LOS ANGELES COMMUNITY COLLEGES
770 WILSHIRE BOULEVARD, LOS ANGELES, CALIFORNIA 90017 • 213/891-2000
CITY • EAST • HARBOR • MISSION • PIERCE • SOUTHWEST • TRADE-TECHNICAL •
VALLEY • WEST•ADMINISTRATIVE OFFICES • Darroch "Rocky" Young, Chancellor

OFFICE OF FACILITIES PLANNING AND DEVELOPMENT

REQUEST FOR QUALIFICATIONS AND PROPOSALS (RFQP)

RENEWABLE ENERGY PROGRAM

DESIGN, ENGINEERING AND INSTALLATION OF TURN-KEY 1MW SOLAR PHOTOVOLTAIC/ HYDROGEN FUEL CELL SELF GENERATION AND OTHER GREEN RENEWABLE ENERGY SYSTEMS

Section 1a – Introduction and Objectives

The Los Angeles Community College District (hereinafter referred to as the District), Office of Facilities Planning and Development, on behalf of the Board of Trustees, seeks written Statement of Qualifications and Proposals from interested firms and Photovoltaic/ Hydrogen Fuel Cell [PV/HFC] developers and/or partnerships (hereinafter referred to as the Entity or Entities) to provide cost effective PV/HFC electric generating systems at all nine (9) colleges and two (2) satellite sites within the District. The entities may also be asked to assist the District with identifying similar projects at other than college sites depending upon the success of the initial program.

The District intends to enter into long-term Energy Service Agreements for terms up to twenty five years and beyond if necessary, with PV/HFC entities under the auspices of California Government Code 5956 which provides the legal authority for local government agencies (including Community College Districts) in California to utilize public finance and private investment capital to study, plan, design, construct, develop, finance, maintain, rebuild, improve, repair, or operate, or any combination thereof, fee-producing infrastructure facilities. Furthermore, a governmental agency may solicit proposals and enter into agreements with private entities for the design, construction, or reconstruction by, and may lease to private entities for energy or power production. **(California Government Code Section 5956.4 sub-paragraph [c]).**

As part of the District's Renewable Energy Program for modernization and new construction, the District plans to expand existing non-fossil fuel self-generation resources and build new green renewable energy projects on selected campuses and properties within the College District. The District intends to develop a variety of renewable resources, including solar, wind, biomass, geothermal, hydrogen fueled and storage technologies.

The District's goal in advancing this Request for Qualifications and Proposals [RFQP], is to eventually eliminate its annual energy bill by having alternative energy systems installed that will fully cover each College's maximum base load during the day, and in the evening as well. A possible scenario for the District is to install sufficient alternative energy capacity to allow excess solar generated electricity, or other alternative power to be used to produce hydrogen gas through the electrolysis of water. In turn, the hydrogen gas would be used to power fuel cells for the production of electricity to fully cover the evening electrical demand at each College. The District welcomes entities to suggest other packages of alternative energy technology to achieve the goal of providing enough energy to meet both the day time and evening needs of the Colleges and enable all campuses to achieve "Climate Neutrality" and hence "Energy Independence".

In responding to this RFQP, entities are encouraged to consider and describe structures which take into account and may take advantage of any available federal and state tax and other deductions, credits, rebates, and other incentives with respect to the requested PV/HFC electric generating systems. Responses should include a description and quantitative analysis of each such federal and state benefit.

To avoid any or all ambiguous interpretation of terms a lexicon of definitions for terminology, nomenclature and other engineering data used throughout this document is presented in Appendix D and must be strictly adhered to and referenced in all correspondence and submittal documents.

The objective of this RFQP is to identify and select the most qualified turnkey PV/HFC entity to begin negotiating for the design, installation, commissioning and monitoring of up to 9 MW of fully functioning non grid-connected PV/HFC systems. The District is interested in receiving proposals from qualified entities for the detailed design and engineering, identification, and selection of code compliant components, materials and equipment for the installation and operation of turn-key solar PV/HCF systems, at its campuses and other properties. All submittals are confidential and proprietary.

Using production modules certified by an independent recognized laboratory, and direct current (DC) watts measured under stabilized PVUSA Test Conditions (PTC), and fuel cell systems meeting standards set forth in the CSA FC1 standard (formerly ANSI Z21.83), "American National Standard for Fuel Cell Power Systems", suitably qualified entities are invited to submit proposals for arrays ranging from 200kW (DC) up to 1200kW (DC) per campus.

Prior, or simultaneous, to the installation of the technology sought through this RFQP, the District will be implementing a comprehensive demand reduction program through a separately awarded performance management contract. The goal of this effort will be to identify and install every possible cost-effective technology that will minimize the demand for energy at each of the District's colleges on a building by building and space by space basis. This demand reduction concept is intended to offset the growth in energy demand that will be caused by the District's large capital construction program.

Section 1b – Background

The District serves over one hundred cities and communities within a geographical area covering eight hundred and eighty two square miles. Extending from Agoura Hills in the west San Fernando Valley to the City of San Fernando in the north and Burbank to the east, the service area includes Beverly Hills and Westwood on the west side of the greater

Los Angeles basin, Monterey Park and San Gabriel on the east side and includes Palos Verdes Estates and San Pedro to the south. Nine colleges within the district educate more than 120,000 students a year. In addition, two satellite campuses are in the planning stage.

The mission of the District is to provide comprehensive lower-division general education, occupational education, transfer education, counseling and guidance, community services, and continuing education programs which are appropriate to the communities served and which meet the changing needs of students for academic and occupational preparation, citizenship, and cultural understanding." The Western Association of Schools and Colleges accredits each of the nine colleges. A seven-member Board of Trustees, elected at large for four-year terms, governs the District. Educational master plans and facilities master plans have been developed at each of the nine colleges in response to the unique needs of their respective communities.

The colleges range in size from twenty-two to over four hundred and fifty acres. Facilities include newly constructed classroom buildings as well as outdated structures older than fifty years. On April 10, 2002 the voters authorized the District to issue $1.245 billion of general obligation bonds under Proposition A which passed with a 67% majority (only 55% being required). In May 2003, under Proposition AA, the voters approved an additional $980 million of general obligation funds. The bond proceeds are allocated for construction, repair, improvement, and upgrade of District buildings, classrooms, and other facilities. The Board of Trustees has appointed a District Citizens' Oversight Committee that includes representatives from each college.

The nine colleges are:

- Los Angeles City College
- East Los Angeles College
- Los Angeles Harbor College
- Los Angeles Mission College
- Los Angeles Pierce College
- Los Angeles Southwest College
- Los Angeles Trade-Technical College
- Los Angeles Valley College
- West Los Angeles College

The satellite campuses are:

- Northeast Satellite Campus-L.A. City College
- Southgate Educational Center-East L.A. College

Further information about the District is available on our web site: http://www.laccd.edu and more specifically about the Proposition A/AA Bond Program at: www.propositiona.org.

The results of this solicitation and final award to one or more entities will be made available to all public entities in the State of California, and to other interested public entities and colleges and universities throughout the United States. The District recognizes that alternative energy incentive programs vary by state, utility and locality. Final pricing and project conceptualization will logically vary by specific location and will need to be established based on the specific needs of those other entities. No guarantee of contract with any other public entity is being offered through this Request for Qualification.

Section 2: Solicitation Process

Each respondent to the RFQP must demonstrate that it satisfies the minimum requirements described herein. An eligible Respondent must address ALL questions in each section.

Responses to this RFQP must be submitted in writing, signed by an authorized officer or an agent of the respondent. The District must receive five (5) hard copies and one (1) electronic copy of the respondent's qualifications and proposal package no later than the date and time shown below. Responses submitted after this date will not be accepted, and responses that are incomplete or do not conform to the requirements of this RFQP will not be considered responsive.

After evaluation of the qualifications and proposal packages, the District intends to select one or more entities from the qualified list to implement its turnkey PV/HFC system installation plans.

The qualifications and proposals, to be submitted in the format specified below, will include equipment specifications, permitting and installation processes, timelines, funding and costs inclusive of all federal and state taxes, co-funding, financing, incentives, grants, rebates and other awards, in addition to safety and certification plans, and minimum specified warranties for equipment, materials and labor. A minimum 25 year warranty on the photovoltaic modules and a minimum 10 year warranty for the inverter components within the electronic package is mandatory. Prospective entities must include evidence of certification of their production modules, and specified DC watts at PTC, from an independent laboratory.

Responses to this RFQP shall be submitted to:

Larry Eisenberg
Executive Director, Facilities Planning and Development
c/o DMJM/JGM, Program Managers
515 South Flower Street, Ninth Floor
Los Angeles, CA 90071

Submittals must be received by no later than: **2:00 p.m. on Friday, February 02, 2007**.

All questions related to this RFQP must be in writing via e-mail (preferred) or by Fax and must be received no later than: **2:00p.m. on Friday, January 12, 2007.**

Direct all questions to: **Bill Gardner, Contracts Manager**
E-Mail: bill.gardner@dmjmjgm.com
Fax: (213) 593-8641

Following the questions deadline date all Questions and Responses will be summarized and posted on the website: www.propositiona.org

Section 3: Assumptions and Minimum Project Requirements

Proposals submitted in response to this RFQP must be as specific as possible concerning each of the areas identified herein, including obligations of each party as envisioned by the respondent. Each respondent must provide sufficient information to enable The District to understand the overall proposal, the service(s) to be provided, and the potential adverse impacts of the proposal. The District reserves the right to deem any proposal as non-responsive and to give it no further consideration. The District also reserves the right to request clarification and or additional information from any respondent.

