Transportation selected Ameresco from a competitive procurement on an innovative solar PV project using excess MassDOT land along Massachusetts state highways. Through this public-private partnership, MassDOT is expected to save $15 million over the 20-year project life, and zero up-front capital was required from MassDOT. The DOT will also receive lease revenue for each of the individual sites. Phase 1A of the project was completed in August 2015 and includes a total of 2.45 MW of solar PV.

MassDOT also asked Ameresco to complete a Phase 1B project (ground mounts) and a Phase 2 project (parking canopy and roof of new building) to meet the SREC II deadline set by the DOER.

City of Newton, MA – Newton Rumford Landfill

Project Name and Location	Newton Rumford Landfill Project
Project Size (total cost and project capacity kW)	$4,000,000 2170 MW
Project Type (turnkey or third-party energy sale)	PPA – City of Newton
Cumulative kWh (produced since system installation)	2,788,105
Year Completed	2017
Name of Project Manager	Geri Kantor
Name of Client Contract	Bill Ferguson, Energy Project Manager 1000 Commonwealth Ave Newton Centre, MA 02459 wferguson@newtonma.gov Phone: 857-404-4929
Physical Description of the Project (equipment manufacturer, model, etc.)	Ballasted Landfill, Canopy, Flat Rooftop, Pitched Rooftop
Challenges Met:	For this project Ameresco took on responsibility for material processing and removal of over 70,000 cy of composting organic material, plus site regrading, without the benefit of good survey data or other information on the total material amounts and composition. The project still met the incentive program deadline, for which no extensions would have been allowed.

In late 2015, Ameresco was awarded the 2.17 MW DC Newton Rumford landfill project. This closed and capped landfill was still an active DPW operations site that had been used for storage of street excavate, street sweepings and as a compost operation. As part of the preparation of the site for solar PV, Ameresco processed, reused or disposed of more than 70,000 cubic yards of on-site material, which added four to five months to a typical solar PV site preparation timeline. The existence of the material further complicated the solar PV design, as we worked closely with the DEP and the Town's engineering firm to develop at least five iterations of a grading plan that would accommodate continued DPW operations at the site, maximize the area available for the solar PV array, and minimize the cost associated with the processing and disposal of the existing on-site material.

This 2.17 MW DC project is comprised of nearly 6,700 325W solar panels and 47 string inverters for an AC capacity of 1.67 MW. The project reached mechanical completion in April, nearly two weeks ahead of the May 8th deadline and was in operation by July 2017.

The aerial photo of the site shown in this section was taken at approximately 90% completion.

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Section E: Technical Description

E.1: System Schematic Design Layout

- *A system schematic design layout for the solar PV system, including PV model type and model number, wattage, number of modules, year 1 estimated production, degradation percentage, inverter type and model, mounting system type, azimuth, tilt, and system size (AC and DC).*
- *Details about the estimated kilowatt hours (kWh) generated by the proposed PV systems, including all necessary assumptions such as sunlight availability, dark time, maintenance downtime, mean time between failures, efficiency of the system proposed, efficiency losses, and net metering.*
- *A complete project schedule indicating major project milestones and durations.*

Ameresco's system plan is based on:

- Site visit to the premises on March 23rd, 2018
- Long-term weather/solar data analysis using PVSyst
- Discussions with our environmental, civil, and electrical subcontractors, and
- Engineering design and evaluation by our in-house engineers.

The following equipment types and configurations were selected to maximize the performance of the system.

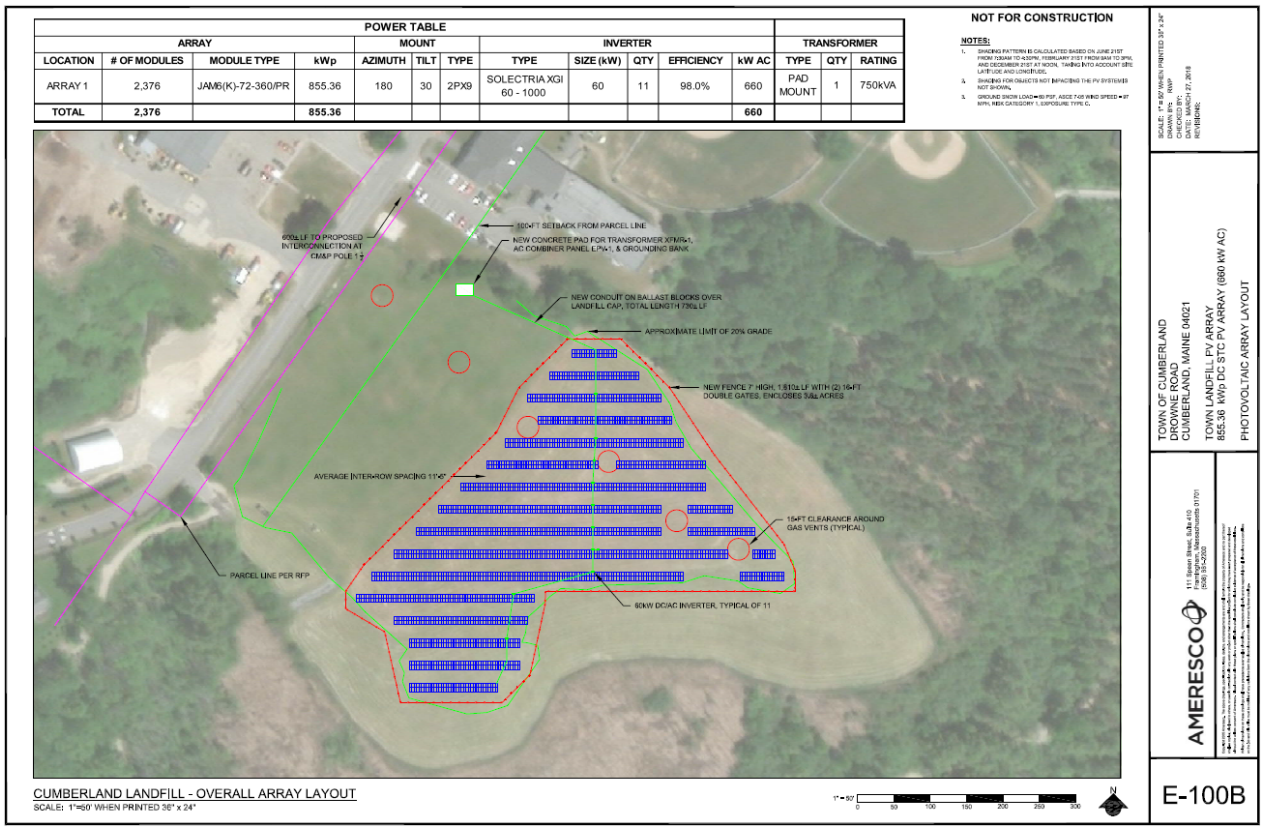
Proposed Ground-Mount System Installation Details

The table below specifies the equipment for the 855.36 kW DC (660 kW AC) PV project at the Town of Cumberland Landfill on Drowne Road. A system layout below shows the proposed locations of all modules, inverters, transformers, medium voltage equipment, and utility interconnection point. Manufacturer's specification sheets for materials can be found in **Appendix D** (equipment/materials subject to change). Note that 660kW AC is the maximum size for Net Energy Billing (NEB) in Central Maine Power (CMP) territory. The 1,176,000kWh/year that will be produced by the system is greater than the Town's usage of 650,812kWh. Ameresco will structure the project as a community solar project to allow up to 9 other off-takers to subscribe for a percentage of the remaining output beyond what the Town uses to offset its bills.

Middle Road Landfill – Town of Stockbridge, Massachusetts

Design	DC Capacity (kW)	AC Capacity (kW)	Inverter Type	Inverter (Qty) Model-kW	Racking Manufacturer	Racking Design	Tilt Angle	kWh/ Year	kWh/ kWp/ Year
Cumberland Landfill	855.36	660	String	(11) Solectria XGI 60 – 1000V	Ballasted Solar FlexRack	2X9 Portrait	30°	1,176,000	1,375

The proposed system layout is shown below. The array is set-back from the street to help mitigate possible abutter concerns. Ameresco will work with the Town and concerned abutters as necessary to develop a workable screening solution as needed.



POWER TABLE

ARRAY				MOUNT			INVERTER					TRANSFORMER		
LOCATION	# OF MODULES	MODULE TYPE	kWp	AZIMUTH	TILT	TYPE	TYPE	SIZE (kW)	QTY	EFFICIENCY	kW AC	TYPE	QTY	RATING
ARRAY 1	2,376	JAM6(K)-72-360/PR	855.36	180	30	2PX9	SOLECTRIA XGI 60 - 1000	60	11	98.0%	660	PAD MOUNT	1	750kVA
TOTAL	2,376		855.36								660			

NOT FOR CONSTRUCTION

NOTES:
1. SHADING PATTERN IS CALCULATED BASED ON JUNE 21ST FROM 7:00AM TO 4:30PM, FEBRUARY 21ST FROM 9AM TO 3PM, AND DECEMBER 21ST AT NOON, TAKING INTO ACCOUNT SITE LATITUDE AND LONGITUDE.
2. SHADING FOR OBJECTS NOT IMPACTING THE PV SYSTEM IS NOT SHOWN.
3. GROUND SNOW LOAD = 60 PSF, ASCE 7-05 WIND SPEED = 97 MPH, RISK CATEGORY 1, EXPOSURE TYPE C.

CUMBERLAND LANDFILL - OVERALL ARRAY LAYOUT
SCALE: 1"=50' WHEN PRINTED 36" x 24"

TOWN OF CUMBERLAND
DROWNE ROAD
CUMBERLAND, MAINE 04021

TOWN LANDFILL PV ARRAY
855.36 kWp DC STC PV ARRAY (660 kW AC)

PHOTOVOLTAIC ARRAY LAYOUT

AMERESCO

E-100B

System Installation: Design Benefits

Ameresco's design objectives are always a) to lower the system installation costs for a given amount of constructed solar PV capacity (expressed as $/watt) and b) to increase the alternating current (AC) electricity generation output for the same generation capacity (expressed as kWh(AC)/kW(DC)).

For the Cumberland Landfill project, the design choices that best achieved these objectives were the inverter and racking selection as follows:

- **Inverters**: Ameresco will provide string inverters for the PV system. This inverter option was chosen as the most cost-effective means of complying with 2017 NEC requirements including rapid shutdown and arc fault detection. The selected inverters provide three-phase, 480-Volt output for economic power delivery to transformers. String inverters are selected for system installation to provide the optimal DC to AC conversion ratio for the proposed system capacity on the available land area. This design decision results in an optimized project option with a lower installation cost and lower PPA payment for the Town.

- **Racking:** The proposed Solar FlexRack racking system will have 2x9 (2 panels high by 9 panels long) galvanized steel table racks and panels will be installed in portrait configuration. Each rack is supported by two (2) concrete ballast blocks. Racking solutions with two concrete ballast blocks have the following advantages:
  - Designed for the uneven topography of a landfill by being easily adjusted for land settling;
  - Speeds installation time by construction workers since there are only two concrete blocks to install per rack section – lowering the $/watt ratio;
  - Increases power density as panels are stacked in portrait formation in the 2x9 configuration with a lower percentage of inter-row space than a racking solution with a single panel in height (such as Panel Claw or Solstice ballasted ground mount solutions).
  - Increased winter generation output as the panels are elevated off the ground for snow with the lowest point on the south edge of the panels not less than 2.5' above the ground.

