This is a guidance document with sample specification language intended to be inserted into project specifications on this subject as appropriate to the agency's environmental goals. Certain provisions, where indicated, are required for U.S. federal agency projects. Sample specification language is numbered to clearly distinguish it from advisory or discussion material. Each sample is preceded by identification of the typical location in a specification section where it would appear using the SectionFormat™ of the Construction Specifications Institute; the six digit section number cited is per CSI Masterformat™ 2004 and the five digit section number cited parenthetically is per CSI Masterformat™ 1995.

SECTION 48 14 00 (SECTION 13600) – SOLAR ENERGY ELECTRICAL POWER GENERATION EQUIPMENT

SPECIFIER NOTE:

resource management: Once energy efficiency is maximized for a project, providing the required energy via clean, renewable resources is more sustainable than using fossil fuels which are finite in supply and incur environmental impacts throughout their lifecycle. The Federal Energy Management Program (FEMP) provides information on technologies that have been proven in field testing or recommended by reliable sources.
The US Federal Government is one of the largest energy users; it purchases $10–20 billion in energy-related products annually. With ownership of more than 500,000 buildings, including 422,000 housing structures, the Federal Government has a tremendous interest in energy efficiency in buildings.
The Energy Policy Act of 1992 and Executive Order 13123 set goals for energy reduction and provide some guidelines for implementing conservation measures and renewable energy measures. Annual energy use in Federal buildings has dropped from 140,000 Btu/sq ft (1,600 MJ/m2) in 1985 to 116,000 Btu/ sq ft (1,300 MJ/m2) in 1997. To meet the Executive Order 13123 requirements, annual energy use must drop to 90,800 Btu/sq ft (1,000 MJ/m2) by 2010. EO13123 also directs agencies to significantly increase the use of renewable energy and to install 20,000 solar energy systems by 2010. Agencies have set a goal of 2.5 percent of Federal energy use from renewables by 2010 from green power purchases, on-site renewable energy projects, or other projects developed on Federal land.
Executive Order (E.O.) 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. http://www.ofee.gov/execorders.asp It expands upon the energy and environmental performance requirements of previous Executive Orders. In particular, it requires that all new Federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.
http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html
Refer to “Greening Federal Facilities: An Energy, Environmental, and Economic Resource Guide for Federal Facility Managers and Designers" http://www.eere.energy.gov/femp/pdfs/29267-0.pdf
Renewables are characterized by a high initial cost and low operating cost, and are often designed to minimize life cycle cost.

toxicity/IEQ: Some renewable energy technologies such as photovoltaics are available to generate power on-site with no toxics or emissions. Non-toxic alternatives should be specified for all system components where available, such as food-grade propylene glycol as the heat transfer fluid in solar water heating systems.
Electric renewables systems include battery storage if off-grid, and safeguards should be taken while installing and maintaining the electrolyte and batteries shall be properly recycled at the end of their useful life.
While there are well-known concerns regarding the toxic components of batteries, overall the systems that utilize renewable energy sources are generally considered to be less hazardous to human health and environmental health because they do not involve the combustion of a fossil fuel.

performance: This is a rapidly changing field. DOE – Energy Efficiency and Renewable Energy (EERE) and the National Renewable Energy Laboratory (NREL) offer resources for renewable energy, green power, and high performance buildings. Refer to http://www.nrel.gov/ and to http://www.eere.energy.gov
- Photovoltaic, or PV, cells are semiconductor devices that convert sunlight into electricity. They have no moving parts. While expensive, they are expected to have very long lifetimes (25 years) with little or no maintenance. PV products are often integrated into building materials such as standing seam metal roofing, window or overhead glazing, or shingles. While PV is often deployed on buildings connected to the utility, they have a higher value in remote locations where they displace more expensive and more polluting diesel generators. Energy storage in remote applications, if needed, is provided with batteries. The US EPA has developed a solar environmental benefits calculator which computes, based on the amount of electricity produced by a PV system and the geographic location of that system, the amount of nitrogen oxide (NOx), sulfur dioxide (SO2), and carbon dioxide (CO2) that is prevented from being emitted each year.
- Fuel cells generate electricity by converting chemical energy into electrical power with few moving parts. Fuel cells produce no noxious gases that produce acid rain, no particulate pollutants, no unburned hydrocarbons, and proportionately less carbon dioxide (CO2) than other, less efficient technologies. The U.S. Department of Energy has launched a major initiative, the "Solid State Energy Conversion Alliance", to bring about dramatic reductions in fuel cell costs. The goal is to cut costs to as low as $400/kW by 2010. It should be pointed out that fuel cells utilize hydrogen fuel, often derived by reforming natural gas, and thus are not renewable energy sources. However, due to their reduced emissions, they will be favored over heat engines as they become cost effective and reliable.
- Combined heat and power, or CHP, is the joint production of both heat (usually steam or hot water) and electricity from a single fuel source. Conventional U.S. power production converts roughly one-third of the Btu from the primary energy source (e.g. coal or natural gas) into electricity; most of the rest is lost as waste heat. Collecting and making productive use of that waste heat can result in total efficiencies over 70 percent. Combined heat and power is often referred to as cogeneration. Technologies for cogeneration include gas turbines, steam turbines, and reciprocating engines.