While specific sites have not yet been identified, for the purposes of responding to the pricing section of this RFQP, respondents are asked to make the following general project assumptions. Assume one or a combination of the following project types at each site and submit information related to each as indicated in **Appendix A:**

i. Turn-key grid-connected PV/HFC projects
ii. California based installations in the Los Angeles area
iii. Roof-mounted fixed-tilt installations
iv. Parking Structure fixed-tilt installations
v. Ground-mounted fixed-tilt installations
vi. Provide 1-axis and 2-axis options for all three project types
vii. 480 volt electrical panel located within 100 feet of the installed system
viii. A fully programmable open architecture SCADA/DAQ monitoring system
ix. Prevailing wage rates for all installation labor

All parties agree to negotiate in good faith to adjust actual pricing as necessary for specific sites to accommodate unique site requirements.

All products and components outlined herein must conform to the following codes, standards and rating methodologies:

Section 3a: Fuel Cells

All fuel cell systems proposed for inclusion in this RFQP must meet standards set forth in CSA FC1 standard (formerly ANSI Z21.83), “American National Standard for Fuel Cell Power Systems”. Performance of the HFC will have an impact on the overall HFC/PV system performance. As such, performance parameters of the HFC will be reported in based upon ASME PTC 50 “Performance Test Code for Fuel Cell Power Systems Performance”. Installation of the HFC will comply with NFPA 853-2007, “Standard for the Installation of Stationary Fuel Cell Power Systems”. Integral to this program is the generation of on-site hydrogen for use in the fuel cell. Hydrogen generators will comply with CSA FC 5 standard, Gaseous Hydrogen Generation Appliances. All Systems and locations for hydrogen storage must comply with NFPA 50A and 50B, as appropriate (for gaseous and liquid hydrogen respectively).

Section 3b: Photovoltaic Systems

3.1 PV system must be compliant with the requirements of the California Energy Commission (CEC) for Renewable Energy programs.

3.2 PV modules specified in the RFQP must be certified by the CEC's Emerging Technologies program.

3.3 Rated PV system capacity must be specified in direct current (DC) kilowatts peak STC and PTC.

3.4 The STC rating, or standard test conditions rating, assumes direct current, standard test conditions. (kWdc-stc). It is also referred to as kilowatts peak, or kWp. Specific PV module manufacturer maximum and minimum power data must be specified for this rating.

3.5 The PTC rating, or PV USA Test Conditions rating, is based on 1000 Watts/square meter solar irradiance, 20 degree Celsius ambient temperature and 1 meter/second wind speed.

The mathematical method for specifying PV system output in kWh must be specified for each of the following steps:

3.6 Calculate effective alternating current (AC) power of the proposed module type, from the rated kWdc-stc. AC losses due to wiring, soiling and power conditioning unit (PCU) (inverter) efficiency must be taken into consideration. (For full list of AC losses to consider please see Appendix B).

3.7 Specify annual degradation expected over 25 years.

3.8 UL certification.

3.9 National Electrical Code – NFPA 2002.

3.10 Must comply with wind uplift requirements per the American Society of Civil Engineers Standard for Minimum Design Loads for Buildings and Other Structures (ASCE 7), and must be able to withstand design wind speeds of at least 100 mph (3-second gusts).

3.11 All outdoor enclosures should be at minimum rated NEMA 3R.

3.12 Occupational Health and Safety Administration (OSHA) directives for roof-mounted installations.

3.13 PV array adds no more than 8 pounds per square foot to the facility roof structure in the array area.

3.14 Rooftop system components should achieve Uniform Building Code (UBC) fire code rating of "B" or better.

Additional Requirements

If any components in the PV modules and balance of plant are normally manufactured to non-U.S. standards, conformance of the equipment to the specified U.S. standards shall be certified by the Respondent. The PV Modules and balance of plant design shall comply with all applicable State of California regulations and local codes in effect on the date of the contract.

PV module structure shall be designed to resist dead, live, plus wind or seismic loads in Zone 4. The PV modules operating parameters (amperage, voltage, transients, etc.) shall be compatible with the specifications of the associated UL certified inverters. Compression type terminal strip PV module output terminals shall be provided in a water tight module mounted terminal box with knockouts for ½ inch water tight conduit mountings. Bypass diodes shall be supplied, mounted and connected on each PV module in the water tight module mounted terminal box. Alternatives may be acceptable with the District's approval. If bypass diodes are not required, evidence of this must be supplied with bid for approval by the District. PV modules without junction boxes but with UL approved interconnection wiring methods may be acceptable with the District's approval.

A complete listing of applicable codes and standards is presented in **Appendix C.**

Section 4: Warranty and Service Contract Requirements

4.1 All entities must offer comprehensive on-site training in PV system operations, safety and maintenance consistent with warranty and service contract provisions.

4.2 All entities will be asked to make their installation process available as a training opportunity for Los Angeles Community College District students. The specific manner in which this will occur will be negotiated with the entities selected as a result of this RFQP and will include at least a professionally produced training aid in DVD format.

4.3 The entities standard warranty coverage should be at least 10 years for systems and 25 years for PV modules and provide:

a. Annual on-site system inspection, including:
   - system testing (including a check of the operating current of each electrical string)
   - adjustment and routine maintenance
b. System performance monitoring and historical data access for customer via secure website. Data should include: system energy and power production, ambient temperature, wind speed, and insolation data.

Section 5: Comprehensive List of RFQP Components for all Bidders

5.1 Submit a transmittal letter signed by a party authorized to sign binding agreements for projects of the nature ultimately contemplated by this RFQP. The letter shall clearly indicate that the respondent has carefully read all the provisions in the RFQP.
5.2 Project Team Qualifications – Please provide the following information:
5.3 Identify the team leader for the entire proposal, and his/her full contact information.
5.4 Identify each entity, person or firm involved in the proposal and their role e.g. Design, installation, permitting, equipment supply by component, operations and maintenance.
5.5 Identify the lead person responsible for each of the entities or firms described in 1b.
5.6 Provide both an organizational chart and a description of responsibilities for each person or firm, and an overall project organization chart.

5.7 Respondent Qualifications – Please provide a complete profile of your firm, including:

i) Year founded

ii) Status (private/ publicly-held)

iii) Number of employees

iv) States and countries in which you do business

v) Target customers (residential, commercial, industrial, government etc.)

vi) Organizational structure

vii) Resumes or bios of personnel to be directly involved with the development of the proposed systems

viii) Audited financial statements for the most recent three years

ix) Letter from bonding company on respondent's performance to date.

5.8 Respondent Experience and References

5.81 Provide an overview of your company's grid connected PV experience and total MWp of grid connected PV installed to date, by application (roof mounted, ground mounted, fixed-tilt, 1-axis and 2-axis tracking).

5.82 List 5 or more grid-connected PV projects installed over the last three years that exceeded 100 kWp. Include for each:

i. Exact role(s) your organization performed for the project (eg. Lead contractor, electrical subcontractor, design, consulting etc.)
ii. Location
iii. Application description (roof vs. ground mounted)
iv. Product name/type
v. Customer name
vi. Date installed, including length of time from bid acceptance to project completion
vii. PV module used
viii. KWdc-STC and kWac-PTC rating
ix. Cumulative kWh produced since system installation
x. Current status of system (operational yes/no)

5.9 For the systems described above, please provide five active U.S.-based large grid connected (>100 kWdc) customer references and their contact information.

5.10 Has your firm or any of the executive officers of your firm been a party to a lawsuit involving the performance of any equipment it has installed? If so, please include a summary of the issues and the status of the lawsuit.

5.11 Product/technology description.

Entities shall state that their systems will comply with all of the requirements of Section 3, or list the items that would not comply and state why.

Describe the technology (or technologies) that your company typically proposes for rooftop and/or ground-mounted applications including at least the following information:

Photovoltaic module description, brand(s) and model numbers
Inverter type and brand(s) and efficiency (in %)
Structural materials
Balance of system components
Installed weight per square foot

For each technology described above, please provide evidence that your technology and equipment is commercially proven as evidenced by completed projects.

For each technology described above, please describe any other benefits your system provides that other system might not provide, but only if such benefits can be readily measured and confirmed by an independent engineering study.

For each technology described above, please provide information about any potentially adverse effects. For example, for rooftop systems, does your system typically penetrate the roof? If so, please describe, including expected number of penetrations per square foot, and plans to mitigate their effect.

Indicate the typical degradation experienced in the field, and, if empirical evidence is not available, project the degradation rates for the useful life of the panels (but not in excess of 30 years)

5.12 Pricing – The District's goal in advancing this Request for Qualifications is to identify a private sector firm that can fully utilize federal, state, local and utility incentives, tax credits and tax deductions to offset the cost of the proposed system. The selected firm will also be able to utilize the renewable energy credits created through the installation of this technology to further offset the cost of installation. The District wants to see the final net cost of the system, after all incentives and tax benefits have been applied, to be amortized over the necessary period of years and be paid back to the vendor through an annual Power Purchase Agreement, The goal is to have the annual payment be no more than the present annual energy payment experienced by each College.

The District does want to have the option of purchasing the installed system immediately upon activation and project completion at the net cost, or on an annual basis at a pre-set date and at a pre-set price for the life of the Power Purchase Agreement solely at the District's option. To that end, Entities will be asked to develop a buy-out schedule that will be incorporated into any final contract established for this purpose.

Using Appendix A as a template, for each PV system product/ application, please provide turnkey system pricing information in $/kW (kWdc-stc) and ($/kWdc-ptc) for a 250 kWp roof-mounted PV system and/or a 1 MWp ground-mounted tracking system.

a) Do not include any sales tax or performance/payment bond fees.

b) Provide the estimated total kWh output of the system over 20 years using the methodology suggested in Section 4. Clearly list the AC loss assumptions in Appendix B.

c) Clarify any pricing assumptions inherent in your bid at the time of submittal, and describe any market forces that could occur in the next 6 months to 1-year time frame that could affect those assumptions.

d) Assume a Notice to Proceed will be signed on **April 12, 2007.**

5.13 Please provide an overview of your proposed system output performance verification methodology. Is it web-based? What does the end-user interface look like? Please also indicate whether or not you can comply with the minimum system performance and monitoring requirements set forth in Section 4, under Warranty and Service Requirements.