Other Proposed Design Elements

Additional design elements include:

- **Installation Type**: Ballasted ground mount, 2x9 in portrait racks, 2 concrete blocks per rack.
- **Installation Area**: Covering the majority of the landfill. Slope between 0 – 6 degrees
- **Additional Fill**: Not expected.
- **Ground Preparation**: Installation of gravel underneath the concrete ballast blocks and for access roads on landfill cap.
- **DC System Voltage:** 1000 VDC
- **Module Orientation**: Portrait, 30-degree tilt to maximize generation and only 2-high to minimize inter-row spacing and maximize panel capacity. However, the resulting 13-foot inter-row spacing will still be sufficient to allow mowing.
- **Module Size**: 72-cell, 360W polycrystalline
- **String Size**: 18-module
- **Interconnection Point**: Three phase utility line adjacent on the site to be used as interconnection point.
- **Insolation Data**: For our PVSyst analysis, we are using insolation data from Portland, ME.

Additional Design Considerations

As described, above, Ameresco evaluates alternative solar PV technologies and site design choices to:

a) Increase electricity generation efficiency (kWh(AC)/kW(DC));
b) Reduce installation costs per installed capacity ($/Watt), and:
c) Increase the total power generation capacity (kW installed).

a) Design Decisions that Increase Generation Efficiency

- Systems oriented due south to face most directly toward the sun for the longest sunshine hours of the day;
- PV racking inter-row spacing set to minimize row-to-row shading with a Shading Limit Angle of 22 degrees;
- DC equipment designed to operate at 1000 Volts, which reduces DC loses compared to 600-Volt systems;
- Racks elevated 2.5 feet off the ground with a 30-degree tilt -- facilitating snow sliding from the panels more quickly than flatter rack configurations, optimizing generation for Massachusetts winters.
- Maintain inter-row spacing distance at 3X to maximize annual system output
- Maintain tilt angle of 30 degrees to maximize annual system output

b) Design Decisions that Lower Installation Costs

- Racking system includes "tables" of several (18) solar modules mounted together, which increases installer efficiency during construction;
- DC equipment utilizing 1000 volts has lower wiring and balance of system costs compared to 600-volt systems

Equipment Selection

Ameresco has exclusively installed polycrystalline and monocrystalline PV modules from Tier I module manufacturers for our projects under Power Purchase Agreements, Energy Management Services Agreements and Leases. Ameresco only sources from Tier I suppliers to ensure the quality of the product as well as the longevity of the manufacturer to ensure the warranty can be upheld for the duration of their term. With our solar experience, we recommend one of the following manufacturers, all of which we have used on past projects:

- **Solar Modules:** Canadian Solar, JA Solar, Jinko Solar, Hanwha, Hyundai or Trina Solar
- **Inverters:** Solectria/Yaskawa, SMA, Sungrow or Power Electronics
- **Mounting System**: Terrasmart, Schletter, SolarFlex Rack, Panel Claw, RBI, Solaire (carports)
- **Data Acquisition System**: Draker or AlsoEnergy

Ameresco is vendor neutral. At this point Ameresco has not made a commitment or guarantee to use any specific equipment manufacturer. Prior to construction, Ameresco will select the Tier 1 manufacturer and procure the equipment that provides the most cost effective and highest quality solar PV system to be installed at the specific sites.

The following table summarizes the specific warranties as examples of components we propose to use for this project. In Ameresco's experience, all active warranties are transferrable should the ownership of the system change.

Equipment	Manufacturer	Warranty Provisions
Modules	JA Solar, Canadian Solar, or similar	• During the first year, JA Solar guarantees the actual power output of the module will be no less than 97% of the labeled power output. • From year 2 to year 24, the actual annual power decline will be no more than 0.7%; by the end of year 25, the actual power output will be no less than 80% of the labeled power output
Inverter	Solectria/Yaskawa, SMA or similar	• Standard 10 year warranty • Warranty extensions to 15 and 20 years are available for all inverters.
Racking	Solar FlexRack, Panel Claw, RBI, or similar	Warranty for products' durability for a period of twenty (20) years after the date the Project is Substantially Completed.
DAS	Draker	Standard 5 year warranty on hardware features.

Schedule

c) Schedule: Include a Preliminary Project Implementation Schedule that accounts for milestones in the Design, Construction and Closeout Stages. Milestones should include (at a minimum):

- *Award & Contract Negotiation*
- *Design Period*
- *Permitting*
- *Installation*
- *LDC Interconnection*
- *System Commissioning (Energizing)*
- *Delivery of Closeout Documentation*

RFP-REQUIRED MILESTONE	AMERESCO'S PROPOSED MILESTONE DATE
Award and Contract Negotiation	04/18-05/31/2018
Design Period	05/1-6/14/2018
Permitting	06/15-09/15/2018
Installation	10/15/2018-03/15/2019
LDC Interconnection	04/30/2019
System Commissioning	03/31 – 04/30/18
Delivery of Closeout Documentation	05/31/2019

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Appendix A: Pricing Proposal Form

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PRICING PROPOSAL FORM
FOR A SOLAR POWER PURCHASE AGREEMENT
Town of Cumberland

PAGE 1

Solar Provider Name:	Ameresco, Inc.
Facility Name:	Town of Cumberland Landfill Solar PV

System Equipment

Photovoltaic Module:	
Manufacturer or equivalent:	JA Solar, Jinko Solar, Canadian Solar, or similar
Model or equivalent:	360W Mono or similar
Quantity (panels):	2,376
Inverter:	
Manufacturer or equivalent:	Solectria or similar
Model or equivalent:	Solectria XGI60-1000 or similar
Quantity (inverters):	11

System Cost	**Cost**	**$/kilowatt**
Generating equipment:	$1,015,000	$1,186/kW
Balance of system:	$166,000	$194/kW
Engineering and permitting:	$118,800	$133.9/kW
Construction and installation:	$545,900	$638.2/kW
Operations and maintenance:	$15,000/year	$17.5/kW/Year
Removal cost:	$50,000	$58.5/kW
Total:	$1,910,700	$2,233/kW

PRICING PROPOSAL FORM
FOR A SOLAR POWER PURCHASE AGREEMENT
Town of Cumberland

PAGE 2

Solar Provider Name:	Ameresco, Inc.
Facility Name:	Town of Cumberland Landfill Solar PV

	KW (STC)	**kW (PTC)**
Capacity:	855.38	786.97

	KWh at the meter
Annual AC production	1,175,954

Price Schedule

Year	**Price per kWh**
1	*see below for 30year pricing
2	
3	
4	
5	
6	
7	

Price Schedule - 30 Year PPA	
Year	**Price per kWh ($/kWh)**
1	0.0940
2	0.0964
3	0.0988
4	0.1012
5	0.1038
6	0.1064
7	0.1090
8	0.1117
9	0.1145
10	0.1174
11	0.1203
12	0.1233
13	0.1264
14	0.1296
15	0.1328
16	0.1361
17	0.1395
18	0.1430
19	0.1466
20	0.1503
21	0.1540
22	0.1579
23	0.1618
24	0.1659
25	0.1700
26	0.1743
27	0.1786
28	0.1831
29	0.1877
30	0.1924

PRICING PROPOSAL FORM
CLOSED LANDFILL SITE FOR SOLAR DEVELOPMENT
Town of Cumberland

Solar Provider Name:	Ameresco, Inc.
Facility Name:	Town of Cumberland Landfill Solar PV

System Equipment

Photovoltaic Module:	
Manufacturer or equivalent:	JA Solar, Jinko Solar, Canadian Solar, or similar
Model or equivalent:	360W Mono or similar
Quantity (panels):	2,376
Inverter:	
Manufacturer or equivalent:	Solectria or similar
Model or equivalent:	Solectria XGI 60-1000 or similar
Quantity (inverters):	11

System Cost	**Cost**	**$/kilowatt**
Generating equipment:	$1,015,000	$1,186/kW
Balance of system:	$166,000	$194/kW
Engineering and permitting:	$118,800	$133.9/kW
Construction and installation:	$545,900	$17.5/kW/Year
Operations and maintenance:	$15,000/year	$58.5/kW
Removal cost:	$50,000	$58.5/kW
Total:	$1,910,700	$2,233/kW

Solar Energy Purchaser(s): A description of the type of project proposed and solar energy purchaser(s).

Ameresco will structure the project as a community solar project to allow up to 9 other off-takers to subscribe for a percentage of the remaining output beyond what the Town uses to offset its bills. The Town will only be required under the PPA to purchase enough power to off-set their energy usage for a given year of the contract.

Appendix B: Maine Licenses

- Maine's Authority to Do Business License
- List of Professional Engineers licensed in Main
    - We will provide Professional Engineering certificates upon request.

Employee Name	State	License Number	Expiration Date	Type
Anderson, Kenneth C.	ME	6607	12/31/19	Mechanical
Bruce, Mark	ME	8099	12/31/19	Mechanical
Daigneault, Michael	ME	12311	12/31/19	Mechanical
Hall, Nathan	ME	12650	12/31/19	Mechanical
Pitreau, Brian	ME	12456	12/31/19	Mechanical
VonSaltza, Carl	ME	8048	12/31/19	Mechanical

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FOREIGN
BUSINESS CORPORATION

STATE OF MAINE

APPLICATION FOR AUTHORITY TO DO BUSINESS

Fil File No. 20030706 F Pages 3
Fee Paid $ 250
DCN 2030311600017 QUAL
----FILED----------
01/28/2003

Julie L Flynn
Deputy Secretary of State

A True Copy When Attested By Signature

Julie L Flynn
Deputy Secretary of State

Ameresco, Inc.
(Name of Corporation in Jurisdiction of Incorporation)

Pursuant to 13-A MRSA §1202, the undersigned corporation applies for authority to do business in the State of Maine:

FIRST: If different, the name under which it proposes to apply for authority to do business in the State of Maine pursuant to §301 (if not applicable, so indicate)

☐ Form MBCA-12F accompanies this application.

SECOND: Its jurisdiction of incorporation is Delaware and the date of incorporation is April 25, 2000

THIRD: Business(es) it is authorized to do under the laws of its jurisdiction of incorporation

Energy Conservation Consulting/Services

FOURTH: Does it seek authority to engage in all businesses authorized in its jurisdiction and allowed by Maine Law?

☒ Yes ☐ No If no, specify business(es) for which authority is sought

FIFTH: Address of the registered or principal office, wherever located, is 111 Speen Street, Suite 410
Framingham, MA 01701
(street, city, state and zip code)

SIXTH: The name of its proposed Registered Agent, an individual resident in Maine or a corporation authorized to do business in Maine, and the physical location of the proposed registered office in Maine shall be:

CT Corporation System
(name)

One Portland Square, Portland, Maine 04101
(physical location - street (not P.O. Box), city, state and zip code)

(mailing address if different from above)

SEVENTH: Number of shares it has authority to issue, itemized as follows: (attach separate sheet if necessary)

Class	Series	Par Value Per Share	Number of Shares
Common	A	.0001	30,000,000
Preferred	A	.0001	5,000,000

EIGHTH: This application is accompanied by an original certificate of good standing, executed by the official in the jurisdiction of incorporation having custody of the corporate records, stating that the corporation has legal existence, good standing or similar language and dated not earlier than 90 days prior to the date of delivery for filing of this application.

DATED January 23, 2003

*By _____
(signature of any duly authorized individual)

David J. Corrsin/Secretary
(type or print name and capacity)

THE FOLLOWING SHALL BE COMPLETED BY THE REGISTERED AGENT UNLESS THIS DOCUMENT IS ACCOMPANIED BY FORM MBCA-18 (§1212.1-A.).

The undersigned hereby accepts the appointment as registered agent for the above named foreign business corporation.

REGISTERED AGENT

DATED 1/21/2003

_____
(signature)

_____
(type or print name)

For Registered Agent which is a Corporation

Name of Corporation CT Corporation System

By Amy Berteletti
(authorized signature)

Amy Berteletti
(type or print name and capacity)
Spec. Asst. Secretary

*This document MUST be signed by any duly authorized individual.