Other options for renewable energy include contracting for “green power” generated and supplied by a utility. Refer to Section 01 81 30 – Green Power Requirements.

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Solar Energy System(s).

1.2 SUBMITTALS

A. Product data. Unless otherwise indicated, submit the following for each type of product provided under work of this Section:

SPECIFIER NOTE:
Specifying local materials may help minimize transportation impacts; however it may not have a significant impact on reducing the overall embodied energy of a building material because of efficiencies of scale in some modes of transportation.
Green building rating systems frequently include credit for local materials. Transportation impacts include: fossil fuel consumption, air pollution, and labor.
USGBC-LEED™ v3 includes credits for materials extracted/harvested and manufactured within a 500 mile radius from the project site. Green Globes-US also provides points for materials that are locally manufactured.

1. Local/Regional Materials:
   a. Sourcing location(s): Indicate location of extraction, harvesting, and recovery; indicate distance between extraction, harvesting, and recovery and the project site.
   b. Manufacturing location(s): Indicate location of manufacturing facility; indicate distance between manufacturing facility and the project site.
   c. Product Value: Indicate dollar value of product containing local/regional materials; include materials cost only.
   d. Product Component(s) Value: Where product components are sourced or manufactured in separate locations, provide location information for each component. Indicate the percentage by weight of each component per unit of product.

SPECIFIER NOTE:
USGBC-LEED™ v3 includes credit for using on-site renewable energy for minimum 1 percent of the building's total annual energy. Credit is also offered for green power contracting. The contract must provide minimum 2-years of renewable energy for a minimum 35 percent of the building's total energy.
FEMP references green power as per the Center for Resource Solutions Green-e program.
USGBC-LEED™ v3 also cites the Center for Resource Solutions Green-e program. Refer to http://www.green-e.org/

2. Renewable Energy:
   a. Submit manufacturer's product data for system.
   b. Submit calculations indicating the energy produced by the system relative to the total energy demand for the building.
   c. Submit Letter of Certification from system provider indicating that energy produced by the system represents minimum **[1] [3] [5] [7] [9] [11] [13] [xxxx]** of the total energy demand for the building.

B. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.

1.3 QUALITY ASSURANCE

SPECIFIER NOTE:
Decisions as to appropriateness of system requirements and design are dependent upon project goals and location.
Different code-making organizations promulgate numerous requirements for photovoltaic panels. PowerMark Corporation administers a product certification process that is both nationally and internationally accepted and encompass specific standards promulgated by other organizations. There are certification programs covering PV modules, components, and packaged systems. PMC is the sole U.S. agent for the Global Approval Program for PV (PV-GAP) and the only U.S. PV testing and certification program meeting the requirements for international reciprocity. These standards are compatible with International Electrotechnical Committee (IEC) standards.
For solar water heating systems, the Solar Rating and Certification Corporation (SRCC) rates both collectors and entire systems.
The Institute of Electrical and Electronic Engineers, Inc promulgates standards for electrical and electronic equipment, most notably; P929 Recommended Practice for Utility Interface of Photovoltaic (PV) Systems (specifying frequency and voltage limits, power quality, and non-islanding inverter testing).
Underwriters Laboratory promulgates standards for Electrical Equipment Safety for manufacturers, most notably UL Standard 1703, Flat-plate Photovoltaic Modules and Panels and UL Standard 1741, Standard for Static Inverters and Charge Controllers for Use in Photovoltaic

Power Systems which incorporates the testing required by IEEE 929 and includes design (type) testing and production testing.
The National Electrical Code (NEC) includes requirements for all renewable energy installations for electrical trades and industry experts. Article 690 includes special information for Solar Photovoltaic Systems and requires UL listing for utility interface inverters. Other sections (Article 230, 240, 250 and 300 to 384) include requirements for wiring and overcurrent protection. A good resource is http://www.nmsu.edu/Research/tdi/public_html/Photovoltaics/Codes-Stds/Codes-Stds.html