5.14 Typical project schedule and timing – For evaluation purposes, please submit a schedule for a typical 250 kWp rooftop project indicating the expected milestones, with each task referenced from the notice to proceed.

Section 6: Evaluation Criteria

The evaluation criteria include the following:

Criteria Weighting

Prior experience in developing, designing and constructing turnkey grid-connected PV projects in a timely manner (minimum of five 100kWp functioning grid-connected PV projects):

25%

Price in $/kWh (based on 25 years of output) and $/kWdc-stc:

20%

Overall quality of the response to the RFQP:

10%

Building-friendly or structure-friendly product/system design (no or few penetrations, and weighs < 8lbs/sf):

10%

Safe, sturdy product/system design (ASCE 7 compliant, UBC fire code rating of B or better):

10%

Ability to provide required warranty obligations:

10%

For roof-mounted systems - Incremental passive savings to the facility (e.g. energy conservation delivered to the building):

5%

Ability to provide user-friendly, web-based performance monitoring services:

5%

Aesthetics of system:

5%

Total: 100%

The District reserves the right, at its sole discretion, to accept a response that does not satisfy all requirements but which, in the District's sole judgment, sufficiently demonstrates the ability to produce, deliver, design, permit and install a substantial volume of turnkey grid-connected PV projects and to satisfy the major requirements set forth in this RFQP. The District reserves the right to interview any or all respondents to this RFQP, or to ask for additional information or clarifications. The District expects to complete its evaluation process to select qualified contractors, but reserves the right to change key dates and action as the need arises.

Section 7: General Conditions

7.1 No obligation – This RFQP does not obligate the District to establish eligibility for any respondents, or to issue any subsequent RFQPs or to enter into any agreements. The District reserves the right to cancel or re-issue this RFQP at any time, and to solicit qualifications through any other appropriate method.

7.2 Rejection of Proposals – The District may reject any response that it deems to be incomplete, unresponsive, significantly inaccurate in its representation or which is unacceptable to the District in the context of this RFQP.

7.3 One proposal per organization – a company or non-profit may submit only one response to this RFQP. However, a respondent may be a subcontractor to any number of other respondents that may submit responses to this RFQP.

7.4. Substitutions – Respondents may substitute or alter their responses subsequent to the submission date only if such changes are approved in writing by the District.

7.5 Cost of Proposal and Non Compensation – Each respondent is solely responsible for all costs associated with responding to this RFQP. The District will not in any event reimburse any respondent for any costs associated with this RFQP.

7.6 Delivery of Proposals - Each respondent is solely responsible for assuring a timely submittal of its response. Late responses will not be accepted.

7.7 Withdrawal of Submittal – Reponses to this RFQP may be withdrawn after submission by written request of the respondent's authorized representative prior to the date and time specified for response submissions.

7.8 Disposition of Proposals, Confidential Information – All submittals and the information therein become the property of the District upon submittal. Proposals shall be returned only at the District's sole discretion and at the Respondent's expense. The District will employ reasonable efforts to hold portions of the responses specifically identified and

marked as “confidential” in confidence to the extent permitted by law, for a period of one year beyond the required date of submittal. Upon request, the District will return or destroy all confidential information that is a trade secret or privately held company’s financial information.

Dated: _____, 2006
Los Angeles, California

by:_____
Larry Eisenberg
Executive Director
Facilities Planning & Development

BOARD OF TRUSTEES OF THE
LOS ANGELES COMMUNITY COLLEGE DISTRICT

Appendix A: Pricing Table

Module type(s):_____

Type of technology: Crystalline___ Thin film___

Power output warranty term: 10 years__ 20 years__ 25 years__ Other____

Expected annual degradation in output: ____%

PV System Product/Technology Description _____

Maximum power conditioning unit (PCU) (inverter) efficiency _____ %

PCU Brand _____

Description of 'other benefits' provided by your product/ application _____

Pricing Table: Assume a purchase of 5 MW of PV installations; if more than one PV module is to be used, fill out table and spreadsheet for each module:

System Type in kWp (kW dc-stc):

Expected total cumulative kWh output over 20 years Price in $/Cumulative kWh Price in $/kWp (kW dc-stc):

One 250 kWp roof-mount = $

One 1 MW ground-mount tracking = $

IMPORTANT

The spreadsheet entitled "LACCD – PV RFQP 2006 Pricing Table & System Information" has been provided as part of Appendix 'A'. Please complete 1 (one) spreadsheet for each project type submitted.

Appendix B: AC Loss Assumptions, Backup for AC Power Rating and kWh Output Calculation

Loss factors are used to convert theoretical DC output at STC to actual AC output at PTC. Please indicate the AC loss assumptions in your kWh output calculation. Please be sure to include efficiency factors for the following average annual loss factors:

- DC Cabling

- Connections

- Module Coefficient of Temperature Calculation

- Module Mismatch

- Power Conditioning Unit (inverter)

- Soiling

- Shading Losses

- Tracking Losses

- Transformer Losses

- AC Wiring

- Auxiliary Loads

Appendix C – Applicable Codes & Standards

National Electrical Code - NFPA 70-1990
National Electrical Safety Code - ANSI C2-1990Insulated Cable Engineers Association (ICEA) Standards
UBC - Uniform Building Code - 1995
All outdoor enclosures shall be minimum NEMA 3, or equivalent rating
Occupational Safety and Health Administration (OSHA) Directives
ANSI/IEEE 519 1992 Guide for Harmonic Control and reactive Compensation of Static Power Controllers
- Flat Plate PV Modules: IEEE P 1262 "Recommended Practice for qualifications of Photovoltaic Modules" (If the Standard is not available, use the draft of this IEEE P1262 standard, available from UPVG)

ANSI/IEEE 928-1986 Recommended Criteria for Terrestrial PV Power Systems (PV System Performance criteria)
- ANSI/IEEE 929-1988 Recommended Practice for Utility Interface of Residential and Intermediate PV Systems

All PV Modules, and electrical components shall be required to be listed or recognized by an appropriate and recognized United States Safety Laboratory (for example: UL1703, CEC503, ETL, etc.) for all residential, commercial, customer-sited installations.
Inverters must be UL Certified.
Flat-plate thin film modules shall successfully pass the tests described in the Interim Qualification Tests and Procedures for Terrestrial Photovoltaic Thin-Film Flat-Plate Modules, SERI/TR213-3624, printed January 1990, by R. DeBlasio, et al.
ANSI/ASCE 7-88 - Building code Requirements for Minimum Design Loads in Buildings and Other Structures
FCC Regulations Electromagnetic Interference (EMI) Part 15, Subpart A, Subpart B, Subpart J, October 1992.
Local and State Codes and Standards.
AISC-1989 - Manual of Steel Construction, 9th edition, Allowable Stress Design - 1989
- AWS Dl. 1-90 - Structural Welding Code - Steel, 12th Edition

AWS Dl.3-89 - Structural Welding Code - Sheet Steel, 2nd Edition
AISI SG-673-1980 - Specification for Design of Coldformed Steel Structural Members.
Specifications for Aluminum Structures (The Aluminum Association).

Bolted and similar connections shall be non-corrosive and include locking devices designed to prevent loosening over the 25 year design life of the PV system. ASTM A325 or A490 bolts do not require locking devices but shall be installed in accordance with the applicable standards in the AISC Manual of Steel Construction - 9th Edition.

All fuel cell systems proposed for inclusion in this RFQ must meet standards set forth in CSA FC1 standard (formerly ANSI Z21.83), “American National Standard for Fuel Cell Power Systems”. Performance of the HFC will have an impact on the overall HFC/PV system performance. As such, performance parameters of the HFC will be reported in based upon ASME PTC 50 “Performance Test Code for Fuel Cell Power Systems Performance.” Installation of the HFC will comply with NFPA 853-2007, “Standard for the Installation of Stationary Fuel Cell Power Systems”. Integral to this program is the generation of on-site hydrogen for use in the fuel cell. Hydrogen generators will comply with CSA FC 5 standard, Gaseous Hydrogen Generation Appliances. All Systems and locations for hydrogen storage must comply with NFPA 50A and 50B, as appropriate (for gaseous and liquid hydrogen respectively).