SUBMIT COMPLETED FORMS TO: CORPORATE EXAMINING SECTION, SECRETARY OF STATE,
101 STATE HOUSE STATION, AUGUSTA, ME 04333-0101
TEL. (207) 624-7740

FORM NO. MBCA-12 Rev. 4/16/2001

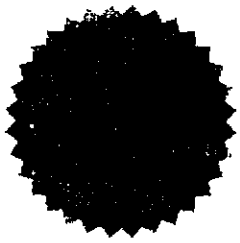
Delaware

The First State

I, HARRIET SMITH WINDSOR, SECRETARY OF STATE OF THE STATE OF DELAWARE, DO HEREBY CERTIFY "AMERESCO, INC." IS DULY INCORPORATED UNDER THE LAWS OF THE STATE OF DELAWARE AND IS IN GOOD STANDING AND HAS A LEGAL CORPORATE EXISTENCE SO FAR AS THE RECORDS OF THIS OFFICE SHOW, AS OF THE TWENTY-FOURTH DAY OF JANUARY, A.D. 2003.

AND I DO HEREBY FURTHER CERTIFY THAT THE ANNUAL REPORTS HAVE BEEN FILED TO DATE.

AND I DO HEREBY FURTHER CERTIFY THAT THE FRANCHISE TAXES HAVE BEEN PAID TO DATE.



Harriet Smith Windsor

Harriet Smith Windsor, Secretary of State

3216839 8300

030050345

AUTHENTICATION: 2222832

DATE: 01-24-03

Appendix C: Resumes

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JAMES WALKER, PE
Vice President, Solar PV Grid-Tie Projects

Education
M.B.A., Massachusetts Institute of Technology

B.S., Mechanical Engineering, Magna Cum Laude, Tau Beta Pi Engineering Honor Society – University of Massachusetts Amherst

Licenses & Certifications
Registered Professional Engineer (P.E.) MA

Professional Affiliations
Airport Cooperative Research Program. Board Review Member. Guidebook for Energy Facilities Compatibility with Airports and Airspace.

Treasurer and Officer, Board of Directors, M.I.T. Enterprise Forum of Cambridge – Six Years

Acton Economic Industrial Development Corporation – Past Board Member

Awards
2006 Presidential Citation from the MIT Association of Alumni and Alumnae for creating and co-founding the Ignite Clean Energy Business Plan Competition

2005 Volunteer of the Year Award from the MIT Enterprise Forum

Project Role:

Mr. Walker is Ameresco's Vice President of Solar Grid-Tie Projects, responsible for Ameresco's solar photovoltaic grid-tie business. Mr. Walker works with our customers to structure Power Purchase Agreements and land lease agreements that provide the best customer value. Mr. Walker also meets with tax assessors, Board of Alderman, Board of Selectmen, siting council members, town and city managers, and town finance committee members to find mutually beneficial agreements to site and build solar PV projects. Mr. Walker is also responsible for meeting with legislators and regulators to educate policy makers on the benefits of solar PV.

Mr. Walker brings 40 years of diverse energy experience in the power and natural gas industry, which included a focus on energy conservation engineering early in his career, then natural gas and power supply trading and delivery during the deregulation period, then technology business development and strategic energy market analysis to energy companies, and currently solar PV business growth and management.

Project Experience:

Mr. Walker has directly developed and/or, through his staff, managed the development of more than 70 solar PV constructed projects totaling more than 25 MW. Projects currently in construction will bring an additional 40 MW to our future constructed portfolio. Awarded projects are more than 71 MW, which we expect to move into construction within the year. Our proposed projects, but not yet awarded set of projects, are more than 230 MW.

JAMES WALKER, PE
Vice President, Solar PV Grid-Tie Projects

Professional Experience

Ameresco
Vice President, Solar PV Grid Tie Business Unit

Global Insight
Managing Director, Energy

Sun Microsystems
Director, Global Energy Business Development

Forrester Research
Senior Analyst, Energy Trading and Markets

XENERGY, Inc.
Senior Vice President, Energy Services

GTE Corporation
Corporate Energy Manager

Representative operating projects:

Project	Number of Sites	Size kW DC	Location
Completed Projects			
Fisher Road Solar I	1	6,000	Dartmouth, MA
MassDOT Phase 1a	5	2,537	Various in MA
City of Waltham, Phase II	6	1,738	Waltham, MA
Town of Acton	1	1,592	Acton, MA
City of Lowell, Phase II	1	1,502	Lowell, MA
Town of Sudbury	1	1,502	Sudbury, MA
Braintree Electric Light Department	1	1,300	Braintree, MA
Town of Lexington, MA	6	1,110	Lexington, MA
Town of Arlington, MA	6	719	Arlington, MA
City of Newton	4	686	Newton, MA
Braintree Electric Light Department Phase 2 - Braintree High School	2	664	Braintree, MA
City of Fall River	4	576	Fall River, MA
Town of Natick, Phase II	3	522	Natick, MA
City of Newburyport	2	502	Newburyport, MA
West Newbury, MA	1	440	West Newbury, MA
City of Hutchinson	1	400	Hutchinson, MN
Massport - Logan International Airport	2	370	Boston, MA
City of Lowell, Phase I	5	348	Lowell, MA
Town of Natick, Phase III	2	311	Natick, MA
City of Melrose	1	301	Melrose, MA
Walnut Hill School	1	235	Natick, MA
City of Englewood, CO	4	219	Englewood, CO
Town of Natick, Phase I	1	213	Natick, MA
City of Waltham, Phase I	1	193	Waltham, MA
Milton Academy	1	192	Milton, MA
Bridgewater State University	1	103	Bridgewater, MA

JOEL LINDSAY, P.E., C.E.M
Director – Solar PV Project Development

Education
MS, Environmental Engineering – University of California – Berkeley

B.A., Geology – Princeton University

Licenses & Certifications
Professional Engineer – Massachusetts

Certified Energy Manager

Professional Affiliations
Association of Energy Engineers

Professional Experience
Ameresco,
2013 - Present
Director – Solar PV Project Development

Weston Solutions, Inc.,
1997-2013
(various positions)
Technical Director
2008 – 2013
Senior Program Manager
2004 – 2008
Senior Project Manager
1997 – 2004

Rizzo Associates, Inc.
1991 – 1997
Project Manager

Project Role:

Mr. Lindsay is a Director of Project Development within the Solar PV Grid-Tie group in Framingham, MA. He is responsible for development and implementation of commercial and utility scale solar PV projects in Massachusetts and across New England. Mr. Lindsay has experience in developing, permitting, and interconnecting solar PV projects across the Northeast, including Massachusetts. He also has extensive past experience in design and construction of large scale environmental remediation projects under CERCLA and Massachusetts Contingency Plan requirements.

Mr. Lindsay has expertise in the development, permitting, design and construction of commercial and utility scale solar PV projects, including conceptual design and development of solar PV project configurations, PPA development and negotiation, environmental permitting, and interconnection. Mr. Lindsay combines solar PV expertise with an extensive background in contaminated site assessment and remediation, and beneficial re-use. Mr. Lindsay drives solar PV development projects with municipalities, school systems, and commercial/industrial corporations.

Project Experience:

City of Pittsfield Landfill Solar, MA 2.9MW Solar Project	**$7.2M**
Town of Weston Landfill Solar, MA 2.2MW Solar Project	**$5.5M**
Town of Lexington Municipal, MA 1.1 MW Solar Project	**$3.5M**
Town of West Newbury Ground Mount 650 kW Solar Project	**$1.6M**
MassDOT Solar PV Program, MA 6MW Solar Project	**$12M**
Greater Lawrence Regional Technical School, MA 4MW Solar PPA	**$10M**
Technology Drive Solar – Brattleboro, VT 2.4MW Solar Project	**$5.5M**
Technology Drive Solar, Brattleboro, VT 2.5 MW Solar Project	**$5M**

LUIS F. ALEGRIA
Director – Solar PV Development Engineering

Education
Master of Science in Energy Engineering, Solar Option – University of Massachusetts Lowell 2002

Bachelor of Science in Electrical Engineering – Universidad del Valle, Colombia, South Africa 1991

Licenses & Certifications
NEBCEP Certification

ASTM, IEC-US 82 Tag

Professional Experience
Ameresco, 2016 – Present
Director – Solar PV Development Engineering

Ameresco, 2015 – 2016
Manager - Development Engineering, PV-Grid -Tie

Ameresco, 2010 – 2015
Senior Project Management Engineer

Evergreen Solar Inc, 2005 – 2010
Manager, Technical Sales and Applications and Field Support Engineer, Product Development Engineer

Global Transition Group, 1999-2004
PV system/Product/Applications Engineer

Merck Colombia S.A, 1992-1998
Technical Support Coordinator

AEI Ltd., 1992-1995
Technical Support Engineer

Project Role:

Luis Alegria has over 17 years of experience in the Renewable Energy Industry. Alegria has knowledge of different RE technologies including PV, Wind, Solar Thermal and Passive Solar. Alegria is knowledgeable in the following areas: PV System Design and Engineering, NEC regulations, PV Product Sales, PV system Troubleshooting, Technical Training, UL and IEC Certification, PCB / Electronic Design, and Product Testing.

Solar PV Project Experience:

City of Waltham, MA Ph 2	$ 6,270,000
Town of Acton, MA Landfill	$ 6,000,000
City of Lowell, MA Landfill	$ 5,800,000
Town of Sudbury, MA Landfill	$ 4,900,000
City of Fall River, MA	$ 2,370,000
Town of Natick, MA Ph 2	$ 2,272,000
City Newburyport, MA	$ 3,415,000
Massport – Logan Airport	$ 2,506,000
City of Lowell, MA	$ 2,036,000
Town of Natick, MA Ph 1	$ 843,000
City of Waltham, MA	$ 1,150,000
City of Newton, MA	$ 2,500,000
Braintree Electric Light Department, MA	$ 4,600,000
Town of Lexington, MA	$ 3,750,000
Town of Arlington, MA	$ 2,100,000
Mass DOT Phase 1A, MA	$ 5,800,000
Town of Weston, MA Landfill	$ 5,700,000

Projects In Construction:

Town of Wayland, MA	$ 5,300,000
City of Pittsfield, MA Landfill	$ 6,800,000
Town of Groton, MA Landfill	$ 6,000,000
Partners Healthcare Assembly Row Solar PV, MA	$ 4,400,000

BRIAN R. PITREAU, PE, NABCEP
Engineering Team Leader

Education
B.S., Biomechanical Engineering, Worcester Polytechnic Institute

Licenses & Certifications
Professional Engineer – Massachusetts and Maine

North American Board of Certified Energy Practitioners (NABCEP)

Professional Experience
Ameresco, 2004 – Present
Senior Project Management Engineer

WB Engineers, 2002 – 2004
Mechanical Engineer, Project Manager

Project Role:

Mr. Pitreau is a senior project management engineer. With ten years of experience in energy engineering, he is responsible for taking a project from the development stage to construction. He is responsible for design and design oversight of energy efficient systems and specification of material and equipment to be used on a project. He is also accountable for ensuring systems conform to applicable codes and standards and for coordinating the work of installation subcontractors during construction.

Project Experience:

Boston Housing Authority **$63.4M**

Assisted with design of space heat decentralization, photovoltaic installation, and boiler replacements.

Providence, RI Housing Authority **$12.1M**

Boiler replacement at 20 sites. Multi-family and senior housing.

Watertown, MA Housing Authority **$3.9M**

Boiler Replacements, Boiler Plant Decentralization, Low Flow Toilets and Showerheads, Faucet Aerators, Washing Machines, Gas Dryers, Lighting, Windows, Boiler Fuel Conversions, Zone Valves, Limiting Thermostats, EMS, Cogeneration, Refrigerators

Cambridge, MA Housing Authority **$3.3M**

Developed solar design for rooftop photovoltaic installation.