A. Solar Energy Systems:

1. Photovoltaic Panels: Provide panels labeled with the PowerMark certification by PowerMark Corporation.

SPECIFIER NOTE:
The PowerMark certification may encompass specific standards promulgated by other organizations.
Nearly 100 standards regarding solar energy systems are promulgated by ASTM International. These include mechanical and electrical integrity of the module under impacts, pressure and thermal cycling.
Following are examples.

a. Weathering:
ASTM E1038-Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls
ASTM E1171- Standard Test Method for Photovoltaic Modules in Cyclic Temperature and Humidity Environments
ASTM E1597- Standard Test Method for Saltwater Pressure Immersion and Temperature Testing of Photovoltaic Modules for Marine Environments
ASTM E1802-Standard Test Methods for Wet Insulation Integrity Testing of Photovoltaic Modules
ASTM E2047- Standard Test Method for Wet Insulation Integrity Testing of Photovoltaic Arrays
ASTM E1830- Standard Test Methods for Determining Mechanical Integrity of Photovoltaic Modules
ASTM E781- Standard Practice for Evaluating Absorptive Solar Receiver Materials When Exposed to Conditions Simulating Stagnation in Solar Collectors With Cover Plates
ASTM E782- Standard Practice for Exposure of Cover Materials for Solar Collectors to Natural Weathering Under Conditions Simulating Operational Mode
ASTM E823- Standard Practice for Nonoperational Exposure and Inspection of a Solar Collector
ASTM E881- Standard Practice for Exposure of Solar Collector Cover Materials to Natural Weathering Under Conditions Simulating Stagnation Mode

b. Calibration:
ASTM E1362- Standard Test Method for Calibration of Non-Concentrator Photovoltaic Secondary Reference Cells

c. Energy Performance:
ASTM E948- Standard Test Method for Electrical Performance of Photovoltaic Cells Using Reference Cells Under Simulated Sunlight
ASTM E1021- Standard Test Methods for Measuring Spectral Response of Photovoltaic Cells

ASTM E1040- Standard Specification for Physical Characteristics of Nonconcentrator Terrestrial Photovoltaic Reference Cells
ASTM E1462- Standard Test Methods for Insulation Integrity and Ground Path Continuity of Photovoltaic Modules

2. Solar Water Heating collectors: Submit OG 100 rating by Solar Rating and Certification Corporation for collector performance characteristics, and for rated systems submit OG 300 rating.

PART 2 PRODUCTS

SPECIFIER NOTE:
EO 13423 includes requirements for Federal Agencies to "… improve energy efficiency and reduce greenhouse gas emissions … by (i) 3 percent annually through the end of fiscal year 2015, or (ii) 30 percent by the end of fiscal year 2015, relative to the baseline of … year 2003" and to "…ensure that (i) at least half of the statutorily required renewable energy consumed … comes from new renewable sources [sources of renewable energy placed into service after January 1, 1999] and (ii) … the agency implements renewable energy generation … for agency use"
Under EO 13423, renewable energy means "energy produced by solar, wind, biomass, landfill gas, ocean (including tidal, wave, current and thermal), geothermal, municipal solid waste, or new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project"
Executive Order 13514; *Federal Leadership in Environmental, Energy, and Economic Performance*; was signed on October 5, 2009. http://www.ofee.gov/execorders.asp It expands upon the energy and environmental performance requirements of previous Executive Orders. In particular, it requires that all new Federal buildings, entering the design phase in 2020 or later, are designed to achieve zero net energy by 2030.
http://www1.eere.energy.gov/femp/regulations/printable_versions/eo13423.html

2.1 EQUIPMENT

SPECIFIER NOTE:
Decisions as to appropriateness of system requirements and design are dependent upon project goals and location. Coordinate with Divisions 22, 23, and 26 (15 and 16).

PART 3 - EXECUTION

3.X SITE ENVIRONMENTAL PROCEDURES

A. Resource Management:
1. Energy Efficiency: Verify equipment is properly installed, connected, and adjusted. Verify that equipment is operating as specified.
2. Renewable Energy: Verify proper operation in all modes of system operation by testing. Verify proper operation under a wide range of conditions to verify energy delivery as calculated for those conditions.
a. Solar Energy Systems: Comply with ASTM E1799- Standard Practice for Visual Inspections of Photovoltaic Modules.

END OF SECTION