Appendix D: Definitions & Terminology

Activated shelf life: The time it takes for the capacity of a charged battery to fall to an unusable level when stored at a specified temperature.
Activation voltage: The voltage at which the controller will operate to protect the batteries.
AGM (Adsorbed Glass Mat): a newer type of battery construction that uses saturated adsorbant glass mats rather than gelled or liquid electrolyte. AGM batteries are typically more expensive than flooded (liquid), but offer enhanced reliability.
Air mass: The air mass relates to the path length of solar radiation through the atmosphere. An air mass of 1.0 means the sun is directly overhead and the radiation travels through one atmosphere thickness. Approximately equal to the secant of the zenith angle, i.e. the angle from directly overhead to a line to the sun.
Alternating current (AC): Electrical current that continually reverses direction of flow. The frequency at which it reverses is measured in cycles-per-second, or Hertz (Hz). The magnitude of the current itself is measured in amps (A).
Alternator: A device for producing Alternating Current ("AC") electricity. Usually driven by a motor, but can also be driven by other means, including water and wind power.
Ambient temperature: The temperature of the surroundings.
Ammeter: A device used for measuring current flow at any point in an electrical circuit.
Amorphous silicon: A thin-film solar PV cell material which has a glassy rather than crystalline structure. Made by depositing layers of doped silicon on a substrate normally using plasma-enhanced chemical vapor deposition of silane.
Amp hour: The quantity of electrical energy corresponding to the flow of current of one ampere for one hour. The term is used to quantify the energy stored in a battery. Most batteries are rated in Ah.
Ampere (A) or amp: The unit for the electric current; the flow of electrons. One amp is 1 coulomb passing in one second. One amp is produced by an electric force of 1 volt acting across a resistance of 1 ohm.
Anemometer: A device used to measure wind speed.
Angle of incidence: Angle between the normal to a surface and the direction of incident radiation; applies to the aperture plane of a solar panel. Only minor reductions in power output within plus/minus 15 degrees.
Anode: The positive electrode in a battery. The positive terminal of a diode.
Anti-reflection coating: A thin coating of a material with a specific refractive index applied to a cell to reduce the reflection of light.
Array: A number of solar modules connected together in a single structure.
Array current: The electrical current output of a PV array when exposed to sunlight.
Array operating voltage: The voltage output of a PV array when exposed to sunlight and feeding a load.
Autonomous system: A PV System that operates without any other energy generating source.
Availability: The quality or condition of a PV system that is available to provide power to a load. Usually measured in hours per year.
AWG: American Wire Gauge: a standard system for designating the size of electrical wire. The higher the number, the smaller the wire. Most house wiring is #12 or 14.
Azimuth: The Angle between the north direction and the projection of the surface normal into the horizontal plane; measured clockwise from north. As applied to the PV array, 180 degree azimuth means the array faces due south.

Balance of system (BOS): All the parts of a PV System excluding the solar module
Ballast: a circuit used to stabilize an electric current, for example, in a fluorescent light.
Battery: A system in which stored chemical energy is converted directly into electrical energy. Can be either rechargeable or non-rechargeable. Different to a fuel cell in that it contains a fixed quantity of stored chemical energy rather than a continuous supply of fuel.
Battery capacity: The total number of ampere-hours (Ah) that a fully charged battery can output.
Battery cell: An individual unit of a battery that can store electrical energy and is capable of furnishing a current to an external load. For lead-acid batteries the voltage of a cell (fully charged) is about 2.2 volts dc. A battery may consist of a number of cells.
Battery charger: A device used to charge a battery by converting (usually) mains voltage AC to a DC voltage suitable for the battery. Chargers often incorporate some form of regulator to prevent overcharging and damage to the battery.
Battery cycle Life: The number of times a battery can undergo a cycle of discharge and recharge before failing. Cycle Life is normally specified as a function of discharge rate and temperature.

Battery self-discharge: Energy loss by a battery that is not under load.
Battery state of charge (SOC): Extent of battery charge status as a percentage of full charge. Also 100 per cent minus the Depth of Discharge.
BIPV: Building Integrated Photovoltaics. As the name suggests, this is where PV modules are integrated into the building construction materials as on integrated unit.
Blocking diode: A diode used to prevent current flow in an undesirable direction e.g. from the rest of the PV array to a failed module or from the battery to the PV array when current generation is low.
British Thermal Unit (BTU): The amount of heat energy required to raise one pound of water from a temperature of 60 degrees F to 61 degrees F at one atmosphere pressure. One Watt hour equals 3,413 BTU.
Bypass diode: A diode connected across one or more solar cells in a photovoltaic module such that the diode will conduct if the cell(s) become reverse biased. [UL 1703]

Capacitor: An electronic component used for the temporary storage of electricity, as well for removing unwanted noise in circuits. A capacitor will block Direct Current but will pass Alternating Current.
Capacity: See Battery Capacity.
Captive electrolyte battery: A battery with an immobilized electrolyte (gelled or absorbed in a material).
Cathode: The negative electrode in an electrochemical cell. Also, the negative terminal of a diode.
Cathodic protection: A method of preventing oxidation (rusting) of exposed metal structures, such as bridges and pipelines, by imposing between the structure and the ground a small electrical voltage that opposes the flow of electrons and that is greater than the voltage present during oxidation.
Cell efficiency: The ratio of the electrical energy produced by a photovoltaic cell (under full sun conditions or 1 kW/m2) to the energy from sunlight falling upon the photovoltaic cell.
Cell junction: The area of immediate contact between two layers (positive and negative) of a photovoltaic cell. The junction lies at the center of the cell barrier or depletion zone.
Cell: The basic unit of a PV module or battery. The most basic unit that contains the necessary materials, such as electrodes and electrolyte in a battery, to produce electricity.
Charge: The process of inputting electrical energy to a battery.
Charge controller: A component that controls the flow of current to and from the battery subsystem to protect the batteries from overcharge and over discharge. Essential for ensuring that batteries obtain maximum state of charge and longest life. The charge controller may also monitor system performance and provide system protection. Charge Controllers are also sometimes called Regulators.
Charge factor: A number corresponding to the time (in hours) for which a battery can be charged at a constant current without damaging it. Usually expressed as a function of battery capacity, e.g. C/10 indicates a charge factor of 10 hours. Related to Charge Rate.
Charge rate: A measure of the current used to charge a battery as a proportion of its capacity.
Circuit: A continuous system of conductors providing a path for electricity.
Circuit breaker: A circuit breaker acts like an automatic switch that can shut the power off when it senses too much current.
Cloud enhancement: The increase in solar intensity due to reflected light from nearby clouds.
Cogeneration: The joint production of electricity and useful heat at a single facility, resulting in more efficient use of the thermal energy.
Concentrator: A photovoltaic device that uses optical elements (e.g. mirrors or lenses) to increase the amount of light incident on a solar PV cell. Concentrator arrays track the sun and use only direct sunlight since the diffuse portion cannot be focused. Concentrators therefore work best in clear sky locations. Efficiency is increased, but cell life may be reduced because operating temperatures are higher.
Conductor: A material used to transfer, or conduct, electricity, often in the form of wires.
Conduit: A pipe or elongated box used to house and protect electrical cables.
Conversion efficiency: The ratio of the electrical energy generated by a solar PV cell to the solar energy impacting the cell.
Cross-flow turbine: A turbine where the flow of water is at right angles to the axis of rotation of the turbine. **Crystalline silicon:** A type of PV cell material made from a single crystal or polycrystalline ingot of silicon.
Current: Current is the flow of electric charge in a conductor between two points having a difference in electrical potential (voltage) and is measured in Amps.
Current at maximum power (Imp): The current at which maximum power is available from a module. [UL 1703]
Cut-off voltage: The voltage levels at which the charge controller (regulator) disconnects the PV array from the battery, or the load from the battery.
Cycle: The discharge and re-charge of a battery, one complete charge/discharge cycle of the battery.

Cycle life: Number of charge-discharge cycles a battery can perform under specified conditions before it fails to meet its specified performance (e.g. capacity decreases to 80% of nominal capacity).

Days of storage: The number of days that a stand-alone system will power a specified load without solar energy input. A measure of system autonomy.
DC to DC converter: Electronic circuit to convert dc voltages (e.g., PV module voltage) into other levels (e.g., load voltage). Can be part of a maximum power point tracker (MPPT).
Dealer: A Retailer of PV products and/or PV Systems.
Deep cycle battery: A battery designed to regularly discharge 80% of its capacity before recharging.
Deep discharge: Discharging a battery by more than 80% of its full charge.
Depth of discharge (DOD): the amount of energy withdrawn from a battery or cell expressed as a percentage of its rated capacity.
Design month: The month in which the combination of insolation and load requires the maximum energy from the array.
Diffuse insolation: Incident sunlight received indirectly because of scattering due to clouds, fog, particulates, or other obstructions in the atmosphere. The other component of sunlight is Direct.
Diffuse radiation: Radiation received from the sun after reflection and scattering by the clouds, fog, haze, dust or other substances in the atmosphere, and the ground.
Diode: Electronic device that allows current flow only in one direction.
Direct beam radiation: Radiation received by direct sunlight. Measured by a pyrheliometer with a solar aperture of 5.7° to transcribe the solar disc.
Direct current (DC): Electrical current that flows only in one direction, although it may vary in magnitude. Contrasts with alternating current.
Direct insolation: Sunlight falling directly upon a collector. Opposite of diffuse insolation.
Direct radiation: Light that has traveled in a straight path from the sun (also referred to as beam radiation). An object in the path of direct radiation casts a shadow on a clear day.
Discharge: Withdrawal of electrical energy from a battery.
Discharge factor: A number equivalent to the time in hours during which a battery is discharged at constant current usually expressed as a percentage of the total battery capacity, i.e., C/5 indicates a discharge factor of 5 hours.
Discharge rate: A measure of the current withdrawn from a battery over time, expressed as a percentage of battery capacity. A C/5 discharge rate indicates a current of one-fifth of the rated capacity of the battery.
Disconnect: Switch used to connect or disconnect components in a PV system.
Dispatchability: The ability of a generating unit or other source of electric power to vary output.
Dispatchable power: Energy output that can be planned on and typically provides a continuous power output. Solar power and Wind power in not dispatchable without configuration and without some other power or storage mechanism. Hydrocarbon based power plants or nuclear plants are dispatchable.
Distributed systems: Systems that are installed at or near the location where the electricity is used, as opposed to central systems that supply electricity to grids. A residential photovoltaic system is a distributed system.
Distributor: Using means a wholesaler of PV products.
Downtime: Time when the PV system cannot provide power to the load, expressed either in hours per year or as a percentage.
Dry cell battery: A battery that uses a solid paste for an electrolyte.
Duty cycle: The ratio of active to total time, used to describe the operating regime of loads in PV systems.
Duty rating: The amount of time an inverter can operate at full rated power. Some inverters can operate at their rated power for only a short time without overheating.