Albany, NY Housing Authority – Ph. 2 **$7.9M**

Electric to Gas Heating/Hot Water Conversions, Oil to Gas Burner Conversion, Combined DHW and Hot Air Heating Systems, Radiator Bypass Valves for Zone Control, Low Flow Toilets and Showerheads, Faucet Aerators, Lighting, Refrigerators, Motor Replacements, Windows, Limiting Thermostats

WILL BLAND
Maintenance Services Supervisor

Education
Communication/Operations Management, University System of New Hampshire

Specializations

Operations management

Facilities management

Maintenance management

Construction Management

Electrical/power distribution

Cogeneration O&M

HVAC/refrigeration

Project Role:

Mr. Bland is a Project Manager with extensive energy services experience including operations, facility, and maintenance management, inventory control, budget preparation and management, and vendor and contractor negotiations and relations. He is also experienced in root cause and failure mode analysis. He has designed and implemented preventive maintenance programs, and developed and maintained predictive computer databases used to project future maintenance requirements and costs and to predict possible equipment failure. His responsibilities include the development, implementation, and monitoring of the operations and maintenance programs that ensure the long-term operational reliability of the electrical and mechanical equipment required by prescribed energy conservation and cogeneration measures.

Mr. Bland was involved in the commissioning of a new cogeneration and package boiler upgrade to the steam/power plant at Portsmouth Naval Shipyard (PNS) in Kittery, Maine. He was the commissioning manager for a shipyard-wide boiler decentralization program consisting of over 50 steam-to-hot-water heat exchangers and domestic boiler heating systems. Mr. Bland is responsible for the ongoing maintenance of the power plant steam and electrical generation equipment, building heating systems, as well as the annual testing and repair of the shipyard's compressed air system and entire complement of steam traps. He has developed short- and long-term maintenance and fiscal plans that will ensure the availability and reliability of this equipment for the next decade and a half.

In addition to these duties, Mr. Bland has the project management responsibilities for a Structural, Mechanical, Electrical (SME) contract at the Portsmouth Naval Shipyard, and is responsible for all aspects of the contract including contract negotiation; government coordination/communication with several levels of Navy personnel; and detailed work scope coordination, safety reviews, and direct oversight of subcontractors performing work on-site. His responsibilities also include the detailed tracking of all aspects of the project including sub-contractor management, submittals reviews, safety reviews, and testing as well as budget oversight and schedule coordination.

Mr. Bland is also responsible for the long term maintenance and repair programs for the HVAC and automated building control systems at York County Jail, a correctional facility in southern Maine and the Wrentham Development Center, a state run long-tern care facility in Wrentham, Massachusetts

Project Experience:

U.S. Navy Portsmouth Naval Shipyard, ME **$42 M**
15 MW cogeneration and package boiler upgrade to the steam/power plant. Boiler decentralization to 50 steam-to-hot-water heat exchanger and domestic boiler heating systems. Ongoing maintenance of the power plant steam and electrical generation equipment and building heating systems.

U.S. Navy Portsmouth Naval Shipyard, ME **$28 M**
Preventative maintenance, inspection, and testing of electrical and mechanical distribution systems and the execution of multiple construction and repair delivery orders.

Professional Experience

Ameresco, 2006 – Present

Project Manager

Select Energy Services, 2003 – 2006

Project Manager

Shafmaster Fishing Group, 1986 – 2003

Operations Manager

Portsmouth Naval Shipyard, 1981 – 1986

Nuclear Special Projects – Team Leader

Project Experience (continued):

U.S. Navy Portsmouth Naval Shipyard, ME **$900 K**
Power plant smokestack removal. Quality control and safety management of a critical demolition project involving hazardous material abatement, confined space and aerial work, and critical crane lifts.

U.S. Navy Portsmouth Naval Shipyard, ME **$3.5 M**
Provided site project management and customer liaison during the Design Engineering Phase of an ESPC project to replace 4500' of underground condensate piping and installation of two trim air compressors and upgraded system controls.

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Appendix D: Manufacturer Specification Sheets

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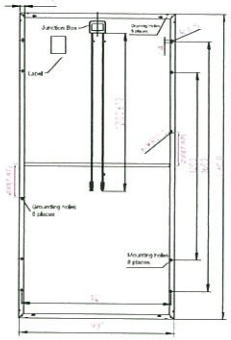
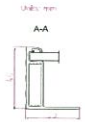
JA SOLAR

JAM6(K)-72/340-360/PR/1500V
F 40-35

Engineering Drawings





■ customized cable length available upon request

MECHANICAL PARAMETERS

Cell (mm)	Almost Full Square Mono 156.75×156.75
Weight (kg)	23 (approx)
Dimensions (L×W×H) (mm)	1960×991×40
Cable Cross Section Size (mm²)	4
No. of Cells and Connections	72 (6×12)
Junction Box	IP67 3 diodes
Connector	Amphenol UTX
Packaging Configuration	27 Per Pallet

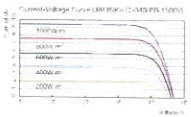
WORKING CONDITIONS

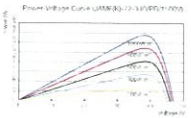
Maximum System Voltage	DC 1500V (IEC)
Operating Temperature	-40℃~+85℃
Maximum Series Fuse	15A
Maximum Static Load, Front Maximum Static Load, Back	5400Pa (112 lb/ft²) 2400Pa (50 lb/ft²)
NOCT	45±2℃
Application Class	Class A

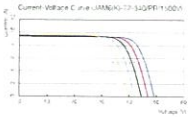
ELECTRICAL PARAMETERS

TYPE	JAM6(K)-72-340/PR/1500V	JAM6(K)-72-345/PR/1500V	JAM6(K)-72-350/PR/1500V	JAM6(K)-72-355/PR/1500V	JAM6(K)-72-360/PR/1500V
Rated Maximum Power at STC (W)	340	345	350	355	360
Open Circuit Voltage (Voc/V)	46.86	47.05	47.24	47.45	47.66
Maximum Power Voltage (Vmp/V)	38.18	38.39	38.58	38.76	38.96
Short Circuit Current (Isc/A)	9.46	9.54	9.61	9.69	9.78
Maximum Power Current (Imp/A)	8.91	8.99	9.07	9.16	9.24
Module Efficiency [%]	17.50	17.76	18.02	18.28	18.57
Power Tolerance (W)	-0~+5W				
Temperature Coefficient of Isc (αIsc)	+0.060%/℃				
Temperature Coefficient of Voc (βVoc)	-0.300%/℃				
Temperature Coefficient of Pmax (γPmp)	-0.390%/℃				
STC	Irradiance 1000W/m², Cell Temperature 25℃, Air Mass 1.5				

I-V CURVE







NOCT

TYPE	JAM6(K)-72-340/PR/1500V	JAM6(K)-72-345/PR/1500V	JAM6(K)-72-350/PR/1500V	JAM6(K)-72-355/PR/1500V	JAM6(K)-72-360/PR/1500V
Max Power (Pmax) [W]	248.57	252.23	255.89	259.55	263.20
Open Circuit Voltage (Voc) [V]	43.18	43.39	43.61	43.84	44.08
Max Power Voltage (Vmp) [V]	35.06	35.33	35.59	35.81	36.03
Short Circuit Current (Isc) [A]	7.68	7.74	7.81	7.88	7.95
Max Power Current (Imp) [A]	7.09	7.14	7.19	7.25	7.31
Condition	Under Normal Operating Cell Temperature, Irradiance of 800 W/m², spectrum AM 1.5, ambient temperature 20℃, wind speed 1 m/s				

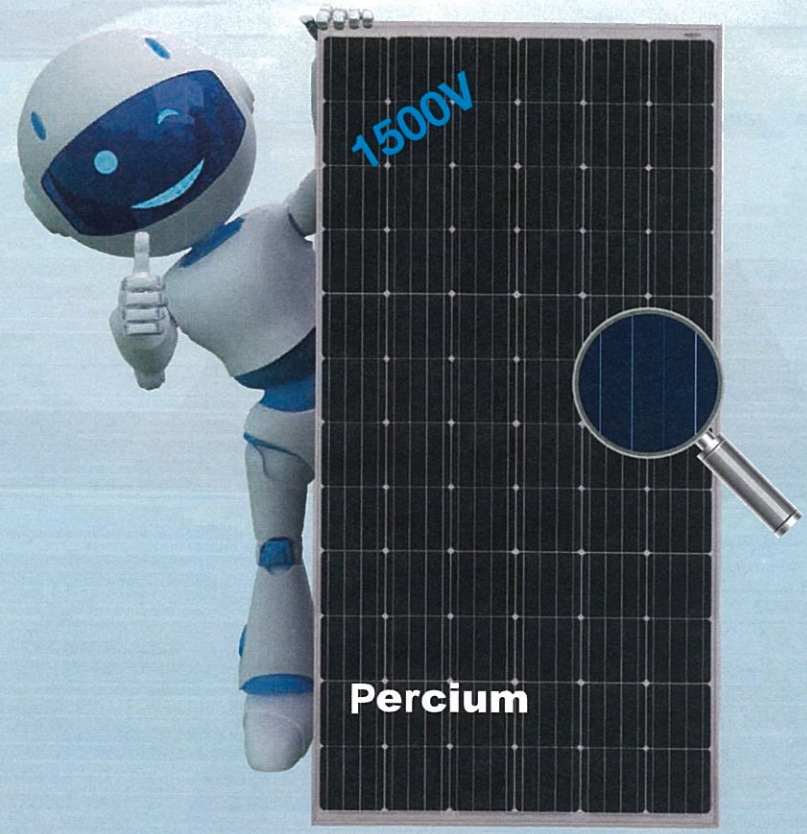
Electrical data in this catalog do not refer to a single module and they are not part of the offer. They only serve for comparison among different module types.

JA SOLAR

PERCIUM

Mono 72/340-360/PR/1500V
F 40-35

350W Mono 72Cells
20W > Average



Harvest the Sunshine
Premium Cells, Premium Modules

www.jasolar.com

JA SOLAR

Harvest the Sunshine
Premium Cells, Premium Modules

Percium Cell

- The mono cell technology with passivated backside and local BSF
- >20.6% average mass production efficiency

More Power Per m²

Higher conversion efficiency - more power production per unit area

Lower System Cost

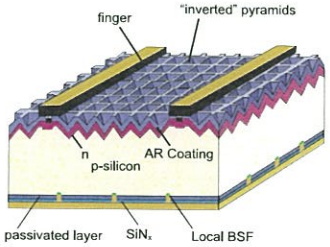
Higher conversion efficiency help you save

- Transportation cost
- Installation cost
- BOS cost

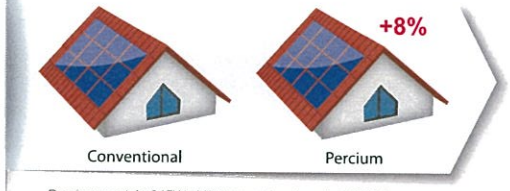
Excellent Low-light Performance

Enhanced spectral response at longer wavelength boosts low-light performance, which can produce more than 3% additional power compared with conventional module at system side.

Average Mass Production Efficiency >20.6%

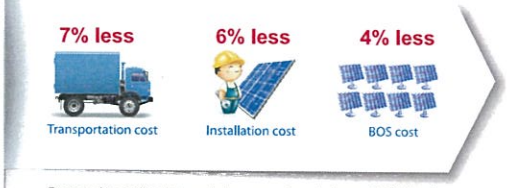


Benefit: 8% More Power



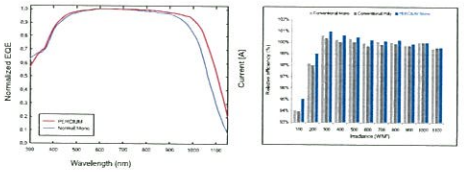
Percium module 345Wp VS Conventional module 320Wp

Benefit: Save System Costs Per Watt



Cost saving estimation made by comparison between 320W and 345W modules

Benefit:Excellent Low-light Performance



EQE—External quantum efficiency

Relative module efficency comparison under different irradiance

Source: TÜVRheinland

JA SOLAR

Harvest the Sunshine
Premium Cells, Premium Modules

High Reliability

- Long-term reliability tests
- Harsh climate environment endurance tests
- PID-resistance tests
- Certified by TÜV SÜD and ETL
- Industry-leading cell tecnology
- High quality components from best suppliers
- Manufacturing inspected and certified by PI-Berlin and Solar-IF
- 100% in-house automatic manufacturing
- 2X 100% EL inspection ensuring defect-free

Fraunhofer

Other Features

0~+5W — Positive power tolerance: 0~+5W

Modules binned by current to improve system performance

5400Pa / 2400Pa — Excellent mechanical load resistance: Certified to withstand high wind loads (2400Pa) and snow loads (5400Pa)

Comprehensive Certificates

- IEC 61215, IEC 61730, UL1703, CEC Listed, MCS and CE
- ISO 9001: 2008: Quality management systems
- ISO 14001: 2004: Environmental management systems
- BS OHSAS 18001: 2007: Occupational health and safety management systems
- Environmental policy: The first solar company in China to complete Intertek's carbon footprint evaluation program and receive green leaf mark verification for our products

Specifications subject to technical changes and tests. JA Solar reserves the right of final interpretation.