Earth: Refers to physically connecting a part of an electrical system to the ground, done as a safety measure, by means of a conductor embedded in suitable soil.
Earth-leakage circuit breaker (ELCB): A device used to prevent electrical shock hazards in mains voltage power systems, including independent power systems. Also known as residual current devices (RCD's).
Efficiency: The ratio of output power or energy to input power or energy, expressed as a percentage.
Electric circuit: Path followed by electrons from a power source (generator or battery) through an external line (including devices that use the electricity) and returning through another line to the source.
Electric current: The flow of electrons measured in Amps.
Electrical grid: A network for electricity distribution across a large area.
Electricity: The movement of electrons (a sub-atomic particle), produced by a voltage, through a

conductor.
Electrode: An electrically conductive material, forming part of an electrical device, often used to lead current into or out of a liquid or gas. In a battery, the electrodes are also known as plates.
Electrolysis: A chemical reaction caused by the passage of electricity from on electrode to another.
Electrolyte: The medium that provides ionic transport between the electrodes of a battery. All common batteries contain an electrolyte, such as the sulfuric acid used in lead-acid batteries.
Energy density: The ratio of the energy available from an energy storage device such as a battery to its volume (Wh/m^3) or weight (Wh/kg).
Energy payback time: The time required for any energy producing system or device to produce as much energy as was required in its manufacture. For solar electric panels, this is normally in the range 6-36 months.
Energy: Power consumed multiplied by the duration of use. For example, 1000 Watts used for four hours is 4000 Watt hours.
Equalization charge: Periodical overcharging the batteries for a short time to mix the electrolyte solution in batteries.
EVA (Ethylene Vinyl Acetate): An encapsulant used between the glass cover and the solar cells in PV modules. It is durable, transparent, resistant to corrosion, and flame retardant.

Fill factor: On an I-V (current-voltage) curve characterizing the output of a solar cell or module, the ratio of the maximum power to the product of the open-circuit voltage and the short-circuit current. The higher the fill factor (FF) the "squarer" the shape of the I-V curve.
Fixed tilt array: A solar PV array set at a fixed angle to the horizontal.
Flat-plate PV: A solar PV array or module that does not contain concentrating devices and so responds to both direct and diffuse sunlight.
Float charge: A battery charge current that is equal to, or slightly greater than, the self-discharge rate.
Float life: The time (usually in years) a battery can maintain its stated capacity when kept at float charge.
Flooded cell battery: A form of rechargeable battery where the plates are completely immersed in a liquid electrolyte. Most cars use flooded-cell batteries. Flooded cell batteries are the most commonly used type for independent and remote area power supplies.
Fluorescent light: A form of lighting that uses long thin tubes of glass which contain mercury vapor and various phosphor powders (chemicals based on phosphorus) to produce white light. Generally considered to be the most efficient form of home lighting.
Frequency: The number of cycles or repetitions per unit time of a complete waveform, in electrical applications usually expressed in cycles per second or Hertz (Hz). Electrical equipment in the United States requires 60 Hz, in Europe 50Hz.
Fresnel lens: A concentrating lens, positioned above and concave to a PV material to concentrate light on the material.
Fuel cell: An electrochemical device that converts the energy of a fuel directly into electricity and heat and is therefore very energy efficient.
Fuse: A fuse is a device used to protect electrical equipment from short circuits. Fuses are made with metals that are designed to melt, when the current passing through them is high enough. When the fuse melts, the electrical connection is broken, interrupting power to the circuit or device.

Gassing: Gaseous by-products when charging a battery, e.g. hydrogen from a lead acid battery.
Gel-type battery: Lead-acid battery in which the electrolyte is immobilized in a gel. Usually used for mobile installations and when batteries will be subject to high levels of shock or vibration.
Generator: A mechanical device used to produce DC electricity. Power is produced by coils of wire passing through magnetic fields inside the generator. Most alternating current generating sets are also referred to as generators.
Gigawatt (GW): A measurement of power equal to a thousand million Watts.
Gigawatt-hour (GWh): A measurement of energy. One Gigawatt-hour is equal to one Gigawatt being used for a period of one hour, or one Megawatt being used for 1000 hours.
Grid: An electrical utility distribution network.
Grid-connected: An energy producing system connected to the utility transmission grid. Also called Grid tied.
Ground loop: An undesirable feedback condition caused by two or more circuits sharing a common electrical line, usually a grounded conductor.

Halogen lamp: A special type of incandescent globe made of quartz glass and a tungsten filament, enabling it to run at a much higher temperature than a conventional incandescent globe. Efficiency is better than a normal incandescent, but not as good as a fluorescent light.

Harmonic content: Frequencies in the output waveform in addition to the primary frequency (usually 50 or 60 Hz.) Energy in these harmonics is lost and can cause undue heating of the load.
Head: The vertical distance that water will fall from the inlet of the collection pipe to the water turbine in a hydro power system.
Hertz (Hz): Unit of measurement for frequency. Home mains power is normally 50Hz in Europe and 60Hz in the USA. The magnitude of the current is measured in Amps.
High voltage disconnect: Voltage at which the charge controller will disconnect the array to prevent overcharging the batteries.
Hot spot: A phenomenon where one or more cells within a PV module or array act as a resistive load, resulting in local overheating or melting of the cells.
Hybrid system: A PV system that includes solar PV and some other electricity generating power source.

Incandescent light: An electric lamp which is evacuated or filled with an inert gas and contains a filament (commonly tungsten). The filament emits visible light when heated to extreme temperatures by passage of electric current through it.
Incident light: Light that shines on to the surface of a PV cell or module.
Independent power system: A power generation system that is independent of the mains grid.
Insolation: The amount of sunlight reaching an area, usually expressed in Watt hours per square meter per day.
Installer: Usually a retailer and installer of PV Systems.
Insulation: A material used to prevent the flow of electricity. Normally used on electrical wires to prevent electric shock. Typical materials used include plastics such as PVC and polypropylene.
Integrator: Integrates PV components in to a complete PV System.
Interconnect: A conductor within a module or other means of connection which provides an electrical interconnection between the solar cells. [UL 1703]
Inverter: An inverter converts DC power from the PV array/battery to AC power. Used either for stand-alone systems or grid-connected systems.
Irradiance: The solar power incident on a surface, usually expressed in kilowatts per square meter. Irradiance multiplied by time gives insolation.
I-V curve: A graph that plots the current versus the voltage from a PV cell as the electrical load (or resistance) is increased from short circuit (no load) to open circuit (maximum voltage). The shape of the curve characterizing cell performance. Three important points on the I-V curve are the open-circuit voltage, short-circuit current, and peak or maximum power (operating) point.
I-V data: The relationship between current and voltage of a photovoltaic device in the power-producing quadrant, as a set of ordered pairs of current and voltage readings in a table, or as a curve plotted in a suitable coordinate system. [ASTM E 1036]

Joule (J): The energy conveyed by one Watt of power for one second, unit of energy equal to 1/3600 kilowatt-hours.
Junction box: A PV junction box is a protective enclosure on a PV module where PV strings are electrically connected and where electrical protection devices such as diodes can be fitted.
Junction diode: A semiconductor device, having a junction and a built-in potential, that passes current better in one direction than the other. All solar cells are junction diodes.

Kilowatt(kW): A unit of electrical power, one thousand Watts.
Kilowatt-hour (kWh): The amount of energy that derives from a power of one thousand Watts acting over a period of 1 hour. The kWh is a unit of energy. 1 kWh=3600 kJ.

Langley: Unit of solar irradiance, one calorie per square centimeter. 1 L = 41.84 kJ/m2.
Lead-acid battery: A type of battery that consists of plates made of lead, lead-antimony, or lead-calcium and lead-oxide, surrounded by a sulfuric acid electrolyte. The most common type of battery used in RAPS systems.
Life: The period during which a system can operate above a specified performance level.
Life-cycle cost: The estimated cost of owning, operating and disposing of a system over its useful life.
Light emitting diode: A semi conductor device composed of a p-n junction designed such that electrons emit visible light during their migration across the junction.
Light trapping: The trapping of light inside a semiconductor material by refracting and reflecting the light at critical angles; trapped light will travel further in the material, greatly increasing the probability of absorption and hence of producing charge carriers.
Light-induced defects: Defects, such as dangling bonds, induced in an amorphous silicon semiconductor upon initial exposure to light.

Line wire loss: refers to the voltage or power lost due to the resistance of any wire or wires in any electrical circuit.
Linear current booster: an electronic circuit that matches PV output directly to a motor. Used in array direct water pumping.
Liquid electrolyte battery: A battery containing a liquid solution of an electrolyte in a solvent (e.g. sulfuric acid in water). Also called a flooded battery because the plates are covered with the electrolyte solution.
Load: The electrical power being consumed at any given moment or averaged over a specified period. The load that an electric generating system supplies varies greatly with time of day and to some extent season of year. Also, in an electrical circuit, the load is any device or appliance that is using power.
Load circuit: The wiring including switches and fuses that connects the load to the power source.
Load current: The current required to power the electrical device.
Load resistance: The electrical resistance of the load.
Low voltage cut-off: The voltage at which a controller will disconnect the load from the battery.
Low voltage disconnect (LVD): The voltage at which the charge controller will disconnect the load from the batteries to prevent over-discharging.
Low voltage warning: A warning buzzer or light that indicates the low battery voltage set-point has been reached.

Maintenance free battery: A sealed battery to which water cannot be added to maintain the level of the electrolyte solution.
Maximum power point (MPP): Operating a PV array at that voltage will produce maximum power. The point on the current-voltage (I-V) curve of a module under illumination, where the product of current and voltage is maximum. [UL 1703] This corresponds to the point on an I-V curve that represents the largest area rectangle that can be drawn under the curve. For a typical silicon cell panel, this is about 17 volts for a 36 cell configuration.
Maximum power point tracker (MPPT): A power conditioning unit that automatically operates the PV generator at its MPP under all conditions. An MPPT will typically increase power delivered to the system by 10% to 40%, depending on climate conditions and battery state of charge.
Megawatt (MW): A measurement of power equal to one million Watts.
Megawatt-hour (MWh): A measurement of power with respect to time (i.e. energy). One megawatt-hour is equal to one megawatt being used for a period of one hour, or one kilowatt being used for 1000 hours.
Microgroove: A small groove scribed into the surface of a cell which may be filled with metal for contacts.
Modified sine wave: A waveform with at least three states (positive, off, and negative) used to simulate a sine wave. It has less harmonic content than a square wave. This type of waveform is better than a square wave, but not as suitable for some appliances as a sine wave.
Modularity: The use of complete sub-assemblies to produce a larger system. Also the use of multiple inverters connected in parallel to service different loads.
Module: An encapsulated panel containing a number of electrically connected PV cells.
Module de-rating factor: A factor that lowers the power output of a module to account for field operating conditions e.g. dirt build-up on the module.
Monocrystalline solar cell: A form of solar cell made from a thin slice of a single large crystal of silicon.
Monolithic: Fabricated as a single structure, as used to describe thin film series interconnected PV cells on a single sheet substrate.
Multicrystalline: A material that has solidified at a rate such that many small crystals (crystallites) form. The atoms within a single crystallite are symmetrically arranged with a particular orientation, whereas the crystallites themselves are differently oriented. The multitude of grain boundaries in the material (between the crystallites) reduce the cell efficiency. Multicrystalline is also referred to as polycrystalline.
Multi-junction device: A PV device containing two or more cell junctions each of which may be different in nature and optimized to absorb a particular part of the solar spectrum in order to achieve higher overall cell efficiency.
Multi-stage controller: A charge controller that allows different charging currents as the battery approaches full state of charge.

NEC: US National Electrical Code which contains guidelines for all types of electrical installations which should be followed when installing a PV system.
NEMA: US National Electrical Manufacturers Association, sets standards for some non-electronic products e.g. junction boxes.
Net metering: The practice of exporting surplus solar power during the day (to actual power needs) to the electricity grid, which either causes the home owner electric meter to (physically) go backwards and/or

simply creates a financial credit on the home owner's electricity bill. (At night, the homeowner draws from the electricity grid the normal way.)
Nickel-cadmium battery (NiCad): A form of rechargable battery, having higher storage densities than that of lead-acid batteries, that uses a mixture of nickel hydroxide and nickel oxide for the anode, and cadmium metal for the cathode. The electrolyte is potassium hydroxide.
Noise: Unwanted electrical signals produced by electric motors and other machines that can cause circuits and appliances to malfunction.
Nominal voltage: A rounded voltage value used to describe batteries, modules, or systems based on their specification (e.g. a 12V, 24V or 48V battery, module, or system).
Normal Operating Cell Temperature (NOCT): The estimated temperature of a solar PV module when it is operating under 800 W/m^2 irradiance, 20°C ambient temperature and a wind speed of 1 meter per second. NOCT is used to estimate the nominal operating temperature of a module in the field.
N-type semiconductor: A semiconductor produced by the doping of an intrinsic semiconductor with an electron-donor impurity, for example phosphorous in silicon.
N-Type silicon: Silicon doped with an element that has more electrons in its atomic structure than does silicon (e.g. phosphorus).

Ohm: The resistance between two points of a conductor when a constant potential difference of one Volt applied between these points produces in the conductor a current of one Amp.
Ohm's Law: A simple mathematical formula that allows either voltage, current or resistance to be calculated when the other two values are known. The formula is: V = I x R, where V is the voltage, I is the current, and R is the resistance.
One-axis tracking: A PV System structure that is capable of rotating on a single axis in order to track the movement of the sun.
Open circuit voltage: The maximum voltage produced by an illuminated solar PV cell, module, or array when no load is connected. OCV increases as the temperature of the PV material decreases.
Operating point: Defined by the current and voltage that a module or array produces when connected to a load. It is dependent on the load or the batteries connected to the output terminals.
Orientation: Position with respect to the cardinal directions, N, S, E, W.
Overcharge: Applying current to a fully charged battery. This can damage the battery.

Panel: Used interchangeably with "module".
Parallel connected: A method of connection in which positive terminals are connected together and negative terminals are connected together. Current output adds and voltage remains the same.
Passive solar home: A house that utilizes part of the building as a solar collector, as opposed to active solar, such as PV.
Peak load: The maximum usage of electrical power occurring in a given period of time, typically a day. The electrical supply must be able to be meet the peak load if it is to be reliable.
Peak power current: Current in Amperes produced by a module or array operating at the voltage on the I-V curve that will produce its maximum power.
Peak sun hours: The equivalent number of hours per day when solar irradiance averages 1000 W/m^2.
Peak Watt: The amount of power a solar PV cell or module will produce under standard test conditions (normally 1000 W/m^2 and 25°C cell temperature, AM 1.5 spectrum).
Photon: Light is composed of energy particles called photons which have variable energy but constant speed.
Photovoltaic (PV) array: A number of PV modules connected together in a single structure.
Photovoltaic (PV) cell: The smallest discrete element in a PV module that performs the conversion of light into electrical energy to produce a DC current and voltage.
Photovoltaic (PV) conversion efficiency: The ratio of the electrical power generated by a PV device to the power of the light incident on it. This is typically in the range 5% to 15% for commercially available modules.
Photovoltaic (PV) generator: The total of all PV strings of a PV power supply system, which are electrically interconnected.
Photovoltaic (PV) module: A single assembly of solar cells and ancillary parts, such as interconnections, terminals, (and protective devices such as diodes) intended to generate DC power under un-concentrated sunlight. The structural (load carrying) member of a module can either be the top layer (superstrate) or the back layer (substrate). [UL 1703]
Photovoltaic (PV) panel: a term often used interchangeably with PV module (especially in single module systems).
Photovoltaic (PV): refers to any device which produces free electrons when exposed to light.

Photovoltaic system: All the parts connected together that are required to produce solar electricity.
Photovoltaic cell: The semiconductor device that converts solar irradiance (light) into dc electricity.
Photovoltaic effect: The effect that causes a voltage to be developed across the junction of two different materials when they are exposed to light.
Photovoltaic-thermal (PV/T) system: A photovoltaic system that, in addition to converting sunlight into electricity, collects the residual heat energy and delivers both heat and electricity in usable form. Also called a total energy system.
Plates: The electrodes in a battery, usually take the form of metal plates.
Polycrystalline cell: a wafer of silicon with a multi-grained structure. All grains have the same atomic crystal lattice, however, each grain has a unique orientation in space thereby producing a unique reflection of light.
Polycrystalline silicon: A material used to make solar PV cells which consists of many crystals, compared to single crystal silicon.
Poly-vinyl chloride (PVC): A plastic used as an insulator on electrical cables. A toxic material, which is being replaced with alternatives made from more benign chemicals.
Power (Watts): Basic unit of electricity equal to the product of current and voltage (in DC circuits).
Power conditioning equipment: Electrical equipment, or power electronics, used to convert power from a photovoltaic array into a form suitable for subsequent use. A collective term for inverter, converter, battery charge regulator, and blocking diode.
Power conversion efficiency: The ratio of output power to input power e.g. of an inverter.
Power density: The ratio of the power available from a battery to its volume (Watts per liter) or weight (Watts per kilogram).
Power factor: The cosine of the phase angle between the voltage and the current waveforms in an AC circuit. A measure of inverter performance.
Power: The rate of doing work. Expressed as Watts (W). For example, a generator rated at 800 watts can provide that amount of power continuously. 1 Watt = 1 joule/sec.
Primary battery: A battery that cannot be re-charged.
PV array: two or more photovoltaic panels wired in series and or parallel.
PV: Short hand for Photovoltaics.
PV components: The individual parts of a PV System. Individual items like Batteries, Inverters, Regulators, Wiring.
PV system: All the parts in combination required to generate solar electricity.
Pyranometer: An instrument for measuring total hemispherical solar irradiance on a flat surface, or "global" irradiance; thermopile sensors have been generally identified as pyranometers, however, silicon sensors are also referred to as pyranometers.

Qualification test (PV): A testing procedure for PV modules relating to electrical, mechanical, or thermal stress.
Quasi sine-wave: A description of the type of waveform produced by some Inverters.

RAPS (Remote Area Power Supply): A power generation system used to provide electricity to remote and rural homes, usually incorporating power generated from renewable sources such as solar panels and wind generators, as well as non-renewable sources such as petrol-powered generators.
Rated battery capacity (Ah): Term used by battery manufacturers to indicate the maximum amount of energy that can be withdrawn from a battery at a specified discharge rate and temperature.
Rated module current (A): The current output of a PV module measured under standard test conditions of 1000 W/m^2 and 25°C cell temperature.
Rated power: Nominal power output of an inverter, some units cannot produce rated power continuously.
Reactive power: The sine of the phase angle between the current and voltage waveforms in an AC system.
Rechargeable battery: A type of battery that uses a reversible chemical reaction to produce electricity, allowing it to be re-used many times. The chemical reaction is reversed by forcing electricity through the battery in the opposite direction to normal discharge.
Rectifier: A device that converts ac to dc, as in a battery charger or converter.
Regulator: A device used to limit the current and voltage in a circuit, normally to allow the correct charging of batteries from power sources such as solar panels and wind generators.
Remote site: A site with no electrical utility grid connection.
Renewable energy: Energy that is produced from a renewable source.
Resistance (R): The property of a material which resists the flow of electric current when a potential difference is applied across it, measured in Ohms.