JA Solar Holdings Co., Ltd.

JA Solar Holdings Co.,Ltd is a world leading manufacturer of high-performance solar power products that convert sunlight into electricity for residential, commercial and utility-scale power generation. The company was founded in May 2005 and publicly listed on NASDAQ in February 2007. JA Solar has been the world's leading cell producer since 2010, and has firmly established itself as a tier 1 module supplier since 2012. Capitalizing on our strength in solar cell technology, we are committed to provide modules with unparalleled conversion efficiency, yield efficiency, and reliability to enable you to maximize your returns on PV projects. With its leading industry experience, continuous effort on R&D, customer-oriented service and sound financial status, JA Solar is your best choice of long-term trustworthy partner.

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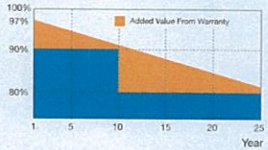
Tel: +86 (10) 63611868
Fax: +86 (10) 63611999
Email: sales@jasolar.com market@jasolar.com

Product Warranty

- 12-year product warranty
- 25-year linear power warranty



Additional Insurance Options

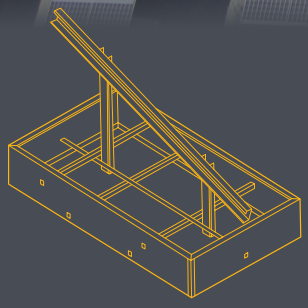
PowerGuard SOLAR

Partner Section

FLEXRACK SERIES B

SOLAR FLEXRACK™
A Division of Northern States Metals

3MW Ballasted Project
New Jersey Meadowland's Kearny Landfill



FlexRack Series B – Cast in Place

+ TURN-KEY SERVICES

We're here for you because we care about your projects. From engineering to installation, you can leverage our expert turn-key services on any job from start to finish.

Contact us to see how our team of project engineers, field techs, geologists and other specialists can help make sure your next project is a success.

Experience the Flex

CALL US TO FIND OUT HOW THIS GROUNDBREAKING RACK CAN IMPROVE HOW YOU DO SOLAR

1.888.380.8138 | SOLARFLEXRACK.COM

Pre-Cast

The FlexRack Series B pre-cast system makes use of a two-support system, rather than the one-support system of its contemporaries; transferring loads into the block through two supports instead of one reduces ballast block thickness. The two-support system also enables the use of a split block system, which requires lighter lifting machinery to accommodate sites with low bearing pressure requirements.

Cast in Place

- Economical shipping – one piece pre-assembled form
- Posts are set plumb prior to pouring concrete for ease of installation
- Ability to level posts after form is set for tolerances in installation
- Form is a customized roll form shape to optimize size and reduce wasted material
- Requires only four screws for form assembly. Form assembly in under 3 minutes with 2 people
- Customizable block size allows form to always be filled to the top
- Internal bracing eliminates need for construction shoring or additional bracing requirements
- Utilizes same two support system benefits as pre-cast solution

Reduced costs

Our system uses steel and concrete more efficiently, reducing the overall cost of the unit and allowing for a lower array profile. It's also custom engineered to make installation a breeze—no matter the conditions, the Series B can be installed quickly and efficiently, saving you money on labor costs.

Complete compatibility

The FlexRack Series B offers compatibility with all of our ground systems, including the G2 and G3. That means that all the innovative labor savings features and flexibility are still realized with the Series B. The Series B is offered as a pre-cast system or cast in place to meet project specific requirements.

MATERIALS	
Module Hardware	Magni 560 coating standard. Stainless available upon request
Racking Hardware	Hot Dip Galvanized coating is standard
Racking Structure	G90 galvanized steel standard. Higher coatings available for high corrosion areas
DESIGN	
Orientation	Portrait or Landscape
Tilt Angle	5° - 45° (custom tilts can be accommodated)
Racking Slope Tolerance	20% E/W
Local Ballast Slope	5% N/S, E/W
Wind Speed	Any
Snow Load	Any
Module Accommodation	Any 60 or 72 cell framed module along with any frameless module
Module Mounting Type	Direct bolt directly to horizontal rails (bonded connection)
Foundation Accommodation	Pre-cast or Cast in Place
Warranty	20 years
Design Life	30 year service life on all galvanized components
CERTIFICATIONS AND TESTING	
UL Certification	UL 2703 (Issue 2) compliant
Wind Tunnel Testing	CPP third party testing laboratory
Structural Connection Testing	Element Materials Technology
Code Compliance	Racks are designed using site specific loads (wind, snow, and seismic) per the governing local building codes
Finite Element Modeling	Risa 3D
Engineering	PE stamped drawings and calculations
SERVICES	
Geotechnical Engineering	Field investigation and engineering, laboratory testing, engineering analysis, push/pull tests, ballast design
Structural/Civil Engineering	Preliminary investigation, engineering
Installation	Foundation, racking, module, and module prewiring
Training	Onsite installation training at no additional cost

YASKAWA

SOLECTRIA XGI 1000

Premium 3-Ph Transformerless Commercial String Inverters

Features

- Made in the USA with global components
- Buy American Act (BAA) compliant
- 50kW, 60kW and 65kW
- Built to last
- Lowest cost of labor/installation
- Access to all inverters on-site via WiFi from one location
- Lowest cost of O&M
- Remote diagnostics
- Remote software & firmware upgrades
- 5-90° installation angles
- 4 MPPTs
- Advanced grid-support functions
- Integrated AFCI

Options

- Plug & play MC4 or H4 connectors
- Web-based monitoring
- Revenue grade metering
- Extended warranty

Yaskawa Solectria Solar's XGI 1000 commercial string inverters are designed for high reliability and built with the highest quality components. Components were selected, tested and proven to last beyond their warranty. The XGI 1000 inverters provide advanced grid-support functionality and meet the latest IEEE 1547 and UL 1741 standards for safety. Offering a wide mounting-angle range (5 – 90° from horizontal), the XGI inverters can be installed to meet NEC array-level rapid shutdown requirements. Designed and engineered in Lawrence, MA, the new XGI inverters are assembled and tested at Yaskawa America's facilities in Buffalo Grove, IL. The all new XGI 1000 inverters are Made in the USA with global components and are compliant with the Buy American Act.

Made in the USA
with global components

SOLECTRIA SOLAR

SOLECTRIA XGI 1000

Specifications

	XGI 1000-50/60	XGI 1000-60/60	XGI 1000-60/65	XGI 1000-65/65
DC Input				
Absolute Maximum Input Voltage	1000 VDC	1000 VDC	1000 VDC	1000 VDC
Maximum Power Input Voltage Range (MPPT)	580-850 VDC	580-850 VDC	580-850 VDC	580-850 VDC
Operating Voltage Range (MPPT)	350-950 VDC	350-950 VDC	350-950 VDC	350-950 VDC
Maximum Operating Input Current	88.0 A (22.0 A per zone)	105.6 A (26.4 A per zone)	105.6 A (26.4 A per zone)	110.6 A (27.65 A per zone)
Maximum Operating PV Power (per MPPT)	12.8 kW	15.3 kW	15.3 kW	16.6 kW
Maximum Rated PV Input (per MPPT)	18.75 kW	22.5 kW	22.5 kW	24.4 kW
Number of MPP Trackers	4 / 1 (default)	4 / 1 (default)	4 / 1 (default)	4 / 1 (default)
Number of PV Source Circuits (Fused Inputs)	4 per MPPT; 16 total	4 per MPPT; 16 total	4 per MPPT; 16 total	4 per MPPT; 16 total
Maximum PV Current (Isc x 1.25) per Zone / Single Zone	50 A / 180 A	50 A / 180 A	50 A / 180 A	50 A / 180 A
Maximum Recommended DC to AC Ratio	1.5	1.5	1.5	1.5
AC Output				
Nominal Output Voltage	480 VAC, 3-Ph	480 VAC, 3-Ph	480 VAC, 3-Ph	480 VAC, 3-Ph
AC Voltage Range	-12 / +10%	-12 / +10%	-12 / +10%	-12 / +10%
Continuous Real Output Power	50 kW	60 kW	60 kW	65 kW
Continuous Apparent Output Power	60 kVA	60 kVA	65 kVA	65 kVA
Maximum Output Current	72.2 A	72.2 A	78.2 A	78.2 A
Nominal Output Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Power Factor (Unity default)	+/- 0.85 Adjustable	+/- 0.85 Adjustable	+/- 0.85 Adjustable	+/- 0.85 Adjustable
Total Harmonic Distortions (THD) @ Rated Power	<3%	<3%	<3%	<3%
Grid Connection Type	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND
Fault Current Contribution (1 cycle RMS)	93.9 A	93.9 A	101.7 A	101.7 A
AC Breaker	100 A	100 A	100 A	100 A
Efficiency				
Peak Efficiency	98.2%	98.2%	98.2%	98.2%
CEC Average Efficiency	98.0%	98.0%	98.0%	98.0%
Tare Loss	<1 W	<1 W	<1 W	<1 W
Temperature				
Ambient Temperature Range	-40°F to 140°F (-40°C to 60°C)			
De-Rating Temperature	122°F (50°C)		113°F (45°C)	
Storage Temperature Range	-40°F to 167°F (-40°C to 75°C)			
Relative Humidity (non-condensing)	0-95%			
Operating Altitude	9,842.5 ft (3,000 m)			
Communications				
Advanced Graphical User Interface	WiFi			
Communication Interface	RJ-45 Ethernet			
Third-Party Monitoring Protocol	Sunspec Modbus TCP/IP			
Web-Based Monitoring	Optional			
Revenue Grade Metering	Optional			
Firmware Updates	Remote/Local			
Testing & Certifications				
Safety Listings & Certifications	UL 1741 / IEEE 1547, UL 1699B, UL 1998			
Advanced Grid Support Functionality	Rule 21, UL 1741SA			
Testing Agency	Intertek			
FCC Compliance	FCC Part 15, Class A			
Warranty				
Standard and Options	10 Years Standard; Options for 15 and 20 Years			
Enclosure				
Acousting Noise Rating	55 dBA @ 1 m			
DC Disconnect	Integrated, 2 Pole			
Mounting Angle	5-90° Measured from horizontal			
Dimensions (H x W x D)	45.8 in. x 28.3 in. x 11.6 in. (1163 x 719 x 295 mm)			
Weight	Inverter: 117 lbs (53.07 kg); Wiring Box: 49 lbs (22.22 kg)			
Enclosure Rating and Finish	Type 4, Polyester Powder-Coated Aluminum			

SOLECTRIA SOLAR

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Email: inverters@solectria.com

DOCR-070604-F | February 2018

YASKAWA

YASKAWA

SOLECTRIA XGI 1500

Premium 3-Ph Transformerless Utility-Scale Inverters

Features

- Made in the USA with global components
- Buy American Act (BAA) compliant
- Four models: 125kW/125kVA, 125kW/150kVA, 150kW/166kVA, 166kW/166kVA
- Flexible solution for distributed and centralized system architecture
- Advanced grid-support functionality Rule 21/UL1741SA
- Robust, dependable and built to last
- Lowest O&M and installation costs
- Access all inverters on site via WiFi from one location
- Remote diagnostics and firmware upgrades

Options

- Attachable string combiner for distributed architecture
- Plug & play MC4 or H4 connectors for the attachable string combiner
- Web-based monitoring
- Extended warranty

MADE IN THE USA

With U.S. and Global Components

Yaskawa Solectria Solar's XGI 1500 utility-scale string inverters are designed for high reliability and built of the highest quality components that are tested and proven to last beyond their warranty. The XGI 1500 inverters provide advanced grid-support functionality and meet the latest IEEE 1547 and UL 1741 standards for safety. The virtual HMI allows users to connect wirelessly to the inverters using a smart phone or tablet, to accelerate commissioning. The XGI 1500 inverters are the most powerful 1500VDC string inverters in the PV market, and engineered for both distributed and centralized system architecture. Designed and engineered in Lawrence, MA, the XGI inverters are assembled and tested at Yaskawa America's facilities in Buffalo Grove, IL. The all new XGI 1500 inverters are Made in the USA with global components, and are compliant with the Buy American Act.