Resistive voltage drop: The voltage developed across a cell by the current flow through the resistance of the cell which may result from the bulk resistance of the materials in the cell and at interfaces between them.
Resistor: An electronic component used to restrict the flow of current in a circuit. Sometimes used specifically to produce heat, such as in a water heater element.
Reverse bias: Condition where the current producing capability of a PV cell is significantly less than that of other cells in its series string. This can occur when a cell is shaded, cracked, or otherwise degraded or when it is electrically poorly matched with other cells in its string.
Reverse current protection: Any means of preventing current flow from the battery to the solar PV array (e.g. at night) that would discharge the battery.

Sacrificial anode: A piece of metal electrically connected to a buried or submerged structure that is to be protected from corrosion. The metal of the sacrificial anode is selected to corrode preferentially to the metal of the protected structure and so reduce its corrosion rate.
Sealed battery: A battery with a captive electrolyte and a re-sealing vent cap to which electrolyte cannot be added. Also called a valve-regulated battery.
Sealed lead-acid battery: A form of lead-acid battery where the electrolyte is immobilized, either by being contained in an absorbent fibre separator or gel between the batteries plates.
Secondary battery: A battery that can be recharged; a rechargeable battery.
Self discharge: Self discharge represents energy lost to internal chemical reactions within the cell.
Self discharge rate: The rate at which a battery will lose its charge when at open circuit (with no load connected).
Semiconductor: A material that has an electrical conductivity in between that of a metal and an insulator. Transistors and other electronic devices are made from semiconducting materials, and are often called semiconductors. Typical semiconductors for PV cells include silicon, gallium arsenide, copper indium diselenide, and cadmium telluride.
Series connected: A method of connection in which the positive terminal of one device is connected to the negative terminal of another. The voltages add and the current is limited to the least of any device in the string.
Series regulator: A type of battery charge controller or regulator in which the charging current is controlled by a switch, transistor, or field-effect transistor connected in series with the PV module or array.
Series resistance: Resistance to current flow within a cell due to factors such as the bulk resistance of the cell materials and contact resistances.
Shallow-cycle battery: A battery with small plates that cannot withstand many deep discharges (i.e. to a low state of charge).
Shelf life: The time for which a device can be stored and still retain its specified performance.
Short circuit current (Isc) : The current generated by an illuminated solar PV cell, module, or array when its output terminals are shorted; the maximum current possible.
Shunt controller: A controller or regulator that re-directs, or shunts, the charging current away from the battery. Generally used for smaller systems.
Silicon (Si): A chemical element with atomic number 14, a dark gray semi-metal. Occurs in a wide range of silicate minerals and makes up approximately 28% of the earth's crust (by weight). Silicon has a face-centered cubic lattice structure like diamond. The most common semiconductor material used in making PV cells either traditionally in its crystalline form or more recently as an amorphous thin film.
Sine wave: A waveform that has is defined by an equation in which one variable is proportional to the sine of the other, as generated by an oscillator in simple harmonic motion. The sine wave is the most ideal form of electricity for running more sensitive appliances, such as radios, TVs, computers and the like.
Sine wave inverter: An inverter that produces grid-quality, sine wave AC electricity.
Single-crystal silicon: Silicon material with a single crystal structure. A common material for the construction of solar PV cells.
Solar constant: The power density of solar radiation on a plane perpendicular to the direction of the sun at the mean earth-sun distance outside the earth's atmosphere; its value is 1.37 kW per square meter.
Solar energy: Energy from the sun.
Solar noon: The mid-point between sunrise and sunset; the time when the sun reaches its highest point in its daily arc across the sky.
Solar power: Electricity generated by conversion of sunlight, either directly through the use of photovoltaic panels, or indirectly through solar-thermal processes.
Solar module: A device used to convert light from the sun directly into DC electricity by using the photovoltaic effect. Usually made of multiple solar cells bonded between glass and a backing material. A

typical Solar Module would be 100 Watts of power output (but module powers can range from 1 Watt to 300 Watts) and have dimensions of 2 feet by 4 feet.
Solar resource: The amount of solar insolation received at a site, normally measured in units of kWh/m^2/day which equates to the number of peak sun hours.
Solar spectrum: The total distribution of electromagnetic radiation emanating from the sun.
Solar thermal electric: Method of producing electricity from solar energy by using focused sunlight to heat a working fluid, which in turn drives a turbogenerator.
Solar thermal: A form of power generation using concentrated sunlight to heat water or other fluid that may then used to drive a motor or turbine.
Solar-grade silicon: Intermediate-grade silicon used in the manufacture of solar cells. Less expensive than electronic-grade silicon.
Specific gravity: The ratio of the weight of a solution to the weight of an equal volume of water at a specified temperature; used with reference to the sulfuric acid electrolyte solution in a lead acid battery as an indicator of battery state of charge. More recently called relative density.
Split-spectrum cell: A compound photovoltaic device in which sunlight is first divided into spectral regions by optical means. Each region is then directed to a different photovoltaic cell optimized for converting that portion of the spectrum into electricity. Such a device achieves significantly greater overall conversion of incident sunlight into electricity.
Square wave: A train of rectangular voltage pulses that alternate between two fixed values for equal lengths of time.
Square wave inverter: The simplest and the least expensive type of inverter, but which produces the lowest quality of power. The inverter uses switches that can carry a large current and withstand a high voltage that are turned on and off in the correct sequence and at a certain frequency.
Stand-alone (PV system): A solar PV system that operates without connection to a grid a supply of electricity.
Standard test conditions (STC): Conditions under which a module is typically tested in a laboratory: (1) Irradiance intensity of 1000 W/square meter (0.645 watts per square inch), AM1.5 solar reference spectrum, and (3) a cell (module) temperature of 25 degrees C, plus or minus 2 degrees C (77 degrees F, plus or minus 3.6 degrees F). [IEC 1215]
Standby current: The current used by the inverter when no load is active, corresponding to lost power.
Stand-off mounting: Technique for mounting a PV array on a sloped roof, which involves mounting the modules a short distance above the pitched roof and tilting them to the optimum angle.
State of charge (SOC): The capacity of a battery at a particular time expressed at a percentage of its rated capacity.
Static head: The height of the water level above the point of free discharge of the water, normally measured when the pump is off.
Storage: Storing energy in a battery or battery stack. In water pumping, storage can be achieved by pumping water to a storage tank.
Storage density: The capacity of a battery, in amp-hours compared to its weight. Measured in Watt-hours per kilogram.
Stratification: Occurs in a liquid electrolyte solution when its concentration varies from top to bottom. Can be solved by periodic controlled charging at voltages that produce gassing to mix the electrolyte solution.
String: A number of cells, modules or panels interconnected electrically in series to produce the required operating voltage.
Substrate: The physical material upon which a photovoltaic cell is made. Sub-system: Any one of several components in a PV system (i.e., array, controller, batteries, inverter, load).
Suction head: The height of pump above the surface of the water source when the pump is located above the water level.
Sulfation: The formation of lead-sulfate crystals on the plates of a lead-acid battery; large crystals of lead sulfate grow on the plate, instead of the usual tiny crystals, making the battery extremely difficult to recharge. If the crystals get large enough, shorting of the cell may occur.
Superstrate: The covering on the sun side of a PV module, providing protection for the PV materials from impact and environmental degradation while allowing maximum transmission of the appropriate wavelengths of the solar spectrum.
Surge capacity: The ability of an inverter or generator to deliver instantaneous high currents when starting motors, for example.
Surge: An excessive amount of power drawn by an appliance when it is first switched on. An unexpected flow of excessive current, usually caused by excessive voltage, that can damage appliances and other electrical equipment.
Switch: A common device which breaks an electrical circuit thereby halting the flow electricity through the

circuit.
Switch-mode: A form of converting one form of electricity to another by rapidly switching it on and off and feeding it through a transformer to effect a voltage change.
System availability: The proportion of time (usually expressed in hours per year) that a solar PV system will be able to meet fully the load demand.
System operating voltage: The output voltage of a solar PV array under load, dependent on the electrical load and size of the battery stack connected to the output terminals.

Temperature compensation: Adjustment via the use of electronic circuitry to change the charge controller activation points depending on battery temperature. This is desirable if the battery temperature is expected to vary by more than 5 deg C from the ambient temperature. The temperature coefficient for lead acid batteries is typically -3 to -5 millivolts/deg C per cell.
Temperature factors: Are used to decrease battery capacity at cold temperatures, to decrease PV module voltage at high temperatures and to increase the resistance of wire at high temperatures.
Thermal electric: Electric energy derived from heat energy, usually by heating a working fluid, which drives a turbogenerator.
Thermophotovoltaic (TPV) device: A device in which solar energy is concentrated onto a radiator which reaches a high temperature and emits the energy in a different part of the spectrum, better matched to the bandgap of the matched solar cell. This approach should enable high cell efficiencies to be obtained.
Thick cells : Conventional solar cells in most types of PV modules, such as crystalline silicon cells, which are typically from 200-400 micrometers thick. In contrast, thin-film cells are several microns thick.
Thick-crystalline materials: Semiconductor material, typically measuring from 200-400 micromterers thick that is cut from boules, ingots or ribbons.
Thin film PV module: A solar PV module constructed with sequential layers of thin film semiconductor materials usually only micrometers thick. Currently, thin film technologies account for around 12% of all solar modules sold around the world. This share is expected to increase, since thin film technologies represent a potential route to lower costs.
Thin film: A layer of semiconductor material, such as copper indium diselenide, cadmium telluride, gallium arsenide, or amorphous silicon, a few microns or less in thickness, used to make photovoltaic cells.
Tilt angle: The angle of inclination of a solar collector or solar module measured from the horizontal.
Total AC load demand: The sum of the AC loads; its value is important to select the correct Inverter.
Total internal reflection: The trapping of light within the PV cell by internal reflection of incident light at angles greater than the critical angles for the interfaces, so that the light cannot escape the cell and is therefore eventually absorbed by the semiconductor.
Tracker: any device used to direct a PV array towards the sun.
Tracking array: A PV array that is moved to follow the path of the sun in order to maintain the maximum incident solar radiation on its surface. The two most common methods are firstly single-axis tracking in which the array tracks the sun from east to west, and secondly, two-axis tracking in which the array points directly at the sun all the time. Two-axis tracking arrays capture the maximum possible daily energy. Typically, a single axis tracker will give 15% to 25% more power per day, and dual axis tracking will add a further 5%.
Transformer: A transformer is a device that changes voltage from one level to another. A device used to transform voltage levels to facilitate the transfer of power from the generating plant to the customer.
Transistor: A semi-conductor device used to switch or otherwise control the flow of electricity.
Trickle charge: A small charging current designed to keep a battery fully charged.
Two-axis tracking: A system capable of rotating independently about two axes (e.g., vertical and horizontal) and following the sun for maximum efficiency of the solar array.
Turnkey project: A project in which an Entity contracts to construct a completed facility that includes all items necessary for use and occupancy. All that is required of the buyer to begin using the facility is to turn a key in the new door lock and enter.