SOLECTRIA SOLAR

SOLECTRIA XGI 1500

Specifications

	XGI 1500-125/125	XGI 1500-125/150	XGI 1500-150/166	XGI 1500-166/166
DC Input				
Absolute Maximum Input Voltage	1500 VDC	1500 VDC	1500 VDC	1500 VDC
Maximum Power Input Voltage Range (MPPT)	860-1250 VDC	860-1250 VDC	860-1250 VDC	860-1250 VDC
Operating Voltage Range (MPPT)	860-1450 VDC	860-1450 VDC	860-1450 VDC	860-1450 VDC
Number of MPP Trackers	1 MPPT	1 MPPT	1 MPPT	1 MPPT
Maximum Operating Input Current	147.6 A	147.6 A	177.1 A	196.0 A
Maximum Operating PV Power	127 kW	127 kW	152 kW	169 kW
Maximum DC/AC Ratio	1.5	1.5	1.5	1.5
Maximum Rated PV Input (at 1.5 DC/AC Ratio)	188 kWdc	188 kWdc	225 kW	250 kW
Attachable String Combiner (Optional, engineered for use with XGI 1500 inverters)				
Maximum Number of DC Inputs	18		24	
Fuse Rating Options	15 A, 20 A, 25 A, 30 A		15 A, 20 A, 25 A, 30 A	
Fuse Configuration Options	Both polarities fused (NEC 2014), Positive polarity fused (NEC 2017)			
PV Connector Options	Amphenol H4, Multi-Contact MC4			
DC Disconnect	Isolated by use of integrated 2-Pole DC Disconnect on the XGI 1500 inverter			
Dimensions and Weight	Height: 29.5 in. (749 mm) | Width: 15.1 in. (385 mm) | Depth: 12 in. (305 mm) | Weight: 30 lbs (13.6 kg)			
AC Output				
Nominal Output Voltage	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph	600 VAC, 3-Ph
AC Voltage Range	-12% to +10%	-12% to +10%	-12% to +10%	-12% to +10%
Continuous Real Output Power	125 kW	125 kW	150 kW	166 kW
Continuous Apparent Output Power	125 kVA	150 kVA	166 kVA	166 kVA
Maximum Output Current	120 A	144 A	160 A	160 A
Nominal Output Frequency	60 Hz	60 Hz	60 Hz	60 Hz
Power Factor (Unity default)	+/- 0.85 Adjustable	+/- 0.85 Adjustable	+/- 0.85 Adjustable	+/- 0.85 Adjustable
Total Harmonic Distortion (THD) @ Rated Load	<3%	<3%	<3%	<3%
Grid Connection Type	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND	3-Ph + N/GND
Fault Current Contribution (1 cycle RMS)	144 A	173 A	192 A	192 A
Efficiency				
Peak Efficiency	98.8%	98.8%	98.8%	98.7%
CEC (pending) Average Efficiency	98.5%	98.5%	98.5%	98.5%
Tare Loss	<1 W	<1 W	<1 W	<1 W
Temperature				
Ambient Temperature Range	-40°F to 140°F (-40C to 60C)		-40°F to 140°F (-40C to 60C)	
De-Rating Temperature	122°F (50C)		113°F (45C)	
Storage Temperature Range	-40°F to 167°F (-40C to 75C)		-40°F to 167°F (-40C to 75C)	
Relative Humidity (non-condensing)	0 - 95%		0 - 95%	
Operating Altitude	9,840 ft (3 km)		9,840 ft (3 km)	
Communications				
Advanced Graphical User Interface	WiFi			
Communication Interface	RJ-45 Ethernet			
Third-Party Monitoring Protocol	SunSpec Modbus TCP/IP			
Web-Based Monitoring	Optional			
Firmware Updates	Remote and Local			
Testing & Certifications (pending)				
Safety Listings & Certifications	UL 1741, IEEE 1547, UL 1998			
Advanced Grid Support Functionality	Rule 21, UL 1741SA			
Testing Agency	ETL			
FCC Compliance	FCC Part 15, Class A			
Warranty				
Standard and Options	5 Years Standard; Options for 10, 15 and 20 Years			
Enclosure				
Acoustic Noise Rating	55 dBA @ 1 m			
DC Disconnect	Integrated 2-Pole 250 A DC Disconnect			
Mounting Angle	Vertical only			
Dimensions	Height: 29.5 in. (750 mm) | Width: 38.4 in. (975 mm) | Depth: 15.1 in. (384 mm)			
Weight	230 lbs (104 kg)			
Enclosure Rating and Finish	Type 4X, Polyester Powder-Coated Aluminum			

Specifications subject to change.

SOLECTRIA SOLAR

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solectria.com

1-978-683-9700
Email: inverters@solectria.com

DOCR-070730-F | March 2018

YASKAWA

Power[IT] Liquid Filled Three Phase Padmounted Transformers

45-3750 kVA

Industrial[IT]
enabled

ABB

Introduction to ABB

ABB is a global leader in power and automation technologies that enable utility and industry customers to improve their performance while lowering their environmental impact.

Distribution Transformers

ABB Distribution Transformers provide the most complete line of padmounted transformers to meet the applications of any distribution system. We are a dominant force in the industry. We lead the way with the introduction of new products and services for the ever-changing distribution transformer industry.

We can offer cost-effective solutions for power distribution. We support our industry with a commitment to product development. We utilize the latest manufacturing technology to maintain state-of-the-art quality and productivity. Large vertical integration allows us to ship high quality products in the shortest possible production cycle. We are in alliances with major utilities and businesses around the world providing products and services to meet all their needs.

ABB will continue to build on a heritage of quality, customer satisfaction and technology, and capitalize on its resources, to maintain its position as the number one supplier of transformers in the industry.

Industrial^{IT}

Industrial^{IT} is the ABB name for our commitment to real-time integrated solutions for power, automation, and information.

Our Quality Policy

Total customer satisfaction through continual process improvement.

Our Values

Our values guide us in how we go about meeting our vision and mission.

Customer Success – We seek to provide solutions for mutual competitive advantage. We set the highest standards for quality, meet delivery commitments and provide high value.

Quality Excellence – We want to be recognized as a company that exceeds our customers' expectations.

ABB Quality Strategy

Start with a focus on the customer.

Measure what is important.

Define a benchmark for "highest standard for quality."

Have a means to dramatically improve performance against the benchmark.

Three Phase Padmounted Transformers

The ABB MTR is an oil-filled, three-phase, commercial padmounted distribution transformer specifically designed for servicing such underground distribution loads as shopping centers, schools, institutions and industrial plants. It is available in both live front and dead front construction, for radial or loop feed applications, with or without taps.

ABB MTR meets the following industry standards:

ANSI C57.12.00	ANSI C57.12.80
ANSI C57.12.22	ANSI C57.12.90
ANSI C57.12.26	ANSI C57.91
ANSI C57.12.28	NEMA TR1
ANSI C57.12.29	WUG 2.13 Rev. 4
ANSI C57.12.70	

Ratings:

- 45 through 3750 kVA
- 65° C average winding rise
- 60 hertz standard, 50 hertz optional

45-1500 kVA

- High voltages: 4160 Grd Y/2400 through 34,500 Grd Y/19,920 for Grounded Wye systems; 2400 through 34,500 for Delta systems; various dual high voltages

2000-3750 kVA

- High voltages: 7200 Grd Y/4160 through 34,500 Grd Y/19,920 for Grounded Wye systems; 4160 through 34,500 for Delta systems; various dual high voltages
- Taps: All voltages are available with or without taps
- Insulation classes: 35 kV, 150 kV BIL and below

45-1500 kVA

- Low voltages: 208Y/120, 216Y/125, 460Y/265, 480Y/277, 480Δ, 240Δ and 240Δ with 120 volt mid-tap in one phase; (4160Y/2400, 4160Δ, 2400Δ , 2400/4160Y/2400 for 500 kVA and larger)

2000-3750 kVA

- Low voltages: 460Y/265, 480Y/277, 480Δ, 4160Y/2400, 2400Δ, 2400/4160Y/2400

Standard Features:

1. Four lifting lugs.
2. Bolted-on terminal compartment (18" or 24" deep depending on KVA) with removable front sill.
3. Hinged, lift-off cabinet doors.
4. Interlocked penta-head bolt/padlock handle operates a cam assembly which is part of the 3-point door latching mechanism. (A hex-head bolt is available.)
5. For live front construction, externally clamped high voltage porcelain bushings with a single eyebolt, clamp-type connector (accommodates #6 AWG solid to 250 MCM stranded conductors).
6. For dead front construction, externally clamped high voltage bushing wells for loadbreak or non-loadbreak inserts.
7. Lightning arrester mounting pads (live front only).
8. Tank ground pads (1 in HV, 1 in LV).
9. Steel high/low voltage compartment barrier.
10. One 1/2" penta-head bolt must be removed from the flange formed on the steel high/low barrier before the HV door can be opened (1/2" hex-head bolt available as an option).
11. Externally clamped low voltage bushings with threaded copper stud for full load current below 2100 amps. Externally clamped integral low voltage bushings for current above 2100 amps. NEMA spades provided per ANSI hole requirements.
12. Nameplate.
13. Fill plug and self-actuating pressure relief device.
14. Drain plug.
15. Removable neutral ground strap.
16. Five-legged core/coil assembly.
17. Handhole cover bolted onto tank top (protected by weathercover).
18. Panel-type coolers.
19. NEMA safety labels.
20. The paint finish process applies a durable, corrosion resistant finish to the product. The finish meets or exceeds all the performance requirements of ANSI C57.12.28. The multi-step process includes an epoxy primer uniformly applied by cationic electrodeposition and a urethane top coat.

Optional Features:

Primary Termination

- Externally-clamped bushing wells with loadbreak or non-loadbreak inserts.
- Integral loadbreak bushings.

Secondary Termination

- Externally-clamped bushings with NEMA 6-hole, 8-hole, 10-hole, or 12-hole spades.
- Spade supports are available. They are provided for 8-hole spades and larger when the current is 1400 amps or greater.

Primary Switching

- LBOR oil switch: one for radial, two for loop feed.
- Externally-operated tap changer.
- Externally-operated dual voltage switch.
- Externally-operated delta-wye switch.

Overcurrent Protection

- Internal primary protective links.
- Bayonet-type expulsion fuses.
- Drawout, loadbreak current limiting fuses, with or without interlocking transformer switch.
- Secondary oil circuit breaker.
- Internal, partial-range current limiting fuses.

Overvoltage Protection

- Distribution class, metal oxide arresters, 3-36 kV.
- Distribution class, valve-type lightning arresters, 3-27 kV.

Construction Options

- 18", 24" and 30" deep terminal cabinet.
- Drain valve and sampling device.
- Mounting plate for CT's or PT's.
- Interphase barriers.
- Molded case external secondary breaker.
- Substation Accessories – Oil gauge, thermometer, drain valve and sampler, pressure-vacuum gauge provision.
- Weathercover.
  - Transformers may feature an optional weathercover over the cabinet which is hinged to allow clearance for replacement of the bayonet-type fuses.
  - The weathercover can be lifted easily into place and secured with a single supporting arm.
  - The weathercover requires no additional holddown hardware.

Some optional features are not available on larger kVA units.

Live Front, Radial Feed

ANSI Fig. 1, 2, and 3 (C57.12.22)

KVA	A	B	C	D	E	Wt.	Gal. of Oil
75	54.5	56	44.8	44.8	56	2280	115
112	54.5	56	44.8	44.8	56	2400	115
150	54.5	56	44.8	44.8	56	2700	125
225	54.5	56	49.8	46.8	56	3350	150
300	54.5	60	50.8	46.8	56	3650	165
500	58.5	66	58.8	48.8	56	5200	200
750	66.5	81	60.8	50.8	66	7100	270
1000	66.5	84	62.8	52.8	66	7900	320
1500	66.5	86	66.8	54.8	66	9700	390
2000	70.5	92	68.8	58.8	70	12800	430
2500	70.5	98	70.8	58.8	70	14100	500
3000	Contact Factory						
3750	Contact Factory						

Design Dimensions:

Approximate weights and dimensions: Dimensions are in inches, weights are in pounds. Dimensions may change to meet the customer spec.

Dead Front, Radial Feed

ANSI Fig. 1, 3, and 4 (C57.12.26)

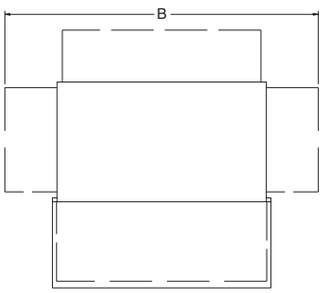
KVA	A	B	C	D	E	Wt.	Gal. of Oil
75	46.5	62	44.8	44.8	62	2350	115
112	46.5	62	44.8	44.8	62	2450	115
150	46.5	62	44.8	44.8	62	2700	125
225	46.5	62	49.8	46.8	62	3400	150
300	46.5	62	50.8	46.8	62	3700	165
500	54.5	66	58.8	48.8	62	5400	200
750	58.5	81	60.8	50.8	66	7100	270
1000	66.5	84	62.8	52.8	66	7900	320
1500	66.5	86	66.8	54.8	66	9700	390
2000	70.5	92	68.8	58.8	70	12800	430
2500	70.5	98	70.8	58.8	70	14100	500
3000	Contact Factory						
3750	Contact Factory						

Dead Front, Loop Feed

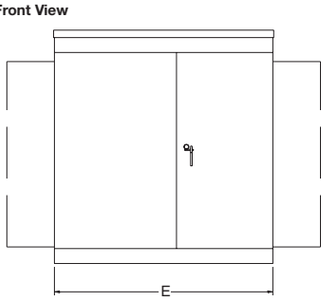
ANSI Fig. 2, 3, and 4 (C57.12.26)

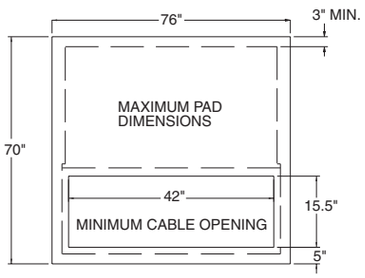
KVA	A	B	C	D	E	Wt.	Gal. of Oil
75	54.5	66	44.8	44.8	66	2400	120
112	54.5	66	44.8	44.8	66	2500	120
150	54.5	66	44.8	44.8	66	2800	130
225	54.5	66	49.8	46.8	66	3500	160
300	54.5	66	50.8	46.8	66	3800	170
500	54.5	68	58.8	48.8	66	5600	200
750	66.5	82	60.8	50.8	70	7400	270
1000	66.5	86	62.8	52.8	70	8200	320
1500	66.5	88	66.8	54.8	70	10300	390
2000	70.5	92	68.8	58.8	70	12800	430
2500	70.5	98	70.8	58.8	70	14100	500
3000	Contact Factory						
3750	Contact Factory						

Top View

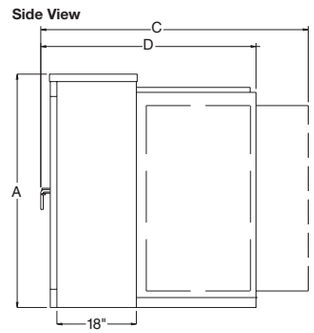


Front View





Side View



Fliptop Cabinet Design

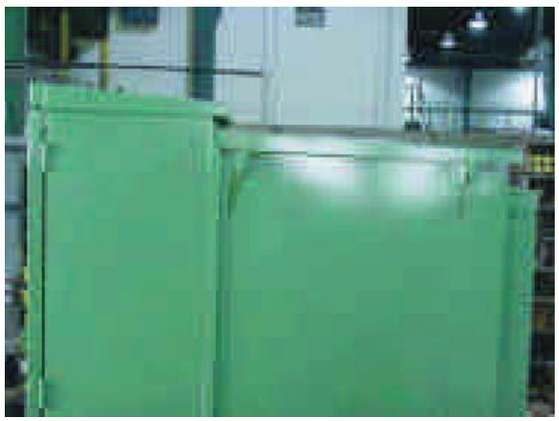
We offer a fliptop air enclosure for three phase padmounted transformers. It is designed to improve operation and to better withstand its outdoor environment. New manufacturing equipment has allowed ABB to fabricate a "fliptop" cabinet design to better serve the needs of our customers. Material choices consist of both carbon steel and stainless steel.

The improvement features of the new cabinet design include:

- One piece "sloped" cabinet weather cover. The cabinet weather cover has a four degree sloped surface to shed all moisture to the rear of the transformer.
- Both the handhole weather cover and the full tank weather cover have a four degree sloped surface to shed water. The full tank weather cover option extends beyond the rear of the transformer to insure all moisture is directed away from the top of the tank.
- The cabinet weather cover support arm is free floating and locks into place automatically. This allows the linemen to use both hands when raising the cover. No reaching into the compartment is necessary to secure the cover in place.
- The cabinet weather cover can be rotated beyond center or easily removed for better access into the the cabinet compartment. The capability of "pulling" cables from above was a feature requested by utilities.

Support Arm Locking Mechanism

- The interface between the sidewalls and the cabinet weather cover has been redesigned to better receive the weather cover when closed. This new interface minimizes surface contact to prevent the rubbing of paint.



Sloped Tank and Cabinet Weather Cover

This cabinet design has successfully passed all industry tamper resistance requirements. Using Guidelines for Testing Enclosure Integrity, the design passed pry tests, pull tests, wire probe tests, deflection tests, and the operation test. The tests performed confirm that the cabinet meets the tamper resistance requirements of ANSI C57.12.28 at both 0 and 15 psig, as well as ANSI C57.12.22.1989 and ANSI C57.12.26.1992 demonstrating sufficient strength to withstand an internal static pressure of 7 psig without permanent distortion and 15 psig without rupturing or displacing components of the transformer or affecting cabinet security.

MTP Mini-Three Phase Padmounted Transformer

The Mini-Three Phase Padmounted Transformer (MTP) is designed for the needs of utility customers to reduce costs and improve aesthetics. The design is easier to handle, install and maintain. The discreet profile of the MTP is ideal for commercial applications such as banks, stores and restaurants.

The MTP features a hood and removable sill instead of doors. The design allows easy access for installation and maintenance of the transformer.

The ABB MTP meets the following industry standards:

ANSI C57.12.00	NEMA TR-1
ANSI C57.12.26	ANSI C57.12.28
ANSI C57.12.29	WUG 2.13, Rev. 4
ANSI C57.12.70	ANSI C57.91
ANSI C57.12.80	ANSI C57.12.90

Ratings @ 65° C Rise:

KVA: 45-150 kVA
HV: 4160GY/2400 through 24940Y/14400VΔ at 95 BIL spacing only, 2400Δ through 14400Δ at 95 BIL spacing only
BIL: 60, 75, 95 kV
LV: 208Y/120, 216Y/125, 460Y/265, 480Y/277, 480Δ, 240Δ and 240Δ with 120 volt mid-tap in one phase
60 hertz standard, 50 hertz optional

Standard Features:

1. A flip-top hood and heavy duty 3/8", removable stainless steel hinge pins provide safe and durable service.
2. A recessed locking assembly with padlock provisions and a penta-head locking bolt is standard for tamper-resistant operation. A hex-head locking bolt is available.
3. All tanks are constructed of heavy gauge steel. Tank seams are welded and each unit is pressure tested and inspected for leaks prior to shipment.
4. The front sill latches with the flip-top hood, is attached on the side of the tank and is removable.
5. The high voltage universal bushing wells are externally clamped and removable. A parking stand between the bushing wells is provided for attachment of bushing accessories.
6. Externally clamped low voltage bushings.
7. Loop or radial feed, dead front only for high voltage configurations. Loop pattern will be loop "V" with minimum dimensions per ANSI C57.12.26, Fig. 2 at 8.3/14.4 kV. Radial pattern will be either horizontal with minimum dimensions per ANSI C57.12.26, Fig. 1 or a non-ANSI slant pattern.
8. Standard low voltage pattern is the staggered arrangement per ANSI C57.12.26, Fig. 4a with minimum dimensions.
9. Cabinet depth is standardized to be 19 inches.
10. Tamper-resistant design that exceeds ANSI C57.12.28.
11. NEMA safety labels.
12. Nameplate.
13. Five legged core/coil assembly.
14. The paint finish process applies a durable, corrosion resistant finish to the product. The finish meets or exceeds all the performance requirements of ANSI C57.12.28. The multi-step process includes an epoxy primer uniformly applied by cationic electrodeposition and a urethane top coat.

Optional Accessories:

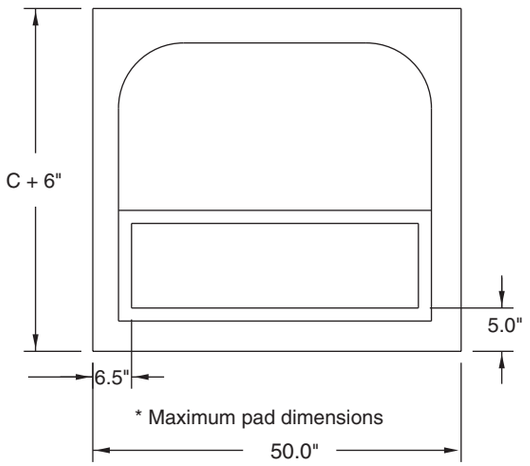
1. Standard fusing is bayonet with or without under oil partial range current limiting fusing.
2. Taps or delta x wye or dual voltage are available, but not combined with each other.
3. One loadbreak oil switch is possible.
4. A live HO bushing is possible in the high voltage compartment.
5. A high-low barrier will be either metal or glasspoly.
6. Stainless steel designs, including the Mini-Skirt, are available.
7. Full range general-purpose current limiting fuses in dry well canisters will only be available in radial units with single fuse application.
8. Special slant low voltage pattern available upon request. This feature allows more space to mount metering current transformers.
9. Substation accessories available (normally in the low voltage compartment).

Minimum/Maximum Design Dimensions
(Actual dimensions will vary according to voltage, loss evaluation, and accessories.)