Uninterruptible power supply (UPS): A power supply capable of providing continuous uninterruptible service; normally containing batteries to provide energy storage.
Utility-interactive inverter: An inverter that can operate only when connected to the utility grid supply and an output voltage frequency fully synchronized with the utility power.

VAC: Volts alternating current
Varistor: A non-Ohmic or voltage-dependent variable resistor. Normally used as over-voltage limiters to protect sensitive equipment from power spikes or lightning strikes by shunting the energy to ground.

VDC: Volts direct current.
Vented cell: A battery with a vent to expel gases liberated during charging.
Vmp: The voltage at which a PV device is operating at maximum power.
Voc: Open-circuit voltage Volt (V): The unit of electromotive force that will force a current of one ampere through a resistance of one Ohm. Voltage at maximum power
Volt: The unit if electric potential and potential difference. The amount of work done per unit charge in moving a charge from one place to another. The potential difference across a resistance of 1 Ohm when a current of 1 Amp is flowing.
Voltage drop: The voltage lost along a length of wire or conductor due to the resistance of that conductor. This also applies to resistors. The voltage drop is calculated by using Ohm's Law.
Voltage protection: A sensing circuit on an Inverter that will disconnect the unit from the battery if input voltage limits are exceeded.
Voltage regulator: A device that controls the operating voltage of a photovoltaic array.
Voltage: Unit of measurement for the electrical `pressure' of electricity. Measured in Volts (V).
Voltmeter: An electrical or electronic device used to measure voltage.

Wafer: A thin sheet of crystalline semiconductor material either made by mechanically sawing it from a single-crystal boule or multicrystalline ingot or block, or made directly by casting. The wafer is "raw material" for the solar cell.
Watt (W) : The unit of electrical power commonly used to define the electricity consumption of an appliance. The power developed when a current of one ampere flows through a potential difference of one volt; 1/746 of a horsepower. 1 Watt = 1 Joule/s.
Watt hour (Wh): A unit of energy equal to one Watt of power being used for one hour.
Waveform: The shape of a wave or pattern representing a vibration. The shape characterizing an AC current or voltage output.
Watt peak (User friendly definition): Is the Direct Current Watts output of a Solar Module as measured under an Industry standardized Light Test before the Solar Module leaves the Manufacturers facility.
Watt peak: (technical definition): The Watt Power output of a Solar module is the number of Watts Output when it is illuminated under standard conditions of 1000 Watts/meter^2 intensity, 25°C ambient temperature and a spectrum that relates to sunlight that has passed through the atmosphere (AM or Air Mass 1.5).
Wet shelf life: The period over which a charged battery, filled with electrolyte, can remain unused before its performance falls below a specified.

Zenith angle: The angle between directly overhead and a line through the sun. The elevation angle of the sun above the horizon is 90° minus the zenith angle.

[TITLE ???]

Alkali: A chemical "base" (loosely, the opposite of an acid). Certain types of alkalis (especially potassium hydroxide) have been used as fuel cell electrolytes.

Anion: A negative ion. Alkali, molten carbonate and solid oxide fuel cells are "anion-mobile" cells – anions migrate through the electrolyte toward the anode.

Anode: One of two electrodes in a fuel cell or battery. In a fuel cell it is where the fuel reacts or "oxidizes", and releases electrons.

Capital Cost: The purchase price of a power generating system.

Carnot Limit: A theoretical limit on the efficiency of an engine based on the flow of heat between two reservoirs. Named for its discoverer Sadi Carnot (1796-1832) of France, this limit stems from basic physical laws and applies to all steam engines. Fossil fuel and nuclear power plants are bound by this limit, but most fuel cells are not.

Catalyst: A substance that causes or speeds a chemical reaction without itself being affected.

Cathode: One of two electrodes in a fuel cell or battery. In a fuel cell, it is where oxygen (usually taken from the air) "reduction" occurs.

Cation: A positive ion. Phosphoric acid and PEM fuel cells are "cation-mobile" cells – the cation migrates through the electrolyte toward the cathode.

Cogeneration: The use of waste heat from industrial processing, a steam turbine, or a fuel cell to generate electricity. Harnessing otherwise wasted heat boosts the efficiency of power-generating systems.

Direct Fuel Cell: A type of fuel cell in which a hydrocarbon fuel is fed directly to the fuel cell stack, without requiring an external "reformer" to generate hydrogen.

Electrode: An electrical terminal that conducts an electric current into or out of a fuel cell.

Electrolyte: A chemical compound that conducts ions from one electrode to the other inside a fuel cell.

Electron: A sub-atomic particle carrying a negative charge.

Fuel Cell: A device for generating electricity by the chemical combination a fuel and oxygen.

Generating Capacity: The maximum amount of electric power produced by a generator.

Graphite: A soft form of the element carbon. It is used for pencil leads, as a lubricant, as a moderator in nuclear reactors, and for other products. It does not burn easily or fuse at high temperatures, and is an important material in the construction of phosphoric acid fuel cells.

Hydrogen: A chemical element consisting of one proton and one electron. Two hydrogen atoms combine with one oxygen atom to form a molecule of water. Hydrogen serves as the fuel for most fuel cells.

Inverter: A device used to convert direct current electricity produced by a fuel cell (or other source) to alternating current.

Ion: An atom that carries a positive or negative charge due to the loss or gain of an electron.

kW: Kilowatt (1,000 watts). A measure of electric power.

kWh: Kilowatt-hour (1,000 watts for one hour). A measure of electric power consumption.

Matrix: A framework within a fuel cell that supports an electrolyte.

Molten Carbonate: A type of fuel cell electrolyte that contains carbon, oxygen and another element. Solid at room temperature, it must be melted in order to function.

MW: Megawatt (1,000,000 watts). A measure of electric power.

MWh: Megawatt-hour (1,000,000 watts for one hour). A measure of electric power consumption.

Nafion: A sulfuric acid in a solid polymer form. It is usually the electrolyte of PEM fuel cells.

O&M Costs: Operations and Maintenance. The cost of keeping a power plant running and in good repair.

Oxygen: A chemical element consisting of eight protons, eight neutrons and eight electrons. Two hydrogen atoms combine with one oxygen atom to form a molecule of water.

Peak Load: The maximum demand for electricity from an electrical system in a given period of time.

Phosphoric Acid: A solution of the elements phosphorus, hydrogen, and oxygen that serves as the electrolyte for one type of fuel cell. Chemically: $4H_3PO_4$.

Polymer: A natural or synthetic compound composed of repeated links of simple molecules.

Potassium Hydroxide: A solution of the elements potassium, hydrogen, and oxygen that serves as the electrolyte for one type of fuel cell. Chemically: KOH.

Proton Exchange Membrane (PEM): A polymer sheet that serves as the electrolyte in one type of fuel cell.

Reformer: A device that extracts pure hydrogen from hydrocarbons.

Regenerative Fuel Cells: Several fuel cell types in which fuel and, in some types, the oxidant are regenerated from the oxidation product.

Solid Oxide: A solid combination of oxygen and another element (often zirconium) that serves as the electrolyte for one type of fuel cell.

Stack: Individual fuel cells connected in series within a generating assembly.

APPENDIX E - ABBREVIATIONS

AC Absorption Cooling
ARB Air Resources Board
ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers
Btu British Thermal Units (3412.14 Btu = 1 kWh)
CHP Combined Heat and Power
CO2 Carbon Dioxide
COLL College/school building
COP Coefficient of Performance
CSFCC California Stationary Fuel Cell Collaborative
DER Distributed Energy Resources
DG Distributed Generation
DG-CHP DG types with CHP capabilities
DHW Domestic Hot Water
DoD Department of Defense
DOE-2 Public domain building energy simulation code
E/T Electrical load to thermal load
EEM Energy Efficiency Measures
EIA Energy Information Agency
eQUEST Graphical interface for whole-building energy analysis tool derived from DOE-2
FC Fuel cell/s
GT Gas Turbine/s
HOSP Hospital building
HTFC High Temperature Fuel Cell/s
HVAC Heating, Ventilating and Air-Conditioning
ICE Internal Combustion Engine/s
LA Los Ángeles (California)
LAWDP Los Angeles Department of Water and Power
MCFC Molten Carbonate Fuel Cell
MOB Medium Office Building
MTG Micro turbine generator/s
NFCRC National Fuel Cell Research Center
NOx Nitrogen Oxides
O&M Operating & Maintenance
PAFC Phosphoric acid fuel cell
PEMFC Proton Exchange Membrane Fuel Cell
PV Photovoltaic solar panel
SCE Southern California Edison (California electric investor-owned utility)
SOB Small Office Building
SOFC Solid Oxide Fuel Cell
SoCalGas Southern California Gas (California gas investor-owned utility)