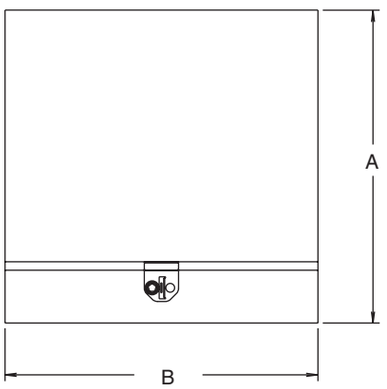
MTP	A	B	C	D	Wt.
Min.	36	44	51.5	19.25	1750
Max.	42	44	57.5	19.25	2500

Design Dimensions:
Physical data is approximate and is based on single voltage units with or without taps, with standard 19.25" cable compartment depth. Dimensions are in inches. Weights are in pounds. Dimensions may change to meet specific customer requirements.

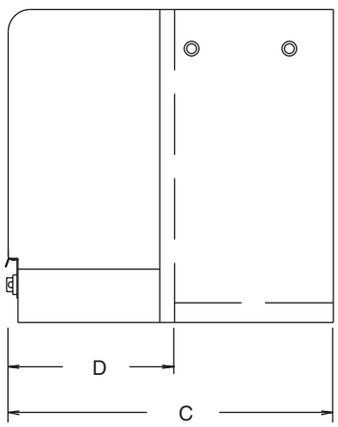
Recommended Pad Dimensions



Front View



Side View



Distribution Transformer Testing

The ABB commitment to manufacture quality distribution transformers is backed by a series of transformer tests used to verify conformance to performance characteristics outlined in the latest revisions of ANSI C57.12.00 and ANSI C57.12.90. These identified tests are also part of the Quality System which is audited semi-annually by DET NOSKE VERITAS (DNV) to ISO Standards.

Testing Program

Factory tests are performed on a transformer to confirm that it is properly designed and constructed to carry rated load and that it will withstand the conditions it will be exposed to in service.

Each transformer manufactured by ABB must undergo a series of tests.

1. Polarity, Phase-Relation, and Ratio
2. Demag Test
3. Applied Voltage Test of the HV
4. Applied Voltage Test of the LV
5. Induced Voltage Test
6. No-Load (Excitation) Loss and Excitation Current
7. Impedance Voltage and Load Loss
8. Full Wave Impulse
9. Continuity Check

Test Facilities

The multi-station, automated test facilities are operated by process control computers. Required interaction with test floor personnel is minimal with the computers initiating and monitoring each test, and then analyzing the test results feedback. The computers are programmed to conduct tests according to ANSI standards, and according to the ratings of each transformer style, the test floor computers will initiate appropriate test setups, compare results with established ANSI standard limits, and determine acceptance for each tested unit.

The test results for each unit are recorded and stored on computer files for access and analysis.

Polarity, Phase-Relation, and Ratio Tests

These tests verify proper phase-relation (three phase), ratio, and polarity (single phase) of the transformer under test. To pass, a unit must demonstrate the proper polarity or phase-relation and have a turns ratio within one-half of one percent of the nominal voltage ratio.

Demag Test

Some transformers require the Demag Test to remove any residual magnetism in preparation for an impulse test. It also serves as a no-load exciting current test. A transformer passes this test if the exciting current does not exceed the limit specified for the design of the transformer.

Applied Voltage Test of the HV

This test checks the dielectric integrity of insulation structures between the high voltage and low voltage, and between the high voltage and ground. A pass/fail decision is made by monitoring the test current intensity. If the resulting current is larger than specified normal leakage and capacitive currents, the unit is rejected. This test is omitted for transformers with a permanently grounded high voltage winding.

Applied Voltage Test of LV

This dielectric test is similar to the Applied Voltage test of the high voltage circuitry except that the integrity of insulation structures between the low voltage and the high voltage, and between the low voltage and ground is checked. A pass-fail decision is made by monitoring the test current intensity. If the resulting current is larger than specified normal leakage and capacitive current, the unit is rejected.

Induced Voltage Test

The principal purpose of this test is to verify the dielectric strength of turn to turn, layer to layer, phase to phase, and other insulation structures within the transformer windings by inducing an overvoltage condition (at higher than normal frequency to avoid saturation of the core). The test current is monitored, and if it exceeds limits specified for each transformer, the unit is rejected.

No-Load Loss and Excitation Current

This test measures the no-load (excitation) loss and the transformer exciting current with rated voltage applied. If the exciting current and/or the no-load loss exceed the limits specified, the transformer is rejected.

Impedance Voltage and Load Loss

This test measures the load loss and the impedance voltage at rated current. The load loss and the impedance voltage must be within specified limits.

Full Wave Impulse

The impulse test is one of several tests designed to verify the dielectric strength of the many insulation structures within the distribution transformer against line voltage surges. It is performed to comply with ANSI standards and for quality assurance. The change in the ANSI standard in 1993 required all manufacturers to install fault detection sensitive enough to detect a single turn short.

Continuity Check

This test is performed on all transformers to verify transformer circuit and component integrity. This test is performed with an ohmmeter to verify that the internal wiring is correct.

The transformer's nameplate is compared to manufacturing information for style, serial number, kVA, HV rating, LV rating, tap voltages, impedance, conductor materials and coil BIL rating. The bushings, electrical accessories, and fuses are verified.

Special Tests

Some tests are performed at the option of the customer.

Sound Testing

ANSI standards define the required sound levels for transformer but some customers specify reduced sound levels. The sound generated by a transformer is affected by the core geometry, flux density, tank design, and the quality of assembly of all the transformer components into a completed unit. Sound tests are made with the unit powered at 100% and 110% of rated voltage under no-load conditions.

Temperature Tests

Core losses and coil losses are the primary sources of heating within the transformer. Our transformers are guaranteed to have an average coil winding temperature of no more than 65° C rise over ambient air temperature when operated at rated voltage and load conditions.

The temperature test is performed to determine the thermal characteristics of the transformer and to verify that they are within design limits.

Calibration

Test equipment is calibrated on a scheduled basis by trained technicians. Calibration records are maintained in accordance with the Quality System procedures. These are audited semi-annually by DNV in accordance with ISO Standards.

Short Circuit Withstand Capabilities

Distribution transformers are subjected to external short circuits on the secondary side. Such external faults can develop on the service line, in the house wiring or in connected loads due to numerous environmental reasons. These faults can be line-to-ground, double line-to-ground or line-to-line.

To meet these operating conditions, the American National Standard Institute (ANSI) has set standards concerning short circuit withstand capability. These standards require that distribution transformers shall be designed and constructed to withstand the mechanical and thermal stresses produced by these external short circuits.

The current standards relating to short circuit strength are ANSI C57.12.00 which sets the short circuit withstand requirements for distribution transformers and ANSI C57.12.90 which provides procedures for short circuit testing.

For distribution transformers, the magnitude of the short circuit current, the numbers of short-circuit tests and the duration of each short circuit test are defined by ANSI standards as follows.

A. Magnitude

Category	Single Phase kVA	Three Phase kVA	Withstand Capability*
I	5-25	15-75	40
	37.5-100	112.5-300	35
	167-500	500	25
II		750-2500	$1/Z_{T**}$

*Base current (Symmetrical) per unit for all distribution transformers with secondary rated 600 V and below.
**The short circuit current will be limited by the transformer impedance only.

B. Number of Tests
Each phase of the transformer shall be subjected to a total of six tests, four with symmetrical fault currents and two with asymmetrical fault currents.

C. Duration of Short Circuit Tests
When short circuit tests are performed the duration of each test shall be 0.25 s except that one test satisfying the symmetrical current requirement shall be made for a longer duration on distribution transformers. The duration of the long test in each case shall be as follows:

Category I:
$T=1250/I^2$

Where T is the duration in seconds,

And $I=I_{sc}/I_R$=symmetrical short circuit current, in multiples of normal base current except I shall not exceed the maximum symmetrical current magnitudes listed in A.

Where $I_{sc}=I_R/Z_T$=symmetrical short circuit current, in rms amperes

I_R=rated current on the given tap connection, in rms amperes

Z_T=transformer impedance on the given tap connection in per unit on the same apparent power base as I_R

Category II:
T=1.0 second

Criteria of Satisfactory Performance
According to ANSI Standards a unit is considered to have passed the test if it passes a visual inspection and dielectric tests. Recommended additional checks include examination of wave shape of terminal voltage and current, leakage impedance measurement and excitation current test. (Refer to ANSI C57.12.90.)

The standard allows the following variations in the leakage impedance:

Z_T (Per Units)	Percentage Variation
0.0299 or less	22.5-500 (Z_T)
0.0300 or more	7.5

Z_T=per unit impedance of the transformer

Paint Finish Process

ABB utilizes a multi-step process to apply a corrosion resistant finish to transformers. The materials and processes used are designed to protect against the effects of abrasion, sunlight, rural and industrial atmospheres, and humidity. Each carefully controlled process step has a specific purpose, and each step builds on the previous steps to form the complete protection system that ensures that our transformers meet ANSI functional paint specification guidelines.

Paint Process Procedure

Transformer parts receive the following steps of surface preparation prior to painting.

1. Shotblast: All parts are centrifugally blast cleaned to remove welding by-products and provide a uniform surface profile for better, more consistent adhesion and corrosion protection.
2. Alkaline wash cleaner: Removes mill oils, drawing oils, and shop soils that could interfere with good adhesion.
3. Water rinse.
4. Zinc phosphate coating: Provides a firm anchor for good paint adhesion and provides resistance to underfilm corrosion should the paint film be damaged, exposing bare metal.
5. Water rinse.
6. Deionized water rinse: Removes any ionic contamination to prepare for first application of paint.

This entire cleaning and pretreating process is automatic and conveyorized with all chemicals applied by spray.

The pretreatment system combines the latest in cleaning technology such as DI rinses and zinc phosphate over shotblasting in a tried and true format to provide the best possible pretreatment before paint is applied.

One of the keys to effectiveness of the ABB paint finish system is the primer. The green epoxy primer is applied by cationic electrodeposition – a dip process in which positively charged primer particles are attracted to grounded parts (cathodes). This method applies a very uniform, pinhole-free coating which penetrates and thoroughly coats all parts. This is a highly effective process for coating parts with difficult geometry. The process utilizes practically 100% of the primer paint, and since the primer is water borne OSHA and EPA emission standards are met. The primer is free of lead and chrome. After rinsing, parts are cured in an oven in preparation for the next step.

After the transformer is assembled, a final coating of two-component urethane paint is spray applied for color and additional film build. The final coat provides the weatherability necessary to protect the unit from sunlight and maintain its appearance.

Summary

The ABB paint system utilizes advanced techniques and materials to provide a superior finish system on pad-mounted distribution transformers. Each step in the process is specifically designed to maximize finish performance while minimizing waste to provide the best possible combination of performance and cost.

Paint Finish Specifications and Test Results

Parameter	Test Method	Specification	Typical ABB Value
Total exterior film build	Elcometer 256NF	3.0 mil min.	3.5 mils
Salt fog 1500 hrs.	ASTM B117	6 rating per ASTM D1654, no blisters	7 rating per ASTM D1654, no blisters
Adhesion	ASTM D3359 Method A or B	100%	100%
Humidity 1000 hrs.	ASTM D4585 @45c	No blisters, 1 pencil hardness	No blisters, no softening
Impact, 80 InLb	ASTM D2794/ ASTM B117	No red rust after 24 hrs.	No red rust after 24 hrs.
Oil resistance	Immerse in 100c Oil for 72 hrs.	No loss of adhesion, no blisters	No loss of adhesion, no blisters
QUV, 500 hrs.	ASTM G53/D523	50% loss of gloss, no cracks, no crazing	40% loss of gloss, no cracks, no crazing
Abrasion, 3000 cycles	ASTM D4060 24 hrs.	No red rust after 24 hrs.	No red rust after
Gravelometer, 60 PSI	ASTM 3170/ SAE J400	After 24 hrs. red rust in chips to not exceed 4B rating	No red rust in chips
QUV/SCAB, 15 cycles	ASTM G53	6 rating per ASTM D1654, no blisters	7 rating per ASTM D1654, no blisters
Paint meets or exceeds ANSI C57.12.28, C57.12.29 and EEMAC Y1-2, Canadian Standard.			

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